ADOPTED

CITY OF PENDLETON

Stormwater Master Plan

MSA Murray, Smith & Associates, Inc.
Engineers | Planners

MAY 2015

ORDINANCE NO. 3864

AN ORDINANCE ADOPTING A STORMWATER SYSTEM MASTER PLAN AS A COMPONENT OF THE COMPREHENSIVE PLAN

WHEREAS; the City owns and operates a public stormwater drainage system; and

WHEREAS; pursuant to Oregon Statewide Goal 11 (Public Facilities), the City of Pendleton is required to adopt and/or update public facilities master plans for the 20 year planning horizon; and

WHEREAS; in the last 20 years, the City's Urban Growth Boundary (UGB) has been expanded; and

WHEREAS; expansion of the UGB necessitates planning for areas not previously planned for; and

WHEREAS; the proposed Stormwater System Master Plan (SWMP) addresses the additional demand of and capacity necessary to serve the entire UGB; and

WHEREAS; the SWMP assumes growth according to the projections contained in the Comprehensive Plan both for the 20 year horizon and for full build out of the UGB; and

WHEREAS; the SWMP includes the following major components, consistent with Goal 11 requirements and specific needs identified by City staff:

- Study area characteristics
- Description of the City's existing drainage system
- Regulations and Policies
- System Analysis
- Operations and Maintenance
- Capital Improvement Program
- Financial Plan

WHEREAS; the SWMP provides the City with a solid inventory and factual basis upon which to make informed decisions about future rates and expenditures; and

WHEREAS; the request is consistent with the City's responsibilities under Goal 11 (Public Facilities and Services); and

WHEREAS; the proposal is consistent with the standards and criteria for an amendment to the Comprehensive Plan because it adopts a formal Public Facilities component of the Comprehensive Plan in a manner consistent with Statute and Rule.

WHEREAS; notice was provided to the general public as set forth in Oregon Revised Statutes and the City of Pendleton Unified Development Code, and;

WHEREAS; the City of Pendleton Planning Commission held a hearing on May 7, 2015, and recommended adoption of the proposed master plan based on the findings and conclusions contained in the staff report; and

WHEREAS; a public hearing was held before the City of Pendleton City Council on June 2, 2015, and all written and oral testimony concerning the matter was received and addressed at the hearing;

NOW, THEREFORE, THE CITY OF PENDLETON ORDAINS AS FOLLOWS:

The City of Pendleton Comprehensive Plan is amended to include the attached Collection System Master Plan (Exhibit A) as part of a Goal 11 (Public facilities) Element.

This ordinance is effective 30 days after passage.

PASSED by the City Council and approved by the Mayor June 2, 2015.

Approved as to form

Nancy Kerns, City Attorney

APPROVED

Phillip W. Houk, Mayor

ATTEST

Andrea Denton, City Recorder

STORMWATER MASTER PLAN

FOR

THE CITY OF PENDLETON
MAY 2015

MURRAY, SMITH & ASSOCIATES, INC.
345 Bobwhite Court, Suite 230
Boise, ID 83706
208.947.9033

ACKNOWLEDGMENTS

Appreciation is expressed to all who contributed to the completion of this report.

The City of Pendleton
Jeff Brown
Wayne Green
Bob Patterson, P.E.
Tim Simons, P.E.

Murray, Smith & Associates, Inc.
Dené Breakfield
Michael Carr, P.E.
Mark Cummings, P.E.
Joe Foote, P.E.
LaDonne Harris
Nicholas McMurtrey, P.E.
David Stangel, P.E.

Galardi Rothstein Group
Deborah Galardi

Geo-spatial Solutions
Alex Friant
Rusty Merritt

COMMON ENGINEERING ACRONYMS & ABBREVIATIONS

A

AACE	AACE International
ABF	activated biological filter
AC	asbestos cement
ADA	Americans with Disabilities Act
ADD	average daily demand
AF	acre-feet
AIA	Airport Industrial Area
AMCL	alternative maximum concentration level
AMI	automated metering infrastructure
AMR	automated meter reading
AMZ	asset management zone
AOR	actual oxygen required
APWA	American Public Works Association
ASR	aquifer storage and recovery
AWWA	American Water Works Association

B

BFP	belt filter press
BLI	buildable lands inventory
BOD	biochemical oxygen demand
BWF	base wastewater flow

C

C&R	construction and replacement
CAA	Clean Air Act
CAD	computer aided drafting
CAS	cast iron
ccf	100 cubic feet
CCI	Construction Cost Index
CCR	Consumer Confidence Report
CCTV	closed-circuit television
cf	cubic feet
cfs	cubic feet per second
CHL	clarifier hydraulic loading
CIA	current impact area
CIP	capital improvement program
CMOM	capacity, management, operation and maintenance
CN	curve number
COD	chemical oxygen demand
COMPASS	Community Planning Association of Southwest Idaho
COSM	Central Oregon Stormwater Manual
CP	concrete pipe

CPI-U	Consumer Price Index, Urban Consumers
CSL	clarifier solids loading
CSMP	Collection System Master Plan
CTUIR	Confederated Tribes of the Umatilla Indian Reservation
CWA	Clean Water Act

D

DBP	disinfection byproducts
d/D	depth to diameter ratio
D/DBP	disinfectants and disinfection byproducts
DEQ	Department of Environmental Quality
DIP	ductile iron pipe
DOD	depth of flow over diameter of pipe
DOE	Department of Ecology
DWF	dry weather flow

E

ENR	Engineering News Record
EOCI	Eastern Oregon Correctional Institution
EPA	U.S. Environmental Protection Agency
ERP	Emergency Response Plan
EUAC	Equivalent Uniform Annual Cost

F

FEMA	Federal Emergency Management Agency
FM	flow monitors
FMB	flow meter basin
FOG	fats, oils, grease
fps	feet per second
ft	foot, feet
FTE	full-time equivalent
FV	future value
FY	fiscal year

G

GAC	granular activated carbon
GBT	gravity belt thickener
GIS	geographical information system
gpapd	gallons per acre per day
gpcpd	gallons per capita per day
gpd	gallons per day
gpm	gallons per minute
GPS	Global Positioning System
gpupd	gallons per unit per day
GWI	groundwater infiltration

H

HDPE	high-density polyethylene
HGL	hydraulic grade line
hp	horsepower
hr	hour
HRT	hydraulic retention time
HVAC	heating, ventilating and air conditioning

I

ID	inside diameter
IEEE	Institute of Electrical and Electronics Engineers
I/I	inflow/infiltration
in	inch, inches
IOC	inorganic compound

K

kVA	kilovolt-ampere
kW	kilowatt

L

L	liter
lb	pound
LCR	Lead and Copper Rule
lf	linear feet
LRAA	locational running annual averages
LS	lift station

M

M	million
ma	milliamp
MCL	maximum concentration level
MCLG	maximum concentration level goal
M/DBP	microbial and disinfection byproducts
MDD	maximum day demand
mg	milligram
MG	million gallons
mgd	million gallons per day
mgh	million gallons per hour
mg/L	milligrams per liter
MH	manhole
mL	milliliter
MLSS	mixed liquor suspended solids
MLVSS	mixed liquor volatile suspended solids
mm	millimeter
MRDL	maximum residual disinfectant levels
mrem	millirems

MSA	Murray, Smith & Associates, Inc.
MSL	mean sea level
N	
NPDES	National Pollutant Discharge Elimination System
NPV	net present value
O	
O&M	operations and maintenance
OAR	Oregon Administrative Rules
ODOT	Oregon Department of Transportation
P	
%	percent (use with numerals – e.g., 13%)
PAL	provisionally accredited levee
pCi/L	picoCuries per liter
PDF	peak design flow
PDWF	peak dry weather flow
PER	Preliminary Engineering Report
PFP	Public Facility Plan
pH	measure of acidity of alkalinity
PHD	peak hour demand
ppb	parts per billion
ppm	parts per million
PRS	pressure-reducing stations
PRV	pressure reducing valve
psi	pounds per square inch
PSV	pressure-sustaining valve
PUD	public utility district
PV	present value
PVC	polyvinyl chloride
PWMP	Public Works Management Practices Manual
PWWF	peak wet weather flow
Q	
QA	quality assurance
QC	quality control
R	
RDII	rainfall dependent infiltration/inflow
ROW	right-of-way
RRF	resource recovery facility
RSSD	Rieth Sanitary Sewer District
S	
SBOD	soluble biochemical oxygen demand
SCADA	supervisory control and data acquisition
SDC	system development charge

SDR	standard dimension ratio
sec	second (measurement of time)
SOC	synthetic organic compound
SOW	scope of work
SRT	solids retention time
SSOAP	Sanitary Sewer Overflow Analysis and Planning
SVI	sludge volume index
SWMP	Stormwater Master Plan

T

TAZ	traffic analysis zones
Tc	time of concentration
TCR	Total Coliform Rule
TDH	total dynamic head
TMDL	total maximum daily load
TP	transite pipe
T/S	transit/storage
TSS	total suspended solids
Tt	travel time
TTHM	total trihalomethanes

U

UGA	urban growth area
UGB	urban growth boundary
UIC	underground injection control
USACE	United States Army Corps of Engineers
USBR	United States Bureau of Reclamation
USDA	United States Department of Agriculture
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey

V

VFD	variable-frequency drive
VCP	vitrified clay pipe
VFD	variable frequency drive
VOC	volatile organic compound
VSS	volatile suspended solids

W

WAS	waste-activated sludge
WFP	water filtration plant
WMCP	Water Management and Conservation Plan
WRF	water reclamation facility
WSMP	Water System Master Plan
WWTP	wastewater treatment plant

TABLE OF CONTENTS

4. REGULATIONS AND POLICIES

5. SYSTEM ANALYSIS

6. OPERATIONS AND MAINTENANCE

7. CAPITAL IMPROVEMENT PROGRAM

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

SECTION 1
EXECUTIVE SUMMARY

Introduction

The City of Pendleton (City) owns and operates a municipal stormwater drainage system serving the residents and businesses within its service area. This Stormwater Master Plan (SWMP) serves as a planning document to help guide sound stewardship of this system by addressing the City's need to maintain existing infrastructure and improve identified conveyance capacity deficiencies to facilitate growth. Future development anticipated to build-out of the City's urban growth boundary (UGB) will approximately double the number of current residents and increase anticipated stormwater flows. The UGB covers an area of 13.4 square miles and defines the extent to which the City may expand in the future; it was used as the boundary for build-out projections within this SWMP.

How This Plan Should Be Used

This SWMP serves as the guiding document for future stormwater drainage system improvements, infrastructure investments and maintenance activities and should:

- Be reviewed annually in accordance with other utilities to prioritize and budget needed improvements.
- Have its mapping updated regularly to reflect new system data, ongoing development and construction.
- Have its specific system improvement recommendations regarded as conceptual. (The location, size and timing of projects may change as additional site-specific details and potential alternatives are investigated and analyzed in the preliminary engineering phase of project design).
- Update and refine its cost estimates with preliminary engineering and final project designs.

Scope of Work

The City selected Murray, Smith & Associates, Inc. (MSA) to create master plans for the potable water, stormwater, and sewer collection systems. The scope of work (SOW) for this SWMP includes the following major tasks and deliverables:

- Describe the City's existing stormwater drainage system.
- Review regulations and policies relevant to the City's stormwater drainage system for both present and future conditions.
- Develop and calibrate a hydraulic model.
- Develop flow projections consistent with the 2011 Comprehensive Plan Update.

- Develop planning and design criteria, including the selection of a City-specific storm event to define the minimum level of system performance.
- Evaluate the stormwater drainage system's hydraulic capacity to identify deficiencies for existing and future planning horizons.
- Conduct and summarize benchmarking data comparing the City's operations and maintenance (O&M) practices to similar municipalities.
- Review the City's current O&M program and present recommendations.
- Develop an ongoing repair and replacement program for system piping, catch basins and manholes.
- Develop capital improvement program (CIP) recommendations and cost opinions for projects identified by the plan.
- Develop a stormwater drainage system financial plan that identifies a funding strategy for the CIP, aging infrastructure repair and replacement (R&R), and staffing.

Organization of the SWMP

This SWMP is organized into seven sections, as described in Table 1-1. Detailed technical information and support documents are included in the appendices.

Table 1-1
SWMP Organization

Section	Description
1 – Executive Summary	Purpose and scope of the SWMP and summary of key components of each part of the plan.
2 – Study Area Characteristics	Description of the service area.
3 – Existing System Description	Description of the existing stormwater drainage system, both in terms of its general management and physical infrastructure.
4 – Regulations and Policies	Summary of the current and potential future regulations applicable to the stormwater drainage system.
5 – System Analysis	Summary of calibration methodology and results, overview of the evaluation criteria and approach, discussion of the hydraulic deficiencies for existing and future planning horizons.
6 – Operations and Maintenance	Describes current operations and maintenance procedures, summary of benchmarking results comparing the City to similar municipalities, summary of recommendations.
7 – Capital Improvement Program	Improvement recommendations including cost opinions and timeframe for implementation.
8 – Financial Plan	Strategy for funding collection system improvements.

Study Area Characteristics

An understanding of land use and demographic characteristics within the study area is important in stormwater planning because of the impact these characteristics have on the transformation of rainfall to runoff. Land use characteristics in particular are critical in estimating existing and future stormwater flows in an urban setting. The way land is used impacts the percentage of impervious area within a basin, and as a result influences the behavior of stormwater runoff. All land within the City has been assigned a land use designation consistent with the amended Comprehensive Plan, which includes various categories of commercial, industrial, institutional, and residential land uses. As part of this SWMP, the City's service area was separated into nine tributary basins shown in Figure 1-1.

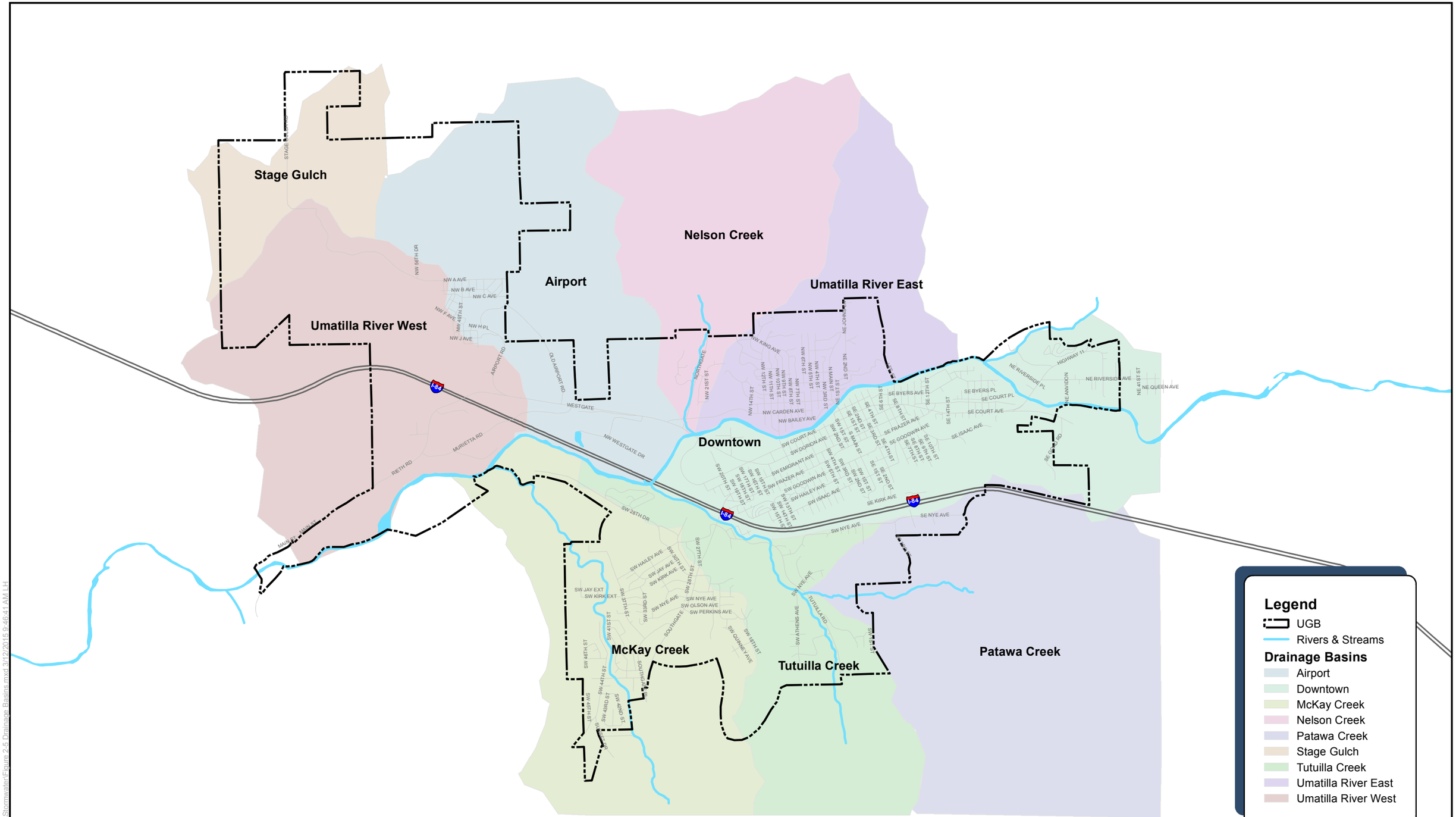
The City is located centrally within Umatilla County, Oregon and lies at the bottom of a large chasm carved by the Umatilla River through the rolling terrain of eastern Oregon's upper plateau areas. Ground elevations range from approximately 950 feet to approximately 1,570 feet above MSL. The lower elevations are located along the Umatilla River, which flows east to west. Pendleton is nestled in the western base of the Blue Mountains. The highest mountain peaks within the range, such as the Elkhorn, Ireland, and Strawberry, exceed 9,000 feet. These mountains directly influence the weather patterns and precipitation experienced at their base.

Detailed information on the soils found throughout the study area is summarized in the U.S. Soil Conservation Service's Soil Survey of Umatilla County Oregon (OR 667, 2013). The soil types identified in this survey are organized into hydrologic groups, and are used to predict area-wide hydrologic responses to rainfall. These groups are particularly important when assigning pervious area runoff curve numbers during stormwater modeling.

There are generally no instances of well-drained soils within the UGB. Moderately drained soils can be found within the study area where the topography flattens out into gently sloping terrain. The steeper sloping regions within the UGB are typical of poorly drained soils, with very poorly drained soils located around the City's surface waters.

Existing System Description

The Public Works Director manages the City-owned stormwater drainage system and supervises the Public Works Superintendent, who oversees the system's operation. The City's existing stormwater drainage system consists of 46 miles of gravity drainage piping, 646 manhole structures, 3.5 miles of open channels, and 15 flow control facilities. There are 73 outfalls within the City's system, which drain into the Umatilla River, McKay Creek, Tutuilla Creek, Nelson Creek and other ditches and drainages. Of these 73 outfalls, 38 discharge directly into local waterways, with the remainder discharging to ditches, drainages or other manmade drainage structure. The City's levee system along the Umatilla River comprises approximately 3.5 miles of embankment. Figure 1-2 depicts an overview map of the conveyance system.



MSA Murray, Smith & Associates, Inc.

CITY OF PENDLETON INCORPORATED 1880 OREGON

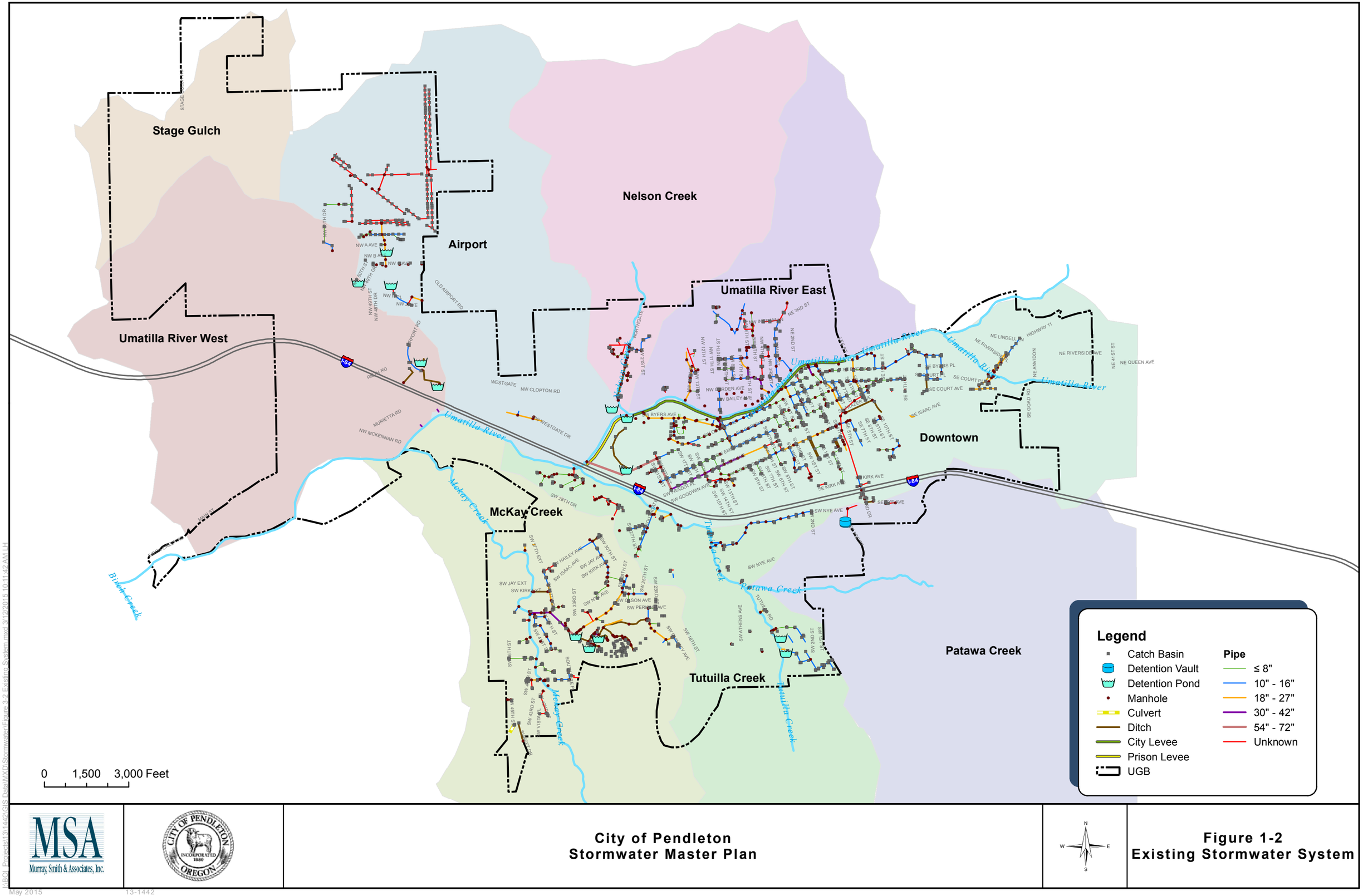
City of Pendleton
Stormwater Master Plan

N W E S

Figure 1-1
Drainage Basins

May 2015 13-1442

I:\BOI_Projects\13\1442\GIS Data\MXD\Stormwater\Figure 2-5 Drainage Basins.mxd 3/12/2015 9:46:41 AM LH



MSA Murray, Smith & Associates, Inc.

CITY OF PENDLETON INCORPORATED 1880 OREGON

City of Pendleton
Stormwater Master Plan

Figure 1-2
Existing Stormwater System

I:\BOI_Projects\13\1442\GIS Data\MXD\Stormwater\Figure 3-2 Existing System.mxd 3/12/2015 10:11:42 AM LH

May 2015 13-1442

Prior to the planning process, MSA and the City undertook an effort to create a Geographic Information System (GIS) of the water, sewer, and stormwater drainage systems. The City recently hired a GIS Coordinator who is working to improve the quality of the information in addition to collecting new data points and attributes. It is recommended that the City continue to improve the system's GIS through the continued inventory and system updates. This updated GIS would further serve to improve the accuracy of the hydraulic model, to confirm identified deficiencies and recommended improvements.

Regulations and Policies

The City is ultimately responsible for management and operation of infrastructure provided under its jurisdiction in accordance with all known federal, state, and local regulations. The Clean Water Act (CWA) is the principal federal law in the United States governing surface water pollution. The law was passed by Congress in 1972 with the goal of protecting and restoring the nation's surface waters to fishable and swimmable conditions. The CWA was amended in 1987 to include non-point stormwater discharges generated from large communities, industries, and construction sites. These discharges are managed through the National Pollutant Discharge Elimination System (NPDES) Permit Program; the national Environmental Protection Agency (EPA) has delegated primary enforcement of these permits to the state Department of Environmental Quality (DEQ).

Because of its population size, the City has not been required by DEQ to obtain an NPDES Permit for its stormwater discharges. Due to several economic and political factors, the City's potential for incorporation into the NPDES Permit program is unlikely in the immediate future. Although no indication or timetable currently exists for expanding the NPDES program to include Pendleton, federal regulations provide the EPA and DEQ the discretion to require the City to apply for a permit.

Because the requirement for an NPDES Permit may materialize in the future, the formation of a stormwater utility within the City's Public Works Department would be highly desirable. The City would be responsible for enforcement of the conditions of the permit, including routine operation and maintenance of the stormwater drainage system. Creation of stormwater standards applicable to development within the City is also anticipated to be required by a future permit.

Presently, the City lacks a formal stormwater management manual of development standards. These types of documents help formulate cohesive policy and guide orderly development within the jurisdiction through a transparent set of drainage criteria, rules, and guidelines. They also allow for the transfer of knowledge on the administrative side of system operations as staffing changes occur. It is recommended that the City adopt the Central Oregon Stormwater Manual (COSM), either outright or with modifying addenda unique to the City. Another more costly option could be to generate a similar manual specific to the City's needs. Either of these actions would serve to position the City favorably, should NPDES Permit be required in the future, necessitating development of stormwater standards.

The City is currently in the process of obtaining a Provisionally Accredited Levee (PAL) certification of the City Levee and Prison Levee with the Federal Emergency Management Agency (FEMA) under the requirements of the National Flood Insurance Program (NFIP) and 44 CRF 65.10. A general summary of the approach towards achieving this certification is provided in Table 1-2.

Table 1-2
PAL Certification Summary

Phase	Completed	Next Steps	Description
I	X		Review historical documentation and assess data gaps to complete levee certification application. Develop a SOW, schedule and budget for Phase II.
II		X	Conduct field reconnaissance and technical evaluation of levees.
III		X	Apply to FEMA for levee certification.

The formation of a stormwater utility by the City would be a desirable step towards maintaining the levee system in conformance with NFIP and FEMA requirements. Ongoing operation and maintenance activities to keep the levees functional would be funded through the utility fees established and collected by the utility.

System Analysis

The stormwater drainage system analysis includes a hydraulic model calibration process followed by evaluations of gravity pipe and open channel conveyance capacity. Stormwater basins were delineated as part of this SWMP and were used to assist in describing deficiency locations.

The City's entire stormwater drainage system was analyzed during this master planning process; however, due to the lack of system information in most locations, the hydraulic modeling of the system was conducted using two separate methods. Where survey and general system information was more readily available and flooding had been reported during past rain events, a dynamic simulation was performed using InfoSWMM. These areas were primarily confined to the downtown commercial area, but selected areas near the airport and Southgate districts were analyzed in InfoSWMM using supplemental data at the request of the City. The InfoSWMM model provides dynamic system results, including backwater effects and surcharging. For the rest of the system, a simplified non-dynamic HEC-HMS calculation method was used for system analysis.

Model calibration was based on comparing model results to firsthand accounts of the system during August 2013 and June 2014 rain events. Following model calibration and verification,

a design storm was used to evaluate the stormwater drainage system and identify system deficiencies.

A 25-year recurrence period was selected for the design storm to evaluate the system for deficiencies. A rainfall frequency analysis was completed to validate the *NOAA Atlas 14 Type 2* precipitation maps for the Pendleton area. In addition to comparing the general frequency analysis to the *Atlas* rainfall depth, historical summer and winter rainfall events were reviewed to examine the seasonal variation in storm events in the City. Each component of the modeled stormwater drainage system was assessed based on the ability to convey the peak flow generated by a 1.35-inch, Type 2 (Pendleton Storm) rain event. This storm event was determined by compiling and ranking maximum annual rainfall events for each year on record by total rainfall depth. These data points were fitted to a probability distribution function for each data set. The probability distribution function was then used to estimate the rainfall depth for storm events with a 25-year recurrence interval.

These general conclusions were developed through the system analysis and subsequent validation with City staff:

- A large portion of the existing stormwater drainage system is deficient when the 25-year storm is applied to the system, most notably in the downtown commercial area.
- System deficiencies were primarily due to undersized conveyance pipes, not undersized outfalls.
- Existing deficiencies are not appreciably exacerbated by future conditions attributed to new development.
- No deficiencies were observed in the Southgate area.
- A number of potential deficiencies were observed outside of the dynamic simulation area. These deficiencies should be investigated further and verified before any additional action is planned.
- The stormwater drainage system was calibrated using a historic rainfall event and firsthand descriptions of the system during the event. The model was adjusted to produce results consistent with first-hand reports. Further calibration can be conducted in the future with the collection of additional system data.
- Being the first stormwater master planning effort within the City, it is recommended that the City continue to improve the inventory information available for the system through the continued development of stormwater GIS.
- The system should be re-analyzed as additional inventory information, including survey data becomes available.

Operations and Maintenance

The assessment of the City's stormwater drainage system O&M program included review of information from City staff and comparison to the O&M practices of similarly sized utility

and regulatory requirements. Staff from the City's Street Division are responsible for the operations and maintenance of the stormwater collection system. The Street Division is currently structured to have 0.5 full-time equivalent employees (FTEs) for operating and maintaining the stormwater collection system.

The current scheduled maintenance activities include the following:

- Regular street sweeping on a six-week rotation.
- Catch basin cleaning in early spring.
- Manhole and pipe cleaning as needed.
- Semiannual outfall obstruction removal and cleaning.
- Flow Control Facility vegetation control as needed.
- Levee vegetation removal and management.

Historically, the City's stormwater maintenance program has focused on addressing drainage capacity and flooding problems. This approach can generally be characterized as a "reactive" maintenance program.

For a benchmark comparison, one other storm utility in the region (Redmond) was surveyed in order to compare their current O&M practices to the City's. Unlike the City, which enacts no service fees, Redmond assesses a monthly stormwater utility service charge, which is used to fund water quality improvement projects. Also, Redmond has three O&M FTEs dedicated to the stormwater drainage system, while the City has none.

The City's current levee maintenance practices of outfall cleaning and vegetation management will need to continue if it is to comply with the levee certification requirements of FEMA and the NFIP. Additional levee O&M activities must be implemented to meet levee maintenance requirements. These additional activities drive the need for the City to create a new stormwater utility, as the staffing and equipment necessary to operate the levee system within federal requirements will necessitate a recurring financial commitment from the City. These funds can be derived from stormwater utility fees.

The following conclusions and recommendations are based on a review of the City's O&M practices and benchmarking of the other stormwater drainage system:

- Transfer one FTE for street sweeping activities from Streets Division to Storm Utility.
- Add two FTEs as dedicated staff for the operations and maintenance of the stormwater collection system. This is in addition to transferring the street sweeper FTE positon from the Streets Division.
- Hire 0.5 additional FTEs, which will be part of a second crew of four full time staff with dedicated equipment to perform the ongoing pipe replacement program on a 150-year cycle. The other 3.5 FTEs on the crew would be shared and funded with the

Water and Sewer Utilities. This also includes transferring the funding of 0.5 FTEs from the existing dedicated pipe crew from the Sewer Utility to Storm Utility.

- Acquire a dedicated Combo Truck for the stormwater drainage system to improve structure cleaning deficiencies.
- Consider developing an annual inspection program.
- Consider developing an Annual Storm Drainage Main Replacement Program.
- Continue to improve the stormwater drainage system inventory through continued development of the City's public works GIS.
- The City should consider maintenance agreements that are defined for individual land owners or for legal entities in charge of developments to provide for the perpetual maintenance of all elements of the stormwater drainage system located outside of the public right-of-way.
- Begin implementing a stormwater drainage system O&M program that would meet NDPES Permit requirements and is based on incorporation of the American Public Works Association's *Public Works Management Practices Manual* – 8th Edition best management practices.

Capital Improvement Program

The CIP describes projects identified to address existing and future capacity deficiencies and to plan for ongoing stormwater drainage system repair and replacement of aging infrastructure. Implementation timeframes for these projects include immediate to 5-year, 10-year, and 20-year planning horizons. Projects needed to facilitate private development in key areas within the City have also been estimated, and are noted as "developer-paid". These are private projects, and the cost would be borne by the developer rather than the City. Regular SWMP updates are also recommended and budgeted for approximately every five years. The total expected cost by timeframe, per category and infrastructure type, is shown in Tables 1-3 through 1-6. All CIP projects are presented in Figures 1-3 and 1-4.

In general, it is recommended that the City focus short-term financial resources towards data collection and maintenance of the existing storm drainage infrastructure. Once those needs have been met, additional resources may be directed towards revising the stormwater model which will produce a robust identification of system deficiencies that can be prioritized accordingly. Other short-term resources may be directed towards the existing gravity system within the downtown commercial area. This section of the City's storm drainage system is inadequately sized to serve existing flows, and represents the highest priority area to receive stormwater improvements over the study period.

This CIP includes $45,586,000 in improvements over the study period, including capacity projects, levee system operations and maintenance, 150 years of an annual pipeline replacement program, and developer-paid projects.

The City does not currently collect System Development Charges (SDCs) to fund stormwater capital improvements associated with future development, or growth, as allowed under Oregon Revised Statute 223.297 through 223.314. A column has been included in Tables 1-3 through 1-6 to aid the City in establishing SDCs for the stormwater conveyance system. Because SDCs may only be collected based on the infrastructure needed for future growth, the percentage listed for each project correlate the SDC charge associated with providing service towards new development. For improvements that benefit both current and new customers, a fraction of the project cost is allocated to SDCs proportional to the benefits. A summary of all recommended projects is in Table 1-7.

Table 1-3
Recommended Immediate to 5-Year Projects

Project ID	Project Name	Project Description	Project Cost	Percentage Attributed to Growth
SD-01	Combo Truck	New Combo Truck	$50,000	0%
SD-02	Provisional City and Prison Levee Certification	PAL application to FEMA by consultant team, to include field testing, surveying and engineering	$527,000[1]	0%
SD-03	City and Prison Levee O&M	Inspection of levees, including maintenance repairs and report documentation[2]	$665,000	0%
SD-04	Local Improvement Fund	Maintenance of the existing system by City staff	$200,000[3]	0%
SD-05	Annual Storm Drainage Main Replacement Program	Average approximately 400 feet of pipe replacement each year	$270,000[3]	0%
SD-06	GIS Data Field Work	Field survey work of existing conveyances and updating the GIS	$50,000	0%
SD-07	Deficiency Upgrades	10,165 feet of piping upgrades, ranging from 8-inch to 36-inch	$5,761,000	10%
Total 5-Year Project Costs			**$7,523,000**	

[1] *Costs identified by MSA subconsultant Phase I levee review.*
[2] *Levee inspection requirements vary depending on structure from annual to bi-annual. Flows in the Umatilla River exceeding 10,000 cubic feet per second trigger additional inspection requirements.*
[3] *Costs provided by City of Pendleton.*

Table 1-4
Recommended 10-Year Projects

Project ID	Project Name	Project Description	Project Cost	Percentage Attributed to Growth
SD-08	Stormwater Master Plan Update	Periodic review provisions of OAR Chapter 660, Section 25	$150,000	5%
SD-09	City and Prison Levee O&M	Inspection of levees, including maintenance repairs and report documentation[1]	$560,000	0%
SD-10	Local Improvement Fund	Maintenance of the existing system by City staff	$200,000[2]	0%
SD-11	Annual Storm Drainage Main Replacement Program	Average approx. 400 feet of pipe replacement each year	$270,000[2]	0%
SD-12	GIS Data Field Work	Field survey work of existing conveyances and updating the GIS	$50,000	0%
SD-13	Deficiency Upgrades	14,950 feet of pipe upgrades, ranging from 10-inch to 36-inch	$9,075,000	5%
Total 10-Year Project Costs			**$10,305,000**	

[1] *Levee inspection requirements vary depending on structure from annual to bi-annual. Flows in the Umatilla River exceeding 10,000 cubic feet per second trigger additional inspection requirements.*
[2] *Costs provided by City of Pendleton.*

Table 1-5
Recommended 20-Year Projects

Project ID	Project Name	Project Description	Project Cost	Percentage Attributed to Growth
SD-14	City and Prison Levee O&M	Inspection of levees, including maintenance repairs and report documentation[1]	$1,120,000	0%
SD-15	Local Improvement Fund	Maintenance of the existing system by City staff	$400,000	0%
SD-16	Annual Storm Drainage Main Replacement Program	Average approx. 400 feet of pipe replacement each year	$540,000[2]	0%
SD-17	Stormwater Master Plan Update	Periodic review provisions of OAR Chapter 660, Section 25	$300,000	5%
SD-18	Deficiency Upgrades	18,500 feet of pipe upgrades, ranging from 8-inch to 54-inch	$12,250,000	10%
SD-19	Eastern Oregon Regional Airport Expansion	450 feet of 24-inch diameter gravity piping and 13,000 feet of open channel conveyance	$3,530,000	100%
SD-20	Combo Truck	Purchase of new Combo Truck	$420,000	0%
Total 20-Year Project Costs			**$18,560,000**	

[1] *Levee inspection requirements vary depending on structure from annual to bi-annual. Flows in the Umatilla River exceeding 10,000 cubic feet per second trigger additional inspection requirements.*
[2] *Costs provided by City of Pendleton.*

Table 1-6
Recommended Developer-Paid Projects

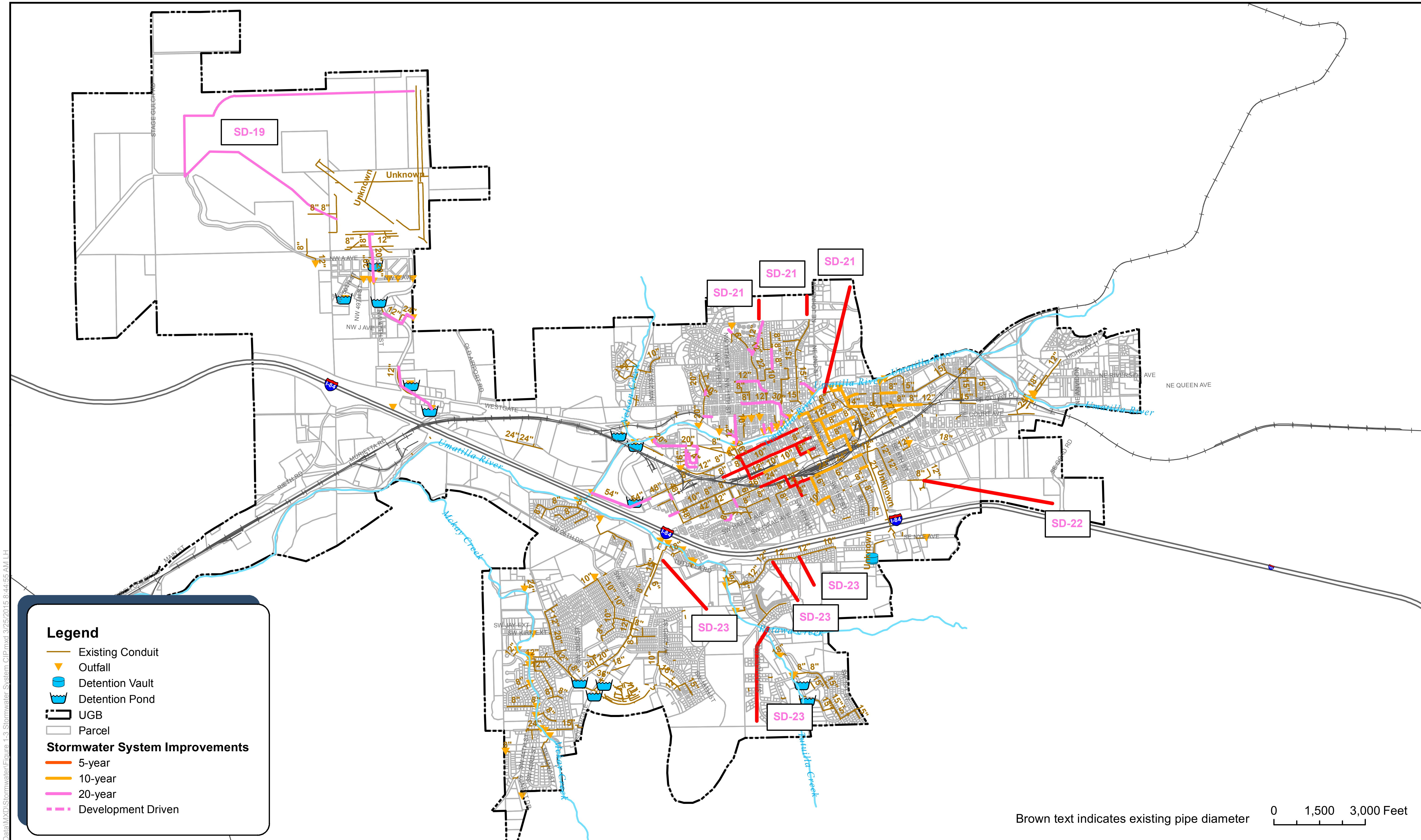
Project ID	Project Name	Project Description	Project Cost	Percentage Attributed to Growth
SD-21	North Hill Development	3,500 ft of 24-inch and 2,000 ft of 36-inch gravity piping	$2,500,000	100%
SD-22	Pendleton East End and Goad Property Development	4,500 ft of 36-inch gravity piping	$2,657,000	100%
SD-23	Southgate Development	2,400 ft of 18-inch and 5,500 ft of 36-inch gravity piping and one new outfall to Patawa Creek	$4,041,000	100%
Total Developer-Paid Project Costs			**$9,198,000**	

General note: Project timelines vary.

Table 1-7
CIP Summary

Project Name	CIP Schedule and Project Cost Summary				
	0-5 Years (Immediate)	6-10 Years	11-20 Years	Developer Paid	Total
Data Collection	$50,000	$50,000			$100,000
Combo Truck	$50,000		$420,000		$470,000
Levee Certification	$527,000[1]				$527,000
Levee O&M	$665,000	$560,000	$1,120,000		$2,345,000
System Maintenance	$200,000[2]	$200,000[2]	$400,000[2]		$800,000
Annual Replacement Program	$270,000[2,3]	$270,000[2,3]	$540,000[2,3]		$1,080,000
Deficiency Upgrades	$5,761,000	$9,075,000	$12,250,000		$27,086,000
Stormwater Master Plan Update		$150,000	$300,000		$450,000
Airport Expansion			$3,530,000		$3,530,000
North Hill Development				$2,500,000	$2,500,000
Pendleton East End and Goad Property Development				$2,657,000	$2,657,000
Southgate Development				$4,041,000	$4,041,000
CIP Total	**$7,523,000**	**$10,305,000**	**$18,560,000**	**$9,198,000**	**$45,586,000**

[1] *Costs identified by MSA subconsultant Phase I levee review.*
[2] *Costs provided by City of Pendleton.*
[3] *Costs based on 150 years of annual replacement programs.*



MSA
Murray, Smith & Associates, Inc.

City of Pendleton
Stormwater Master Plan

Figure 1-3
Stormwater System CIP

May 2015 13-1442

Brown text indicates existing pipe diameter

SD-21

SD-22

SD-23

Umatilla River

Wildhorse Creek

Tutuilla Creek

0 750 1,500 Feet

Legend

- Existing Conduit
- Outfall
- Detention Vault
- Detention Pond
- Parcel
- UGB

Stormwater System Improvements

- 5-year
- 10-year
- 20 -year
- Development Driven

MSA Murray, Smith & Associates, Inc.

CITY OF PENDLETON INCORPORATED 1880 OREGON

City of Pendleton
Stormwater System Master Plan

Figure 1-4
Stormwater System
CIP Downtown

May 2015 13-1442

I:\BOI_Projects\13\1442\GIS Data\MXD\Stormwater\Figure 1-4 Stormwater System CIP Downtown.mxd 3/25/2015 8:50:20 AM LH

Financial Plan

Background

The City's stormwater system currently lacks a dedicated funding source. Some stormwater-related maintenance activities such as street sweeping are funded out of the Street Fund, and limited capital projects (levee certification) and maintenance are funded from the Sewer Fund. As the Street and Sewer funds face their own funding challenges to address a backlog of capital improvements and staffing needs, it will be necessary for the City to establish a separate Stormwater Utility in order to fund ongoing maintenance and capital needs associated with its stormwater system.

The City's 2013 survey of small cities in Oregon found that about half of the cities surveyed charge separate stormwater fees, with monthly bills for residential customers ranging from $1.00 to $12.00, with a median bill of about $5.00.

Financial Capacity

Without a separate funding source for stormwater, the Street and Sewer funds do not provide sufficient financial capacity to address the projected stormwater system needs (both operating and capital). Over the next five years, additional stormwater system requirements are projected to average about $500,000 per year, including $200,000 for staffing three FTEs, and $300,000 for capital improvements.

It is recommended that the additional revenue come by implementing dedicated stormwater rates and a new System Development Charge (SDC). The City currently charges SDCs for the street system, but not for the water, wastewater, or stormwater systems, and is missing an important funding source for capital improvements. Following industry standards for development of SDCs, the recommended CIP would support an SDC of approximately $125 per equivalent residential unit. A recent survey by the League of Oregon Cities indicated the typical range for stormwater SDCs is about $100 to $2,000, with the median equal to about $500 per unit.

While SDCs are generally an important part of a capital funding strategy, they are only part of the solution, as user fees will be needed to fund the majority of capital improvements related to rehabilitation and replacement, and remedying existing deficiencies, and all increases to operating costs (SDCs may not be used for system O&M). Stormwater charges are generally assessed based on property size, with impervious area being the most common measure of system impact (owing to increased stormwater runoff).

The City will need to further develop its GIS and billing systems in order to implement an area-based fee. In the interim, the City could implement a flat fee per customer account to begin generating needed revenue for capital improvements and maintenance. A monthly fee of $5 per account (equal to the median charge in other small communities) would generate approximately $350,000 per year (based on 5,800 water system accounts). To fully fund the

estimated $500,000 per year of expenses, a monthly fee of $7.25 would be required, which is still within the range of surveyed communities.

Recommendations

The following recommendations are offered for the City's consideration related to funding the staffing and capital improvements recommended in the Stormwater Master Plan:

- Adopt a new SDC based on the growth-related portion of this SWMP CIP. Adjust the SDCs annually for inflation based on the Engineering News Record (ENR) Construction Cost index (20-city average). Update SDCs as necessary to incorporate significant changes to the CIP.
- Create a new Stormwater Fund, and implement monthly stormwater rates. Initially, implement a flat rate per account, and then move to an area-based fee, following development of GIS and billing system capacity.
- Index future rates to an inflationary index such as the ENR.
- Review the financial plan annually, and make modifications to planned rate increases and capital phasing as needed to meet system performance targets.

Summary and Overall SWMP Recommendations

This SWMP constituted a major investment of time and resources for City staff and consultant team. The City, and in particular the Public Works Department, should be commended for their foresight in initiating such a comprehensive SOW in order to successfully operate, maintain, design and improve the City's stormwater drainage system. This SWMP utilized industry-standard approaches by compiling and converting information to a GIS database and successfully utilizing hydraulic modeling software.

Prior to this SWMP no single stormwater drainage system inventory nor hydraulic model existed. Collecting and compiling system data allowed for a more accurate and comprehensive look at the stormwater drainage system as a whole than what was previously available. The hydraulic modeling allowed for the evaluation of stormwater drainage system alternatives based on system hydraulics. The capital projects that have been identified and prioritized provide the City with a phased plan over the next 20 years that is affordable and realistic.

Based on the findings in this SWMP, the following recommendations are made:

- Further consider the option of creating a distinct stormwater utility to provide funding to facilitate system operation, management and necessary improvements.
- The City should focus short-term financial resources towards improving the quality of system data and expanding the GIS database and updating the hydraulic model to reevaluate system deficiencies and improvements.
- Reassess improvements using future SWMP updates.

- After additional data collection and validation of the recommended improvements, the City can prioritize improvements in the short term (immediate to five years), prioritizing the existing gravity system within the downtown commercial area and provide for operation of the levee system in conformance with FEMA requirements. In order to maintain infrastructure, an annual repair and replacement program should also be implemented.
- Implement O&M programs to increase the lifecycle of infrastructure and reduce unplanned maintenance.
- Transfer one FTE for street sweeping activities from Streets Division to Storm Utility.
- Add two FTEs as dedicated staff for the operations and maintenance of the stormwater collection system. This would be in addition to the transfer of the street sweeper FTE positon from the Streets Division.

Policy Recommendations

In order to prevent unnecessary large expenditures in the future, it is recommended that the City reconsider its financial and planning review policies, as follows:

Planning Review Policies

Although planning documents have detailed stormwater drainage system upgrades, there are no policies in place requiring regular updates, public discussion, or review. Consequently, as updated information becomes available and changes in the system occur, planning may be altered and significant investments could be made when an alternative based on new information may be a better option. The following policy recommendations will better define the requirements of future stormwater drainage system planning and help future City councils and the public plan for future investments long before they are needed:

- Require City staff to provide an annual review to Council on the status of the master plan.
- Provide an updated or new master plan to City Council every five years for adoption.

Once the City revises its policies, it is crucial that future City councils and staff understand the rationale behind these policies. To realize the potential impact of any future policy revisions, the historical context and reasoning behind existing policies must be clearly understood.

SECTION 2
STUDY AREA CHARACTERISTICS

Introduction

This section of the Stormwater Master Plan (SWMP) provides a broad overview of all areas within Pendleton's city limits and urban growth boundary (UGB), and describes such characteristics as topography, climate, geology, natural resource areas, surface water, and tributary drainage basins. Land use and population projections are also provided to reflect the analysis and findings documented in the City of Pendleton's 2011 Comprehensive Plan Update.

Study Area and Study Period

The stormwater system service area includes all areas within the city limits and UGB. These areas collectively comprise the study area for this document. The modeling effort for this SWMP will consist of two scenarios: existing conditions, and a future condition considering a build-out projection. Build-out occurs when all available land within the UGB has been developed to the target density anticipated for each land use or zoning designation.

A build-out analysis provides an understanding of long-term requirements and determines whether substantial improvements are required beyond the 20-year horizon addressed by the Capital Improvement Program (CIP). Staging facilities through incremental expansion is recommended where feasible. However, improvements recommended in this plan were specified to accommodate build-out development which, if current population growth rates are held constant, should occur after the year 2050.

Use of Datum

Unless noted otherwise, all elevations reported in this SWMP are based on the 1929 National Geodetic Vertical Datum (NGVD29), the City's officially adopted vertical datum. Another relevant datum is the 1988 North American Vertical Datum (NAVD88); to achieve equivalent elevations in the NAVD88 datum, add 3.3-feet from the elevations in this SWMP.

This section makes reference to Mean Sea Level (MSL). The relationship of MSL to either the NGVD29 or NAVD88 vertical datum requires calibration from tide models, which is outside the scope of this document; however, MSL can be approximated to NGVD29.

Topography

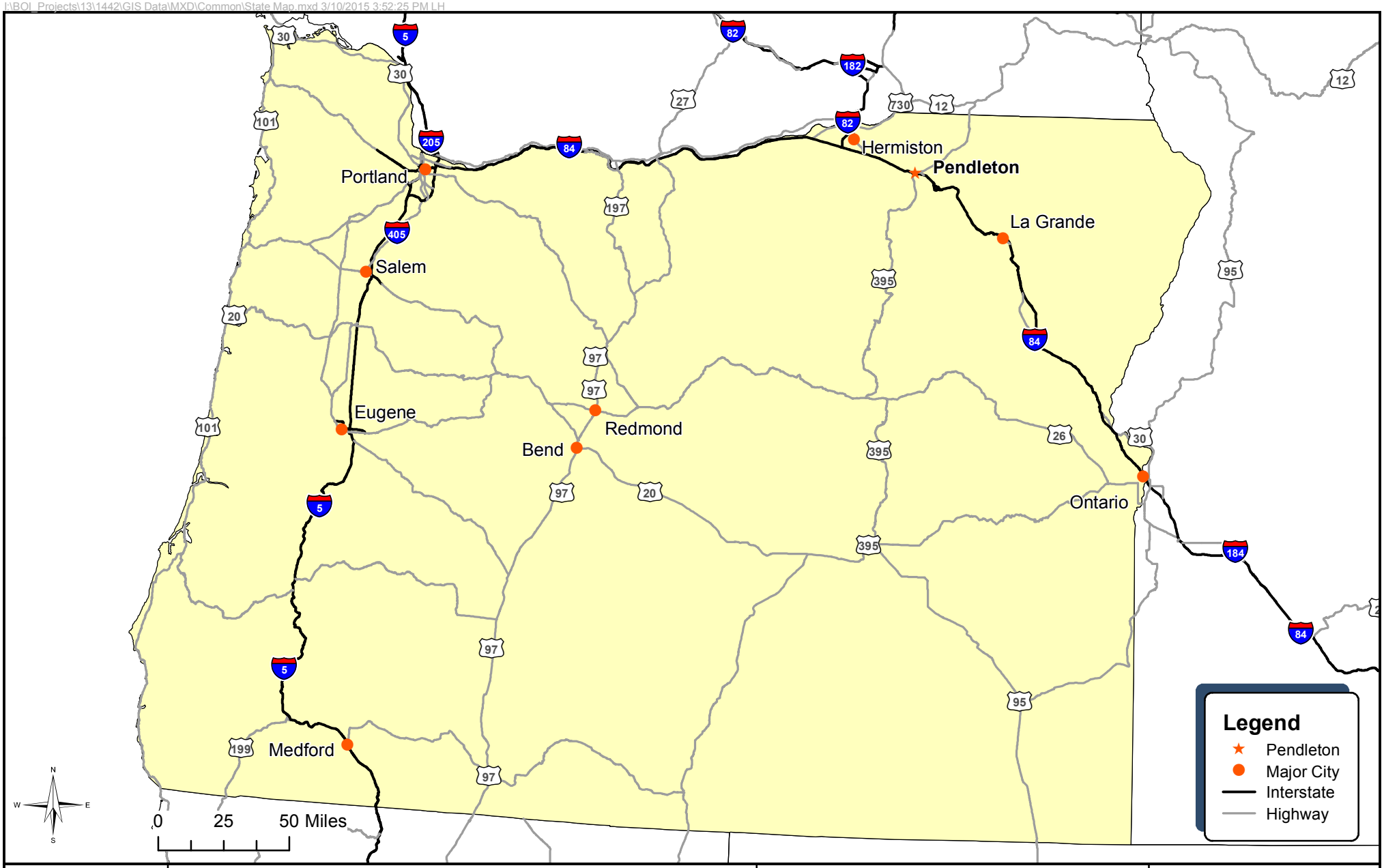
The City of Pendleton (City) is located centrally within Umatilla County, Oregon as seen in Figure 2-1. Highways serving the City include Interstate 84 and U.S. Route 30 running east-west and U.S. Route 395 running north-south. The city is also served by Oregon Route 37 and Oregon Route 11.

The City lies at the bottom of a large chasm carved by the Umatilla River through the rolling terrain of eastern Oregon's upper plateau areas. Ground elevations range from approximately 950 feet to approximately 1,570 feet above MSL. The lower elevations are located along the Umatilla River, which flows east to west.

The Umatilla River and Wildhorse Creek flow into the east side of the study area at an elevation of approximately 1,100 feet, and exit to the west at an elevation of approximately 1,000 feet. To the north and south of the Umatilla River, elevations rise quickly; the highest elevations of the UGB are near the airport, with an elevation of approximately 1,520 feet. Topographic mapping is shown in Figure 2-2.

Pendleton is nestled in the western base of the Blue Mountains. The highest mountain peaks within the range, such as the Elkhorn, Ireland and Strawberry, exceed 9,000 feet. These mountains directly influence the weather patterns and precipitation experienced at their base.

I:\BOI_Projects\13\1442\GIS Data\MXD\Common\State Map.mxd 3/10/2015 3:52:25 PM LH



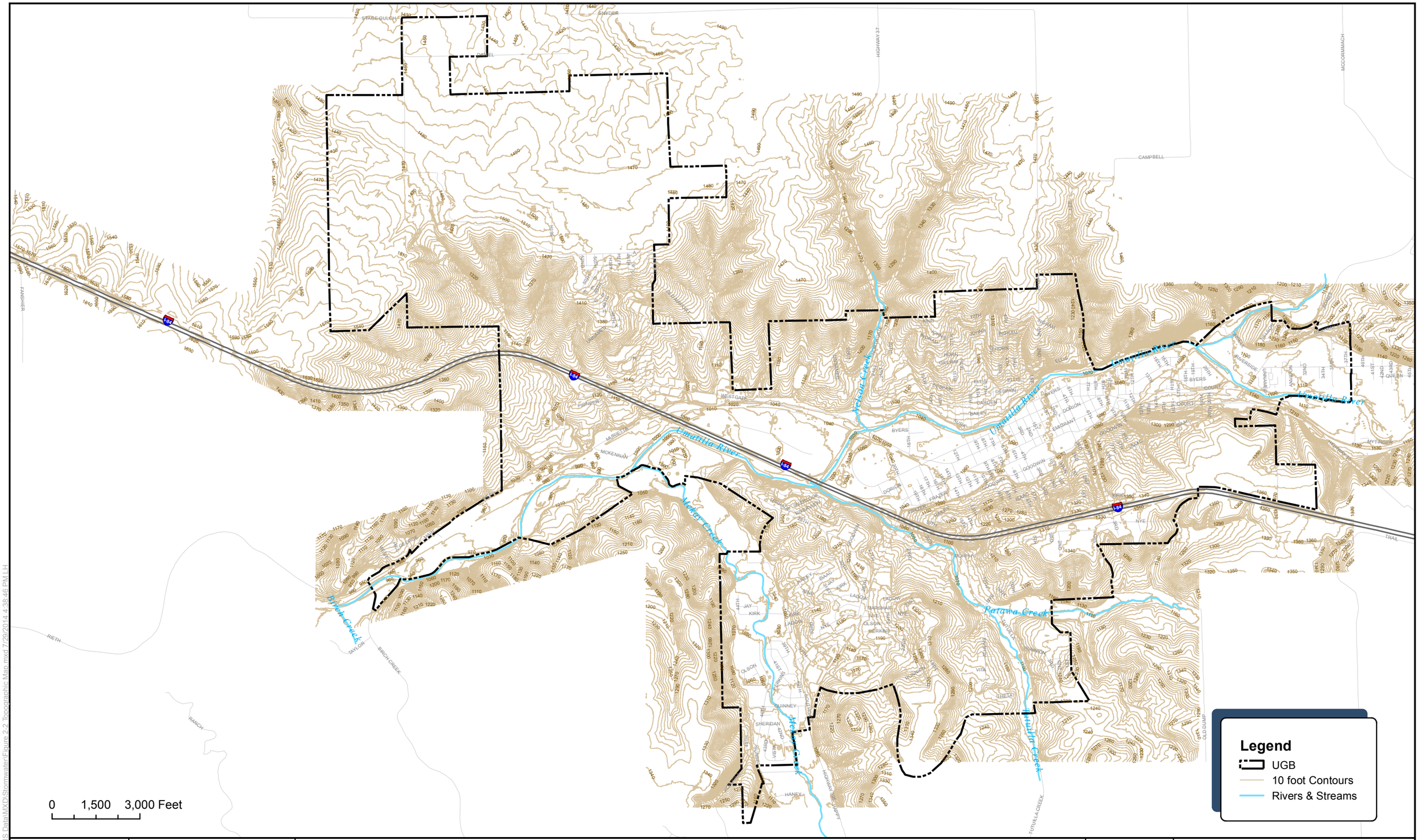
MSA
Murray, Smith & Associates, Inc.

City of Pendleton
Stormwater Master Plan

Figure 2-1
State Map

CITY OF PENDLETON OREGON INCORPORATED 1880

May 2015 13-1442



MSA
Murray, Smith & Associates, Inc.

CITY OF PENDLETON INCORPORATED 1880 OREGON

City of Pendleton
Stormwater Master Plan

N W E S

Figure 2-2
Topography

I:\BOI_Projects\1311442\GIS Data\MXD\Stormwater\Figure 2-2 Topographic Map.mxd 7/29/2014 4:38:46 PM LH

May 2015 13-1442

Climate and Rainfall

The City is located in the semi-arid region of eastern Oregon, with short, cool winters and long, hot summers. It holds the highest temperature recorded in the state, at 119 degrees Fahrenheit (ºF). Pendleton receives most of its precipitation during the winter months, with the wettest period from November through March. July and August are the warmest months with an average high temperature of 87 °F, while December is the coolest month with an average low temperature of 27 °F. November is the wettest month, with 1.52 inches of average precipitation. Additional climate information is provided in Table 2-1.

Table 2-1
Summary of Climatological Information

Temperature and Precipitation	°F and Inches
Record High Temperature	119°F
Average Annual High Temperature	63.2°F
Average Annual Low Temperature	41.2°F
Record Low Temperature	-28°F
Average Annual Rainfall	12.65 inches

Eastern Oregon lies within a "rain shadow" created by the Cascade Mountains, as storms from the Pacific Ocean bring warm, moist air inland. After passing over the Cascades, any remaining moist air is then obstructed by the Blue Mountains.

There are generally two distinct types of rainfall events in Pendleton: a short, intense summer thunderstorm and a longer duration regional storm. Thunderstorms are typically experienced in late spring to early fall, and tend to occur over localized areas. These types of storms can produce high peak flows and flash flooding in urban areas.

Regional storms can occur at any time of the year, but are most prevalent between late fall and early spring. These events can also cause localizing flooding due to rapid snow melt, and rain-on-snow events when conveyances can be blocked by snow and ice. A more in-depth discussion of the storms used in the analysis of the Pendleton stormwater conveyance system is provided in Section 5—Stormwater System Analysis.

Geology

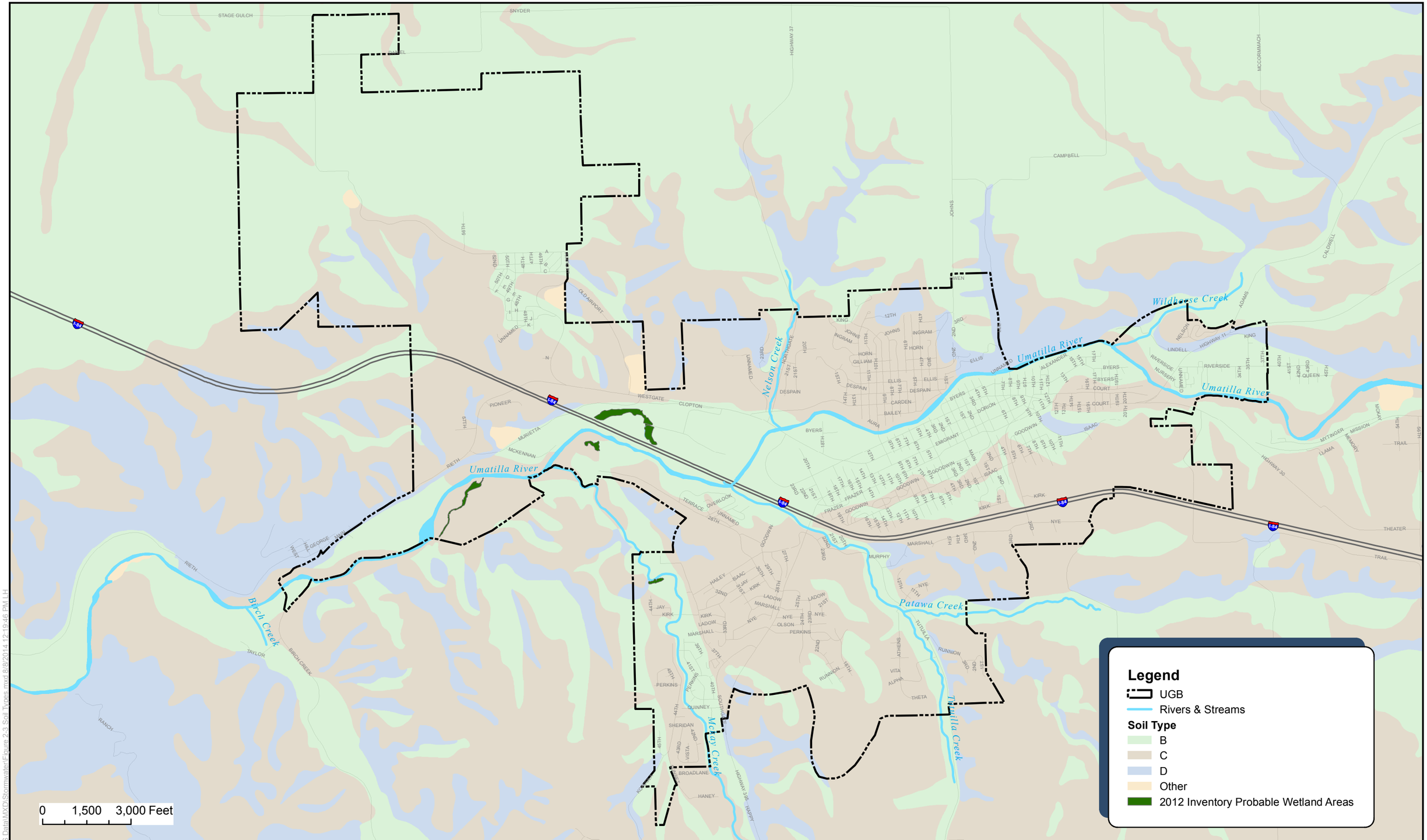
Detailed information on the soils found throughout the study area is summarized in the U.S. Soil Conservation Service's Soil Survey of Umatilla County Oregon (OR 667, 2013). The soil types identified in this survey are organized into hydrologic groups, and are used to predict area-wide hydrologic responses to rainfall. These groups are particularly important when assigning pervious area runoff curve numbers (CN) during stormwater modeling, as detailed in Section 5.

The soil types within the study area are summarized in Table 2-2, along with their corresponding hydrologic groups and their relative percentage area. To simplify the table, soils with a percentage area less than 0.1 were omitted. The distribution of these soil groups within the study area is shown in Figure 2-3.

Hydrologic soil groups are labeled A, B, C, or D, based on the rate of water transmission through the soil. Group A soils have a low runoff potential since they are typically well drained and infiltrate water into the soil quickly. Conversely, Group D soils are poorly drained, have a high runoff potential, and infiltrate water into the soil slowly. A category of "Other" in Figure 2-3 captures minor soil groups that do not conform to classification criteria of Group A through D soils, such as gravel pits and surface water.

Table 2-2
Study Area Hydrologic Soil Groups

Map Unit Name	Group	Acres in UGB	Percentage of UGB
Anderly silt loam, 1 to 7% slopes	C	147	1.7
Anderly silt loam, 7 to 12% slopes	C	992	11.6
Anderly silt loam, 12 to 20% slopes	C	342	4.0
Anderly silt loam, 20 to 35% slopes	C	94	1.1
Anderly-Urban Land Complex, 7 to 12% slopes	C	706	8.2
Freewater gravelly silt loam, 0 to 3% slopes	B	288	3.4
Freewater very cobbly loam, 0 to 3% slopes	B	39	0.5
Freewater-Urban Land Complex, 0 to 3% slopes	B	280	3.3
Hermiston silt loam, 0 to 3% slopes	B	147	1.7
Lickskillet very stony loam, 7 to 40% slopes	D	486	5.7
Nansene silt loam, 35 to 70% slopes	B	34	0.4
Onyx silt loam, 0 to 3% slopes	B	39	0.5
Pilot Rock silt loam, 1 to 7% slopes	C	691	8.1
Pilot Rock silt loam, 7 to 12% slopes	C	372	4.3
Pilot Rock silt loam, 12 to 20% north slopes	C	37	0.4
Pilot Rock silt loam, 12 to 20% south slopes	C	140	1.6
Pits, gravel	-	45	0.5
Umapine silt loam, reclaimed, 0 to 3% slopes	C	155	1.8
Veazie silt loam, 0 to 3% slopes	B	56	0.7
Walla Walla silt loam, 1 to 7% slopes	B	1693	19.8
Walla Walla silt loam, 7 to 12% slopes	B	189	2.2
Walla Walla silt loam, 12 to 25% north slopes	B	505	5.9
Walla Walla silt loam, 25 to 40% north slopes	B	43	0.5
Wrentham-Rock Outcrop Complex, 35 to 70% slopes	C	5	0.1
Xerofluvents, 0 to 3% slopes	C	183	2.1
Yakima silt loam, 0 to 3% slopes	B	204	2.4
Yakima-Urban Land Complex, 0 to 3% slopes	B	559	6.5
Water	-	95	1.1


Wildhorse Creek
Umatilla River
Nelson Creek
Patawa Creek
Birch Creek
McKay Creek
Trullia Creek
Legend
UGB
Rivers & Streams
Soil Type
B
C
D
Other
2012 Inventory Probable Wetland Areas
0 1,500 3,000 Feet

There are generally no instances of Group A soils within the UGB. Group B soils can be found within the study area where the topography flattens out into gently sloping terrain. The steeper sloping regions within the UGB are typical of Group C soils, with Group D soils located around the City's surface waters.

Natural Resource Areas

Natural resources are derived from the environment. They may exist as a separate entity, such as air and water, or as living organisms such as fish and wildlife. The Umatilla River and its tributary streams are a significant natural resource which the City has taken strides to protect through enactment of protective ordinances such as floodplain development and future zoning sub-districts under consideration for riparian corridors and wetlands.

Surface Water

The primary surface water feature of the area is the Umatilla River. The river conveys drainage from nearly 2,550 square miles of tributary area, originating on the western slopes of the Blue Mountains. Within the study area, the Umatilla River is fed by five smaller fish-bearing tributaries: Patawa Creek, Wildhorse Creek, Tutuilla Creek, McKay Creek, and Nelson Creek. These surface waters provide a significant source of potable water for the City, in addition to acting as the disposal route for stormwater drainage and treated wastewater effluent.

These rivers and streams have been influenced by historic land and water management practices such as agricultural irrigation. These practices, in combination with Eastern Oregon's hot, dry summers, have formed limiting factors affecting aquatic habitat. The Oregon Department of Environmental Quality (DEQ), has designated some of these waters as Essential Fish Habitat and Water Quality Limits streams, which is discussed in further detail in Section 4—Regulations and Policies.

Floodplains

A floodplain is an area of land adjacent to a river or stream that experiences flooding during periods of high flows. Floodplains are natural places for surface waters to dissipate their energy during periods of high discharge. The City has enacted restrictions on development within floodplains under their jurisdiction, to protect these natural resources from infill.

The most notable floodplain area within the City was previously the downtown commercial district prior to urbanization of the area. A system of levees was constructed in the 1930s to protect this commercial center from periodic inundation of the Umatilla River. These levees are described in further detail in Section 3—Existing System Description.

Wetlands

Wetlands are distinct ecosystems created by the saturation of land area by water. This saturation can occur either permanently or seasonally, and creates unique hydric soil conditions supporting characteristic flora, fauna or algae. Wetlands play a number of roles in the environment, primarily water purification, flood control and shoreline stability. These natural resources are also considered the most biologically varied of all ecosystems, serving as home for a wide array of plant and animal life.

The preliminary mapping of wetlands is shown in Figure 2-3. The City is presently updating this wetland inventory through a study commissioned in 2012. The results of this effort are ongoing, and initial documentation suggests the presence of numerous classes of palustrine wetlands within the study area, comprising nearly 14 acres.

Population Projections

This SWMP utilizes information from a technical memorandum produced by Winterbrook Planning contained in the 2011 amendments to the City's Comprehensive Plan. These amendments outline the basis for growth and development within the City. Information regarding current and future population, land use, density and other assumptions used in this SWMP are consistent with the 2011 Comprehensive Plan amendments. The assumptions used to project growth for existing and future study area populations in the City's UGB are provided in Table 2-3.

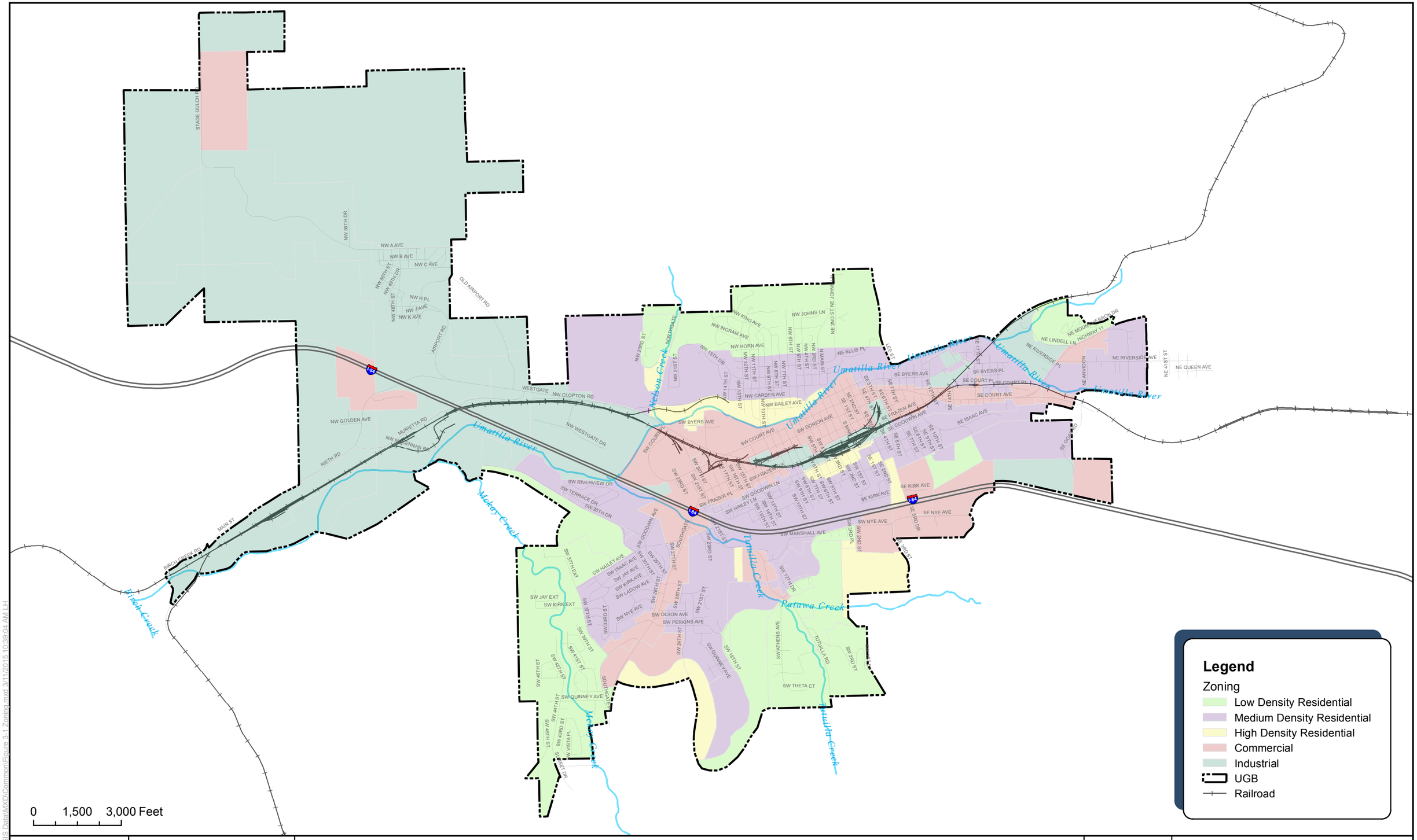
Table 2-3
Comprehensive Plan Population Data

Attribute	Value
2010 UGB Population	17,611 people
Build-Out Population Estimate	31,324 people
Household Size	2.34 people/household

In addition to forecasting the anticipated population growth, the 2011 Comprehensive Plan provides parameters for how this growth will occur within the UGB as shown by land use designations in Figure 2-4.

Land Use

An understanding of land use and demographic characteristics within the study area is particularly important in stormwater planning because of the impact these characteristics have on the transformation of rainfall to runoff. Land use characteristics in particular are critical in estimating existing and future stormwater flows in an urban setting. Land use impacts the percentage of impervious area within a basin, and stormwater runoff increases with increased impervious area.



MSA
Murray, Smith & Associates, Inc.

CITY OF PENDLETON INCORPORATED 1880 OREGON

City of Pendleton
Stormwater Master Plan

Figure 2-4
UGB Land Use

I:\BOI_Projects\131442\GIS Data\MXD\Common\Figure 3-1 Zoning.mxd 3/11/2015 10:39:04 AM LH

May 2015 13-1442

All land within the City has been assigned a land use designation consistent with the amended Comprehensive Plan, which includes various categories of commercial, industrial, institutional, and residential land uses. This land use information then became the basis for analyzing and projecting storm sewer flows to the stormwater conveyance system. Table 2-4 summarizes land use and zoning classifications for the planning area as identified in the amended Comprehensive Plan.

Table 2-4
Comprehensive Plan Land Use Summary

Zone	Percentage of UGB	Area (acres)
Aviation Activities	10	812
General Commercial	4	396
Tourist Commercial	2	147
Service Commercial	5	408
Exclusive Farm Use County	9	751
Industrial Reserve Area	0	41
Light Industrial	22	1,891
Low-Density Residential	19	1,576
Medium-Density Residential	20	1,718
High-Density Residential	4	300
Unincorporated Community Zone	0	1
Heavy Industrial	5	448
Total	**100**	**8,489**

Non-Residential Land Use

The non-residential land use category is a generic grouping of commercial (including institutional and municipal uses) and industrial zones within the study area. Areas zoned as exclusive farm use are also contained within this grouping. To meet community needs, these areas are anticipated to develop parallel to residential population growth.

Residential Land Use

Table 2-5 provides density categories for residential land development within the UGB by land use designation. Documentation of these land use categories is important in regards to modeling the runoff anticipated for each area. Lower density residential areas have a greater percentage of pervious landscaped areas compared to more densely developed residential areas. More information related to how these land use areas are assigned unique stormwater runoff characteristics is provided in Section 5—Stormwater System Analysis.

Table 2-5
Comprehensive Plan Residential Density Ranges

Land Use	Density Range (dwellings/acre)
Low-Density Residential	4-9
Medium-Density Residential	6-18
High-Density Residential	12-35
Overall Average Residential	7

Land Use Runoff Characteristics

Although few data sets are available specifically from the City, studies across the U.S. have correlated urbanization to increases in the types and quantities of pollutants in receiving waters. Regardless of the climatic setting, development within urbanized areas such as roadway pavements and industrial, commercial, and residential construction can contain many different pollutants. Each of these activities can be generalized as follows:

- Pavement runoff is contaminated with pollutants such as oil and grease from motorized vehicles, polynuclear aromatic hydrocarbons (PAHs), lead, zinc, copper, cadmium, sediments (soil particles), road salts, and other anti-icers. Pavements also generate runoff flows that have short, intense peaks.
- Residential areas contribute the same pavement-based pollutants to runoff, as well as herbicides, pesticides, nutrients (from fertilizer and animal waste), bacteria, viruses, and other pathogens (from animal wastes). Residential areas contain a higher percentage of pervious landscaped area compared to industrial and commercial areas, with runoff characteristics of longer, less intense peak flows.
- Runoff from industrial areas typically contains heavy metals, sediments, and a variety of man-made organic pollutants, including phthalates, PAHs and other petroleum hydrocarbons. Since industrial areas typically consist of a large percentage of impervious area, runoff can be characterized with short, intense peak flows.
- Runoff from commercial areas contains concentrated pavement-based pollutant runoff and may also contain other contaminants typical of industrial and/or residential areas. Commercial areas typically consist of a large percentage of impervious area, and runoff can be characterized with short, intense peak flows.
- Runoff from exclusive farm use areas can contain similar chemical characteristics as residential areas, albeit at higher concentrations. Agricultural lands contain a much higher percentage of pervious landscaped area compared to all other uses, with runoff characteristics of longer, lesser peak flows.

Tributary Drainage Basins

The study area has several well-defined drainage basins. These basins are areas of land where surface water from precipitation converges to a single, low-lying elevation to join another water body. The drainage basin acts as a funnel, channeling runoff towards downstream rivers, creeks and streams. Each drainage basin is defined by a perimeter of surrounding topographical barriers such as mountain ridges or hills.

The study area is divided into nine tributary basins; all except the Stage Gulch basin ultimately flow into the Umatilla River. The catchment basins are summarized in Table 2-6. It should be noted that the area totals within the UGB vary slightly from the totals provided in Table 2-4 due primarily to flow draining away from the project area within the Stage Gulch basin.

Table 2-6
Drainage Basin Area Summary

Basin Name	Total Basin Area (acres)	Area within UGB (acres)	Percentage of Area within UGB
Airport	2,311	1,341	16%
Downtown	2,232	1,774	21%
McKay Creek	2,337	1,094	13%
Nelson Creek	1,833	166	2%
Patawa Creek	3,000	245	3%
Stage Gulch	766	590	7%
Tutuilla Creek	1,542	839	10%
Umatilla River East	1,332	604	7%
Umatilla River West	2,429	1,606	19%
Totals	**17,783**	**8,258**	**100%**

Figure 2-5 illustrates the tributary drainage basins within the study area, which are summarized below.

Airport Basin

The Airport Basin is located on the north side of the City, bound to the west by the Umatilla River West Basin, to the south by the Umatilla River and Interstate 84, to the east by the Nelson Creek Basin, and to the north by a high plateau where the airport resides. This area comprises approximately 1,341 total acres within the UGB and accounts for 16% of the boundary.

Drainage originating within the basin flows south towards the Umatilla River, and is generated from a mixed use of developed and undeveloped property. A majority of the basin lies outside of the UGB. The portions of the basin within the UGB are zoned for industrial use, however much of the area is difficult to develop due to steep terrain.

The Airport Basin is comprised largely of Group B soils. Its terrain slopes are generally less than 10% on the north region of the basin, and transition to slopes approaching 25% in the south. Due to this configuration, the basin is susceptible to erosion and scour by surface runoff.

Downtown Basin

The Downtown Basin is centrally located within the City, bound to the north and west by the Umatilla River, to the east by the Urban Growth Boundary, and to the south by Interstate 84. This area comprises approximately 1,774 total acres within the UGB and accounts for 21% of the boundary.

Drainage originating within the basin flows north towards the Umatilla River, and is generated from almost fully developed property. The bulk of the City's core commercially zoned areas can be found within this basin, along with the City's older residential areas.

The Downtown Basin consists almost entirely of Group B soil types. Its commercial areas can be found on the low-lying, flat slopes of the valley floor, while the residential areas on the south side of the basin can be found on slopes approaching 10 to 15%.

McKay Creek Basin

The McKay Basin is located on the southwest side of the City, bound to the west and south by a ridge of high elevation, to the east by the Tutuilla Creek Basin, and to the north by the Umatilla River. This area comprises approximately 1,094 total acres within the UGB and accounts for 13% of the boundary.

Drainage originating within the basin flows north towards the Umatilla River, and is generated from a mixed use of developed and undeveloped property. The bulk of the City's south side residential and commercial areas lie within this basin.

The McKay Creek Basin is largely comprised of Group B and C soil types. Its terrain slopes are generally less than 10% through the center potion of the basin, while its perimeter has steeper slopes approaching 25%.

Nelson Creek Basin

The Nelson Creek Basin is located on the north side of the City, bound to the west by the Airport Basin, to the south by the Umatilla River, to the east by the Umatilla River East Basin, and to the north by a plateau of high topography. This area comprises approximately 166 total acres within the UGB and accounts for 2% of the boundary.

Drainage originating within the basin flows south towards the Umatilla River, and is generated from primarily undeveloped property. A majority of the basin lies outside of the

UGB; however, the southern portion of the basin that resides within the UGB is zoned for residential development.

The undeveloped portion of the Nelson Creek Basin is comprised largely of Group B soils and gently sloping terrain, while the residential areas consist mainly of Group C soils on steeply sloping terrain.

Patawa Creek Basin

The Patawa Creek Basin is located on the southeast side of the City, bound to the west by the Tutuilla Creek Basin, to the south and east by a ridge of high topography, and to the north by Interstate 84. This area comprises approximately 245 total acres within the UGB and accounts for 3% of the boundary. The basin drains a relatively large area comprising 3,000 total acres, making it the largest basin in the study area.

Drainage originating within the basin flows northerly and westerly through Patawa Creek before discharging into Tutuilla Creek. Runoff is generated from primarily undeveloped property, however the portions of the basin within the UGB are zoned for residential and commercial use.

The Patawa Creek Basin primarily consists of Group C soil types, however these is a broad mix of type B and D soils in the basin. Its terrain slopes are generally steep, with residential development taking place in the few more gently sloping areas.

Stage Gulch Basin

The Stage Gulch Basin is located on the northwest side of the City, bound to the north and west by a plateau of high topography, to the south by the Umatilla River Basin West and to the east by the Airport Basin. This area comprises approximately 590 total acres within the UGB and accounts for 7% of the boundary.

This is the only basin within the UGB that drains away from the Umatilla River. Drainage originating within the basin flows north, and is generated mainly by undeveloped land. This basin contains industrial and commercial zoning designations and is anticipated to develop in the near term with services near the airport.

The Stage Gulch Basin is comprised almost entirely of Group B soils on gently sloping terrain with grades generally less than 10%.

Tutuilla Creek Basin

The Tutuilla Creek Basin is located on the south side of the City, bound to the west by the McKay Creek Basin, to the south by a ridge of high topography, to the east by the Patawa Creek Basin, and to the north by the Umatilla River and Interstate 84. This area comprises approximately 839 total acres within the UGB and accounts for 10% of the boundary.

Drainage originating within the basin flows to the north through Tutuilla Creek where it combines with Patawa Creek before discharging into the Umatilla River. Runoff is generated from a mixture of developed and undeveloped property. Most of the basin within the UGB is zoned for residential use, with a notable recent development of the Grecian Heights Park community and Sunridge Middle School.

The Tutuilla Creek Basin primarily consists of Group C soil types. Its terrain generally slopes gradually towards to river between 5% and 15%.

Umatilla River Basin East

The Umatilla River Basin East is located on the north side of the City, bound to the west by the Nelson Creek Basin, to the south by the Umatilla River, to the east and north by a plateau of high topography. This area comprises approximately 604 total acres within the UGB and accounts for 7% of the boundary.

Drainage originating within the basin flows westerly and southerly towards the Umatilla River, and is generated from mainly undeveloped property. This basin contains all types of zoning categories.

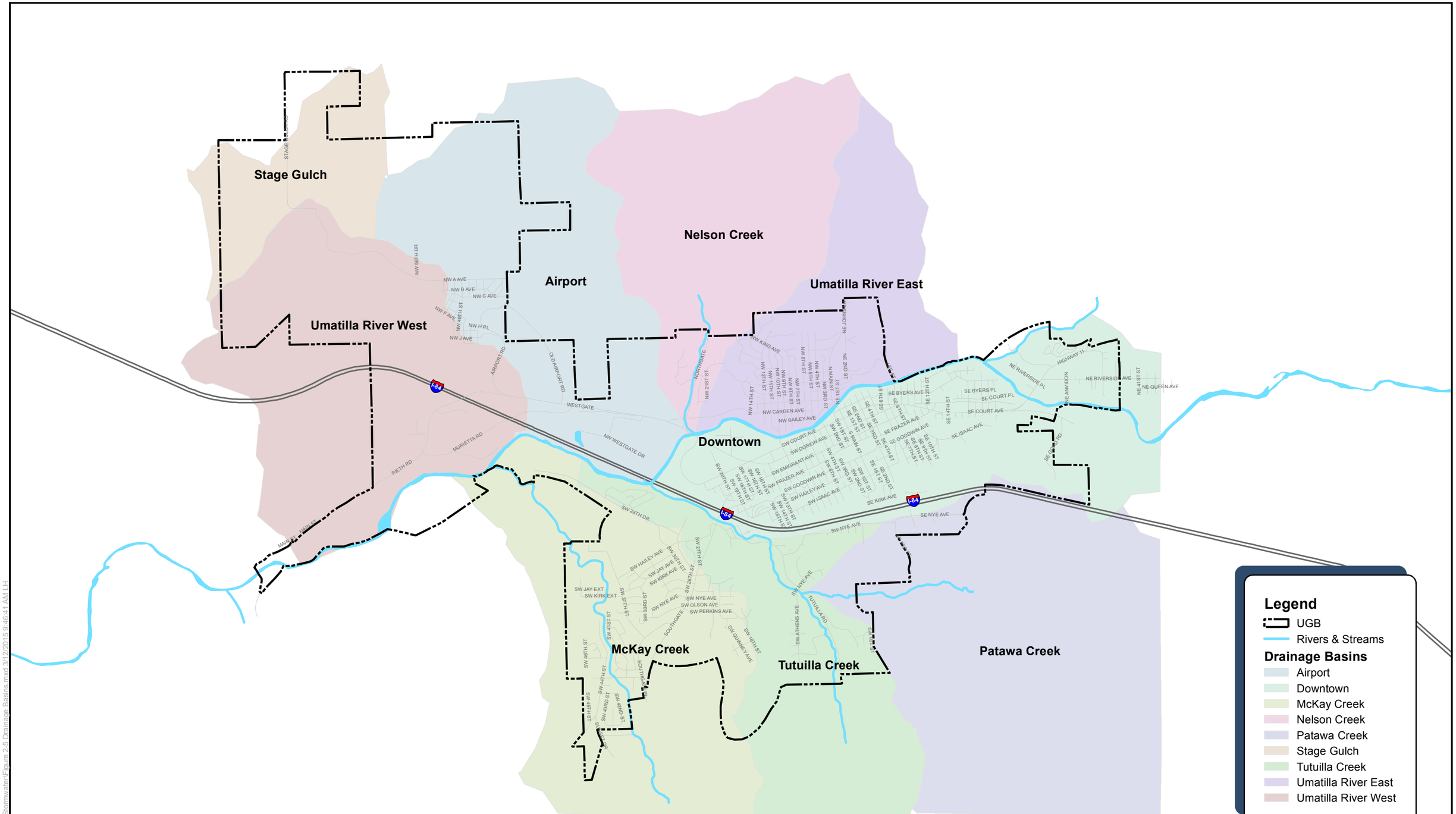
The Umatilla River Basin East is comprised of nearly an equal mixture of Group B and C soils with small sections of Group D soil. Its terrain slopes are generally less than 10%.

Umatilla River Basin West

The Umatilla River Basin West is located on the west side of the City, bound to the west by a plateau of high topography, to the south by the Umatilla River, to the east by the Airport Basin, and the north by the Stage Gulch Basin. This area comprises approximately 1,606 total acres within the UGB and accounts for 19% of the boundary.

Drainage originating within the basin flows south towards the Umatilla River, and is generated from mainly undeveloped property. This basin contains industrially zoned lands and is slated for the bulk of the City's near term development for new industries.

The Umatilla River Basin West is comprised of predominately of Group C soils with a large component of Group B soils intermixed with small pockets of Group D soils. The northern and south regions of the basin are gently sloping with grades generally less than 10%. The central portion of the basin is steep with slopes approaching 25%.



MSA
Murray, Smith & Associates, Inc.

CITY OF PENDLETON
INCORPORATED 1880
OREGON

City of Pendleton
Stormwater Master Plan

N
W
E
S

Figure 2-5
Drainage Basins

I:\BOI_Projects\13\1442\GIS Data\MXD\Stormwater\Figure 2-5 Drainage Basins.mxd 3/12/2015 9:46:41 AM LH

May 2015 13-1442

SECTION 3
Existing System Description

SECTION 3
EXISTING SYSTEM DESCRIPTION

Introduction

This section provides an overview of the City of Pendleton's (City's) existing storm drainage system, location, general management, and physical infrastructure.

An inventory of the existing stormwater conveyance system under the City's jurisdiction is provided below. This inventory was recently documented, put into a new Geographic Information System (GIS) database of the stormwater network, and was used to inform this Stormwater Master Plan (SWMP). It should be noted that several different sources of information were used to develop the inventory and characteristics of the existing stormwater facilities. These sources included City maps of storm drainage facilities, record drawings for newly constructed storm drainage facilities, and site visits.

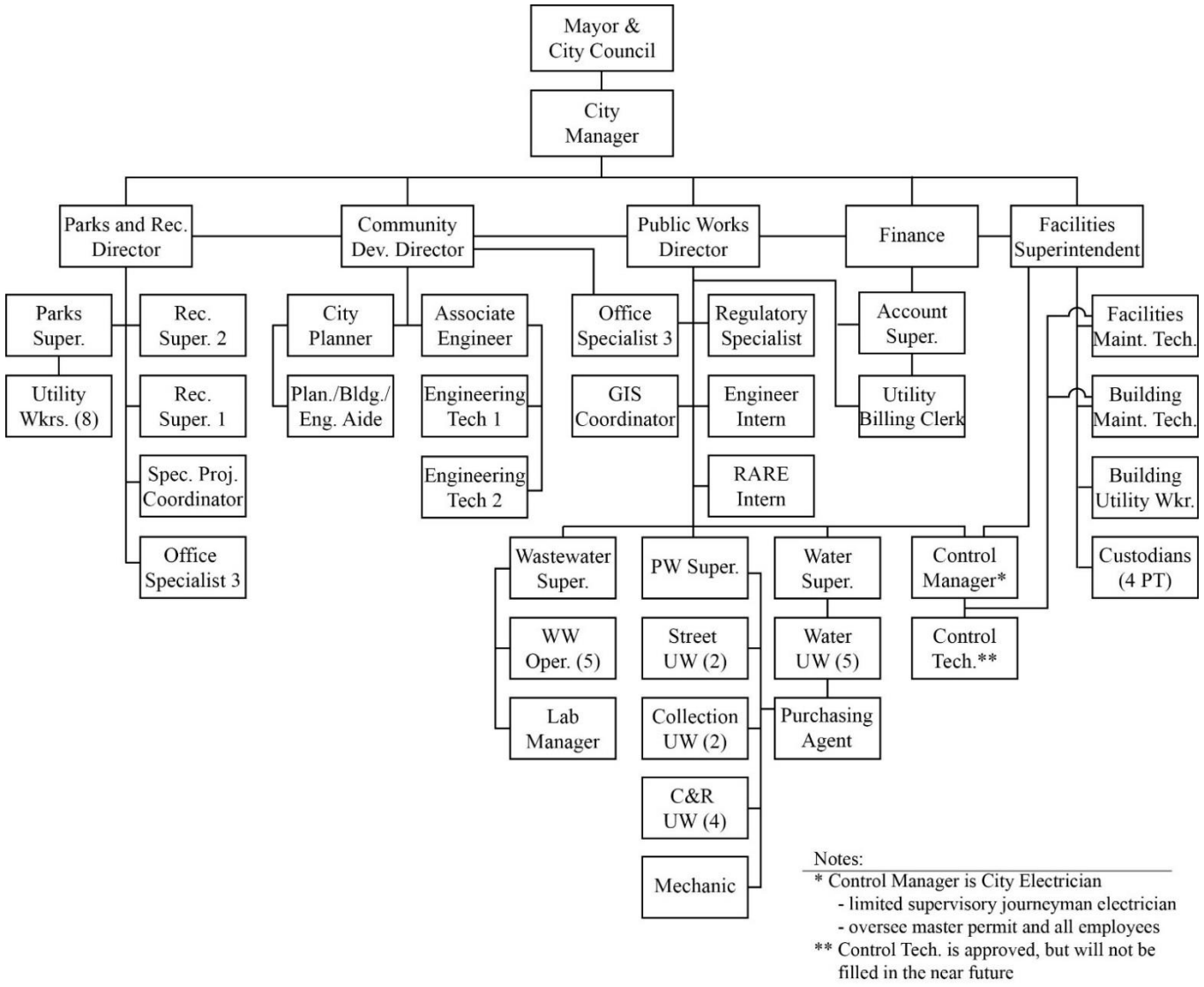
As this SWMP reflects the first intensive effort to record the City's stormwater infrastructure, numerous data gaps still exist relative to the City's water and sewer systems. Given the age of the stormwater drainage system and lack of documentation in some instances, these gaps include undocumented storm sewer improvements in terms of pipe sizes, slopes, materials and age. Interviews with City staff were conducted to help fill in some of the missing information. The City intends to continue to add to and refine the stormwater GIS over time.

System Management and Overview

The City is governed by the Mayor and City Council, with operations overseen by the City Manager. The City Manager directs all City departments, including those primarily involved in infrastructure considerations, such as Parks and Recreation, Community Development, Public Works, Finance, and Facilities. The Public Works Director manages the wastewater, stormwater, water, and street utilities. See Figure 3-1 for an organizational chart illustrating the existing City structure.

Presently, the Public Works Department is responsible for performing maintenance activities on the City's stormwater drainage system. The department is interested in creating a new separate Stormwater Division assigned to the maintenance of the drainage system, with a dedicated staff and annual operations budget separate from sanitary sewer collections. This transition of the organizational structure would occur if a new stormwater utility is adopted by the City.

Figure 3-1
Organizational Chart



Summary of Stormwater Conveyance System Facilities

The City's stormwater conveyance system consists of 46 miles of gravity drainage piping, 646 manhole structures, 3.5 miles of open channels, and 15 flow control facilities. Most of the pipes locations are known and range in size from 4 to 72 inches. The vast majority of the system's materials by location are unknown but are thought to include polyvinyl chloride (PVC), concrete, steel, and iron materials. There are 73 outfalls into the Umatilla River, McKay Creek, Tutuilla Creek, Nelson Creek and other ditches and drainages. 38 of these 73 outfalls discharge directly into local waterways, with the remainder discharging to ditches, drainages or other manmade drainage structure. Outfalls within 100 feet from a waterway were classified as direct discharges. See Figure 3-2 for an overview map of the conveyance system.

The conveyance system shown in Figure 3-2 also consists of levees along the Umatilla River. The levee system creates a man-made artificial barrier between the river and development that has occurred in the lower elevations of the City. The City's storm conveyance system has outfalls through the levees, which are outfitted with one-way tide gates to prevent river water from back flowing through the storm system. These tide gates are inspected regularly by the City as part of the levees routine operation and maintenance regime. The storm system was analyzed for conditions interior to the levees as part of a government levee certification program, and found to perform acceptably. Additional information related to the levees is provided below and information related to their national regulations is provided in Section 4—Regulations and Policies.

The existing conveyance system has generally remained a gravity system and does not contain lift stations, force mains, flow control weirs or sanitary sewer interconnects that are more commonly found in large complex urban systems. A lift station previously installed to convey drainage over the levees has been abandoned. The stormwater conveyance system is dedicated entirely to serving areas within the study area, and does not involve service agreements or interties to other adjacent jurisdictional authorities.

The existing stormwater conveyance system is generally adequate to meet the City's needs; however, there have been occasions of temporary and isolated areas of flooding, which are discussed in further detail in Section 5—System Analysis. The flooding typically occurs during the short, intense summer thunderstorms, and while standing water may occur in portions of the system it generally does not cause property damage.

Gravity Piping System

There is limited information regarding the oldest portion of the conveyance system, which is 50 to 100 years old and located in the downtown area. As the conveyance system has expanded over the past 20 to 30 years, the newer piping that is 18 inches and smaller is primarily PVC, with concrete manholes. Trunk sewer pipes larger than 18 inches are typically concrete, with concrete manholes. Table 3-1 summarizes the conveyance system's gravity pipe based on information provided in the GIS.

Approximately 38% of the City's storm piping is of unknown size at this time; 18% of the system is known to be 8 inches and smaller, and the conveyance capacity of these smaller pipes is generally considered substandard.

Table 3-1
Gravity Pipe

Diameter (inches)	Total Length (miles)	Percentage of Total Length
8 and smaller	8.4	18%
10	3.3	7%
12	5.0	11%
14, 15 and 16	4.2	9%
18	1.7	4%
20	1.5	3%
21 and 22	0.3	1%
24	1.9	4%
27 and 30	0.5	1%
36	0.4	1%
42	0.7	1%
48	0.4	1%
54	0.4	1%
Unknown	17.6	38%
Total	**46**	**100%**

As the majority of the system's age and materials are unknown, an effort to identify their condition should be undertaken in the future. This data could then be entered into the GIS system to create a more comprehensive set of information. This effort will allow the City to perform analyses to better estimate system performance, serviceability, and remaining useful life of components of the system.

Highway Culvert Undercrossings

The rights-of-way for regional highways through the study area are under the jurisdictional authority of the Oregon Department of Transportation (ODOT). There are numerous culverts that cross underneath these highways and convey drainage from areas within the City. ODOT manages a comprehensive GIS database of their facilities, which can be referenced online by the public to locate and obtain additional information about these culverts.

Open Channel Conveyances

There are many roadside ditches, creeks, and streams within the study area, comprising approximately 3.5 miles of stormwater conveyance. While these natural and constructed open channels are significant in terms of overall length and capacity, the effort to survey and

model these channels was not included as part of this first SWMP. It is anticipated that the City will perform additional stormwater drainage system surveying prior to future master plan updates to quantify and analyze the open channels within the study boundary to further refine their GIS inventory.

Detention Ponds

Detention ponds are low-lying areas designed to temporarily hold a set volume of water while slowly draining to another location. These ponds typically accept concentrated surface runoff from a development and mimic pre-development hydrologic runoff patterns from developed areas.

There are 13 stormwater detention ponds and two underground vaults within the City of Pendleton. The general location of these facilities is shown on Figure 3-2, while their coordinate location, approximate physical dimensions, and storage capacities are summarized below in Table 3-2.

Table 3-2
Detention Facility Summary

Detention Basin/Vault ID	Drainage Basin Location	Coordinate Location		Approximate Physical Characteristics		
		Longitude	Latitude	Area (sq.ft.)	Depth (feet)	Volume (cu.ft.)
1	McKay Creek	45°38ft 58.77in N	118°49ft 4.52in W	3,500	5	17,500
2	McKay Creek	45°38ft 56.53in N	118°48ft 56.25in W	3,500	5	17,500
3	McKay Creek	45°38ft 58.08in N	118°48ft 53.93in W	3,500	5	17,500
4	Tutuilla Creek	45°38ft 50.54in N	118°47ft 19.14in W	10,000	5	50,000
5	Tutuilla Creek	45°38ft 57.03in N	118°47ft 19.99in W	10,000	5	50,000
6	Downtown	45°39ft 57.00in N	118°48ft 37.79in W	6,000	5	30,000
7	Downtown	45°40ft 15.14in N	118°48ft 36.92in W	2,500	5	12,500
8	Airport	45°40ft 18.41in N	118°48ft 44.94in W	3,000	5	15,000
9	Airport	45°41ft 15.61in N	118°50ft 35.61in W	7,500	5	37,500
10	Airport	45°41ft 3.12in N	118°50ft 33.22in W	7,000	5	35,000
11	Umatilla River West	45°40ft 28.26in N	118°50f t12.28in W	2,500	5	12,500
12	Umatilla River West	45°40ft 34.38in N	118°50f t19.67in W	3,000	5	15,000
13	Umatilla River West	45°41ft 3.86in N	118°50ft 50.84in W	3,500	5	17,500
14 (Underground Vault)	Patawa Creek	45°39 ft 37.1in N	118°46ft 48.3in W	No Data	No Data	No Data
15 (Underground Vault)	Patawa Creek	45°39 ft 37.1in N	118°46ft 48.3in W	No Data	No Data	No Data

Water Quality Treatment Facilities

Presently, there are no City-owned facilities dedicated towards water quality treatment of stormwater drainage. The detention ponds previously mentioned will remove some nominal amount of sediments and pollutants from drainage as they manage stormwater, however the degree to which they function is unknown.

Water quality treatment of stormwater typically refers to the physical removal of pollutants from surface water runoff. These pollutants consist of sediments; sand, silt and other suspended solids; dissolved metals such as copper, lead, and zinc; nutrients such as nitrogen and phosphorus; pathogens such as bacteria and viruses; and organic matter such as petroleum, hydrocarbons and pesticides. The facilities that provide treatment come in many different forms. They can be naturally occurring environmental systems such as wetlands or manufactured filters installed within precast vaults.

Flood Control Levees

As part of FEMA's efforts to develop and update National Flood Insurance Program (NFIP) maps, levee owners must furnish documentation certifying the levee's ability to provide protection from base flood levels (typically the 100-year flood). In September 2006, FEMA issued guidance for how this documentation needs to be prepared. Lack of certification will result in areas previously protected from flooding on NFIP insurance maps to be designated as flood-prone. This will result in some property owners needing to obtain flood insurance, when previously none was required.

There are two main levee systems along the Umatilla River within the City, the City Levee and the Prison Levee, which can be seen in Figure 3-2. Available information related to the origins of these levees is sparse; however, the City Levee (USACE System No. 5005000053 Pendleton 1b) was the original embankment for the area and was constructed along the north side of the downtown commercial district in the 1880s by local pioneers. Upgrades to the City Levee were completed in the mid-1930s, and in 1947 by the 2nd Portland District of the U.S. Army Corps of Engineers. The levee extends from the Highway 11 Bridge downstream to the Westgate Bridge.

Additional improvements in 1958 fortified the levee with 18 to 24 inches of revetment for additional bank stabilization and scour protection, and also included the construction of the Prison Levee (USACE System No. 5005000040 Pendleton 1a) on the west side of the Umatilla River opposite from the City's downtown area. The Prison Levee extends from the Westgate Bridge to the Interstate 84 Bridge.

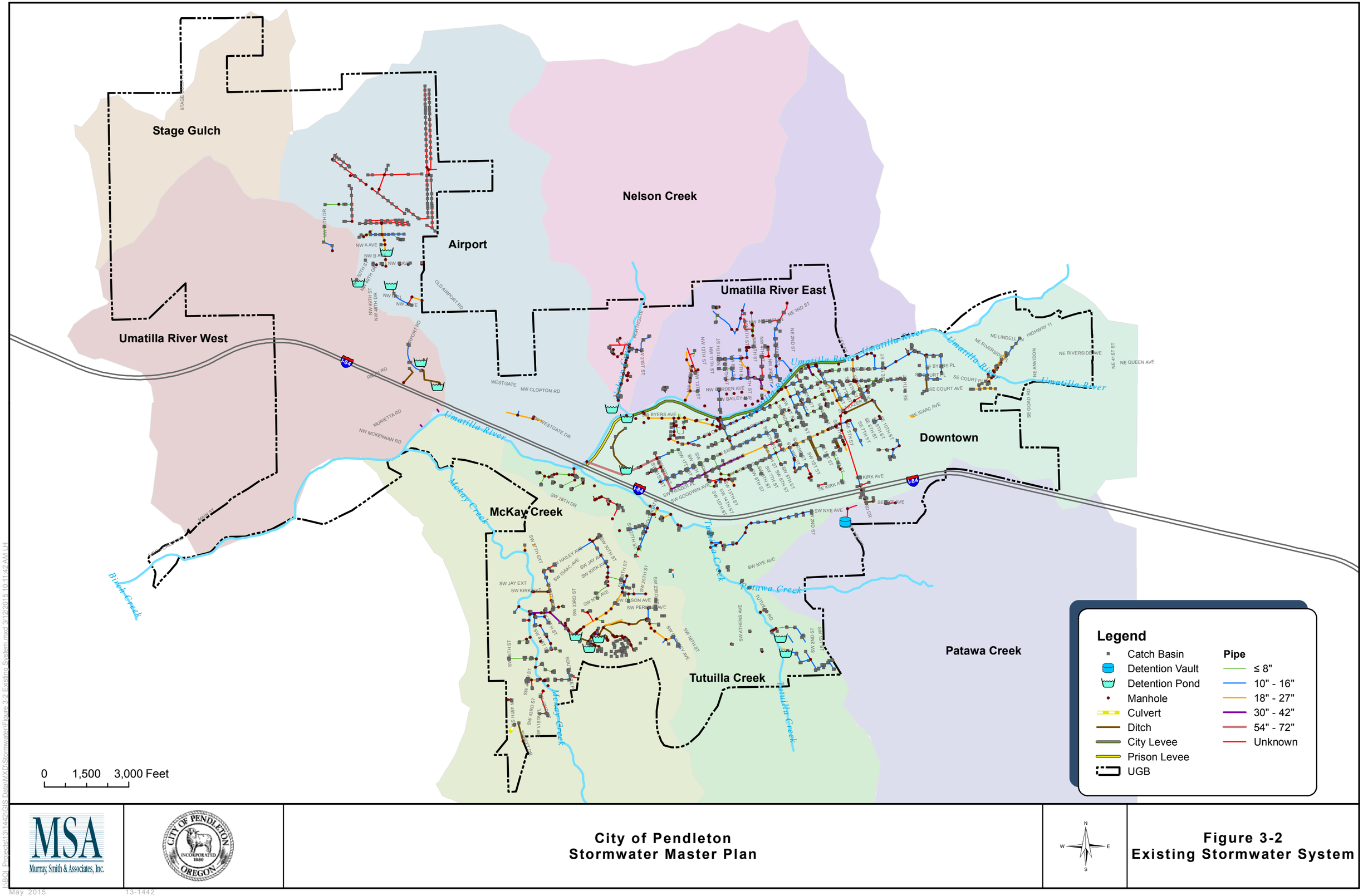
The USACE has indicated that due to construction of the Interstate 84 bridge crossing over the Umatilla River in the early 1960s at the levee location, documentation regarding the highway embankment's ability to provide flood protection is required. Additionally, trees growing along the levee have prompted the USACE to cite the levee system as non-conforming with their vegetative management policies. These two issues require resolution

in order for the levees to remain within the Federal Levee Rehabilitation Program and prevent the remapping of the downtown commercial area as flood prone on NFIP insurance maps.

A detailed historical account of the City's levees is found in an August 15, 2013 memorandum by Cornforth Consultants, contained in Appendix A. This memorandum includes the results of the Phase I review of the levees, analyzes existing documents relating to the levee system, and summarizes existing deficiencies as they relate to federal regulations.

Another Cornforth document in Appendix B, dated February 6, 2014, proposes an outline for the Phase II levee certification process. This phase includes a proposal for field reconnaissance, geotechnical evaluation of the levee's materials, and preparation of supporting technical documentation to be used in the levee certification application to FEMA.

Once the application is reviewed and deemed technically complete, FEMA's approval would then constitute a provisional levee certification for the City. This would allow the NFIP maps to remain unchanged, and flood insurance would not be required for the properties protected by the levees.



MSA
Murray, Smith & Associates, Inc.

CITY OF PENDLETON INCORPORATED 1880 OREGON

City of Pendleton
Stormwater Master Plan

Figure 3-2
Existing Stormwater System

I:\BOI_Projects\13\1442\GIS Data\MXD\Stormwater\Figure 3-2 Existing System.mxd 3/12/2015 10:11:42 AM LH

May 2015 13-1442

SECTION 4
REGULATIONS AND POLICIES

Introduction

The City of Pendleton (City) is ultimately responsible for management and operation of infrastructure provided under its jurisdiction in accordance with all known federal, state, and local regulations. This section summarizes the regulations applicable to the conveyance system and serves as the basis for the content and recommendations in this Stormwater Master Plan (SWMP).

Federal Statutes, Regulations, and Permits

Clean Water Act

The Clean Water Act (CWA) is the principal federal law in the United States governing surface water pollution. The law was passed by Congress in 1972 with the goal of protecting and restoring the nation's surface waters to fishable and swimmable conditions. This was to be accomplished primarily through regulating potential pollution sources and maintaining the integrity of wetlands.

Section 303(d) of the CWA was enacted to keep the beneficial uses of surface waters intact through the establishment of Total Maximum Daily Loads (TMDLs) allowed for pollutants. Pollutant monitoring and testing in Oregon is done by the Department of Environmental Quality (DEQ), which has listed several surface waters within the City's urban growth boundary (UGB) as quality impaired. These impaired streams and their pollutants are summarized in Table 4-1. These pollutants originate from sources such as animal wastes, chemical fertilizers, pesticides, and urban development.

The CWA was amended in 1987 to include non-point stormwater discharges generated from large communities, industries, and construction sites. These discharges are managed through the National Pollutant Discharge Elimination System (NPDES) Permit Program; the national Environmental Protection Agency (EPA) has delegated primary enforcement of these permits to the DEQ. The NPDES Permit Program is the DEQ's primary tool to enforce TMDL pollutant thresholds placed on surface water.

Table 4-1
303(d) Water-Quality Impaired Surface Waters

Pollutant/Source	Birch Creek	McKay Creek	Umatilla River	Wildhorse Creek	Tutuilla Creek	Patawa Creek
Temperature	●	●	●	●		
Flow modification	●	●	●	●	●	●
Habitat modification	●	●	●	●		
Iron	●	●	●	●		
pH	●	●	●		●	
Fecal coliform		●	●			
Manganese			●	●		
Aquatic weeds/algae			●			
Ammonia			●			
Turbidity			●			
Nitrates				●		
Sedimentation			●			

NPDES Phase I Stormwater Permits

Under Phase I of the NPDES Stormwater Permit Program, certain cities within Oregon are required to obtain a permit on their stormwater conveyance system for discharging runoff into state waters. These conveyances, referred to as Municipal Separate Storm Sewer Systems (MS4), consist of roads with drainage systems, municipal streets, catch basins, curbs, gutters, manmade channels, and storm drains. Phase I targets areas primarily within the Portland metropolitan region with populations exceeding 100,000.

NPDES Phase II Stormwater Permits

Urbanized areas identified for Phase II of the permit program consist of large populations of at least 50,000 people within close proximity and may consist of a single city or a group of closely neighboring cities.

Currently, Phase II includes Bend, the only municipality in Oregon east of the Cascade Mountains required to obtain a Phase II NPDES Permit. Although no indication or timetable currently exist for expanding the Phase II program, federal regulations grant the EPA and DEQ the discretion to require other MS4s outside of urbanized areas to apply for a permit. Given the size of Pendleton's population, its potential for incorporation into the program is unlikely in the immediate future. Table 4-2 lists Phase I and Phase II Oregon MS4 NPDES permit holders.

Table 4-2
Oregon MS4 NPDES Permit Holders

Phase I	Phase II	
Clackamas County Group	Ashland	Philomath
Portland Group	Bend	Polk County
Multnomah County	Benton County	Rogue Valley Sewer Services
Gresham Group	Corvallis	Springfield
Salem	Keizer	Troutdale
Eugene	Lane County	Turner
Clean Water Services	Marion County	Wood Village
	Medford	

Safe Drinking Water Act

The Safe Drinking Water Act (SDWA) is the principal federal law in the United States intended to ensure safe drinking water for the public. Pursuant to the act, the EPA is authorized to regulate underground injection of stormwater to safeguard drinking water quality. The Oregon DEQ's Underground Injection Control (UIC) Program regulates injection wells that place fluids underground for storage or disposal under the SDWA.

National Flood Insurance Act

The Federal Emergency Management Agency (FEMA) regulates floodplain protection in part through the National Flood Insurance Act. FEMA's Region X, located in Bothell, Washington, has regulatory oversight over the City. The agency facilitates the National Flood Insurance Program (NFIP), which provides federally subsidized insurance to properties within flood hazard areas.

Code of Federal Regulations, 44 CFR 65.10

The NFIP relies upon inundation maps to establish the level of hazard and insurance requirements for areas subject to flooding. The Code of Federal Regulations (44 CFR 65.10) defines the design criteria that levees must meet in order to protect areas from flooding under the NFIP. If levees meet these criteria, the NFIP recognizes the levee's ability to reduce the extent of the flood-prone area. In addition to outlining the design criteria for levees, this regulation defines the ongoing inspection and maintenance requirements levees must uphold to remain eligible for the NFIP.

The City is currently in the process of obtaining a Provisionally Accredited Levee (PAL) certification of the City and Prison levees with FEMA under the requirements of the NFIP

and 44 CRF 65.10. The current work program to complete the certification has been divided into three distinct phases, and a general summary of the approach towards achieving this certification is provided in Table 4-3.

Table 4-3
PAL Certification Summary

Phase	Completed	Next Steps	Description
I	X		Review historical documentation and assess data gaps to complete levee certification application. Develop an SOW, schedule and budget for Phase II.
II		X	Conduct field reconnaissance and technical evaluation of levees.
III		X	Apply to FEMA for levee certification.

Phase I has been completed through the work of a consultant. A memorandum summarizing the process is provided in Appendix A. At the time of this writing, the City is soliciting proposals to begin Phase II.

Rivers and Harbors Act

This piece of legislation is administered by the U.S. Army Corps of Engineers (USACE) to improve navigation in state waters for the purposes of transportation, commerce, and national defense. Section 10 of the Act prohibits in-water work that affects the navigable capacity of any state waters without prior approval from the USACE. Any recommended levee improvements necessary to comply with FEMA and NFIP requirements will also need USACE approval, due to its regulatory authority over levees granted through this legislation.

Endangered Species Act

Presently, an incidental "take" permit is required from the National Oceanic and Atmospheric Administration's National Marine Fisheries Service for any action that adversely impacts a federally listed or threatened species under Section 4(d) of the Endangered Species Act. According to the U.S. Department of Fish and Wildlife (Department), the only reported species in Umatilla County that may be affected by the City's actions pertaining to stormwater is the bull trout (*salvelinus confluentus*), which is listed as a threatened species. A 2002 Department study indicates that the degree to which the bull trout is affected by chemicals and sediments in stormwater runoff is unknown.

Should the bull trout's status be elevated to "endangered," the DEQ may require discharges into the Umatilla River and its tributaries within the City limits to be accompanied by

NPDES permits to enforce TMDLs established for the river. In any case, the local agency ordinances and planning policies described in this chapter exist to help protect endangered or threatened species within the City's jurisdiction.

State Statutes, Regulations, and Permits

Oregon Drainage Law

Oregon court rulings have been largely responsible for developing Oregon's drainage law. While no legislative action has been passed putting a particular law into effect, court decisions dictate that:

- Adjoining landowners are entitled to have the normal course of natural drainage maintained.
- Owners of low-lying land must accept water that naturally drains onto their land from higher elevations, but are entitled not to have the normal drainage changed or substantially increased.
- Owners of low-lying land may not obstruct the runoff from the higher-elevated land, if the landowner of the higher-elevated land has properly discharged the water.

Like any private landowner, the City must comply with Oregon drainage laws. Any public projects, such as roadway embankments, municipal developments, storm drainage systems, or culverts would be required to maintain the same natural flow pattern of runoff as before development occurred.

OAR 141, Divisions 85 and 86

Oregon Administrative Rule (OAR) 141 contains Oregon's Removal-Fill Law, which requires developers who plan to remove or fill material in state waters to obtain a permit from the Department of State Lands (DSL). Drainage projects conducted within the City may be subject to the oversight of this law if the project involves 50 cubic yards of fill or excavation to occur within a regulatory waterway. Projects conducted within essential salmon habitat are required to obtain a permit, regardless of the quantity of earthwork. Several waterways within the City's boundary meet this designation, such as McKay Creek, Patawa Creek, Tutuilla Creek, Wildhorse Creek, and the Umatilla River. Due to overlapping jurisdictional boundaries with the USACE pertaining to work within waters of the state, these permits are typically called Joint Permit Applications and are administrated by both the DSL and USACE.

OAR 340, Division 40

The CWA and SDWA are the basis for this rule, which assigns the DEQ numerous responsibilities pertaining to regulating State waters. The DEQ designates beneficial uses and establishes TMDLs for watersheds falling under these rules. It also outlines the requirements

for Underground Injection Control (UIC) facilities as they relate to groundwater quality protection.

In addition to establishing TMDLs, this OAR outlines the DEQ's responsibility for issuing NPDES discharge permits intended to limit the release of pollutants to levels the receiving water can sustain. In addition to the aforementioned MS4 permits, another subset of the NPDES project relates to construction stormwater permits (1200-C), which regulate construction activities that disturb one or more acres, and industrial stormwater permits (1200-Z), which regulate a wide variety of industrial activities.

Both the construction and industrial permits require site operators to implement stormwater best-management practices and ensure that stormwater runoff leaving their site does not violate in-stream water quality standards. Presently, the DEQ has documentation for 26 properties with UIC installations within the City.

OAR 635, Division 412

This rule states that no obstruction may be placed across state waters that are currently or historically inhabited by native migratory fish without providing passage for these fish.

OAR 660, Division 10

This state rule establishes Statewide Planning Goals (goals 5 through 7) to be carried out by the Department of Land Conservation and Development. These goals, structured to protect natural resources and conserve scenic and historical areas and open spaces, are summarized as follows:

- Goal 5 - Local governments shall adopt programs that will protect natural resources and conserve scenic, historic, and open space resources for present and future generations. Stream flow and water levels should be protected and managed at a level adequate for fish, wildlife, pollution abatement, recreation, aesthetics and agriculture.
- Goal 6 - All waste and process discharges from development shall not threaten, degrade or violate applicable environmental quality statutes, rules and standards.
- Goal 7 - Local governments shall adopt comprehensive plans to reduce risk to people and property from natural hazards, including floods. Local governments should consider programs to manage stormwater runoff as a means to help address flood and landslide hazards.

OAR 660, Division 11

Cities and counties are required by state law to develop and adopt pubic facility plans for areas within a UGB containing a population greater than 2,500 persons. These plans outline the infrastructure required to meet the needs of the area to be served and advise how to implement this infrastructure in a timely, orderly, and efficient manner.

This SWMP has been developed in conformance with Division 11 of OAR 660, and is therefore considered a public facilities plan that will act as a supporting document to the City's Comprehensive Plan. All major drainage ways (major trunk lines, streams, ditches, and detention basins) and outfall locations within the City have been documented by this SWMP as required under this ordinance.

Local Agency Ordinances and Planning Policies

City of Pendleton, Ordinance 3241 – Capital Improvements

This ordinance establishes a Capital Improvement Program within the City. It authorizes the City to construct the improvements recommended by this SWMP.

City of Pendleton, Ordinance 3693 – Floodplain Management

This ordinance authorizes the City to manage flood risk through the control of alterations to natural floodplains and stream channels within the study area. This SWMP aids the City's efforts in meeting these commitments by providing a management tool for understanding stormwater drainage within the study area.

City of Pendleton, Ordinance 3250 – Land Use and Zoning

This ordinance regulates zoning for the City within its UGB. Its intent is to protect residential, commercial, industrial, and civic areas from disturbances generated by incompatible uses. It is a critical document for preparation of this SWMP, as it defines the planning densities and uses for the study area. These zoning areas are the basis for estimating the types of pervious and impervious surfaces that can be anticipated within each drainage basin. These surface types provide the foundation for calculating the resulting runoff and sizing of conveyance infrastructure for the City's stormwater drainage system.

City of Pendleton, Ordinance 3485 – Unified Development Code

This ordinance authorizes the creation of a single Unified Development Code for development related standards and criteria. The ordinance also specifies that construction of stormwater infrastructure within the City is required to comply with the code. New standard details for construction have been created in accordance with this ordinance.

City staff is presently striving to consolidate all development-related ordinances into a Unified Development Code with a single set of development definitions and procedures. The resulting code is intended to repeal the existing Zoning and Subdivision Ordinances.

City of Pendleton, Ordinance 3791 – Flood Insurance

This ordinance enrolls the City in the NFIP and makes commitments to preserve and restore natural floodplains, stream channels and natural protective barriers which carry potential flood waters. This SWMP aids the City's efforts in meeting these commitments by providing a management tool for stormwater drainage within the study area.

The City may elect to enforce stormwater management activities related to flow control under this ordinance as increases in runoff rates and volumes from property development impact downstream floodplains. The City may also elect to create a new stormwater utility, which would help fund the levee maintenance necessary to remain eligible for the NFIP.

City of Pendleton, Ordinance 3814 – Development Near Streams

This ordinance prohibits development within 50 feet of the top bank of a stream within the UGB and was recently passed in response to Oregon's Statewide Planning Goal 5. This "safe harbor" approach towards development near water resources allows the City to bypass a more rigorous and expensive economic, social, environmental and energy (ESEE) impact analysis; however, it precludes development from occurring adjacent to streams that may otherwise have been environmentally benign.

City of Pendleton, Ordinance 3836 - Comprehensive Plan

This ordinance's Comprehensive Plan officially states the goals, policies, implementation measures and physical plan for City development. The plan was completely revised in 2011 by Winterbrook Planning to include numerous amending ordinances adopted over time. This revised document is presently under consideration for adoption by City Council under Ordinance No. 3836.

Umatilla County

Umatilla County does not have any specific regulation or rule that would apply to drainage within the City.

Future Regulations

Since enactment of the CWA, stormwater regulations are becoming more stringent, and great strides have been made in pollution reduction from point sources. While point pollution sources have been regulated, the growing source of degradation of surface waters can typically be attributed to non-point pollution sources such as urban stormwater runoff. To address these non-point sources, federal, and state agencies are working to improve their stormwater policies and regulations; current efforts applicable to the City are noted below.

Federal Regulation Considerations

The EPA announced in the spring of 2014 that it would postpone issuance of new national stormwater rules in an attempt to overhaul the federal stormwater program. The agency had previously indicated that the rules would expand the NPDES program and adopt a retention-based national performance standard for new development and redevelopment.

Instead, the EPA will direct its attention on strengthening partnerships with other federal agencies, promoting nationwide stormwater education, and bolstering existing incentive programs and greater enforcement of the current MS4 NPDES program. As the City is currently not under the NPDES permit program, the bulk of these federal efforts will likely not be applicable; however, the City may elect to enroll in incentive programs aimed at integrated planning of its water, collection, and stormwater systems.

Cities often struggle to finance construction of new stormwater infrastructures while concurrently rehabilitating aging sanitary collection systems. To assist in this challenge, the EPA is promoting integrated planning practices as a method of demonstrating compliance with the requirements of the CWA while keeping in mind the cities' limited financial resources. In some instances, SDWA expenditures have been able to qualify for relief from obligations under the CWA through the integrated planning process.

The EPA is currently initiating a pilot project for five communities to receive technical assistance in establishing integrated planning policies, with the aim of identifying efficiencies and prioritizing capital improvements that will better promote objectives of the CWA. Results from the pilot project will help develop practical examples for how to implement steps in developing an integrated plan. More information pertaining to this topic can be found at the EPA's website: http://www.epa.gov/.

State Regulation Considerations

In addition to the federal government enacting retention-based stormwater management standards promulgated by the Energy Independence and Security Act, 18 states have legislated stormwater standards aimed at requiring a retention-based metric. While the federal stormwater rulemaking has been deferred, many states are imposing stricter stormwater standards. The DEQ has yet to indicate its position on enacting a retention-based standard, making these types of requirements within the state uncertain.

Phase II of the NPDES Stormwater Permit program was DEQ's most recent effort to expand stormwater requirements for municipalities within the state. While it has been nearly a decade since the last NPDES program expansion, any future expansion plans for the program remain unclear. The tools are in place for DEQ to require the City to apply for an NDPES permit through the provisions of the CWA and the ESA.

Some communities that neighbor the City have recently revised their stormwater management practices to improve surface water quality. Eastern Washington has adopted

standards due to the imposition of NPDES Permit requirements by the Washington State Department of Ecology. Cities and counties in central Oregon, including Bend, Redmond, Madras, Prineville, Sisters, Deschutes County and Crook County, have voluntarily begun to update their management policies to be at the forefront of developing standards to improve stormwater management.

Because the requirement for an NPDES Permit may materialize in the future, the formation of a stormwater utility within the City's Public Works Department would be highly desirable. The City would be responsible for enforcement of the conditions of the permit, including routine operation and maintenance of the stormwater drainage system. Creation of stormwater standards applicable to development within the City is also anticipated to be required by a future permit.

Local Agency Regulation Considerations

The City currently lacks a formal stormwater management manual of development standards. Such a manual would help formulate cohesive policy and guide orderly development within the jurisdiction through a transparent set of drainage criteria, rules and guidelines, and would also allow for the transfer of knowledge on the administrative side of system operations as staffing changes occur. The communities previously mentioned in Deschutes County and Crook County have developed the Central Oregon Stormwater Manual (COSM) with these objectives in mind.

It is recommended that the City either adopt the COSM into ordinance, or generate a similar manual specific to the City's regional needs. COSM may be adopted in its entirety, or through enacting amendments applicable to the City's unique needs. If the City is required to follow NPDES requirements in the future, it will likely need to create a development standards manual. Adoption of the COSM by the City would proactively meet this NPDES requirement.

The enforcement of the stormwater standards within the document would need to be conducted through dedicated staff under a new stormwater utility division within the City's Public Works Department. More information pertaining to this new utility is provided in Section 6—Operations and Maintenance. The formation of a stormwater utility by the City would also be a desirable step towards maintaining the levee system in conformance with NFIP and FEMA requirements. Ongoing operation and maintenance activities to keep the levees functional would be funded through the utility fees established and collected by the utility.

SECTION 5
SYSTEM ANALYSIS

Introduction

This section evaluates the City of Pendleton's (City's) stormwater system under existing and future conditions. The following analysis summary was developed using InfoSWMM software and additional modeling tools such as HEC-HMS. The results of this analysis were used to identify system deficiencies and recommend system improvements presented in Section 7—Capital Improvement Program.

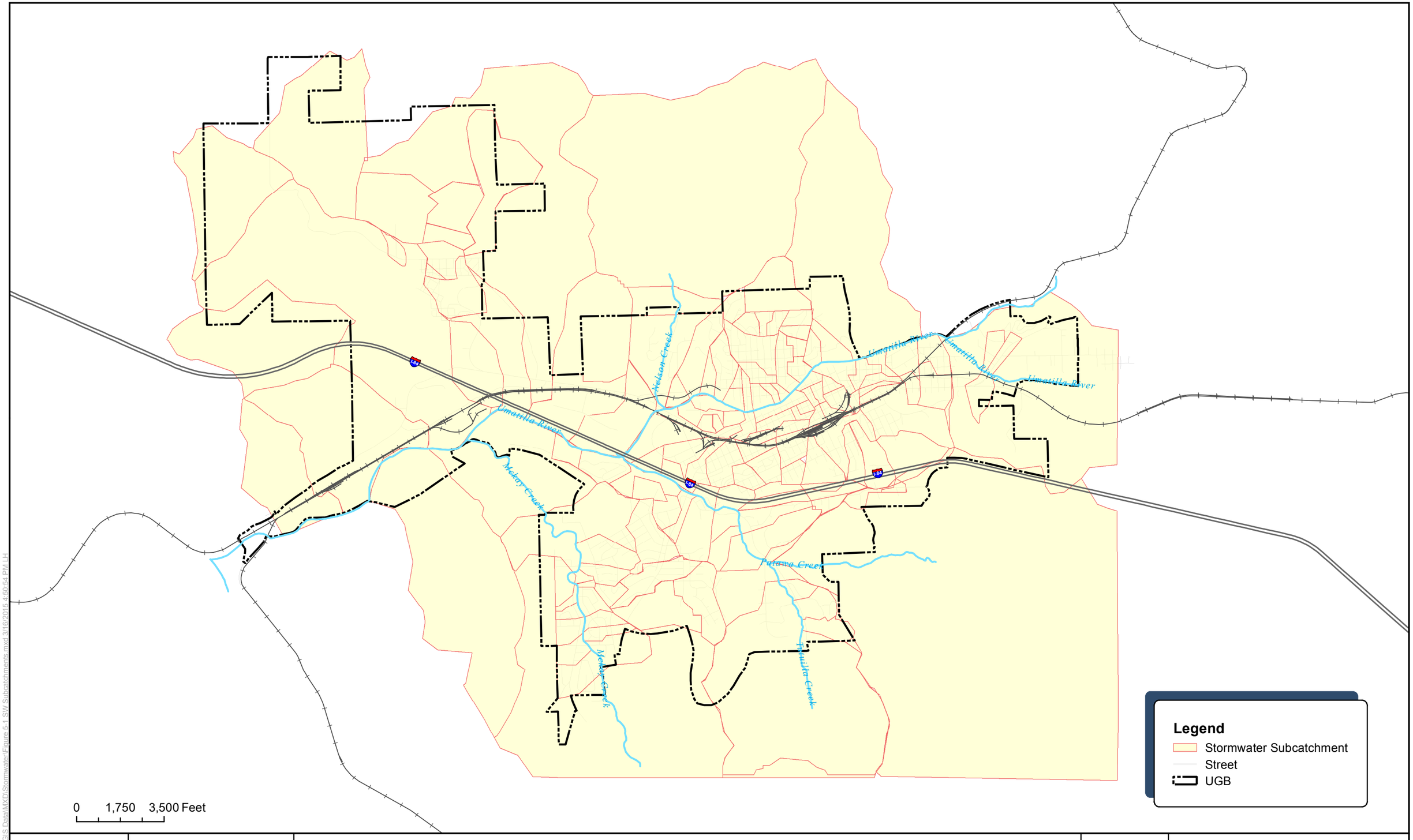
The methodology used to evaluate the stormwater system contains both hydrologic and hydraulic components. The hydrologic components address generation of runoff within the study area and consider climate, topography, soil type, land use and development status. The hydraulic component addresses how the physical stormwater system responds to the runoff generated.

Hydrologic Analysis Methodology

The hydrologic component of stormwater analysis converts a rainfall hyetograph (rainfall over time) into a runoff hydrograph (flow rate over time) that can be applied to the physical stormwater system. The conversion of rainfall to runoff is a complex process influenced by initial loss (ponding, depression storage), loss over time (evapotranspiration, infiltration), and flow routing. These processes depend on factors such as soil type, land cover, topography, and antecedent moisture conditions. Several methods that consider the various processes can be used to generate a runoff hydrograph. For this Stormwater Master Plan (SWMP), the Natural Resources Conservation Service (NRCS) curve number method was used.

Subcatchments

The NRCS method requires a number of inputs for runoff calculation. The inputs were determined for each subcatchment within the study area; 192 subcatchments were delineated based on topography, stormwater infrastructure and other runoff barriers such as roads and railroads. Figure 5-1 illustrates the subcatchment delineation established and used in this analysis.



MSA
Murray, Smith & Associates, Inc.

CITY OF PENDLETON INCORPORATED 1880 OREGON

City of Pendleton
Stormwater Master Plan

N
W
E
S

Figure 5-1
Stormwater Subcatchments

\\BOI_Projects\13\1442\GIS Data\MXD\Stormwater\Figure 5-1 SW Subcatchments.mxd 3/16/2015 4:50:54 PM LH

May 2015 13-1442

Curve Number

The NRCS method utilizes a curve number (CN) to describe the runoff condition within a subcatchment. CNs are calculated based on land cover, soil type, and antecedent conditions. For this analysis, an area-weighted composite CN was developed for each subcatchment based on specific land cover and soil conditions within the subcatchment. The composite CN reflects the amount of impervious area within its subcatchment, the amount of infiltration that will occur, and how much runoff is generated from a rain event. CNs range from 0-100, with 0 reflecting no runoff and 100 reflecting a condition where all effective rainfall runs off of a given surface. The City's developed downtown areas have a high CN; in contrast undeveloped areas primarily consisting of open land have much lower CNs and therefore generate significantly less runoff from a rain event.

Tax lot development status was used to estimate existing and build-out conditions for each subcatchment. Two separate sets of CNs were developed to reflect existing and projected system runoff. The composite CN was determined by tax lot, with those identified as undeveloped assumed to be open space; the CN for developed tax lots was based on land use and soil type.

Antecedent (pre-rain event) moisture conditions also impact CN. The soil saturation level plays a role in how much water is lost through infiltration and how fast water will run off of a given soil. While both wet and dry antecedent conditions were tested in this analysis, a dry condition was selected for the final analysis. Due to the selection of a summer design storm discussed later in this section, using dry antecedent conditions aligns the soil moisture conditions typically present during the arid summer months with the type of storm that typically occurs in the summer. The final CN values for each subcatchment are presented in Table 5-1.

Time of Concentration

Time of concentration (Tc) and travel time (Tt) measurements are necessary to estimate runoff. Tc is the time it takes for water to travel from the most distant point within a subcatchment to a given point of interest. Tt is the time it takes water to travel from one place to another within a basin and depends on land cover, soil type, topography, and the existence of channels along a flow path.

For this analysis, the point of interest within each subcatchment is where runoff enters the conveyance system. For more complex flow paths, Tc is the sum of Tt for each segment of the flow path from the most distant point within a subcatchment to the system inlet.

In this analysis, the Tc for each subcatchment was calculated using the method outlined in NRCS TR-55. This method considers both sheet flow and shallow concentrated flow. Sheet flow is assumed to occur for only the first 300 feet of a flow path, and after that is assumed to be shallow concentrated flow.

A flow path was identified from the most distant point within each subcatchment to the stormwater system inlet. The average slope of the flow path was estimated using GIS contour information. If the flow path was longer than 300 feet, sheet flow was assumed for the first 300 feet, followed by shallow concentrated flow.

Sheet flow Tt is calculated using Manning's kinematic solution, which considers slope, flow path length, rainfall depth and a roughness coefficient based on land cover. Shallow concentrated flow Tt is estimated based on surface type (paved or unpaved). The Tt for the sheet flow and shallow concentrated flow segments are added to determine Tc.

Initial Loss

An additional component used to determine runoff is initial loss. This term includes both interception of rainfall by vegetation and depression storage in the form of puddles or ponding of water behind runoff barriers. Rainfall lost in either of these ways will not contribute to runoff and remains within the subcatchment. This term was adjusted during model calibration, and a final value of 0.1 inches was used.

Calculation

Using the variables described above, a rainfall hyetograph can be converted to a runoff hydrograph. The initial loss term subtracts a given amount of the total rainfall that will remain within the subcatchment, and determines the effective rainfall. The runoff flow is determined using the CN term, and flow routing and timing is determined using Tc. At this point, the rainfall time series has been converted to a flow time series that can be applied to a stormwater inlet. The runoff described above was calculated using both InfoSWMM and HEC-HMS models.

Both of these programs can be setup to utilize the NRCS CN method and both require the same inputs. The results of the InfoSWMM model runoff calculations can be applied to a system inlet established in the same model, thereby allowing for hydraulic analysis of the system. InfoSWMM cannot calculate runoff for subcatchments without a loading point where runoff enters stormwater collection system.

Many of the subcatchments within the project area have no stormwater infrastructure, or there is insufficient information to include the subcatchment's infrastructure in a hydraulic model. Where insufficient data excluded the subcatchment from the InfoSWMM model, runoff was calculated using HEC-HMS. Subcatchment attributes, including Tc, existing CN, build-out CN, area, and the calculation method are presented in Table 5-1.

Table 5-1
Subcatchment Attributes

Subcatchment ID	Existing CN	Build-Out CN	Area (acres)	Tc (min)	Modeling Method
11	49	3	439	174	HEC-HMS
12	65	87	1062	90	HEC-HMS
13	83	84	33	6	InfoSWMM
14	68	68	1598	97	HEC-HMS
15	70	80	1112	106	HEC-HMS
16	80	81	76	51	HEC-HMS
17	59	69	767	134	HEC-HMS
18	66	85	473	73	HEC-HMS
19	67	78	91	51	HEC-HMS
20	67	91	440	69	HEC-HMS
21	78	80	58	113	InfoSWMM
22	90	90	7	6	InfoSWMM
23	55	72	259	67	HEC-HMS
24	74	77	29	243	InfoSWMM
25	64	87	2969	185	HEC-HMS
26	66	78	188	45	HEC-HMS
27	70	82	1422	78	HEC-HMS
28	73	80	878	99	HEC-HMS
29	88	92	12	22	HEC-HMS
30	67	84	112	15	HEC-HMS
31	78	81	58	4	HEC-HMS
32	90	90	7	1	HEC-HMS
33	88	89	26	52	InfoSWMM
34	87	88	44	6	InfoSWMM
35	78	78	11	8	InfoSWMM
36	74	77	28	29	HEC-HMS
37	92	92	14	6	InfoSWMM
38	72	79	24	17	HEC-HMS
39	83	87	20	8	InfoSWMM
40	87	91	24	54	InfoSWMM
41	88	92	36	16	InfoSWMM
42	90	90	12	6	InfoSWMM
43	89	90	13	17	InfoSWMM
44	69	75	45	6	InfoSWMM
44	69	75	45	6	HEC-HMS
45	59	72	873	95	HEC-HMS

Subcatchment ID	Existing CN	Build-Out CN	Area (acres)	Tc (min)	Modeling Method
47	90	90	26	33	HEC-HMS
48	87	88	44	36	HEC-HMS
49	92	92	11	41	HEC-HMS
50	67	86	19	6	InfoSWMM
51	78	81	68	23	HEC-HMS
54	78	78	28	12	InfoSWMM
55	90	91	17	6	InfoSWMM
56	92	92	8	6	InfoSWMM
57	89	89	16	29	HEC-HMS
58	82	83	20	17	HEC-HMS
59	73	87	51	6	InfoSWMM
61	63	83	24	17	HEC-HMS
62	83	92	36	17	HEC-HMS
63	83	87	16	177	InfoSWMM
64	88	91	13	8	HEC-HMS
65	68	76	45	6	HEC-HMS
66	78	88	18	4	HEC-HMS
68	78	78	18	8	InfoSWMM
69	91	92	17	10	InfoSWMM
70	91	92	23	6	InfoSWMM
73	79	80	31	6	InfoSWMM
74	84	90	16	14	InfoSWMM
75	81	81	18	6	InfoSWMM
76	80	80	58	6	InfoSWMM
78	79	79	12	4	InfoSWMM
79	86	86	12	6	InfoSWMM
81	77	80	43	6	InfoSWMM
83	82	82	28	7	HEC-HMS
84	90	91	17	3	HEC-HMS
85	92	92	8	4	HEC-HMS
86	78	88	156	6	InfoSWMM
87	82	82	12	5	HEC-HMS
88	82	82	39	6	InfoSWMM
89	75	94	15	5	HEC-HMS
90	63	74	80	6	InfoSWMM
91	82	87	124	21	InfoSWMM
95	79	81	30	2	HEC-HMS
96	66	91	70	1	HEC-HMS
98	83	83	35	10	HEC-HMS

Subcatchment ID	Existing CN	Build-Out CN	Area (acres)	Tc (min)	Modeling Method
99	82	88	16	4	HEC-HMS
100	81	81	44	28	InfoSWMM
100	81	81	44	28	HEC-HMS
101	81	83	17	8	InfoSWMM
102	65	81	0	16	InfoSWMM
102	62	81	32	7	HEC-HMS
103	73	85	31	17	InfoSWMM
104	80	83	12	88	InfoSWMM
105	69	69	12	76	InfoSWMM
106	68	68	6	116	InfoSWMM
107	69	69	7	130	InfoSWMM
108	77	77	1	161	InfoSWMM
109	78	78	4	9	InfoSWMM
110	78	78	13	7	InfoSWMM
111	82	82	38	78	InfoSWMM
112	64	75	87	33	InfoSWMM
113	79	79	28	24	InfoSWMM
114	68	68	11	42	InfoSWMM
115	86	87	24	95	InfoSWMM
116	79	79	11	6	InfoSWMM
117	81	81	18	2	HEC-HMS
119	80	80	58	13	HEC-HMS
121	76	77	37	9	HEC-HMS
122	79	79	12	50	HEC-HMS
123	82	82	11	7	InfoSWMM
124	92	92	6	6	InfoSWMM
125	92	92	7	17	InfoSWMM
128	79	81	43	6	HEC-HMS
130	81	81	17	11	HEC-HMS
131	88	89	9	6	InfoSWMM
133	91	92	7	15	InfoSWMM
134	70	88	73	20	HEC-HMS
135	83	88	156	61	HEC-HMS
138	77	89	14	14	HEC-HMS
139	88	88	39	9	HEC-HMS
141	88	88	5	42	HEC-HMS
143	62	82	80	60	HEC-HMS
145	82	88	124	38	HEC-HMS
147	77	77	64	53	HEC-HMS

Subcatchment ID	Existing CN	Build-Out CN	Area (acres)	Tc (min)	Modeling Method
149	76	77	14	27	HEC-HMS
151	75	89	26	8	HEC-HMS
152	67	86	60	46	HEC-HMS
153	66	89	20	69	HEC-HMS
154	66	89	19	78	HEC-HMS
155	73	73	8	96	HEC-HMS
156	75	75	11	6	HEC-HMS
157	65	68	3	4	HEC-HMS
158	74	74	24	9	HEC-HMS
160	82	82	73	47	HEC-HMS
163	64	74	229	20	HEC-HMS
164	75	78	52	15	HEC-HMS
165	69	69	24	25	HEC-HMS
166	66	68	6	7	HEC-HMS
167	67	90	24	47	HEC-HMS
169	84	88	41	57	HEC-HMS
171	76	79	83	48	HEC-HMS
172	67	93	54	3	HEC-HMS
173	84	91	18	47	HEC-HMS
174	83	90	9	3	HEC-HMS
176	66	75	37	3	HEC-HMS
178	63	76	29	31	HEC-HMS
179	78	81	155	17	HEC-HMS
181	79	79	11	2	HEC-HMS
182	66	94	28	72	HEC-HMS
183	74	76	49	22	HEC-HMS
184	74	74	23	1	HEC-HMS
185	64	70	25	10	HEC-HMS
187	70	87	137	70	HEC-HMS
189	73	75	34	42	HEC-HMS
191	86	86	11	27	HEC-HMS
192	92	92	6	57	HEC-HMS
193	92	92	7	5	HEC-HMS
194	85	86	22	53	HEC-HMS
195	92	92	5	8	HEC-HMS
196	92	92	8	4	HEC-HMS
197	87	89	19	38	HEC-HMS
198	75	76	21	45	HEC-HMS
200	89	92	9	1	HEC-HMS

Subcatchment ID	Existing CN	Build-Out CN	Area (acres)	Tc (min)	Modeling Method
201	91	91	14	7	HEC-HMS
202	90	92	7	4	HEC-HMS
203	76	76	28	5	HEC-HMS
204	76	82	19	2	HEC-HMS
207	74	74	22	6	HEC-HMS
208	70	81	16	4	HEC-HMS
209	80	82	16	8	HEC-HMS
210	66	92	59	14	HEC-HMS
211	71	82	34	3	HEC-HMS
212	69	80	10	2	HEC-HMS
274	70	94	6	2	HEC-HMS
275	70	94	6	2	HEC-HMS
127A	78	80	5	6	InfoSWMM
128A	92	92	8	11	InfoSWMM
129A	89	90	19	6	InfoSWMM
130A	76	77	21	18	InfoSWMM
19_A	91	92	12	85	InfoSWMM
83A	59	86	190	11	InfoSWMM
84A	78	80	28	6	InfoSWMM
85A	78	80	73	7	InfoSWMM
SG_1	63	68	4	6	InfoSWMM
SG_2	77	77	17	6	InfoSWMM
SG_3	67	89	87	6	InfoSWMM
SG_4	59	59	44	6	InfoSWMM
SUB-10	85	89	7	6	InfoSWMM
SUB-12	80	85	6	6	InfoSWMM
SUB-14	40	62	90	31	InfoSWMM
SUB-16	73	76	16	6	InfoSWMM
SUB-18	72	81	12	6	InfoSWMM
SUB-20	76	82	10	6	InfoSWMM
SUB-22	80	81	15	6	InfoSWMM
SUB-24	90	91	12	6	InfoSWMM
SUB-26	92	92	7	6	InfoSWMM
SUB-28	92	92	6	6	InfoSWMM
SUB-30	89	89	9	6	InfoSWMM
SUB-32	81	81	16	6	InfoSWMM
SUB-34	78	79	21	6	InfoSWMM
SUB-36	81	81	6	6	InfoSWMM
SUB-38	88	90	13	6	InfoSWMM

Hydraulic Analysis Methodology

The hydraulic analysis investigates the impact of subcatchment runoff on the stormwater system. Important attributes required for this analysis include system infrastructure locations, connectivity, and conveyance system geometry.

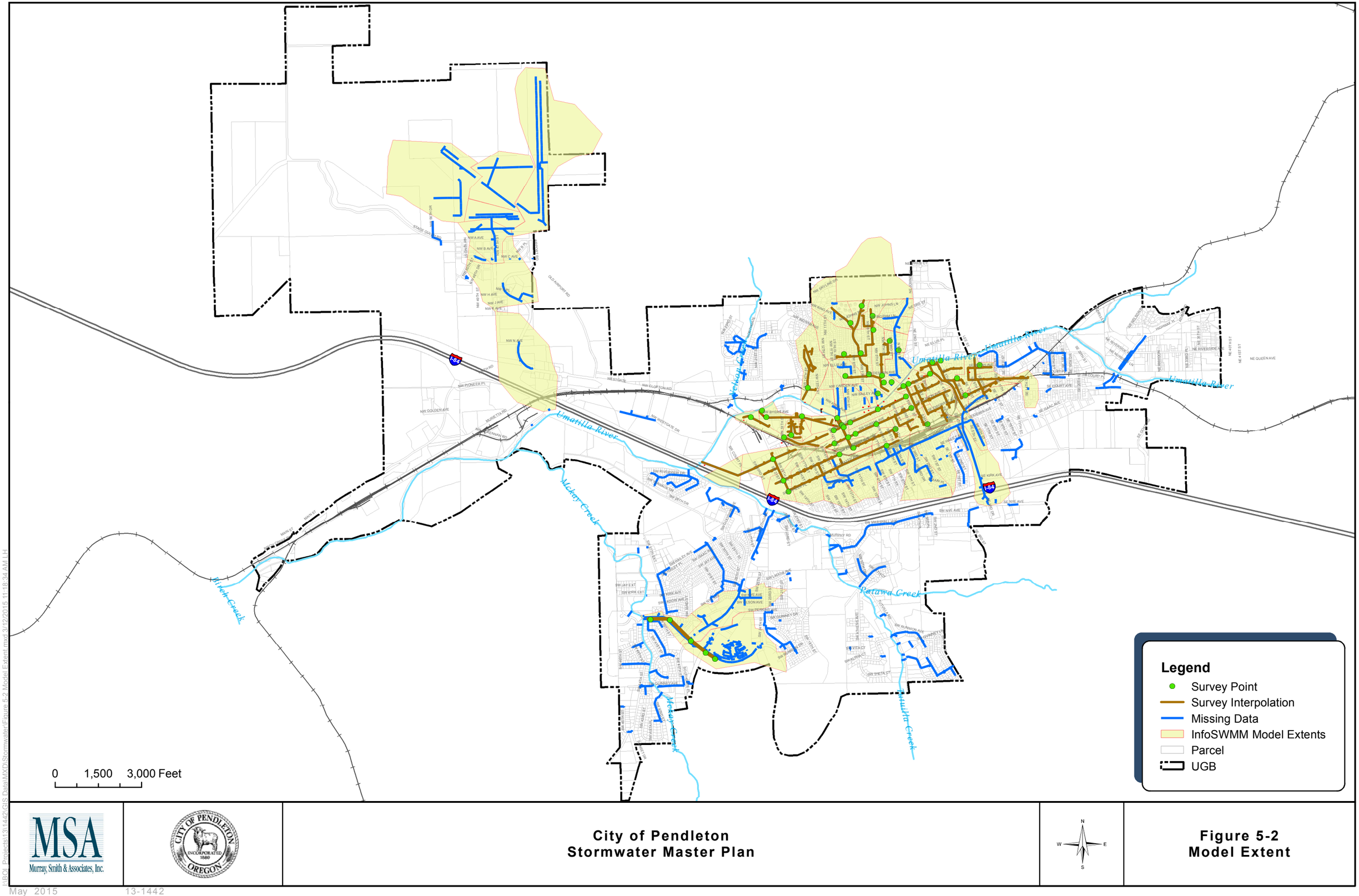
Conveyance system information was provided by the City, primarily in the form of maps and record drawings that illustrate pipe alignment and pipe diameters. This information was compiled in a GIS database used as the primary source of information for the hydraulic model. Additional survey information was collected to develop pipe profiles for the main downtown portion of the system and the Southgate area. Because of the small extent of survey information, much of the system did not have known or verified elevation or slope information. In those cases, manhole elevations and pipe slopes were interpolated using survey data, minimum pipe slope standards, and topography.

The City's entire stormwater drainage system was analyzed during this master planning process; however, due to the lack of system information in most locations, the hydraulic modeling of the system was conducted using two separate methods. Where survey and general system information was more readily available and flooding had been reported during past rain events, a dynamic simulation was performed using InfoSWMM. These areas were primarily confined to the downtown commercial area, but selected areas near the airport and Southgate districts were analyzed in InfoSWMM using supplemental data at the request of the City. The InfoSWMM model provides dynamic system results, including backwater effects and surcharging. The remainder of the system was evaluated using HEC-HMS. An overview of which parts of the study area were modeled using InfoSWMM or HEC-HMS is shown in Figure 5-2.

A simplified non-dynamic calculation method was used to analyze the rest of the system. Where pipe material data was available, an appropriate roughness coefficient was applied. Where no pipe material data was provided, a Manning's roughness coefficient of 0.013 was assumed.

Select outfall inverts were also surveyed during data collection. Following field verification of several outfall locations, it was determined that all outfalls could be modeled as a free surface. Outfalls on the south bank of the Umatilla River were well above the ordinary high-water elevation, typically established by line in visible vegetation near the water surface. The stormwater conveyance system's slope on the north side of the river provides enough head so that a submerged outfall would have little or no impact on flow.

The stormwater system contains infrastructure other than pipes, including ditches, detention ponds and vaults. These components are included in the GIS database, but very few of them have enough attribute data to include them in the hydraulic model. Two detention ponds located in the Southgate area of the McKay Creek Basin are exceptions, and are included in the model. The information available for detention facilities is outlined in Section 3—Existing System Description, Table 3-2.



MSA
Murray, Smith & Associates, Inc.

CITY OF PENDLETON INCORPORATED 1880 OREGON

City of Pendleton
Stormwater Master Plan

N W E S

Figure 5-2
Model Extent

I:\BOI_Projects\13\1442\GIS Data\MXD\Stormwater\Figure 5-2 Model Extent.mxd 3/12/2015 11:18:34 AM LH

May 2015 13-1442

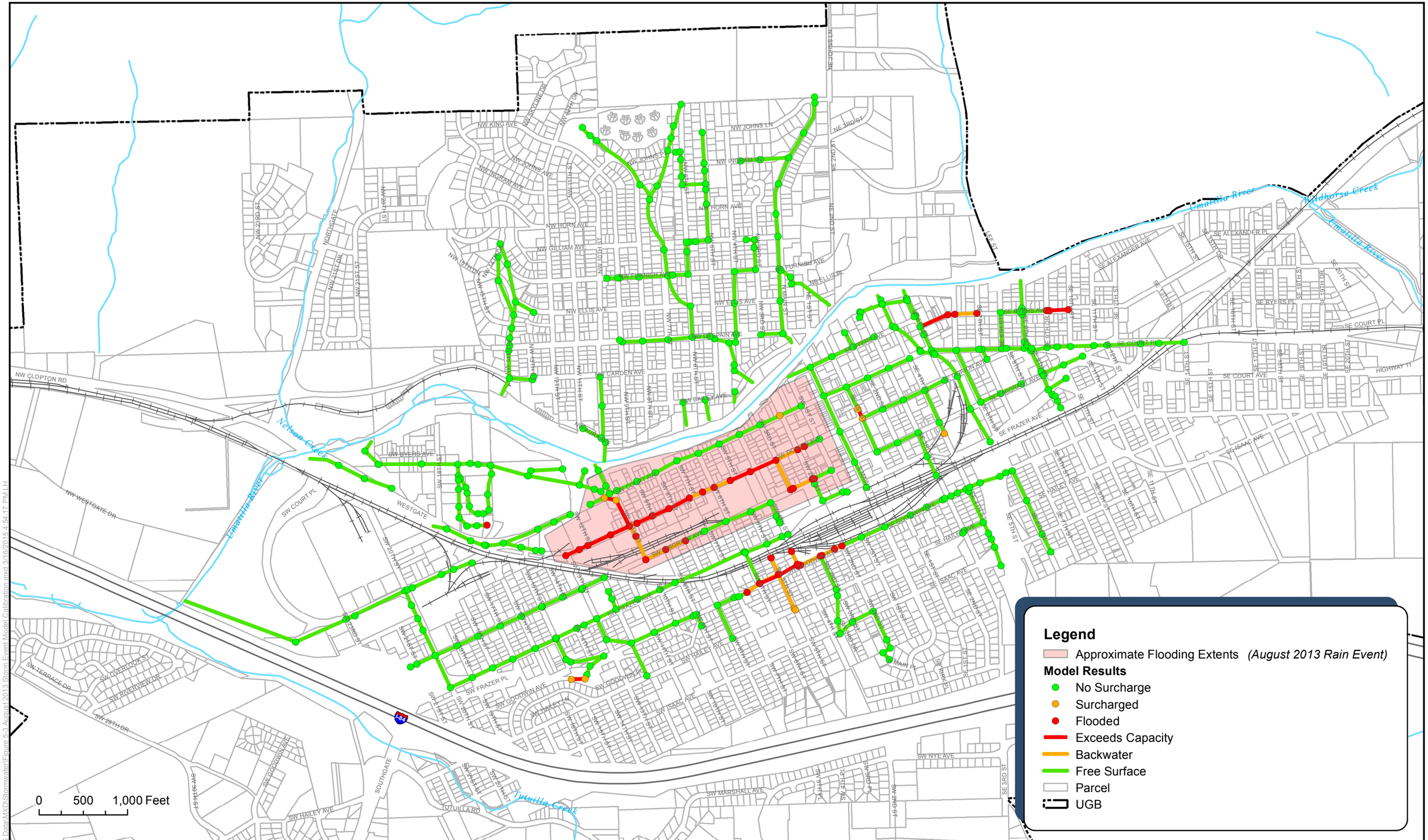
Model Calibration

Hydraulic and hydrologic models are typically calibrated after they have been developed to verify that the model produces results consistent with the physical system.

Model calibration often involves comparing model results to field observations and data collected from the conveyance system, and adjusting model parameters until the results from the model and field data are reasonably close. For this system, no measured flow data was available. The calibration was based on comparing model results to firsthand accounts of the system during August 2013 and June 2014 rain events. Accounts provided for the August event are primarily in the downtown area, while the firsthand accounts from the June event are mostly outside of the InfoSWMM model area or relate to detention facilities. As a result, the August event was used as the primary calibration event. During these events, several areas experienced overflow caused by either manhole flooding, or lack of drainage from surfaces due to a full system.

Based on their location, a number of manholes and pipes in the model were determined relevant to the flooding that had been observed. Measured rainfall data from the calibration events was loaded into the detailed InfoSWMM model, and results were compared to the firsthand accounts provided by the City. Initial loss, CN and subcatchment delineation, and loading distribution were adjusted until the model results provided a reasonable approximation of the actual system performance during the calibrated rain event. This is an example of a qualitative calibration process. A comparison between model results and the flooding location from the August 2013 rain event is shown in Figure 5-3.

Calibration based on flow data provides for greater confidence in results compared to a qualitative calibration process. The model was built using a number of approximations and interpolations most significantly related to system geometry and elevation data. Slope plays a critical role in system capacity; therefore, assumptions made for unknown pipe slopes could significantly misrepresent system capacity. To provide greater accuracy and increased confidence in model results, further calibration of this model is recommended, along with the collection of additional system information for unknown pipe lengths, diameters, and inverts.



MSA
Murray, Smith & Associates, Inc.

CITY OF PENDLETON
INCORPORATED 1880
OREGON

City of Pendleton
Stormwater Master Plan

N
W
E
S

Figure 5-3
Model Calibration

May 2015 13-1442

I:\BOI_Projects\13\1442\GIS Data\MXD\Stormwater\Figure 5-3 August 2013 Storm Event Model Calibration.mxd 3/16/2015 4:54:17 PM LH

Design Storm Selection

Following model calibration and verification, a design storm was used to evaluate the stormwater system and identify system deficiencies. A synthetic rainfall event is often used where total rainfall depth and rainfall distribution are based on statistical analysis of precipitation data. The *NOAA Rainfall Atlas 14* is one resource typically used to determine rainfall depth. The depth estimated in the *Atlas* is based on data from a number of precipitation gauges and does not always provide an accurate rainfall depth for a specific location.

The NRCS has developed a number of rainfall distributions that can be applied to the total rain event depth to generate a synthetic hyetograph for a design storm. Two types of distributions commonly observed in Pendleton are the Type 1A and Type 2 distributions, which are described as follows:

- The Type 1A storm distribution is typical of the Pacific maritime climate. This distribution is characterized by low to moderate intensity precipitation, and typically occurs in the late spring and early summer. More regional in nature, these storms are typically responsible for producing floods with moderate peak discharge and large runoff volumes.
- The Type 2 storm distribution is representative of much of the United States. These "thunderstorms" typically occur in the late spring through early fall, and are characterized by high rainfall intensities for short periods over localized areas.

The frequency analysis used to develop the *Atlas'* estimated rainfall depth can also be completed using local precipitation data to provide a location specific design storm rainfall depth. A description of this process is provided in the following paragraphs. Both 10- and 25-year storm events were evaluated in the design storm development.

Pendleton Design Storm Development

A rainfall frequency analysis was completed to validate the *NOAA Atlas 14 Type 2* precipitation maps for the Pendleton area. The Pendleton Eastern Oregon Regional Airport precipitation gauge (Station ID- GHCND:USW00024155) was used for the frequency analysis, and the period of record is January 1, 1928 to August 4, 2014. In addition to comparing the general frequency analysis to the *Atlas* rainfall depth, summer and winter rainfall depths were calculated to examine the seasonal variation in storm events in the City.

Maximum annual rainfall events for each year on record were compiled and ranked by total rainfall depth. This procedure was repeated for summertime and wintertime events. The result produced a list of 87 rainfall events for each frequency analysis. These data points were fitted to a Gumbel distribution to develop a probability distribution function for each data set, as shown in Figure 5-4. The probability distribution function was then used to estimate the rainfall depth for storm events with a given recurrence interval.

A summary of the frequency analysis results are shown in Table 5-2. Histograms developed for the overall, summer and winter storms are shown in the Figures 5-5, 5-6, and 5-7.

Table 5-2
Storm Frequency Analysis

Storm Event	NOAA Atlas	Frequency Analysis Depth	Frequency Analysis Summer Storm Depth[1]	Frequency Analysis Winter Storm Depth[2]
10-Year, 24-Hour	1.4 in.	1.20 in.	1.07 in.	1.01 in.
25-Year, 24-Hour	1.6 in.	1.46 in.	1.35in.	1.23in.

[1] *Summer events occur from May 1 until September 30.*
[2] *Winter events occur from October 1 until April 30.*

Figure 5-4
Rainfall Probability Distribution at Pendleton Eastern Regional Airport

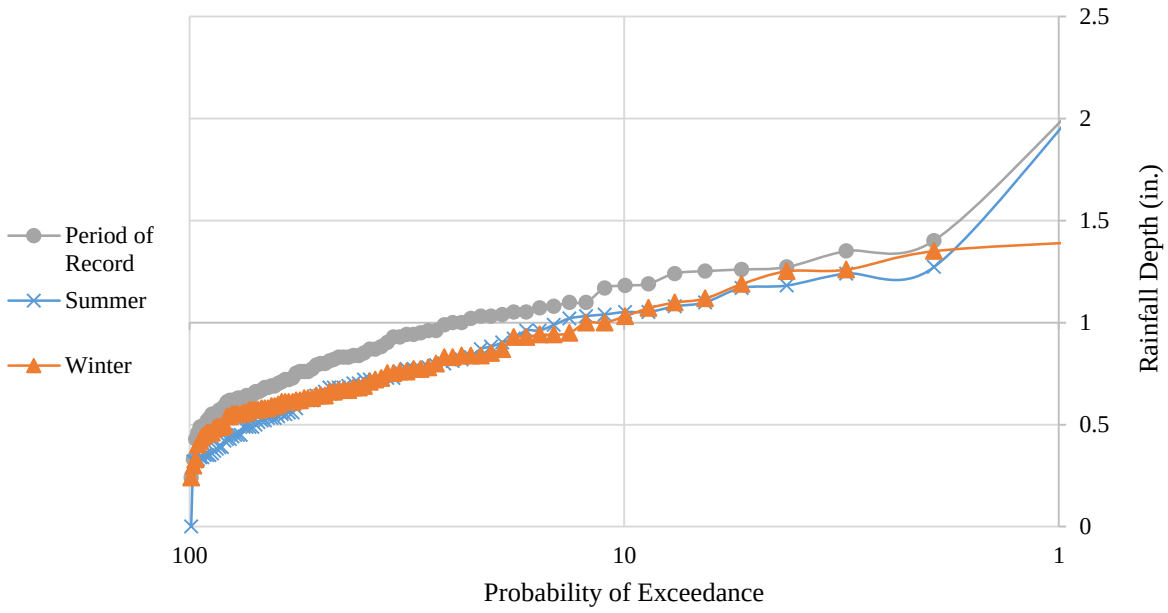


Figure 5-5
Histogram for Overall Period of Record

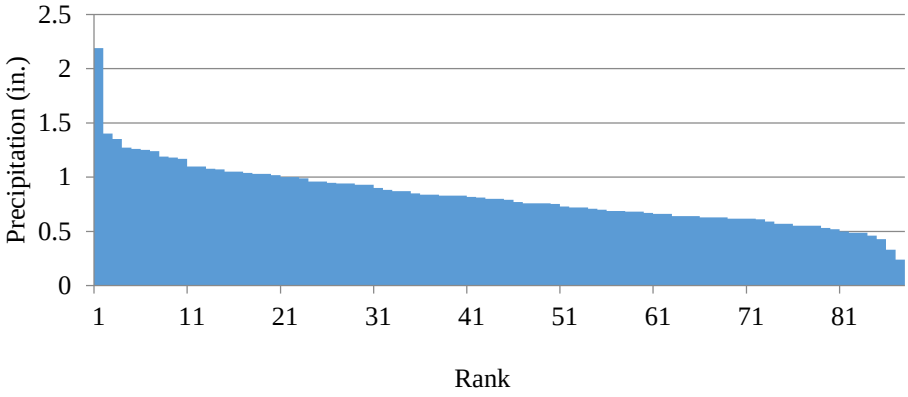


Figure 5-6
Histogram for Summer Storm Events

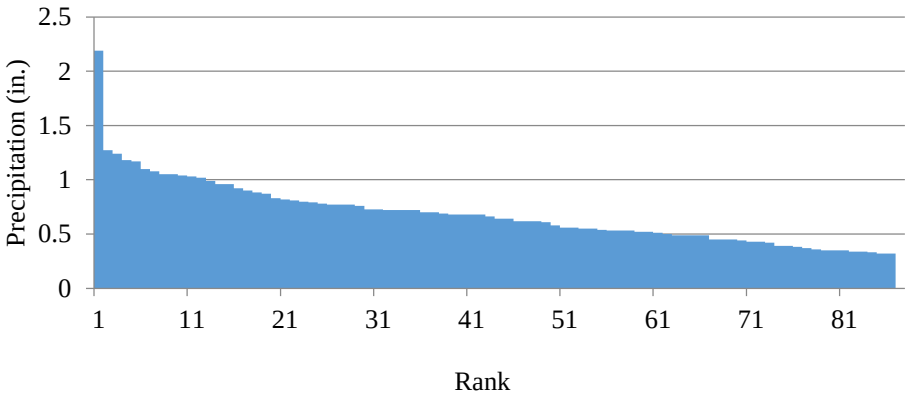
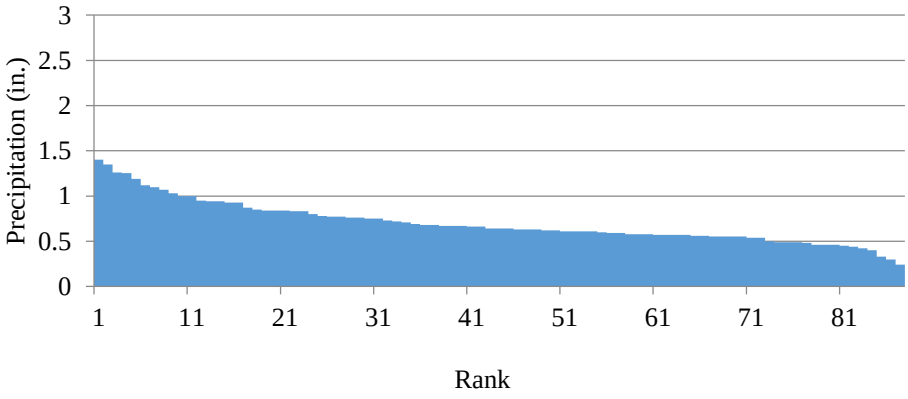


Figure 5-7
Histogram for Winter Storm Events



Rainfall Distribution

Both Type 1A and Type 2 NRCS design storm distributions, shown in Figure 5-8, are valid for Oregon. To determine which type of storm to use, hourly precipitation data from Pendleton Eastern Oregon Regional Airport beginning in December 1, 1948 was evaluated. Several of the rain events that have caused localized flooding in the City have occurred during summer months. Therefore, summer rain events were used to investigate an appropriate rainfall distribution for the City's design storm. Summer storm events (May through October) with a total rainfall depth greater than 0.6 inches (approximately a 2-year event) were examined to determine the most applicable design storm distribution to apply to the rainfall depth calculated in the frequency analysis. During the period of recorded hourly rainfall data (1948-2014), only 14 storm events meet the criteria listed above. Several representative storms are shown in Figures 5-9 through 5-11 along with the theoretical Type 2 rainfall distribution. Figures 5-12 and 5-13 also include the Type 1A distribution.

Figure 5-8
Theoretical Rainfall Distribution Comparison

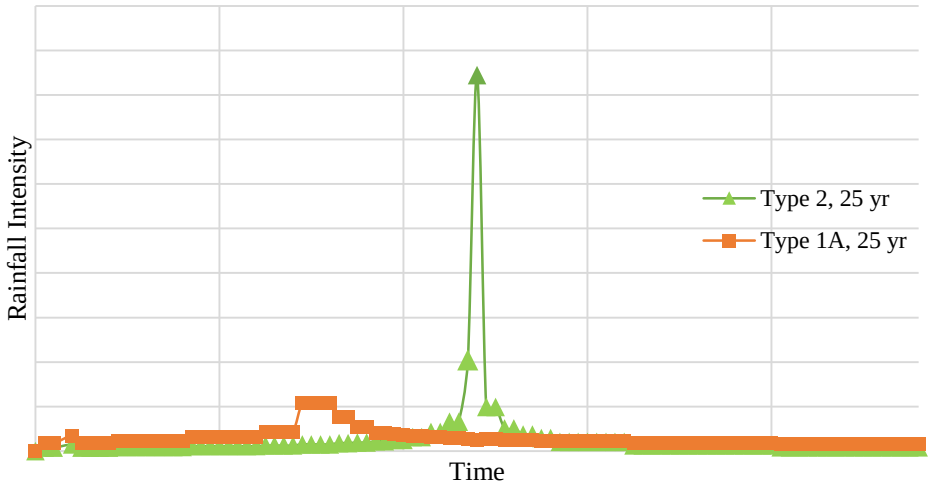


Figure 5-9
Distribution Comparison, June 1991 Storm Event

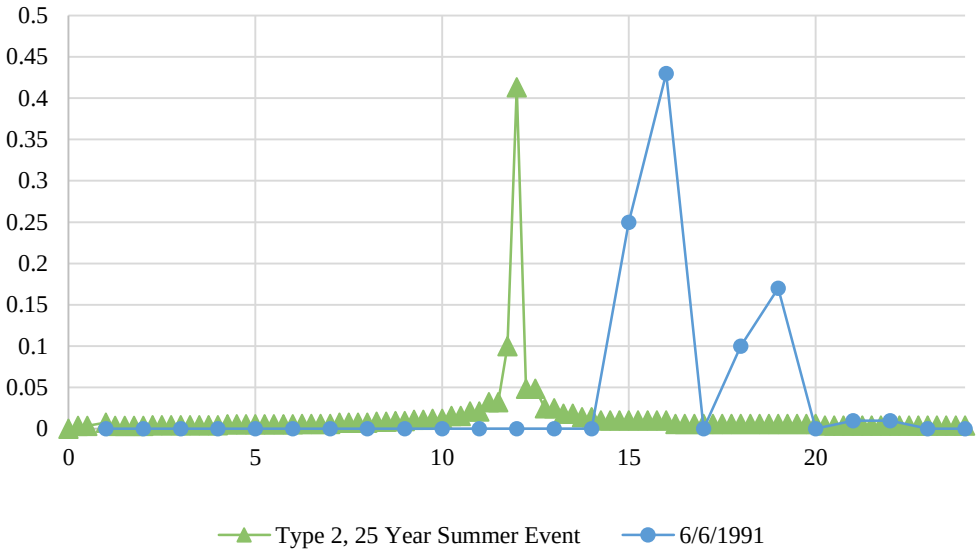


Figure 5-10
Distribution Comparison, April 1984 Storm Event

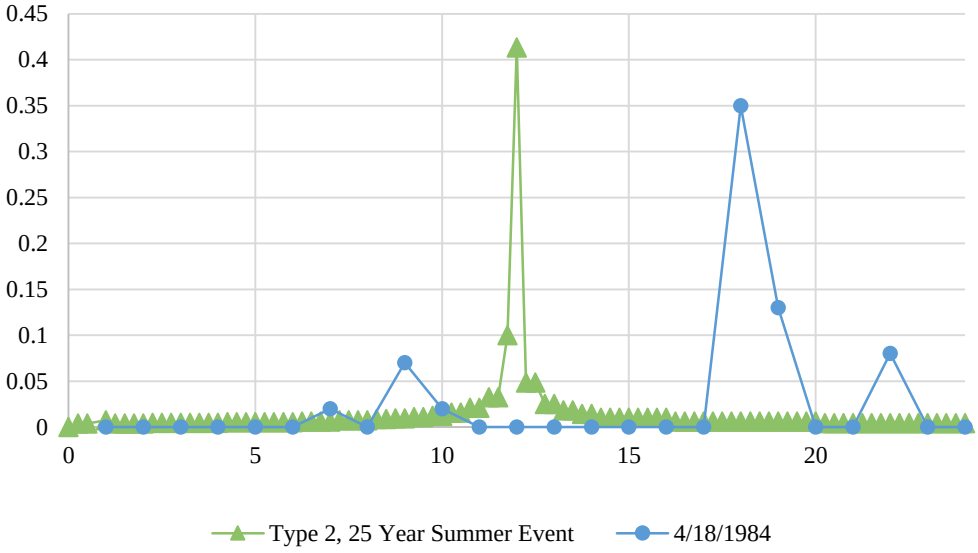


Figure 5-11
Distribution Comparison, June 2006 Storm Event

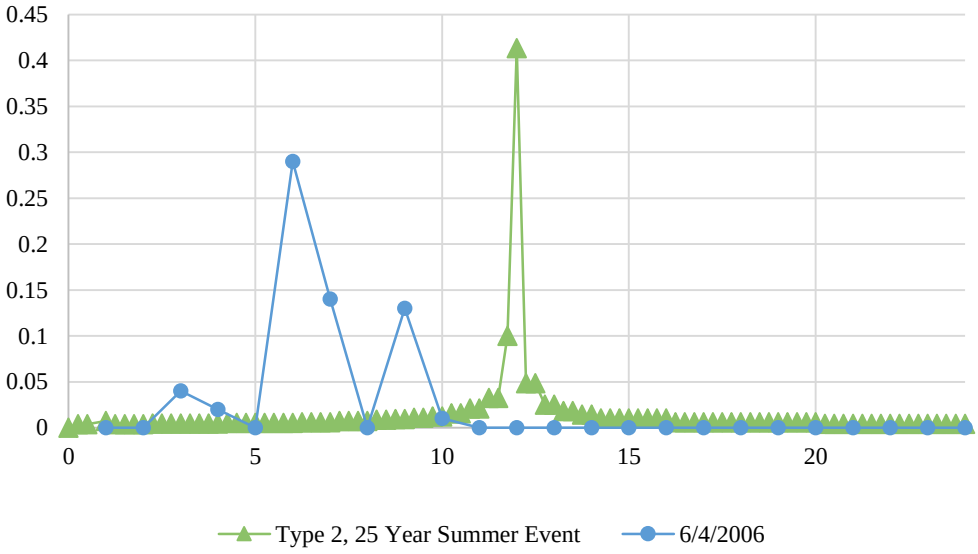


Figure 5-12
Distribution Comparison, June 1959 Storm Event

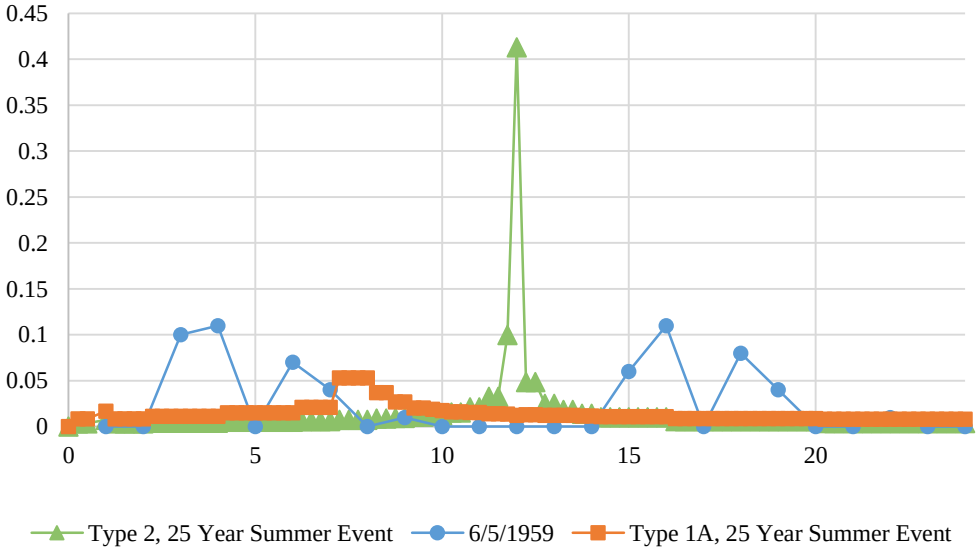
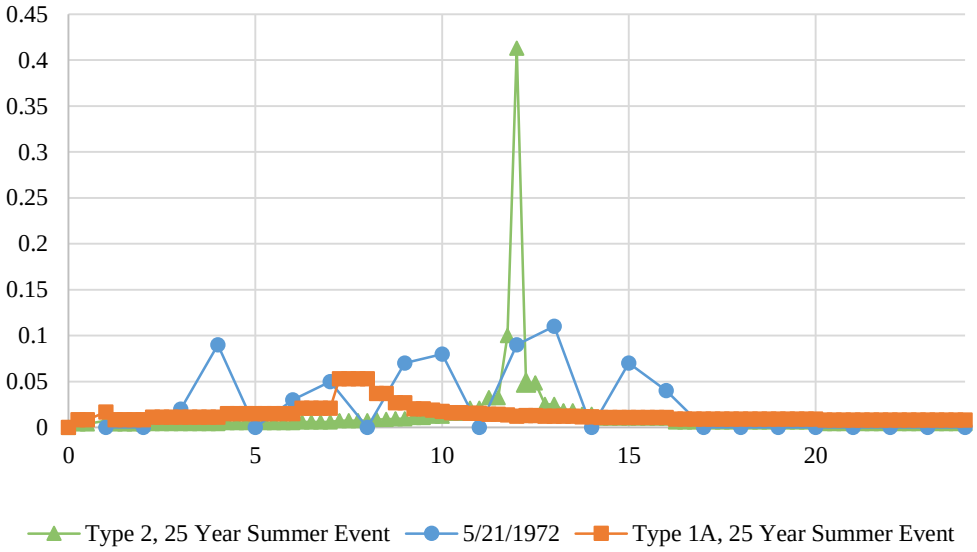


Figure 5-13
Distribution Comparison, May 1972 Storm Event



Out of the 14 rain events with a total rainfall depth greater than 0.6 inches that occurred during summer months, nine can be categorized as Type 2 events and display the characteristic sharp peaks that indicate short periods of high intensity rainfall. The remaining five rainfall events occur over longer periods of time with a lower peak intensity that falls between Type 2 and Type 1A theoretical rainfall distributions.

Collection systems are more sensitive to peak intensity and rainfall distribution than overall depth. For this reason, a Type 2 distribution was selected as the design storm event. Ultimately, a 25-year recurrence period was selected for the design storm to evaluate the system for deficiencies.

System Analysis

Each component of the modeled stormwater system should be able to convey the peak flow generated by a 25-year, 1.35-inch, Type 2 City rain event. Pipe capacity was used as the main deficiency criteria. Manhole surcharging and overflows can indicate a pipe where flow exceeds capacity; it was one factor used to identify potentially problematic pipe sections. Surcharging and manhole overflows were not used directly as criteria, because many assumptions were made regarding pipe depth and, therefore, manhole depth. Ultimately, deficient pipe sections were identified by examining the hydraulic grade line in pipe sections.

For the detailed InfoSWMM model, the system was simulated with sealed manholes. This allows pipe-related deficiencies to be identified without any upstream flooding. Deficient

pipes were identified by examining the maximum flow class result for each pipe segment. Three classes are used: free surface, backwater, and exceeds capacity. Free surface indicates additional capacity within the pipe; during maximum flow conditions, the pipe is not completely full.

A backwater condition identifies that one or more pipes downstream of the given location has a flow rate that exceeds the pipe's flow capacity and as a result, water is backing up in the system. For pipes tagged with this flow condition, the pipeline HGL profile is investigated to determine the location causing the backup. A pipe exceeding capacity cannot accommodate the flow entering the upstream node of a pipe segment and is deficient, but if the deficient pipe has sufficient depth and available freeboard, the deficiency may not warrant replacement. This was determined on a pipe-by-pipe basis.

For pipes outside the detailed InfoSWMM model area, a more simplified modeling approach was used. In these areas, a maximum discharge was calculated for each subcatchment using HEC_HMS and the NRCS CN method. Every pipe within a given subcatchment was labeled with the subcatchment ID. A maximum flow was estimated for each pipe segment based on pipe diameter, material, and slope (either topography-based or minimum-slope-based). The full-flow capacity for each pipe was compared to the maximum discharge for each subcatchment area. Pipes with a full flow capacity less than the maximum discharge were tagged potentially deficient.

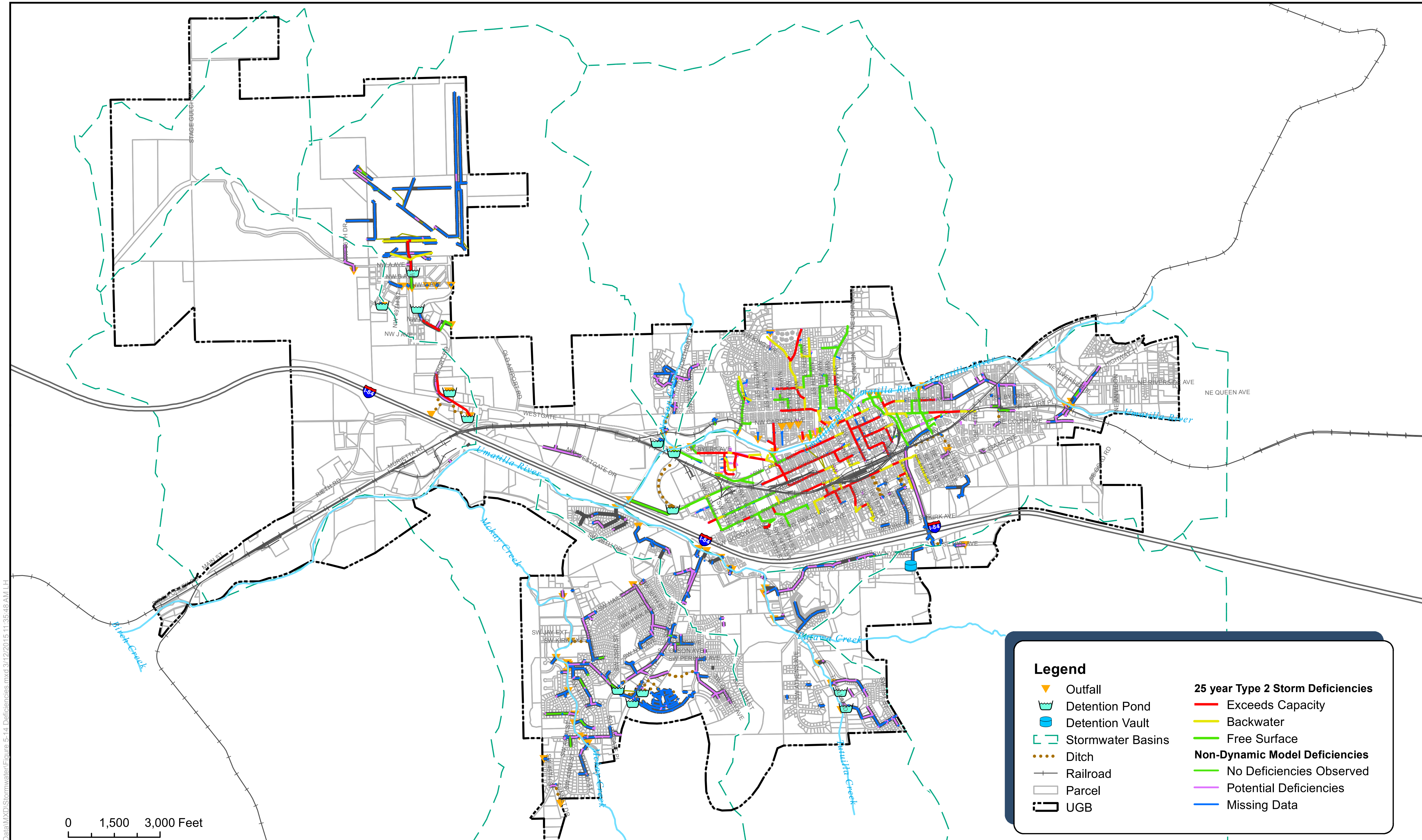
These pipes are not necessarily deficient, but warrant further investigation. The majority of pipes not in the InfoSWMM model have an unknown pipe diameter, which prevents flow or deficiency calculations to be performed. Figure 5-14 shows all of the identified system deficiencies, and Figure 5-15 shows a detailed view of system deficiencies in the downtown area.

Pipes identified as deficient were upsized to accommodate the maximum flow rate for that pipe section using Manning's equation (factoring the existing pipe slope and a roughness of 0.013). Several iterations of this process were performed to identify and improve all deficient pipe sections within the network.

A large portion of the stormwater system was found to be deficient using the 25-year design storm. This is consistent with the firsthand accounts of flooding that has occurred under a rain event with approximately a two-year recurrence interval. Most of the system deficiencies are cause by deficient pipes within the collection system and not necessarily undersized outfall pipes.

A majority of the downtown area was identified as deficient, as was a portion of the system on the north side of the Umatilla River. The deficiency analysis was conducted for existing, and build-out development scenarios to facilitate phasing of the CIP in Section 7. However, the change in curve number and runoff generation due to future development had no significant effect on system deficiencies and CIP phasing could not be established based on these development periods.

CIP phasing was established based on location and deficiencies identified using a more frequent storm event. Any deficiency identified under the 25-year event, that was also deficient during a two-year event was selected as an "Immediate to 5-Year" priority project. Any additional pipes deficient during the 25-year event located within the model extents in the downtown area were identified as "10-year" projects. Remaining deficiencies were included in the "Beyond 20-Year" CIP project list.

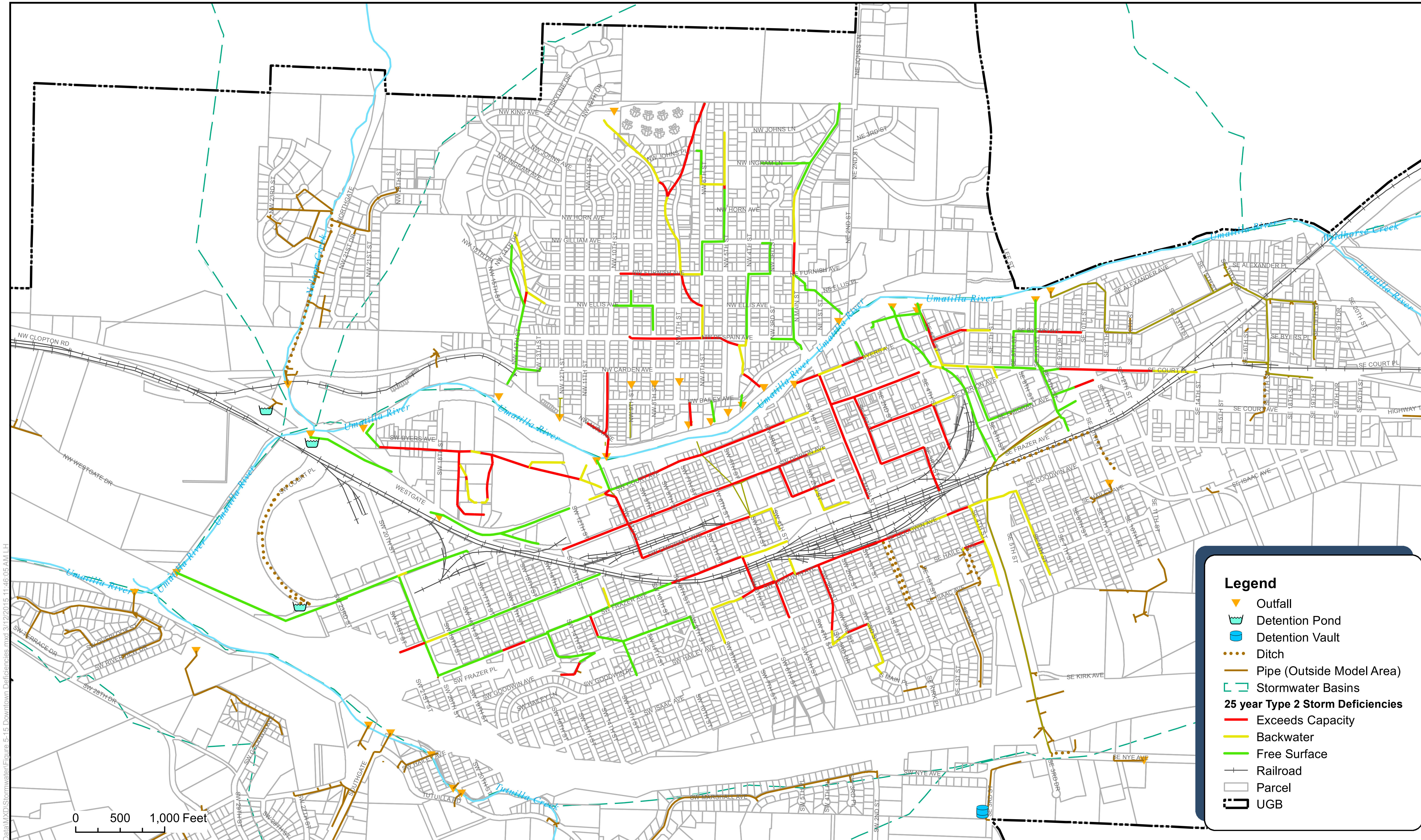


MSA
Murray, Smith & Associates, Inc.

City of Pendleton
Stormwater Master Plan

Figure 5-14
System Deficiencies

May 2015 13-1442



MSA
Murray, Smith & Associates, Inc.

City of Pendleton
Stormwater Master Plan

Figure 5-15
Downtown Deficiencies

May 2015 13-1442

System Analysis Summary

- A large portion of the existing stormwater drainage system is deficient when the 25-year storm is applied to the system, most notably in the downtown commercial area.
- System deficiencies were primarily due to undersized conveyance pipes, not undersized outfalls.
- Existing deficiencies are not appreciably exacerbated by future conditions attributed to new development.
- No deficiencies were observed in the Southgate area.
- A number of potential deficiencies were observed outside of the dynamic simulation area. These deficiencies should be investigated further and verified before any additional action is planned.
- The stormwater drainage system was calibrated using a historic rainfall event and firsthand descriptions of the system during the event. The model was adjusted to produce results consistent with first-hand reports. Further calibration can be conducted in the future with the collection of additional system data.
- Being the first stormwater master planning effort within the City, it is recommended that the City continue to improve the inventory information available for the system through the continued development of stormwater GIS.
- The system should be re-analyzed as additional inventory information, including survey data becomes available.

Alternatives Analysis

The primary emphasis of the system analysis presented here is to identify conveyance capacity constraints. The resulting improvements necessary to correct these constraints is presented in Section 7. While these improvements will alleviate the identified constraints, may be other alternative methods for correcting the deficiency. These methods generally revolve around strategies to either increase capacity or reduce the peak stormwater flows within the conveyance system, such as additional system piping, regional stormwater detention systems, and runoff reduction techniques.

The stormwater system within the downtown commercial area presents the City's most significant system deficiency area in terms of existing constrained piping capacity and the resulting impact they would potentially generate. Options for alleviating the conveyance deficiencies within this area are summarized below.

Option 1 – New Outfall to Umatilla River

Adding new trunk conveyance main(s) discharging to the Umatilla River within the downtown area adds capacity to the system and alleviates the loading on existing piping. One potential alignment for such additional conveyance would be within existing right-of-way

under SW 6th Street, extending from SW Frazer Avenue to the Umatilla River. This approach offers relatively little additional maintenance to the overall system, and no special new maintenance techniques.

Installation of new conveyance piping along this alignment could alleviate approximately 15% of the street flooding within the downtown area. Since the existing piping within this part of the City is significantly undersized, it quickly becomes deficient within close proximity to the alleviated portion of the system. While localized flood reduction would be experienced within the immediate vicinity of these improvements, they would not correct deficiencies within the entire basin.

Adding a new outfall poses unique challenges in terms of engineering and permitting, as the piping would need to either punch through the City's levee system, or be constructed underneath the levee and while avoiding relatively shallow bedrock. Permitting a new outfall through the levee would be under the jurisdictional review of the USACE and the Oregon DSL. As explained in Section 3, the City's levees are currently undergoing a process to become provisionally accredited by the USACE. The introduction of a new outfall through the levee would complicate this accreditation process, and would require additional engineering analysis and documentation to obtain USACE approval.

Option 2 – Regional Detention System

This option entails installing a storage facility within the conveyance system, attenuating peak stormwater discharges. City staff has preliminarily identified the open space in front of City Hall as a potential location for such a system. Other potential locations include right-of-way or underneath private parking lots. Facilities constructed on private property would either require property acquisition or enactment of an easement before improvements could be made. Of the three options, constructing a storage facility outside of the right-of-way would cause the least amount of traffic disruption.

Installing a regional detention system at the City Hall location could alleviate approximately 15% of the street flooding within the downtown area. Since the existing piping within this part of the City is significantly undersized, it quickly becomes deficient within close proximity to the alleviated portion of the system. Additional regional detention facilities within the basin would provide a similar reduction in flooded area.

Option 3 – Roadway Pavement and Curb Retrofits

Runoff reduction techniques using pervious pavements decreases the amount of stormwater entering the system and alleviates system deficiencies. Similarly, infiltration facilities constructed along curbs promotes disposal of stormwater into the ground instead of the piped conveyance system. Further analysis of these systems is necessary to evaluate their performance under the types of high-intensity, short-duration storms that typically accompany flooding in the downtown area.

Runoff reduction through infiltration is a stormwater management technique that aligns with many regulatory agency requirements. Should the City be prompted in the future by regulatory action to implement non-point source stormwater pollution reduction measures, these runoff reduction techniques can aid in compliance.

Alternatives Analysis Summary

The alternatives presented in this analysis offer various methods of alleviating the flooding conditions within the downtown area, above those recommended in Section 7. The advantages and disadvantages of each method are presented in Table 5-3.

Table 5-3
Alternatives Analysis Summary

Option & Description	Advantages	Disadvantages
Option 1: New Outfall to Umatilla River	Utilize existing right of way Low maintenance Localized flood reduction	Does not fully alleviate constraints Complicates USACE levee approval process
Option 2: Regional Detention System	Least disruption to traffic and general public Localized flood reduction	Does not fully alleviate constraints Potentially requires property acquisition
Option 3: Roadway Pavement and Curb Retrofits	Aligns with any future NPDES permit	Reduction in parking Traffic disruption Highest maintenance of three options

The analysis model of the conveyance system contains numerous assumptions related to pipe condition and interpolated pipe invert elevations. These assumptions have a direct impact upon the conveyance capacity calculated by the model. A qualitative calibration of the model was performed using anecdotal accounts of flooding within the downtown area, as opposed to a quantitative approach using flow monitoring data. While this level of analysis is consistent with the requirements of OAR 660-011 for the creation of public facility plans, further engineering analysis is recommended before the City chooses the approach it will take to improve its stormwater drainage system.

SECTION 6
OPERATIONS AND MAINTENANCE

Introduction

This section assesses the Operations and Maintenance (O&M) program for the City of Pendleton's (City's) stormwater drainage system. The assessment is based on pertinent regulatory requirements, information from City staff, and a comparison to the O&M practices of a similarly sized utility. Improvement recommendations for the City's O&M program are detailed at the end of this section, and are based on the results of this assessment, state and federal requirements, City code, and benchmarking with a similar utility.

O&M Regulations and Guidelines

The City's stormwater drainage system O&M program is currently guided by City Ordinance Nos. 3241, 3693, 3250, 3485, 3791, 3814, and 3836, which pertain to capital improvements, floodplain management, land use, and development near streams. While these City ordinances do not explicitly prescribe O&M schedules or detailed procedures, they serve as the basis for authorizing the City's Street Division to perform the operations and maintenance activities used to maintain the system.

System Overview and O&M Staff

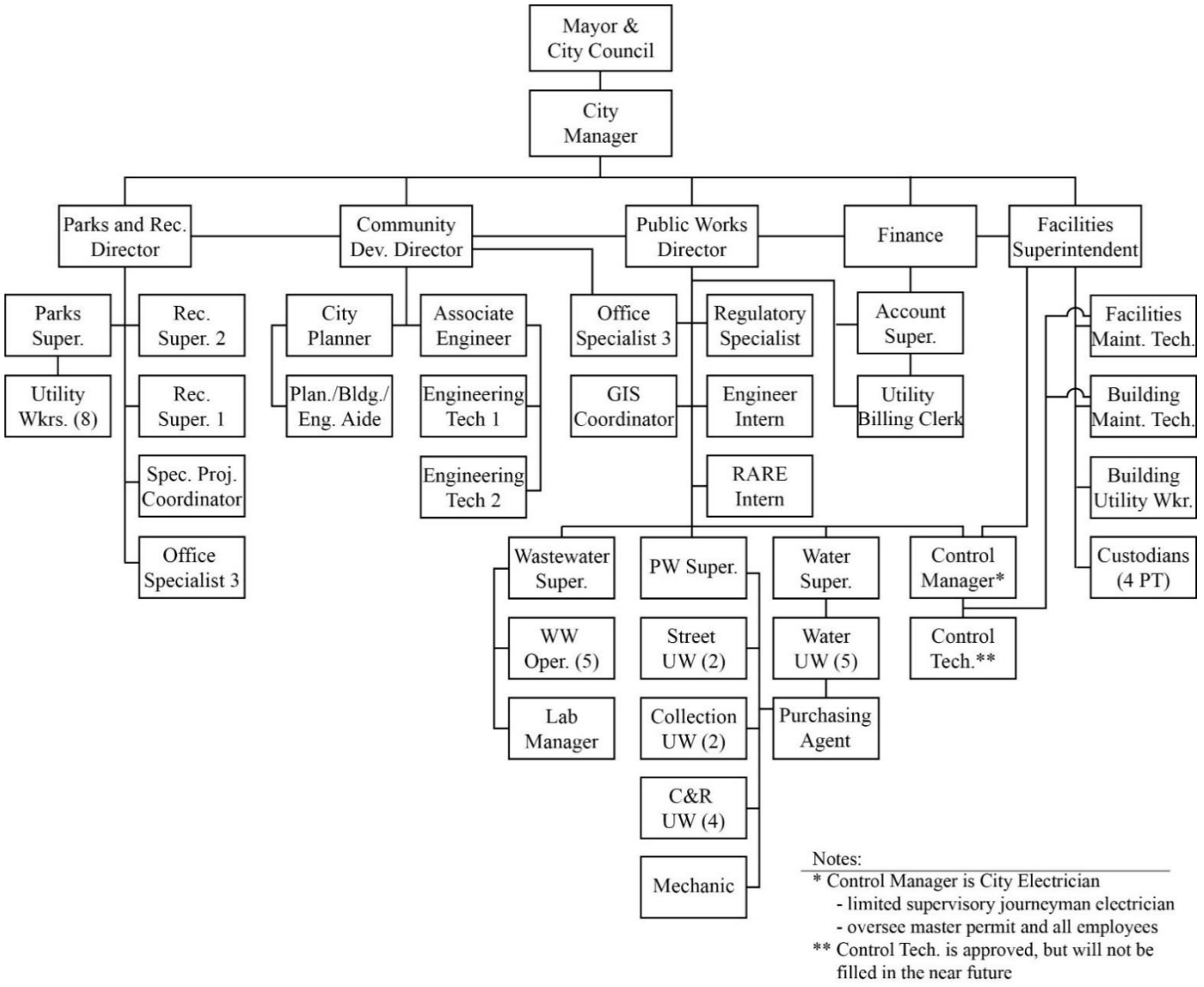
The following list provides an overview of the City's stormwater drainage system. It is noted that this inventory is not complete due to the City's recent focus on updating and development of utility base mapping for the stormwater drainage system, and only information inventoried to date is included.

- They system's service area is 13.4 square miles.
- The system serves approximately 17,600 people.
- Gravity lines total 242,880 linear feet (lf).
- Open channels total 18,480 lf.
- The system has 646 manholes.
- The system has 15 flow-control facilities.
- The City's 73 outfalls are distributed as follows: 43 into the Umatilla River; 16 into McKay Creek; 13 into Tutuilla Creek; 1 into Nelson Creek.

Presently, the Street Division within the Public Works (PW) Department is responsible for performing O&M activities on the City's stormwater drainage system. This occurs under the direction of the PW Superintendent, who reports to the Public Works Director. There are currently two full-time equivalent (FTE) staff in the Street Division working under the direction of the PW Superintendent. These staff are primarily responsible for street O&M

and rotate to cover the stormwater drainage system, collection system O&M, and weed spraying as needed. The dedicated O&M staff time for the stormwater drainage system from the Street Division is estimated at 0.5 FTE. The City would like to have dedicated O&M staff for each utility with some sharing of resources as needed. The City's organizational structure is outlined in Figure 6-1.

Figure 6-1
Organizational Chart



Additionally, the City maintains a construction and replacement (C&R) crew, consisting of four FTEs under the PW Superintendent. This crew handles in-house water, wastewater collection, and drainage system construction and replacement for pipes shallower than 8 feet. This crew is intended to be fully dedicated to wastewater collection and water pipe replacement, but provides limited storm drainage system repair and replacement on an as-needed basis.

Current O&M Practices and Procedures

Historically, the City's stormwater maintenance program has focused on addressing drainage capacity and flooding problems. This approach can generally be characterized as a "reactive" maintenance program. Stormwater drainage system inspections, cleaning, and repairs are performed when problems are reported by customers or when City staff discover problems. Current maintenance activities conducted on the system include the following:

- Regular street sweeping on a six-week rotation.
- Catch basin cleaning in early spring.
- Manhole and pipe cleaning as needed.
- Semiannual obstruction removal and cleaning of levee outfalls.
- Flow Control Facility vegetation control as needed.
- Levee vegetative removal and management

The City is working to update their O&M program through pursuing Public Works Accreditation, which is implementation of best practices in accordance with the American Public Works Association's *Public Works Management Practices Manual – 8th Edition* (PWMP Manual). The following lists the best practices for stormwater and flood management as they are described in the PWMP Manual:

- Storm and Flood Management Service Levels: A policy establishes the storm magnitudes, level of protection, and ways of addressing stormwater quality.
- Operation Plan: A policy is established to maintain stormwater and flood control facilities.
- Floodplain and Floodway Management: A policy is established to define and manage the floodplain and floodway.
- Water Quality Goals: Stormwater quality best management practices are established.
- System In-Flow of Polluted Runoff: Potential sources of polluted runoff are identified and mitigated.
- Allowable Non-Stormwater Discharge into System: Federal, provincial, state, and local regulations define allowable non-stormwater discharge to the stormwater system or receiving waters.
- Watershed Stormwater Drainage Master Plan: A stormwater and flood management master plan is developed.

- Infrastructure Inventory: An inventory of the stormwater infrastructure location is maintained and updated.
- Infrastructure Condition: A record of stormwater infrastructure condition is maintained and updated.
- Stormwater Design: Design standards are developed and utilized.
- Stormwater System Improvement: Necessary improvements or additions to the stormwater system are identified along with appropriate funding sources.
- Sediment and Erosion Control: A policy establishes a sediment and erosion control program.
- Stormwater Flood Warning Systems: Flood warning systems are periodically evaluated and tested.
- Infrastructure Inspection: An established program provides for inspection of the stormwater infrastructure to ensure compliance with water quality standards.
- Conveyance, Storage, and BMP Operations: Procedures are developed for the operation and maintenance of conveyance, storage, and permanent best management practice (BMP) facilities, and details their drainage, flood control and water quality operational practices.
- Private Owner Operations and Maintenance: An ordinance defines the operations, maintenance and inspection requirements for private conveyance, stormwater storage, and BMP facilities.
- Private Facility Inspection: An inspection program is developed for private stormwater facilities, which details inspection activities, establishes monitoring criteria and penalties for noncompliance.
- Pollution Prevention Plans: Pollution prevention plans are established to protect and improve the quality of the receiving waters.
- Public Education: A public education program is developed to increase awareness of stormwater quality system needs.

In anticipation of future regulatory requirements, the City will be implementing these best management practices in development of a comprehensive stormwater O&M program. This program will conform to National Pollutant Discharge Elimination System (NPDES) standards as required.

Safety Procedures

The City's Safety Manual provides the Street Division with a standardized approach for the establishment, implementation, administration, and governance of a comprehensive safety program. The City is accountable for the safety of its employees, and is expected to safely conduct operations at all times.

Benchmark Comparisons

The City was compared to Redmond, another eastern Oregon community with a similar population (28,000) that also lacks an NPDES stormwater permit. Redmond has adopted the

Central Oregon Stormwater Manual (COSM), which does not specifically define O&M program requirements, but does define required maintenance activities for implemented best-management practices. The Redmond stormwater utility was surveyed to compare its O&M practices with the City's. The survey reveals that both stormwater systems:

- Do not operate under a NPDES stormwater permit.
- Separate stormwater systems from the wastewater collection system.
- Are completely gravity-based.
- Do not monitor flow or water quality from outfalls.

The benchmarking comparison included system components and characteristics, budgets, and staffing levels. A number of system characteristics were calculated on a unit basis to enable comparison. The results of these performance indicators are summarized in Table 6-1. Tables 6-2 to 6-5 compare specific system components and characteristics.

Unlike the City, Redmond funds stormwater improvement projects through monthly stormwater utility charges applied to its residential, multifamily and commercial properties. Redmond assesses a monthly stormwater utility service charge of $7.06 per residential account and $6.67 per multifamily account. For commercial accounts, there is a base service charge of $5.81 plus a variable-rate based on the amount of customer vehicular traffic generated by the business. This additional variable-rate amounts to $0.05 per daily trip end (based on current Institute of Transportation Engineers *Trip Generation Manual*).

With less than one FTE committed to its stormwater drainage system, the City has a reactive O&M program that deals with system problems after they arise. Conversely, Redmond's proactive program employs three O&M FTEs dedicated to its stormwater system. Table 6-1 shows the number of FTEs the City has dedicated to O&M of the stormwater drainage system, indicating that it is understaffed when compared to Redmond.

Table 6-1
Benchmarking – Performance Indicators

Utility Name	Number of FTEs	Annual Budget/ Gravity System Length ($/lf)	Annual Budget/ Outfall ($/Outfall)	Length of Gravity System/ FTE	Number of Outfalls/ FTE	Annual Budget/ FTE
Pendleton	0.5[1]	0.8	4,000	485,760	100	400,000
Redmond	3	5.9	75,000	58,830	4.7	350,000

[1] *Estimated FTE based on shared staffing resources from the Street Division.*

Table 6-2
Benchmarking – Gravity Pipe

Rank (Gravity Pipe Length)	Utility Name	Total Length of Gravity Pipe (lf)	Range of Pipe Sizes (inch)	Number of Manholes	Number of Catch Basins
1	Pendleton	242,880	4-30	646	1,601
2	Redmond	176,490	6-30	195	3,645

Table 6-3
Benchmarking – Discharge Facilities

Rank (Number of Outfalls)	Utility Name	Number of Outfalls	Number of UIC[1] Facilities	Number of Detention Ponds	Number of Water Quality Facilities
1	Pendleton	50	0	15	0
2	Redmond	14	1,713	246	180

[1] *UIC = Underground Injection Control.*

Table 6-4
Benchmarking – Budget

Rank	Utility Name	Total O&M Budget
1	Redmond	$1,050,000
2	Pendleton	$200,000

Table 6-5
Benchmarking – Budget Allocation Percentages

Budget Activity	Pendleton	Redmond
Street Sweeping	28%	12%
Catch Basin Cleaning	23%	16%
Repair Projects	4%	19%
Misc. Equipment and Materials	18%	4%
Employee Salary	27%	8%
Staff Training	0%	1%
Contract Services	0%	2%
Other	0%	38%

The following summarizes responses to other survey questions:

- *System Age*: The oldest portion of the City's system is 100 years old, while Redmond's oldest portion is 80.
- *Preventative, Planned and Unplanned Maintenance*: The City spends less time on preventative maintenance (50% of total) than Redmond, which reported that 80% of its total maintenance time was preventative. The City also had a higher percentage of unplanned maintenance at 50%, compared to 2% for Redmond. (It should be noted that there are likely some differences between how each utility defines preventative, planned and unplanned maintenance. The system age will also have an impact on the amount of time spent on preventative maintenance versus repairs.)
- *Pipe Inspection and Cleaning*: Unlike Redmond, the City does not have a routine pipe inspection program. The City indicated that it inspects approximately 200 feet of pipe a year, compared to Redmond's 5,000 feet a year. Both cities clean approximately 1,000 feet of pipe each year.
- *Manhole and Catch Basin Cleaning*: The City cleaned, on average, 12 manholes and all of their catch basins annually. Redmond cleaned five manholes a year and all of their catch basins each year.
- *Maintenance Management System*: The City does not have a maintenance management system. Redmond uses the Lucity computerized maintenance management system.
- *GIS*: Redmond indicated that both office and field staff use GIS software. Redmond has had a full time GIS coordinator in place for approximately 10 years. The City has begun development of a GIS and hired their first dedicated resource.

Conclusions and Recommendations

The following conclusions and recommendations are based on a review of the City's stormwater drainage system.

Insufficient maintenance of stormwater drainage systems can lead to poor performance, shortened life, increased maintenance and replacement costs, possible downstream property damage, and regulatory non-compliance. Typical stormwater maintenance activities are summarized below, and include the City's currently undertakings in each area. Because the City's system maintenance program is primarily reactive, the following recommendations under each activity aim to proactively increase the efficiency and reliability of the stormwater system O&M practices and are based on incorporation of the PWMP Manual best management practices.

System O&M Practices

Structure Inspection – City inspections are conducted in areas where problems are reported. Inspection of catch basins, manholes, grates, and inlets is the primary method used to

determine the cause of ponding and drainage problems. The City should consider developing a scheduled structure inspection program to systematically review structures each year.

Structure Cleaning – Catch basins are cleaned yearly as part of street cleaning to prevent potential clogging. It is recommended that the City consider purchasing a dedicated Combination or "Combo" truck for the stormwater system to improve structure-cleaning efficiencies. These trucks provide cleaning services to help remove difficult, immobile debris that would otherwise restrict the conveyance capacity of the storm drainage system from large depths or long lengths of piping. Cleaning services are comprised of powerful telescoping reels, centrifugal vacuums, hydraulic booms, water jet rodder pumps and specialized nozzles. These tools are mounted onto a large truck, allowing them to be mobilized and deployed to areas in need of maintenance within the drainage system.

Storm Line Inspections – As with catch basin and manhole inspections, storm line inspections are used primarily to investigate reported problems. In 2006, the City purchased new closed-circuit television equipment, but currently only inspects stormwater pipes if there are reported issues. To better assess the condition of the existing stormwater drainage system, the City should consider developing an ongoing annual inspection program.

Storm Line Cleaning – Storm lines are cleaned in response to reported and known problem areas. Most storm line cleaning addresses larger blockages such as rocks, trash, or debris, and the associated build-up of sediment behind the blockage. In conjunction with the annual inspection program mentioned previously, the City should consider incorporating a pipe-cleaning element into this program. This cleaning program should be supported through the purchase of a dedicated Combo truck.

Ditch Cleaning – City staff occasionally clean and maintain conveyance ditches along roadsides and the railroad right-of-way (ROW) in order to maintain flow paths to adjacent areas of the stormwater system. Ditch cleaning is typically limited to areas near culverts and is performed using a Combo truck.

Levee Outfall Cleaning – The City currently cleans levee outfalls twice a year to remove weeds and debris that are obstructing inspection of the outlet check valve, and to maintain the outfall trench to the river.

Minor Repairs – The City's C&R crew occasionally identifies and repairs minor problems, installs new structures to address minor flooding problems, or replaces aged infrastructure.

Stormwater Facility Maintenance – The City does not routinely maintain stormwater facilities, but does spray detention ponds for weed control. The City should consider developing a program for annual maintenance and repair of stormwater facilities. A dedicated Combo truck is typically necessary to remove debris and litter from these types of facilities.

Street Sweeping – The City has established a rotational six-week street-sweeping schedule; each street is swept six to eight times per year, or more often if impacted by occasional weather and emergency maintenance.

The City should consider enacting policies for the maintenance of stormwater system structures located outside of the public ROW or easements that serve public ROW runoff. As defined in Section 4—Regulations and Policies, these policies would be defined through the City adopting COSM or developing a formal stormwater management manual. The City should consider maintenance agreements that are defined for individual land owners or for legal entities that are in charge of developments to provide for the perpetual maintenance of all elements of the stormwater system located outside of the public ROW. Maintenance agreements should require an O&M manual for facilities, a financial plan for covering costs incurred to maintain and replace facilities, and ensure that facilities have appropriate access to City inspectors. The maintenance requirements need to be defined during the development review, and require compliance consistent with the City's adopted stormwater standards.

Monitoring Program

Because it does currently not fall under NPDES Municipal Separate Storm Sewer System (MS4) permit regulations, the City is not required to have a monitoring program for its stormwater drainage system. Should the City become subject to these permit policies, it will be expected to monitor outfalls and effluent from its stormwater system.

Annual Storm Drainage Main Replacement Program

The City's stormwater drainage system comprises approximately 105,000 feet (19.9 miles) of conveyance main lines, which will require replacement as they reach the end of their service life. A 150-year replacement program was initially devised by City staff based on existing known inventory of storm drainage infrastructure. As the City continues to inventory storm drainage facilities and identify replacement needs, it may be determined that this replacement cycle could increase if it is concluded that the stormwater drainage system has a longer life based on its limited use. A program of this magnitude will require annual replacement of approximately 700 feet of the City's stormwater piping. The prioritization and location of these improvements is at the discretion of City staff, and may factor locations based on pipe age, field observations, and phasing of other City projects. Further details on the program, including costs are in Section 7—Capital Improvement Program.

Levee Operations and Maintenance Program

The City is also responsible for operating and maintaining the levee system along the Umatilla River within its limits. The City has developed a Levee Maintenance Plan, dated May 29, 2009, established by Resolution No. 2377, and passed June 16, 2009, which was updated in February 2011. In 2015, the City will be starting Phase 2 of the FEMA certification process, which includes further defining requirements for levee maintenance including future staffing needs.

Planning for future ongoing operations and maintenance of the levee system is a critical driver in the need for the City to create a new stormwater utility. The staffing and equipment necessary to keep the levee system maintained within federal requirements will necessitate a recurring financial commitment from the City. These funds can be derived from stormwater utility fees which factor the following types of maintenance tasks into the rates:

- Mending erosion caused by rain runoff, wave wash and scour.
- Repair of slope stability problems.
- Removal of accumulated debris.
- Animal and pest control.
- Maintaining levee vegetation through promotion of good grass cover, regular mowing, and control of weeds, brush, and trees.
- Repair ruts, depressions and cracks.
- Replace outfalls and culverts protruding through levees that have exceeded their service life.
- Maintaining security fencing, gates and closure structures.

Operational aspects of the levee system revolve around flood preparedness. Flood fight responsibilities for the City entail the stockpile and storage of necessary equipment and supplies to respond to high-water events. These materials and supplies allow the City to quickly provide an initial flood response while additional materials and supplies are being delivered. Typical stockpiled materials include sandbags, plastic sheeting, shovels, emergency lighting, pumps, floatation vests, and sources of borrow material.

Staffing

As noted earlier in this section, the stormwater drainage system has 0.5 FTEs, not including the PW Superintendent. Staff are assigned from the Street Division to operate and maintain the stormwater drainage system. As defined in the benchmarking comparison, the City is operating with a smaller staff to maintain the stormwater drainage than the comparable city, indicating that current staffing is inadequate to meet the requirements of operating and maintaining the system. Additionally, the need for additional staff will grow as the system expands and regulatory requirements become more stringent during the planning horizon.

Based on the staffing review above, the City should have more staff to implement current and proposed operations and maintenance activities. It is recommended that the City transfer one FTE for street sweeping activities from Streets Division to Storm Utility. The City should also consider adding two FTE staff working in conjunction with the Street Division. Hire 0.5 additional FTEs, which will be part of a second crew of four full time staff with dedicated equipment to perform the ongoing pipe replacement program on a 150-year cycle. The other 3.5 FTEs on the crew would be shared and funded with the Water and Sewer Utilities. This also includes transferring the funding of 0.5 FTEs from the existing dedicated

pipe crew from the Sewer Utility to Storm Utility. Exact staffing levels will be determined by the City.

Future NPDES MS4 Program

The U.S. Environmental Protection Agency (EPA) delegated the Oregon Department of Environmental Quality (DEQ) the authority to implement the NPDES permitting program, including writing and issuing MS4 permits for municipal stormwater discharges. To date, NPDES MS4 permits have been issued to municipalities with populations greater than 50,000 and smaller communities within larger urbanized areas.

Due to its population size and distance from large urbanized areas, the City has not yet been required to obtain a NPDES MS4 Permit. As stated in Section 4, given the size of the City's population, its potential for incorporation into the program is unlikely in the immediate future.

Future required permits would likely impact the City's O&M procedures. The formation of a City-operated stormwater utility would provide the municipal framework necessary to comply with the operational and maintenance requirements typically required by these permits. Typical tasks allocated to stormwater utilities under NPDES requirements include:

- Monitoring water quality of the Umatilla River and its tributaries.
- Development of design and construction standards (See Section 4 for recommendations on adopting the COSM).
- Implementation and enforcement of construction site erosion control regulations.
- Enforcement of buffer zones between new development and creeks and wetlands.
- Construction of regional water quality, stream enhancement and flood management projects.
- Cleaning the public stormwater conveyance system on the following schedules:
    - A four-year rotating basis for open ditches, storm pipelines.
    - Annual cleaning of stormwater catch basins.
    - Quarterly inspection and cleaning of stormwater detention ponds and water quality facilities.
- Sweeping public streets on a four- to six-week basis.
- Emergency response to flooding and water pollution complaints.
- Water quality investigation and spill response.
- Watershed planning, public outreach, and partnerships for pollution prevention and education.

The tasks typically performed by municipalities as they conform to NDPES permit requirements are generally beneficial for good stewardship of stormwater system

infrastructure. It is recommended that these tasks be incorporated into the City's current O&M program, regardless of any NPDES requirements. Doing so will position the City to meet any future NDPES permit requirements.

Summary

The assessment of the City's stormwater drainage system O&M program included review of information from City staff and comparison to the O&M practices of similarly sized utility and regulatory requirements. Staff from the City's Street Division are responsible for the operations and maintenance of the stormwater drainage system. The Street Division currently has 0.5 FTEs operating and maintaining the stormwater drainage system.

The current scheduled maintenance activities include the following:

- Regular street sweeping on a six-week rotation.
- Catch basin cleaning in early spring.
- Manhole and pipe cleaning as needed.
- Semiannual outfall obstruction removal and cleaning.
- Flow control facility vegetation control as needed.
- Levee vegetation removal and management.

Historically, the City's stormwater maintenance program has focused on addressing drainage capacity and flooding problems. This approach can generally be characterized as a "reactive" maintenance program.

For a benchmark comparison, one other storm utility in the region (Redmond) was surveyed in order to compare their current O&M practices to the City's. Unlike the City, which enacts no service fees, Redmond assesses a monthly stormwater utility service charge, which is used to fund water quality improvement projects. Also, Redmond has three O&M FTEs dedicated to the stormwater drainage system, while the City has none.

The City's current levee maintenance practices of outfall cleaning and vegetation management will need to continue if it is to comply with the levee certification requirements of FEMA and the NFIP. Additional levee O&M activities must be implemented to meet levee maintenance requirements. These additional activities drive the need for the City to create a new stormwater utility, as the staffing and equipment necessary to operate the levee system within federal requirements will necessitate a recurring financial commitment from the City. These funds can be derived from stormwater utility fees.

The following conclusions and recommendations are based on a review of the City's O&M practices and benchmarking of the other stormwater system:

- Transfer one FTE for street sweeping activities from Streets Division to Storm Utility.
- Add two FTEs as dedicated staff for the operations and maintenance of the stormwater collection system. This is in addition to transferring the street sweeper FTE positon from the Streets Division.
- Hire 0.5 additional FTEs, which will be part of a second crew of four full time staff with dedicated equipment to perform the ongoing pipe replacement program on a 150-year cycle. The other 3.5 FTEs on the crew would be shared and funded with the Water and Sewer Utilities. This also includes transferring the funding of 0.5 FTEs from the existing dedicated pipe crew from the Sewer Utility to Storm Utility.
- Acquire a dedicated Combo Truck for the stormwater drainage system to improve structure cleaning deficiencies.
- Consider developing an annual inspection program.
- Consider developing an Annual Storm Drainage Main Replacement Program.
- Continue to improve the stormwater system inventory through continued development of the City's public works GIS.
- The City should consider maintenance agreements that are defined for individual land owners or for legal entities in charge of developments to provide for the perpetual maintenance of all elements of the stormwater drainage system located outside of the public right-of-way.
- Begin implementing a stormwater drainage system O&M program that would meet NDPES Permit requirements and is based on incorporation of the American Public Works Association's *Public Works Management Practices Manual* – 8th Edition best management practices.

SECTION 7
CAPITAL IMPROVEMENT PROGRAM

Introduction

This section presents the Capital Improvement Program (CIP) for the City of Pendleton's (City's) stormwater system. It summarizes the recommended system improvement projects to correct deficiencies identified in Section 5—System Analysis and ongoing replacement and maintenance requirements identified in Section 6—Operations and Maintenance. The recommended improvements in this CIP prioritize projects and assign suggested planning-level costs for each project. It also acts as a blueprint for forecasting capital expenditures and preparing the City to meet its stormwater planning needs for existing and future customers.

The conveyance system repair, improvement and expansion programs identified in previous chapters have been combined into the CIP, resulting in a comprehensive listing of prioritized projects and estimated costs.

For the projects identified in this CIP, the recommended facility sizes or designated locations are schematic. A Preliminary Engineering Report (PER) should be completed for each improvement project to identify the final sizing and location. A PER looks at a specific project in more detail than the analysis conducted within this Stormwater Master Plan (SWMP).

During final design of each project, it will be necessary to survey elevations and identify flows to determine pipe and facility sizes that will be constructed.

Project Cost Estimates

An estimate of project cost for each identified improvement was developed in conjunction with this study. These costs are "rough estimates" consistent with the definition of OAR 660-011-0005(2) and OAR 660-011-035 for public facility planning. Cost estimates represent opinions of cost only, acknowledging that final costs of individual projects will vary depending on actual labor and material costs, market conditions for construction, regulatory factors, final project scope, project schedule and other factors. Each cost estimate contained herein represents a Class 5 budget estimate, as established by AACE International. This preliminary estimate class is used for conceptual screening. The expected accuracy range of Class 5 estimates is -30% to +50%. As the project is better defined, the accuracy level of the estimates can be narrowed.

Project cost estimates are used as guidance in establishing funding requirements based on information available at the time of the estimate. Since construction costs change periodically, an indexing method to adjust present estimates in the future is useful. The Engineering News-Record (ENR) 20-City Average Construction Cost Index (CCI) is

commonly used for this purpose. CIP project costs were developed in December 2013 dollars based on the ENR 20-City Average CCI of 9668. CIP cost estimates should be reevaluated periodically to account for inflation.

Appendix C presents a detailed description of the methodology used for estimating costs in this SWMP. This description explains the procedures used in determining project costs and describes the assumptions made for encountering bedrock, commonly occurring construction activities (such as erosion control), contingency factors, and other project costs.

Project Implementation Timeframe

CIP projects have been grouped into four implementation timeframes. General priorities for stormwater system improvement projects and their associated time frames are summarized in Table 7-1. Developer-paid projects are dependent on the timing of development in specific areas.

Table 7-1
Prioritization Criteria for Recommended Improvements

Implementation Time Frame	Priority Description
Immediate to 5-Year	Continued data collection; Creation of stormwater utility, identify dedicated funding, hire dedicated staff; Begin proactive maintenance program.
10-Year	Reanalyze system using hydraulic model and update CIP; Reassess condition of system based on updated information and updated R&R Program; Address flooding occurring within developed areas.
20-Year	Reanalyze system using hydraulic model and update CIP; Reassess condition of system based on updated information and updated R&R Program; Address flooding occurring within developed areas.
Developer-Paid (Time Varies)	Assess impacts using hydraulic model and identify developer specific requirements.

Projects in which existing infrastructure has condition-based issues are also included within each short-, mid- and long-term time frames. The City has identified these projects for inclusion in the CIP based on observation of current system operation made during routine system inspection, maintenance and repair efforts.

Capital Improvement Program

The following storm drainage improvement projects have been identified to address the deficiencies identified by City staff and the stormwater system analysis. The need for each project is described, along with a general description of the improvement. Where applicable, project locations are illustrated in Figures 7-1 and 7-2.

Projects are generally presented in order of priority, and the time schedule anticipated for each project is summarized in Tables 7-2 through 7-5. Projects SD-01 through SD-07 are recommended in the next 5 years. Projects SD-08 through SD-13 are recommended in the next 10 years and the projects beyond the 10-year horizon are SD-14 through SD-20. Some of the improvements are for ongoing maintenance and replacement and recur in all time horizons.

For completely new improvements and developer-paid improvements (SD-19, SD-21, SD-22 and SD-23), stormwater analysis indicates that large pipe diameters will be necessary to convey flows. These improvements likely will include some combination of open channel conveyances and smaller diameter piping, but given the unknown configuration of future improvements, the larger diameter piping has been indicated as a conservative planning measure.

Project SD-01 – Combo Truck
Project Location: Citywide

Project Need: The City currently owns one Combo Truck which is scheduled for replacement in 2017. This existing truck is used for both sewer and stormwater conveyance cleaning and has traditionally been used to service approximately 12,000 feet of pipeline per month. Depending on the location and use of these pipelines, they may be cleaned on a monthly basis, or once every 3 to 6 months as part of the preventative maintenance program. Currently the majority of pipeline is in the sewer collection system with less than 10% of the pipelines cleaned part of the storm drainage system. With the advent of a stormwater utility, a dedicated Combo Truck used solely for the stormwater system is recommended.

Project Description: A budgetary cost of $50,000 has been provided to transfer the City's existing Combo Truck from the Public Works' Sewer Division to the Storm Division. This cost represents the anticipated equipment value that is to be credited back to the sewer division upon transfer. The sewer division would then need to replace the existing truck at the time of transfer, the cost of which would be provided under the sewer use fees.

Project SD-02 – Provisional City and Prison Levee Certification
Project Location: Umatilla River, Downtown Area

Project Need: The current Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM) of the downtown area indicate protection from the base flood

(100-year) event by a levee system that is provisionally accredited. In order to retain this status, the levee must be recertified.

Project Description: Obtaining a Provisionally Accredited Levee (PAL) certification from FEMA will require completion of a previously submitted application. The field testing, surveying, and engineering analysis to complete the certification of the levees has been preliminarily identified. The approximate cost for PAL certification is $527,000. A detailed description of the remaining work is provided in Appendix B. This consultant work may reveal the need for addition levee repairs, which would increase the costs indicated under Projects SD-03, SD-09, and SD-14 below.

Project SD-03 – City and Prison Levee O&M

Project Location*:* Umatilla River, Downtown Area

Project Need: Retaining a FEMA PAL certification requires ongoing inspection and maintenance of the levees, which must be documented and submitted annually to FEMA for approval. The estimated cost per year is $133,000, and may be subject to revision pending the outcome of Project SD-02.

Project Description: The levees surrounding the City's downtown area require annual inspections and repairs for structural failures, outfall replacement, scour, erosion, animal and pest control, and ongoing maintenance activities that include removal of debris and vegetation. When flows within the Umatilla River reach 10,000 cubic feet per second (cfs), City staff conduct special inspections of the levee system. The City also is required to prepare for flood fight response procedures, while maintaining adequate stockpiles of emergency materials to aid in the event of flooding. The cost above includes a provision to repair City identified erosion and scour near the 8th Street bridge crossing, prorated over 5 years.

Projects SD-04, SD-10, & SD-15 – Local Improvement Fund

Project Location: Citywide

Project Need: It is anticipated that relatively small local drainage problems will need to be addressed annually by City crews. Based on City staff input, a yearly budget of approximately $40,000 is required. This cost is based on comparable efforts put forth by the City of Redmond for similar activities.

Project Description: City staff will facilitate maintenance of the existing system, including cleaning of ditches and culverts and spraying weeds.

Projects SD-05, SD-11, & SD-16 – Annual Storm Drainage Main Replacement

Project Location: Citywide

Project Need: Storm drainage main replacement is necessary to keep approximately 105,000 feet (19.9 miles) of storm drainage main lines in good repair. This length of piping is reduced through the Short-, Mid- and Long-Term Existing Deficiency Upgrades identified under Projects SD-07, SD-13 and SD-18, resulting in a total replacement length of 62,550 feet. A 150-year replacement program was determined by City staff based on existing known inventory of storm drainage infrastructure. This 150-year cycle may be revised as the City continues to collect existing system information and inventory storm drainage facilities, based on the limited use of these facilities.

Project Description: A 150-year life cycle equates to replacement of about 400 feet of the existing storm drainage piping, catch basins, manholes, etc., each year at an average annual cost of $54,000.

Projects SD-06 & SD-12 – GIS Data Field Work

Project Location: Citywide.

Project Need: Data gaps in the City's stormwater system records were identified during the development of this SWMP. This information is helpful to accurately define the existing system and develop future storm drainage improvements. A cost of $10,000 per year for 10 years is recommended to develop a systematic as-built survey program that can improve the accuracy of the existing stormwater system GIS. This effort will lead to a more complete and accurate system model for use in SWMP updates.

Project Description*:* This project task would include field survey work by City staff, along with updating the GIS system to reflect field acquired data of the system.

Project SD-07 – Short-Term Existing Deficiency Upgrades

Project Location: Central downtown commercial area

Project Need: The existing conveyance system in the central downtown commercial area floods during periods of heavy rainfall. Larger-diameter pipes are recommended to improve the system's conveyance capacity and reduce the likelihood of flooding.

Project Description: Replace existing piping along Court, Dorion, Emigrant, Frazer, and Goodwin Avenues between SW 2nd and SW 10th Streets, as illustrated in Figures 7-1 and 7-2. The estimated cost for these improvements is $5,761,000 and includes 9,000 feet of conveyance upgrades ranging from 24-inch to 36-inch diameter pipe.

Project SD-08 & SD-17 – Stormwater Master Plan Update

Project Location: Citywide

Project Need: This SWMP is recommended to be updated every five years in accordance with the periodic review provisions of OAR Chapter 660, Section 25. An estimated cost of $150,000 would be necessary to update the master plan.

Project Description: Any future updates to the SWMP should document changes to the City's conveyance system, population, land use policies, development density, regulatory policies, GIS and hydraulic model.

Projects SD-09 & SD-14 – City and Prison Levee O&M

Project Location*:* Umatilla River, Downtown Area

Project Need: Retaining a FEMA PAL certification requires ongoing inspection and maintenance of the levees, which must be documented and submitted annually to FEMA for approval. The estimated cost per year is $112,000 and may be subject to revision pending the outcome of Project SD-02.

Project Description: The levees surrounding the City's downtown area require annual inspections and repairs for structural failures, outfall replacement, scour, erosion, animal and pest control, and ongoing maintenance activities that include removal of debris and vegetation. Anticipated upgrades to the 8th Street Bridge in the future would remove the requirement for the City to execute flood response procedures.

Project SD-13 – Mid-Term Existing Deficiency Upgrades

Project Location: East and west downtown commercial areas

Project Need: The existing conveyance system in the east and west downtown commercial areas are outside of observed flooding during periods of heavy rainfall. As these improvements are outside of directly observed flooding, they have been deferred beyond the Short-Term Deficiency Upgrades. The modeling analysis indicates that larger-diameter pipes are needed to improve the conveyance capacity of the system and reduce the likelihood of simulated flooding.

Project Description: For the east downtown area, replace pipes in the east downtown area, along Court, Dorion, Emigrant, Frazer, and Goodwin Avenues between SE 1st and SE 12th. For the west downtown area, replace pipes in SW Byers Avenue, SW 18th Street, SW 20th Street, and SW Emigrant Avenue. These improvement areas are illustrated in Figures 7-1 and 7-2. The estimated cost for these improvements is $9,075,000 and includes 14,950 feet of conveyance upgrades ranging from 10-inch to 36-inch diameter pipe.

Project SD-18 – Long-Term Existing Deficiency Upgrades

Project Location: North Hill neighborhood and Airport area

Project Need: The existing conveyance system in the North Hill neighborhood and the Airport area are outside of observed flooding during periods of heavy rainfall. As these improvements are outside of directly observed flooding or present lower recurrence interval to future flooding compared other areas of the City, they have been excluded from the Short- and Mid-Term Deficiency Upgrades. The modeling analysis indicates that larger-diameter pipes are needed to improve the conveyance capacity of the system and reduce the likelihood of simulated flooding.

Project Description: For the North Hill neighborhood, replace existing piping along NW Despian and Furnish Avenues, and NW adjacent piping between NW 1st and NW 14th Streets. For the Airport area, replace the piping along Airport Road, NW J Avenue, and NW 48th Streets. These improvement areas are illustrated in Figures 7-1 and 7-2. The estimated cost for these improvements is $12,250,000 and includes 18,500 feet of conveyance upgrades ranging from 8-inch to 54-inch diameter pipe.

Project SD-19 – Eastern Oregon Regional Airport Expansion

Project Location: Airfield and surrounding industrially zoned area expansion consistent with the pending *Eastern Oregon Regional Airport at Pendleton Master Plan* (currently in progress).

Project Need: Expansion of the airfield and surrounding industrially zoned area is anticipated to accommodate growth in unmanned aerial vehicle (UAV) testing and other industrial customers.

Project Description*:* Approximately 450 feet of 24-inch diameter storm sewer and 13,000 feet open channel conveyance is anticipated to meet the service needs for this area. These improvements are anticipated to cost $3,530,000.

Project SD-20 – Combo Truck

Project Location: Citywide

Project Need: The existing Combo Truck transfer from the sewer utility to the stormwater utility described under Project SD-01 will need to be replaced in the 20-year timeframe.

Project Description: A budgetary cost of $420,000 has been provided for a new Combo Truck. This cost may be reduced through the procurement of a used vehicle, or a transfer of used equipment from the Sewer Division in a similar manner as proposed under SD-01.

Project SD-21 – North Hill Development

Project Location: Undeveloped areas zoned for low-density residential land use to the north and east of the current North Hill neighborhood.

Project Need: Shortage of residential housing.

Project Description: Approximately 3,500 feet of 24-inch diameter and 2,000 feet of 36-inch diameter storm sewer is anticipated to meet the service needs for this area. These improvements will likely be conducted by developers and cost approximately $2,500,000.

Project SD-22 – Pendleton East End and Goad Property Development

Project Location: Undeveloped areas zoned for commercial and low-density residential land use east of Downtown and north of Interstate-84.

Project Need: Shortage of residential housing and commercial space.

Project Description: Approximately 4,500 feet of 36-inch diameter is anticipated to meet the service needs for this area. These improvements will likely be conducted by developers and cost approximately $2,657,000.

Project SD-23 – Southgate Development

Project Location: Undeveloped areas zoned for low-, medium- and high-density residential land use south of Interstate-84 and east of Highway 395.

Project Need: Shortage of residential housing.

Project Description: Approximately 2,400 feet of 24-inch diameter and 5,500 feet of 36-inch diameter is anticipated to meet the service needs for this area. These improvements will likely be conducted by developers and cost approximately $4,041,000.

Summary of Recommended Storm Drainage Improvement Projects

Recommended improvement projects are summarized in Tables 7-2 through 7-5. The tables include information regarding each project's implementation time frame, estimated cost and percentage attributed to growth.

In general, it is recommended that the City focus short-term financial resources towards data collection and maintenance of the existing storm drainage infrastructure. Once those needs have been met, additional resources may be directed towards revising the stormwater model which will produce a robust identification of system deficiencies that can be prioritized accordingly. Other short-term resources may be directed towards the existing gravity system within the downtown commercial area. This section of the City's storm drainage system is inadequately sized to serve existing flows, and represents the highest priority area to receive stormwater improvements over the study period.

Percentage Attributed to Growth

The City does not currently collect System Development Charges (SDCs) to fund stormwater capital improvements associated with future development, or growth, as allowed under

Oregon Revised Statute 223.297 through 223.314. A column has been included in Tables 7-2 through 7-5 to aid the City in establishing SDCs for the stormwater conveyance system. A summary of all recommended projects is in Table 7-6.

Because SDCs may only be collected based on the infrastructure needed for future growth, the percentage listed for each project correlate the SDC charge associated with providing service towards new development. For improvements that benefit both current and new customers, a fraction of the project cost is allocated to SDCs proportional to the benefits.

The method used to calculate the growth allocation percentage for a proposed project is the percent of impervious area added by the development relative to existing impervious area of the study area. Entirely new improvements (such as the Eastern Oregon Regional Airport Expansion) and developer-paid improvements are only to serve future growth and so are assigned a value of 100%.

Table 7-2
Recommended Immediate to 5-Year Projects

Project ID	Project Name	Project Description	Project Cost	Percentage Attributed to Growth
SD-01	Combo Truck	New Combo Truck	$50,000	0%
SD-02	Provisional City and Prison Levee Certification	PAL application to FEMA by consultant team, to include field testing, surveying and engineering	$527,000[1]	0%
SD-03	City and Prison Levee O&M	Inspection of levees, including maintenance repairs and report documentation[2]	$665,000	0%
SD-04	Local Improvement Fund	Maintenance of the existing system by City staff	$200,000[3]	0%
SD-05	Annual Storm Drainage Main Replacement Program	Average approximately 400 feet of pipe replacement each year	$270,000[3]	0%
SD-06	GIS Data Field Work	Field survey work of existing conveyances and updating the GIS	$50,000	0%
SD-07	Deficiency Upgrades	10,165 feet of piping upgrades, ranging from 8-inch to 36-inch	$5,761,000	10%
Total 5-Year Project Costs			**$7,523,000**	

[1] *Costs identified by MSA subconsultant Phase I levee review.*
[2] *Levee inspection requirements vary depending on structure from annual to bi-annual. Flows in the Umatilla River exceeding 10,000 cubic feet per second trigger additional inspection requirements.*
[3] *Costs provided by City of Pendleton.*

Table 7-3
Recommended 10-Year Projects

Project ID	Project Name	Project Description	Project Cost	Percentage Attributed to Growth
SD-08	Stormwater Master Plan Update	Periodic review provisions of OAR Chapter 660, Section 25	$150,000	5%
SD-09	City and Prison Levee O&M	Inspection of levees, including maintenance repairs and report documentation[1]	$560,000	0%
SD-10	Local Improvement Fund	Maintenance of the existing system by City staff	$200,000[2]	0%
SD-11	Annual Storm Drainage Main Replacement Program	Average approx. 400 feet of pipe replacement each year	$270,000[2]	0%
SD-12	GIS Data Field Work	Field survey work of existing conveyances and updating the GIS	$50,000	0%
SD-13	Deficiency Upgrades	14,950 feet of pipe upgrades, ranging from 10-inch to 36-inch	$9,075,000	5%
Total 10-Year Project Costs			**$10,305,000**	

[1] *Levee inspection requirements vary depending on structure from annual to bi-annual. Flows in the Umatilla River exceeding 10,000 cubic feet per second trigger additional inspection requirements.*
[2] *Costs provided by City of Pendleton.*

Table 7-4
Recommended 20-Year Projects

Project ID	Project Name	Project Description	Project Cost	Percentage Attributed to Growth
SD-14	City and Prison Levee O&M	Inspection of levees, including maintenance repairs and report documentation[1]	$1,120,000	0%
SD-15	Local Improvement Fund	Maintenance of the existing system by City staff	$400,000	0%
SD-16	Annual Storm Drainage Main Replacement Program	Average approx. 400 feet of pipe replacement each year	$540,000[2]	0%
SD-17	Stormwater Master Plan Update	Periodic review provisions of OAR Chapter 660, Section 25	$300,000	5%
SD-18	Deficiency Upgrades	18,500 feet of pipe upgrades, ranging from 8-inch to 54-inch	$12,250,000	10%
SD-19	Eastern Oregon Regional Airport Expansion	450 feet of 24-inch diameter gravity piping and 13,000 feet of open channel conveyance	$3,530,000	100%
SD-20	Combo Truck	Purchase of new Combo Truck	$420,000	0%
Total 20-Year Project Costs			**$18,560,000**	

[1] Levee inspection requirements vary depending on structure from annual to bi-annual. Flows in the Umatilla River exceeding 10,000 cubic feet per second trigger additional inspection requirements.
[2] Costs provided by City of Pendleton.

Table 7-5
Recommended Developer-Paid Projects

Project ID	Project Name	Project Description	Project Cost	Percentage Attributed to Growth
SD-21	North Hill Development	3,500 ft of 24-inch and 2,000 ft of 36-inch gravity piping	$2,500,000	100%
SD-22	Pendleton East End and Goad Property Development	4,500 ft of 36-inch gravity piping	$2,657,000	100%
SD-23	Southgate Development	2,400 ft of 18-inch and 5,500 ft of 36-inch gravity piping and one new outfall to Patawa Creek	$4,041,000	100%
Total Developer-Paid Project Costs			**$9,198,000**	

General note: Project timelines vary.

Table 7-6
CIP Summary

Project Name	CIP Schedule and Project Cost Summary				
	0-5 Years (Immediate)	6-10 Years	11-20 Years	Developer Paid	Total
Data Collection	$50,000	$50,000			$100,000
Combo Truck	$50,000		$420,000		$470,000
Levee Certification	$527,000[1]				$527,000
Levee O&M	$665,000	$560,000	$1,120,000		$2,345,000
System Maintenance	$200,000[2]	$200,000[2]	$400,000[2]		$800,000
Annual Replacement Program	$270,000[2,3]	$270,000[2,3]	$540,000[2,3]		$1,080,000
Deficiency Upgrades	$5,761,000	$9,075,000	$12,250,000		$27,086,000
Stormwater Master Plan Update		$150,000	$300,000		$450,000
Airport Expansion			$3,530,000		$3,530,000
North Hill Development				$2,500,000	$2,500,000
Pendleton East End and Goad Property Development				$2,657,000	$2,657,000
Southgate Development				$4,041,000	$4,041,000
CIP Total	**$7,523,000**	**$10,305,000**	**$18,560,000**	**$9,198,000**	**$45,586,000**

[1] Costs identified by MSA subconsultant Phase I levee review.
[2] Costs provided by City of Pendleton.
[3] Costs based on 150 years of annual replacement programs.

Brown text indicates existing pipe diameter

SD-21

SD-21

SD-21

SD-22

SD-23

SD-23

SD-23

Umatilla River

Wildhorse Creek

Legend

- Existing Conduit
- Ditch
- Outfall
- Detention Vault
- Detention Pond

Storm Water System Improvements

- 5-year
- 10-year
- 20-year
- Development Driven
- Parcel
- UGB

0 750 1,500 Feet

MSA Murray, Smith & Associates, Inc.

CITY OF PENDLETON INCORPORATED 1880 OREGON

City of Pendleton
Stormwater Master Plan

Figure 7-2
Downtown CIP

May 2015 13-1442

FIGURE 7-1

City of Pendleton
Stormwater Master Plan

CIP Projects

MSA
Murray, Smith & Associates, Inc.

Stage Gulch

Umatilla River West

Airport

Nelson Creek

Umatilla River East

Downtown

McKay Creek

Tutuilla Creek

Patawa Creek

SD-19

SD-21

SD-22

SD-23

Umatilla River

Wildhorse Creek

Jarrett Creek

Legend

- Existing Conduit
- Outfall
- Detention Vault
- Detention Pond

Stormwater System Improvements

- 5-year
- 10-year
- 20-year
- Development Driven
- Parcel
- UGB

Brown text indicates existing pipe diameter

N
W E
S

0 450 900 Feet

I:\BOI_Projects\13\1442\GIS Data\MXD\Stormwater\Figure 7-1 CIP Projects.mxd 3/12/2015 3:14:49 PM LH

May 2015 13-1442

SECTION 8
FINANCIAL PLAN

Introduction

This section provides a general framework for implementing the 5-year capital improvements and staffing additions recommended in this Stormwater Master Plan (SWMP).

Background

The City's stormwater system currently lacks a dedicated funding source. Some stormwater-related maintenance activities (e.g., street sweeping) are funded by the Streets Fund, and limited capital projects such as levee certification and maintenance are funded from the Sewer Fund. As the Streets and Sewer funds face their own funding challenges to address a backlog of capital improvements and staffing needs, it will be necessary for the City to establish a separate Stormwater Utility to fund ongoing maintenance and capital needs associated with its stormwater system.

The City's 2013 survey of Oregon cities with populations under 37,000, and the City of Bend, with a population of about 77,000, found that about half of the cities surveyed charge separate stormwater fees. Of those with separate stormwater rates, the monthly bill for a residential customer ranges from $1.00 to $12.00, with the median bill about $5.00.

Financial Analysis

Overview

To develop adequate revenues from stormwater rates, the system's annual revenue requirements must be determined. Basic revenue requirements are composed of the following:

- Operation and maintenance (O&M) costs.
- Annual capital improvement projects funded by rates and reserves (cash outlays or pay-as-you-go capital).
- Transfers to the City's other funds for direct and indirect services provided to the utility.

Key Forecast Assumptions

The following is a list of key assumptions used in the forecast:

- The number of water customers has been used to estimate the number of stormwater customers.

- Labor costs are as recommended in Section 6—Operations and Maintenance. Specifically, additional full time equivalent (FTE) positions are assumed to include:

    - Street Sweeping (1 FTE).
    - Dedicated Utility Workers (1.5 FTE).
    - Pipe Replacement Crew (0.5 FTE).

Annual labor costs for utility workers are assumed to average $65,000 per year in current dollars.

Future capital expenditures for the stormwater system are based on the Capital Improvement Program (CIP), which identifies $7.5 million in system improvements for fiscal year (FY) 2014-15 through FY 2019-20, as shown in Section 7—Capital Improvement Program. The following assumptions are made with respect to funding:

- Levee certification costs ($0.5 million) will be funded from the Sewer Capital Reserve.
- Deficiency upgrades ($5.7 million) will be deferred beyond the 5-year planning window.
- The remaining $1.3 million ($1.5 million when adjusted for inflation) will be funded from new stormwater rates and system development charges (SDCs).

This financial plan includes development of a new stormwater SDC. The SDC methodology is documented in a separate report, but following industry standards and Oregon statutory requirements, the CIP supports an SDC of $125 per equivalent residential unit. Capital improvements detailed in the CIP are necessary to repair and maintain existing system facilities, and meet the needs of projected growth, particularly in the Airport Industrial Area (AIA).

Revenue Requirements from Rates

Projected requirements from rates are assumed to average about $0.5 million per year, as shown in Table 8-1.

Table 8-1
Projected Revenue Requirements from Rates

	Annual Costs
Operations and Maintenance	$200,000
Average CIP Costs	$300,000
Total Requirements	**$500,000**

Recommendations

The following recommendations are offered for the City's consideration related to funding the staffing and capital improvements identified in this SWMP:

Rates

All operating costs, as well as most capital improvements for rehabilitating replacing, and remedying existing deficiencies, will need to be funded by dedicated stormwater user fees. Stormwater charges are generally assessed based on property area, with the most common measure of system impact determined from impervious area (due to increased stormwater runoff).

The City will need to further develop its GIS and billing systems to implement an area-based fee. In the interim, the City could implement a flat fee per-customer account to begin generating needed revenue for capital improvements and maintenance. A monthly fee of $5 per account (equal to the median charge in other small communities) would generate approximately $350,000 per year (based on the City's existing 5,800 water system accounts). But to fully fund the estimated $500,000 in annual expenses, a monthly fee of $7.25 is recommended; this fee is comparable to those of similar small cities.

Once rates are implemented, the City should continue adjusting all utility rates annually for inflation using the Engineering News Record (ENR) 20-city average *Construction Cost Index*.

System Development Charges

The SDCs calculated as part of this financial plan result in an equitable distribution of capital costs to future development. The SDC per equivalent dwelling unit (EDU) is $125, which is within the range of SDCs charged in Oregon. Based on 2014 data, stormwater SDCs generally range from $100 to $2,000 per EDU. It is recommended that the City adjust the SDCs annually for inflation based on the ENR, and complete comprehensive updates as necessary to incorporate any significant changes to the CIP.

Appendix A

FEMA Levees Phase 1 – Cornforth Memorandum

CORNFORTH CONSULTANTS

10250 S.W. Greenburg Road, Suite 111
Portland, Oregon 97223
Phone 503-452-1100 Fax 503-452-1528

MEMORANDUM

To: Bob Patterson, P.E. Job 2294
City of Pendleton
Public Works Director
500 S.W. Dorion Avenue
Pendleton, Oregon 97801-2090

From: Randy Hill, P.E.

Subject: Phase 1 - Documentation Review
City of Pendleton – Umatilla River Levees
Pendleton, Oregon

Date: August 15, 2013

In accordance with your authorization, this memorandum summarizes our review of existing documentation for the City of Pendleton's Umatilla River levees (including the Prison Levee). Available documentation has been collected and reviewed for compliance with FEMA levee certification requirements. Based on our review, we provide the following preliminary comments and recommendations to assist the City of Pendleton in meeting FEMA requirements for certification.

Note: For consistency purposes, the primary elevations presented in this memorandum are stated in units of feet relative to the NAVD88 vertical datum. Where appropriate, elevations from earlier documents that use a different elevation datum should be converted to NAVD88. The conversion from NGVD datum to NAVD88 datum varies based on location. For the City of Pendleton location, 3.3 feet should be added to obtain the NAVD88 elevations.

FEMA Certification

As part of FEMA's efforts to develop and update National Flood Insurance Program (NFIP) maps, levees must provide protection from the base flood levels (typically the 1 percent annual probability of exceedence, or 100-year flood). The Code of Federal Regulations (44 CFR 65.10) states that "FEMA will only recognize in its flood hazard and risk mapping effort those levee systems that meet, and continue to meet, minimum design, operation, and maintenance standards that are consistent with the level of protection sought through the comprehensive flood plain management criteria established by § 60.3 of this subchapter."

The information to assess a levee system for compliance with FEMA guidelines includes the following criteria from 44 CFR 65.10:

1. Design Criteria

- **Freeboard.** Provide a minimum three feet of freeboard above the base flood profile plus an additional one foot of freeboard within 100 feet either upstream or downstream of any structures (such as bridges) or flow constrictions, and an additional one-half foot above the minimum freeboard at the upstream end of the levee tapering to the minimum freeboard at the downstream end. All freeboard should account for potential wave run-up.
- **Closures.** Openings in the levee must be fitted with closure devices that are structurally part of the system and designed according to sound engineering practice.
- **Embankment Protection**. Engineering analyses must be submitted that demonstrate: (i) no appreciable erosion of the levee embankment would be expected during the base flood; and (ii) any anticipated erosion that does occur would not decrease seepage paths and lead to piping or instability.
- **Embankment and Foundation Stability**. Engineering analyses must be submitted that evaluate embankment stability. Loading conditions must include seepage into/through the levee foundation and embankment during flooding and demonstrate that this will not jeopardize stability of either the embankment or foundation. Alternatively, the analysis must demonstrate that the levee is designed and constructed for stability against Case IV loading conditions from the US Army Corps of Engineers (USACE) manual, EM 1110-2-1913, "Design and Construction of Levees".
- **Settlement.** Analyses must be submitted that assess the potential magnitude of future freeboard loss from settlement. Analyses should follow USACE manual, EM 1100-2-1904, "Soil Mechanics Design – Settlement Analysis".
- **Interior Drainage**. Analysis must be submitted that identifies the source(s) and magnitude of interior flooding and the capacity of drainage features and pumping facilities to remove interior flood waters. The analyses must consider the joint possibility of both interior and exterior flooding occurring simultaneously and the capacity of the system to evacuate interior flood waters.
- **Other Design Criteria.** In unique situations, FEMA may require other design criteria and analyses to show that the levees provide adequate protection.

2. Operation Plans and Criteria

- **Closures.** Operational plans for closure devices must include: (i) documentation of flood-warning system used to trigger emergency activities; (ii) a formal plan of action; and (iii) provisions for periodic operation for testing and training.
- **Interior Drainage Systems.** The following must be included in an operation plan for interior drainage systems: (i) documentation of the flood warning system that will be used to trigger emergency plan operations; (ii) identification of storage areas, gravity outlets and pumping stations; (iii) a formal plan of operation with specific actions; (iv) provisions for

manual backup of automated systems; and (v) provisions for periodic inspection and operation for testing and training purposes.

- **Other Operation Plans and Criteria**. FEMA may require other operating plans and criteria to ensure that adequate protection is provided in specific situations.

3. Maintenance Plans and Criteria

Levee systems must be maintained in accordance with an officially adopted maintenance plan that documents the formal procedures that will be used to ensure that the stability, height and integrity of the levee and its associated appurtenant structures are maintained. The plan shall specify the minimum maintenance activities that will be performed, the frequency of the maintenance, and the person (name/title) responsible to complete the tasks.

4. Certification Requirements

- Data and analyses submitted to satisfy the design, operation and maintenance sections discussed above must be certified by a registered professional engineer. In lieu of these requirements, a Federal agency with responsibility for levee design may certify that the levee has been adequately designed and constructed to provide protection against the base flood.
- In addition, certified "As-Built" plans of the levee must be submitted for FEMA review.

Levee System Description

The most informative description of the two Umatilla River levee systems for the City of Pendleton (i.e. the levee adjacent to the City and to the Prison) found in the project documentation was found in the "Pendleton – Zone 1, Flood Damage Reduction Project – Levee, Floodwall, and Drainage Structures, Periodic Inspection No. 1", January 2011, prepared under contract to the US Army Corps of Engineers (USACE) by Tetra Tech. The key features of the levees found in this report are as follows:

- Levee System consists of two levees segments identified in the report as the Umatilla River Left Bank Levee (adjacent to the main downtown area of the City, also known as the City Levee) and the Right Bank Levee (also known as the Prison Levee)
- Left Bank Levee is approximately 16,800 feet in length (as determined from the 1960 As-Built levee repair drawings dated January 5, 1960), and the current Right Bank Levee is approximately 2,240 feet in length. It should be noted the Right Bank Levee was significantly modified by the construction of the Interstate I-84 embankment roadway and bridge in the early 1960s, which post-dates the above-referenced levee repairs and As-built drawings. The Periodic Inspection Report indicates the current levee systems extend from Umatilla River Mile (RM) 51.0 to 55.5; however, this seems to conflict with the 1960 As-Built Drawings, which indicates the two levee systems extend from approximately RM 50.6 to 53.7 (rough estimations).
- The levees have approximately 18,770 feet of earthen levee segments, supplemented by 8,455 feet of floodwall structures incorporated into the levee.

- The typical crown width is 10 feet, the riverward sideslopes are generally 2H:1V (horizontal:vertical), and the landward sideslopes are 1½H:1V and 2H:1V. The riverward slopes have 18 to 24 inch-depths of dumped riprap revetment materials.
- Original levee construction was completed by local pioneers in the 1880s, with subsequent levee repairs and upgrades completed by the U.S. Federal government in the late 1930s, again in 1947, and a major reconstruction project completed in 1958 (this is the latest reconstruction work, referenced by the 1960 As-Built Drawings).
- Relatively recent (2009) borings completed for levee certification purposes indicate that the majority of the levee embankments consist of sands and gravels with some silt zones, which are underlain by relatively shallow (15 to 30 feet depth) basalt bedrock.
- There are no estimations of the total acreage protected by the levee systems. The protected areas are mostly urbanized industrial, residential and commercial properties and a large imprisonment correctional facility.

Hydrology and Hydraulic Information

Our firm has been assisted in the review of flood hazard evaluation, risk mapping and hydraulic studies by WEST Consultants of Salem, Oregon. Hydrology and hydraulic information for the levee systems are summarized by WEST Consultants in a memorandum included in Appendix A.

Existing Documentation

Copies of select FEMA policy memoranda, geotechnical and hydrologic/hydraulic engineering studies relating to the levees, correspondence between FEMA and the City of Pendleton and the City of Pendleton and the USACE, and two information review and response documents for the Pendleton Levee Systems were provided to Cornforth Consultants, Inc. by the City for review. A brief summary of the existing documents and reports is provided below.

1. FEMA Procedure Memorandum No. 51, Guidance for Mapping of Non-Levee Embankments Previously Identified as Accredited, February 27, 2009. This policy memorandum by FEMA outlines the procedures that will be used to address non-levee embankments in completing FEMA's Flood Insurance Rate Maps. Additional analyses are outlined and briefly discussed for levee owners to consider and complete to account for non-levee embankment situations.

2. Executive Summary – Umatilla River Levee Hydraulic Analysis, prepared by Pacific Water Resources, Inc., May 28, 2009. This summary document appears to be the initial summary by Pacific Water Resources (PWR) discussing and summarizing their hydrologic and hydraulic analyses specific to the two Pendleton Levee Systems. As indicated, it is a summary of their key findings and specific issues relating to storm drain closures, their field reconnaissance, levee freeboard, a hydraulic model of the Umatilla River, and a review of the interior drainage behind the City and Prison Levees. The complete, initial hydraulic analysis report associated with this

"executive summary" was not available for review; however, updated similar summary and complete report documents were reviewed (see document Nos. 6 and 7 below).

3. Report of Geotechnical Site Investigation and Engineering Analyses, Earthen Levee Slope Stability, Settlement and Seepage Analyses, report prepared by GN Northern, Inc., June 1, 2009. This geotechnical report was completed to provide technical information on the subsurface conditions that underlie the levee systems, and to complete engineering analyses to evaluate embankment stability, potential crest settlement, and possible seepage through the earthen embankment and foundation materials for levee certification. The report documents the relatively recent site investigations (9 borings completed in March 2009) drilled on the levee crest at select locations. The site investigation locations were considered to be some of the more critical levee embankment areas, at major structure locations. Engineering analyses relating to embankment stability, crest settlement and potential seepage were completed for typical cross sections developed at the 9 boring site locations. The report also evaluated the erosion protection of the riverward slope based on field observations of in-place riprap revetment. The results of the site explorations, engineering analyses and the consultant's recommendations relating to the integrity of the embankment under various loading conditions are summarized in the report.

4. FEMA Review Comments of the Certification Data and Documentation, March 12, 2010. This memorandum prepared by the USACE (technical assistance) and FEMA present their assessment and review comments of the City of Pendleton's initial certification package. The memorandum indicates that the City submitted the following technical documents for levee certification on June 24, 2009:

- "Engineer Report: Umatilla River Levee Hydraulic Analysis", dated May 28, 2009, prepared by Pacific Water Resources, Inc. (the Executive Summary of this report was part of the documents submitted to Cornforth Consultants for review during this assessment, Document No. 2 above).
- "Report of Geotechnical Site Investigation and Engineering Analysis and Earthen Levee Slope Stability, Settlement and Seepage Analysis", dated June 1, 2009, prepared by GN Northern, Inc. (same report as Document No. 3 above).
- Emergency Flood Response Plan, dated June 4, 2009, established by Resolution No. 2376, passed June 16, 2009.
- Levee Maintenance Plan, dated May 29, 2009, established by Resolution No. 2377, passed June 16, 2009.
- As-built levee plans.

The memorandum provides review comments by the USACE and FEMA as to where they considered the technical assessments and documentation to be incomplete in meeting all of the requirements of 44 CFR 65.10. The referenced CFR requirements are the criterion that FEMA uses to establish minimum standards for levee certification. This review memorandum is the first

of two key documents that provide specific feedback on what additional information is needed to meet the 44 CFR 65.10 requirements for levee certification.

5. FEMA Procedure Memorandum No. 63, Guidance for Review of Levee Accreditation Submittals, September 2, 2010. This is a policy memorandum that establishes the guidelines that are to be used by FEMA, or any subcontracted consultant, in reviewing levee certification applications and whether the submittals are sufficient in meeting the minimum requirements for technical information. This memorandum establishes a 3-tier/10-step process that will be used "to improve and clarify the review process for compliance with 44 CFR Section 65.10." The primary intent of this policy memorandum is to establish a consistent set of guidelines for reviewers to use for all submittals for levee system certification.

6. Executive Summary – Umatilla River Levee Hydraulic Analysis, prepared by Pacific Water Resources, Inc., November 1, 2010. This appears to be an updated executive summary of PWR's hydraulic analyses for the two Pendleton Levee Systems. The text of this summary is almost identical to the first executive summary listed as Document No. 2 above, dated May 28, 2009. The major headings are the same and the conclusions are very similar. There has been some minor updating from the original summary. Additional assessment of the information presented by this summary was completed by WEST Consultants as part of the current review. A brief memorandum discussing their review is provided in Appendix A attached to this report.

7. Engineer Report: Umatilla River Levee Hydraulic Analysis, prepared by Pacific Water Resources, Inc., November 1, 2010. This is the main hydrology and hydraulic analysis report for the two levees. It is assumed that this is an updated report (see reference to initial hydraulic report submitted in the initial documentation package, Document No. 4). This report provides the details of PWR's assessments relating to closures for all openings through the levee, freeboard analysis (including hydraulic river modeling), analysis of interior drainage, and areas protected by the levees. Conclusions and recommendations are presented relating to hydraulic issues. As with the hydraulic analysis executive summary, additional assessment of the information presented by this main hydraulic analysis report was completed by WEST Consultants as part of the current review. A brief memo discussing their review is provided in Appendix A attached to this report.

9. Pendleton – Zone 1, Flood Damage Reduction Report, Umatilla River – Levee, Floodwall, and Drainage Structures, Periodic Inspection No. 1, prepared by Tetra Tech under contract to the US Army Corps of Engineers, Portland District, January 2011. This report documents a comprehensive general assessment of the current condition of the levee systems based on visual inspections and a review of available information. It was completed under a contract by an engineering firm working for the USACE, Portland District. Information is summarized on the system background, project descriptions, foundation conditions, hydrologic and hydraulic data, interior drainage features, field inspection findings and evaluations, design criteria review, and conclusions and recommendations relating to the status of the levee at that time. The report also includes a set of the 1960 As-Constructed Drawings relating to channel and levee upgrades.

These drawings show the most recent major re-construction and repairs completed for the levees. There are also numerous photographs of field observations and aerial photograph figures along the entire levee alignments with notations of where project deficiencies were observed and documented, and where representative photographs were collected.

10. City of Pendleton – Final Response to FEMA Review Comments dated March 12, 2010, response package prepared by the City of Pendleton, March 4, 2011. In response to the first "review comment memorandum" provided by FEMA on March 12, 2010 (see Document No. 4 listed above) and comments noted in an August 2010 inspection of the levees by the USACE (see Document No. 9), the City of Pendleton prepared an extensive, detailed response letter and package of information. The items that were presented and discussed in the letter and in the appendices attached to the letter (15 total appendix sections) attempt to address all of the deficiencies noted in the March 2010 FEMA review/comment document and the USACE Inspection Report. This second submittal package prepared by the City addresses numerous items relating to the following issues:

- Tasks completed from June 2010 (after initial FEMA comment letter) up to and including March 2011 (date of the second submittal package)
- Line by line response to FEMA's March 12, 2010 review comments
- Updated Levee Operations and Maintenance Manual (dated February 2011)
- Updated Flood Emergency Response Plan (dated February 2011)
- Response to FEMA Review, Umatilla River Levee Geotechnical Analysis (dated December 16, 2010)
- Response to FEMA Review, Umatilla River Levee Hydraulic Analysis (dated November 1, 2010)
- Recent maintenance on Stormwater Outfalls
- An Oregon Department of Transportation (ODOT) Bid Package Documents for a levee upgrade/raising along a portion of the Prison Levee immediately north of the Interstate I-84 bridge adjacent to the Oregon Correctional Institution Facility on the west side of the City (dated November 2010)
- Hydrographic Data for the Umatilla River at Pendleton – Gage Station #1402100
- Response of City to specific recommendations presented by the USACE in an inspection report (field inspections completed in August 2010)
- City of Pendleton – Request for City Council Action (dated Mach 1, 2011), resolutions by the City Council relating to some of the deficiencies and issues noted by FEMA and the USACE

- Letter signed by 27 US Senators (dated February 3, 2011) requesting FEMA to discontinue their policy in the use of "without levees" analyses in the development of new Flood Insurance Rate Maps in certain situations
- Letter from the US Environmental Protection Agency, Region 10 (dated March 4, 2011) to FEMA in support of the City of Pendleton's proposed vegetation management along the levee, and disagreement with the USACE's policy for extensive vegetation removal from levees
- Letter from the Oregon Department of Environmental Quality (dated March 4, 2011) expressing similar concerns for large woody vegetation removal along the Pendleton Levees, and the potential that this action may significantly impact endangered fish habitat

This is a key document (with the appendices) that provided significant information relating to specific issues along the two levees. It was intended that this document would be sufficient to address all concerns expressed by FEMA and allow the certification process to move forward.

11. Letter from the City of Pendleton to the USACE, June 19, 2012. Letter submitted by the City to request that the USACE review project documents prepared by ODOT to design and raise a portion of the Prison Levee crest over a short segment in the vicinity of the Interstate I-84 Bridge southeast of the Prison. The project was completed in 2011 by ODOT, but a review and permit from the USACE was never obtained by ODOT or the City prior to construction. The City's letter was to request the USACE to complete a review of the project documents and construction records and issue a post-construction permit for the project.

12. Response Letter from the USACE, Portland District to the City of Pendleton, August 7, 2012. The USACE provided a response letter to the City regarding a post-construction permit for a levee segment raise (see Document No. 11 above) near the Prison facility. The letter disapproved a post-construction permit for the project on the basis of "its impact on the in-place flood damage reduction levee system". Three primary reasons for disapproval were discussed relating to a block retaining wall that had been included in the upgrade project, a bridge drainage pipe that was extended and incorporated into the levee, and the observation that the new crest elevation of the segment raise was below the original design grade that was authorized for the project.

13. Letter from FEMA to the City of Pendleton, Review of Certification Data and Documentation, September 6, 2012. This is the second review/comment letter and summary of findings prepared by the USACE and FEMA in response to the City's submittal of additional documentation (see Document No. 10 above) for certification of the Pendleton Levees. This letter responds to the City's second information submittal and identifies those items that have "met" the requirements of 44 CFR 65.10 and those that were found to be incomplete. Again, specific issues and recommendations were outlined in the summary as to the information that is needed to be in compliance with the CFR requirements. This letter and the accompanying comment summary is the second key correspondence outlining deficiencies in the technical

information. It is the most recent and important document for the City to consider in addressing any remaining outstanding issues for levee certification.

14. Routine Inspection of the Pendleton Zone 1 Flood Damage Reduction Systems (Pendleton 1 FDR Systems), annual inspection completed by the USACE June 13-14, 2012. This is an annual inspection report which is the latest inspection of the levee system by USACE and City staff available for review. The inspections, a USACE requirement of its Federal Levee Protection Program, are conducted to evaluate the structural integrity, assess flood emergency preparedness, and provide recommendations regarding operation and maintenance. The report outlines the latest observations along the levee systems and indentifies both the Right Bank (Prison) and Left Bank (City) levees as meeting the minimum requirements of levee safety and integrity, with an overall system rating of "Minimally Acceptable". Currently, the Pendleton levees remain active in the rehabilitation and inspection program. There were some areas that received an "Unacceptable" rating, with the primary deficiencies relating to unwanted vegetation growth within the levee prism, unpermitted encroachments into the levee, an unapproved closure structure, and some minor concrete monolith joint openings.

Existing Plan Sheets

Cornforth Consultants, Inc. also received three sets of levee plan sheets from the City of Pendleton and the US Army Corps of Engineers, Portland District for the Pendleton Levees. One of the drawing sets was right-of-way and real estate maps and was somewhat redundant to one of the other drawing sets; therefore this first drawing set was not used for the current review. A summary of the other two existing plan sets is provided below:

1. ***Umatilla River, Oregon - Flood Control Survey 1935.*** The first set of review drawings (3 drawings total) for the Pendleton Levees were maps for flood control and channel improvements for an older levee system that extended farther upstream to the east and downstream to the west. The information presented on these map-drawings was somewhat limited and did not provide useful information for the current assessments.

2. ***Pendleton Levees Umatilla River, Oregon - Channel and Levee Construction, As-Constructed Drawings, dated January 5, 1960.*** This 10-drawing set shows the river channel improvements and the levee embankment upgrades that were completed in 1957-58, which was the latest major improvements completed for the Pendleton Levees. The City provided one copy of these drawings along with others from their files; however, a later "As-Constructed" version of the same drawing set, with construction-related modifications, was included as an appendix in Document No. 9 listed above. These drawings provide information on typical embankment section upgrades and new construction at many locations along both levee systems, construction of a new floodwall through a short segment of the City Levee alignment, and river channel excavations and riprap revetments through numerous segments of both levees. It is anticipated that new topographic mapping of the

existing levee systems (required for levee certification) will show general agreement with the geometric configurations shown in these drawings.

Information to Meet FEMA Compliance

Based on our review of the documents provided for the Pendleton levee systems, we provide the following comments on the design, operation and maintenance information that is available to assess compliance with the levee certification requirement found in 44 CFR 65.10.

The current status of the Pendleton Levees certification is unique, and substantially different from most other levee districts, in that there have already been two major submittals to FEMA to determine compliance with the CFR requirements. There has also been significant feedback from the regulatory agency (FEMA) in the form of two summary comment lists identifying those areas in the technical documentation they consider to be deficient. It is important to note that the summary review comments also list those areas that have been judged to be adequate in satisfying the requirements; thus accepting what has already been submitted relating to certain issues (i.e. all components using the same flood elevation datum, interior drainage studies completed, some embankment protection assessments are satisfactory, and evaluations of potential embankment settlement are complete). Most levee owners are at the beginning of the submittal process whereas the City of Pendleton is well along and has significant review comments and directions as to what additional information is required.

The key document to focus on going forward is the latest letter and review comments provided in the FEMA correspondence dated September 6, 2012 (Document No. 13 listed above). The comments provided in this summary of findings correspondence follow FEMA's Procedure Memorandum No. 63 for levee reviews (Document No. 5 above), which uses a 3-tiered, 10-step assessment approach to evaluate technical documentation submitted for levee certification, in conjunction with the requirements of 44 CFR 65.10. Several observations from the FEMA September 6, 2012 letter are presented below:

1. ***Prison Levee.*** The September 6, 2012 review comments break out the Prison Levee separately and indicate it has significant issues to resolve before it can be considered further for levee certification, such as:

- Resolving a request for a post-construction permit from the USACE for a levee raise project completed by ODOT in 2011 on a short segment of levee immediately north of the Interstate I-84 Bridge, southeast of the Prison. There are three items to resolve with the USACE as identified in Document No. 12 above, which is a response letter from the USACE dated August 7, 2012 disapproving the project and rejecting a post-construction permit request from the City. FEMA is using the August 7, 2012 USACE letter as a reason to withhold certification until the three identified issues are resolved.
- Resolving issues related to the I-84 embankment section acting as a water-retaining embankment structure, similar to a levee. A policy memorandum released on September 10,

2008 by the U. S. Department of Transportation, Federal Highway Administration discourages any certification of a highway embankment as a levee structure. The issues relating to this restriction will require significant discussions and possible site investigations, analyses and concurrence from several federal agencies (FEMA, FHWA and USACE).

- Resolving embankment stability and low crest elevation concerns for a segment of levee near the railroad trestle along the northeast limits of the Prison Levee (near BH-6 drillhole). The City has already addressed this issue, but there are still concerns raised by the September 6, 2012 FEMA letter and additional discussions and evaluations appear to be needed.

2. ***City Levee.*** The FEMA letter/review comments continue with issues relating to the City Levee (Pendleton levee system - as referenced in their summary comments) identifying 17 additional areas of concerns relating to various issues. Four of the 17 appear to be relatively significant and the remaining 13 could, in our opinion, be handled with a little more discussion, clarifications and additions to other documents such as the Operations and Maintenance Plans. All future technical documentation and submittals should address the specific topics identified in the latest FEMA summary comments.

In our opinion, the four most significant deficiency issues indentified by the September 6, 2012 FEMA correspondence relates to the following:

- Submittal of a current topographic map showing the as-constructed, current geometry of the levee systems; identifying other items such as the location and dimensions of adjacent structures, pipeline and utility crossings, and all facilities that are considered part of the interior drainage system. We understand that the City is in the process of retaining a licensed surveying firm to complete this task.

- Develop additional geotechnical information and complete engineering analyses to confirm the integrity of the levee in terms of embankment and foundation stability and potential seepage (settlement has already been assessed and considered adequate) at additional locations along the levee. The review comments requested that the coverage of the geotechnical assessments be extended over the entire levee systems, beyond the nine locations that have already been reviewed.

- Complete a structural analysis of the Christian Science Building lower wall that will act as a water-retaining structure during flood events. Confirm by analysis that the wall will not fail causing a breach during the base flood (i.e. the 1% annual exceedence or 100-year flood event). It is our understanding the City will have this analysis completed under the contract already in place with Murray, Smith and Associates, Inc.

- Resolve the issues of un-permitted encroachments into the levee as identified by the USACE in their 2010 Periodic Inspection Report (Document No. 9 listed earlier) and their 2012 Routine Inspection Report (annual report – Document No. 14 above). Clarifications should be requested from FEMA on how these un-permitted encroachments could be addressed in

the Operation and Maintenance Plans, as suggested by the review comments in their summary of findings (i.e. the attachment to the September 6, 2012 letter).

Summary and Recommendations

Based on our assessments, it is our opinion that the City of Pendleton levee systems could possibly meet the requirements in 44 CFR 65.10. However, there are several significant issues yet to be resolved, especially relating to the Prison Levee segments; including the I-84 embankment along the south side acting as a levee, the ODOT-completed construction along the southeast side of the Prison and the issues identified with obtaining a post-construction permit from the USACE. Additional information and documentation in these and other areas are needed to satisfy the concerns of FEMA and the USACE.

As stated in the previous section, the most significant document to consider at this point is the September 6, 2012 FEMA summary of findings document that outlines what additional information they are looking for to satisfy their concerns and compliance with the 44 CFR 65.10.

In addition to the issues outlined above for the Prison Levee, those areas requiring additional documentation include, but may not be limited to, the following:

- Preparing a new topographic map of the current geometry of the levee with other features, as discussed in the previous section.
- Review the freeboard analysis using the updated topographic map (first bullet item) as a basis for comparison.
- Address the seven items identified in the FEMA letter relating to the Operation and Maintenance Plan.
- Provide additional clarification of how the SE 8th Street Closure Structure ties into the existing parapet walls. There seems to be some misunderstanding of how the closure system will work.
- Additional analyses and discussion showing no appreciable scour or erosion on the riverward slope of the levee during the base flood event, due to wind action, wave action, ice or debris; and that any anticipated scour would not result in instability of the levee as a result of reduced seepage paths through the embankment or foundation soils.
- Analyses that demonstrate levee stability during the base flood loading conditions. These analyses should include potential shear failures within the embankment and/or foundation soils, and potential seepage through or underneath the levee. Address the expressed concerns noted for shallow failures on the levee slopes.
- Complete additional subsurface explorations that adequately characterize the subsurface soil and geologic conditions in reaches of the levee that are anticipated to have similar subsurface conditions. The purpose of these additional site explorations would be to develop additional slope stability/seepage analyses sections as suggested by the summary letter to expand the

geotechnical assessments over a greater portion of the levee system. Guidelines prepared by the USACE for evaluation of levee under-seepage indicate that a minimum target level of subsurface explorations should be a series of borings approximately every 1,000 feet, consisting of an exploration at the riverside toe, at the landside toe, and a deeper exploration at the levee crest. Because basalt bedrock was encountered at shallow depths in the nine initial exploratory borings, and many exposures of rock can be observed in the river channel, it is likely that concurrence could be obtained from the regulatory agencies to eliminate any borings on the riverward side of the levees as they would not provide any additional significant information for engineering analyses.

- Applying the Corps exploration guidelines to the Pendleton levees would suggest approximately 35 to 40 additional borings would be needed across the approximately 3½ miles of levee alignment. The actual number of borings required for certification will need to be reviewed and coordinated with FEMA/USACE to gain their concurrence on levee reaches (segments) and the location of proposed borings prior to completing the explorations.
- Complete structural analyses on how the Christian Science Building will respond to the 1% annual exceedence event, as requested by the summary comment letter.
- Coordinate with the USACE to address the issues of, unacceptable, un-permitted encroachments into the levee. Discussions with the USACE will determine what information will be needed for them to provide a permit for these structures. It is likely they will require some form of analysis to show that the levee protection will be maintained with these structures in-place during design flood events; which will probably be different (higher) than the 1% annual exceedence event. These analyses would likely be used to satisfy the USACE levee design standards, not the FEMA/44 CFR 65.10 criteria that is used for levee certification by FEMA.

Again, as stated earlier, the primary intent for any additional analyses or development of technical documentation relating to certification of the Pendleton levee systems should address the specific issues discussed in the September 6, 2012 FEMA correspondence. Some of those issues relating to the Prison Levee are quite significant and will require extensive discussions and negotiations with FEMA and the USACE to resolve.

We trust that this memorandum is sufficient for your current requirements. Should you have any questions or comments, please call at 503-452-1100.

APPENDIX A

WEST Consultants Memorandum

TECHNICAL MEMORANDUM

WEST Consultants, Inc.
2601 25th Street SE, Suite 450
Salem, OR 97302-1286
(503) 485-5490 phone (503) 485-5491 fax
www.westconsultants.com

REGISTERED PROFESSIONAL ENGINEER
59786PE
OREGON
JAN. 12, 1999
THOMAS R GRINDELAND
7/30/13
EXPIRATION DATE: 6/30/15

Name:	Randy Hill, P.E.
Company:	Cornforth Consultants, Inc.
Date:	7/30/13
From:	Tom Grindeland, P.E.
Subject:	Pendleton Levee Certification Phase 1 Work Tasks

Objective: To review existing data and information to understand existing conditions and assess whether available information is sufficient to assess the adequacy of the levee system for FEMA certification. Specifically, data and information relevant to the following topics were reviewed.

1) Freeboard

2) Closures

3) Embankment Protection

4) Interior Drainage

Task 1 Teleconference

A face to face meeting was held on May 23, 2013 with the City of Pendleton to introduce the project team, review the project background and conduct a reconnaissance of the levee system.

Task 2 Document Review

The available project documentation provided by Murray Smith and Associates, Inc. was reviewed. A summary of information relevant to the topics of freeboard, closures, embankment protection and interior drainage is provided in Appendix A. Outstanding certification issues regarding these topics identified from the literature review are summarized in the Table 1.

Topic	No.	Description
Freeboard	1	Figure 6 from Appendix E of the City's response to FEMA Certification Review Comments, dated 3/4/11, shows inadequate freeboard exists along the City Levee at a location about 3,500 ft upstream of the downstream limit of the profile.
	2	According to the 8/7/12 letter from Mr. Lance Helwig, COE, to the Bob Patterson of the COP, the final grade of the Prison Levee upstream of the I-84 bridge is below the original design grade of the levee crest. Also, according to the FEMA Certification Review Comments included in the letter from Mr. David Ratte, FEMA, to Bob Patterson, COP, the Prison Levee has inadequate freeboard at the I-84 bridge (page 3 of 8).
	3	According to the FEMA Certification Review Comments included in the letter from Mr. David Ratte, FEMA, to Bob Patterson, COP, the I-84 embankment adjacent to the Prison Levee is a non-levee embankment.
Closures	1	According to the FEMA Certification Review Comments included in the letter from Mr. David Ratte, FEMA, to Bob Patterson, COP, no structural design information for the closure structure for the SE 8th Street bridge along the City Levee was provided.
	2	According to the 8/7/12 letter from Mr. Lance Helwig, COE, to the Bob Patterson of the COP, the Stormwater Drain beneath the Prison Levee is not consistent with COE levee design policy.
	3	According to the 11/6/12 letter from Lance Helwig, COE, transmitting the June 13-14, 2012 routine inspection results to the COP, a sewer siphon is shown on the as-built levee drawings at PT1A_2012_a_0008: Station_1 NA
Embankment Protection	1	According to the FEMA Certification Review Comments included in the letter from Mr. David Ratte, FEMA, to Bob Patterson, COP, no analysis of wind action, wave action, ice and debris flow impacts to existing riprap protection by a hydraulic engineer was provided (page 6 of 8).
	2	According to the FEMA Certification Review Comments included in the letter from Mr. David Ratte, FEMA, to Bob Patterson, COP, no discussion on the duration of flood stages and its impact on embankment protection was provided (page 6 of 8).
Interior Drainage	1	According to the 9/6/12 letter from David Ratte of FEMA, page 6 of 8 of the FEMA Certification Review Comments, **"No issues with the interior drainage analysis were noted."** However, it is recognized that the interior drainage analysis was conducted for a 2-year 24-hour flood event, which was determined by PWR to be the most likely rainfall to occur coincident with a 100-year flood along the Umatilla River. The analysis presented is contrary to the purpose of the interior drainage analysis. The interior drainage analysis should have been based on a 100-year rainfall event and the coincident flow event in the Umatilla River, which is not necessarily the 100-year flood, should have been determined. Accordingly, the presented interior drainage analysis is considered to be deficient.

Task 3 Document Review Memo

The current memo was produced to fulfill this requirement.

Task 4 Review Meeting + Phase 2 Scope & Cost

This task is to be completed.

Appendix A Documentation Review Comments

Date	Item	From[1]	To[1]	Review Comment
5/28/09	Executive Summary	Pacific Water Resources, Inc.	COP	This document is an executive summary of the hydraulic analysis of the City Levee and Prison Levee conducted by PWR for the City. It provides a summary of the work performed and the conclusions of the study. A hydraulic model of the Umatilla River was developed based on the "best available survey data". The model was calibrated to flows from a Bureau of Reclamation stream gage. The report noted deficiencies in the existing levee system that would need to be corrected before certification by FEMA. The noted deficiencies included missing or inoperative closure structures for storm drains, inadequate freeboard in the vicinity of the SE 8th St bridge along the City Levee and along a 350 ft length of the Prison Levee close to I-84. PWR also analyzed interior drainage conditions. They concluded that the 2-year 24-hour rainfall would most likely occur during a 100-year flood event. For this event, it was concluded that depths of inundation would be less than 1 ft behind both the City Levee and the Prison Levee.
11/1/10	Report	Pacific Water Resources, Inc.	COP	This report that addresses freeboard, closures on levee openings and interior drainage. Various deficiencies in the closures for levee openings were identified. Figure 3 shows the freeboard profile for the City Levee. Freeboard was insufficient near SE 8th street but enough elsewhere. Figure 7 illustrates the freeboard for the Prison Levee. Its freebgoard was insufficient for the 350 ft of levee closest to I-84, an area where ODOT had removed the original levee to construct the freeway and replaced it with one that is several feet lower. The interior drainage analysis analyzed rainfall records to determine what rainfall was most likely to occur coincident with a 100-year flood. It was determined to be a 2-year 24 hour rainfall. The river flood most likely to be coincident with the 100-year rainfall event was not determined.
Letter 3/4/11 Report 3/12/11	Letter & Report	COP-Patterson	FEMA-Ratte	This letter and supporting information, entitled "City of Pendleton – Provisionally Accredited Levee – Final Response Documentation – Pendleton Levee - Prison Levee", were submitted in response to a letter from Mr. David Ratte of FEMA dated 3/12/10 and a meeting at City Hall

				held on 5/5/10. Relevant information included the following: <u>Appendix A – Response to FEMA Review Comments Dated March 12, 2010</u> • Freeboard: PWR determined that previous areas determined to be deficient in freeboard were still deficient. A temporary closure structure at the SE 8th Street bridge that ties to existing parapet walls at the bridge was proposed to provide the necessary freeboard at that location. It was also noted that the Oregon Department of Transportation (ODOT) agreed to provide closure in the area of deficient freeboard on the Prison Levee near its intersection with I-84. Project was to be completed by June 15, 2011. • Closure Structures: It was noted that all missing closure devices have been installed, obstructed closure devices cleared and all openings have functional closure devices. • Embankment Protection: The city noted that there have been no problems experienced with the levee system, despite five flood events with flows greater than 10,000 cfs since 1935. It was cited that the GN Northern report concluded that the existing armoring is adequate in the arease analyzed with the exception of BH-1. It was indicated that "some riprap armoring will be necessary near BH-1 at the left bank". The city planned to work on the levee in the summer 2011. The city noted that wave action is minimal on the Umatilla River through Pendleton during a flood event; therefore, a formal analysis of wave disturbance was not conducted. • Interior Drainage: <u>No issues with interior drainage were noted</u>. It was remarked that the average depth is less than one foot.
3/30/11	Letter	COE-Chambers	COP-	Letter transmitting results of COE periodic

			Patterson	inspection of the Pendleton Flood Damage Reduction Systems conducted on August 2 and 3, 2010. Various system components were identified to have an "unacceptable" rating and require immediate correction. As described in the letter, "minimally acceptable" or "unacceptable" ratings should be evaluated by the levee owner to determine the potential impacts to FEMA certification. . Noted items rated as unacceptable which are pertinent to FEMA certification include: Culverts/discharge pipes; closure structures; flap gates,flap valves and pinch valves. The former Christian Science Building located immediately downstream of the Main Street bridge was noted to serve as a floodwall. It was recommended that analyses be undertaken to ensure that it provides adequate protection.
8/7/12	Letter	COE-Helwig	COP-Patterson	Response to 6/19/12 letter from Bob Patterson regarding levee reconstruction in vicinity of the I-84 bridge. 1. Block retaining wall must be designed and evaluation documentation provided to verify the integrity of the levee 2. Stormwater drain beneath levee is not consistent with policy 3. Final grade of levee restoration project is below the original design grade of the levee crest
9/6/12	Letter	FEMA-Ratte	COP-Patterson	Letter transmitting results of FEMA's (Corps') review of levee certification documentation received on March 4, 2011 and November 11, 2011. The COE provided technical assistance in the detailed review of the submitted certification data and documentation. Additionally, the COE reviewed the Oregon Department of Transportation project to restore a portion of the Prison Levee at the I-94 bridge. It was concluded that the supporting data and documentation are incomplete. Specific deficiencies included the following: <u>Freeboard</u> ➢ The Prison Levee has inadequate freeboard at the I-84 bridge ➢ The City Levee is shown to have inadequate free board in two locations:

				• 3,500 ft upstream of Hwy 30 • In the vicinity of SE 8th St bridge ➢ The freeboard at the windows of the former Christian Science Building at the SE 8th Street bridge was surveyed by the City and indicated to be adequate; however, the structural stability of the building to withstand flood forces was not defined by the city. <u>Interior Drainage</u> The Interior Drainage Analysis was noted to have met certification requirements; however, it recognized that the interior drainage analysis was conducted by a 2-year 24 –hour rainfall event, based on the conclusion that the 2-year rainfall event was most likely when a 100-year flood occurred on the Umatilla River. It is recognized that the interior drainage analysis should have been conducted for the 100-year rainfall event and the flow condition in the Umatilla River that would most likely be coincident. <u>Embankment Protection</u> ➢ No analysis of wind action, wave action, ice and debris flow impacts to existing riprap protection was provided by a hydraulic engineer. ➢ No discussion of the duration of flood stages and its impact on embankment protection was provided. <u>Closure Structures</u> ➢ No documentation was provide regarding the design of the 8th Street Bridge closure structure.
11/6/12	Letter	COE-Helwig	COP-Patterson	Letter transmitting results of COE routine inspection of the Pendleton Flood Damage Reduction Systems to the City. The routine inspection was conducted June 13-14, 2012. Various system components were identified to have an "unacceptable" rating and require immediate correction. As described in the letter, "minimally acceptable" or "unacceptable" ratings should be evaluated by the levee owner to

				determine the potential impacts to FEMA certification. Noted items rated as unacceptable which are pertinent to FEMA certification include: Culverts/discharge pipes, closure structures. Numerous locations were identified where the level of protection should be verified.
No date	Project Description	NA	NA	This document summarized the analysis conducted by Pacific Water Resources, Inc. for the "Umatilla River Levee Hydraulic Analysis". The document indicates that one location was identified "where the levee needed to be raised and several locations where closure devices were needed." The write up also described how an analysis was conducted to define the joint probability of peak rainfall with river flow. It was concluded that a 2 year 24 hr rainfall was most likely when a 100-year flood occurred. It was not defined what river flow was most likely when the 100-year rainfall occurred.

1 COE – Corps of Engineers Portland District
COP – City of Pendleton
FEMA – Federal Emergency Management Agency

MSA
Murray, Smith & Associates, Inc.
Engineers/Planners

Appendix B
FEMA Levees Phase 2 – Cornforth Proposal

CORNFORTH CONSULTANTS

10250 S.W. Greenburg Road, Suite 111
Portland, Oregon 97223
Phone 503-452-1100 Fax 503-452-1528

February 6, 2014 2294-2

Mr. Bob Patterson, P.E.
City of Pendleton
Public Works Director
500 S.W. Dorion Avenue
Pendleton, Oregon 97801-2090

Proposed Phase 2 Engineering Services
FEMA Levee Certification Studies
Umatilla River Levees
Pendleton, Oregon

Dear Mr. Patterson:

We are pleased to present this proposal for Phase 2 engineering services related to the Federal Emergency Management Agency (FEMA) certification of the City of Pendleton – Umatilla River Levee Systems in Pendleton, Oregon. This proposal summarizes our scope of work, estimated cost and an approximate schedule for completion of the proposed services.

BACKGROUND

The City of Pendleton (City) has requested engineering assistance to obtain FEMA certification of the Umatilla River Levee Systems within the city limits in accordance with 44 CFR 65.10 requirements. The City is pursuing levee certification to comply with FEMA's request for information to develop updated flood hazard and risk maps for areas protected by certified levee systems. The updated mapping is part of the comprehensive flood plain management program administered by FEMA under the National Flood Insurance Program (NFIP).

Phased Approach. The key tasks identified to pursue levee certification were broken down into two phases. The first phase consisted of a review of existing documentation and correspondence that was available for the subject levee systems, and to assess whether that information was sufficient to satisfy the requirements of 44 CFR 65.10. The status of the City's levee systems are somewhat different from most drainage districts in that the City has already received a significant amount of feedback and response from FEMA as to the additional information that they suggest is needed to comply with the CFR levee certification requirements. Therefore, the proposed services under a second phase engineering assessment should be focused on what has been identified by FEMA to complete unresolved requirements for certification.

Our firm was retained in the spring of 2013 to complete the Phase 1 tasks and prepare a summary memorandum identifying the existing documentation and the adequacy of this information for levee certification, as well as the most-recent FEMA requirements based on their review of prior information submittals. The Phase 1 summary memo was submitted to the City on August 15, 2013.

The Phase 1 memorandum identified the following missing information and analyses, which are necessary for FEMA certification:

Prison Levee

- Resolve issues relating to a post-construction permit from the U.S. Army Corps of Engineers (USACE) for a levee reconstruction project completed by the Oregon Department of Transportation (ODOT) in 2011 on a short segment of levee adjacent to Interstate I-84.
- Resolve issues relating to the I-84 highway embankment serving as a water-retaining levee structure along major portions of the south levee boundary.
- Resolve embankment stability and low crest concerns for a short segment of the levee adjacent to the railroad trestle at the northeastern limits of the levee.

City Levee

- Submit updated as-built maps of both levee networks (City and Prison Levees).
- Review freeboard analyses of the levee crest using the latest as-built survey information.
- Provide additional FEMA-requested information (multiple items) on the Operation and Maintenance Plans developed by the City.
- Provide additional information and clarification on the proposed SE 8th Street Bridge closure structure to be installed under high flooding conditions.
- Complete additional analyses to demonstrate that no appreciable scour or erosion would occur during the base flood event under specified loading conditions.
- Complete additional analyses demonstrating adequate stability and seepage control during the base flood, along extended portions of the levee system.
- Complete additional site investigations and laboratory testing to adequately characterize the subsurface soil conditions to support the stability and seepage analyses referenced above.
- Review and coordinate with the USACE addressing issues relating to unacceptable, unpermitted encroachments into the levee prism. Resolve all issues relating to each area in order to obtain an acceptable permit/rating based on the USACE requirements.
- Complete structural analyses to confirm that the Christian Science Building will respond favorably to the base flood loading conditions. (These analyses are being performed by another engineering group and are not part of the current scope of work in this proposal).

These requirements are based on the latest FEMA review letter and attachments of September 6, 2012.

Phase 2 Studies. A proposed scope of work to complete the Phase 2 evaluation is presented below. As with our Phase 1 work, we would be assisted by WEST Consultants of Salem, Oregon on tasks related to hydrology and hydraulic engineering. It is our understanding that the City is currently working toward satisfying some of the items listed above, including coordination and additional discussions with the USACE on several of the items relating to a post-construction permit on a segment of the Prison Levee, and multiple levee encroachments on the City Levee. Also, the City is working on the additional clarification from the City on the 8th Street Bridge Closure structure, updated revisions to the Operations and Maintenance plans, and the as-built survey maps. It is anticipated that the Cornforth/WEST role on these task items will be a support role to provide review comments and assist the City in developing sufficient additional data to satisfy the requests for additional information.

Site Exploration Work Plan/USACE Permit. Based on recent changes to the USACE's levee management program, the Corps now follows a permit process for any drilling work in a levee network. The permit process requires submittal of a formal Site Exploration Work Plan, which documents the proposed drilling methods and locations, equipment, borehole depths, sample types, cleanup procedures, schedule and driller credentials. The USACE also requires a basic sensitivity analysis (stability and seepage) to demonstrate the need for drilling. Based on the foregoing, Task 10 below includes our estimated efforts to prepare a Site Exploration Work Plan and assist the City with the USACE permit process.

Levee Reaches. A key step in the certification process involves separating the levees into segments with similar features and conditions, called "reaches." This method, also employed by the USACE, allows several thousand feet of levee alignment to be analyzed in manageable segments. For each reach, it is necessary to document subsurface conditions and provide evidence of the required engineering evaluations to demonstrate compliance with 44 CFR 65.10. Following a review of the Pendleton levee system construction documents and available subsurface information, Cornforth Consultants has broken the two Pendleton levee systems into 7 individual reaches. The proposed site explorations are intended to provide sufficient information to characterize the subsurface conditions within each of these individual levee reaches.

PHASE 2 SCOPE OF WORK

The first three proposed tasks relate to specific issues regarding the Prison Levee only, while the remaining tasks relate to both levee systems. The one exception is the embankment encroachments task (Task 11 below), which are only along the City Levee segments.

Task 1 – Post-Construction Permit for Re-Constructed Levee near I-84 Bridge (Prison Levee). The USACE identified three issues that they used to deny a post-construction permit for a short segment of levee re-construction near an Interstate 84 (I-84) bridge as completed by the ODOT in 2011. These issues relate to the use of a block retaining wall as part of the levee, a bridge drainage pipe passing through the levee, and low crest elevation as compared to original USACE levee design. The City will need to discuss these issues with a USACE representative to determine a resolution that would allow the post-construction permit to be issued. Cornforth

Consultants efforts are somewhat indeterminate at this time for this task. We have therefore allowed for an estimated time/budget amount (see cost estimate breakdown below) to provide assistance to the City with consultations, technical assessments (if any), and participation in meetings or teleconference discussions with the City and the USACE; with the intent to arrive at a resolution that would allow for a post-construction permit to be issued.

Task 2 – Resolving Concerns for Intestate 84 Embankment Serving as a Levee (Prison Levee). This task will also require the City to initiate discussions with FEMA and ODOT to assess what information will be needed to confirm that the I-84 embankment could be used as a water-retaining levee structure for temporary flood control under the assumed base flood event (i.e. the 100-year flood). CCI would provide consultation, and as needed, participation in meetings and teleconference discussions to assist the City in negotiations to obtain concurrence from FEMA on this issue. At a minimum, it is anticipated that the I-84 embankment will need to be investigated to characterize the subsurface conditions and analyzed to assess embankment stability and potential for seepage in a manner similar to the other levee segments for the Pendleton Levees. Site investigations, engineering analyses and inclusion of the results in a summary report for this segment of levee have been incorporated with the other similar tasks and budget items listed below for the other levee segments. However, it is likely that additional efforts and associated cost would be needed to assist the City with the negotiations, meetings and discussions referenced above. This additional level of effort by CCI, beyond the site investigations and analyses, are undetermined at this time. An estimated budget amount has been included as an additional line item in the table below to account for additional consultation and meetings for this specific task. For budgeting purposes, we have allowed 48 hours for our Project Manager to assist the City with this task along with limited support staff time.

Task 3 – Resolving Embankment Stability and Crest Elevation Concerns near Railroad Trestle (Prison Levee). As discussed in our Phase 1 memorandum, the City has addressed this issue in past submittals, but the most recent FEMA correspondence indicates there are still concerns for the levee crest elevation and stability near the railroad trestle. We anticipate that the City will need to initiate additional discussions with FEMA to determine what is needed to fully satisfy their concerns. Based on recent experience at other levee districts, we expect that our additional site investigation work and stability analyses will likely answer some of FEMA's questions, but there may be additional issues to resolve. We have accounted for additional borings and stability and seepage assessments for this area in other tasks listed below. However, we anticipate there could be other involvement (e.g. consultations, meetings, teleconferences, etc.) to assist the City in their clarifications with FEMA and the USACE. The level of effort for this task is difficult to forecast. For budgetary purposes, we have allowed 24 hours for our Project Manager to assist the City with this task and some support staff time.

Task 4 – Review of City-developed Topographic Maps. We understand that the City will be providing an updated survey of the levee systems to serve as the As-Built drawings necessary for certification. We would coordinate with the City to review these maps and help customize the

As-Built drawings to meet the certification requirements, based on our recent experience with FEMA's review of this type of topographic information for other drainage districts.

Task 5 – Freeboard Review using Updated Survey Maps. Using the City-developed topographic information, WEST Consultants would conduct a freeboard analysis using the updated crest elevation information and the base flood elevations from the existing FEMA hydraulic model for the Umatilla River. The analysis would determine if there are any areas along the levees that do not meet the freeboard criteria as outlined in the 44 CFR 65.10 regulations.

Task 6 – Review Updated Operation and Maintenance Plan(s). The latest FEMA correspondence requested additional information relating to the Operation and Maintenance Plans that the City already has developed and submitted for review. Multiple items were specifically identified in the FEMA correspondence. It is assumed that the City would provide this updated information and that CCI would be involved with providing review comments to assist the City in developing the information and reviewing the final submittal to FEMA.

Tasks 7 –Clarifications on the 8th Street Bridge Closure Structure. Based on preliminary discussions with the USACE, it appears that they and FEMA require additional clarification on how the proposed closure structure would fit the bridge opening, how it would be sealed, how the City would practice installing the structure, and other miscellaneous details to help the agencies understand its design and function. It is anticipated that CCI would assist the City in developing a narrative describing how this closure system would work; details on the installation; the proposed plan and schedule for training City staff on the installation, and the timing of when it would be deployed. Again, CCI would be in a review mode assisting the City as they develop the details of their plans for this structure. For budgetary purposes, we have allowed 8 hours for our Project Manager to assist the City with this task.

Task 8 – Embankment Erosion and Scour Protection Analyses. WEST Consultants would perform this task with some assistance from our firm. Their work tasks would include a site reconnaissance to observe existing levee conditions, documenting existing levee openings, and collecting information necessary to assess the potential for embankment erosion under various loading conditions. Their analyses would include additional evaluations of existing bank erosion protection, estimation of toe scour potential, impacts due to wind and wave action, and the potential impacts from ice, debris and debris flows. They would provide documentation of all data collection, engineering assessments, and supporting information that would be sufficient for FEMA's review.

Task 9 – Embankment and Foundation Stability and Potential Seepage Analysis. Cornforth Consultants would take the lead on an extended evaluation of the stability of the embankment and foundation materials using information developed from a comprehensive field investigation and laboratory testing program (presented below under the next task) to characterize existing subsurface conditions. FEMA requires analyses that demonstrate levee stability during the base flood loading conditions. WEST Consultants would assist with this task in defining the water surface elevations along the levee under the base flood conditions. These analyses must include

potential shear failure surfaces within both the embankment and foundation soils, and also an assessment of the potential seepage through and underneath the levee. Current USACE design manuals and technical memorandums that describe levee analysis, design and construction guidelines and procedures would be used to provide guidance during the assessment of the levee embankments and foundation soils. The two most relevant USACE design guides include EM-1110-2-1913, Design and Construction of Levees (April 2000), and ETL 1110-2-569, Design Guidance for Levee Underseepage (May 2005).

Task 10 – Additional Subsurface Explorations and Laboratory Testing. Cornforth Consultants has developed proposed subsurface and laboratory testing programs to obtain the data needed to perform the required engineering analyses discussed in the previous task. These programs are described in general terms below. Additional details on the proposed site exploration program would be presented in the Site Exploration Work Plan that would be developed for the exploration permit application to the USACE for their review and approval.

Subsurface Explorations. Table A (attached at the end of the text) contains a summary of all the proposed borings for a new site investigation program, along with the existing borings that already have been completed along the levee. The information from the earlier borings would be used to supplement the new boring information to use in the stability and seepage analyses. The table includes the approximate levee stations where the borings would be performed. The exploration plan includes 39 new borings overall for both levee systems (City and Prison), with 14 drilled through the levee crest, 5 at the riverside toe (all can be accessed from land), and 20 at the landward toe. The total estimated drilling footage is 810 feet. It should be noted that there are no proposed overwater borings and no riverside borings except for the five borings along the outside toe of the I-84 highway embankment.

It is proposed that the drilling work be performed by Haz-Tech Drilling, Inc. of Meridian, Idaho. A field engineer or geologist from Cornforth Consultants would be present throughout the drilling operations to coordinate the drilling activities, and collect and log samples of the subsurface materials encountered. All soil samples would be returned to our office for review and laboratory testing.

***Laboratory Testing*.** A laboratory testing program would be performed on samples obtained from the drilling program to help develop soil parameters that would be used in the engineering analyses. The laboratory testing would generally consist of: i) natural moisture contents on all samples; ii) grain size distribution tests on approximately 16 samples; and iii) Atterberg Limit tests on approximately 8 samples (if any cohesive samples are encountered by the drilling). All laboratory testing would be performed at Cornforth Consultants office in Portland.

Task 11 – Assist the City with Resolving Levee Encroachments. The USACE has identified unacceptable encroachments that impact the levee structure and may have an effect on the embankment stability or the capability to prevent unacceptable seepage. The latest FEMA correspondence indicates that these areas may need to be resolved by obtaining permits from the USACE to address these specific areas along the levee. It is anticipated that initial discussions with USACE personnel will be required to identify the information that will be needed to address

each area and what they would be looking for to satisfy their concerns. CCI subtasks for this issue would include a site reconnaissance to photograph and measure the encroachment features, consultation with the City on probable levee impacts, and developing preliminary recommendations for potential treatment measures. An additional component to this task would be to follow-up with the USACE to discuss our assessments and the proposed treatment options in an effort to obtain their concurrence and to establish a future plan of action for each area. In the longer term, it is possible that the USACE could require more detailed assessments of the proposed solutions to the encroachments. However, our level of effort for these future consulting services are unknown at this time, and as such are beyond the scope of work for the current phase. For budgetary purposes we have allowed 100 hours for our Project Manger to assist the City with encroachment issues for this phase of the project, plus a limited amount of time for two other engineers to address preliminary technical issues.

Task 12 – Summary Report. The results of all field investigations, laboratory testing, engineering analyses, and CCI's review of City-generated information would be summarized in a report that the City could provide to FEMA as part of an updated levee certification submittal. The report would include: i) a summary of the new site explorations; ii) summary logs of all exploratory borings (both existing and new); iii) plots and tabulations of laboratory test results; iv) summaries and key results of engineering analyses; v) summaries of discussions and issue-resolutions with regulatory agencies on various areas; vi) CCI comments on the Operations & Maintenance Plans prepared by the City; vii) a summary of the embankment encroachment discussions and resolution with the USACE; and viii) conclusions on the overall compliance of the levee systems with the requirements for FEMA certification. The report will be submitted as a draft to allow for the City to review and provide comments prior to final publication and submittal. This task includes a teleconference meeting with the City to address review comments on the draft version of the report.

Task 13 – Levee Certification Application Package. Following completion of the summary report, we would assist the City, as requested, in the preparation of a new application package to FEMA Region X for levee accreditation. We anticipate that this task would include providing assistance/review of the application letters to FEMA. This task includes two teleconference meetings with the City to facilitate preparation and acceptance of the certification submittal package.

SCHEDULE AND COST ESTIMATE

Schedule. If selected for this work we would be prepared to begin work as soon as we receive a written Notice-to-Proceed (NTP). We estimate that the initial coordination and completion of the fieldwork and laboratory testing programs would take approximately ten to twelve weeks. Completing all engineering analyses would require another ten weeks, and completing the reviews of City-developed information and assisting with the discussions and meetings with various regulatory agencies on the issues identified in the latest FEMA correspondence and outlined above will likely require another ten to twelve weeks. The preparation of the summary report would require approximately eight weeks. There will be some overlap in the task

durations as some are completed concurrently. It is estimated that the total estimated schedule from NTP to submittal of a draft summary report to the City would be approximately 40 weeks (10 months).

Cost Estimate. Our estimated cost to complete the scope of work outlined above is a Not-to-Exceed amount of $ 409,100. This amount is based on our 2014 Fee Schedule (attached). The amount shown would not be exceeded without your prior authorization. We anticipate that the City will request that the work be performed in accordance with their agency's standard agreement form. We look forward to the opportunity of reviewing the terms and conditions of the City's standard agreement. The cost estimate is broken down by tasks on the following table:

Cost Estimate Breakdown

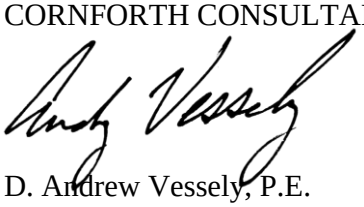
Phase 2 Tasks	**Estimated Budget**			
	Labor	**Reimbursables**	**Subconsultant/ Subcontractor**	**Total**
1. Post-Construction Permit near I-84 Bridge	$7,000	$800	--	$7,800
2. I-84 Embankment Serving as a Levee	$13,500	$1,200	--	$14,700
3. Embankment Issues near Railroad Trestle	$5,000	$500	--	$5,500
4. Review of New City Topographic Maps	$3,500	$300	--	$3,800
5. Crest freeboard Review using Updated Maps	$3,500	$300	$6,500	$10,300
6. Review of O&M Plans	$3,000	$400	--	$3,400
7. Clarification of 8th Street Bridge Closure Structure	$1,500	$100	--	$1,600
8. Embankment Erosion and Scour Analyses	$3,000	$200	$6,500	$9,700
9. Embankment Stability and Seepage Analyses	$39,200	$3,500	--	$42,700
10. Additional Subsurface Explorations & Laboratory Testing	$148,000	$13,900	$36,100	$198,000
11. Assisting with Levee Encroachments	$35,500	$2,700	--	$38,200
12. Summary Report	$48,000	$3,000	$7,500	$58,500
13. Assisting with Levee Application Submittal	$12,500	$2,400	--	$14,900
			Total Estimated Budget =	$409,100

Task 10 in the above table includes all charges for the subcontract driller, Haz-Tech Drilling, Inc.

We appreciate the opportunity to be of assistance to the City of Pendleton on this challenging project. If you have any questions, please call Randy Hill at (503) 452-1100.

Very truly yours,

CORNFORTH CONSULTANTS, INC.



D. Andrew Vessely, P.E.
President

Table A - Pendleton Levees: Proposed Borings

2/4/2014 **2294-2**

Reach				Borings								
	USACE Crest Stationing (approx.)			USACE Crest Stationing	Distance Between	In-Board	Proposed		Proposed /Drilled	Out-Board	Proposed	Wet
No.	Begin	End	Length (ft.)	(approx.)	Boring Sections (ft.)	Toe	Depth, (ft.)	Crest	Depth, (ft.)	Toe	Depth, (ft.)	Borings
1	L0+00	L15+75	1575	L8+00		1	20	1	30	-	-	-
					875							
2	L15+75	L52+72	3697	L16+75		1	15	BH-1	25	-	-	-
					1425							
				L31+00		1	15	1	25	-	-	-
					1100							
				L42+00		1	15	1	25	-	-	-
					900							
				L51+00		1	15	BH-2	15	-	-	-
					1200							
3	L52+72	L77+00	2428	L63+00		1	15	1	25	-	-	-
					1100							
				L74+00		1	15	1	25	-	-	-
4	L77+00	L104+21	2721	L82+20	1220	-	0	BH-3	16.5	-	-	-
				L86+20		1	15	BH-8	19	-	-	-
				L95+00	1280	-	0	BH-4	30	-	-	-
				L99+00		1	15	BH-9	20	-	-	-
					1000							
5	L104+21	L137+51	3330	L109+00		1	15	1	25	-	-	-
					1000							
				L119+00		1	15	1	25	-	-	-
				L125+00	1000	-	0	BH-5	20	-	-	-
				L129+00		1	15	1	25	-	-	-
					-							
6	R145+70	165+00	1930	R147+70		1	15	BH-6	20	-	-	-
(Prison		(approx.)			850							
Levee)				R156+20		1	15	1	25	-	-	-
					850							
				R164+70		1	15	BH-7	21	-	-	-
					1000							
7	165+00	(??)	2400	1		1	20	1	30	1	20	-
(I-84	(approx.)		(approx.)		1000							
Embank.)				2		1	20	1	30	1	20	-
					1000							
				3		1	20	1	30	1	20	-
					1000							
				4		1	20	1	30	1	20	-
					1000							
				5		1	20	1	30	1	20	-
				Total Borings/Drilling Footage =		20	330	14	380	5	100	0

Total No. of borings	39	
Total No. of overwater borings	0	
Total estimated drilling footage	810	ft.
Total of distances between borings	18,800	ft.
No. of spacings between borings/sections	18	
Average spacing between borings	1044	ft.
Range of boring spacing	850 - 1425	ft.

= Boring already drilled by GN Northern, with BOH depth shown. All borings hit auger refusal on bedrock (basalt ?).

Total boring no. / drill footage only includes proposed new borings, not holes already completed by GN Northern.

CORNFORTH CONSULTANTS

Fee Schedule

Personnel	Hourly Rate
Senior Associate Engineer/Geologist*	$210
Associate Engineer/Geologist	$182
Project Engineer/Geologist	$154
Staff Engineer/Geologist	$140
Engineer/Geologist	$128
Senior Technician	$110
CADD/Graphics	$ 88
Secretary	$ 73

*Includes Principal and Staff Consultant

Effective January 1, 2014

MSA
Murray, Smith & Associates, Inc.
Engineers/Planners

Appendix C
Cost Estimating Methodology and Assumptions

APPENDIX C
COST ESTIMATING METHODOLOGY AND ASSUMPTIONS

Introduction

This appendix summarizes the approach used in development of unit costs and project costs used in the Capital Improvement Program (CIP) for the City of Pendleton's (City) Stormwater Master Plan (SWMP).

Cost Estimating

The probable costs estimated for each improvement are based on average costs from the 2013 RS Means Heavy Construction Cost Data (RSMeans), City input, construction costs for similar projects across the Northwest, and information provided by local suppliers. All costs identified in this section reference U.S. dollars. The *Engineering News Record* Construction Cost Index (ENR CCI) basis is 9668 (20-City Average, December 2013).

Project cost estimates were prepared in accordance with the guidelines of AACE International, formerly the Association for the Advancement of Cost Engineering International. (*AACE International Recommended Practice No. 56R-08 Cost Estimate Classification System - As Applied For The Building and General Construction Industries - TCM Framework: 7.3 - Cost Estimating and Budgeting Rev. December 31, 2011*). The project cost estimates in this SWMP are categorized Class 5, as defined by AACE:

> *Class 5 estimates are generally prepared based on very limited information, and subsequently have wide accuracy ranges. As such, some companies and organizations have elected to determine that due to the inherent inaccuracies, such estimates cannot be classified in a conventional and systemic manner.*
>
> *Class 5 estimates are prepared for any number of strategic business planning purposes, such as but not limited to market studies, assessment of initial viability, evaluation of alternate schemes, project screening, project location studies, evaluation of resource needs and budgeting, long-range capital planning, etc.*
>
> *Typical accuracy ranges for Class 5 estimates are -20% to -30% on the low side, and +30% to +50% on the high side, depending on the construction complexity of the project, appropriate reference information and other risks (after inclusion of an appropriate contingency determination). Ranges could exceed those shown if there are unusual risks.*

All project descriptions and cost estimates in this SWMP represent planning-level accuracy and opinions of costs (+50%, -30%). During the design phase of each improvement project, project definition, scope and specific information (e.g., pipe diameter and length) should be

verified. The final cost of individual projects will depend on actual labor and material costs, site conditions, competitive market conditions, regulatory requirements, project schedule and other factors. Because of these factors, project feasibility and risks must be carefully reviewed prior to making specific financial decisions or establishing project budgets to help ensure proper project evaluation and adequate funding.

The project costs presented in this SWMP include estimated construction costs, and allowances for permitting, legal, administrative and engineering fees. A contingency factor is also added to each cost to help account for any unanticipated components of the project costs. Construction costs are based on the preliminary concepts and layouts of the system components developed during the system analysis.

Total estimated project costs were developed through a progression of steps and multiple methodologies. The steps included development of component unit costs, construction costs and, finally, project costs. The component unit cost includes the sum of materials, labor and equipment of a project's basic features. The construction cost is the sum of component costs and mark-ups to determine the probable cost of construction (i.e., the contractor bid price). The project cost is the sum of construction costs with additional cost allowances for engineering, legal and administrative fees as well as a contingency factor to estimate the total project cost to the City.

The following costs are not included:

- Land or right-of way-acquisition, unless directed by the City.
- Stormwater System planning or modeling.
- Borrowing or finance charges during the planning, design, or construction of assets.
- Improvements to conveyance, pumping, storage, or treatment facilities in response to changes in regulatory standards or rules.
- Remediation or fines associated with system violations.

Component Unit Costs

Pipelines

Stormwater pipe material was assumed to be PVC D3034 SDR 35 (for 15-inch diameter pipe and smaller) and PVC F-679 (for pipe with a diameter greater than 15 inches). The pipe material costs were obtained from a local distributor and were similar to RSMeans.

A specific cost has been identified for each pipe diameter and each pipe depth for gravity pipe. For all pipe installations, the cost is assumed to include excavation, waste of the material associated with the trenching (which includes haul, load and dump fees), imported bedding and zone material, native backfill (including minimal haul and compaction of material), trench box use (for trenches deeper than 8 feet) and testing fittings by either hydrostatic testing or closed-circuit television (CCTV) video inspection.

Other construction methods may be utilized, especially for deep storm drain pipelines; prior to budgeting or construction, additional cost analyses should be completed. See Table C-1 for linear feet costs for stormwater pipes.

Table C-1
Stormwater Pipeline Costs per Linear Foot

Pipe Invert Depth (feet)	Diameter (inch)												
	8	10	12	15	18	21	24	27	30	36	42	48	54
≤ 10	$37	$43	$49	$59	$72	$88	$97	$117	$152	$200	$256	$304	$352
11	$39	$45	$50	$60	$74	$90	$99	$119	$154	$203	$259	$307	$355
12	$40	$46	$52	$62	$76	$92	$101	$121	$157	$206	$262	$310	$358
13	$41	$48	$53	$64	$78	$94	$103	$124	$159	$208	$265	$313	$361
14	$43	$49	$55	$65	$80	$96	$106	$126	$161	$211	$268	$317	$366
15	$44	$51	$57	$67	$82	$98	$108	$128	$164	$214	$271	$320	$369
16	$46	$52	$58	$69	$84	$100	$110	$131	$166	$216	$274	$323	$372
17	$48	$55	$61	$72	$87	$103	$113	$134	$170	$220	$278	$327	$376
18	$52	$59	$65	$76	$91	$107	$118	$139	$174	$225	$283	$333	$383
19	$57	$63	$70	$81	$96	$113	$123	$144	$180	$231	$289	$339	$389
20	$62	$69	$75	$87	$102	$119	$129	$151	$187	$238	$296	$347	$398
21	$69	$76	$82	$94	$109	$126	$137	$158	$194	$246	$305	$355	$405
22	$77	$84	$91	$102	$118	$135	$145	$167	$203	$255	$314	$365	$416
23	$86	$93	$100	$111	$127	$144	$155	$177	$213	$265	$325	$376	$427
24	$96	$103	$110	$122	$137	$155	$166	$188	$224	$277	$336	$388	$440
≥ 25	$107	$114	$121	$133	$149	$167	$178	$200	$236	$289	$349	$400	$451

Bedrock

There is typically ripable rock in the project areas. For planning purposes, rock excavation will be applied to projects identified by the City. Based on rock at or very near the surface, rock excavation will increase pipeline unit costs by 100%.

Special Pipe Crossings

Special pipe crossings are required for crossing rivers, canals, railroads and highways, or areas where traditional open cut construction is not possible. An additional 100% is applied to pipeline unit costs for any projects with these conditions.

Surface Restoration

Surface restoration of construction sites is required to complete every project. As with the pipe installation costs, the surface restoration costs will increase with the size of pipe and depth of construction, due to the larger trench that will need to be excavated. Therefore, a unit surface restoration cost has been used for each pipe diameter at pipe invert depths of 5-foot increments. The surface restoration is developed from local supplier costs and RSMeans.

Table C-2 tabulates costs for surface restoration. The tables are separated to define costs associated with local and arterial asphalt roadways and unpaved surfaces. These are further described as follows:

- Local: Road repair and replacement along trench: 3.5-inch asphalt and 4 inches of 3/4-inch minus and 8 inches of 2-inch minus.
- Arterial: Road repair and replacement along trench: 4.5-inch asphalt and 4 inches of 3/4-inch minus and 8 inches of 2 inch minus.
- Unpaved: Repair and replacement of trench using rock backfill to ground surface along trench cross-country.

Table C-2
Surface Restoration Costs Per Unit Length - Asphalt

Pipe Diameter (inches)	Surface Restoration Type and Pipe Invert Depth (feet)											
	Local				Arterial				Unpaved			
	≤ 10	15	20	≥ 25	≤ 10	15	20	≥ 25	≤ 10	15	20	≥ 25
8	$19	$19	$30	$30	$20	$20	$31	$31	$5	$5	$9	$9
10	$20	$20	$30	$30	$20	$20	$31	$31	$5	$5	$9	$9
12	$20	$20	$30	$30	$21	$21	$31	$31	$5	$5	$9	$9
15	$21	$21	$30	$30	$22	$22	$31	$31	$6	$6	$9	$9
18	$22	$22	$30	$30	$23	$23	$31	$31	$6	$6	$9	$9
21	$23	$23	$30	$30	$24	$24	$31	$31	$6	$6	$9	$9
24	$23	$23	$30	$30	$24	$24	$31	$31	$7	$7	$9	$9
27	$24	$24	$30	$30	$25	$25	$31	$31	$7	$7	$9	$9
30	$25	$25	$30	$30	$26	$26	$31	$31	$7	$7	$9	$9
36	$27	$27	$30	$30	$28	$28	$31	$31	$8	$8	$9	$9
42	$28	$28	$30	$30	$30	$30	$31	$31	$8	$8	$9	$9
48	$30	$30	$30	$30	$31	$31	$31	$31	$9	$9	$9	$9
54	$32	$32	$32	$32	$34	$34	$34	$34	$9	$9	$9	$9

Manholes and Catch Basins

New storm drain pipelines include costs for new manholes and catch basins. The costs for manholes were developed from RSMeans and vary depending on the depth. Upgrades or replacements to existing pipelines include costs for repairing existing manholes provided the corresponding pipe size does not compromise the structural integrity of the existing manhole. See Table C-3 for new manhole construction costs.

Table C-3
2014 Unit Costs for New Manholes ($/each)

Manhole Diameter (inch)	Corresponding Pipe Size	Material, Installation and Equipment Cost with Depth Category					Catch Basin Allow.
		≤ 8 ft	10 ft	15 ft	20 ft	≥ 25 ft	
48	Pipe Ø < 24 in	$4,919	$6,239	$10,484	$16,080	$23,026	$20,000
60	24in ≤ Pipe Ø < 48 in	$6,796	$8,662	$14,599	$22,356	$31,932	
72	Pipe Ø ≥ 48 in	$8,811	$11,139	$18,383	$27,657	$38,963	

For new manholes, project costs for new storm drains include manholes along the length of the asset spaced 400 feet on center for diameter less than and equal to 15-inch and 500 feet for larger pipe diameter. New manhole costs include the cost for the base, frame, standard cover, installation and testing. A cost allowance of $20,000 per manhole is included in the project cost for new storm drains to accommodate four new catch basins and associated connection piping and surface restoration to the manhole.

Manhole related surface restoration costs have been excluded from project costs and assumed to be addressed separately in the surface restoration costs.

Outfalls

Where outfalls are indicated along an improved pipe segment, it is assumed that an armored discharge pad will be required to dissipate erosive forces cause for stormwater exiting the pipe. An allowance of $10,000 has been included within the cost of these improvements to account for approximately 10 cubic yards of excavation, replaced with riprap and a beveled end section for the pipe. Costs for these improvements are assumed to avoid in-water work.

Construction Cost Allowances

The construction cost is the sum of materials, labor, equipment, mobilization, contractor's overhead and profit, and contingency for each project.

Traffic Control

Traffic control will be required for all projects that occur in roadways. The cost and level of effort for traffic control should be evaluated based on the scope and size of each project and

as local conditions at the time of construction dictate. For planning purposes, the cost of traffic control is estimated at 0.5% for low traffic control areas or 2% for high traffic control areas depending on project location. Traffic control mark-up accounts for the cost of signage, flagging and temporary barriers, street widening, pavement markings, lane delineators and lighting at flagging locations.

Erosion Control

Erosion control will be required for all projects. For planning purposes, the erosion control is estimated at 1% of the construction costs. Erosion control mark-up accounts for materials and practices to protect adjacent property, storm water systems, and surface water in accordance with regulatory requirements. The level of effort and cost for erosion control depends on the size and scope of a project, and the local conditions at the time of construction.

Dewatering

Dewatering groundwater is expected to be necessary when construction is near the Umatilla River and other smaller water drainages as identified by the City. For planning purposes, dewatering is estimated at 1% of the construction costs for projects located in these areas.

Construction Contractor Overhead and Profit

This 10% mark-up accounts for the contractor's indirect project costs and anticipated profit.

Construction Mobilization

A 10% mobilization mark-up accounts for the cost of the contractor's administrative and direct expenses to mobilize equipment, materials and labor to the work site.

Construction Contingency

A 30% increase was added in each project's construction cost to account for a contingency factor to cover the uncertainties inherent to planning-level development. The contingency is provided to account for factors such as:

- Unanticipated utilities.
- Relocation and connection to existing infrastructure.
- Minor elements of work not addressed in component unit cost development.
- Details of construction.
- Changes in site conditions.
- Variability in construction bid climate.

The contingency excludes:

- Major scope changes such as end product specification, capacities and location of project.
- Extraordinary events such as strikes or natural disasters.
- Management reserves.
- Escalation and currency effects.

A summary of construction mark-ups is provided in Table C-4.

Table C-4
Additional Construction Costs

Additional Cost Factor	Percent
Low Traffic Control	0.5%
High Traffic Control	2%
Erosion Control	1%
Dewatering	1%
Contractor Overhead and Profit	10%
Mobilization	10%
Contingency	30%

Total Project Cost

The total project cost is the sum of construction costs with additional cost allowances for engineering, legal, and administrative fees. Table C-5, shown below, presents the cost allowances for each additional project cost. The engineering costs include design and surveying. Construction administration is the cost associated with managing the construction of the project. The administrative and legal costs are those associated with the City providing financial and legal oversight of the contract.

Table C-5
Summary of Additional Costs

Additional Cost Factor	Percent
Construction Administration	5%
Engineering	15%
Legal and Administrative	10%

MSA

MURRAY, SMITH & ASSOCIATES, INC.
ENGINEERS | PLANNERS