CITY OF PASCO, WASHINGTON
IRRIGATION SYSTEM MASTER PLAN

December 2013

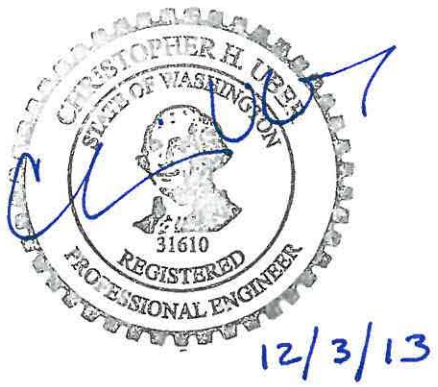
MSA Murray, Smith & Associates, Inc.
GSI Water Solutions, Inc.

IRRIGATION SYSTEM MASTER PLAN

FOR

THE CITY OF PASCO, WASHINGTON

DECEMBER 2013



12/3/13

MURRAY, SMITH & ASSOCIATES, INC.
1145 Broadway Plaza, Suite 1010
Tacoma, Washington 98402-3542
253.627.1520

In association with
GSI WATER SOLUTIONS, INC.
55 Southwest Yamhill Street, Suite 300
Portland, Oregon 97205
971.239.8799

13-1444.407

ACKNOWLEDGEMENTS

The following City of Pasco staff contributed to the development of this Irrigation System Master Plan:

Ahmad Qayoumi, Public Works Director
Teresa Reed-Jennings, Senior Utilities Engineer
Cameron Magelsen, Irrigation System Manager
Curtis Glines, Irrigation System Operations
Reuel Klempel, Wastewater Treatment Plant Manager
Doyle Heath, Engineering Technician

The following GSI Water Solutions, Inc. staff contributed to the development of this Irrigation System Master Plan:

Phillip A. Brown, RG LHg
Kenny Janssen, RG

TABLE OF CONTENTS

EXECUTIVE SUMMARY

1. INTRODUCTION

2. EXISTING SYSTEM

3. CRITERIA, ANALYSIS, AND FINDINGS

4. RECOMMENDATIONS

APPENDICES

LIST OF FIGURES

LIST OF TABLES

EXECUTIVE SUMMARY

Authorization

On June 4, 2013, Murray, Smith & Associates, Inc. (MSA) was authorized by the City of Pasco (City) to prepare this plan.

Background

The City of Pasco owns and operates an irrigation water utility that provides water to residential customers and a limited number of commercial customers. Providing a system for irrigation water separate from the potable water utility allows the City's customers to avoid using treated drinking water to irrigate. The City's existing irrigation system is supplied by water from 11 groundwater wells and water pumped from the Columbia River. The City acquired the first portions of the system in 2002 from a private irrigation utility. The system has grown considerably since that time. The City uses the irrigation system annually from April 1st to October 31st. The City has established the goal of developing a capital improvements plan for the irrigation system to ensure the continued delivery of economical irrigation water to City residents.

Purpose

The purpose of this plan is to provide a basis for identifying, analyzing, and planning capital improvements to the irrigation system. The study includes a hydraulic analysis of the existing system which compares the existing system's performance to analysis criteria in order to identify deficiencies and develop system improvements. A capital improvements plan is developed to assist in planning future projects. Included with this plan are conceptual level project cost estimates.

The system's existing groundwater wells will also be evaluated through a tabletop review of existing data. The results of this review will be used to develop preliminary recommendations for improvements, further assessment, and rehabilitation work.

Irrigation System Plan Overview

This plan is organized by sections. Section 2 presents an inventory of the irrigation system and its components as they currently exist and operate. The City's irrigation water rights are also discussed in Section 2. Section 3 presents analysis criteria that form the basis for identifying deficiencies in system performance and planning improvements to the irrigation system. Section 3 also includes a description of the hydraulic model and the results of the modeling analysis work. Groundwater well condition assessments are also documented in this section. Section 4 presents recommendations for improvements to the system and to the groundwater wells, as well as recommended further study and planning work.

Existing System

The City's irrigation system piping is polyvinyl chloride (PVC), ductile iron (DI), and steel distribution pipes ranging from 3 inches to 24 inches in diameter. Table ES-1 shows a summary of irrigation main sizes in the distribution system. Figure ES-1 shows an overview of the irrigation system.

Table ES-1
Irrigation Main Inventory by Size

Diameter (inches)	Length (ft)	Length (miles)
< 6	356,347	67.49
6	125,506	23.77
8	80,678	15.28
10	5,122	0.97
12	96,254	18.23
15	8,078	1.53
16	27,878	5.28
18	4,488	0.85
24	483	0.09
Total	**711,797**	**134.81**

The oldest parts of the system are approximately 15 to 20 years old, with most of the system constructed less than 10 years ago. Parts of the irrigation system were first acquired by the City in 2002 from Kidwell Farms, Inc., a private irrigation utility owner. This utility was part of subdivisions built by private developers.

Supply

The City's irrigation system is supplied by groundwater produced from 11 wells located throughout the system and surface water pumped from the Columbia River. All sources of supply pump to the system's main service zone, referred to as the 639 pressure zone. Supply to lower zones is accomplished through the use of pressure-reducing stations.

Groundwater Supplies

The City's irrigation wells range between 135 and 245 feet deep and are completed in an unconfined alluvial aquifer consisting mainly of sand and gravel. The wells range between 1 and 39 years old. Roughly half of the wells are constructed with perforated casing and the others with stainless steel, wire wrap well screen. The reported production capacities range between 450 and 2,500 gpm. Table ES-2 summarizes the City's irrigation wells.

Figure ES-1

City of Pasco
Irrigation System Master Plan

EXISTING CITY IRRIGATION SYSTEM

December 2013

Murray, Smith & Associates, Inc.
Engineers/Planners
Tacoma, Washington

13-1444.407

LEGEND

- Existing Storage Tank
- Existing Booster Pump Station (BPS)
- Existing Irrigation Well
- Existing Pressure Reducing Valve (PRV)
- Existing Irrigation Main (Diameter Indicated in Inches)
- County Line
- Franklin County Irrigation District (FCID) Irrigation Service Area
- Pasco City Limits
- Urban Growth Area Boundary

Pressure Zones:

- River Intake Zone
- 547 Zone
- 560 Zone
- 594 Zone
- 600 Zone
- 639 Zone

Dry System Boundaries:

- Broadmoor Estates
- Broadmoor Place
- Cole's Estates
- Desert Oasis
- Desert Plateau
- Mediterranean Villas

BROADMOOR ESTATES

MEDITERRANEAN VILLAS

COLE'S ESTATES

639 ZONE

POWERLINE WELL

ROAD 52 WELL

NORTHWEST COMMONS WELL

ROAD 68 IRRIGATION TANK CAP: 2.28 MG OE: 639 FT

DESERT SUNSET WELL

DESERT ESTATES WELL

PRV

594 ZONE

HARRIS ROAD BPS CAP: 3,125 GPM

RIVER INTAKE ZONE

RIVER INTAKE STATION CAP: 3,000 GPM

BROADMOOR PLACE

ISLAND ESTATES WELL

VILLAGE AT PASCO HEIGHTS WELL

ROAD 108 BPS CAP: 3,000 GPM

560 ZONE

CITY OF PASCO

LINDA LOVIISA WELL

DESERT OASIS

SIRROCO WELL

600 ZONE

DESERT PLATEAU

I-182 WELL

547 ZONE

FIRST PLACE WELL

Columbia River

FRANKLIN COUNTY
BENTON COUNTY

WEST PASCO

N

1,000 0 1,000
SCALE IN FEET

SOURCE:
Base Mapping - Franklin County GIS (June 2013) and Benton County GIS (June 2013).
Irrigation System Mapping - City of Pasco (April 2013).

G:\PDX_Projects\13\1444\CAD\GIS\FIGURES\13-1444-407-WA-FIGURE 2-1.mxd 12/3/2013 8:45:34 AM DKH

Table ES-2
Irrigation Well Summary

Well Name	Year Constructed	Depth (BGS[1])	Pump Type	Fixed/ Variable Speed	Average Production Rate (gpm[2])	Motor Size (HP[3])
Desert Estates	1951	152	Submersible	Fixed	650	75
Desert Sunset	1929	202	Vertical Turbine	Variable	1,450	150
First Place	2007	123	Vertical Turbine	Variable	2,500	350
Island Estates	1976	190	Submersible	Fixed	450	50
I-182	Unknown	134	Vertical Turbine	Variable	1,850	200
Linda Loviisa	2012	205	Vertical Turbine	Fixed	1,100	150
Northwest Commons	Unknown	203	Vertical Turbine	Variable	1,300	150
Powerline Road	1980	171	Vertical Turbine	Fixed	1,900	200
Road 52	2006	185	Vertical Turbine	Variable	2,350	250
Sirroco	1976	222	Vertical Turbine	Variable	1,400	150
Village of Pasco Heights	1975	184	Submersible	Fixed	1,000	125

Notes
1. Below ground surface
2. Gallons per minute
3. Horsepower

Surface Water Supplies

In addition to groundwater wells, the City uses water pumped from the Columbia River for irrigation supply. The river intake pump station conveys water directly to the Road 108 Booster Pump Station located on the west side of the system. The Road 108 Booster Pump Station pumps the irrigation water to the irrigation distribution system. Irrigation water pumped from the river is metered through a master meter at the Road 108 Booster Pump Station.

Water Rights Summary

The City's current irrigation water rights are a combination of water rights issued by the Washington State Department of Ecology (DOE) and water rights which were given to the City by private parties. The City's annual irrigation water rights total 7,592.9 acre-ft. Table ES-3 shows a summary of the City's existing irrigation water rights.

Table ES-3
Irrigation Water Rights Summary

Well Name	Water Right[3]	Q_i[4] (gpm)	Q_a[4] (acre-ft)	Approximate Pumping Capacity (gpm)
First Place	G3-01243C	1,400	558.0	2,500
Desert Sunset	G3-20243P(B)[1]	214	107.9	1,450
	G3-20243P(C)	1,174	441.6	
Island Estates	G3-20242C(B)	1,134	504.0	450
Sirocco	G3-20243P(B)[1]	214	107.9	1,450
	G3-28452C	450	172.0	
Road 52	G3-20242P(A)	1,430	636.0	2,350
Village of Pasco Heights	G3-23525C	1,300	660.0	1,000
Northwest Commons	G3-20243P(A)	1,612	483.6	1,300
	G3-20243P(B)[1]	214	107.9	
Desert Estates	G3-24981C(A)	80	41.9	750
	G3-24981C(B)	400	155.9	
Linda Loviisa	G3-20244C[2]	1,880	759.8	1,000
	G3-24978C[1]	1,600	660.0	
	G3-26368C[1]	400	164.0	
I-182	G3-24978C[1]	1,600	660.0	1,850
	G3-26368C[1]	400	164.0	
Powerline Road	G3-27413P(B)	270	108.1	1,900
	G3-27413P(C)[1,2]	573.75	203.4	
	G3-27413P(D)	281.25	112.6	
	G3-27413P(F)	270	108.0	
Road 108 Booster Pump Station	G3-27413P(C)[1,2]	573.75	203.4	3,000
	S3-28615C	1,643	732.0	
	S3-28788C	139	56.0	
	S3-28789C	121	48.0	
	S3-28790C	195	200.0	
	S3-28932C	597	240.0	
Total Rights		**17,164**	**7,152.8**	**19,000**

Notes
1. Indicates that water right is shared
2. This water right has two points of withdrawal
3. G indicates a groundwater right; S indicates a surface water right.
4. Q_i is the instantaneous allowable flow; Q_a is the average annual allowable volume

Storage

The irrigation system has one storage tank located near the intersection of Sandifur Parkway and Road 76. The storage tank sets the hydraulic grade for most of the City's system. The storage tank serves the 639 pressure zone by gravity, so the water is able to serve the other pressure zones at lower elevations through pressure-reducing stations. The City currently operates the tank below full at a volume of 2.28 million gallons (MG).

Pressure Zones

The irrigation system has six pressure zones. The zones are separated by pressure-reducing stations which allow zones with a higher hydraulic grade to supply zones having a lower hydraulic grade with water.

Booster Pump Stations

The City currently has one booster pump station in its irrigation system. This is the Road 108 Booster Pump Station located at the intersection of Road 108 and Crescent Road in the western portion of the irrigation service area. The design capacity of this station is 3,000 gpm. This station is used to boost water pumped from the Columbia River Intake Station to the 639 Pressure Zone.

Another pump station is planned for construction in 2013. This station will be called the Harris Road Booster Pump Station and will be located on Harris Road near Interstate 182. This booster pump station has a design capacity of 3,125 gpm. The station will also pump water supplied by the Columbia River Intake Station to the distribution system.

Dry Systems

The City's irrigation system includes portions that are installed and ready for use, but not currently used. These systems are referred to as dry systems. The existing dry systems are shown in Figure ES-1. Table ES-4 shows a summary of the current dry systems.

Table ES-4
Dry System Summary

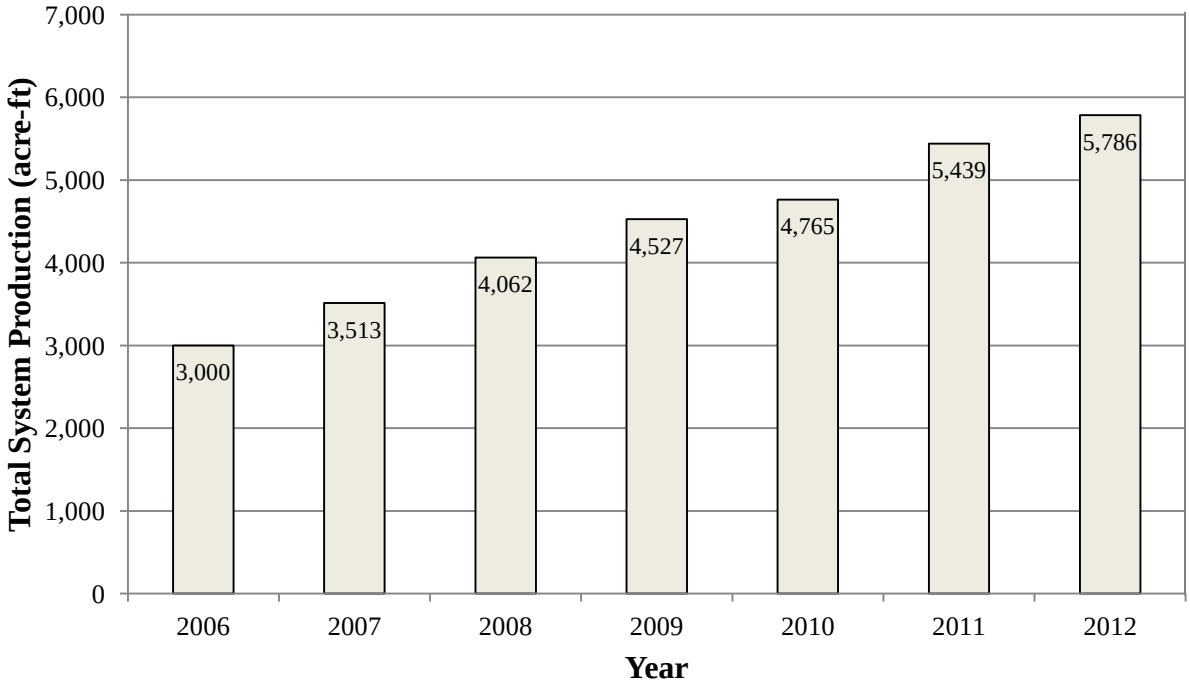
Subdivision Name	Number of New Connections	Estimated Acreage (ac)
Broadmoor Estates	304	90.67
Broadmoor Place	233	62.33
Desert Oasis	170	54.17
Desert Plateau	304	108.48
Total	**1,011**	**315.65**

Irrigation Water Demands

The City typically uses its irrigation system from April to October every year. Production is monitored and recorded by meters on each of the system's wells. Some large users are metered, but most connections to the system are not currently metered.

Total system production is the sum of water produced by the irrigation system wells and water pumped from the Columbia River. Figure ES-2 shows total system production from 2006 to 2012. As seen from the figure, system production has increased steadily from 2006 to 2012.

Figure ES-2
Total System Production



Irrigation System Analysis and Findings

The analysis of the irrigation system uses a hydraulic model to simulate pressure and flow conditions in the system under several demand conditions. The results are compared to analysis criteria and form the basis for identifying deficiencies.

Hydraulic Model

The initial layout of the hydraulic model was completed by tracing pipes and junctions over the City's GIS data. Graphical and tabular data provided by the City were used to locate critical hydraulic elements such as the Road 68 Irrigation Tank, wells, pumps, and pressure-reducing stations. The demands presented in Section 2 were distributed throughout the

model using a nearest node method. The nearest node method assigns known demands with a known spatial distribution to the nearest node in the system. Model calibration was completed using data collected by the City's SCADA system. The system collects and logs information from the system every 30 to 60 minutes. Monitoring points on the system include well discharges, booster pump station discharges, and the storage tank.

Analysis Criteria

The analysis criteria used to evaluate the hydraulic performance of the irrigation system include minimum system pressures and maximum flow velocities. Any result not meeting these criteria is subject to further investigation and potential corrective action.

Flow Velocities

Pipes whose flow velocities exceed 5 feet per second (fps) under average day demand conditions are considered to have inadequate capacity. Pipe flow velocities are allowed to increase up to 8 fps during peak hour demand (PHD) conditions. Any pipes with flow velocities above 8 fps under PHD conditions are considered to have inadequate capacity.

Irrigation System Pressures

The City's pressure criteria at service connections are summarized below. These pressure criteria are based on industry standards, Uniform Plumbing Code requirements, and a review of landscape irrigation equipment water pressure requirements.

1. Each service connection should maintain a minimum water pressure of 30 pounds per square inch (psi) during all demand conditions.
2. No service connection should exceed a water pressure of 120 psi. Individual customers are responsible for reducing water pressures over 80 psi if they desire to do so.
3. During a failure of any part of the system, the maximum water pressure at customer meters will not exceed 150 psi.

Model and Analysis Findings

The calibrated model was used to simulate two scenarios: year 2012 conditions and an anticipated future demand condition. Modeling for the future condition included the City's existing dry systems, but did not include any new pipes or new developments. The results of each analysis are described below.

Existing Conditions

Existing conditions were modeled using 2012 PHD conditions. Two pipes in the system exceed the flow velocity criteria of 8 fps under PHD conditions. These pipes are 4 inches in diameter and located adjacent to the Sirocco Well discharge. All analysis criteria were

satisfied with regard to system pressures. The results are summarized below. A graphical summary of modeling results for the existing conditions scenario is shown in Figure ES-3.

- The system does not experience pressures over 120 psi under any demand condition. In order to verify that maximum allowable pressures were not exceeded, a low-demand condition was used to approximate static conditions.
- The system experiences pressures over 80 psi near discharges for wells and the Road 108 Booster Pump Station during high production. None of the locations which experience pressures between 80 and 120 psi serve customers. They are typically located on dedicated transmission mains and are caused by topography.
- Low system pressures were not predicted by the model under this scenario during normal tank levels. If the storage tank water surface elevation reaches 600 feet above mean sea level (AMSL), the system begins to experience isolated low pressures.
- No part of the system experiences pressures over 150 psi during a failure of pressure-reducing valves. It is possible that pumps could fail in such a manner as to cause high system pressures downstream of their discharges.

Future Conditions

The calibrated model was used to predict the hydraulic performance of the City's irrigation system under anticipated future conditions. The future condition assumptions are:

- All of the City's current dry systems are connected and in use
- All of the City's existing subdivisions are fully developed
- All of the City's sources are producing the maximum allowed flows simultaneously

These assumptions represent near-term conditions that could occur within the next two to five years. The actual timing of these conditions is dependent on a number of variables. Any changes in the following conditions would alter the analysis results:

- Expansion of the irrigation system service area beyond assumed service limits
- Additional sources of supply
- Changes in water rights

High system pressures were found near the discharges of wells and pump stations as in the 2012 PHD scenario. No pipes that serve customers directly experienced high pressures. No low system pressures were found by the model. High flow velocities were found by the model at two locations:

- Near the discharge of the Sirocco Well as observed in the 2012 PHD scenario
- North of the intersection of Road 52 and Sandifur Parkway

A graphical summary of modeling results for the future conditions scenario is shown in Figure ES-4.

Figure ES-3

City of Pasco
Irrigation System Master Plan

HYDRAULIC MODELING RESULTS FOR EXISTING CONDITIONS

December 2013

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

13-1444.407

LEGEND

- Existing Storage Tank
- Existing Booster Pump Station (BPS)
- Existing Irrigation Well
- Existing Pressure Reducing Valve (PRV)
- Existing Irrigation Main (Diameter Indicated in Inches)
- County Line
- Franklin County Irrigation District (FCID) Irrigation Service Area
- Pasco City Limits
- Urban Growth Area Boundary
- Pressure Between 80 PSI and 120 PSI
- Flow Velocity Greater Than 8 FT/S

POWERLINE WELL
ROAD 52 WELL
NORTHWEST COMMONS WELL
ROAD 68 IRRIGATION TANK CAP: 2.28 MG OE: 639 FT
DESERT SUNSET WELL
DESERT ESTATES WELL
PRV
HARRIS ROAD BPS CAP: 3,125 GPM
RIVER INTAKE STATION CAP: 3,000 GPM
ISLAND ESTATES WELL
VILLAGE AT PASCO HEIGHTS WELL
ROAD 108 BPS CAP: 3,000 GPM
CITY OF PASCO
LINDA LOVIISA WELL
SIRROCO WELL
HIGH FLOW VELOCITY NEAR SIRROCO WELL
I-182 WELL
FIRST PLACE WELL
WEST PASCO
Columbia River
FRANKLIN COUNTY
BENTON COUNTY

N
1,000 0 1,000
SCALE IN FEET

SOURCE:
Base Mapping - Franklin County GIS (June 2013) and Benton County GIS (June 2013).
Irrigation System Mapping - City of Pasco (April 2013).

G:\PDX_Projects\131444\CAD\GIS\FIGURES\13-1444-407-WA-FIGURE 3-1.mxd 12/3/2013 8:49:20 AM DKH

Figure ES-4

City of Pasco
Irrigation System Master Plan

HYDRAULIC MODELING RESULTS FOR FUTURE CONDITIONS

December 2013

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

13-1444.407

LEGEND

- Existing Storage Tank
- Existing Booster Pump Station (BPS)
- Existing Irrigation Well
- Existing Pressure Reducing Valve (PRV)
- 16" Existing Irrigation Main (Diameter Indicated in Inches)
- County Line
- Franklin County Irrigation District (FCID) Irrigation Service Area
- Pasco City Limits
- Urban Growth Area Boundary
- Pressure Between 80 PSI and 120 PSI
- Flow Velocity Greater Than 8 FT/S

HARRIS ROAD BPS
CAP: 3,125 GPM

RIVER INTAKE STATION
CAP: 3,000 GPM

ROAD 108 BPS
CAP: 3,000 GPM

ROAD 68 IRRIGATION TANK
CAP: 2.28 MG
OE: 639 FT

ISLAND ESTATES WELL

POWERLINE WELL

ROAD 52 WELL

NORTHWEST COMMONS WELL

DESERT SUNSET WELL

DESERT ESTATES WELL

VILLAGE AT PASCO HEIGHTS WELL

LINDA LOVIISA WELL

SIRROCO WELL

HIGH FLOW VELOCITY NEAR SIRROCO WELL

I-182 WELL

FIRST PLACE WELL

PRV

CITY OF PASCO

WEST PASCO

Columbia River

FRANKLIN COUNTY
BENTON COUNTY

N

1,000 0 1,000
SCALE IN FEET

SOURCE:
Base Mapping - Franklin County GIS (June 2013) and Benton County GIS (June 2013).
Irrigation System Mapping - City of Pasco (April 2013).

G:\PDX_Projects\13\1444\CAD\GIS\FIGURES\13-1444-407-WA-FIGURE 3-2.mxd 12/3/2013 8:52:05 AM DKH

Storage Analysis

The system storage was evaluated at projected peak hour demand conditions to determine whether or not enough storage is available in the system. The analysis concluded that the existing irrigation system reservoir has adequate capacity to meet projected storage needs as long as the water level in the tank is raised. Modeling confirmed that raising the water level does not have any adverse impacts on the distribution system.

Well Condition Assessment

A tabletop condition assessment of the City's groundwater supply wells was completed as part of this plan. The assessment consisted of gathering and analyzing available information. The objective of this analysis is to identify wells having apparent construction, performance, or water quality issues that may be limiting production with the purpose of developing a targeted approach at candidate wells to regain performance and optimize individual and combined system production. The results of the well condition assessments are summarized as follows:

- Review of available information for the Desert Sunset, Sirocco, NW Commons, Island Estates, I-182, and Powerline Road wells indicated the presence of biofouling and incrustation which are possibly plugging screens and perforations. Significant accumulations of sediment or debris in the wells are also noted.
- Observations indicated minor mineral and biological deposits within the First Place and Desert Estates wells.
- Based on the information provided and relatively newer construction, the apparent conditions of the Road 52 and Linda Loviisa Wells are considered good.

Recommendations

Recommendations for improvements to wells, improvements to the irrigation system, and opportunities for further planning and study were developed as part of this report. The recommendations are separated into near-term improvements and long-term improvements. Near-term improvements are those which should be completed within the next one to five years. Long-term improvements should be completed in six to twenty years.

The recommended capital improvement program totals approximately $800,000 for near-term improvements. The sum of recommended budget for long-term improvements is $6.87 million and does not include the $800,000 of near-term recommended investment. Table ES-5 shows a summary of the recommended capital improvement budgets. Tables ES-6 and ES-7 include tabulated summaries of all recommended improvements and their associated estimated project costs.

Table ES-5
Recommended Capital Improvement Budget Summary

Near-Term	$800,000
Long-Term	$6,867,000
Total	**$7,667,000**

Table ES-6
Near-Term Capital Improvement Program Summary

Group	ID	Project Location or Name	Project Limits	Project Description	Estimated Project Cost
Distribution System Improvements	IR.2	Powerline Road	Road 56 to Road 52	Extend existing 16-inch diameter main east to Road 52. The new main may be built in right of way that is being platted as part of the construction of a new elementary school at the intersection.	$186,000
	IR.4	Sahara Drive	West along Sahara Drive from end of existing mains to Road 44	Extend two 4-inch diameter distribution mains on Sahara Drive west to the existing 12-inch diameter main on Road 44. This improvement provides a redundant connection to the rest of the system if the connection at Burden Boulevard is out of service for any reason.	$46,000
	IR.5	Sirocco Drive	Sahara Drive to Saguaro Drive	Install approximately 1,200 linear feet of new 6-inch diameter distribution piping near the discharge of the Sirocco Well. The new pipes should be installed in public right of way. The existing pipes should be abandoned to eliminate pipe crossings in the rear of private lots.	$90,000
	D.2	Isolation Valve Improvements Phase 1	Island Estates and Sunny Meadows Subdivisions	Installation of up to 52 isolation valves in public right of way will reduce the need for City staff to access back yards during maintenance and repairs and allow more customers to stay online during emergencies.	$156,000
	D.3	Isolation Valve Improvements Phase 2	Interstate Highway 182 Crossing	Installation of two isolation valves in the vicinity of the crossing may help to prevent complete shutdown of the crossing during maintenance and repair activities.	$10,000
	D.4	Northwest Commons Pivot Improvements	Northwest Commons Subdivision	This improvement would tie the Northwest Commons irrigation pivot directly to the irrigation system and meter the pivot at the point of withdrawal. This will allow the City to operate the Northwest Commons Well independently of the pivot. Proposed pipe is 8 inches in diameter.	$30,000[1]
Dry Systems	DS	Activate Dry Systems	-	This improvement is an operational improvement that consists of activating the portions of the City's irrigation system which are currently not in use.[2]	-

Table ES-6
Near-Term Capital Improvement Program Summary (continued)

Group	ID	Project Location or Name	Project Limits	Project Description	Estimated Project Cost
Source and Storage Improvements	S.1	Road 68 Irrigation Tank Improvements	-	This improvement proposes to change the maximum water level in the Road 68 Irrigation Tank from 639 to 641.5. It is an operational change and requires no capital investment. This project also includes inspection and repair or replace level sensing equipment inside the Road 68 Irrigation Tank.	$10,000
	S.2	Irrigation Well Rehabilitation Program	-	Rehabilitation and data acquisition on all wells except Village at Pasco Heights Well.[3]	$220,000
Planning and Studies	P.1	Freshwater Mussel Study	-	Conduct a study to determine the most effective way to address freshwater mussel colonization of distribution piping exposed to Columbia River Water.	$25,000
	P.2	Linda Loviisa Well Field Study	-	Conduct a well field study in order to determine the optimal locations and sizes of new irrigation wells in the Linda Loviisa area.	$24,000
	P.3	Data Acquisition on Existing Wells	-	This recommendation consists of gathering data consistent with Table 4-3 as presented in Section 4. The City has resources to accomplish this project so there is no project cost.	-
				Total Budget Recommended for all Near-Term Capital Improvements	**$797,000**

Notes

1. For cost estimating purposes, 200 linear feet of 6-inch diameter PVC was assumed and $15,000 was added for installation of a new meter and valves.
2. See Figure 2-1 for the location of the City's existing dry systems.
3. See text for detailed description of rehabilitation activities and wells involved.

Table ES-7
Long-Term Capital Improvement Program Summary

Group	ID	Project Location or Name	Project Limits	Project Description	Estimated Project Cost
Distribution System Improvements	IR.1	Powerline Road	Road 90 to Convention Drive	Extend existing 16-inch diameter main west to Road 90 to improve flow and eliminate dead ends.	$1,000,000
	IR.3	Sandifur Parkway and Road 44	Porto Lane to Burden Boulevard	Extend existing dead-end 8-inch diameter main on Sandifur Parkway near Porto Lane along east side of Road 44 south to Burden Boulevard. Connect all dead-end distribution mains along Road 44 to the new main.	$325,000
	IR.6	Wrigley Drive	Road 68 east to Convention Drive	Installation of a 12-inch diameter main between existing distribution mains on Road 68 and Convention Drive. This improvement requires additional right-of-way.	$212,500
	D.1	600 Zone PRV Supply	600 Zone	This improvement proposes installation of a redundant 12-inch diameter source of supply to the 600 Zone. The ultimate size and routing of the pipe and source zone would be chosen by the City at a later time once right of way, easements, or land can be acquired between the two zones.	$915,000[1]
Telemetry Improvements	T.1	Road 52 Telemetry Improvements	Road 52	This improvement proposes installation of a signal converting station to improve communications from the central telemetry system to the Powerline Road Well, Road 52 Well, and Northwest Commons Well.	$35,000
Source Improvements	S.3	Village at Pasco Heights Well Replacement	Village at Pasco Heights	Construction of a new well at Village of Pasco Heights. This project assumes that the existing pump and motor will be reused.	$173,000
	S.4	Well Houses	-	Construction of well houses to enclose existing wells and associated equipment. It is assumed that a total of seven well houses will be built at a project cost of $65,000 per well house.	$455,000

Table ES-7
Long-Term Capital Improvement Program Summary (continued)

Group	ID	Project Location or Name	Project Limits	Project Description	Estimated Project Cost
Source Improvements	S.5	Construction of New Irrigation Wells	-	Up to six new irrigation wells could be necessary to improve the irrigation system capacity. For budgeting purposes, a project cost of $616,000 per well has been assumed.[2]	$3,696,000[3]
Planning and Studies	P.4	Rate Study	-	Conduct a rate study to see if irrigation system rates are adequate. The rate study will be informed by the selection of a capital improvements program.	$25,000
	P.5	Irrigation System Master Plan Update	-	Update of this irrigation system master plan following major changes to the irrigation system or after five years, whichever occurs first.	$30,000
Total Budget Recommended for all Long-Term Capital Improvements					**$6,867,000**

Notes

1. For cost estimating purposes, 6,500 linear feet of 12-inch diameter PVC was assumed and $100,000 was added for a pressure-reducing station.
2. The location of new wells will depend on data acquisition and the Linda Loviisa well field study.
3. The project cost is $616,000 per new irrigation well. With a total of six wells, the total project cost is $3.70 million. It is possible that fewer than six new wells will be necessary.

SECTION 1
INTRODUCTION

Authorization

On June 4, 2013, Murray, Smith & Associates, Inc. (MSA) was authorized by the City of Pasco (City) to prepare this plan.

Background

The City of Pasco owns and operates domestic and irrigation water utilities that provides water to residential customers and a limited number of commercial customers. Providing a system for irrigation water separate from the potable water utility allows the City's customers to avoid using treated drinking water to irrigate. The City's existing irrigation system is supplied by water from 11 groundwater wells and water pumped from the Columbia River. The City acquired the first portions of the system in 2002 from a private irrigation utility. The system has grown considerably since that time. The City uses the irrigation system annually from April 1st to October 31st. The City has established the goal of developing a capital improvements plan for the irrigation system to ensure the continued delivery of economical irrigation water to City residents.

Purpose and Scope

The purpose of this plan is to provide a basis for identifying, analyzing, and planning capital improvements to the irrigation system. The study includes a hydraulic analysis of the existing system which compares the existing system's performance to analysis criteria in order to identify deficiencies and develop system improvements. A capital improvements plan is developed to assist in planning future projects. Included with this plan are conceptual level project cost estimates.

The system's existing groundwater wells will also be evaluated through a tabletop review of existing data. The results of this review will be used to develop preliminary recommendations for improvements, further assessment, and rehabilitation work.

Irrigation System Plan Overview

This plan is organized by sections. Section 2 presents an inventory of the irrigation system and its components as they currently exist and operate. The City's irrigation water rights are also discussed in Section 2. Section 3 presents analysis criteria that form the basis for identifying deficiencies in system performance and planning improvements to the irrigation system. Section 3 also includes a description of the hydraulic model and the results of the modeling analysis work. Groundwater well condition assessments are also documented in this section. Section 4 presents recommendations for improvements to the system and to the groundwater wells, as well as recommended further study and planning work.

SECTION 2
EXISTING SYSTEM

Introduction

This section describes the City's existing irrigation system's supply, storage, and distribution facilities. Water rights and historical production and demand data are presented. General operations are also discussed in this section. The information in this section forms the basis for building the hydraulic model and for developing the recommendations which result from analysis of the irrigation system.

Existing Irrigation System

The City's irrigation system piping is polyvinyl chloride (PVC), ductile iron (DI), and steel distribution pipes ranging from 3 inches to 24 inches in diameter. Table 2-1 shows a summary of irrigation main sizes in the distribution system.

Table 2-1
Irrigation Main Inventory by Size

Diameter (inches)	Length (ft)	Length (miles)
< 6	356,347	67.49
6	125,506	23.77
8	80,678	15.28
10	5,122	0.97
12	96,254	18.23
15	8,078	1.53
16	27,878	5.28
18	4,488	0.85
24	483	0.09
Total	**711,797**	**134.81**

The oldest parts of the system are approximately 15 to 20 years old, with most of the system constructed less than 10 years ago. Parts of the irrigation system were first acquired by the City in 2002 from Kidwell Farms, Inc., a private irrigation utility owner. This utility was part of subdivisions built by private developers.

The system has six pressure zones. The largest is the 639 pressure zone. All of the system's sources of supply and storage are located in this zone. The other five zones have a lower hydraulic grade line (HGL) and are supplied from the 639 pressure zone through pressure-reducing valves. Figure 2-1 shows an overview of the existing system. Figure 2-2 shows a hydraulic profile of the system.

Figure 2-1

City of Pasco
Irrigation System Master Plan

EXISTING CITY IRRIGATION SYSTEM

December 2013

Murray, Smith & Associates, Inc.
Engineers/Planners
Tacoma, Washington

13-1444.407

LEGEND

- Existing Storage Tank
- Existing Booster Pump Station (BPS)
- Existing Irrigation Well
- Existing Pressure Reducing Valve (PRV)
- Existing Irrigation Main (Diameter Indicated in Inches)
- County Line
- Franklin County Irrigation District (FCID) Irrigation Service Area
- Pasco City Limits
- Urban Growth Area Boundary

Pressure Zones:

- River Intake Zone
- 547 Zone
- 560 Zone
- 594 Zone
- 600 Zone
- 639 Zone

Dry System Boundaries:

- Broadmoor Estates
- Broadmoor Place
- Cole's Estates
- Desert Oasis
- Desert Plateau
- Mediterranean Villas

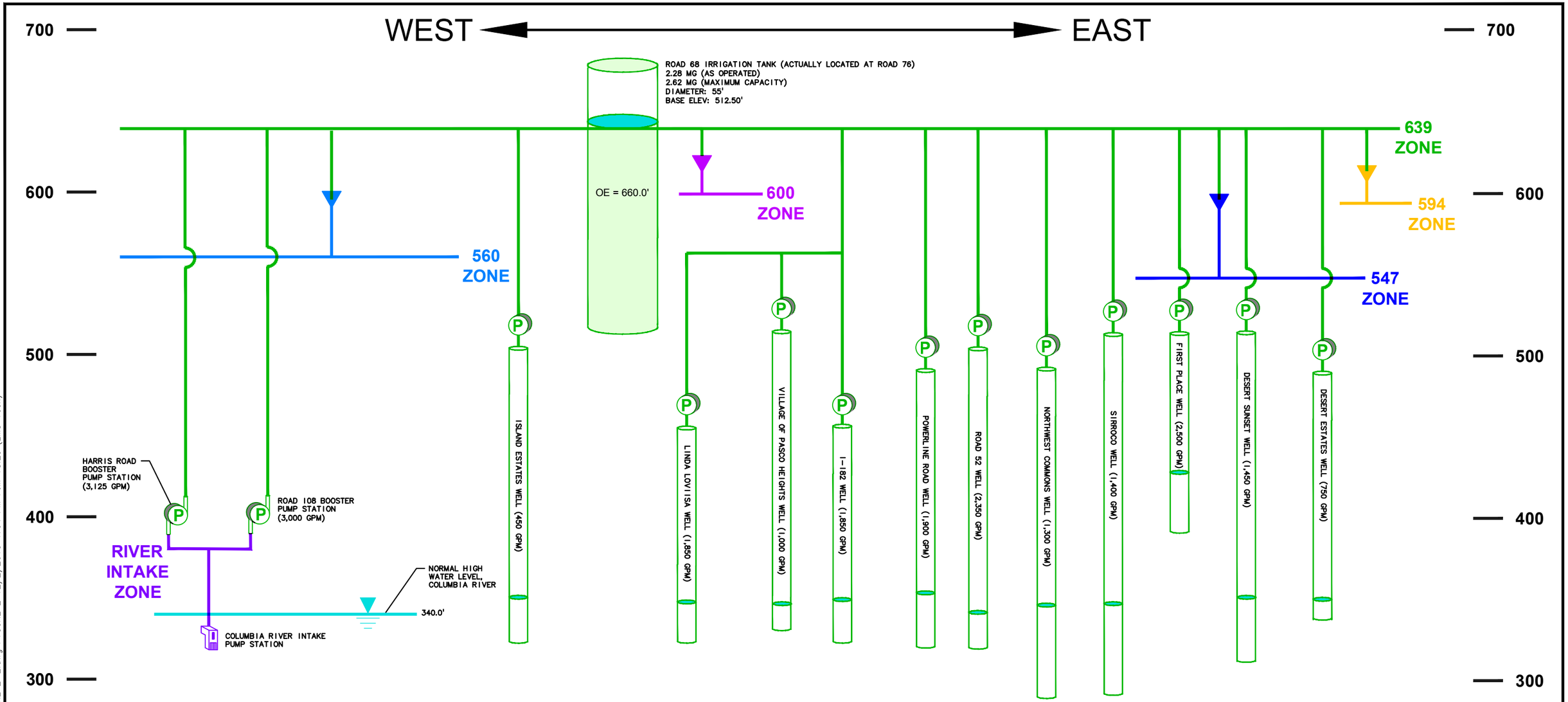
BROADMOOR ESTATES
MEDITERRANEAN VILLAS
COLE'S ESTATES
BROADMOOR PLACE
HARRIS ROAD BPS
CAP: 3,125 GPM
RIVER INTAKE ZONE
RIVER INTAKE STATION
CAP: 3,000 GPM
ROAD 108 BPS
CAP: 3,000 GPM
639 ZONE
ROAD 68 IRRIGATION TANK
CAP: 2.28 MG
OE: 639 FT
ISLAND ESTATES WELL
POWERLINE WELL
ROAD 52 WELL
NORTHWEST COMMONS WELL
DESERT SUNSET WELL
DESERT ESTATES WELL
PRV
594 ZONE
VILLAGE AT PASCO HEIGHTS WELL
DESERT OASIS
SIRROCO WELL
LINDA LOVIISA WELL
560 ZONE
600 ZONE
DESERT PLATEAU
I-182 WELL
547 ZONE
FIRST PLACE WELL
CITY OF PASCO
WEST PASCO
Columbia River
FRANKLIN COUNTY
BENTON COUNTY

N

1,000 0 1,000
SCALE IN FEET

SOURCE:
Base Mapping - Franklin County GIS (June 2013) and Benton County GIS (June 2013).
Irrigation System Mapping - City of Pasco (April 2013).

G:\PDX_Projects\13\1444\CAD\GIS\FIGURES\13-1444-407-WA-FIGURE 2-1.mxd 12/3/2013 8:45:34 AM DKH



LEGEND

- ZONE 639 (H.E. 639')
- ZONE 600 (H.E. 600')
- ZONE 594 (H.E. 594')
- ZONE 560 (H.E. 560')
- ZONE 547 (H.E. 547')
- RIVER INTAKE ZONE
- BOOSTER PUMP STATION
- PRESSURE REDUCING VALVE
- WELL PUMP
- WATER LEVEL
- RIVER INTAKE PUMP STATION

ABBREVIATIONS

ELEV	ELEVATION
FT	FEET
GPM	GALLONS PER MINUTE
MG	MILLION GALLONS
OE	OVERFLOW ELEVATION

December 2013

CITY OF PASCO
IRRIGATION SYSTEM
MASTER PLAN

FIGURE 2-2
EXISTING IRRIGATION SYSTEM HYDRAULIC PROFILE

13-1444.407

K:\TAC_Projects\13\1444 - Pasco Water Resources Study\CAD\FIGURE 2-2.dwg FIGURE 2 12/2/2013 1:04 PM FJM 18.2s (LMS Tech)

Supply

The City's irrigation system is supplied by groundwater produced from 11 wells located throughout the system and surface water pumped from the Columbia River. All sources of supply pump to the system's main service zone, referred to as the 639 pressure zone. Supply to lower zones is accomplished through the use of pressure-reducing stations.

Groundwater Supplies

The City's irrigation wells range between 135 and 245 feet deep and are completed in an unconfined alluvial aquifer consisting mainly of sand and gravel. The wells range between 1 and 39 years old. Roughly half of the wells are constructed with perforated casing and the others with stainless steel, wire wrap well screen. The reported production capacities range between 450 and 2,500 gpm. Table 2-2 summarizes the City's irrigation wells.

Most of the City's irrigation wells are located on concrete pads and are open to the atmosphere with nearby electrical equipment in weatherproof enclosures. The Desert Sunset and Sirocco Wells are enclosed within buildings. The City has current capital improvement projects planned to construct new well houses around the First Place Well and the Linda Loviisa Well. The construction of these well houses is intended to prevent damage to equipment from exposure and reduce noise levels to nearby properties when the pumps are operating. None of the wells have backup power supply.

Surface Water Supplies

In addition to groundwater wells, the City uses water pumped from the Columbia River for irrigation supply. The river intake pump station conveys water directly to the Road 108 Booster Pump Station located on the west side of the system. The Road 108 Booster Pump Station pumps the irrigation water to the irrigation distribution system. Irrigation water pumped from the river is metered through a master meter at the Road 108 Booster Pump Station. Since there are no services between these two stations, all of the water pumped is metered prior to distribution and use.

Water Rights Summary

The City's current irrigation water rights are a combination of water rights issued by the Washington State Department of Ecology (DOE) and water rights which were given to the City by private parties. The City's annual irrigation water rights total 7,592.9 acre-ft. Table 2-3 shows a summary of the City's existing irrigation water rights.

Storage

The irrigation system has one storage tank located near the intersection of Sandifur Parkway and Road 76. The storage tank sets the hydraulic grade for most of the City's system. The

storage tank serves the 639 pressure zone by gravity, so the water is able to serve the other pressure zones at lower elevations through pressure-reducing stations.

Table 2-2
Irrigation Well Summary

Well Name	Year Constructed	Depth (BGS[1])	Pump Type	Fixed/ Variable Speed	Average Production Rate (gpm[2])	Motor Size (HP[3])
Desert Estates	1951	152	Submersible	Fixed	650	75
Desert Sunset	1929	202	Vertical Turbine	Variable	1,450	150
First Place	2007	123	Vertical Turbine	Variable	2,500	350
Island Estates	1976	190	Submersible	Fixed	450	50
I-182	Unknown	134	Vertical Turbine	Variable	1,850	200
Linda Loviisa	2012	205	Vertical Turbine	Fixed	1,100	150
Northwest Commons	Unknown	203	Vertical Turbine	Variable	1,300	150
Powerline Road	1980	171	Vertical Turbine	Fixed	1,900	200
Road 52	2006	185	Vertical Turbine	Variable	2,350	250
Sirroco	1976	222	Vertical Turbine	Variable	1,400	150
Village of Pasco Heights	1975	184	Submersible	Fixed	1,000	125

Notes
1. Below ground surface
2. Gallons per minute
3. Horsepower

The storage tank is referred to as the Road 68 Irrigation Tank. Construction of the tank was completed in 1992 and it was originally used as a potable water storage tank. The tank was repurposed for use in the irrigation system in 2006. The tank is a welded steel standpipe with an approximate volume of 2.62 million gallons (MG) when full. The City currently operates the tank below full at a volume of 2.28 MG. The tank has a diameter of about 55 feet and the current water storage height is 126.5 feet which corresponds to an elevation of 639 feet above mean sea level (AMSL). The maximum water storage height is 147.5 feet or 660 feet AMSL. The tank has approximately 18,000 gallons of storage per vertical foot of storage

height. The tank is equipped with an impressed current cathodic protection system. It was fully recoated in 2008.

Table 2-3
Irrigation Water Rights Summary

Well Name	Water Right[3]	Q_i[4] (gpm)	Q_a[4] (acre-ft)	Approximate Pumping Capacity (gpm)
First Place	G3-01243C	1,400	558.0	2,500
Desert Sunset	G3-20243P(B)[1]	214	107.9	1,450
	G3-20243P(C)	1,174	441.6	
Island Estates	G3-20242C(B)	1,134	504.0	450
Sirocco	G3-20243P(B)[1]	214	107.9	1,450
	G3-28452C	450	172.0	
Road 52	G3-20242P(A)	1,430	636.0	2,350
Village of Pasco Heights	G3-23525C	1,300	660.0	1,000
Northwest Commons	G3-20243P(A)	1,612	483.6	1,300
	G3-20243P(B)[1]	214	107.9	
Desert Estates	G3-24981C(A)	80	41.9	750
	G3-24981C(B)	400	155.9	
Linda Loviisa	G3-20244C[2]	1,880	759.8	1,000
	G3-24978C[1]	1,600	660.0	
	G3-26368C[1]	400	164.0	
I-182	G3-24978C[1]	1,600	660.0	1,850
	G3-26368C[1]	400	164.0	
Powerline Road	G3-27413P(B)	270	108.1	1,900
	G3-27413P(C)[1,2]	573.75	203.4	
	G3-27413P(D)	281.25	112.6	
	G3-27413P(F)	270	108.0	
Road 108 Booster Pump Station	G3-27413P(C)[1,2]	573.75	203.4	3,000
	S3-28615C	1,643	732.0	
	S3-28788C	139	56.0	
	S3-28789C	121	48.0	
	S3-28790C	195	200.0	
	S3-28932C	597	240.0	
Total Rights		**17,164**	**7,152.8**	**19,000**

Notes
1. Indicates that water right is shared
2. This water right has two points of withdrawal
3. G indicates a groundwater right; S indicates a surface water right.
4. Q_i is the instantaneous allowable flow; Q_a is the average annual allowable volume

Distribution

The distribution system consists of pipe ranging from 3 inches in diameter to 24 inches in diameter. The majority of the system piping is PVC with parts of the system in ductile iron (DI) or steel.

Pressure Zones

The irrigation system has six pressure zones. The zones are separated by pressure-reducing stations which allow zones with a higher hydraulic grade to supply zones having a lower hydraulic grade with water. Table 2-4 summarizes the pressure zones.

Table 2-4
Pressure Zone Summary

Zone Name	Maximum Hydraulic Grade (ft AMSL)	Storage Facilities	Supply Facilities	General Location or Service Area
639	639	Road 68 Irrigation Tank	All groundwater wells	Main portion of irrigation system
600	600	No storage facilities	No supply facilities	Chapel Hill subdivision
594	594	No storage facilities	No supply facilities	Desert Estates subdivision
560	560	No storage facilities	No supply facilities	Loviisa Farms
547	547	No storage facilities	No supply facilities	First Place subdivision
River Intake	549	No storage facilities	Columbia River Intake Station	Intake near I-182 bridge over Columbia

Booster Pump Stations

The City currently has one booster pump station in its irrigation system. This is the Road 108 Booster Pump Station located at the intersection of Road 108 and Crescent Road in the western portion of the irrigation service area. The design capacity of this station is 3,000 gpm. This station is used to boost water pumped from the Columbia River Intake Station to the 639 Pressure Zone.

Another pump station is planned for construction in 2013. This station will be called the Harris Road Booster Pump Station and will be located on Harris Road near Interstate 182. This booster pump station has a design capacity of 3,125 gpm. The station will also pump water supplied by the Columbia River Intake Station to the distribution system.

Dry Systems

The City's irrigation system includes portions that are installed and ready for use, but not currently used. These systems are referred to as dry systems. The existing dry systems are shown in Figure 2-1. Table 2-5 shows a summary of the current dry systems.

Table 2-5
Dry System Summary

Subdivision Name	Number of New Connections	Estimated Acreage (ac)
Broadmoor Estates	304	90.67
Broadmoor Place	233	62.33
Desert Oasis	170	54.17
Desert Plateau	304	108.48
Total	**1,011**	**315.65**

Interties to Other Systems

The irrigation system is not connected to any other irrigation or water distribution systems. The irrigation system was formerly connected to the City's potable water distribution system through a backflow prevention device. The City completely removed the connection in 2006.

Irrigation System Demands

This section presents information on irrigation water production and demands. The City typically uses its irrigation system from April to October every year. Production is monitored and recorded by meters on each of the system's wells. Some large users are metered, but most connections to the system are not currently metered.

Production Records

Total system production is the sum of water produced by the irrigation system wells and water pumped from the Columbia River. Figure 2-3 shows total system production from 2006 to 2012. As seen from the figure, system production has increased steadily from 2006 to 2012. The City performed two studies related to water use: one in 2001 and one in 2007. The study from 2001 includes information cited in this report on irrigation water use for public facilities and agriculture. The 2007 study contains more recent data on residential irrigation water usage which are also used in this report.

Overall System Usage

Historical production data was used to calculate overall system usage and peaking factors. The City has collected hourly data on all of its source meters and its storage tank for the past

three years. This data was used to analyze variations in demand and to develop the average day demand (ADD), maximum day demand (MDD), and peak hour demand (PHD). The results of this analysis are shown in Table 2-6.

Figure 2-3
Total System Production

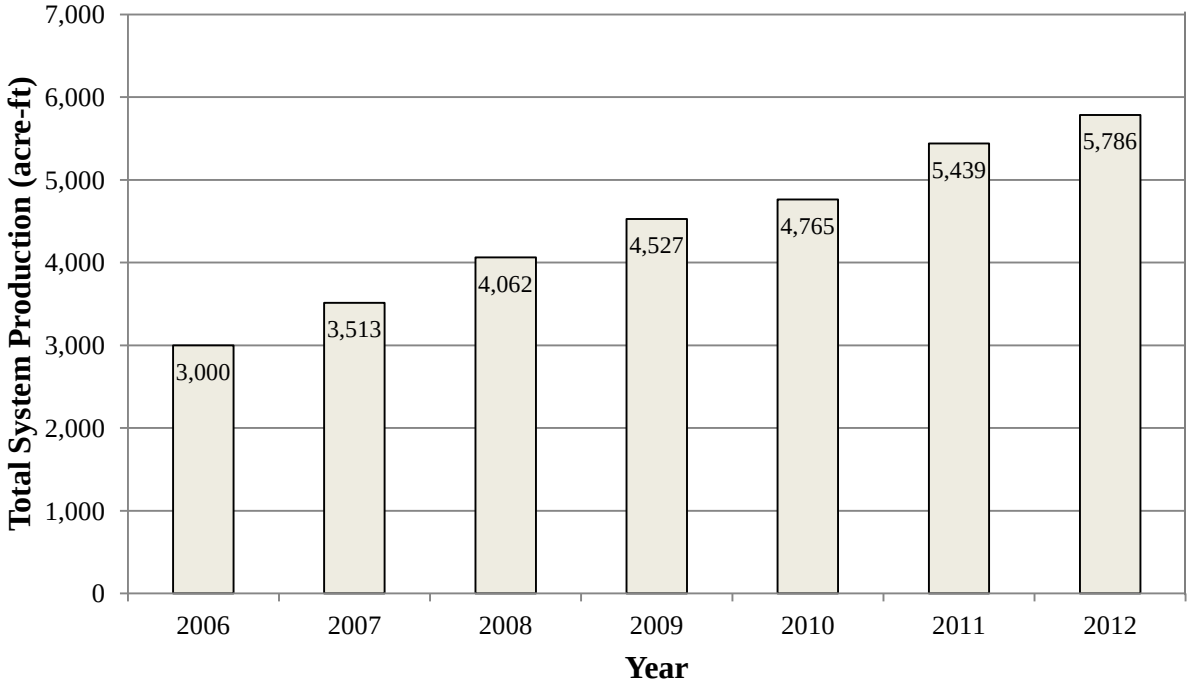


Table 2-6
Peaking Factor Summary

Year		2012	2011	2010
Total System Production (MG)		1,885.28	1,722.40	1,552.61
Average Day Demand	**gpm**	6,118	5,572	5,038
	mgd	8.810	8.282	7.255
Maximum Day Demand	**gpm**	9,700	8,487	9,704
	mgd	13.968	12.221	13.973
	Date	8/8/2012	8/2/2011	8/8/2010
Peak Hour Demand	**gpm**	17,529	15,116	16,077
	mgd	25.241	21.767	23.151
	Hour	6:00 AM	10:00 AM	6:00 AM
MDD/ADD (Average: 1.662)		1.586	1.476	1.926
PHD/MDD (Average: 1.748)		1.807	1.781	1.657
PHD/ADD (Average: 2.895)		2.865	2.628	3.191

The irrigation system has grown since the City began acquiring the system in 2002. The City classifies connections to the system as either residential, billed on a flat fee basis, or connections for customers billed by the acre. These larger accounts are typically commercial irrigation customers and include public schools, parks, apartment complexes, and sports facilities. Table 2-7 shows the number of connections to the system each year.

Table 2-7
Irrigation System Connections Summary

Year	Residential Connections	Customers Billed by Acre
2006	2,964	-
2007	3,351	-
2008	4,053	-
2009	4,403	-
2010	4,812	-
2011	5,159	22
2012	5,379	23
2013	5,434	25

Production has kept uniform pace with the number of connections to the system on an annual basis. Since 2006, the production per residential connection to the system has remained relatively constant at 1,575 gallons per day per connection per year.

Residential Demands

The City does not meter water use on residential connections to the irrigation system. Residential irrigation use varies widely across the City's service area and is dependent on economic factors, maturity of the landscaping, and whether or not the property is irrigated using domestic or irrigation water.

The City studied residential water use patterns in a 2007 memorandum and determined that residential irrigation usage averages 3.18 acre-ft per gross acre per year or 5.31 acre-ft per irrigated acre per year. The memorandum is attached as Appendix B.

Commercial Demands

Commercial users of the City's irrigation system include public schools and the City of Pasco Department of Parks and Recreation. Irrigated facilities include a soccer complex, a track facility, a softball complex, and five residential City parks. The soccer complex is metered.

Commercial irrigation usage varies according to the facility. City park use varied from 19 gallons per square foot to 34 gallons per square foot. Water use at the athletic facilities averaged 40 gallons per square foot which is higher than the rest of the system.

Agricultural Demands

The City of Pasco supplies irrigation water to three pivots from its system. Crops which are commonly grown at the three sites vary annually and include wheat, alfalfa, and potatoes. The pivots and land are not owned by the City. They include:

- A single pivot located at Linda Loviisa Farms
- A single pivot near the Northwest Commons Well
- A single pivot north of Powerline Road near the Powerline Well

All of the pivots are served directly by the system except for the pivot at the Northwest Commons Well. The Northwest Commons pivot may only run when the Northwest Commons Well is operating. Each pivot connection is metered.

Pivot acreages were calculated by scaling aerial photo maps. An annual demand of 3.30 acre-ft per acre was used to estimate the annual water usage of each of these pivots. This estimated demand was calculated as part of a water usage study prepared by the City in 2001. Table 2-8 shows a summary of the agricultural demands.

Table 2-8
Summary of Agricultural Demands

Pivot	Instantaneous Demand (gpm)	Estimated Irrigated Acreage (acres)	Estimated Annual Usage (acre-ft)
Powerline Road	380	125.7	414.8
Linda Loviisa	580	72.1	237.9
Northwest Commons	560	73.5	242.6
Total	**1,520**	**271.3**	**895.3**

General Operating Procedures

City staff use a process referred to as staging to operate the irrigation system. In each stage, various wells or combinations of wells are selected for production. Each stage includes more pumps than the previous stage. When an additional pump is called to operate, it is referred to as a step up. When a pump is called to stop, it is called a step down. The system uses a delay between stepping up or stepping down to minimize pump cycling and prevent dramatic increases or decreases in pressure and flow. The order of pumps is chosen by the operator and varies on a regular schedule. The maximum number of stages is set by the operator and varies up to 11, which is the number of well pumps in the system. The system has the ability to operate manually or automatically via a master telemetry unit.

Under automatic control, pumps are called to operate based on signals from pressure sensors within the system. The Island Estates Well, Sirocco Well, I-182 Well, and Desert Sunset

Well are equipped with pressure sensors that communicate with the telemetry system. If a low pressure is registered at any of these sites and lasts for 30 seconds, a new pump is called to operate. This is called a low pressure step-up. When a pressure sensor sends a high pressure alarm that lasts for 10 seconds, the stage will step down. This is called a high pressure step-down.

When the tank level is low, the stage is stepped up. This is referred to as a low tank level step-up. As long as the level remains low, additional pumps will be called to operate until the level rises above the low tank set point or the maximum stage is reached. If there is a high tank level signal, the stage is stepped down until the tank level falls below the high tank set point.

Water Quality

Water for the irrigation system is not treated. Available water quality data is attached in Appendix A.

Agreements with Kidwell Farms, Inc.

The City supplies irrigation water to three sites owned by Kidwell Farms, Inc. The three sites are the Northwest Commons subdivision, the Linda Loviisa Subdivision, and land leased from the Washington State Department of Natural Resources in Section 16, T-9-N, R-29-E. The City leases use of the Northwest Commons Well for an annual flat fee. The other pivots are connected to the system and a flat fee is paid to the City by Kidwell Farms for the connection. The fee varies by site and Kidwell Farms agrees to pay all maintenance and electrical costs associated with its use of the City facilities.

Rate Schedule

The City bills most of its customers based on a flat fee for connection to the irrigation system. Some large users are billed by the number of irrigated acres. Some users are billed by an irrigation unit which is defined as 5,000 square feet of irrigated area. The City's rate schedule and fees associated with the irrigation utility are summarized in Table 2-9.

Summary

This section presented information on the existing irrigation system including sources of supply, storage facilities, and the distribution system. Current demand data and trends were documented. General operation of the system was explained and the irrigation rates charged to customers are shown. The next section will present the hydraulic analysis of the irrigation system and the well condition assessments. Findings from each of these analyses will be discussed.

Table 2-9
Irrigation Utility Fees and Rates Summary

Irrigation Service Type	Fee/Charge	Reference
Irrigation water service; monthly rate during irrigation season:		
Base rate per unit for single-family residential properties	$26.00	13.61.190(A)
Base rate per unit for non-single-family residential property	$26.00	13.61.190(B)
Per irrigation unit	$8.12	13.61.190(C)
Per irrigated acre (public parks, playgrounds, and open spaces)	$75.81	13.61.190(D)
Unauthorized turn-on (any repair cost additional)	$50.00	13.61.090
Disconnect/connect service due to violation	$50.00	13.61.100
Annual system availability fee	$88.00	16.61.060

SECTION 3
CRITERIA, ANALYSIS, AND FINDINGS

Introduction

Section 3 presents a hydraulic analysis of the City's irrigation system and an assessment of the City's irrigation wells. The irrigation system analysis criteria include pressure, flow velocity, and storage criteria. A description of the analyses and associated findings are also presented.

Irrigation System Analysis

This section describes analysis of the irrigation system which uses a hydraulic model to simulate pressure and flow conditions in the system under several demand conditions.

Model Layout

The initial layout of the hydraulic model was completed by tracing pipes and junctions over the City's GIS data. Graphical and tabular data provided by the City were used to locate critical hydraulic elements such as the Road 68 Irrigation Tank, wells, pumps, and pressure reducing stations.

Once initial layout was completed, the irrigation piping system was then skeletonized to simplify the layout and increase modeling efficiency. Skeletonization is a process that consolidates multiple real pipes into hydraulically equivalent single pipes. For this model, the majority of skeletonization converted dead ends to demands at a single node where the real pipe branches away from the system. Skeletonization was not performed on pipes larger than 8 inches in diameter.

The modeling software's terrain extraction (TREX) program was used to apply elevations to the model nodes. The TREX program has the ability to apply elevations to hydraulic model nodes using a representation of a three-dimensional surface. The representation, usually contours, can be constructed using United States Geological Survey (USGS) data. The contours are superimposed on the model layout and the distance to the nearest two contours is used to interpolate the elevation of every node in the model. The final node elevations in the model are indicative of the surface elevation. The accuracy of the data and the final product is within 5 feet, which gives calculated pressures accurate to approximately 2 pounds per square inch (psi).

Pipe Characteristics

The hydraulic modeling software uses default modeling properties for common pipe materials. The City's irrigation system was modeled using the Hazen-Williams theory of

pressurized flow. For PVC pipe, an initial C value of 150 was used. An initial value of 140 was used for steel pipe and 120 for ductile iron pipe.

Water Demand Distribution

The demands presented in Section 2 were distributed throughout the model using a nearest node method. The nearest node method assigns known demands with a known spatial distribution to the nearest node in the system.

ArcGIS, a GIS software program, was used to identify irrigated parcels. The area and the geographic center of each parcel was calculated by the GIS program. This information was used to assign the geographic area of each parcel, in acres, to the nearest node in the model.

To convert each node's area assignment to a water demand, the demands from Section 2 were used. The total irrigated area in 2012 was approximately 1,492 acres. The PHD from 2012 was approximately 17,529 gpm. The known point demands were subtracted from this total and assigned to the appropriate location in the model. Based on information received from prior water demand studies performed by the City, it was determined that the remaining total irrigation system demand could be distributed evenly across the irrigated area. This method gives an average demand of 11.75 gpm/acre which was then applied universally to all of the nodes in the hydraulic model. The modeled demand is within 1 percent of the demand measured by the City's SCADA system.

Wells

Wells were modeled using flow control valves attached to virtual reservoirs with a HGL higher than the rest of the City's system. The flow control valves were set to reflect the documented production rates of each well.

Model Calibration

Model calibration was completed using data collected by the City's SCADA system. The system collects and logs information from the system every 30 to 60 minutes. Monitoring points on the system include well discharges, booster pump station discharges, and the storage tank. Pressure and flow data were known at each pump discharge point within the system during the peak hour. The tank level was not known, so it was estimated using data from nearby points within the system.

Flows from each of the wells were modeled using flow control valves. The initial simulation of the model produced hydraulic grade calculations at each well. These calculated hydraulic grades were then compared to the known hydraulic grades collected by the SCADA system and served as the primary calibration criteria. After several iterations, pipe roughness coefficients were universally lowered to a value of 130. All of the hydraulic grades were then within 4 percent of the target grades. Well calibrated models typically have discrepancies of 10 percent or less. Table 3-1 shows the results of the calibration.

Table 3-1
Hydraulic Modeling Calibration Summary

Well	Flow Target (gpm)	Flow from Model (gpm)	HGL Target	HGL from Model	Discrepancy (%)
Island Estates	590	590	610.5	612.47	0.3
Linda Loviisa	443	443	628.6	611.92	– 2.7
I-182	1238	1,238	651.6	638.94	– 1.9
First Place	1663	1,663	649.9	642.72	– 1.1
Sirroco	1415	1,415	640.0	653.29	2.1
Desert Estates	491	491	634.4	617.16	– 2.7
Desert Sunset	1418	1,418	628.2	618.46	– 1.6
Northwest Commons	0	0	629.1	627.01	– 0.3
Road 52	2125	2,125	644.4	634.34	– 1.6
Powerline	1758	1,758	657.8	637.53	– 3.1
Village Pasco Heights	936	936	622.6	614.52	– 1.3

Analysis Criteria

Once the physical layout and calibration of the model were completed, the model could be used to analyze flow velocities and pressures within the system. The analysis criteria used to evaluate the hydraulic performance of the irrigation system include minimum system pressures and maximum flow velocities. Any result not meeting these criteria is subject to further investigation and potential corrective action.

Flow Velocities

For this analysis, pipes whose flow velocities exceed 5 feet per second (fps) under average day demand conditions are considered to have inadequate capacity. Pipe flow velocities are allowed to increase up to 8 fps during PHD conditions. Any pipes with flow velocities above 8 fps under PHD conditions are considered to have inadequate capacity. These velocity limits reflect standard industry practices for acceptable flow velocities in pressurized piping systems. They are chosen to limit excessive head loss in the system.

Irrigation System Pressures

The City's pressure criteria at service connections are summarized below. These pressure criteria are based on industry standards, Uniform Plumbing Code requirements, and a review of landscape irrigation equipment water pressure requirements.

1. Each service connection should maintain a minimum water pressure of 30 psi during all demand conditions.

2. No service connection should exceed a water pressure of 120 psi. Individual customers are responsible for reducing water pressures over 80 psi if they desire to do so.
3. During a failure of any part of the system, the maximum water pressure at customer meters will not exceed 150 psi.

System Storage

This analysis uses standby storage recommendations provided by the Washington State Department of Health (DOH) for drinking water systems as water storage criteria because the City does not have established water storage criteria for its irrigation system. The DOH typically recommends that drinking water systems provide 150 minutes of water storage during peak demand conditions and that this storage be available to all customers at a minimum pressure of 30 psi. The City does not use the irrigation system to provide fire suppression, so no fire suppression storage is provided.

Model and Analysis Findings

The calibrated model was used to simulate two scenarios: 2012 conditions and an anticipated future demand condition. Modeling included the City's existing dry systems, but did not include any new pipes or new developments. The results of each analysis are described below.

Existing Conditions

Existing conditions were modeled using 2012 PHD conditions. These conditions are the same as those used for the calibration of the hydraulic model. Two pipes in the system exceed the flow velocity criteria of 8 fps under PHD conditions. These pipes are 4 inches in diameter and located adjacent to the Sirocco Well discharge. All analysis criteria were satisfied with regard to system pressures. The results are summarized below:

- The system does not experience pressures over 120 psi under any demand condition. In order to verify that maximum allowable pressures were not exceeded, a low-demand condition was used to approximate static conditions.
- The system experiences pressures over 80 psi near discharges for wells and the Road 108 Booster Pump Station during high production. None of the locations which experience pressures between 80 and 120 psi serve customers. They are typically located on dedicated transmission mains and are caused by topography.
- Low system pressures were not predicted by the model under this scenario during normal tank levels. If the storage tank water surface elevation reaches 600 feet AMSL, the system begins to experience isolated low pressures.
- No part of the system experiences pressures over 150 psi during a failure of pressure-reducing valves. It is possible that pumps could fail in such a manner as to cause high system pressures downstream of their discharges.

A graphical summary of modeling results for the existing conditions scenario is shown in Figure 3-1.

Future Conditions

The calibrated model was used to predict the hydraulic performance of the City's irrigation system under anticipated future conditions. The future condition assumptions are:

- All of the City's current dry systems are connected and in use
- All of the City's existing subdivisions are fully developed
- All of the City's sources are producing the maximum allowed flows simultaneously

These assumptions represent near-term conditions that could occur within the next two to five years. The actual timing of these conditions is dependent on a number of variables. Any changes in the following conditions would alter the analysis results:

- Expansion of the irrigation system service area beyond assumed service limits
- Additional sources of supply
- Changes in water rights

High system pressures were found near the discharges of wells and pump stations as in the 2012 PHD scenario. No pipes that serve customers directly experienced high pressures. No low system pressures were found by the model. High flow velocities were found by the model at two locations:

- Near the discharge of the Sirocco Well as observed in the 2012 PHD scenario
- North of the intersection of Road 52 and Sandifur Parkway

A graphical summary of modeling results for the future conditions scenario is shown in Figure 3-2.

Storage

The system storage was evaluated at projected peak hour demand conditions to determine whether or not enough storage is available in the system. The City currently operates the tank at a water level of 126.5 feet which corresponds to an elevation of 639 feet. At this level, the tank provides a total storage of 2.28 MG. The overflow of the tank is at elevation 660 feet. Water stored below elevation 597.5 feet is considered dead storage according to the storage criteria described above. The volume of dead storage in the tank is approximately 1.51 MG and the volume of active storage in the tank, as currently operated, is approximately 0.77 MG.

The maximum possible average day demand was calculated by dividing the sum of the City's annual irrigation water rights by the days in service. This demand, 7,744 gpm, was used to

Figure 3-1

City of Pasco
Irrigation System Master Plan

HYDRAULIC MODELING RESULTS FOR EXISTING CONDITIONS

December 2013

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

13-1444.407

LEGEND

- Existing Storage Tank
- Existing Booster Pump Station (BPS)
- Existing Irrigation Well
- Existing Pressure Reducing Valve (PRV)
- Existing Irrigation Main (Diameter Indicated in Inches)
- County Line
- Franklin County Irrigation District (FCID) Irrigation Service Area
- Pasco City Limits
- Urban Growth Area Boundary
- Pressure Between 80 PSI and 120 PSI
- Flow Velocity Greater Than 8 FT/S

POWERLINE WELL
ROAD 52 WELL
NORTHWEST COMMONS WELL
ROAD 68 IRRIGATION TANK CAP: 2.28 MG OE: 639 FT
DESERT SUNSET WELL
DESERT ESTATES WELL
PRV
HARRIS ROAD BPS CAP: 3,125 GPM
RIVER INTAKE STATION CAP: 3,000 GPM
ROAD 108 BPS CAP: 3,000 GPM
ISLAND ESTATES WELL
VILLAGE AT PASCO HEIGHTS WELL
LINDA LOVIISA WELL
HIGH FLOW VELOCITY NEAR SIRROCO WELL
SIRROCO WELL
I-182 WELL
FIRST PLACE WELL
CITY OF PASCO
WEST PASCO
Columbia River
FRANKLIN COUNTY
BENTON COUNTY

N
1,000 0 1,000
SCALE IN FEET

SOURCE:
Base Mapping - Franklin County GIS (June 2013) and Benton County GIS (June 2013).
Irrigation System Mapping - City of Pasco (April 2013).

G:\PDX_Projects\131444\CAD\GIS\FIGURES\13-1444-407-WA-FIGURE 3-1.mxd 12/3/2013 8:49:20 AM DKH

Figure 3-2

City of Pasco
Irrigation System Master Plan

HYDRAULIC MODELING RESULTS FOR FUTURE CONDITIONS

December 2013

Murray, Smith & Associates, Inc.
Engineers/Planners
Tacoma, Washington

13-1444.407

LEGEND

- Existing Storage Tank
- Existing Booster Pump Station (BPS)
- Existing Irrigation Well
- Existing Pressure Reducing Valve (PRV)
- Existing Irrigation Main (Diameter Indicated in Inches)
- County Line
- Franklin County Irrigation District (FCID) Irrigation Service Area
- Pasco City Limits
- Urban Growth Area Boundary
- Pressure Between 80 PSI and 120 PSI
- Flow Velocity Greater Than 8 FT/S

POWERLINE WELL
ROAD 52 WELL
NORTHWEST COMMONS WELL
ROAD 68 IRRIGATION TANK CAP: 2.28 MG OE: 639 FT
DESERT SUNSET WELL
DESERT ESTATES WELL
PRV
PRV
PRV
HARRIS ROAD BPS CAP: 3,125 GPM
RIVER INTAKE STATION CAP: 3,000 GPM
ROAD 108 BPS CAP: 3,000 GPM
PRV
PRV
ISLAND ESTATES WELL
VILLAGE AT PASCO HEIGHTS WELL
LINDA LOVIISA WELL
HIGH FLOW VELOCITY NEAR SIRROCO WELL
SIRROCO WELL
PRV
I-182 WELL
FIRST PLACE WELL
PRV
PRV
CITY OF PASCO
WEST PASCO
Columbia River
FRANKLIN COUNTY
BENTON COUNTY

N

1,000 0 1,000
SCALE IN FEET

SOURCE:
Base Mapping - Franklin County GIS (June 2013) and Benton County GIS (June 2013).
Irrigation System Mapping - City of Pasco (April 2013).

G:\PDX_Projects\131444\CAD\GIS\FIGURES\13-1444-407-WA-FIGURE 3-2.mxd 12/3/2013 8:52:05 AM DKH

calculate a projected peak hour demand of 22,419 gpm. A peak hour demand peaking factor of 2.895 was used.

This demand would be met by a combination of the City's wells and storage. It was assumed that all of the City's sources would be pumping at the current instantaneous water right of 17,164 gpm. The tank would need to provide approximately 5,255 gpm for 150 minutes at a minimum pressure of 30 psi. Based on this analysis, the system requires approximately 788,250 gallons of storage for the projected peak demand, not including dead storage. Based on this analysis, the existing irrigation system reservoir has adequate capacity to meet these storage needs.

Operations and Maintenance Problems

The City experiences some operations and maintenance problems with the irrigation system which are described below.

Northwest Commons Well Use

The Northwest Commons well is plumbed so that it supplies the City's irrigation system and a nearby agricultural pivot simultaneously. Whenever the well is being operated, the pivot must also operate. Any water produced in excess of the pivot's requirements flows to the irrigation system. The City currently allows a private third party to use the well to operate the pivot, limiting the City's ability to use the well. The agreement under which this well is operated is attached as Appendix C.

Freshwater Mussels

Some parts of the irrigation system which convey water drawn from the Columbia River experience annual buildup of freshwater mussels in the piping. The most problematic area of the mussel infestation is in the piping between the Road 108 Booster Pump Station and the crossing under Interstate I-182. During the summer, high flows dislodge some mussels from the pipe walls which can cause operational problems such as plugging.

Access to Pipes in Island Estates and Sunny Meadows

The original irrigation system piping that was constructed by private developer Water, Inc. is located in the Island Estates and Sunny Meadows subdivisions. These pipes were installed in easements located in the less accessible alignments on private property. City operations staff may have difficulty accessing these areas for routine or emergency maintenance.

Interstate Highway 182 Crossing

Irrigation water supplied by pumps from the river intake station and the Road 108 Booster Pump Station is conveyed underneath Interstate Highway 182 to serve the majority of the City's irrigation system. The crossing ties into a pipe near Quadra Drive adjacent to the

interstate highway. Discussions with City staff indicate that a complete shutdown of the highway crossing is usually necessary to perform system maintenance and repairs in this area because of inadequate local isolation valving.

Telemetry System and Communications

According to discussions with City staff, the Powerline Well, Road 52 Well, and the Northwest Commons Well all rely on the same radio for communication with the system. If this single radio were to fail or be compromised, communication and control at all three sites would fail. City staff have indicated that the radio has experienced some irregular communication problems in the past.

Data collected by the City's supervisory control and data acquisition (SCADA) system indicate that there is a problem with the remote level sensor in the Road 68 Irrigation Tank. Data received for the last several years does not include accurate or consistent readings on the tank water level.

Well Condition Assessment

A tabletop condition assessment of the City's groundwater supply wells was completed as part of this plan. The assessment consisted of gathering and analyzing available information. The objective of this analysis is to identify wells having apparent construction, performance, or water quality issues that may be limiting production with the purpose of developing a targeted approach at candidate wells to regain performance and optimize individual and combined system production. The results of this assessment are discussed below.

Data Review and Gap Analysis

The following information was provided by the City and was used in assessing the irrigation supply system:

- Water Rights
- Driller’s well logs
- Well construction records
- Aquifer test results
- Specific capacity
- Well inspection reports
- Well video surveys
- Water quality data
- Well usage information
- General notes and observations gathered by City operations staff

All of the wells have some information available, but there are some data gaps that result in recommendations for further assessment. A tabular summary identifying the data available and the data gaps is presented in Table 3-2.

Observations and Analysis

The results of the well condition assessments are summarized as follows:

- Review of available information for the Desert Sunset, Sirocco, NW Commons, Island Estates, I-182, and Powerline Road wells indicated the presence of biofouling and incrustation which are possibly plugging screens and perforations. Significant accumulations of sediment or debris in the wells are also noted.
- Observations indicated minor mineral and biological deposits within the First Place and Desert Estates wells.
- Based on the information provided and relatively newer construction, the apparent conditions of the Road 52 and Linda Loviisa Wells are considered good.

Table 3-3 ranks the wells in terms of priority, potential for improvement, and overall condition assessment. The Desert Sunset Well received the highest priority ranking which means that it should be the first well to receive maintenance and rehabilitation. The Sirocco well has the highest potential for improvement which means that its capacity could be improved the most. The Desert Sunset Well received the highest condition assessment ranking indicating that it is in the worst overall condition. The overall assessment found that there are opportunities for well performance and yield improvements. The three highest-ranking wells in need of improvements are the Desert Sunset Well, the Sirocco Well, and the Northwest Commons Well. Table 3-4 presents a summary of the well condition assessments.

Summary

This section presented an analysis of the City's irrigation system. The distribution system was analyzed using a hydraulic model. Current conditions and an anticipated future condition were modeled. Low pressures and high velocities, as defined by the analysis criteria, were noted. The irrigation system storage was analyzed for deficiencies. The condition of the City's groundwater supply wells was also assessed. The results of these analyses will be used in Section 4 to develop recommendations for improvements to the irrigation system.

Table 3-2
Irrigation Well Data Summary and Gap Analysis[1]

Well	Water Rights	Location Map	Driller's Well Log	Well Construction	Aquifer Test Data and Analysis	Specific Capacity Measurements	Well Inspection or Rehabilitation Report	Well Video Survey	Water Quality Data	Well Usage Information	Notes and Observations	Comments and Data Gaps
Desert Estates	4	4	4	4	4	4	4	1	0	2	4	▪ 407 gpm/ft SC[2] (source: 4-hr pump test by Layne) ▪ Construction apparent from video log does not match driller's log or City's specification sheet ▪ Extensive biofouling observed during well video survey precluded adequate assessment of existing conditions
First Place	2	4	4	4	2	2	4	4	0	2	4	▪ 3,591 gpm/ft SC (source: 2-hr step-rate test conducted by Layne; 3 steps, with first two only lasting approx. 10 min each step) ▪ 1,426 gpm/ft SC (source: MSA)
Village at Pasco Heights	2	4	4	4	2	2	4	4	0	2	4	▪ 856 gpm/ft SC (source: 4.5-hour pump test conducted at variable rate by Green Valley Pump Services; quality of test data is considered poor)
Desert Sunset	4	4	3	3	0	2	4	4	1	2	4	▪ 829 gpm/ft SC (source: MSA) ▪ Well log mentions pump test completed, but test data not discovered ▪ 24 mg/L Nitrate-N sampled on 7/6/2005
Island Estates	2	4	4	4	0	0	4	4	1	2	4	▪ No available aquifer testing data ▪ Construction noted on driller's log not consistent with video log ▪ 22 mg/L Nitrate-N sampled on 7/6/2005
I-182	2	4	4	4	0	1	2	4	1	2	3	▪ 11,333 gpm/ft SC (source: MSA); lacks detailed well data ▪ 28 mg/L Nitrate-N sampled on 7/6/2005
Road 52	2	4	4	4	0	2	2	1	0	2	3	▪ 1,333 gpm/ft SC (source: 4-hr well test by Layne); 2,200 gpm/ft SC (source: MSA) ▪ Well inspection reports do not match construction noted on driller's log ▪ Well inspection reports titled "5766 NW Commons well" however, do appear to match Road 52 well construction ▪ No video log provided for review; existing condition was defined to the extent possible using observations made during well inspections
Powerline Road	2	4	4	4	0	0	0	4	0	2	4	▪ Little data available
Sirocco	2	4	4	4	0	0	0	4	1	2	2	▪ Perforated casing span observed during video survey does not match well construction noted driller's well log; ▪ 28 mg/L Nitrate-N sampled on 7/6/2005
Northwest Commons	2	4	1	1	0	2	4	2	0	2	4	▪ 111 gpm/ft SC (source: MSA) ▪ Rehabilitated December 2007 (sonic blasting, bailing to remove sediment) ▪ Well inspection reports and video survey observations do not match construction noted on driller's well log ▪ Well construction information taken from well inspection and rehabilitation reports
Linda Loviisa	2	4	4	3	0	0	0	0	0	1	0	▪ New well constructed December 2012

Notes
1. A rank of 4 indicates best quality data and a rank of 0 indicates no data available
2. Specific capacity

Table 3-3
Irrigation Well Ranking Summary

Well	Improvement Priority Rank	Improvement Potential Rank	Condition Assessment Rank
Desert Sunset	1	4	1
Sirocco	2	1	4
Northwest Commons	3	3	3
Island Estates	4	2	5
I-182	5	7	6
Powerline Road	6	7	7
First Place	7	6	10
Desert Estates	8	6	8
Village at Pasco Heights	9	5	2
Road 52	9	7	9
Linda Loviisa	9	6	11

Table 3-4
Well Condition Assessment Summary

Well	Observations and Findings
Desert Sunset	▪ Well is 39 years old and is approaching the typical life expectancy for groundwater supply infrastructure (commonly assumed to be between 30 and 50 years in normal groundwater environments). ▪ Flow to well is through perforated casing rather than a more efficient, engineered well screen. ▪ Static and pumping water levels are within perforated interval. ▪ Approximately 45 ft of accumulated sediment/debris possible (video depth < reported depth) ▪ Bottom depth of open-interval span not known. ▪ Accumulated sediment/debris in well approaching intake depth setting. ▪ Heavy biofouling; precluded adequate assessment of existing conditions from video survey. ▪ Moderate incrustation of perforations previously reported.
Sirocco	▪ Well is 37 years old and is approaching the typical life expectancy for groundwater supply infrastructure (commonly assumed to be between 30 and 50 years in normal groundwater environments). ▪ Flow to well is through perforated casing rather than a more efficient, engineered well screen. ▪ Major biofouling present, mostly encompassing and possibly plugging perforations. ▪ 17 ft of sediment/debris buildup in bottom of well? (video depth < reported depth)
Northwest Commons	▪ Well age is unknown. ▪ Previously rehabilitated (Dec-07). ▪ Flow to well is through perforated casing rather than a more efficient, engineered well screen. ▪ Major biofouling present, mostly encompassing and possibly plugging perforations. ▪ Approximately 3 ft of accumulated sediment/debris in bottom of well. ▪ Accumulated sediment/debris near intake.

Table 3-4
Well Condition Assessment Summary (continued)

Well	Observations and Findings
Island Estates	▪ Well is 38 years old and is approaching the typical life expectancy for groundwater supply infrastructure (commonly assumed to be between 30 and 50 years in normal groundwater environments). ▪ Approximately 9 feet of sediment/debris buildup blocking three feet of perforated interval? (video depth < reported depth) ▪ Flow to well is through perforated casing rather than a more efficient, engineered well screen. ▪ Major biofouling present, mostly encompassing and possibly plugging perforations.
I-182	▪ Well is 34 years old. ▪ Approximately 2 feet of sediment/debris accumulation in well? (video depth < reported depth) ▪ Some biofouling and incrustation of well screen present, blocking roughly 25% of open area.
Powerline Road	▪ Well is 33 years old. ▪ Varying degree of biofouling present (minor to major).
First Place	▪ Well is 6 years old. ▪ Minor biofouling present at top and bottom of well screen.
Desert Estates	▪ Well is 31 years old. ▪ Minor scale/mineral deposits on well screen. ▪ Some minor corrosion observed near bottom of screen.
Village at Pasco Heights	▪ Well is 38 years old and is approaching the typical life expectancy for groundwater supply infrastructure (commonly assumed to be between 30 and 50 years in normal groundwater environments). ▪ Approximately 1 ft of sediment/debris accumulation in well/screen bottom? ▪ Heavy incrustation/mineral deposits; approximately 50 to 80% of screen open area estimated to be blocked . ▪ The well is equipped with a sand filter. ▪ Casing noted to have been pulled back to 159 ft bgs during screen exposure, roughly 3 ft above top of screen assembly. ▪ Gap from casing pullback could be allowing formation material to enter well. ▪ Small gap noted during review of video survey, though may be from separated casing joint/weld ▪ Blasting cap debris previously observed in well; possibly from previous rehabilitation. May have caused the separation noted above.
Road 52	▪ Well is 7 years old. ▪ Inspection report notes damage to top of well screen; no video log available for review to confirm or assess. ▪ Besides noted damage, the well screen (based on inspection report photos) appears in relatively good condition. ▪ Inspection report notes stainless steel banding material in well.
Linda Loviisa	▪ New well constructed December 2012 ▪ No inspection reports or well video survey available for review

SECTION 4
RECOMMENDATIONS

Introduction

Section 4 presents recommendations based on the analysis and findings of Section 3. Recommendations for improvements to wells, improvements to the irrigation system, and opportunities for further planning and study are provided.

Improvements Completed Since 2005

The City of Pasco has completed irrigation system improvements that were recommended as part of its 2005 I-182 Corridor Irrigation System Plan (2005 Plan). Table 4-1 shows a summary of the improvements recommended in the 2005 Plan that have since been completed.

Table 4-1
Irrigation System Improvements Completed Since 2005

Improvement Number from 2005 Plan	Project Description
IW-1	Construction of the First Place Well
IW-2	Existing Well Rehabilitation
IW-3	Existing Well Rehabilitation
IW-4	Future Well Rehabilitation
IW-5	Future Well Rehabilitation
IW-6	Future Well Rehabilitation
IS-1	Conversion of Road 68 Standpipe from domestic system to irrigation system
IB-1	Construction of the Harris Road Booster Pump Station (currently under construction)
IR 1.1	16-inch diameter irrigation main from Court Street to Harris Road Booster Pump Station (currently under construction)
IR 1.2	16-inch diameter main along Harris Road from Harris Road Booster Pump Station to Broadmoor Boulevard (currently under construction)
IR 1.3	16-inch diameter main from Broadmoor Boulevard to Sandifur Parkway
IR 1.5	Construction of 10-inch diameter PVC main from I-182 Well to system
IR 1.7	16-inch diameter irrigation main along Road 52 from Leopard Drive (Powerline Road) to Sandifur Parkway

In addition to these improvements as described by the 2005 Plan, the City has completed the construction of two additional new irrigation wells. Construction of improvement IR 1.4 is

no longer necessary because the City constructed an irrigation main along Sandifur Parkway to the tie-in point proposed by improvement IR 1.4. The main along Sandifur Parkway accomplishes the same hydraulic task as the main which had been proposed by IR 1.4.

The City is currently completing design for a project proposing construction of a new river intake near the City's existing river intake station. The new intake would be used exclusively for drinking water and the old intake would be converted to irrigation use.

Distribution System Improvements

Recommended improvements to the distribution system include irrigation main extensions, replacement of undersized mains, looping improvements, isolation valve installation, and other minor improvements. Each is discussed below.

Irrigation Main Improvements

Irrigation main improvements include replacing undersized pipes to reduce head loss, extending existing mains, and looping mains to improve connectivity and reliability of the system. Recommended irrigation main projects are:

- Extend arterial main on Powerline Road west to Road 90
- Extend arterial main on Powerline Road east to Road 52
- Extend arterial main on Sandifur Parkway east and south along Road 44 to tie in at Burden Boulevard
- Extend distribution mains on Sahara Drive west to Road 44
- Replace small-diameter pipes on Sirocco Drive near Sirocco Well discharge with larger pipes
- Extend existing main on Wrigley Drive from North Road 68 to Convention Drive. Completing this improvement requires right of way or easement acquisitions.

Approximately 22,000 linear feet of new irrigation main are recommended for construction. The total estimated project cost for these improvement is approximately $2.77 million. An itemized tabulation of irrigation main projects and their associated costs is included later in this section.

Interstate Highway 182 Crossing Isolation Valve Improvements

It is possible to make complete shutdown of the Interstate Highway 182 crossing less frequent by installing isolation valves in the system nearby. This would allow operations staff to shut off portions of the line along Quadra Drive instead of the main crossing in order to make repairs. Repairs on the main crossing would still require the crossing to be shut down.

Based on a review of available information, it is recommended that the City install two 12-inch diameter isolation valves near the highway crossing. For budgeting purposes, a project cost of $5,000 per valve has been allowed for a total project cost of $10,000. It is recommended that the installation of the valves be done between October 31 and April 1 when the irrigation system is not in use.

Island Estates and Sunny Meadows Distribution Isolation Valve Improvements

The Island Estates and Sunny Meadows subdivisions have irrigation systems that were installed in easements that run through the rear of residential lots. When one of these older mains breaks, City operations staff have difficulty getting access to residents' back yards to make repairs. Where possible, it is recommended that isolation valves be installed so that mains can be turned off from public right-of-way while repairs are made. It is recommended that the installation of the valves be done between October 31 and April 1 when the irrigation system is not in use.

It is recommended that an estimated preliminary budget of $156,000 be provided to complete these improvements. This estimated budget is based on the installation of up to 52 valves at $3,000 per installation. The number of proposed isolation valves recommended is based on a review of the City's GIS data. It is further recommended that City staff identify final locations of the isolation valve improvements and confirm the final budget for this work.

Northwest Commons Well and Pivot

The Northwest Commons Well is currently plumbed to serve the nearby irrigation pivot and the City's irrigation system. It is recommended that the City install piping and valves near the well that allow the irrigation pivot to be supplied from the system instead of just the well. This new connection should be metered. The direct connection from the well to the pivot should be abandoned. This will allow the City to use the Northwest Commons well on its own schedule and allow the pivot owner to operate the pivot without operating the well. The estimated project cost for this recommendation is approximately $68,000.

Telemetry Improvements

Based on discussions with City staff, it is recommended that the City upgrade communication capacity along Powerline Road with the installation of a fiber optic line. The fiber optic line would serve as a more reliable means of communication from the central telemetry unit to the Powerline Well, Road 52 Well, and Northwest Commons Well. Having two ways to communicate to the wells makes the system more reliable as well. The estimated project cost for this recommendation is approximately $35,000.

Source and Storage Improvements

Recommendations for storage and irrigation well improvements are discussed below.

Storage

The storage analysis presented in Section 3 found that the existing irrigation system reservoir has adequate storage capacity for the future conditions described if the reservoir is operated at a higher water level. It is also recommended that existing new water level sensing equipment be repaired or replaced to obtain more accurate water level readings. The estimated project cost for this recommendation is $10,000.

Irrigation Well Improvements

The results of the analysis presented in Section 3 were used to develop recommendations on irrigation well assessment, rehabilitation, replacement, and monitoring. A discussion of these recommendations is presented below.

Well Assessment and Rehabilitation Plan

The analysis presented in Section 3 was used to develop a well assessment and rehabilitation plan. The plan prioritizes candidate wells for further assessment and potential rehabilitation for the purposes of optimizing individual well performance and maintaining the value of the City's irrigation assets. This plan is developed to ensure that this asset remains in service for the long term at minimal operating costs.

The main objective for rehabilitating a well is to restore or prevent losses in both production capacity and well efficiency. Conditions routinely found to contribute to declining well performance include incrustation, biofouling, physical plugging of formation or screen or both, and corrosion. These conditions could be caused by inherent characteristics of the aquifer, well design and construction, water quality, well operations, or combinations thereof. Rehabilitation techniques used to address these conditions in attempts to restore or recondition wells include:

- Mechanical methods such as brushing, surging, and airlift pumping to loosen and remove incrustation, organic material, and accumulated sediment
- Chemical treatments designed to dissolve and weaken encrusting minerals and biological slimes
- Impulse generation methods (e.g., Hydropuls®) that generate high-pressure pulses that loosen mineral and biological deposits in the well and adjacent formation. This technology is typically used in combination with other mechanical and/or chemical methods to increase its effectiveness

A combination of mechanical, chemical, and impulse generation well rehabilitation methods are recommended for the following wells:

- Desert Sunset
- Sirocco

- Northwest Commons
- Island Estates
- I-182
- Powerline Road

The recommended order of activities is as follows:

1. Conduct a one-hour specific capacity test to establish baseline conditions pre-rehabilitation and collect a groundwater quality sample for inorganic chemistry and bacterial assessment.
2. Remove pumping equipment and install rehabilitation equipment.
3. Brush and surge well to loosen buildup and airlift pump to remove debris.
4. Tremie dissolved chemical solution into the water column and agitate by surging to penetrate the formation and enhance the effectiveness of the treatment.
5. Apply impulse generation technology.
6. Remove the loosened debris by airlift pumping.
7. Conduct a video survey of the well, disinfect the well, and reinstall pumping equipment.
8. Conduct a one-hour specific capacity test to evaluate the effectiveness of the rehabilitation and assess the post-rehabilitation well performance.

A combination of mechanical and chemical methods is recommended for the First Place and Desert Estate Wells to address the minor mineral and biological deposits observed. Activities to be performed would be those identified above, excluding the impulse generation efforts.

Based on the information provided and relatively newer construction, the apparent conditions of the Road 52 and Linda Loviisa Wells are considered good and no rehabilitation efforts are recommended at this time. It is recommended that well video surveys be completed at these wells to verify existing conditions and monitoring each well's yield and drawdown. This work will establish baseline performance conditions and monitor for potential performance declines over time.

It is recommended that no rehabilitation work be completed for the Village at Pasco Heights Well due to its age and poor condition. Based on an evaluation of the well rehabilitation is not likely to adequately address the significant incrustation, poor casing condition, and sanding conditions at this well. The recommended rehabilitation activities for each well are summarized in Table 4-2.

Well Data Acquisition

Section 3 identified gaps in the available information concerning the City's existing irrigation water supply wells. A list of recommendations to fill those data gaps was developed and is presented in this section. Table 4-3 shows a summary of the proposed data acquisition

activities. It is assumed that the City has the resources necessary to complete the recommended activities, so a project cost was not developed for this work.

Table 4-2
Recommended Well Rehabilitation and Performance Testing Activity Summary

Well	Rehabilitation and Performance Testing Activities				
	Mechanical	Chemical	Impulse Generation	Pre- and Post-Performance Testing	Video Survey
Desert Sunset	X	X	X	X	X
Sirocco	X	X	X	X	X
NW Commons	X	X	X	X	X
Island Estates	X	X	X	X	X
I-182	X	X	X	X	X
Powerline Rd.	X	X	X	X	X
First Place	X	X		X	X
Desert Estates	X	X		X	X
Road 52				X	X
Linda Loviisa				X	X
Village at Pasco Heights					

Table 4-3
Irrigation Well Data Acquisition Recommendations Summary

Well	Recommended Data Acquisition Activities
Northwest Commons	Conduct a specific capacity test to confirm yield and reassess whether the yield can be increased at this well.
I-182	Establish the pump intake depth setting. This can be done in conjunction with rehabilitation activities. Assess available drawdown and evaluate the ability to increase yield at this well.
Island Estates	Conduct a specific capacity test. This test can be done in conjunction with rehabilitation activities. Assess whether the yield can be increased at this well.
Linda Loviisa	A well field study should be performed to determine the optimal sizes and locations of new wells in the Linda Loviisa area. More information is presented below.

Village of Pasco Heights Well Replacement

It is recommended that a new well be drilled to replace the existing Village of Pasco Heights Well. To confirm the timing and need for this improvement, it is recommended that the well's yield and drawdown be monitored to assess changes in its performance over time and

plan for replacement. The estimated project cost for a replacement well is approximately $173,000. A detailed cost summary is provided in Appendix D.

Construction of New Irrigation Wells

Based on the assessment presented in Section 3, up to six new wells could be necessary. These new irrigation wells would be a mixture of wells meant to replace some of the City's existing irrigation wells and wells improve the City's irrigation system capacity. For budgeting purposes, a project cost of approximately $616,000 per well has been developed. A detailed cost summary is available in Appendix D.

The number of new irrigation wells that will be necessary will not be known until a well field study and data acquisition have been completed. The capital improvements program presented in this section assumes that all six wells will be necessary.

Well Houses

It is recommended that the City continue to improve its wells by enclosing them within well houses. Enclosures minimize potential damage to equipment from exposure and reduce noise levels. Well houses also improve the security of the well and add aesthetic value to the vicinity. The estimated project cost for this improvement is approximately $65,000 per well house.

Well Performance Monitoring Program

It is recommended that the City implement a monitoring program at all existing wells to track well performance and plan for periodic well maintenance, rehabilitation, and potential replacement. The recommended monitoring plan consists of bi-annual measurements of specific capacity from each well. The specific capacity measurements should be made prior to system start-up in the spring and following system shut-down in the fall. The process is described below:

- Measure the static water level from a common measuring point during a period when the well has been idle.
- Measure the pumping water level from the same measuring point after 30 and 60 minutes of pumping.
- Maintain a constant pumping rate and record the flow rate at 30 and 60 minutes of pumping.
- Calculate the specific capacity for each well. The specific capacity is the pumping rate divided by the amount of drawdown. Drawdown is calculated by subtracting the static water level from the pumping water level.

The specific capacity measurements for each well should then be monitored over time to evaluate the need for maintenance and rehabilitation. Water levels should also be recorded

during periods when the well has been idle to assess whether apparent changes in specific capacity are actually related to well performance or groundwater level declines in the aquifer.

Dry Systems

It is recommended that the City begin using its existing dry systems. According to predictions based on hydraulic modeling, the City's existing irrigation system has the hydraulic capacity to support the new systems. This operational change does not have any associated capital cost as long as no new pipe is required to connect the dry systems to the existing system.

Recommendations for Further Study and Planning

During the course of this study, opportunities for further study that could improve planning efforts for the City's irrigation system were identified. This section presents those findings.

Well Field Study

It is recommended that a well field study be completed in order to determine the optimal locations and sizes of new irrigation wells in the Linda Loviisa area. These wells will increase the irrigation system capacity. A budget of $24,000 is recommended for this work.

Freshwater Mussels

It is recommended that the City conduct further investigation on the nature of the freshwater mussel infestation in the western portion of the system near the Road 108 Pump Station. Depending on the type of mussel, there may be federal or state regulations regarding acceptable ways to clear the pipes. The mussels should be identified and the extent of the infestation determined via television inspection or some other means. In the meantime, it is recommended that the City decrease pressure at the Road 108 Pump Station or limit its use. This may limit or halt the spread of the freshwater mussel colonization. A budget of $25,000 is recommended for this work.

Rate Structure Study

The City currently charges a flat rate to residential customers. Large customers are billed by irrigated acre. Some of its larger customers are served and billed according to undocumented verbal agreements. Industry experience has shown that the use of water under this rate structure is relatively uncontrolled. It is recommended that the City undertake a rate study and a financial review. The results of this work will assist the City in developing rates that ensure that the current level of service is maintained and that funds are available for capital projects and system growth. A budget of $25,000 is recommended for this work.

Irrigation System Master Plan Update

As the City's irrigation system grows and additional water rights are acquired, the City should re-evaluate its capital improvements plan and check on the performance of the hydraulic system. This plan should be updated every five years or sooner to reflect major system expansions or changes as well as any significant changes in water rights. As part of this study it is recommended that the skeletonized hydraulic model be further developed to include all system piping. A budget of $30,000 is recommended for this work.

Project Cost Estimates

Project cost estimates were developed for all recommended irrigation system improvements. The project cost estimates include construction cost with a 10 percent contingency, sales tax, and a 35 percent allowance for administration, engineering, and legal services. The cost estimates developed are commensurate with a Class 4 cost estimate as defined by the American Association of Cost Engineers. The actual cost can vary from 30 percent under to 50 percent over the estimated cost. Appendix D includes data and detailed breakdowns of the project costs for the recommended system improvements.

Since construction costs change periodically, an indexing method to adjust present estimates in the future is useful. The Engineering News Record (ENR) Construction Cost Index (CCI) is a commonly used index for this purpose. For purposes of future cost estimate updating, the September 2013 ENR CCI for Seattle, Washington is 10147.96.

Summary

This section presented recommendations for capital improvements to the irrigation system and maintenance programs. These recommendations were based on analysis of the system as presented in Section 3. Tables 4-4 and 4-5 include tabulated summaries of all recommended improvements and their associated estimated project costs. The recommendations are separated into near-term improvements and long-term improvements. Near-term improvements are those which should be completed within the next one to five years. Long-term improvements should be completed in six to twenty years. Figure 4-1 shows the City's irrigation system with recommended improvements highlighted and the dry systems operational.

Table 4-4
Near-Term Capital Improvement Program Summary

Group	ID	Project Location or Name	Project Limits	Project Description	Estimated Project Cost
Distribution System Improvements	IR.2	Powerline Road	Road 56 to Road 52	Extend existing 16-inch diameter main east to Road 52. The new main may be built in right of way that is being platted as part of the construction of a new elementary school at the intersection.	$186,000
	IR.4	Sahara Drive	West along Sahara Drive from end of existing mains to Road 44	Extend two 4-inch diameter distribution mains on Sahara Drive west to the existing 12-inch diameter main on Road 44. This improvement provides a redundant connection to the rest of the system if the connection at Burden Boulevard is out of service for any reason.	$46,000
	IR.5	Sirocco Drive	Sahara Drive to Saguaro Drive	Install approximately 1,200 linear feet of new 6-inch diameter distribution piping near the discharge of the Sirocco Well. The new pipes should be installed in public right of way. The existing pipes should be abandoned to eliminate pipe crossings in the rear of private lots.	$90,000
	D.2	Isolation Valve Improvements Phase 1	Island Estates and Sunny Meadows Subdivisions	Installation of up to 52 isolation valves in public right of way will reduce the need for City staff to access back yards during maintenance and repairs and allow more customers to stay online during emergencies.	$156,000
	D.3	Isolation Valve Improvements Phase 2	Interstate Highway 182 Crossing	Installation of two isolation valves in the vicinity of the crossing may help to prevent complete shutdown of the crossing during maintenance and repair activities.	$10,000
	D.4	Northwest Commons Pivot Improvements	Northwest Commons Subdivision	This improvement would tie the Northwest Commons irrigation pivot directly to the irrigation system and meter the pivot at the point of withdrawal. This will allow the City to operate the Northwest Commons Well independently of the pivot. Proposed pipe is 8 inches in diameter.	$30,000[1]
Dry Systems	DS	Activate Dry Systems	-	This improvement is an operational improvement that consists of activating the portions of the City's irrigation system which are currently not in use.[2]	-

Table 4-4
Near-Term Capital Improvement Program Summary (continued)

Group	ID	Project Location or Name	Project Limits	Project Description	Estimated Project Cost
Source and Storage Improvements	S.1	Road 68 Irrigation Tank Improvements	-	This improvement proposes to change the maximum water level in the Road 68 Irrigation Tank from 639 to 641.5. It is an operational change and requires no capital investment. This project also includes inspection and repair or replace level sensing equipment inside the Road 68 Irrigation Tank.	$10,000
	S.2	Irrigation Well Rehabilitation Program	-	Rehabilitation and data acquisition on all wells except Village at Pasco Heights Well.[3]	$220,000
Planning and Studies	P.1	Freshwater Mussel Study	-	Conduct a study to determine the most effective way to address freshwater mussel colonization of distribution piping exposed to Columbia River Water.	$25,000
	P.2	Linda Loviisa Well Field Study	-	Conduct a well field study in order to determine the optimal locations and sizes of new irrigation wells in the Linda Loviisa area.	$24,000
	P.3	Data Acquisition on Existing Wells	-	This recommendation consists of gathering data consistent with Table 4-3 above. The City has resources to accomplish this project so there is no project cost.	-
				Total Budget Recommended for all Near-Term Capital Improvements	**$797,000**

Notes

1. For cost estimating purposes, 200 linear feet of 6-inch diameter PVC was assumed and $15,000 was added for installation of a new meter and valves.
2. See Figure 2-1 for the location of the City's existing dry systems.
3. See text for detailed description of rehabilitation activities and wells involved.

Table 4-5
Long-Term Capital Improvement Program Summary

Group	ID	Project Location or Name	Project Limits	Project Description	Estimated Project Cost
Distribution System Improvements	IR.1	Powerline Road	Road 90 to Convention Drive	Extend existing 16-inch diameter main west to Road 90 to improve flow and eliminate dead ends.	$1,000,000
	IR.3	Sandifur Parkway and Road 44	Porto Lane to Burden Boulevard	Extend existing dead-end 8-inch diameter main on Sandifur Parkway near Porto Lane along east side of Road 44 south to Burden Boulevard. Connect all dead-end distribution mains along Road 44 to the new main.	$325,000
	IR.6	Wrigley Drive	Road 68 east to Convention Drive	Installation of a 12-inch diameter main between existing distribution mains on Road 68 and Convention Drive. This improvement requires additional right-of-way.	$212,500
	D.1	600 Zone PRV Supply	600 Zone	This improvement proposes installation of a redundant 12-inch diameter source of supply to the 600 Zone. The ultimate size and routing of the pipe and source zone would be chosen by the City at a later time once right of way, easements, or land can be acquired between the two zones.	$915,000[1]
Telemetry Improvements	T.1	Road 52 Telemetry Improvements	Road 52	This improvement proposes installation of a signal converting station to improve communications from the central telemetry system to the Powerline Road Well, Road 52 Well, and Northwest Commons Well.	$35,000
Source Improvements	S.3	Village at Pasco Heights Well Replacement	Village at Pasco Heights	Construction of a new well at Village of Pasco Heights. This project assumes that the existing pump and motor will be reused.	$173,000
	S.4	Well Houses	-	Construction of well houses to enclose existing wells and associated equipment. It is assumed that a total of seven well houses will be built at a project cost of $65,000 per well house.	$455,000

Table 4-5
Long-Term Capital Improvement Program Summary (continued)

Group	ID	Project Location or Name	Project Limits	Project Description	Estimated Project Cost
Source Improvements	S.5	Construction of New Irrigation Wells	-	Up to six new irrigation wells could be necessary to improve the irrigation system capacity. For budgeting purposes, a project cost of $616,000 per well has been assumed.[2]	$3,696,000[3]
Planning and Studies	P.4	Rate Study	-	Conduct a rate study to see if irrigation system rates are adequate. The rate study will be informed by the selection of a capital improvements program.	$25,000
	P.5	Irrigation System Master Plan Update	-	Update of this irrigation system master plan following major changes to the irrigation system or after five years, whichever occurs first.	$30,000
Total Budget Recommended for all Long-Term Capital Improvements					**$6,867,000**

Notes

1. For cost estimating purposes, 6,500 linear feet of 12-inch diameter PVC was assumed and $100,000 was added for a pressure-reducing station.
2. The location of new wells will depend on data acquisition and the Linda Loviisa well field study.
3. The project cost is $616,000 per new irrigation well. With a total of six wells, the total project cost is $3.70 million. It is possible that fewer than six new wells will be necessary.

Figure 4-1

City of Pasco
Irrigation System Master Plan

PROPOSED IRRIGATION SYSTEM IMPROVEMENTS

December 2013

Murray, Smith & Associates, Inc.
Engineers/Planners
Tacoma, Washington

13-1444.407

LEGEND

- 16" Proposed Irrigation Main (Proposed Diameter Indicated in Inches)
- Existing Storage Tank
- PS Existing Booster Pump Station (BPS)
- W Existing Irrigation Well
- Existing Pressure Reducing Valve (PRV)
- 16" Existing Irrigation Main (Diameter Indicated in Inches)
- County Line
- Franklin County Irrigation District (FCID) Irrigation Service Area
- Pasco City Limits
- Urban Growth Area Boundary

Pressure Zones:

- River Intake Zone
- 547 Zone
- 560 Zone
- 594 Zone
- 600 Zone
- 639 Zone

IR1
16"
639 ZONE
IR2
16"
POWERLINE WELL S2
ROAD 52 WELL
NORTHWEST COMMONS WELL S2
T1
D4
IR3
DESERT SUNSET WELL S2
DESERT ESTATES WELL
PRV
594 ZONE
PRV
D3
NEW ISOLATION VALVE
HARRIS ROAD BPS
CAP: 3,125 GPM
RIVER INTAKE ZONE
RIVER INTAKE STATION
CAP: 3,000 GPM
ROAD 108 BPS
CAP: 3,000 GPM
PRV
560 ZONE
PRV
ROAD 68 IRRIGATION TANK
CAP: 2.28 MG
OE: 639 FT
S1
IR6
12"
D2
ISLAND ESTATES WELL S2
VILLAGE AT PASCO HEIGHTS WELL S3
IR5
IR4
SIRROCO WELL S2
LINDA LOVIISA WELL
600 ZONE
PRV
NEW ISOLATION VALVE
I-182 WELL S2
547 ZONE
FIRST PLACE WELL
PRV
PRV
Columbia River
CITY OF PASCO
WEST PASCO
FRANKLIN COUNTY
BENTON COUNTY
N
1,000 0 1,000
SCALE IN FEET

SOURCE:
Base Mapping - Franklin County GIS (June 2013) and Benton County GIS (June 2013).
Irrigation System Mapping - City of Pasco (April 2013).

G:\PDX_Projects\13\1444\CAD\GIS\FIGURES\13-1444-407-WA-FIGURE 4-1.mxd 12/3/2013 8:56:25 AM DKH

APPENDIX A
WATER QUALITY DATA

Appendix A includes water quality information for the water supplied by the City's irrigation system wells. Available water quality data is attached on the following pages.

System Review

ID #:	664003	Type:	A-COMM
System Name:	Pasco Water Department		
County:	Franklin	Permit Color:	Yellow

Services

Residential:	6606	Res. Population:	24746
Total:	6606	Approved:	

Coliform Summary

	First 12 Months												Second 12 Months											
Year	02	02	02	01	01	01	01	01	01	01	01	01	01	01	01	00	00	00	00	00	00	00	00	00
Month	Mar	Feb	Jan	Dec	Nov	Oct	Sep	Aug	Jul	Jun	May	Apr	Mar	Feb	Jan	Dec	Nov	Oct	Sep	Aug	Jul	Jun	May	Apr
Required Samples	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Routines Taken	32	40	39	39	38	37	38	40	37	38	39	30	29	31	31	34	32	31	31	32	31	33	32	32
Present Routines																								
Present Fecal/E Coli																								
Required Repeats																								
Repeats Taken																								

Water Quality Violations

Violation Date	Parameter Group	#	Name	M S	Violation Type
04/ 30/ 92	COLI	1	Total Coliform	M	Minor Repeat
10/ 31/ 91	COLI	1	Total Coliform	S	Non-Acute

Lead and Copper Monitoring Summary

Monitoring Period Start	to End	Lead 90th	Lead High	Copper 90th	Copper High	Samples Act	Samples Req
07/ 1992	12/ 1992	0.0070	0.0550	0.2300	0.7020	70	60
01/ 1993	06/ 1993	0.0040	0.0140	0.4500	0.8280	60	60
07/ 1993	12/ 1993	0.0040	0.0080	0.4000	0.6700	36	30
01/ 1994	06/ 1994	0.0090	0.0190	0.3420	0.4100	32	30
07/ 1994	12/ 1994	0.0030	0.0050	0.2370	0.8700	32	30
01/ 1995	12/ 1995	0.0070	0.0140	0.5570	0.7750	44	30
01/ 1996	12/ 1998	0.0020	0.0020	0.1810	0.2440	30	30

Volatile Organic Chemical Samples

Sample #	Collected	Type	S0#	Detects	No D	Not A
046-11531	12/ 12/ 01	THM	92	3	2	1
EPA	DOH	Parameter			Measurement	
2941	27	Chloroform			20.1000	
2943	28	Bromo-Dichloromethane			3.1000	
2950	31	Total Tri-Halomethane			23.2000	
046-08765	09/ 24/ 01	THM	92	3	2	1
EPA	DOH	Parameter			Measurement	
2941	27	Chloroform			27.5000	
2943	28	Bromo-Dichloromethane			3.3000	
2950	31	Total Tri-Halomethane			31.0000	
046-05160	06/ 13/ 01	THM	92	4	1	1
EPA	DOH	Parameter			Measurement	
2941	27	Chloroform			38.7000	
2943	28	Bromo-Dichloromethane			5.3000	
2944	29	Dibromo-Cholormethane			0.5000	
2950	31	Total Tri-Halomethane			44.5000	
046-02032	03/ 14/ 01	THM	92	3	2	1
EPA	DOH	Parameter			Measurement	
2941	27	Chloroform			20.7000	
2943	28	Bromo-Dichloromethane			1.9000	
2950	31	Total Tri-Halomethane			22.6000	
046-11010	12/ 12/ 00	THM	92	3	2	1
046-08242	09/ 20/ 00	THM	92	3	2	1
046-04569	06/ 07/ 00	THM	92	3	2	1

Inactive Sources

S02	Name			Type	Use
	Well #1 A & B			W	E
gpm	Depth	T: N	R: E	Section	¼ - ¼
200	180	9	29	18	NE - NW
Treated:	Disinfection, Chlorination, Hypochlorite				

Inorganic Chemical Samples

Sample #	Collected	Type	S0#	Detects	No D	Not A
062-00466	08/ 20/ 93	Ichem	02	1		
EPA	DOH	Parameter			Measurement	
1040	20	Nitrate-N			3.900	

S05	Name			Type	Use
	Dradie ST Well #4			W	E
gpm	Depth	T: N	R: E	Section	¼ - ¼
350	130	9	29	22	NE - NE

Inorganic Chemical Samples

Sample #	Collected	Type	S0#	Detects	No D	Not A
062-00571	08/ 30/ 94	NIT	05	1		
EPA	DOH	Parameter			Measurement	
1040	20	Nitrate-N			16.40	
062-00343	05/ 25/ 94	NIT	05	1		
EPA	DOH	Parameter			Measurement	
1040	20	Nitrate-N			17.40	
062-00123	02/ 16/ 94	NIT	05	1		
EPA	DOH	Parameter			Measurement	
1040	20	Nitrate-N			17.30	
062-00858	11/ 30/ 93	Ichem	05	1		
051-14434	04/ 06/ 93	Ichem	05	22		

Synthetic Organic Chemical Samples

Sample #	Collected	Type	S0#	Detects	No D	Not A
095-12212	12/ 18/ 95	547	05		1	
095-12212	12/ 18/ 95	549	05		1	1

Radionuclide Samples

Sample #	Collected	Type	S0#	Detects	No D	Not A
101-04030	04/ 05/ 93	RAD	05	3		
EPA	DOH	Parameter			Measurement	
4020	39	Radium 226		LT	1.000	
4000	41	Gross Alpha (Minus Uranium)			5.900	
4100	42	Gross Beta		LT	10.00	

Permanent Sources

S01	Name			Type	Use
	Columbia River			S	P
gpm	Depth	T: N	R: E	Section	¼ - ¼
18000	0	9	30	3	SW - NE
Susceptibility		Vulnerability		Renewed	

Treated:	Taste / Odor Control & Dechlorination:	Permanganate
	Particulate:	Filtration, Rapid Sand
	(Turbidity):	Rapid Mix / In-Line Blender Sedimentation Coagulation
	Removal:	Flocculation
	Disinfection:	Chlorination, Gaseous Chlorination, Hypochlorite
	Corrosion Control:	Ph Adjustment

Inorganic Chemical Samples

Sample #	Collected	Type	S0#	Detects	No D	Not A
046-05158	06/ 13/ 01	IOC	01	9	19	15

EPA	DOH	Parameter	Measurement
1025	19	Fluoride	0.770
1041	114	Nitrite-N	ND
1040	**20**	**Nitrate-N**	0.590
1038	161	Total (NO3 / NO3-)	0.590
1028	8	Iron	ND
1032	10	Manganese	ND
1915	15	Hardness	68.90
1064	16	Conductivity	177.0
0100	17	Turbidity	0.200
1905	18	Color	5.000
1057	26	TDS-Total Dissolved Solids	NA

Sample #	Collected	Type	S0#	Detects	No D	Not A
046-04567	06/ 07/ 00	IOC	01	5	23	15

EPA	DOH	Parameter	Measurement
1915	15	Hardness	58.40
1064	16	Conductivity	155.0
0100	17	Turbidity	0.200
1905	18	Color	ND
1025	19	Fluoride	ND
1040	**20**	**Nitrate-N**	**ND**
1055	22	Sulfate	18.60
1057	26	TDS-Total Dissolved Solids	NA
1041	114	Nitrite-N	ND

Sample #	Collected	Type	S0#	Detects	No D	Not A
119-95462	06/ 14/ 99	ASB	01	1		

EPA	DOH	Parameter	Measurement
1094	115	Asbestos	LT 0.098

Sample #	Collected	Type	S0#	Detects	No D	Not A
046-03457	05/ 04/ 99	IOC	01	5	23	15

EPA	DOH	Parameter	Measurement
1915	15	Hardness	73.90
1064	16	Conductivity	182.0
0100	17	Turbidity	0.200
1905	18	Color	ND
1025	19	Fluoride	ND
1040	**20**	**Nitrate-N**	**ND**
1055	22	Sulfate	19.60
1057	26	TDS-Total Dissolved Solids	NA

Sample #	Collected	Type	S0#	Detects	No D	Not A
046-01045	02/ 23/ 98	IOC	01	8	21	14
046-03304	07/ 01/ 97	IOC	01	7	21	15
062-00338	10/ 13/ 96	NIT	01	1		2
046-04111	10/ 01/ 96	IOC	01	7	21	15
111-99186	11/ 03/ 95	IOC	01	28		15

Volatile Organic Chemical Samples

Sample #	Collected	Type	S0#	Detects	No D	Not A
046-09521	10/ 15/ 01	524.2	01	3	56	4

EPA	DOH	Parameter	Measurement
2941	27	Chloroform	10.80
2943	28	Bromo-Dichloromethane	2.400
2950	31	Total Tri-Halomethane	13.20

Sample #	Collected	Type	S0#	Detects	No D	Not A
046-06214	07/ 12/ 01	524.2	01	3	56	4

EPA	DOH	Parameter	Measurement
2941	27	Chloroform	16.00
2943	28	Bromo-Dichloromethane	3.100
2950	31	Total Tri-Halomethane	19.40

Sample #	Collected	Type	S0#	Detects	No D	Not A
046-03230	04/ 18/ 01	524.2	01	3	56	4

EPA	DOH	Parameter	Measurement
2941	27	Chloroform	8.900
2943	28	Bromo-Dichloromethane	2.700
2950	31	Total Tri-Halomethane	12.00

Sample #	Collected	Type	S0#	Detects	No D	Not A
046-00623	01/ 23/ 01	524.2	01	3	56	4

EPA	DOH	Parameter	Measurement
2941	27	Chloroform	8.900
2943	28	Bromo-Dichloromethane	2.700
2944	29	Dibromo-Cholormethane	ND
2950	31	Total Tri-Halomethane	12.00

Sample #	Collected	Type	S0#	Detects	No D	Not A
046-09306	10/ 16/ 00	524.2	01	3	56	3
046-06003	07/ 19/ 00	524.2	01	3	56	3
046-03280	04/ 25/ 00	524.2	01	3	56	3
046-01549	02/ 29/ 00	524.2	01	3	56	3
046-03459	05/ 04/ 99	524.2	01	3	56	3
046-04812	07/ 08/ 98	THM	01	3	2	1
046-01064	02/ 23/ 98	524.2	01	3	56	2
046-00432	01/ 26/ 98	THM	01	3	2	1

Synthetic Organic Chemical Samples

Sample #	Collected	Type	S0#	Detects	No D	Not A
046-05161	06/ 13/ 01	515.1	01		14	3
046-04570	06/ 07/ 00	531.1	01		10	
046-04570	06/ 07/ 00	525.2	01		60	3
046-04570	06/ 07/ 00	515.1	01		14	3
046-03458	05/ 04/ 99	515.1	01		14	3
046-03458	05/ 04/ 99	525.2	01		60	3
046-03458	05/ 04/ 99	531.1	01		10	
046-01046	02/ 23/ 98	525.2	01		59	3
046-01046	02/ 23/ 98	515.1	01		14	3
046-01046	02/ 23/ 98	531.1	01		10	
046-03308	08/ 18/ 97	515.1	01		13	4
046-03308	07/ 01/ 97	525.2	01		21	41

Radionuclide Samples

Sample #	Collected	Type	S0#	Detects	No D	Not A
023-68311	04/ 18/ 01	RAD	01		3	7

EPA	DOH	Parameter	Measurement
4000	41	Gross Alpha (Minus Uranium)	ND
4100	42	Gross Beta	ND
4102	43	Tritium	ND

Sample #	Collected	Type	S0#	Detects	No D	Not A
023-67752	10/ 16/ 00	RAD	01		3	7

EPA	DOH	Parameter	Measurement
4000	41	Gross Alpha (Minus Uranium)	ND
4100	42	Gross Beta	ND
4102	43	Tritium	ND

Emergency Sources

S06	Name		Type	Use
	WP WF/ S07,S08, S09, S10		WF	E
gpm	Depth	T: N	R: E	Section	¼ - ¼
500	160	9	29	18	NE - NW
Treated:	Disinfection, Chlorination, Hypochlorite				

S03	Name		Type	Use
	WP - Well #2		WW	E
gpm	Depth	T: N	R: E	Section	¼ - ¼
1400	160	9	29	18	NE - NW

Inorganic Chemical Samples

Sample #	Collected	Type	S0#	Detects	No D	Not A
062-00160	04/ 15/ 93	Ichem	03	1		

EPA	DOH	Parameter	Measurement
1040	20	Nitrate-N	15.70

S04	Name		Type	Use
	WP - Well #3		WW	E
gpm	Depth	T: N	R: E	Section	¼ - ¼
300	200	9	29	18	NE - NW

S07	Name		Type	Use
	WP - Well 1A		WW	E
gpm	Depth	T: N	R: E	Section	¼ - ¼
100	180	9	29	18	NE – NW

S08	Name		Type	Use
	WP - Well 1B		WW	E
gpm	Depth	T: N	R: E	Section	¼ - ¼
108	179	9	29	18	NE – NW

Inorganic Chemical Samples

Sample #	Collected	Type	S0#	Detects	No D	Not A
062-00434	10/ 15/ 99	NIT	06	1		2

EPA	DOH	Parameter	Measurement
1040	20	Nitrate-N	3.300

046-06753	08/ 12/ 99	NIT	06	1		2

EPA	DOH	Parameter	Measurement
1040	20	Nitrate-N	4.200

062-00241	06/ 14/ 99	NIT	06	1		2

EPA	DOH	Parameter	Measurement
1040	20	Nitrate-N	6.100

062-00087	03/ 17/ 99	NIT	06	1		2

EPA	DOH	Parameter	Measurement
1040	20	Nitrate-N	5.900

046-03305	07/ 01/ 97	IOC	06	8	20	15

EPA	DOH	Parameter		Measurement
1915	15	Hardness		217.1
1064	16	Conductivity		542.0
0100	17	Turbidity		0.300
1905	18	Color	LT	5.000
1025	19	Fluoride	ND	
1040	20	Nitrate-N		4.800
1055	22	Sulfate		56.30
1057	26	TDS-Total Dissolved Solids	ND	

046-04088	09/ 30/ 96	NIT	06	1		2
062-00569	08/ 30/ 94	NIT	06	2		
062-00345	05/ 25/ 94	NIT	06	1		
062-00122	02/ 16/ 94	NIT	06	1		

Volatile Organic Chemical Samples

Sample #	Collected	Type	S0#	Detects	No D	Not A
046-03307	07/ 01/ 97	524.2	06	3	55	3

EPA	DOH	Parameter	Measurement
2943	28	Bromo-Dichloromethane	1.40
2944	29	Dibromo-Cholormethane	3.60
2942	32	Bromoform	2.90

111-96210	06/ 20/ 96	THM	06		5	1
111-99909	02/ 07/ 95	THM	06	2	3	1

EPA	DOH	Parameter	Measurement
2941	27	Chloroform	1.10
2950	31	Total Tri-Halomethane	1.10

Synthetic Organic Chemical Samples

Sample #	Collected	Type	S0#	Detects	No D	Not A
046-07733	10/ 28/ 98	504	06		3	
046-03309	07/ 01/ 97	515.1	06		13	4
046-03309	07/ 01/ 97	531.1	06		10	
046-03309	07/ 01/ 97	525.2	06		52	
046-03309	07/ 01/ 97	525.2E	06		2	

Radionuclide Samples

Sample #	Collected	Type	S0#	Detects	No D	Not A
101-04032	04/ 06/ 93	RAD	06	3		

EPA	DOH	Parameter		Measurement
4020	39	Radium 226	LT	1.00
4000	41	Gross Alpha (Minus Uranium)		5.30
4100	42	Gross Beta		8.60

101-04031	04/ 06/ 93	RAD	06	2		

EPA	DOH	Parameter		Measurement
4000	41	Gross Alpha (Minus Uranium)	LT	5.00
4100	42	Gross Beta	LT	5.00

HISTORICAL SAMPLING DATA ON CITY OWNED WELLS USED AS EMERGENCY SUPPLY ONLY. NO LONGER USED.

BILL 10/6/09

Center For Laboratory Sciences
RJ Lee Group, Inc.

2715 St. Andrews Lp Suite C
Pasco, WA 99301
(509)545-4989

LABORATORY REPORT

City of Pasco
P.O. Box 293
Pasco, WA 99301
Attn: Dean Cassinelli
Phone: (509) 545-3469
Fax: (509) 545-345

RJ Lee Group Job No.: WA060720050002
Samples Received: 7/6/2005
Report Date: 7/21/2005
Analysis/Prep Date
Client Project: N/A
Purchase Order No.:

Analysis:

Sample ID	Sample Collection	Analyte	Method/Matrix	Units	Result	Quantitation Limit
Sirrocco	7/6/2005	Nitrate - N	EPA 300.0 - WA	**mg/L**	**28**	0.03
WA060720050002-001			Non-Potable Water			
I-182	7/6/2005	Nitrate - N	EPA 300.0 - WA	**mg/L**	**28**	0.03
WA060720050002-002			Non-Potable Water			
Bihorn	7/6/2005	Nitrate - N	EPA 300.0 - WA	**mg/L**	**25**	0.03
WA060720050002-003			Non-Potable Water			
Iland Est	7/6/2005	Nitrate - N	EPA 300.0 - WA	**mg/L**	**22**	0.03
WA060720050002-004			Non-Potable Water			
Desert Sunset	7/6/2005	Nitrate - N	EPA 300.0 - WA	**mg/L**	**24**	0.03
WA060720050002-005			Non-Potable Water			

* All solid matricies reported on a dry weight basis unless otherwise noted.

Analyst Comments:

These results are submitted pursuant to RJ Lee Group's current terms and conditions of sale, including the company's standard warranty and limitation of liability provisions. No responsibility or liability is assumed for the manner in which the results are used or interpreted. Unless notified in writing to return the samples covered by this report, RJ Lee Group will store the samples for a period of thirty (30) days before discarding. A shipping and handling fee will be assessed for the return of any samples.

Authorized Signature

Richard A. Waterbury

ww.w.rjlg.com

Request for Services

Chain of Custody

RJ Lee *Group,* Inc. in partnersphip with Columbia Basin College

We Create Solutions

Located At
2715 St Andrews Lp. Ste. F
Pasco, WA 99301
Phone: (509) 545-4989
Fax: (509) 544-6010

Drinking Water Sample Only	For CLS Use Only
Sample Purpose: □ Information □ Regulatory	Samples were:
System ID#	1) Shipped □ hand-delivered □
DOH Source #	2) Temp Upon Receipt °C
Multiple Source's #'S	3) Acceptable □ Y □ Other
Group Type □ A □ B □ Other	4) pH checked by:
	5) Labels checked by:

Company: City PASCO Contact: 545-3469

Project Name: Project #: PO# Quote#

Address: P.O. Box 293

City: State: Zip:

Phone: ( ) Fax: ( ) E-mail:

Sampler(s) Signature

Report Delivery Instructions: E-mail Results? YES / NO Fax Results? YES / NO

Turn Around Request: Standard: Priority (busniess days):

Comments/Instructions:

Preservation/Matrix/Container type Key

Preservation Key:		Matrix Key:		Container Key:
Unpres	H2SO4	WW=Wastewater	SW=Surfacewater	P=Plastic
4'C	HCl	GW=Groudwater	DW=Drinkingwater	G=Glass
HNO3	NaOH	S=Soil/Sludge	O=Oil	
Other	NaSO	E=Extract	X=Other	

well water

Client Sample Identification	CLS Sample ID	Sample Date	Sample Time	Preservation	Matrix	Container Type	pH	# Containers	Pres. Upon Receipt (Y/N)	Analysis Requested: NITRATE
SiBRocco		7/6/5	0800	Ø				1		✓
I-182		7/6/5	0820	|				1		✓
BiHon		7/6/5	0850	|				1		✓
IIAND EST		7/6/5	0900	|				1		✓
Desert Sunset		7/6/5	0910	|				1		✓

Relinquished By (sampler): Fred Vanwall	Date: 7/6/5	Time: 951	Received By:	Date:	Time:
Relinquished By:	Date:	Time:	Received By:	Date:	Time:
Relinquished By:	Date:	Time:	Received By (CLS): Mauns	Date: 7/6/05	Time: 0953 am

APPENDIX B
2007 RESIDENTIAL WATER USE MEMORANDUM

Appendix B contains a memorandum completed in 2007 to study residential water use patterns and trends. The memorandum is attached on the following pages.

Residential Water Use Study

TO: Bob Alberts, Public Works Director
FROM: Tony Krutsch, Project Manager
CH2MHILL

DATE: August 3, 2007

INTRODUCTION

This *Residential Water Use Study* looks at residential water consumption at various locations throughout the City of Pasco. Approximately 360 residential housing units were included in the study representing 16 neighborhoods. Neighborhoods were selected to represent a cross section of older and newer construction, with both separate irrigation systems, and those lots dependent on the City domestic water system as the source of supply for irrigation.

This study represents an update of a *Water Usage Study* prepared by the City of Pasco in September 2001. In various locations throughout this technical memorandum, information from September 2001 *Water Usage Study* is quoted.

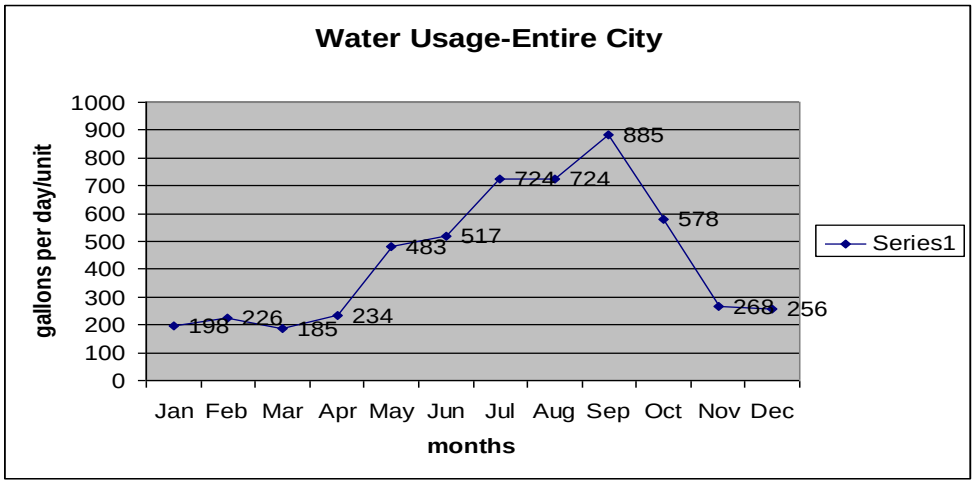
Water records for each residential lot selected for this study were obtained from the City of Pasco Finance Department for the period of January 2005 through June 2007. After the water records were obtained and entered into a spreadsheet, the records were purged to remove inconsistent data that could have affected the analysis and evaluation.

Unlike the September 2001 *Water Usage Study*, this evaluation is primarily based on the residential lot rather than population.

CITY WATER USAGE

Chart 1 identifies the average daily residential lot water usage for the 2-year evaluation period for all neighborhoods included in this evaluation.

Chart 1. Residential Lot Water Usage – gallons per day



The winter average daily residential lot water usage varies between older and newer neighborhoods. In older neighborhoods, winter usage averaged 237 gpd while in newer neighborhoods, winter usage averaged 155 gpd (average of 206 gpd for both older and newer neighborhoods).

For those neighborhoods using the City domestic water system for residential lot irrigation, average daily domestic water usage was calculated at 883 gpd per unit, and the summer average daily water usage was calculated at 1,473 gpd per unit. The older Desert Plateau neighborhood had the highest summer average daily water usage at 2,939 gpd per unit. Older neighborhoods in central and east Pasco averaged 1,107 gpd per unit for the summer monthly period.

Chart 2 identifies each of the 16 neighborhoods included in this evaluation and the average usage of City domestic water by neighborhood in ac-ft/month during the winter (Dec-Feb) and summer (June-Sept) periods.

Chart 2. Seasonal Lot Water Usage – Acre-feet

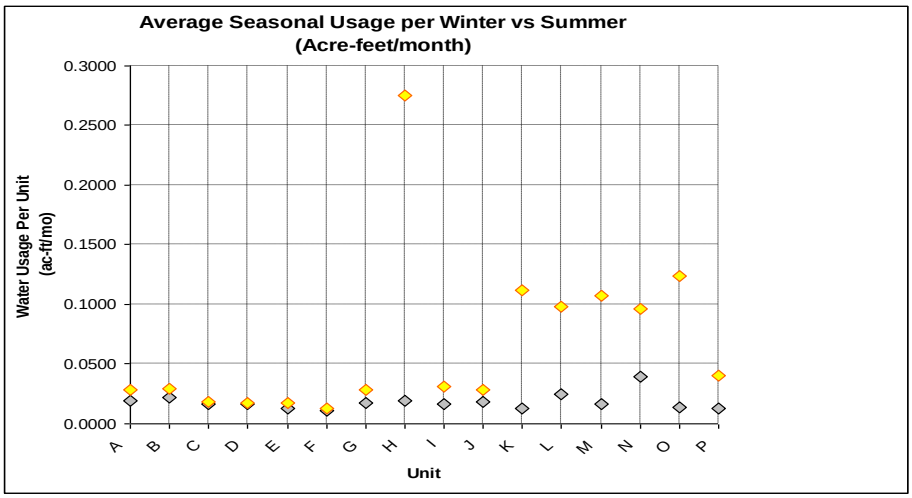
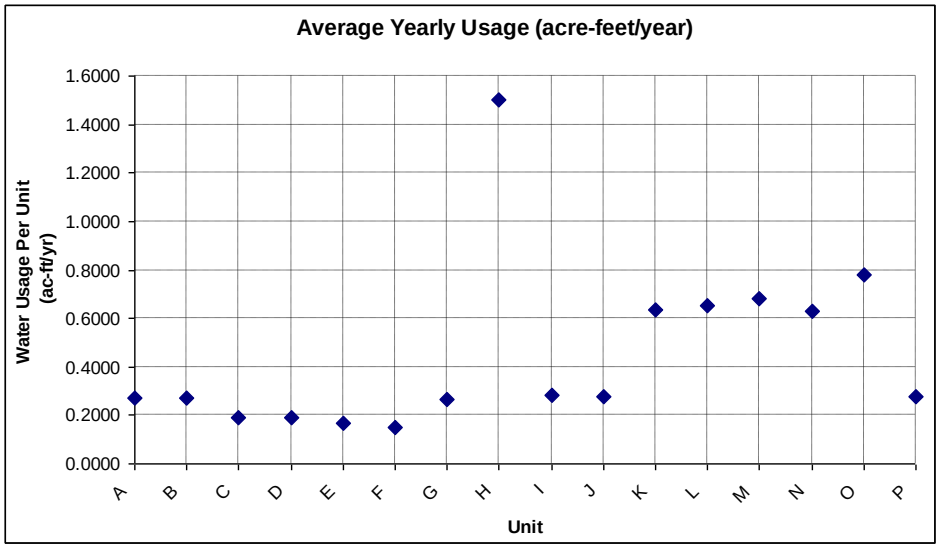


Chart 3 identifies each of the 16 neighborhoods and the total annual average usage of City domestic water by neighborhood in ac-ft/year.

Chart 3. Annual Lot Water Usage – Acre-feet



The average monthly domestic water consumption for all lots in the City was calculated at 0.0412 acre-ft per month and 0.4880 acre-ft per year. For those neighborhoods utilizing a separate irrigation system for irrigation, the average monthly domestic water consumption was calculated at 0.0191 acre-ft per month and 0.2249 acre-ft per year. In neighborhoods relying on the City domestic water supply system for irrigation, the average monthly domestic water consumption was calculated at 0.0729 acre-feet per month and 0.8264 acre-feet per year. The older Desert Plateau neighborhood has the highest monthly average and annual average usage of domestic water at 0.1540 acre-feet per month, and 1.7836 acre-feet per year respectfully. The central and east Pasco neighborhoods, which rely on the City domestic water supply system for irrigation had a monthly average domestic water consumption of 0.0644 acre-feet per month, and an annual water consumption of 0.7229 acre-feet per year.

Chart 4 provides a comparison of the 16 neighborhoods in terms of winter versus summer usage shown in gallons per day per unit.

Chart 4. Seasonal Lot Water Usage – gallons per day

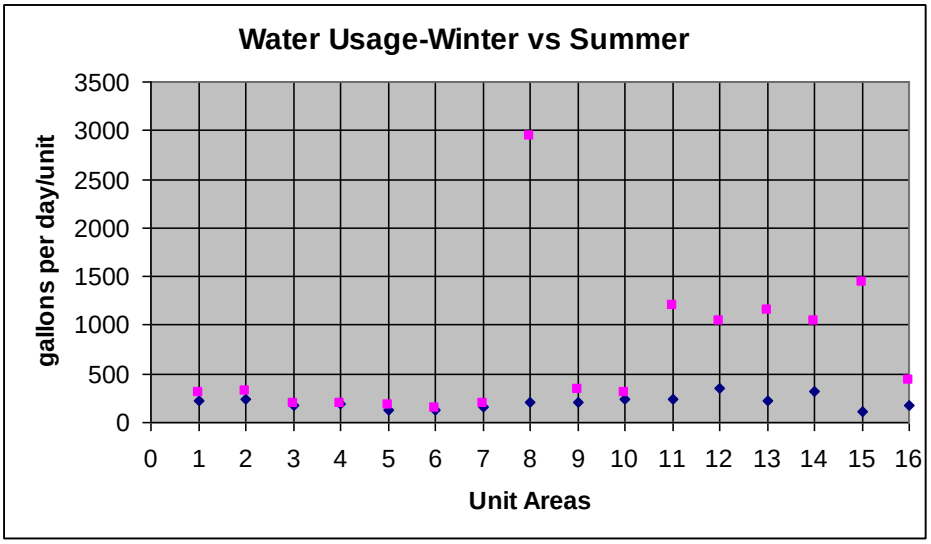


Chart 5 identifies the average daily water usage in terms of gallons per day per unit of the 16 neighborhoods for the entire City (1), those neighborhoods served by a separate irrigation system (2), and those neighborhoods relying on the City domestic water supply system for irrigation (3).

Chart 5. Annual Lot Water Usage for Entire City – gallons per day

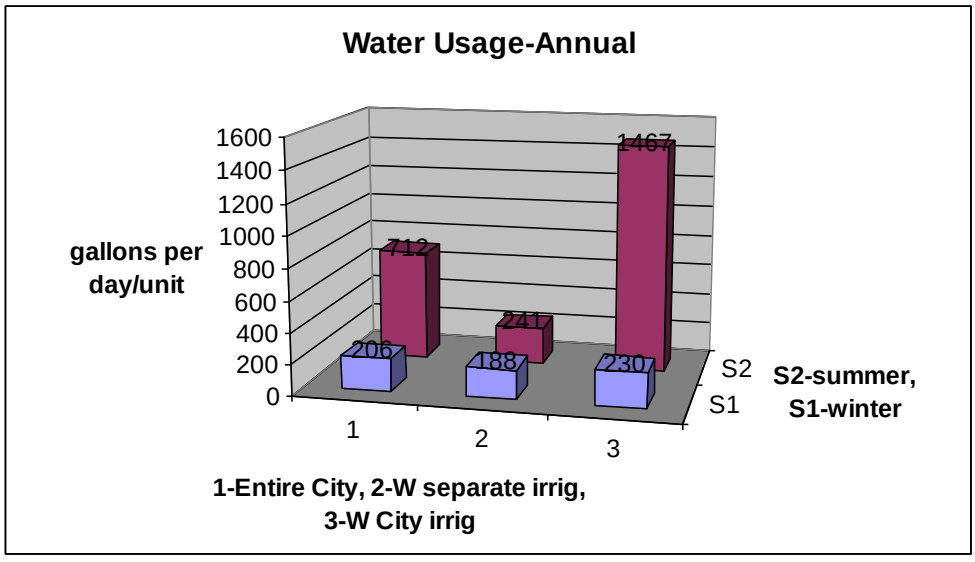


Chart 6 looks at the average daily water usage in terms of gallons per day per unit of all the older neighborhoods evaluated in this report (1), those older neighborhoods served by a separate irrigation system (2), and those older neighborhoods relying on the City domestic water supply system for irrigation (3).

Chart 6. Annual Lot Water Usage for Older Neighborhoods – gallons per day

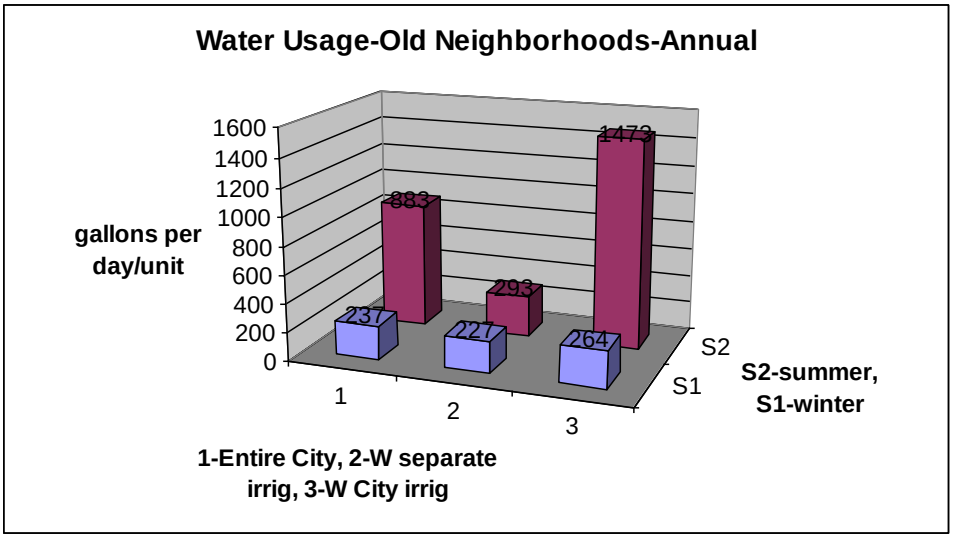
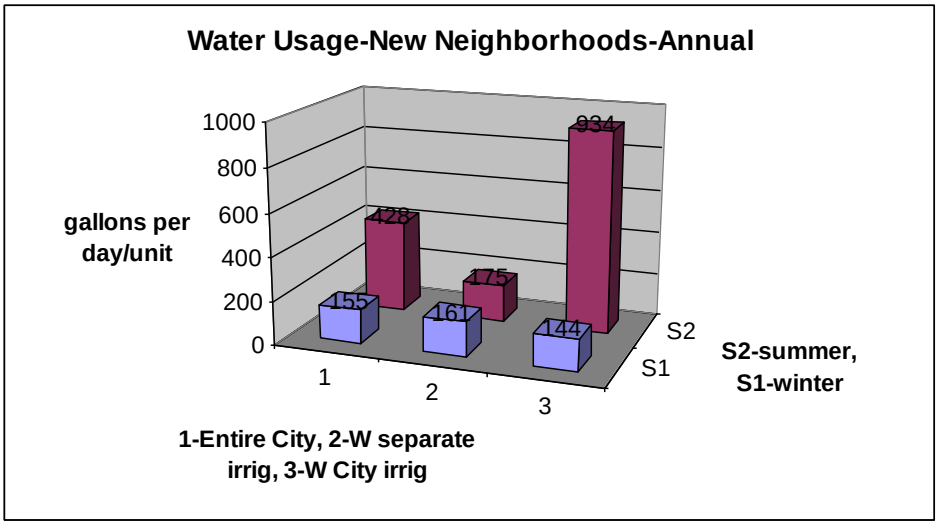


Chart 7 looks at the average daily water usage in terms of gallons per day per unit of all the new neighborhoods evaluated in this report (1), those new neighborhoods served by a separate irrigation system (2), and those new neighborhoods relying on the City domestic water supply system for irrigation (3).

Chart 7. Annual Lot Water Usage for New Neighborhoods – gallons per day



The September 2001 *Water Usage Study* evaluated 10 houses in 8 neighborhoods (total of 80 homes) throughout the City of Pasco. Chart 8 lists the 8 neighborhoods from the September 2001 report, and also identifies the results from this *Residential Water Use Study* separated into the same 8 neighborhoods.

Chart 8. Average Daily Water Usage – gallons per day

Neighborhood	September 2001 Study	Residential Use Study
Sun Willows	601 gpd	771 gpd
Ivy Glades	157 gpd	182 gpd
Wilson	246 gpd	241 gpd
Core City	570 gpd	669 gpd
West Pasco	236 gpd	221 gpd
I. Estate/S. Meadow	143 gpd	157 gpd
Desert Plateau – 1	934 gpd	1,651 gpd
Desert Plateau – 2	----	285 gpd
East Pasco	823 gpd	712 gpd

As Chart 8 points out, there are some differences between the two studies. These differences are likely the results of selecting more residential units in each neighborhood in this *Residential Water Use Study*, and the use of different residents within each neighborhood in each evaluation. Desert Plateau is shown with 2 listings in Chart 8. Desert Plateau – 1 is an older neighborhood which utilizes the City domestic water supply system for irrigation water, while Desert Plateau – 2 is a newer neighborhood with smaller lot size and fewer records available for analysis. One of the calculations presented in the September 2001 report was the estimated percentage of City water used indoors vs. outdoors for those neighborhoods where no separate irrigation supply system was available. Chart 9 compares the results of this *Residential Water Use Study* with the September 2001 report.

Chart 9. City Water Use – Indoor and Outdoor (gallon/year)

Neighborhood	Avg Mo Use-Winter	Total Avg based on Winter	Total Actual Use	% Indoors This Study (Sept 2001)	% Outdoors This Study (Sept 2001)
Desert Plateau – 1	6,525	78,295	581,146	13.5% (27%)	86.5% (73%)
Sun Willows	3,482	41,786	257,657	16.2% (23%)	83.8% (77%)
Core City	9,073	108,878	232,943	46.7% (39%)	53.3% (61%)
East Pasco	8,320	99,839	238,160	42.0% (45%)	58.0% (55%)
Average	**10,038**	**82,200**	**327,477**	**29.6% (33%)**	**70.4% (67%)**

Chart 10 provides a comparison of the outdoor water usage from the September 2001 report and this *Residential Water Use Study* for those neighborhoods relying on the City domestic water supply system for irrigation supply. The average square feet of each lot irrigated is from the September 2001 report.

Chart 10. Average Annual Gallons per square foot and acre-feet

Neighborhood	Gross Lot Size[1] (sq ft)	Avg Lawn Size[1] (sq ft)	Total Outdoor Water (gallons)	Gallons per sq-ft This Study (Sept 01)	Density of Homes per gross acre[1]	Gross Acre-ft per year[2] This Study (Sept 01)	Acre-ft per year per lawn area [3]
Desert Plateau – 1	10,390	8,100	502,851	62 (29)	3.5	5.39 (2.52)	8.30
Sun Willows	6,420	4,900	215,872	44 (31)	4.8	3.18 (2.24)	5.89
Core City	6,820	5,200	124,064	24 (20)	4.9	1.88 (1.55)	3.63
East Pasco	6,970	5,400	138,321	26 (27)	4.8	2.07 (2.17)	3.42
Average	**7,650**	**5,900**	**245,276**	**39 (26)**	**4.5**	**3.18 (2.12)**	**5.31**

[1]From September 2001 *Water Usage Study*

[2] Average sq-ft of lawn times number of homes per acre divided by 43,560 sq-ft, then multiplied by gallons per sq-ft, divided by 7.48

[3] Total Outdoor Water usage divided by Avg Lawn Size, divided by 7.48

The September 2001 *Water Usage Study* noted that the Franklin Conservation District estimated that home lawns accounted for 37.7 inches (3.08 ac-ft or 23 gallons per sq-ft) of water annually. With an anticipated loss of up to 20%, the application rate per lawn area would increase to 3.7 ac-ft or 27.7 gallons per sq-ft.

In both the Desert Plateau – 1 and Sun Willows neighborhoods, irrigation application rates are much higher than those anticipated by the Franklin Conservation District. The average application rate for irrigated lot area for the entire City of 5.31 ac-ft exceeds the anticipated application rate of 3.7 ac-ft (including losses) by approximately 44%.

WATER USE STUDY FINDINGS

The following represents findings of this *Residential Water Use Study* and the evaluation of water consumption throughout the City of Pasco.

1. **Residential Indoor Water Usage.**
   In the older residential neighborhoods, daily domestic indoor water usage averaged 237 gallons per day (annual usage of 0.2655 acre-feet per year). For the new residential neighborhoods, daily domestic indoor water usage averaged 155 gallons per day (annual usage of 0.1736 acre-feet per year), or 53% less than older neighborhoods. For

the new residential neighborhoods, it is highly likely that the plumbing fixtures and devices used have an improved efficiency over those in older neighborhoods.

2. Residential Outdoor Water Usage.

For the 16 neighborhoods evaluated in this *Residential Water Use Study,* the volume of water consumed for domestic purposes was calculated at less than 50% of the total volume consumed for domestic plus irrigation. At the seven neighborhoods, utilizing the domestic water supply system for irrigation, the volume of water consumed for domestic purposes was calculated at about 30% of the total volume consumed for domestic plus irrigation (Over twice as much water was consumed by irrigation of a lot than was used for domestic purposes by each residential unit).

In older residential areas (central and east Pasco), irrigation of the landscaped area of each lot was similar to that anticipated by the Franklin Conservation District (3.7 acre-ft per year) at 3.63 acre-ft per year (central) and 3.42 acre-ft per year (east) respectively. The central and east Pasco area residential units are of older construction, landscaping is considered to be mature and well established, and residents are generally considered to have moderate incomes.

In newer residential areas (Sun Willows and Desert Plateau), irrigation of the landscaped area of each lot far exceeded the Franklin Conservation District anticipated average of 3.7 acre-ft per year. The Sun Willows neighborhood consists of relatively small landscaped areas (Average of 4,900 square feet) in a newly developed area. Residents are generally considered to have higher incomes. Irrigation application rates in the Sun Willows neighborhood were calculated at 5.89 acre-feet per year or nearly 60% greater than the Franklin Conservation District anticipated average.

The Desert Plateau neighborhood evaluated for this study consists of residents with above average lot size, where income levels are generally considered to be high. Landscaping is generally 3 to 5 years old and irrigation application rates were calculated at 8.30 acre-feet per year. This application rate is 124% greater than the Franklin Conservation District anticipated average (3.7 acre-feet per year). Even if the actual irrigated area of lots within this Desert Plateau neighborhood were larger (by 25% to 10,000 square feet) than the average (8,100 square feet) calculated in the September 2001 *Water Usage Study* for Desert Plateau, the irrigation application rate to landscaped areas would be 6.72 acre-feet per acre or over 80% greater than the Franklin Conservation District anticipated average.

APPLICATION TO WATER SYSTEM PLAN

Based on this evaluation, the update of the City of Pasco Water System Plan will utilize the residential water consumption figures shown in Chart 11 for the projection of future domestic and irrigation supply demands for the existing and future residential neighborhoods throughout the Pasco Urban Growth Boundary.

Chart 11. Water Usage in Residential Areas – acre-feet per year per unit

Residential Area	With Separate Irrigation System (acre-ft/year/unit)	With Domestic Water Irrigation (acre-ft/year/unit)	Separate Irrigation Demand (acre-ft/year/unit)
Old Neighborhood	0.2655	0.7229	0.5031
New Neighborhood	0.1736	0.9644	0.8699

Chart 12 identifies the average day domestic and average day irrigation demand per unit, and per gross acre of residential neighborhoods in terms of gallons per day.

Chart 12. Per Unit Water Usage

Residential Area	With Separate Irrigation System (gpd)		With Domestic Water Irrigation (gpd)		Separate Irrigation Demand (gpd)	
	unit	gross acre	unit	gross acre	unit	gross acre
Old Neighborhood	240		660		750	
3.5 units/acre		840		2,540		3,160
4.0 units/acre		960		2,900		3,300
4.5 units/acre		1,080		2,970		3,380
5.0 units/acre		1,200		3,130		3,560
New Neighborhood	160		1,500		2,250	
3.5 units/acre		560		6,300		9,450
4.0 units/acre		640		6,000		9,000
4.5 units/acre		720		6,410		9,610
5.0 units/acre		800		6,750		10,120

APPENDIX C
OPERATING AGREEMENTS

Appendix C contains operating agreements that the City has with Kidwell Farms, Inc. These agreements include the use of the Northwest Commons well and annual contracts for irrigation water use at pivot sites. The agreements are attached on the following pages.

FILED FOR RECORD AT REQUEST OF:
City of Pasco, Washington

WHEN RECORDED RETURN TO:
City of Pasco, Washington
525 North 3rd
Pasco WA 99301

Zona G. Lenhart, Auditor, Franklin County, WA.
AFN # 1722639 Recorded 07/30/2008 at 02:31 P
DocType: ASGN 4 Page(s) Filing Instrument $45.
Recorded at the request of: PASCO CITY OF

ASSIGNMENT OF WELL EASEMENT
(Including Well System)

BY THIS ASSIGNMENT effective this 21 day of July 2008, Farm 2005, LLC, a Washington Limited Liability Company, hereinafter referred to as "Assignor", does by these presents, assign to the City of Pasco, Washington, a Municipal Corporation, hereinafter referred to as "Assignee", all of its right, title and interest as co-owner, to that certain easement and water well system described below according to the following terms and conditions.

WHEREAS, that easement document which is the subject matter of this assignment, was entered into with Glacier Park Company, a Delaware Corporation, as Grantor therein, and Alford Farms, Inc., a Washington Corporation as Grantee therein, on December 20, 1989, designated as Easement Deed No. G-89-3566, and recorded as Franklin County Auditor's No. 548122 ("Easement"); and

WHEREAS, such easement was assigned by the original Grantee to Kenneth G. Smith by Assignment of Easement dated November 25, 1997, and recorded December 23, 1997, in Franklin County, Washington, as Auditor's File No. 548122. Such easement was further assigned by Assignment of Easement dated November 30, 2007, between Kenneth G. Smith as Assignor to Pasco School District No. 1, a Washington Municipal Corporation, and Farm 2005, LLC, a Washington Limited Liability Company, as Franklin County Auditor's No. 1711948, as co-owners each having an undivided one-half interest therein; and

WHEREAS, Farm 2005, LLC, and Pasco School District No. 1 have entered into a Water Well System Shared Use Agreement dated October 22, 2007, thereby establishing their respective interest and responsibilities regarding the water well related water pumping and piping infrastructure located upon and

within the easement, this Agreement is assignable by their respective parties with their successors in interest being bound by the terms thereof; and

WHEREAS, Farm 2005, LLC, desires to convey all of its right, title and interest in the easement and water well and related water pumping and piping infrastructure located thereon, and including all of its rights and responsibilities under the Water Well System Shared Use Agreement; NOW, THERFORE,

IN CONSIDERATION OF MUTUAL COVENANTS CONTAINED HEREIN, and as a donation for public purposes, receipt of which is hereby acknowledged, the Parties agree as follows:

1. Assignment of Easement. Assignor does hereby assign to Assignee all its right, title and interest in that easement designated as Easement Deed No. G-89-3566 dated December 20, 1989, for underground water line, overhead power line, and water well use, upon and over the surface of real property located in the:

> Southeast Quarter or the Southeast Quarter of the Southeast Quarter of Section 3, Township 9 North, Range 29 East, Willamette Meridian, Franklin County, Washington, more particularly described designated by diagram on the attached Exhibit A.

Included in such Assignment are all fixtures located upon such premises consisting of the existing well system including pumps, panels, casings and piping infrastructure constituting the existing well system, including but not limited to:

> 1- GE 150 hp, Serial # OVJ210003
>
> 1- Layne Pump, # W2004033
>
> 1 - Service Disconnect Allen-Bradley # 99454 with PUD Meter # 25879

Assignor warrants that it has the right to transfer its interest in the above-described equipment and further agrees to warrant and defend the transfer, assignment, conveyance, grant, and delivery of the well system and above-described equipment made hereby against all persons whomsoever, to take all steps reasonably necessary to establish the record of Assignor's title and at the request of the Assignee, to execute and deliver further instruments of transfer and assignment and take any other action Assignee may reasonably request to more effectively transfer and assign to and vest in Assignee each and every component of the well system, at the sole cost and expense of the Assignor.

2. Assumption of Water Well System Shared Use Agreement. Assignee hereby accepts the assignment of well easement including the fixtures and components of the water well system described above, and Assignor's interest in the Water Well System Shared Use Agreement dated October 22, 2007, and agrees to be bound by and abide by each and every term and condition of said easement and Water Well System Shared Use Agreement, and hereby expressly assumes all obligations of the original Grantee thereunder except those liabilities arising out of acts or omissions occurring prior to the execution of this Agreement.

3. Reservation. This easement is subject to reservation reserved in the Grantor, Glacier Park Company, in the event that such premises shall cease to be used for underground waterlines, overhead power lines, and water well purposes for a period of twelve (12) months.

4. General Provisions. For the purpose of this Agreement, time is of the essence. In the event a dispute arises concerning the breach, enforcement or interpretation of this Agreement, the parties shall meet in a good faith attempt to resolve the dispute. In the event the dispute is not resolved either by agreement of the parties, or by voluntary mediation, the dispute shall be resolved by arbitration pursuant to RCW 7.04A, the Mandatory Arbitration Rules (MAR). Venue shall be placed in Franklin County, Washington, and the prevailing party shall be awarded its attorney fees and costs against the other.

DATED this 21 day of July 2008.

ASSIGNOR
Farm 2005, LLC

Cheryl L. Berg, LLC Member

ASSIGNEE
City of Pasco, Washington

Gary Crutchfield, City Manager

STATE OF WASHINGTON)
: ss
County of Franklin)

On this day personally appeared before me CHERYL L. BERG, Member of Farm 2005, LLC, described in and who executed the within and foregoing instrument, and acknowledged that she signed the same as her free and voluntary act and deed for the uses and purposes therein mentioned.

GIVEN under my hand and official seal this 21 day of July, 2008.

THOMAS R. KIDWELL COMMISSION EXPIRES NOTARY PUBLIC JAN. 26, 2010 STATE OF WASHINGTON

Notary Public in and for the State of Washington
Residing at Pasco
My Commission Expires 1-26-10

STATE OF WASHINGTON)
: ss
County of Franklin)

On this day personally appeared before me GARY CRUTCHFIELD, City Manager of the City of Pasco, Washington, described in and who executed the within and foregoing instrument, and acknowledged that he signed the same as his free and voluntary act and deed for the uses and purposes therein mentioned.

GIVEN under my hand and official seal this 28th day of July, 2008.

TONI L. ZUNKER COMMISSION EXPIRES NOTARY PUBLIC MAR. 2, 2012 STATE OF WASHINGTON

Notary Public in and for the State of Washington
Residing at Kennewick
My Commission Expires 3/2/12

CITY OF PASCO
PUBLIC WORKS / ENGINEERING DIVISION 509-545-3444 / FAX 509-543
P.O. BOX 293, 525 NORTH THIRD AVENUE, PASCO, WASHINGTON 99301

February 14, 2012

COP

Tom Kidwell
Water, Inc.
2420 W. Court
Pasco, WA 99301

RECEIVED
FEB 22 2012
PUBLIC WORKS #2

RE: Pump Station Agreement

Dear Mr. Kidwell:

The city purchased from Water, Inc., all its facilities including the pump station situated on the FCID cana within Section 16. The purchase agreement provided that the parties would provide, by separate agreemen for your potential use of the pump station for irrigation of certain agricultural lands owned by you at th time. Since that agreement, however, you have sold those certain properties; consequently, the city is n obligated by the purchase agreement to provide for your use of the pump station for other lands.

The city understands, however, your desire to use the pump station to irrigate the agricultural lands y presently lease from the Washington State Department of Natural Resources (DNR). Based on our rece discussions, the city will permit your use of the pump station in strict accord with the following stipulatior In exchange for the city's permission to use the pump station for the 2012 growing season, you shall:

1. be responsible for all electrical costs associated with pump station;
2. be responsible (to the city's satisfaction) for all maintenance and repair costs associated with the u of the pump station during the growing season;
3. pay $2,500 for the seasonal use with payment due not later than April 30, 2012;
4. provide evidence of liability insurance of at least $100,000 and naming the city as an additio insured;
5. indemnify and hold the city harmless from any claims whatsoever associated with use of the pu station;
6. be responsible for all costs whatsoever to acquire water from the FCID canal;
7. assure that use of water transferred through the pump station shall be restricted to those lands wit Section 16 which you have legal authority to use.
8. no chemicals shall be sprayed in any form on the pump and control systems;
9. no chemicals are to be used in or with the irrigation system.
10. pay City $100/year lease for pump equipment. The applicant is responsible for relocation, electr costs and maintenance of equipment pump.

Your signature hereunder will reflect your agreement with the foregoing provisions.

Sincerely,

Ahmad Qayoumi
Public Works Director

Agreed to: Tom Kidwell 2-16-12

Tom Kidwell — Date

CITY OF PASCO
PUBLIC WORKS / ENGINEERING DIVISION 509-545-3444 / FAX 509-543
P.O. BOX 293, 525 NORTH THIRD AVENUE, PASCO, WASHINGTON 99301

February 14, 2012

RECEIVED
FEB 2 < 2012
PUBLIC WORKS #2

COP

Tom Kidwell
Water, Inc.
2420 W. Court
Pasco, WA 99301

RE: Well Agreement

Dear Mr. Kidwell:

The City of Pasco acquired from the Northwest Commons subdivision, as part of the preliminary pla requirements, the water rights and well in 2006. The preliminary plat requirements provided that th owner/developer could negotiate a separate agreement with the City if they wish to continue to utiliz water from the well for irrigation of agricultural lands.

The City understands your desire to use the well to irrigate the agricultural lands you presently lease the subdivision site. The City will permit your use of the well in strict accord with the followir stipulations. In exchange for the city's permission to use the well for the 2012 growing season, yc shall:

1. adhere to the City's operation instructions;
2. be responsible for all electrical costs associated with farm irrigation;
3. be responsible (to the city's satisfaction) for all damage, maintenance and repair costs associat with the use of the well during the growing season;
4. pay $1,500 for the seasonal use with payment due no later than April 30, 2012;
5. provide evidence of liability insurance of at least $100,000 and naming the City as an addition insured;
6. indemnify and hold the City harmless from any claims whatsoever associated with use of the well;
7. assure that use of water shall be restricted to those lands within the subdivision of Northwest Commons;
8. no chemicals shall be sprayed in any form on the pump and control systems;
9. no chemicals are to be used in or with the irrigation system.

Your signature hereunder will reflect your agreement with the foregoing provisions.

Sincerely,

Ahmad Qayoumi
Public Works Director

AQ/jv
Agreed to:

Tom Kidwell

2-16-12
Date

CITY OF PASCO
PUBLIC WORKS / ENGINEERING DIVISION 509-545-3444 / FAX 509-54
P.O. BOX 293, 525 NORTH THIRD AVENUE, PASCO, WASHINGTON 99301

February 14, 2012

RECEIVED
FEB 2 < 2012
PUBLIC WORKS #2

COPY

Tom Kidwell
Water, Inc.
2420 W. Court
Pasco, WA 99301

RE: Well Agreement at Linda Loviisa Subdivision

Dear Mr. Kidwell:

The City understands your desire to use the well to irrigate the agricultural lands you presently lease : the Linda Loviisa subdivision site. The City will permit your use of the well in strict accord with th following stipulations. In exchange for the city's permission to use the well for the 2012 growir season, you shall:

1. Connect your system at a location approved by the City and provide a meter and valving as deemed necessary by the City.
2. adhere to the City's operation instructions;
3. be responsible for all electrical costs associated with farm irrigation;
4. be responsible (to the city's satisfaction) for all damage, maintenance and repair costs associat with the use of the well during the growing season;
5. pay $2,500 for the seasonal use with payment due no later than April 30, 2012;
6. provide evidence of liability insurance of at least $100,000 and naming the City as an addition insured;
7. indemnify and hold the City harmless from any claims whatsoever associated with use of the well;
8. assure that use of water shall be restricted to those lands within the subdivision of;
9. no chemicals shall be sprayed in any form on the pump and control systems;
10. no chemicals are to be used in or with the irrigation system.

Your signature hereunder will reflect your agreement with the foregoing provisions.

Sincerely,

Ahmad Qayoumi
Public Works Director

AQ/jv
Agreed to:

Tom Kidwell

2-16-12
Date

CITY OF PASCO

PUBLIC WORKS / ENGINEERING DIVISION 509-545-3444 / FAX 509-54

P.O. BOX 293, 525 NORTH THIRD AVENUE, PASCO, WASHINGTON 99301

April 2, 2010

Tom Kidwell
Water, Inc.
2420 W. Court
Pasco, WA 99301

RE: Well Agreement at Linda Loviisa Subdivision

Dear Mr. Kidwell:

The City understands your desire to use the well to irrigate the agricultural lands you presently leas the Linda Loviisa subdivision site. The City will permit your use of the well in strict accord with following stipulations. In exchange for the city's permission to use the well for the 2010 grov season, you shall:

1. Connect your system at a location approved by the City and provide a meter and valving as deemed necessary by the City.
2. adhere to the City's operation instructions;
3. be responsible for all electrical costs associated with farm irrigation;
4. be responsible (to the city's satisfaction) for all damage, maintenance and repair costs associ with the use of the well during the growing season;
5. pay $2,500 for the seasonal use with payment due no later than April 30, 2010;
6. provide evidence of liability insurance of at least $100,000 and naming the City as an additi insured;
7. indemnify and hold the City harmless from any claims whatsoever associated with use of th well;
8. assure that use of water shall be restricted to those lands within the subdivision of;
9. no chemicals shall be sprayed in any form on the pump and control systems.

Your signature hereunder will reflect your agreement with the foregoing provisions.

Sincerely,

Bob Alberts

Bob Alberts
Public Works Director

BA/jv
Agreed to:

Tom Kidwell _____ Date _____

CITY OF PASCO

PUBLIC WORKS / ENGINEERING DIVISION 509-545-3444 / FAX 509-543

P.O. BOX 293, 525 NORTH THIRD AVENUE, PASCO, WASHINGTON 99301

March 31, 2010

Tom Kidwell
Water, Inc.
2420 W. Court
Pasco, WA 99301

RE: Well Agreement

Dear Mr. Kidwell:

The City of Pasco acquired from the Northwest Commons subdivision, as part of the preliminary pl requirements, the water rights and well in 2006. The preliminary plat requirements provided that tl owner/developer could negotiate a separate agreement with the City if they wish to continue to utili water from the well for irrigation of agricultural lands.

The City understands your desire to use the well to irrigate the agricultural lands you presently lease the subdivision site. The City will permit your use of the well in strict accord with the followi stipulations. In exchange for the city's permission to use the well for the 2010 growing season, y shall:

1. adhere to the City's operation instructions;
2. be responsible for all electrical costs associated with farm irrigation;
3. be responsible (to the city's satisfaction) for all damage, maintenance and repair costs associat with the use of the well during the growing season;
4. pay $1,500 for the seasonal use with payment due no later than April 30, 2010;
5. provide evidence of liability insurance of at least $100,000 and naming the City as an additio insured;
6. indemnify and hold the City harmless from any claims whatsoever associated with use of the well;
7. assure that use of water shall be restricted to those lands within the subdivision of Northwest Commons;
8. no chemicals shall be sprayed in any form on the pump and control systems.

Your signature hereunder will reflect your agreement with the foregoing provisions.

Sincerely,

Bob Alberts
Public Works Director

BA/jv
Agreed to:

Tom Kidwell

4-2-10
Date

CITY OF PASCO
PUBLIC WORKS DEPARTMENT (509) 543-5738 / FAX (509) 543-5737
P.O. Box 293 (525 North 3rd Avenue) Pasco, Washington 99301 / www.pasco-wa.gov

March 19, 2013

Tom Kidwell
Water, Inc.
2420 W. Court
Pasco, WA 99301

RE: Well Agreement

Dear Mr. Kidwell:

The City of Pasco acquired from the Northwest Commons subdivision, as part of the preliminary plat requirements, the water rights and well in 2006. The preliminary plat requirements provided that the owner/developer could negotiate a separate agreement with the City if they wish to continue to utilize water from the well for irrigation of agricultural lands.

The City understands your desire to use the well to irrigate the agricultural lands you presently lease at the subdivision site. The City will permit your use of the well in strict accord with the following stipulations. In exchange for the city's permission to use the well for the 2013 growing season, you shall:

1. pay for seasonal use $1,330 (which includes $151.34 applicable state leasehold taxes) by April 30, 2013;
2. be responsible for all electrical costs associated with farm irrigation;
3. be responsible (to the city's satisfaction) for all damage, maintenance and repair costs associated with the use of the well during the growing season;
4. adhere to the City's operation instructions;
5. provide evidence of liability insurance of at least $100,000 and naming the City as an additional insured;
6. indemnify and hold the City harmless from any claims whatsoever associated with use of the well;
7. assure that use of water shall be restricted to those lands within the subdivision of Northwest Commons;
8. no chemicals shall be sprayed in any form on the pump and control systems;
9. no chemicals are to be used in or with the irrigation system;
10. maintain and test RP;
11. if chemical is used it must be preapproved by the City.

Your signature hereunder will reflect your agreement with the foregoing provisions.

Sincerely,

Ahmad Qayoumi
Public Works Director

AQ/jv
Agreed to: Tom Kidwell

Tom Kidwell

3-19-13
Date

CITY OF PASCO
PUBLIC WORKS DEPARTMENT (509) 543-5738 / FAX (509) 543-5737
P.O. Box 293 (525 North 3rd Avenue) Pasco, Washington 99301 / www.pasco-wa.gov

March 19, 2013

Tom Kidwell
Water, Inc.
2420 W. Court
Pasco, WA 99301

RE: Well Agreement at Linda Loviisa Subdivision

Dear Mr. Kidwell:

The City understands your desire to use the well to irrigate the agricultural lands you presently lease at the Linda Loviisa subdivision site. The City will permit your use of the well in strict accord with the following stipulations. In exchange for the city's permission to use the well for the 2013 growing season, you shall:

1. pay $2,215 for seasonal use (which includes $252.04 of applicable state leasehold taxes) by April 30, 2013;
2. be responsible for all electrical costs associated with farm irrigation;
3. be responsible (to the city's satisfaction) for all damage, maintenance and repair costs associated with the use of the well during the growing season;
4. connect your system at a location approved by the City and provide a meter and valving as deemed necessary by the City.
5. adhere to the City's operation instructions;
6. provide evidence of liability insurance of at least $100,000 and naming the City as an additional insured;
7. indemnify and hold the City harmless from any claims whatsoever associated with use of the well;
8. assure that use of water shall be restricted to those lands within the subdivision of;
9. no chemicals shall be sprayed in any form on the pump and control systems;

Your signature hereunder will reflect your agreement with the foregoing provisions.

Sincerely,

Ahmad Qayoumi
Public Works Director

AQ/jv
Agreed to:

Tom Kidwell

3-19-13
Date

CITY OF PASCO
PUBLIC WORKS DEPARTMENT (509) 543-5738 / FAX (509) 543-5737
P.O. Box 293 (525 North 3rd Avenue) Pasco, Washington 99301 / www.pasco-wa.gov

March 19, 2013

Tom Kidwell
Water, Inc.
2420 W. Court
Pasco, WA 99301

RE: Pump Station Agreement

Dear Mr. Kidwell:

The city purchased from Water, Inc., all its facilities including the pump station situated on the FCID canal within Section 16. The purchase agreement provided that the parties would provide, by separate agreement, for your potential use of the pump station for irrigation of certain agricultural lands owned by you at that time. Since that agreement, however, you have sold those certain properties; consequently, the city is not obligated by the purchase agreement to provide for your use of the pump station for other lands.

The city understands, however, your desire to use the pump station to irrigate the agricultural lands you presently lease from the Washington State Department of Natural Resources (DNR). Based on our recent discussions, the city will permit your use of the pump station in strict accord with the following stipulations. In exchange for the city's permission to use the pump station for the 2013 growing season, you shall:

1. pay $2,215 for the seasonal use of the pump station and $90/year lease for pump equipment (which includes $262.28 of applicable state leasehold tax) by April 30, 2013.
2. be responsible for all electrical costs associated with pump station;
3. be responsible for relocation, electrical costs and maintenance of equipment pump.
4. be responsible (to the city's satisfaction) for all maintenance and repair costs associated with the use of the pump station during the growing season;
5. provide evidence of liability insurance of at least $100,000 and naming the city as an additional insured;
6. indemnify and hold the city harmless from any claims whatsoever associated with use of the pump station;
7. be responsible for all costs whatsoever to acquire water from the FCID canal;
8. assure that use of water transferred through the pump station shall be restricted to those lands within Section 16 which you have legal authority to use.

Your signature hereunder will reflect your agreement with the foregoing provisions.

Sincerely,

Ahmad Qayoumi
Public Works Director

Agreed to: Tom Kidwell

Tom Kidwell

3-19-13
Date

CITY OF PASCO
PUBLIC WORKS DEPARTMENT (509) 543-5738 / FAX (509) 543-5737
P.O. Box 293 (525 North 3rd Avenue) Pasco, Washington 99301 / www.pasco-wa.gov

March 19, 2013

Tom Kidwell
Water, Inc.
2420 W. Court
Pasco, WA 99301

RE: Well Agreement at Rd 52

Dear Mr. Kidwell:

The City understands your desire to use the well to irrigate the agricultural lands you presently lease at the Rd 52 site. The City will permit your use of the well in strict accord with the following stipulations. In exchange for the city's permission to use the well for the 2013 growing season, you shall:

1. pay $2,215 for seasonal use (which includes $252.04 of applicable state leasehold taxes) by April 30, 2013;
2. be responsible for all electrical costs associated with farm irrigation;
3. be responsible (to the city's satisfaction) for all damage, maintenance and repair costs associated with the use of the well during the growing season;
4. connect your system at a location approved by the City and provide a meter and valving as deemed necessary by the City.
5. adhere to the City's operation instructions;
6. provide evidence of liability insurance of at least $100,000 and naming the City as an additional insured;
7. indemnify and hold the City harmless from any claims whatsoever associated with use of the well;
8. assure that use of water shall be restricted to those lands within the subdivision of;
9. no chemicals shall be sprayed in any form on the pump and control systems;

Your signature hereunder will reflect your agreement with the foregoing provisions.

Sincerely,

Ahmad Qayoumi
Public Works Director

AQ/jv
Agreed to:

Tom Kidwell

3-19-13
Date

APPENDIX D
PROJECT COST ESTIMATES

Appendix D contains detailed cost estimating data used to determine project costs as presented in Section 4.

Irrigation Mains

Irrigation main project cost estimating data was prepared using bid tabulations from nearby irrigation districts. Some of the City of Pasco's recent bid tabulations were also used. The costs assume PVC irrigation pipe. Construction costs represented total estimated construction cost per linear foot (LF) of pipe and included sales tax. A 10 percent contingency was added to bid costs to calculate a construction subtotal. To calculate project costs, a 35 percent contingency was added to account for administrative, legal, and engineering costs. Table D-1 summarizes irrigation main project costs.

Table D-1
Irrigation Main Project Cost Summary

Pipe Diameter (inches)	Project Cost per Linear Foot ($/LF)
4	65
6	75
8	105
10	115
12	125
16	135
18	145
20	150
24	170

Well Rehabilitation and Assessment

The total project cost for well rehabilitation work is estimated at $225,500. Well rehabilitation costs are summarized in Table D-2 and are based on the following assumptions:

- New pump and motor costs are not included
- The City will conduct the specific capacity testing recommended at each well
- The City will conduct well video surveys
- Administrative, legal, and engineering costs for this project are estimated at 50 percent of the construction cost instead of 35 percent to account for additional on-site engineering representation associated with rehabilitation activities. Rehabilitation activities typically require more on-site representation than construction of new facilities.

Table D-2
Well Rehabilitation and Assessment Project Cost Summary

Description	Quantity	Unit	Unit Price	Total
Desert Sunset, Sirocco, Northwest Commons, Island Estates, I-182, and Powerline Road Wells				
Mobilization and Demobilization	6	LS	$1,500.00	$9,000.00
Disconnect, Remove, and Reinstall Existing Equipment	72	HR	$350.00	$25,200.00
Specific capacity testing [1]	12	HR	$0.00	$0.00
Onsite Hourly Work to Perform Rehabilitation	96	HR	$350.00	$33,600.00
Miscellaneous Equipment and Chemicals	6	LS	$1,500.00	$9,000.00
Video Survey[1]	12	EA	$0.00	$0.00
Disinfection	6	EA	$1,000.00	$6,000.00
Wastewater Containment and Disposal	6	EA	$2,500.00	$15,000.00
			Subtotal	$97,800.00
First Place and Desert Estates Wells				
Mobilization and Demobilization	2	LS	$1,500.00	$3,000.00
Disconnect, Remove, and Reinstall Existing Equipment	24	HR	$350.00	$8,400.00
Specific Capacity Testing [1]	4	HR	$0.00	$0.00
Onsite Hourly Work to Perform Rehabilitation	16	HR	$350.00	$5,600.00
Miscellaneous Equipment and Chemicals	2	LS	$1,000.00	$2,000.00
Video Survey[1]	4	EA	$0.00	$0.00
Disinfection	2	EA	$1,000.00	$2,000.00
Wastewater Containment and Disposal	2	EA	$2,500.00	$5,000.00
			Subtotal	$26,000.00
Road 52 and Linda Loviisa Wells				
Specific Capacity Testing[1]	4	HR	$0.00	$0.00
Video Survey[1]	2	EA	$0.00	$0.00
Disinfection	2	EA	$1,000.00	$2,000.00
			Subtotal	$2,000.00

Subtotal	$125,800
Construction Contingency (10 percent)	$12,580
Sales Tax (8.6 percent)	$11,900
Construction Subtotal	$150,280
Administrative, Legal, and Engineering Costs (50 percent[2])	$75,140
Rounded Estimated Project Cost	**$225,500**

Notes

1. Assumes City will conduct specific capacity testing and well video surveys.
2. Administrative, legal, and engineering costs are higher due to increased on-site engineering representation for rehabilitation activities.

Village of Pasco Heights Well Replacement

The total project cost to replace the Village of Pasco Heights Well is estimated at $172,400. Itemized costs are summarized in Table D-3 and are based on the following assumptions:

- The well pump and motor in use at the existing Village of Pasco Heights Well are in good condition and can be reused in the new well.
- Costs for infrastructure expansion for connection to existing water system are not included
- No permitting costs are included
- No cost for a well video survey is included since the City can perform the survey

The total cost includes:

- Aquifer and well performance testing (e.g., step-rate and constant-rate pumping tests)
- Plumbness and alignment testing
- Water quality analysis
- 100 feet of 10-inch diameter PVC discharge piping to connect to the existing irrigation system

General New Irrigation Well Construction

A general-use project cost was developed for use in budgeting construction of a new irrigation water supply well. The total estimated project cost is $616,000. Itemized costs are summarized in Table D-4. This estimated project cost can be used on a per-well basis and is based on the following generalized assumptions:

- The total depth of the new well is 200 feet
- The diameter of the well is 16 inches
- The length of the stainless steel screen is 20 feet
- The pump is a vertical turbine type pump with a 150-HP motor equipped with a variable-speed drive
- 500 feet of 10-inch diameter PVC discharge piping will be needed to connect the well to the existing irrigation system
- The City will perform well video surveys

The total cost includes:

- Aquifer and well performance testing (e.g., step-rate and constant-rate pumping tests)
- Plumbness and alignment testing
- Water quality analysis

It is possible that individual well construction costs may vary from those presented here due to fluctuations factors such as depth, diameter, production rates, aquifer characteristics, and

hydraulic conditions. To take these variations into account, a contingency of 20 percent was used to estimate the construction cost of the well. The project cost included in Table D-4 is a representative cost used for budgeting purposes only.

Table D-3
Village of Pasco Heights Well Replacement Project Cost Summary

Description	Quantity	Unit	Unit Price	Total
Mobilization and Demobilization	1	LS	$10,000.00	$10,000.00
Site Preparation	1	LS	$5,000.00	$5,000.00
Drilling 20-inch Diameter Surface Seal	20	LF	$240.00	$4,800.00
Furnish and Install 20-inch Diameter Casing	20	LF	$100.00	$2,000.00
16-inch Diameter Drill Shoe	1	EA	$1,000.00	$1,000.00
16-inch Diameter Drilling	180	LF	$120.00	$21,600.00
Furnish and Install 16-inch Diameter Casing	200	LF	$70.00	$14,000.00
Install Surface Seal	20	LF	$40.00	$800.00
16-inch Diameter Shoe Cut	1	EA	$4,000.00	$4,000.00
Hourly Operations	8	HR	$525.00	$4,200.00
Well Casing Alignment	1	EA	$500.00	$500.00
16-inch Diameter Telescoping Stainless Steel Screen	10	LF	$200.00	$2,000.00
16-inch Diameter Riser Pipe and Tail Pipe	15	LF	$70.00	$1,050.00
Silica Sand	40	BG	$16.00	$640.00
Installation of Screen Assembly	16	HR	$525.00	$8,400.00
Well Development	16	HR	$325.00	$5,200.00
Remove existing pump and motor and Reinstall in New Well	180	LF	$20.00	$3,600.00
Furnish and Install Discharge Piping	100	LF	$85.00	$8,500.00
Operate Test Pump	30	HR	$240.00	$7,200.00
Well Disinfection	1	LS	$500.00	$500.00
Well Head Completion	1	LS	$350.00	$350.00
Water Quality Analysis	1	LS	$1,500.00	$1,500.00

Subtotal	$106,840
Construction Contingency (10 percent)	$10,685
Sales Tax (8.6 percent)	$10,110
Construction Subtotal	$127,630
Administrative, Legal, and Engineering Costs (35 percent)	$44,670
Rounded Estimated Project Cost	**$172,400**

Table D-4
New Irrigation Well Project Cost Summary

Description	Quantity	Unit	Unit Price	Total
Mobilization and Demobilization	1	LS	$15,140.00	$15,140.00
Site Preparation	1	LS	$5,000.00	$5,000.00
Drilling 20-inch Diameter Surface Seal	20	LF	$240.00	$4,800.00
Furnish and Install 20-inch Diameter Casing	20	LF	$100.00	$2,000.00
16-inch Diameter Drill Shoe	1	EA	$1,000.00	$1,000.00
16-inch Diameter Drilling	180	LF	$120.00	$21,600.00
Furnish and Install 16-inch Diameter Casing	200	LF	$70.00	$14,000.00
Install Surface Seal	20	LF	$40.00	$800.00
16-inch Diameter Shoe Cut	1	EA	$4,000.00	$4,000.00
Hourly Operations	8	HR	$525.00	$4,200.00
Well Casing Alignment	1	EA	$500.00	$500.00
16-inch Diameter Telescoping Stainless Steel Screen	20	LF	$200.00	$4,000.00
16-inch Diameter Riser Pipe and Tail Pipe	15	LF	$70.00	$1,050.00
Silica Sand	40	BG	$16.00	$640.00
Installation of Screen Assembly	16	HR	$525.00	$8,400.00
Well Development	16	HR	$325.00	$5,200.00
New Well Pump and 150-HP Motor with Variable-Speed Drive	1	LS	$125,000	$125,000.00
Furnish and Install Discharge Piping	500	LF	$85.00	$42,500.00
Operate Test Pump	30	HR	$240.00	$7,200.00
Well Disinfection	1	LS	$500.00	$500.00
Well Head Completion	1	LS	$350.00	$350.00
Well House	1	LS	$37,000.00	$37,000.00
Electrical, Instrumentation, and Controls	1	LS	38,450.00	38,450.00
Water Quality Analysis	1	LS	$1,500.00	$1,500.00

Subtotal	$350,030
Construction Contingency (20 percent[1])	$70,000
Sales Tax (8.6 percent)	$36,125
Construction Subtotal	$456,160
Administrative, Legal, and Engineering Costs (35 percent)	$159,660
Rounded Estimated Project Cost	**$616,000**

Notes

1. Construction contingency is higher to account for uncertainty in well construction, aquifer characteristics, and hydraulic conditions.

Murray, Smith & Associates, Inc.
Engineers/Planners
Tacoma, Washington