OREGON WATER RESOURCE DEPARTMENT
WATER CONSERVATON, REUSE AND STORAGE
FEASIBILTY STUDY GRANT PROGRAM

I. Grant Information

Study Name: *Drift Creek Water Supply Development Project*

Type of Feasibility Study: ☐ Water Conservation ☐ Reuse ☒ Above-Ground Storage
☐ Storage Other Than Above-Ground [Including Aquifer Storage and Recovery (ASR)]

Program Funding Dollars Requested: $ $76,320 Total Cost of Feasibility Study: $ $152,640
Note: Request may not exceed $500,000

II. Applicant Information

Applicant Name: ***East Valley Water District***		**Co-Applicant Name:**	
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Certification:

I certify that this application is a true and accurate representation of the proposed work for a project feasibility study and that I am authorized to sign as the Applicant or Co-Applicant. By the following signature, the Applicant certifies that they are aware of the requirements of an Oregon Water Resources Department grant, have read and agree to all conditions within the sample grant agreement and are prepared to conduct the feasibility study if awarded.

Applicant Signature: [signature] Date: *2/1/2016*

Print Name: *David Bielenberg* Title: *Chair, Board of Directors*

III. Feasibility Study Summary

Please give a brief summary of the feasibility study using no more than 150 words.

East Valley Water District has spent over twenty years seeking a long-term stable water supply for its membership. For the past decade, the District has partnered with Oregon Water Resources Department to perform detailed feasibility studies to determine the proper location, storage, and environmental considerations needed to secure a reliable water source for over 15,000 highly productive agricultural acres in Clackamas and Marion counties. The District is now nearly ready to submit documentation needed to proceed through the environmental permitting process; a significant milestone for this project. The funding requested in this application represents the final analyses needed to complete the feasibility phase of this project, submit the permitting package, answer questions by regulatory agencies, and move toward construction and implementation. This work includes: (1) evaluating District water distribution system alternatives; (2) analyzing storage required to provide ecological flows; (3) further investigation of elk; and (4) further cultural resources investigations.

IV. Grant Specifics

Section A. Common Criteria

Instructions: Please answer all questions contained in this section. It is anticipated that completed applications will result in additional pages.

1. Describe your goal and how this study helps to achieve the goal.

   See attached supplemental documentation

2. Describe the water supply need(s) that the proposed project addresses. Identify any critical local, regional, or statewide water supply needs that implementation of the project associated with the feasibility study will address. **Responses should rely upon solid water availability and needs data/analysis.** For examples of water supply needs see "Criteria and Evaluation Guidance Document."

   See attached supplemental documentation

3. Explain how the proposed project will meet the water supply need(s), and indicate what percentage of that need will be met. (For example: If your water supply need is 20,000 acre-feet of additional water and the project will supply 10,000 additional acre-feet, 50 percent of your need will be met).

   See attached supplemental documentation

4. Describe the technical aspects of the feasibility study and why your approach is appropriate for accomplishing the specific study goals and objectives.

   See attached supplemental documentation

5. Describe how the feasibility study will be performed. Include:
   a. General summary statement that describes the study progression.
   b. When the feasibility study will begin.
   c. Listing of key tasks to be accomplished with each task having:
      i. Title
      ii. Timeline for completion
      iii. Description of the activities to be performed in this key task
      iv. Description of the resources necessary for accomplishing the key task

   Example:

   (i) Streamflow measurement;
   (ii) September-April;
   (iii) Weekly streamflow measurements will be performed to gather hydrographic data for the hydrologic analysis to take place in May;
   (iv) A technician will be hired to perform the streamflow measurements.

   (Key tasks listed here are to be placed in Section VI. Project Feasibility Study Schedule for a quick reference "graphical" representation of the schedule.)

   See attached supplemental documentation

6. Please provide the following data and information for the proposed project and the project's sources of water supply:

   a. The location of the proposed project. Include the basin, county, township, range and section. Attach a **map** that identifies the project's implementation area to this application.

      See attached supplemental documentation

   b. The name(s) and river mile(s) of the source water and what they are tributary to, if applicable.

      See attached supplemental documentation

   c. Whether the project will be off-channel or on-channel (for above-ground storage only).

      See attached supplemental documentation

   d. Water availability to meet project storage. For above-ground storage the Department typically evaluates availability using a 50 percent exceedance water availability analysis.

      See attached supplemental documentation

   e. Proposed purposes and/or uses of conserved or stored water.

      See attached supplemental documentation

   f. Environmental flow needs and water quality requirements of supply source water bodies.

      See attached supplemental documentation

7. What local, state or federal project permitting requirements/issues/approvals do you anticipate in order for the feasibility study to be conducted? If approvals are required, indicate whether you have obtained them. If you have not obtained the necessary permits/governmental approval, describe the steps you have taken to obtain them. If no permits are needed, please provide explanation.

   See attached supplemental documentation

8. Describe the level of involvement, interest and/or commitment of local entities associated with the feasibility study. Describe how the feasibility study and/or proposed project will benefit/impact these entities. Attach letters of support if available.

   See attached supplemental documentation

9. Identify when matching funds will be secured, from whom, and the dates of matching funds availability.

   See attached supplemental documentation

10. Provide a description of the relevant professional qualifications and/or experience of the person(s) that will play key roles in performing the feasibility study. If the personnel have not been decided upon, include a description of the professional qualifications and/or experience of the person(s) you anticipate will play key roles in performing the feasibility study.

    See attached supplemental documentation

11. If the project concept is ultimately deemed feasible, describe how the project will be implemented. Response should include a tentative funding plan for project implementation (e.g. other state or federally sponsored grant or loan programs) and the project proponent's track record in implementing similar projects.

    See attached supplemental documentation

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Also Enclosed for Supporting Information:

Attachment A: *1994 Reconnaissance Level Investigation*
Attachment B: *Oregon State University Drift Creek Dam Agriculture Economic Value Analysis*
Attachment C: *Drift Creek Hydrologic Report Update #4*
Attachment D: *Conceptual Design Report*
Attachment E: *Project Map*
Attachment F: *Permitting Strategy Table*
Attachment G: *Overview Schedule*

III. Feasibility Study Summary

East Valley Water District has spent over twenty years seeking a long-term stable water supply for its membership. For the past decade, the District has partnered with Oregon Water Resources Department to perform detailed feasibility studies to determine the proper location, storage, and environmental considerations needed to secure a reliable water source for over 15,000 highly productive agricultural acres in Clackamas and Marion counties. The District is now nearly ready to submit documentation needed to proceed through the environmental permitting process; a significant milestone for this project. The funding requested in this application represents the final analyses needed to complete the feasibility phase of this project, submit the permitting package, answer questions by regulatory agencies, and move toward construction and implementation. This work includes: (1) evaluating District water distribution system alternatives; (2) analyzing storage required to provide ecological flows; (3) further investigation of elk; and (4) further cultural resources investigations.

IV. Grant Specifics

Section A. Common Criteria

1. **Describe your goal and how this study helps to achieve the goal.**

The overarching goal of the Drift Creek Water Supply Development Project (Project) is to secure a stable water supply for the District for the purpose of supporting local agricultural interests, small town economies, mitigate receding groundwater conditions, relieve over-appropriated surface water sources, improve resident fish habitat, and reduce flooding risk. Through various investigations, the District has determined the Project is feasible, and is ready to advance to environmental permitting. The goal of the studies included in this application is to complete the permit package for submittal, to be prepared for questions and further analyses requested by regulatory agencies, and ready this project for construction.

The District was formed in 2002 with the purpose of developing a water supply for its patrons. The District's service area lies within two Groundwater Limited Areas (GLAs); Mt. Angel and Gladtidings. The District is currently served through a combination of time limited permits and temporary transfers – both from strained surface and groundwater surfaces; neither of which are a long term (nor in some cases not even short term) solution. The Drift Creek Water Supply Project would store 12,000 acre-feet of water in a reservoir on Drift Creek near Silverton. That water would then be conveyed to the District for distribution. As of January 2016, the District believes this project is feasible, it can be constructed, and has identified several pieces of work needed to advance through the regulatory phase of this project.

The District, along with its predecessor the Pudding River Basin Water Resources Development Association, have worked for over two decades toward the development of an alternate water supply. After studying over 75 alternate sites and strategies, the District determined a surface water reservoir on Drift Creek would provide the most adequate, acceptable, reliable, affordable and permitable solution. The District has made substantial progress studying the Project site, and is prepared to submit the environmental permitting package (via Joint Permit Application to the U.S. Army Corps of Engineers and Oregon Department of State Lands) in Spring 2016. To date, the District has successfully completed the following investigations to determine the Project is feasible:

- Detailed alternatives analysis and conceptual design;
- Detailed hydrologic analysis;
- Reservoir modeling and yield analyses;
- Land use analysis;
- Agricultural economic value analysis to determine ability-to-pay (90% complete);
- Wetland delineation and analysis;
- Water Right analyses and application (Preliminary Final Order issued 7/22/2014);
- Temperature and flow monitoring;
- Fish and fish habitat assessments*;
- Geotechnical feasibility;
- Elk and wildlife assessments*; and
- Cultural resources analysis*.

**District has completed initial analyses, but regulatory agencies will require more detailed analysis prior to issuing environmental permits for this project. That work is described in detail in further sections.*

As detailed above, the District has made substantial progress in its studies and analysis of the proposed reservoir and transmission system. However, further detailed analyses are needed to complete the regulatory phase of this process. Principally, the District must do further evaluation of District distribution system alternatives and determine the feasibility of providing ecological flows as an additional purpose of the project. The District also is required to continue analyses on elk and cultural resources to answer questions from Oregon Department of Fish and Wildlife as well as the State Historic Preservation Office, respectively. These analyses include:

- *Evaluation of District Distribution System Alternatives:* The District has evaluated alternative reservoir and transmission alternatives and selected the most feasible alternatives based on engineering, environmental and economic studies. Environmental permitting requires that all aspects of a proposed project need to be consider a range of alternatives. The District will evaluate up to three distribution system alternatives for delivering water from the transmission system to access points at property line of each District member.
- *Analyze Storage Required to Provide By-pass, Optimum Peak, Flushing and Other Ecological Flows:* Drift Creek currently experiences extremely low flows in the summer that typically threatening fish species due to high temperatures. The District will analyze the storage needed to provide by-pass, optimum peak, flushing and other ecological flows through the project. This will include an evaluation of environmental benefits and impacts for conveying water supply within Drift Creek to the point of distribution downstream through instream flow augmentation and habitat enhancement.
- *Further Evaluation of Elk Presence and Potential Project Impacts:* The District will evaluate the presence and use of habitat by elk in the project area. The analyses will include the impacts and/or benefits of the Project to their habitat and identify strategies to avoid, minimize and/or mitigate Project impacts to elk and their habitat.
- *Conduct Phase II Cultural Resources Investigations:* In 2015, the District performed cultural resource pedestrian surveys that identified several areas where shovel testing is needed. The District will perform shovel testing and additional evaluation to determine the potential project impacts to cultural resources sites. The studies will allow the District to complete Section 106 National Historic Preservation Act reporting and seek concurrence with the State Historic Preservation Office (SHPO).

These four areas of study are the remaining pieces of work needed to move past the feasibility phase of the Project into the environmental permitting phase; marking a major step forward for the District and its pursuit of a stable water supply source for its members.

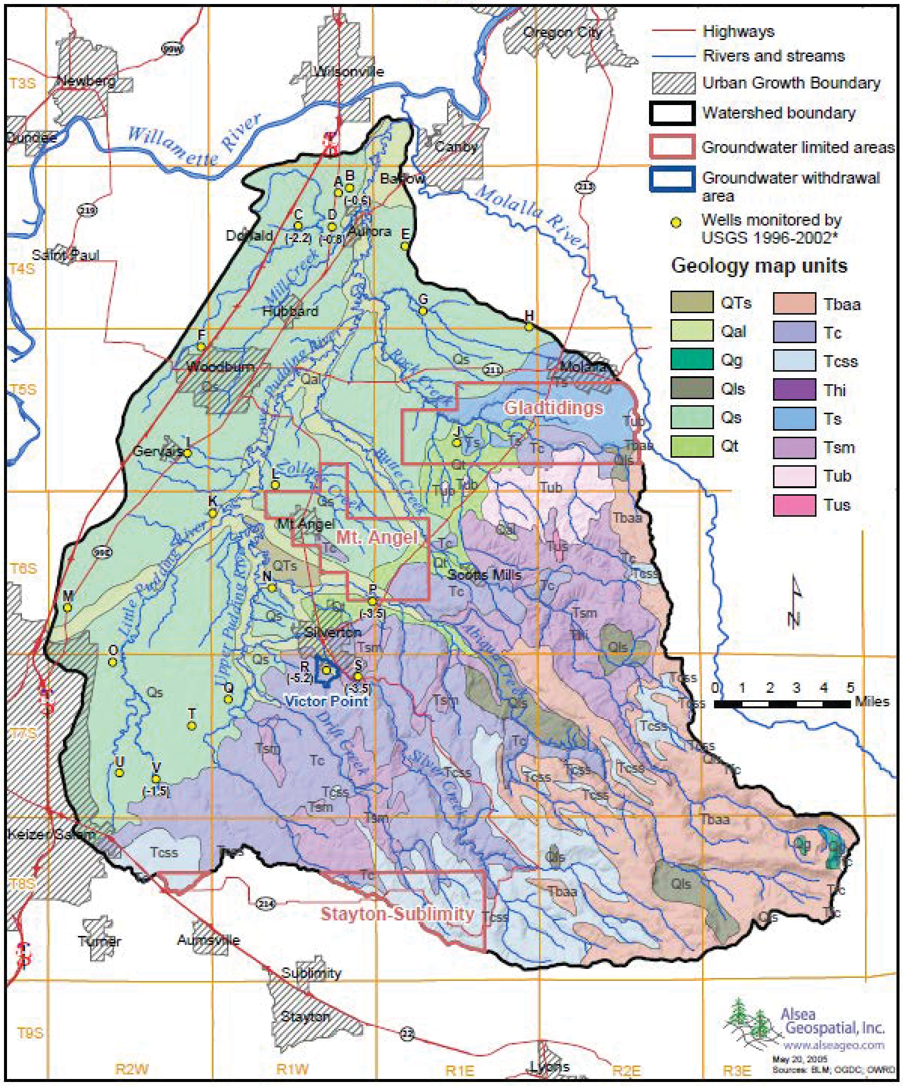
2. **Describe the water supply need(s) that the proposed project addresses. Identify any critical local, regional or statewide water supply needs that implementation of the project associated with the feasibility study will address. Responses should rely upon solid water availability and needs/data analysis. For examples of water supply needs see "Criteria Evaluation and Guidance Document."**

East Valley Water District's Service area extends northerly from Silverton to just south of Woodburn and Molalla, between the Pudding River and west of the Cascade Mountain foothills. Over 18,000 acres of East Valley Water District's service area lies within a Groundwater Limited Area (Mt. Angel and Gladtidings GLAs) as designated by the Oregon Water Resources Department. The surface water supply within the District's area has also been fully appropriated and is regularly limited during the period of use for irrigation purposes. Some of the District's membership have conditional temporary permits for water use; however, there is not a long-term stable water supply available within the District area. This section is divided in three parts (1) Critical Water Needs within the District (2) Purpose and Need for Water Supply Development (3) Proposed Water Supply Availability.

Critical Water Needs within the District

The Mt. Angel GLA includes about 10,640 acres in the vicinity of Mt. Angel and the Gladtidings GLA includes about 16,000 acres. Expanded use for all but domestic purposes is prohibited by the Oregon Water Resource Department. The following map shows the Pudding River drainage area that the District's service area is located with groundwater limited areas outlined:

Designated Groundwater Areas
Pudding River Watershed Assessment
Map 13



Prior to incorporating as East Valley Water District, the landowners within the district boundary were organized as the Pudding River Basin Water Resources Development Association in 1993. That organization performed an extensive *1994 Reconnaissance Level Investigation* to investigate the current conditions and evaluate future water needs (See Attachment A for complete study; referred to as 1994 Study hereafter.) The study found groundwater declines in this area are due to several factors including well installation and deepening in the 1960s and early 1970s. Some of the new and deepened wells were inside the Mt. Angel and Gladtidings GLAs. Many wells were deepened to increase well yield in response to increasing markets for higher value food crops that were developing in the mid-1970s. The irrigation wells rely primarily on deeper basalt aquifers for their water supply; as is typical in the northern Willamette Valley. This condition confines the aquifer in the volcanic rock making refill and recharge difficult. These factors gave Oregon Water Resources Department sufficient evidence to declare these two zones groundwater limited areas.

In addition, surface water supply has been fully appropriated for the area and is regularly limited during the period of use for irrigation. Conditional time-limited permits and temporary transfers are now in place; but there is no long-term water supply solution for District members. Some of the time-limited permits have already been canceled, and water availability in most years is not stable nor reliable. The ability to store water will relieve the strained groundwater and surface water conditions in the Pudding River drainage area serviced by the District.

Purpose and Need for Water Supply Development

The primary purpose for the proposed project is to service agricultural and irrigation needs. Marion County is the largest agriculture producing county in the state in dollar value. Irrigated farms produce more than 80% of the total value of Oregon's harvested crops with 15% of all economic activity in Oregon tied to agriculture. Within the District boundary, the following crops are grown (reported to FSA, note – not all reported acreage are District members):

Crop	Acres	Percentage of EVWD (36160 acres)
Alfalfa	257.4	0.71%
Barley	21.3	0.06%
Beans	1,598.2	4.42%
Beets	108.1	0.30%
Blueberries	283.9	0.79%
Broccoli	243.4	0.67%
Buckwheat	55.7	0.15%
Cabbage	30.8	0.09%
Canary Seed	8.4	0.02%
Caneberries	1,195.4	3.31%
Cauliflower	390.2	1.08%
Cherries	2.8	0.01%
Chicory	104.9	0.29%
Christmas Trees	699.1	1.93%
Clover	721.0	1.99%
Corn	2,201.3	6.09%
CRP	38.7	0.11%
Cucumbers	30.2	0.08%
Fallow	568.4	1.57%
Flowers	852.7	2.36%
Garlic	91.4	0.25%
Grapes	671.1	1.86%
Grass	14,111.2	39.02%
Greens	36.9	0.10%
Hazelnuts	921.9	2.55%
Herbs	25.8	0.07%
Home Garden	1.7	0.00%
Hops	1,129.0	3.12%
Kiwi Fruit	6.6	0.02%
Kohlrabi	13.7	0.04%
Meadow Foam	37.7	0.10%
Mixed Hay / Forage	1,339.9	3.71%
Mustard	22.3	0.06%
Nursery	1,256.1	3.47%
Oats	297.9	0.82%
Olives	4.8	0.01%

Onions	509.4	1.41%
Parsnip	6.0	0.02%
Peas	695.3	1.92%
Peppers	77.3	0.21%
Potatoes	42.6	0.12%
Pumpkins	58.5	0.16%
Radishes	259.6	0.72%
Rhubarb	134.6	0.37%
Squash	174.4	0.48%
Strawberries	230.8	0.64%
Sugar Beets	225.3	0.62%
Trees	28.8	0.08%
Watercress	7.0	0.02%
Wheat	4,299.5	11.89%
Wildlife Food Plot	31.0	0.09%
TOTAL	36,160.0	100.00%

The 1994 Study coupled with the findings of the *Oregon State University Drift Creek Dam Agriculture Economic Value Analysis* (See Attachment B) identified 36,160 acres of net productive agriculture land in the District service area. Currently only 15,000 acres are irrigated in the service area due to several factors including water availability. Permits and certificates for surface water in the District equate to about 10,800 acres with current applications on file to OWRD totaling 940 acres. Some of these lands are currently irrigated under temporary permits that will expire in the very near future. All water rights are held in the names of individuals in the District.

Irrigation water requirements have been estimated for the District in a number of past investigations and planning studies. The commonly developed per-acre estimates for irrigation requirements average 1.8 acre-feet of water per acre of irrigated land. The following calculation table can be found referenced in Page III-6 of the 1994 Study:

TABLE III-4

THEORETICAL UNIT IRRIGATION DEMAND ON STORAGE
(ACRE-FEET/ACRE)

	APR	MAY	JUN	JUL	AUG	SEP	TOTAL
DEMAND ON STORAGE	.02	.15	.44	.62	.37	.16	1.80

Using these calculations, the total estimated need of water for the District is calculated to be 23,357 acre-feet annually. The proposed Project is anticipated to store 12,000 acre-feet of water (~51% of total need). Depending on the project selection, a portion of the need would come from stored water and a portion from existing groundwater, surface water rights, and conservation improvements.

Proposed Project Water Supply Availability

The District has performed extensive hydrologic studies and monitoring of stream flows at the proposed project site on Drift Creek with the latest study update occurring in spring 2015 (See Attachment C, *Drift Creek Hydrologic Report Update #4*). Based on the streamflow data connected coupled with hydrologic analysis, the likelihood of seeing an October – April runoff volume of 12,000 acre-feet available for storage at the project site looks reasonably good. The runoff volume is estimated at 17,700 acre-feet for the 90% exceedance frequency (EF); 26,400 acre-feet for the 50% EF (2-year exceedance interval); and 39,500 acre-feet for the 10% EF (10 year exceedance interval). These volumes can be stored in the reservoir when the project has met 100% of the required in-stream flows listed for Drift Creek at its confluence with the Pudding River. Challenges to meeting the storage objective occur in a limited number of real-time discharge datasets; for example in the driest water years observed (2008-2009) there may be difficulty in reaching a storage volume of 12,000 acre-feet, however the refill tendency is generally robust. More detail on the hydrology analysis (including methods and extensive data analysis) can be found in Attachment C.

3. **Explain how the proposed project will meet the water supply need(s), and indicate what percentage of that need will be met. (For example: If your water supply need is 20,000 acre-feet of additional water and the project will supply 10,000 additional acre-feet, 50 percent of your need will be met).**

East Valley Water District's water supply need is 23,357 acre-feet annually. The proposed project will store 12,000 acre-feet for irrigation use fulfilling slightly over 51% of the District's annual water supply needs.

According to the *Conceptual Design Report* (Attachment D) the proposed project would construct an earthen embankment approximately 70-foot high, 850-foot long to impound the 12,000 acre-feet of water. The resulting inundation area would be approximately 380 acres.

As discussed in Question 2, extensive hydrologic study has shown that runoff can produce the desired storage capacity of 12,000 acre-feet and is available at the proposed location in over 90% of water years. Water availability for a storage project is based on water being available at a 50% exceedance factor. In reviewing OWRD's water availability data, the District factored in existing current uses which have an earlier priority date than the water right requested by the District for storage purposes. The existing consumptive rights are for small amounts of irrigation and related pond storage for agriculture use and equate to 586 acre-feet annually. There is also an existing instream water right with a priority date of October 18, 1990. The water availability quantification developed by the District includes the instream rights as measured at the lower end of the stream reach (as required by the certificate and confirmed by department staff) at the mouth of the creek.

The project is proposed to store water from October – April for release during the irrigation period of use. The District has applied for a surface water right for storage within the reservoir and right to withdraw the water seasonally from the reservoir for agriculture purposes.

In addition to storing water for irrigation and agricultural purposes, the District plans to investigate the ability of the proposed project to benefit fish and habitat conditions downstream of the reservoir. Thus, the District plans to analyze storage required to provide by-pass, optimum peak, flushing and ecological flows as an additional purpose of the project. Drift Creek has noted water quality and temperature issues through the summer due to low summer flows and high air temperatures. The current conceptual design of the reservoir will pass cool water from the bottom of the reservoir throughout the summer; providing opportunity for improved water temperature downstream of the project. However, the District will further investigate other ecological flows that can be provided to improve conditions and habitat for native species downstream.

4. **Describe the technical aspects of the feasibility study and why your approach is appropriate for accomplishing the specific study goals and objectives.**

With support of East Valley Water District's membership and partners like the Oregon Water Resources Department, the District completed most of the feasibility studies and environmental permitting documentation needed for the Drift Creek site. The feasibility studies have determined that the Drift Creek reservoir site is the most suitable alternative to provide the District a stable water supply and there are just a couple pieces of work that are needed to both wrap-up the feasibility studies and to move forward with the submission of the environmental permitting package. Principally, the District plans to evaluate the District Distribution System alternatives and the feasibility of providing ecological flows as an additional purpose of the project. Thus, the District will initiate the following studies:

- *Evaluation of District Distribution System Alternatives:* The District has evaluated alternative reservoir and transmission alternatives and selected the most feasible alternatives based on engineering, environmental and economic studies. Environmental permitting requires that all aspects of a proposed project need to be consider a range of alternatives. Therefore, the District will evaluate up to three distribution system alternatives for delivering water for the end of the transmission system to access points at property line of each District member property. The evaluation of distribution system alternatives will not include any on-farm irrigation systems. It is assumed that all District members will continue to implementation on-farm irrigation systems and practices that are considered highly efficient and conservation focused. The documentation for this evaluation will satisfy OWRD, ODSL and U.S. Army Corps of Engineers guidance with respect to alternatives evaluations.
- *Analyze Storage Required to provide By-pass, Optimum Peak, Flushing and Other Ecological Flows:* Drift Creek currently experiences extremely low flows in the summer; typically threatening fish species due to high temperatures. The District will analyze the storage needed to provide by-pass, optimum peak, flushing and other ecological flows through the project. This would also include an evaluation of environmental benefits and impacts for conveying water supply within Drift Creek to the point of distribution downstream through instream flow augmentation and habitat enhancement.

In addition to initiating the above efforts, there are certain studies the District will investigate in more detail to answer questions from regulatory agencies beyond the studies already performed; those studies include:

- *Further Evaluation of Elk Presence and Potential Project Impacts:* The District will perform further evaluation of the presence and use of habitat by elk in the project area. The analyses will include the impacts and/or benefits of the Project to their habitat and identify strategies to avoid, minimize and/or mitigate Project impacts to elk and their habitat.

- *Conduct Phase II Cultural Resources Investigations:* In 2015, the District performed cultural resource pedestrian surveys that identified several areas that shovel testing and further investigation is needed. The District will perform shovel testing and additional evaluation and determine any potential project impacts to cultural resources sites. The studies would allow the District to complete Section 106 National Historic Preservation Act reporting and seek concurrence with the State Historic Preservation Office (SHPO).

The following list is an overview of studies and evaluations (listed above) that are necessary to complete the pieces of work proposed in this phase of feasibility studies. Detailed information on scope and expertise are included in Question 5 and Question 10.

Evaluation of District Distribution System Alternatives
The District has considered several water supply development strategies and over 75 project sites before determining Drift Creek as a site worthy of detailed feasibility studies. Additionally, the District has evaluated transmission alternatives that included both piped and instream alignments. The District distribution system is the aspect of the water supply project that needs to consider the viable range of alternatives. This evaluation will include identifying potential distribution system alignments, developing conceptual plans for the distribution system alternatives, evaluating engineering feasibility, evaluating environmental benefits and impacts, evaluating land-use impacts, and developing conceptual construction, operations and maintenance cost estimates.

Analyze Storage Required to Provide By-pass, Optimum Peak, Flushing and Other Ecological Flows
The primary purpose of the proposed project is for agricultural use. However, the District recognizes the potential opportunity to improve fish conditions both in and downstream of the reservoir through providing ecological flow conditions. The District would like to perform studies to determine the timing, quantity and quality of flows needed to benefit native species.

The District has performed fish habitat surveys that have identified temperature issues and limited availability of pool habitat. Significant resources have been invested in expanding the District’s knowledge of fish habitat and flow monitoring. The information previously gathered on the current habitat conditions will be vital to evaluating the flow needed to benefit species.

Once the flow relationship has been determined, hydrologists will determine the amount of storage and release needed to create by-pass, optimum peak, flushing or other ecological flow conditions that support healthy ecology. The ability for conveyance flows in the creek will also be evaluated for their benefit to support healthy ecology.

Further Evaluation of Elk Presence and Potential Project Impacts
The District has performed preliminary elk presence surveys and literature reviews. Through consultation with Oregon Department of Fish and Wildlife, the District would like to perform more detailed analysis and identify all potential impacts and benefits to the species due to the proposed reservoir. Dave DeKrey (Project Biologist) met with Don VandeBergh, a wildlife specialist at Oregon Department of Fish and Wildlife (ODFW), on June 24, 2015. ODFW Habitat Mitigation Policy (Oregon Administrative Rules 635-415) outlines habitat approaches for the Project (construction or operational) impacts to Wildlife habitat. Elk habitat has been identified within the proposed reservoir impact area. ODFW requires the quantification of wildlife habitat impacts and that appropriate mitigation be developed to compensate for these impacts. Don VandeBergh (ODFW) has confirmed that there is great elk habitat within the

reservoir footprint. Thus, the District believes further elk studies will be required to quantify the impact to elk and to then identify mitigation measures to compensate for the habitat impact. This analysis will include literature reviews as well as field investigations to observe the presence and behavior of elk and their habitat. All findings will be documented and confirmed with Oregon Department of Fish and Wildlife.

Conduct Phase II Cultural Resources Investigations
The District has conducted pedestrian surveys in the reservoir footprint that have identified the need for more detailed analysis in several areas. The District plans to perform shovel testing and additional evaluation to determine any potential project impacts to cultural resources sites. The studies will allow the District to complete Section 106 National Historic Preservation Act reporting and seek concurrence with the State Historic Preservation Office.

From the pedestrian surveys completed in summer of 2015, we found four high probability areas that were identified for exploratory shovel testing, and that will need up to 160 shovel tests excavated. According to Archaeological Investigations Northwest (AINW – the firm engaged to perform the studies) a permit would not be needed for the testing because the effort would determine resource boundaries and test high probability areas. However, this assumption will need to be tested prior to initiating any study. Any artifacts recovered in shovel tests not on public lands can be evaluated and documented in the field and returned to the shovel tests as they are back filled [there are no high probability areas on public lands, thus artifacts cannot be removed for testing.] Once shovel testing is complete, findings will be documented for agency review by SHPO and potential listing with the National Registry of Historic Places. This work would allow the District to do the necessary documentation for the Section 106 Report and SHPO letter and all other necessary reporting needs.

5. **Describe how the feasibility study will be performed.**

This section describes the scope of work proposed to complete this phase of feasibility studies. All studies and analysis proposed can be done concurrently with the resources listed in Question 10.

The tasks outlined in this grant application will be initiated as soon as a funding agreement is approved and signed. Dates and timelines for completion in this scope of work assume funding agreement is reached in summer 2016. All studies are planned to be performed by consultants or individuals already engaged in the project. Thus, work can begin as soon as a funding agreement is reached.

Task One: Evaluation of District Distribution System Alternatives
Timeline for completion: December 2016
The objective of this task is to evaluate up to three distribution system alternatives for Drift Creek Water Supply Project. The distribution system will need to be cost effective while supply water to District members in adequate quantities, with sufficient pressure and avoid environmentally sensitive areas. Additionally, construction of alignments needs to consider land owner and agriculture season impacts.

Description of Activities:

A. Identify potential distribution system alternatives
B. Develop conceptual plans for potentially distribution system alternatives
C. Evaluate the engineering feasibility of distribution system alternatives including hydraulic and non-hydraulic design considerations, system and sub-system pressures; long-term operations and maintenance considerations, system flexibility and redundancy review, and constructability review
D. Evaluate environmental benefits and impacts of the distribution system alternatives
E. Evaluate land-use impacts and easements needed for each of the distribution system alternatives evaluated.
F. Develop construction, operations (i.e. pumping) and maintenance cost estimates for the distribution system alternatives.

Resources Required: Water Resources Engineer (Kevin Crew, 120 Hours); Environmental Specialist (Dave Dekrey, 40 hours); Planner (Terry Buchholz, 40 hours)

Task Two: Analyze Storage Required to Provide By-Pass, Optimum Peak, Flushing and Other Ecological Flows

Timeline for completion: December 2016

The District will evaluate the storage required to provide by-pass, optimum peak, flushing and other ecological flows that would benefit the ecology downstream of the reservoir. This study will also look at the potential benefits of conveying water instream during the irrigation season to ecological flows.

Description of Activities:

A. Determine and document flow conditions that could benefit ecologic health below the reservoir.
B. Perform hydrologic analysis of the amount of Drift Creek reservoir storage needed to provide by-pass, optimum peak, flushing and other ecological flows.
C. Evaluate the environmental benefits and impacts for conveying water supply within Drift Creek to the point of distribution.
D. Evaluate non-flow-related conditions (e.g. habitat enhancement) needed in order for downstream flow conditions to improve ecology downstream of the reservoir.

Resources Required: Water Resources Engineer (Crew, 100 hours); Hydrologist (Dr. Tanovan, 24 hours); Environmental Specialist (Dekrey, 160 hours)*;* Planner (Buchholz, 40 hours)

Task Three: Evaluate Elk Presence and Potential Project Impacts

Timeline for Completion: November 2017

The District needs to further evaluate the presence and use of elk habitat within the Drift Creek Reservoir project area. Based on information gathered, the District will develop a strategy to avoid, minimize and/or mitigate Project impacts to elk and their habitats.

Description of Activities:

A. Conduct research and field investigations to determine the presence and use of habitat by elk in the project area.
B. Determine the impacts and/or benefits of Project on elk and their habitats.

C. Identify strategies to avoid, minimize and/or mitigate project impacts to elk and their habitat.

Resources Required: Senior Wildlife Biologist (Christine Champe, 32 hours); Wildlife Biologist (Stillwater Sciences, 136 hours)

Task Four: Conduct Phase II Cultural Resources Investigations

Timeline for Completion: December 2016

Description of Activities:

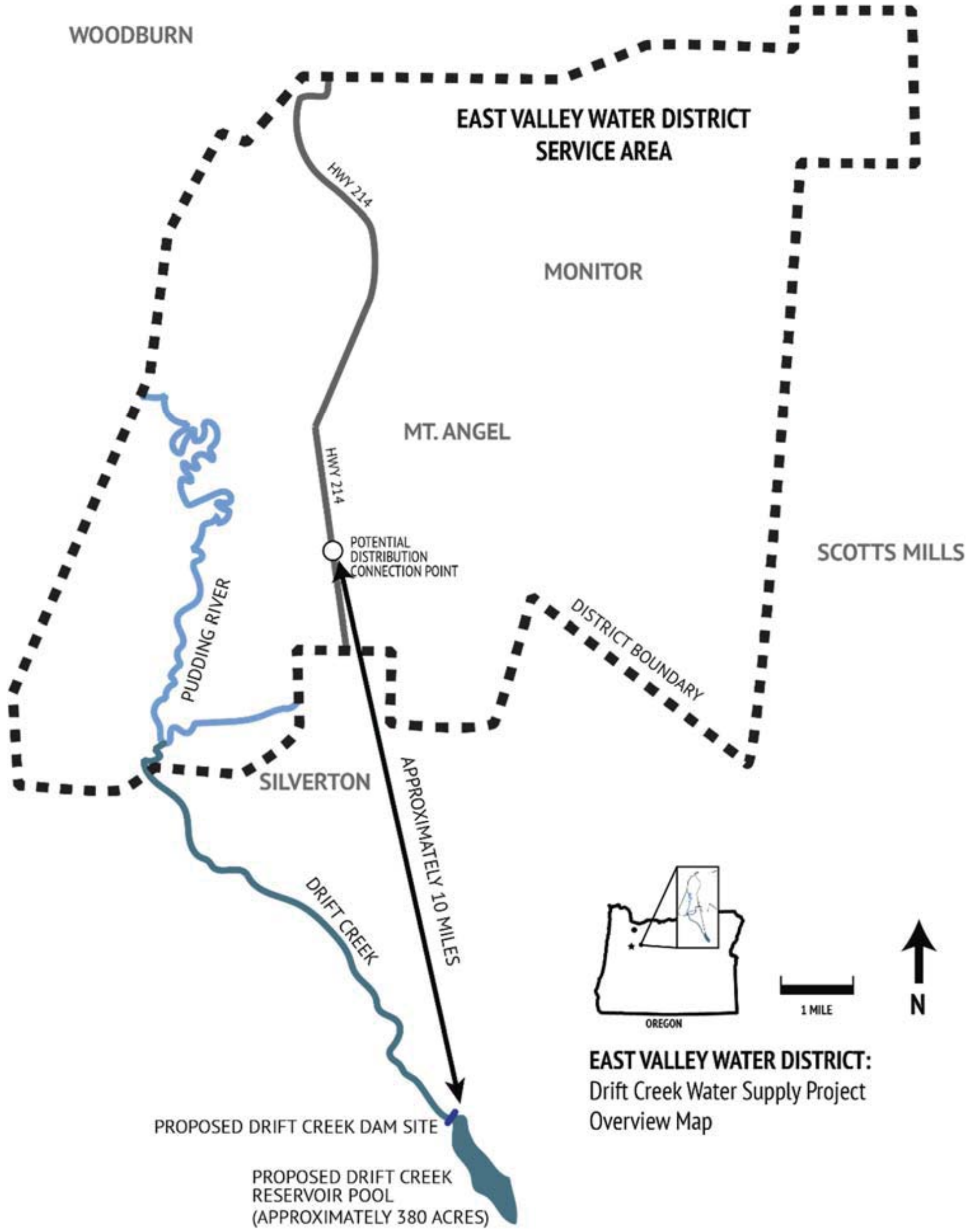
A. Acquire necessary clearances needed to perform shovel testing (if deemed necessary).
B. Establish the area of potential effect for the project and confer with the U.S. Army Corps of Engineers.
C. Use the completed survey information from March 2015 pedestrian surveys to determine high probability areas that require shovel testing.
D. Perform cultural resources shovel testing (up to 160 tests) in identified high probability areas.
E. Identified resources during the shovel testing will be delineated and recorded on SHPO resource forms.
F. Delineated sites will be tested and evaluated for National Register of Historic Places Eligibility (SHPO permits would be needed to evaluate each site, with separate permits for each individual landowner property identified).
G. Assess eligible cultural resources sites for project-related impacts.
H. If determined necessary through impact analysis, mitigation plans will be developed
I. Complete Section 106 National Historic Preservation Act reporting and concurrence with SHPO.

Resources Required: Senior Archaeologists (John Fagan, 120 hours); Archaeologists (Bajdek, 380 hours)

6. **Please provide the following data and information for the proposed project and the project's sources of water supply:**
   A. **The location of the proposed project. Include the basin, county, township, range and section. Attach a map that identifies the project's implementation area to this application.**

The proposed project is located on Drift Creek in the Victor Point area near Silverton. This is located in the Middle Willamette Basin in Marion County.

The proposed dam is located 3,990 feet north and 355 feet east from the S1/4 corner of Section 36, Township 7 South, Range 1 West (W.M.) The Area of Proposed use is Marion County within Section 31, Township 7, Range 1 East, W.M.; Section 6, Township 8 South, Range 1 East, W.M.; Section 1, Township 8 South, Range 1 west, W.M. See Attachment E for Project Map.



B. The name(s) and river mile(s) of the source water and what they are tributary to, if applicable.

The Drift Creek subbasin (6th field HUC) comprises an area of approximately 25.15 square miles (4.3% of total basin area) in the upper left portion of the Pudding River watershed. The site controls this drainage area and could store runoff through April annually. Drift Creek is a small portion of the Pudding River watershed (5th field HUC), comprising approximately 531 square miles of land in Marion and Clackamas Counties. Eight major sub-basins drain into the Pudding River: Silver Creek, Zollner Creek, Abiqua Creek, Butte Creek, Drift Creek, Little Pudding River, Rock Creek and the Senecal/Mill Creek drainage area. Elevations within the watershed range from 4,280’ at the summit to 66’ at the confluence of the Molalla River. Drift Creek drains from the Pudding River, which drains from the Molalla River, a Willamette River tributary. The attached hydrology report (Attachment C) contains extensive flow data and information on gauging stations in the area.

C. Whether the project will be off-channel or on-channel (for above-ground storage only).

The Project will be on-channel storage on Drift Creek.

D. Water availability to meet project storage. For above-ground storage the Department typically evaluates availability using a 50 percent exceedance water availability analysis.

The following section is an excerpt from Attachment C, more detail can be found in the full report:

OWRD defines water availability as *"the amount of water that can be appropriated from a given point on a given stream for new out-of-stream consumptive uses. It is obtained from the natural stream flow by subtracting existing in-stream water rights and out-of-stream consumptive uses*". . Current standards for new appropriation of water are: *(1) consumptive use from allocations for out-of-stream uses can total no more than the 80-percent exceedance natural stream flow, and (2) allocations for in-stream flows can be no more than the 50-percent exceedance natural stream flow".*

OWRD provides up-to-date water availability data for Drift Creek at its confluence with the Pudding River for the 50% and 80% exceedance levels at the following address:

http://apps.wrd.state.or.us/apps/wars/wars_display_wa_tables/display_wa_details.aspx?ws_id=70781&exlevel=80&scenario_id=1

Originally, the drainage area used for that site was shown as being 17.91 sq. mi., which is different from the 25.1 sq. mi. area calculated by Harvest Geographics, Inc. for the same location and lower than the 24.8 sq. mi. area used by Marion Water and Conservation Service District for a Drift Creek stream gauging site near Silverton and upstream from the mouth of Drift Creek. Following contacts by members of the project team, OWRD recognized that Drift Creek watershed was incorrectly delineated and subsequently changed the drainage area to 25.25 sq. mi. in early April 2010. The revised OWRD also reports a mean annual precipitation over Drift Creek watershed of 61.61 inches.

The water availability data as of 5/5/2015 shown on OWRD's website are listed in Table 11.1 for the 50% and 80% exceedance levels. Compared to the previous data postings, in-stream flow requirements remain the same but updates were made by OWRD for Consumptive Uses and Storages, as confirmed during a conference call on June 9, 2015. As a result, data shown for the Expected Stream Flows (third column from the right hand side) and Net Water Available (last column to the right) have been changed. The new numbers include the older flows and the additional flows requested by EVWD in its water use permit application, which was submitted in February 2013 and recommended for approval with conditions by OWRD in July 2014.

Table 11.1 Revised Water Availability Data for Drift Creek at Its Mouth, in cfs
(as of 5/5/2015)

a) 50% Exceedance DRIFT CR > PUDDING R - AT MOUTH

Water Availability as of 5/5/2105

Col. 1 Month	Col. 2 Natural Stream Flow	Col.3 Consumptive Uses and Storages	Col. 4 Expected Stream Flow	Col. 5 Reserved Stream Flow	Col. 6 Instream Flow Requirement	Col. 7 Net Water Available
JAN	149.00	54.40	94.60	0.00	40.00	54.60
FEB	133.00	46.40	86.60	0.00	40.00	46.60
MAR	108.00	33.20	74.80	0.00	40.00	34.80
APR	68.10	13.70	54.40	0.00	40.00	14.40
MAY	32.70	0.22	32.50	0.00	30.10	2.38
JUN	41.90	0.44	41.50	0.00	13.60	27.90
JUL	18.30	0.77	17.50	0.00	3.00	14.50
AUG	8.40	0.61	7.79	0.00	2.00	5.79
SEP	4.65	0.30	4.35	0.00	2.00	2.35
OCT	7.56	0.02	7.54	0.00	5.26	2.28
NOV	61.10	10.80	50.30	0.00	40.00	10.30
DEC	138.00	48.80	89.20	0.00	40.00	49.20
ANN	46,300.00	12,600.00	33,700.00	0.00	17,800.00	15,900.00

Average annual stream flow discharge at 50% Exceedance level = 63.88 cfs

b) 80% Exceedance DRIFT CR > PUDDING R - AT MOUTH

Water Availability as of 5/22/2012

Month	Natural Stream Flow	Consumptive Uses and Storages	Expected Stream Flow	Reserved Stream Flow	Instream Flow Requirement	Net Water Available
JAN	67.30	54.40	12.90	0.00	40.00	-27.10
FEB	74.90	46.40	28.50	0.00	40.00	-11.50
MAR	66.80	33.20	33.60	0.00	40.00	-6.36
APR	48.80	13.70	35.10	0.00	40.00	-4.93
MAY	24.20	0.22	24.00	0.00	30.10	-6.12
JUN	11.50	0.44	11.10	0.00	13.60	-2.54
JUL	5.51	0.77	4.74	0.00	3.00	1.74
AUG	3.34	0.61	2.73	0.00	2.00	0.73
SEP	3.09	0.30	2.79	0.00	2.00	0.79
OCT	4.27	0.02	4.25	0.00	5.26	-1.01
NOV	23.70	10.80	12.90	0.00	40.00	-27.10
DEC	65.80	48.80	17.00	0.00	40.00	-23.00
ANN	46,300.00	12,600.00	33,700.00	0.00	17,800.00	15,900.00

Average annual stream flow discharge at 80% Exceedance level = 33.05 cfs

OWRD exceedance stream flows *"are determined directly from gage records, or for ungaged streams, by estimation through modeling"*. Since the natural stream flow numbers listed above were listed long before October 2008, when actual stream flow monitoring started at the Upper Drift Creek station, those numbers must have been based on modeling results. The following paragraphs document the extent to which the listed 50% and 80% annual runoff volume compare with actually monitored stream flow volumes.

For the 50% exceedance, the OWRD-calculated natural stream flow volume is 39,817 AF for the October-April runoff volume of Drift Creek at its mouth -- a 25.25 sq. mi. drainage area. The actually observed runoff volume for Drift Creek at the lower gauging station (24.8 sq. mi. drainage area) for October 2009-April 2011 (a slightly below average water year) was 35,699 AF. After drainage area adjustment, the observed runoff volume for Drift Creek at its mouth would be 35,699*(25.25/24.8) = 36,347 AF. As calculated, the two numbers are off by less than 9%, part of which could be attributed to higher rainfall distribution over the lower part of the watershed.

For the 80% exceedance flows, the OWRD-calculated natural stream flow volume for Drift Creek at its mouth is only 18,100 AF. This is considerably lower than the 27,847 AF runoff volume observed at Hibbard Road during the October 2008- April 2009 period, a water year that can classified as a low flow year at the 80% or even a lower exceedance level. This could either indicate that the OWRD data for the 80% exceedance level is underestimated or that the 2008-09 flow year should have been ranked higher compared to other historical years. Obviously, this cannot be reliably determined yet with just six years of actual stream flow data.

As briefly discussed with OWRD staff at the June 9, 2015 conference call, updating of the natural stream flows currently shown in Column 2 of the OWRD water availability 50% and 80% exceedance tables is not being contemplated by the Department any time in the near future. Therefore, absent changes in numbers shown in columns 3, 5 and 6, numbers in columns 4 and 7 will not change.

E. Proposed purposes and/or uses of conserved or stored water.

The purpose of use of the stored water is storage for agricultural irrigation use and flow augmentation.

F. Environmental flow needs and water quality requirements of supply source water bodies.

Certificate 72591 with a priority date of October 18, 1990 is an instream water right held by the OWRD for the purpose of providing required streamflows for cutthroat trout for migration, spawning, egg incubation, fry emergence and juvenile rearing, to be maintained in Drift Creek. The stored water may have a secondary impact of improving water quality. Analysis of water quality data on Drift Creek and the Pudding River identifies that releasing water from the middle and lower depths of the reservoir will improve downstream water quality. The proposed reservoir will stratify storage withdrawals during the summer months for this to occur. Stored water releases will allow for better scheduling of flows for fishery migration and related benefits.
The District also will perform more detailed studies analyzing the storage needed to be able to provide ecological flows.

7. **What local, state or federal project permitting requirements/issues/approvals do you anticipate in order for the feasibility study to be conducted? If approvals are required, indicate whether you have obtained them. If you have not obtained the necessary permits/governmental approval, describe the steps you have taken to obtain them. If no permits are needed, please provide explanation.**

For this phase of feasibility study, it is anticipated that the only state or federal project permitting requirements would be for the Phase II Cultural Resources Investigations for shovel testing activities. The District currently does not have the necessary permits. The District has engaged Archaeological Investigations Northwest on the Phase I Cultural Resources Investigations and they have extensive experience in obtaining the necessary permits and coordination with SHPO required for permitting the cultural resources investigation activities.

For the other pieces of work proposed in this phase, other clearances are not expected. The District already operates a gage on Drift Creek that will be used to collect real-time stream data for the other analyses. Field investigations are expected for each study proposed, and the District will coordinate access agreements to fulfil those studies.

8. **Describe the level of involvement, interest and/or commitment of local entities associated with the feasibility study. Describe how the feasibility study and/or proposed project will benefit/impact these entities. Attach letters of support if available.**

East Valley Water District continues to work with our partners who submitted earlier letters to us and to the Water Resources Department for past grant applications and awards. In November 2015, the District was instrumental in convening the Pudding River Watershed Place-based Planning Group. The group consists of Marion County and City of Silverton (co-conveners), City of Mt. Angel, Clackamas Soil and Water Conservation District, Marion Soil and Water Conservation District, East Valley Water District and the Pudding River Watershed Council. The District provided significant support, through executive secretary Lauren Reese and board members Glenn Goschie and Duane Eder, in drafting and submitting a grant application to the Oregon Water Resources Department for the Place-based Planning Pilot Program. The District is hopeful that this group will be able to provide a venue for discussing and resolving water supply, water quality and ecological issues in the Pudding River Watershed. The District also looks forward to providing a significant amount of resources through past and present studies to the group for further collaboration and learning opportunities in the basin.

The Soil and Water Conservation Districts continue to support the conservation measures and environmental aspects of the project and the ability for the eventual project to serve their constituents as well as the District's constituents.

The District continues to work with Marion County, both with the land use department as well as the economic development division as it moves forward with the project.

Other partners in the basin continue to support the District's work on behalf of their constituents from the development of the reservoir and delivery system, including NORPAC Foods and Oregon Water Resources Congress that have provided letters of support for our efforts.

The District is also grateful for the support of our elected officials that have provided their written support in the past and currently. Attached is a letter of support from Representative Vic Gilliam.

In addition to the support received from the agriculture industry, water and environmental groups, and elected officials, this project is extremely important to the over 75 members of the District that need a stable and reliable source of water. Our membership is dependent on this project for the future of their families and farms. East Valley Water District is proud to represent the farmers in our District in securing this stable source of water.

9. **Identify when matching funds will be secured, from whom, and the dates of matching funds availability.**

The District can fully match this grant award with existing resources and future district assessments. District assessments for 2015 are currently being collected ($29,733.75) and 2016 assessments will be due in early 2016 ($30,000). Current funds of the District ($16,586.25) can make up the balance of the grant match requirement.

10. **Provide a description of the relevant professional qualifications and/or experience of the person(s) that will play key roles in performing the feasibility study. If the personnel have not been decided upon, include a description of the professional qualifications and/or experience of the person(s) you anticipate will play key roles in performing the feasibility study.**

East Valley Water District is proud to have a team of consultants engaged in the project to perform the proposed work. The team includes:

Kevin Crew P.E., Principal of Black Rock Consulting: Kevin will coordinate the team of consultants on the project planning studies for this grant. Kevin has been involved managing in earlier work on this project and is a water resource engineer with 29 years of expertise in agricultural, energy and municipal projects. Kevin will be managing the District Distribution System Alternatives Analysis as well as the Ecological Flows Investigations.

Terry Buchholz P.E., C.W.R.E., D.WRE.: Principal of Integrated Water Solutions: Terry serves as the environmental permitting lead for the project. Terry was formerly with the U.S. Army Corps of Engineers for 15 years as well as 18 years of private consulting practice in water resources engineering and management as well as environmental studies. Terry will be managing the Elk Studies and Phase II Cultural Resources Analysis as well as serving as a technical advisor on the District Distribution System Alternatives Analysis and Ecological Flows Investigations.

David Dekrey M.S., Fisheries Biologist at Stillwater Sciences: Dave serves as the lead fisheries biologist for the project. Dave was formerly with Ellis Ecological working with Robert Ellis to perform several of the fish habitat analysis performed for the project. Dave has completed over 20 biological assessments for wide ranging water resources projects. Dave will serve as the technical lead for the Ecological Flows Investigation.

Christine Champe, M.S., President and Wildlife Biologist at Stillwater sciences: Christine is the senior wildlife biologist for the project. She has managed several complex hydroelectric permitting projects in Oregon; including several studies investigating elk impacts. Christine has also managed two studies focusing on the effect of water developments and water conveyance systems on elk and deer in Oregon and northern California.

Steve Cramer, Fish Scientist and Principal, Cramer Fish Sciences: Steve will continue to work with Dave Dekrey and his team on fish habitat analysis and modeling for the project. Steve worked with Oregon Department of Fish and Wildlife before starting his own firm and has over 35 years' experience in the field. Steve will work on the Ecological Flows Investigation.

Dr. Bolyvong Tanovan, hydrologic engineer/consultant: Dr. Tanovan serves as the hydrology lead for the project. He has over 45 years of experience in his field and was formerly with the U.S. Army Corps of Engineers and other major engineering firms. He has performed four updated hydrology reports for the project. Dr. Tanovan will serve as a technical advisor to the Ecological Flows Investigation as well as the District Distribution System Alternatives Analysis.

John L. Fagan, Ph.D., RPA, President/Senior Archaeologist at Archaeological Investigations Northwest: John is the lead for all cultural resources investigation. AINW and John will complete the Phase II Cultural Resources Analysis. AINW has over 23 years of cultural resources experience and employs 19 archaeologists and historians to support this effort.

Lauren Reese, Communication Specialist with Integrated Water Solutions: Lauren serves as the Executive Secretary of East Valley Water District as well as supporting public outreach, project management efforts, and environmental permitting. Lauren will continue to support and coordinate communication and administrative portions of the project.

11. **If the project concept is ultimately deemed feasible, describe how the project will be implemented. Response should include a tentative funding plan for project implementation (e.g. other state or federally sponsored grant or loan programs) and the project proponent's track record in implementing similar projects.**

The District is prepared to complete the necessary analyses to move through the regulatory phase of the Project into construction. Please see Attachment G for a detailed schedule of the steps to complete construction and implementation of the Project.

The District will prepare the necessary documentation and impact analyses needed for the Joint Permit Application through spring of 2016. It is anticipated a draft of the permitting package will be submitted to the regulatory agencies (Kaizen Group) in May 2016. After resolving comments of that draft, a final permitting package will be submitted in July 2016. It is anticipated that the regulatory agencies will have several questions and need more information, thus elk, cultural resources, and other environmental analyses will be performed upon the request of the agencies. It is anticipated that the regulatory phase of this project will last from July 2016 – summer 2018. Parallel to that process, the District will work through the Water Right Process and Project Design. Currently, the District estimates that permits and clearance could be obtained by end of July 2018, with construction beginning immediately after. Construction is expected to last July 2018 – July 2020; with post construction monitoring until July 2024. Attachment G provides substantial detail on the implementation of this Project.

The District anticipates a three-pronged approach to funding this project; consisting of District funding, state funding, and federal funding from a combination of grants and loans.

Oregon State University performed an Agriculture Economic Value Analysis to understand the ability for the District to fund and maintain this project (Attachment B, pages 28 - 30). The study found that the District, as well as Marion County, represents a diverse and economically value agriculture source for the state of Oregon. The study demonstrates the ability for the District to contribute in this funding strategy. This contribution takes into account farm investment, expenses and returns to management, equity and labor. Thus, this is a valuable resource to District patrons, and they have proven their ability to support and fund this project to move forward to construction.

The District also expects to use a variety of federal and state funding programs. A combination of grants and loans are being investigated by the District; including Oregon Water Resources Department's funding opportunities through the Water Resource Development Account.

Completion of this project is estimated to cost $65 million. In the next three years, the District will put a significant amount of effort to finalize the funding strategy to achieve a reliable and sustainable water source for its patrons.

Section B. Unique Criteria

Instructions: Address the set of items below that applies to the type of feasibility study that this grant will fund.

☐ Water Conservation or ☐ Reuse

1. Water Conservation or Reuse projects that are identified by the Department in a statewide water assessment and inventory receive a preference in the scoring process. Contact the Department's Grant Specialist to include your project on the inventory.

2. Explain how the associated project will either: (a) mitigate the need to develop new water supplies and/or (b) use water more efficiently. Reference documentation and/or examples of the success of similar or comparable water conservation/reuse projects that would be available upon request.

3. Provide a description of: (a) Local, state and/or federal permitting requirements and issues posed by the **implementation** of the project associated with the feasibility study and (b) property ownership status within the project implementation area. If permitting or other approvals are not needed please indicate and provide an explanation.

☒ Above-Ground Storage

Please answer the following three questions **BEFORE** proceeding:

Will the project divert more than 500 acre-feet of surface water annually? ☒ Yes ☐ No

Will the project impound surface water on a perennial stream? ☒ Yes ☐ No

Will the project divert water from a stream that supports sensitive, threatened or endangered species? ☒ Yes ☐ No

If you answered "Yes" to any of these questions, by signature on this application, you are committing to include the following required elements in your feasibility study.

Describe how you intend to address the required elements in your feasibility study:

a) Analyses of by-pass, optimum peak, flushing and other ecological flows of the affected stream and the impact of the storage project on those flows.

East Valley Water District provided a preliminary analysis of ecological flows in 2011 (submitted to OWRD.) However, the District wishes to do a more detailed analysis on the ability of the project to improve ecology below the reservoir. Thus, this feasibility study proposes a more detailed analysis on the flow and habitat conditions needed to improve fish habitat and the additional storage required to be able to provide suitable conditions for downstream ecology.

b) Comparative analyses of alternative means of supplying water, including but not limited to the costs and benefits of water conservation and efficiency alternatives and the extent to which long-term water supply needs may be met using those alternatives.

East Valley Water District has performed several alternatives analysis and submitted findings to OWRD in 2011 and 2013. An extensive review of alternate water supply sources have been evaluated by the District, including potential use of reclaimed water from the City of Salem facilities, groundwater recharge, use of stored water in the federal reservoirs on the Willamette and three other potential storage sites. In over a decade of analysis, the Drift Creek site for a surface water reservoir was deemed the most feasible alternative for securing a stable and reliable water supply for the District. This alternatives analysis is discussed in further detail in Attachments A and D.

As a part of this application, the District wishes to evaluate two different distribution strategies for transporting the water from the reservoir to the District. The District wouldlike to investigate three distribution system alternatives as a part of this application.

c) Analyses of environmental harm or impacts from the proposed storage project.

East Valley Water District has made significant progress toward analyses of environmental harm or impacts, details have been submitted to reports to OWRD in 2011 and 2013. It is anticipated that a biological assessment will be able to be drafted in 2016 with the completion of the fisheries and elk studies. The District has also completed a wetland delineation report.

d) Evaluation of the need for and feasibility of using stored water to augment instream flows to conserve, maintain and enhance aquatic life, fish life and any other ecological values.

The feasibility studies proposed in this grant application will do a further analysis of the ability for stored water to augment instream flows to enhance aquatic life, fish life and other ecological values. The District will also look at the potential for additional storage and habitat restoration needed to further improve ecology downstream from the project.

Is the proposed storage project for municipal use?

☐ Yes ☒ No

If "Yes," then please describe how you intend to address the following required element in your feasibility study:

e) For a proposed storage project that is for municipal use, analysis of local and regional water demand and the proposed storage project's relationship to existing and planned water supply projects.

Proceed in addressing the following items:

1. Describe to what extent the project associated with the feasibility study includes provisions for using stored water to augment instream flows to conserve, maintain and enhance aquatic life, fish life or other ecological values. Projects that include the above provisions receive preference in the scoring process.

   East Valley Water District recognizes the opportunity to provide benefits and enhance aquatic life, fish life and other ecological values through providing flow augmentation from the stored water. Thus, this grant proposal includes tasks to do a more detailed analysis of the quantity and timing of flows that would provide the most benefit cross walked with the detailed habitat assessments performed by the District. The studies included in this grant application will give the District the ability to plan and design project features that provide ecological benefit within and downstream of the reservoir. More detail on this study and process can be found in Section A, questions 4 and 5.

2. Provide a review of: (a) Local, state and/or federal permitting requirements and issues posed by the **implementation** of the project associated with the feasibility study and (b) property ownership status within the project implementation area.

   East Valley Water District has produced a detailed permitting table identifying the local, state, and/or federal clearances associated with planning and implementing the project. This detailed table is included as Attachment F.

   The District does not currently own the land needed to implement the project. However, the District plans to work with all landowners in a fair and equitable manner. The District has had preliminary conversations with several of the landowners in the project area regarding this manner.

☐ Storage Other Than Above-Ground [Including Aquifer Storage and Recovery (ASR)]

Please answer the following three questions **BEFORE** proceeding:

Will the project divert more than 500 acre-feet of surface water annually? ☐ Yes ☐ No

Will the project impound surface water on a perennial stream? ☐ Yes ☐ No

Will the project divert water from a stream that supports sensitive, threatened or endangered species? ☐ Yes ☐ No

If you answered "Yes" to any of these questions, by signature on this application, you are committing to include the following required elements in your feasibility *study.*

Describe how you intend to address the required elements in your feasibility study:

a) Analyses of by-pass, optimum peak, flushing and other ecological flows of the affected stream and the impact of the storage project on those flows.

b) Comparative analyses of alternative means of supplying water, including but not limited to the costs and benefits of water conservation and efficiency alternatives and the extent to which long-term water supply needs may be met using those alternatives.

c) Analyses of environmental harm or impacts from the proposed storage project.

d) Evaluation of the need for and feasibility of using stored water to augment instream flows to conserve, maintain and enhance aquatic life, fish life and any other ecological values.

Is the proposed storage project for municipal use?

☐ Yes ☐ No

If "Yes," then please describe how you intend to address the following required element in your feasibility study:

e) For a proposed storage project that is for municipal use, analysis of local and regional water demand and the proposed storage project's relationship to existing and planned water supply projects.

Proceed in addressing the following items:

1. Underground storage projects that are identified by the Department in a statewide water assessment and inventory receive a preference in the scoring process. Contact the Department's Grant Specialist to include your project on the inventory.

2. Provide a review of: (a) Local, state and/or federal permitting requirements and issues posed by the **implementation** of the project associated with the feasibility study and (b) property ownership status within the project implementation area.

V. Match Funding Information

Applicants must demonstrate a minimum dollar-for-dollar match based on the total funding request. The match may include a) secured funding commitment from other sources, b) pending funding commitment from other sources, and/or c) the value of in-kind labor, equipment rental, and materials essential to the feasibility study. For secured funding, you must attach a letter of support from the match funding source that specifically mentions the dollar amount shown in the "Amount/Dollar Value" column. For pending resources, documentation showing a request for the matching funds must accompany the application.

In the "type" column below matching funds may include:	In the "status" column below matching funds may have the following status:
• **Cash** - Cash is direct expenditures made in support of the feasibility study by the applicant or partner*.	• **Secured** - Secured funding commitments from other sources.
• **In-Kind** - The value of in-kind labor, equipment rental and materials essential to the feasibility study provided by the applicant or partner.	• **Pending** - Pending commitments of funding from other sources. In such instances, Department funding will not be released prior to securing a commitment of the funds from other sources. Pending commitments of the funding must be secured within 12 months from the date of the award.

*"Partner" means a non-governmental or governmental person or entity that has committed funding, expertise, materials, labor, or other assistance to a proposed project planning study. OAR 690-600-0010.

Match Funding Source (if in-kind, briefly describe the nature of the contribution)	**Type** **(✓ One)**	**Status** **(✓ One)**	**Amount/ Dollar Value**	**Date Match Funds Available** *(Month/Year)*
2015 District Development Assessments	☒ cash ☐ in-kind	☒ secured ☐ pending	*$29,734*	*September 16*
2016 District Development Assessments	☒ cash ☐ in-kind	☐ secured ☒ pending	*$30,000*	*April 16*
District Development Account Funds	☒ cash ☐ in-kind	☒ secured ☐ pending	*$16,586*	*January 16*
	☐ cash ☐ in-kind	☐ secured ☐ pending		
	☐ cash ☐ in-kind	☐ secured ☐ pending		
	☐ cash ☐ in-kind	☐ secured ☐ pending		
	☐ cash ☐ in-kind	☐ secured ☐ pending		
	☐ cash ☐ in-kind	☐ secured ☐ pending		
	☐ cash ☐ in-kind	☐ secured ☐ pending		
	☐ cash ☐ in-kind	☐ secured ☐ pending		

VI. Feasibility Study Schedule

Estimated Study Duration: February 1, 2016 to November 1, 2017

Place an "X" in the appropriate column to indicate when each Key Task of the project will take place.

	2016			2017				2018 & Beyond
Feasibility Study Key Tasks	**2nd Qtr**	**3rd Qtr**	**4th Qtr**	**1st Qtr**	**2nd Qtr**	**3rd Qtr**	**4th Qtr**	
Evaluation of District Distribution System Alternatives	X	X	X					
Analyze Storage Required to provide By-pass, Optimum Peak, Flushing and Other Ecological Flows	X	X	X					
Further Evaluation of Elk Presence and Potential Project Impacts		X	X	X	X	X	X	
Conduct Phase II Cultural Resources Investigations	X	X	X					
Administrative	X	X	X	X	X	X	X	

- **Please Note**: Successful grantees must include all invoices and identify which key tasks are associated with each invoice when requesting financial reimbursement.

VII. Feasibility Study Budget

Section A

Please provide an estimated line item budget for the proposed feasibility study. Examples would include: labor, materials, equipment, contractual services and administrative costs.

Line Items	Number of Units* (e.g. # of Hours)	Unit Cost (e.g. hourly rate)	In-Kind Match	Cash Match Funds	OWRD Grant Funds	Total Cost
Staff Salary/Benefits	*0*	*$0.00*	*$0*	*$0*	*$0*	*$0*
Contractual/Consulting	*1192*	*$120.00*		*$71,520*	*$71,520*	*$143,040*
Equipment (must be approved)						
Supplies						
Other:						
Administrative Costs**	*80*	*$120.00*		*$4,800*	*$4,800*	*$9,600*
		Total for Section A		*$76,320*	*$76,320*	*$152,640*
		Percentage for Section A				***100%***

** Note: The "Unit" should be per "hour" or "day" – not per "project" or "contract."* *<u>Units x Unit Costs = Total Cost</u>*
*** Administrative Costs may not exceed 10 percent of the total funding requested from the Department*

Section B

If grant amount requested is $50,000 or greater, you MUST complete Section B. Key Tasks in Section B should be the same as the Key Tasks in Section VI (Feasibility Study Schedule).

Feasibility Study Key Tasks	In-Kind Match	Cash Match Funds	OWRD Grant Funds	Total Cost
Evaluation of District Distribution System Alternatives		*$12,000*	*$12,000*	*$24,000*
Analyze Storage Required to provide By-pass, Optimum Peak, Flushing and Other Ecological Flows		*$19,440*	*$19,440*	*$38,880*
Further Evaluation of Elk Presence and Potential Project Impacts		*$10,080*	*$10,080*	*$20,160*
Conduct Phase II Cultural Resources Investigations		*$30,000*	*$30,000*	*$60,000*
Administrative (Project and Grant Management)		*$4,800*	*$4,800*	*$9,600*
Total for Section B		*$76,320*	*$76,320*	*$152,640*

Totals in Section B must match the totals in Section A

APPLICATION CHECKLIST

Instructions: Use this checklist to ensure that your application is complete. An incomplete application will jeopardize your application's review. **<u>This form does not need to be included in your application packet.</u>**

General

If submitting electronically, the preferred format is either a Microsoft word or Adobe pdf

- ☐ Only one application is included with the packet (other applications must be sent separately).

Paper submissions only

- ☐ The application and attachments are on 8 ½" x 11" paper.
- ☐ The application and attachments are single-sided.
- ☐ The application and attachments are not stapled or bound.

Section I – Grant Information

- ☐ All questions in this section have been answered.
- ☐ The Grant Dollars Requested and the Total Project Cost mirror the totals shown in Section VII.

Section II – Applicant Information

- ☐ All contact information for the applicant(s) and fiscal officer is complete and current.
- ☐ The certification is signed by an authorized signer.

Section III – Feasibility Study Summary

- ☐ A brief summary, of no more than 150 words, is complete.

Section IV – Grant Specifics

- ☐ All questions in Section A have been answered.
- ☐ If the type of feasibility study is water conservation, reuse or storage other than above-ground, you have contacted the Department and requested project be added to the Oregon Water Resources Department's statewide water assessment and inventory.
- ☐ All applicable questions for the type of grant requested have been answered.

Section V – Match Funding Information

- ☐ Applicant has identified that at least 50 percent match has been sought, secured or expended.
- ☐ Letters of support are included for "secured" match funding sources.
- ☐ Documentation is included for "expended" match funds.
- ☐ Documentation is included for "pending" match funds.

Section VI – Feasibility Study Schedule

- ☐ Estimated project duration dates have been supplied.
- ☐ All Key Tasks of the project are listed.

Section VII – Feasibility Study Budget

- ☐ Section A is complete.
- ☐ Administration costs do not exceed 10 percent of the requested OWRD Grant Funds.
- ☐ If grant amount requested is $50,000 or greater, Section B has been completed.
- ☐ All Key Tasks listed in Section B mirror the Key Tasks listed in Section VI.

RECONNAISSANCE LEVEL INVESTIGATION OF A WATER RESOURCES PROJECT AND DEVELOPMENT PROGRAM

FOR

PUDDING RIVER BASIN WATER RESOURCES DEVELOPMENT ASSOCIATION

FEBRUARY, 1994

Prepared by

Tucson Myers & Associates

In Association With

David J. Newton Associates, Inc. — Campbell Craven Environmental Consultants

M. John Youngquist — Delvin E. Plaisance, P.E.

PUDDING RIVER BASIN WATER RESOURCES DEVELOPMENT ASSOCIATION

SUMMARY

A major portion of the agricultural production in Marion County occurs in the Pudding River Drainage Area and both surface and groundwater sources supply the significant amounts of irrigation. Groundwater costs range from about $20 to $70 per acre, with a representative value being $40 per acre. Seasonal shortages occur as streamflows drop during the low-flow season, and many users are subject to administration to meet uses with more senior priorities. There are storage facilities in the Drainage Area that serve a few individual farms, but no large-scale or communal reservoirs exist.

The Oregon Water Resources Department has established the Mt Angel and Gladtidings Groundwater Limited Areas (GLA) in the vicinity. The Mt Angel GLA includes about 10,640 acres in the vicinity of Mt Angel and the Gladtidings GLA includes about 16,000 acres. Expanded groundwater use for all but domestic purposes is prohibited by the Department. Additionally, in the Mt Angel GLA, about 2,930 acres irrigated from groundwater sources could be affected by this ruling, of which about 640 acres have been irrigated without water rights, but have submitted applications now pending before the Department. About 1,100 acres are irrigated under permits that, because of the limited area designation, may not be granted certificates. Thus, nearly three square miles of high-value, intensified irrigated agriculture that supply major food-processing operations may be forced to revert to a dry-farm operation.

These conditions motivated water users in both Clackamas and Marion counties to form the Pudding River Basin Water Resources Development Association in early 1993. The Association, through membership fees and donations, raised funds to implement a water resources investigation and water supply formulation study, which this report describes.

The proposed service area includes lands in a triangular shaped area to the east of Pudding River south of Highway 211, the road connecting Woodburn and Molalla, west of Highway 213 and north of Silverton Road.

The Association's major objectives for the study include:

- evaluation of groundwater conditions within the service area
- identification of water needs to meet current and future water needs in the service area
- develop alternatives to meet the needs for all uses
- identify a program to enable the Association to implement the selected alternative.

Primary findings of the study are summarized as follows:

- GROUNDWATER

  Well installation and deepening inside the service area increased annually in the late 1960's and early 1970's. Some concentrations of new wells and deepening were inside the Mt Angel and Gladtidings Groundwater Limited Areas. Many wells were deepened to increase well yield in response to increasing markets for higher value food crops that were developing in the mid 1970's, not because of declining water levels in existing irrigation wells. Irrigation wells in the service area rely primarily on deeper basalt aquifers for water supply.

Most domestic wells tap water bearing zones in sedimentary formations that overlay the deeper basalts. Deepening of these wells does not appear to be directly related to irrigation since domestic and irrigation water supplies are obtained from separate water bearing systems that have little, if any, hydraulic relationship.

Seasonal declines in water table elevations occur, but water levels seem to recover during the time of year when lands are not being irrigated. Initial water level measurements were taken at the time wells were drilled. Since 1989, OWRD has measured wells annually, and these recent measurements show lower elevations than those made initially, up to 30 years previously. These data reflect water level declines, however the rate and actual magnitude of decline is not clear in the absence of seasonally consistent measurements. Although declines have occurred, there is available groundwater under an appropriate monitoring and management program.

Wells for which permits have been issued and those for which applications have been submitted have been in use. Thus, were the Department to approve the pending applications, no expanded use of groundwater would result.

- WATER NEEDS

Within the service area permits and certificates for primary supplies from surface water sources allow water to be diverted to irrigate about 10,800 acres. There are applications for about 940 acres on file with the Department of Water Resources.

Not all lands with certificates and permits are able to obtain reliable full-season irrigation supplies from unregulated surface water sources. The basis of Oregon's water law is "first in time, first in right". As streamflows decrease in spring and early summer, streams may be "administered" by Watermasters, which amounts to prohibiting users with junior, or more recent, rights from continuing to divert water so that water may reach users with more senior, or older, rights.

Instream water rights for aquatic life have been established that specify flow rates to be maintained in Pudding River and Silver, Abiqua and Butte Creeks in the service area. An excerpt of specified flows during the lower-flow season is tabulated below:

		PUDDING RIVER		BUTTE CREEK	ABIQUA CREEK	SILVER CREEK
		MT ANGEL TO AURORA	ABOVE MT ANGEL	SCOTTS MILLS TO MOUTH	ABIQUA CREEK @ MOUTH	SILVERTON TO MOUTH
PRIORITY		6/22/1964	6/22/1964	12/22/1988	11/3/1983	11/3/1983
				(Cubic Feet per Second)		
MAY	16-31	35	10	75	75	60
JUN	1-15	35	10	75	60	50
	16-30	35	10	50	40	35
JUL	1-15	35	10	25	25	23
	16-31	35	10	25	20	23
AUG	1-15	35	10	12	15	23
	16-31	35	10	12	15	23
SEP	1-15	35	10	20	15	23
	16-31	35	10	20	15	23
OCT	1-15	35	10	75	40	23
	16-31	35	10	75	60	60

With regard to irrigation rights that have priority dates senior to the instream water rights, representative "normal" flows in Silver Creek are adequate to meet legal diversion amounts. In Butte Creek, "normal" flows decrease to levels that subject over 3,040 acres in the service area to possible administration during July and August. Flow conditions in Pudding River are such that about 325 acres are subject to administration from mid-July through August, to supply more senior rights.

Consideration of rights with priority dates junior to the instream rights in Silver Creek show that about 90 acres are subject to administration to meet instream rights from late May through early September, under "normal" flow conditions. There are no rights junior to the instream rights on Butte Creek. In Pudding River, about 780 acres with rights junior to the instream right are subject to administration during the months of July through September.

In addition to rights for water to be diverted, "normal" estimated monthly streamflows in Pudding River and tributaries also are insufficient to meet flows specified by the instream water rights. In Silver Creek the total for all months during which shortages occur is about 6,000 acre-feet annually, in Butte Creek the annual shortage amounts to about 7,450 acre-feet and in Pudding River, about 2,710 acre-feet. Hydrologic studies show that watershed parameters in the Abiqua Creek drainage are similar to those in Silver Creek, and instream right shortages are assumed to be equal to those in Silver Creek.

Within the service area, Bureau of Reclamation land classification data show that there are about 33,360 acres of net productive land. As a measure of the irrigation demand for use in analysis of water supply alternates, the Association decided to include the acreage within the Groundwater Limited Areas that have permits and for which applications have been filed, amounting to about 2,100 acres. The cost of water from some wells in the area is in the $60 to $70 per acre range. Were supplies from a proposed project to be less expensive, these users would be prone to purchase a supply and about 900 acres are included to represent this probability. Additionally, a water supply for about 4,500 acres of irrigable but currently unirrigated lands are included. Thus, water to meet the needs of 7,500 acres constitutes the need for irrigation in project formulation studies. An amount of water for augmentation of streamflows in Pudding River and its tributaries also is to be included.

Irrigation water requirements were estimated for the service area in a number of past project investigations and planning studies. These reviews commonly developed per-acre estimates of irrigation requirements in the 1.5 to 1.8 acre-feet per acre range. In discussions with irrigators in the proposed service area, and in review of responses to well-use questionnaires, a figure of 0.75 acre-feet per acre is a representative measure of current use for full-season crops, indicating highly efficient irrigation practices. A value of 1.0 acre-foot per acre is used to estimate water requirements for development and evaluation of alternatives in the proposed service area.

- ALTERNATES

Alternates considered include groundwater recharge, purchase and importation of water from Detroit Reservoir and identification of surface water storage facilities, either a series of smaller reservoirs where development could be staged to meet needs as they arise, or a single relatively large-scale facility with capacity to meet all future needs.

- Groundwater Recharge

- Groundwater recharge is deemed infeasible for three reasons:

- Use of the aquifers for seasonal storage would require a surface water source with accompanying diversion structures or storage reservoir. Before injection, water treatment would be needed in order to meet state mandated non-degradation standards. The cost of treatment facilities would be excessively high.

- In order to meet the demands for an injection well recharge system, several wells would be required. Each injection well must be connected to the diversion or surface storage reservoir, requiring a network of pipes or canals.

- The capacity of the basalt aquifer to receive and transport injected water to points of use is presently unknown. Insufficient hydrogeological data exist to answer many questions that arise in consideration of this topic.

- Purchase and Importation of Water

Water purchased from storage in Detroit Reservoir may be used for irrigation and related purposes only. No supplies for augmenting flows to meet instream needs could be purchased. Consequently, an exchange concept was developed whereby water would be purchased to obtain a supply for the 7,500 acres noted above with additional water purchased to provide a full-season supply to all current water right holders that divert from major tributaries and from Pudding River in and downstream from the project area. This would amount to water for nearly 15,900 acres. Once supplied, water right holders would be requested to relinquish their rights and leave water they customarily divert instream. Evaluation of water rights data indicate that during July, the month of peak irrigation use, these users from Pudding River and its tributaries can legally divert about 90 CFS which, under this concept would remain instream, more than double the average flow measured in Pudding River at Mt Angel.

The facilities required to implement this alternate include a diversion from the North Santiam and a pumping plant to be located just to the east of the city of Stayton, a 66" diameter pipeline routed along public roads to the east and around the north side of Sublimity and thence following the Cascade Highway for a total distance of about 5 miles. At this location, the channel of Pudding River crosses Cascade Highway, and the pipeline would discharge into Pudding River, at about river mile 59. In sizing these facilities, discussions were held with landowners in the Sublimity area and an interest in purchasing water from the pipeline for about 850 acres was ascertained. Thus, once the proposed pipeline passes north of a divide about three miles north of Sublimity and releases to these acreages have been made, the pipeline diameter is reduced to 60". A small hydro-electric plant will be located at the terminus of the pipeline at Pudding River that would operate as flows are discharged.

Purchased water would remain in Pudding River to about river mile 48, where a pumping plant would be constructed to divert imported water for irrigation and exchange/augmentation purposes in the service area and tributaries to Pudding River. Water for exchange/augmentation in Pudding River would be left instream. A pipeline would be routed along public road rights of way to the north of Silverton, with branch lines and/or turnouts to Silver, Abiqua, Zollner and Butte Creeks and to tributaries of Rock Creek in the vicinity of Marquam. Water for irrigation would be released to these streams in lieu of an area-wide pipeline distribution system. Exchange/augmentation water also would be released to each tributary and subsequently reach Pudding River.

Under this concept Mt Angel could acquire an irrigation right with a senior priority and convert the use to municipal purposes. With exchange/augmentation flows present in Pudding tributaries, the supply should be reliable.

- Storage

Over 75 reservoir sites have been identified during studies conducted in the mid- and late-sixties on streams in the vicinity of the proposed project area. A number of dam site inventories formed the basis for site evaluation for this study. Criteria for screening is tabulated below:

- Sufficient inflow must exist at the site to assure a yield adequate to meet service area needs.

- Environmental conditions at the site must allow for site development. This includes consideration of perceived mitigation requirements in light of project related natural resource enhancement.

- The site location must be such that delivery of stored water to the service area may be made at reasonable cost.

- Given existing opportunities for project financing available to the Association, preference will be given to sites with minimum repayment costs.

These criteria are utilized in selection of a site for implementation by the Association. Criteria established by other sponsors for possible implementation of projects of differing scale, to meet different needs or those being evaluated under different priorities would likely find other sites to be suitable.

Three sites were selected for more detailed examination, and are:

- Lower Grange at about stream mile 9 on Silver Creek
- A site at about stream mile 14 on Abiqua Creek, and
- Del Aire Ranch site at about stream mile 14 on Butte Creek.

Water from Lower Grange would be released to Silver Creek to meet project demands. The topography of the canyon downstream of the dam is such that delivery of water to the service area would require a pumping plant and pipeline to lift water over a ridge between Silver Creek and the proposed service area, making water more expensive than from an alternate site.

The cost of construction of storage at the Abiqua Creek site is found to be prohibitive, as a dam to create the necessary storage would require the largest volume embankment of the three sites under consideration.

The Del Aire Ranch site is the preferred site. Surface geology appears acceptable for construction of a Roller Compacted Concrete (RCC) structure. An abbreviated operation study shows that a dam to create a reservoir of about 36,270 acre-feet would be necessary to reliably meet service area demands. The storage amount includes an allowance of 500 acre-feet for inactive storage, about 21,070 acre-feet to regulate flows occurring in a "normal" year and about 14,700 acre-feet for "carry-over" storage to meet demands in years when flows are less than "normal".

To meet project demands, releases would be made to Butte Creek. At a point about 1/2 mile east of Highway 213 some of the releases for irrigation and for exchange/augmentation would be diverted into a pipeline for delivery to Zollner and Abiqua Creeks to the south of Butte Creek and to Rock Creek tributaries in the vicinity of the community of Marquam, to the north. Releases to meet demands to be diverted from Butte Creek would remain in that stream below the pipeline diversion. The pipeline would be located in the right of way of Highway 213.

Development of storage in the basin, even though the project capability would be based on water needs and purposes as currently perceived, will provide flexibility in management of water resources in the future. About 2/3 of the project capacity will be related to providing for increased flow in Pudding River and tributaries during times of low flow, which will contribute to alleviation of existing concerns over water quality conditions and will improve use of streams for natural resource purposes. Mt Angel will be able to purchase a supply from the project, although the city would need to upgrade its treatment facilities. Highly reliable full-season irrigation supplies would be available for all presently irrigated lands in the service area, with capacity for development of new lands.

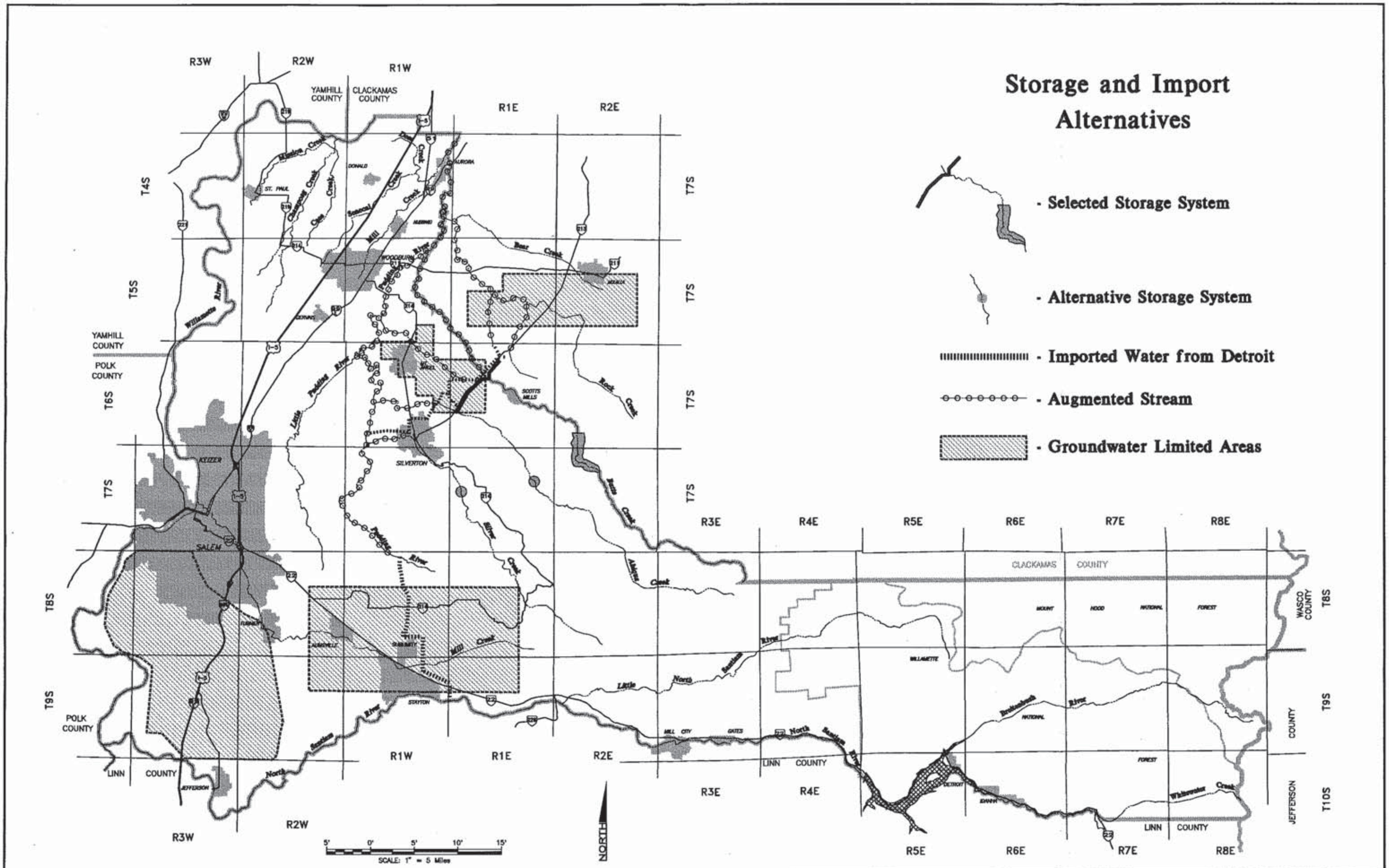
- FINANCING AND IMPLEMENTATION

Estimates for the alternates show project costs in the range of $45 to $55 million dollars, beyond the ability of conceivable sponsors to fund without some borrowing. There is a Federal program that has been used by other entities in Oregon and throughout the west, whereby a portion of the costs attributable to natural resource functions may be offset by grants. Given the direction of Federal and State priorities, and previous actions by Congress in setting grant portions for like purposes in similar programs, we are of the opinion that a storage project can be affordable.

The basis for financing the project would be the existing Federal program. This program provides for grants and a loan to be repaid from project revenues. The program requires a contribution from the sponsor, to be made during construction. The funds necessary to make the contribution can come from two sources. One source would be from the counties, who would provide the costs of relocating and constructing county roads at the reservoir site and construction and operation of recreational facilities at the reservoir. The second is from the sale of bonds by the Association to finance rights of way acquisition, make cash contributions to construction and to retro-fit a hydro plant when the dam is completed, to produce revenue from releases made for project purposes.

To repay the resulting Federal loan and the bonds, revenue would be obtained through water sales to irrigators and other water users. Based on our estimates of project and the net repayment costs for both the Federal loan and the bonds, sufficient funds to cover these amounts could be obtained from annual water charges to irrigators under the following price schedule:

CATEGORY	WATER PRICE ($/ACRE/YEAR)
LANDS WITH RELIABLE FULL SUPPLIES - RARE SHORTAGES	2.00
LANDS W/ PRIORITIES SENIOR TO INSTREAM RIGHTS - PERIODIC ONE MONTH SHORTAGES	7.50
LANDS W/ PRIORITIES JUNIOR TO INSTREAM RIGHTS - FREQUENT TWO TO THREE MONTH SHORTAGES	20.00
LANDS W/ NO SURFACE WATER RIGHTS - FULL SUPPLY FROM PROJECT	40.00



474/211/STIMPALT 7/21/94

RECONNAISSANCE LEVEL INVESTIGATION OF A WATER RESOURCES PROJECT AND DEVELOPMENT PROGRAM

FEBRUARY, 1994

REGISTERED PROFESSIONAL
ENGINEER
6762
OREGON
JULY 17, 1970
TUCSON H. MYERS

TUCSON MYERS & ASSOCIATES
246 PEACH STREET
SILVERTON, OR, 97381-2433
503-873-8472

February 15, 1994

Board of Directors
Pudding River Basin Water Resources Development Association
P.O. Box 851
Mt Angel, OR
97362

Gentlemen:

This is to transmit the report RECONNAISSANCE LEVEL INVESTIGATION OF A WATER RESOURCES PROJECT AND DEVELOPMENT PROGRAM in accordance with our agreement of July 19, 1993.

The least cost alternate is development of a 36,266 acre-foot reservoir at the Del Aire site on Butte Creek. Construction cost for the assumed roller-compacted-concrete structure is estimated to be about $53,800,000, and with federal grants as assumed would provide water at a cost of $40 per acre, or less. The reservoir would provide water to 7,500 acres in the service area, and would also provide full-season supplys to nearly 15,900 acres under an exchange concept. Landowners would exchange customary diversions for use of stored water, under this concept. Water previously diverted then would remain instream for augmentation purposes. The report also describes a program for the Association during the remainder of 1994 and provides a grant application for acquiring funding to support the program.

Each member of the team has enjoyed participation in the study. We sincerely hope this report contributes to solution of your complex water problems.

Thank you for the opportunity.

Sincerely,

Tucson H Myers

Tucson Myers & Associates
Tucson H. Myers, P.E.

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(Bound at end of report)

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CHAPTER I

AREA DESCRIPTION & STUDY OBJECTIVES

The Pudding River Drainage Area comprises the northern and eastern portion of Marion County and the southern portion of Clackamas County. The western boundary of the drainage area lies approximately along Interstate 5 and to the east of Salem. Butte Creek, a major Pudding River tributary, is the easterly boundary of the area, contiguous with the county line, and Pudding River itself, from the confluence with Butte Creek north to Aurora. The southern boundary of the drainage area lies to the north of the communities of Shaw, Aumsville and Sublimity.

The area is drained from the south and east by tributaries to the Pudding River including Drift, Silver, Abiqua and Butte Creeks. The Little Pudding River drains the southwestern portion of the area. The drainage areas of Silver, Abiqua and Butte Creeks reach elevations exceeding 4,000 feet in elevation in their headwaters. All other stream headwaters are in areas below 1,000 feet in elevation. Anadromous fish use the Pudding River to reach tributaries where spawning, egg incubation, hatching and smolt rearing occur. Resident species inhabit the lower reaches of Pudding River.

From Pratum (about river mile 55) to the Marion County line near Barlow (about river mile 5), the gradient of the Pudding River is shallow, stream velocities are low and the channel meanders through numerous oxbows. During low-flow periods of the year, water temperatures become high and other water quality conditions reach levels outside values tolerable to anadromous fish. The Department of Environmental Quality has declared the Pudding River a water-quality-limited stream.

Only two communities use tributaries of the Pudding for their water supplies; Silverton, that diverts from Abiqua Creek and from a storage reservoir on Silver Creek, and Scotts Mills that diverts supplemental supplies from Butte Creek during high-demand periods. Mt Angel, obtaining its water supply from wells is experiencing a decreasing yield from its primary well and has reached the limit of its supply during peak periods of use. The city is initiating a program to identify alternatives to acquire an additional supply. A number of communities discharge treated wastes when allowed under their existing NPDES permits, to the Pudding River. The communities of Mt Angel, Gervais and Hubbard hold treated effluents in lagoons for discharge during high-flow periods and Woodburn and Silverton have detailed planning studies of discharge alternates underway.

A major portion of the agricultural production in Marion County and Clackamas Counties occur in the Pudding River Drainage Area. Both surface and groundwater sources supply the significant amounts of irrigation. Groundwater costs range from about $20 to over $70 per acre, with a representative value being $40 per acre. Seasonal shortages occur as streamflows drop during the low-flow season, and junior users are subject to administration to meet uses with more senior priorities. There are storage facilities developed in the Drainage Area to serve a few individual farms, but no large-scale or communal reservoirs exist.

The Oregon Water Resources Department has established the Mt Angel Limited Groundwater Area that includes about 10,640 acres in the vicinity of Mt Angel. Expanded groundwater use for all but domestic purposes is prohibited by the Department. This ruling places severe limitations on Mt Angel's ability to acquire additional municipal supplies. Additionally, about 2,930 acres irrigated from groundwater sources could be affected by this ruling, of which about 640 acres have been irrigated without water rights, but have submitted applications now pending before the Department. About 1,100 acres are irrigated under permits that, because of the limited area designation, may not be granted certificates. Thus, nearly three square miles of high-value, intensified irrigated agriculture that supply major food-processing operations may be forced to revert to a dry-farm operation.

These conditions motivated water users in both Clackamas and Marion counties to form the Pudding River Basin Water Resources Development Association in early 1993. The Association, through membership fees and donations, raised funds to implement a water resources investigation and preliminary water supply formulation study.

The proposed service area includes lands in a triangularly shaped area to the east of Pudding River, south of Highway 211, west of Highway 213 and north of Silverton Road. The Association's major objectives for the study include:

- evaluation of groundwater conditions within the service area
- identification of water needs to meet current and future water needs in the service area
- develop alternatives to meet the needs for all uses
- identify a program to enable the Association to implement the selected alternative for meeting the needs.

CHAPTER II

LANDS

CHAPTER II

LANDS

This chapter discusses the criteria used to estimate the extent and quality of irrigable lands in the potential service area, the acreage that is deemed irrigable, lands that are irrigated and the amount of new lands that are to form the basis for estimation of the water requirements for the project.

LAND CLASSIFICATION CRITERIA

Due to possible funding opportunities, USBR (Bureau of Reclamation) land classification data are used as the measure of lands capable of sustaining irrigated agriculture. Maps of USBR's 1966 Reconnaissance Land Classification, the latest, were obtained and that data are used as the basis for the following analyses.

Classification standards used in the 1966 efforts remain valid with regard to the physical considerations of soils, topographic and drainage characteristics. The economic limitations shown in the specifications are outdated. Additionally, USBR has since expanded the specifications with regard to leaching requirements, quality of drainage effluent and other considerations that have arisen since these efforts were completed. As project studies are pursued, Land Classification for the service area should be updated.

Land Classification Specifications define the physical parameters relating to the sustainable productivity potential of lands under irrigation, and are presented in Table II-1, overleaf.

USBR describes characteristics of the three arable land classes as follows:

Class 1 — These lands have well-drained soils with good moisture retention capability. There is little or no limitation to cultural operations, with tillage possible over a wide moisture range. Inherently productive, with high cation exchange capacity, soils are deep and permit full root development for all climatically adapted crops.

These lands are well suited for irrigated farming, capable of producing sustained and relatively high yields of all crops at a reasonable cost. They can be irrigated readily and efficiently with the assumed on-farm sprinkler irrigation systems.

Class 2 — Lands classified at level 2 have moderate physical limitations that cause either reduced yield or increased production costs. In some cases these limitations affect both yields and costs. Class 2 lands with soil deficiencies are often droughty, requiring a higher management level to achieve high yields. If of a clayey nature they commonly have minor internal drainage problems that affect yields, at least for the higher value deep-rooted crops.

Class 2 lands are of good quality but are not capable of providing a net return to the irrigator as high as Class 1 lands.

Class 3 — Class 3 lands are the lowest classification mapped that can be considered feasible for irrigation. These lands have multiple deficiencies, generally of the soil and drainage or soil and topography. The effect is that yields of higher-value crops, i.e., orchard and truck crops, would be reduced severely, perhaps to the point of being infeasible. Therefore these lands are generally relegated to the production of lower value, more tolerant forage-type crops such as hay, pasture or small grains.

Class 6 — These lands are unsuitable for sustained irrigation because of excessive deficiencies in soils, topography, drainage, or combination thereof.

TABLE II-1

DETAILED LAND CLASSIFICATION SPECIFICATIONS FOR SPRINKLER IRRIGATION

Land Characteristics	Class 1	Class 2	Class 3
SOILS			
Texture (Surface - 18") (v,h)	Fine sandy loam to friable clay loam	Sandy loam, firm clay loam, or well aggregated clay. May be loamy sand if underlain by finer subsoil.	Loamy sand or clay. Clay should permit root development, water movement, and cultivation.
Depth to clean sand, gravel, cobble (k)	30" plus good free working soil of fine sandy loam or finer	20" plus good free working soil of fine sandy loam or finer; or 30" of sandy loam	15" plus good free working soil of fine sandy loam or finer; or 24" of coarser textured soil
Zone which slightly impedes drainage (p)	24"	15"	12"
Creviced rock or slowly permeable clay substratum (b)	48"	36"	18"
Dense sedimentary substratum (d)	60"	48"	30"
Cobble or gravel in plow layer (x)	Slight restriction (Less than 15% gravel or 5% cobble)	Moderate cultivation restriction (Less than 40% gravel or 25% cobble)	Serious cultivation restriction (Less than 70% gravel and 50% cobble)
TOPOGRAPHY			
Slope (g)	8 percent	14 percent	20 percent
Size-shape (j)[1]	8 acres	5 acres	2 acres
Surface rock (r)[2] or large cobble $3 per cubic yard	Removal cost not over $50/acre (17 cubic yards)	Not over $100/acre (33 cubic yards)	Not over $150 (50 cubic yards)
DRAINAGE			
Surface and subsurface drainage (o) drainage outlet requirements[2]	No specific farm drainage anticipated, under $50/acre; or 165' of 4" tile 6' deep	Not over $100; or 330' of 4" tile 6' depth; or 165' of open ditch 5' deep	Not over $150/acre; or 500' of 4" tile at 6' depth; or 250' of open ditch 5' deep
Drainage deficiency (w) water table	No evidence of development of growing season water table within 5' of surface	No evidence of development of permanent water table within 3' of surface	No evidence of development of permanent water table within 2' of surface

Class 6 - Lands unsuitable for sustained irrigation because of excessive deficiencies in one or more of the above characteristics.

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[1] Larger where shape materially increases labor requirement in irrigation and cultivation. Size limitation does not apply in cases where field constitutes an entire ownership.

[2] Land development costs shown constitute the maximum total permissible cost. Where more than one type of land development cost is included, the total per acre cost should not exceed $50 for Class 1, $100 for class 2, or $150 for class 3.

CLASSIFICATION RESULTS

Land classification maps were obtained from USBR for much of the Pudding Basin, with each map covering one township per sheet. Coverage and summary land classification results are listed in Table II-2.

TABLE II-2

LAND CLASSIFICATION RESULTS
(ACRES)

TOWNSHIP/RANGE	CLASS 1	CLASS 2	CLASS 3	TOTALS
4 South / 1 West	8,075	7,664	2,527	18,266
/ 1 East	9,156	7,589	2,979	19,274
5 South / 2 West	8,459	6,633	5,992	21,084
/ 1 West	9,331	7,045	3,208	19,584
/ 1 East	7,677	8,732	3,708	20,117
/ 2 East	455	9,047	6,697	16,199
6 South / 2 West	12,505	5,890	3,336	21,731
/ 1 West	5,419	9,419	4,068	18,906
/ 1 East	777	6,992	6,969	14,738
/ 2 East	0	2,550	3,407	5,957
7 South / 2 West	11,595	3,841	3,470	18,906
/ 1 West	2,796	8,079	6,582	17,457
/ 1 East	0	4,977	5,249	10,226
/ 2 East	0	1,114	463	1,577
TOTALS	76,245	89,572	58,655	224,022

The area covered by these sheets has a high-quality irrigable land resource in that nearly three-fourths (74%) of classified lands are in classes 1 and 2. It also may be noted that both the amount and quality of irrigable lands decrease to the south and east of the area covered.

The area within which evaluations are to be concentrated as suggested by the Association includes the area bounded on the north by Highway 211, extending from Molalla to Woodburn, on the east and south by Highway 213 from Molalla to Silverton and on the west by the channel of Pudding River and includes lands in four townships:

TOWNSHIP 5 SOUTH RANGE 1 WEST & RANGE 1 EAST
TOWNSHIP 6 SOUTH RANGE 1 WEST & RANGE 1 EAST

USBR maps were planimetered within this area to obtain acreages which are tabulated in Table II-3. Lands in Clackamas and Marion Counties are listed as well.

TABLE II-3
USBR GROSS IRRIGABLE LAND IN PROBABLE SERVICE AREA
(ACRES)

LOCATION	CLACKAMAS COUNTY				MARION COUNTY				SERVICE AREA TOTALS			
	CLASS 1	CLASS 2	CLASS 3	TOTAL[1]	CLASS 1	CLASS 2	CLASS 3	TOTAL[1]	CLASS 1	CLASS 2	CLASS 3	TOTAL[1]
T5S R1W	690	1,326	376	2,392	2,874	2,677	858	6,410	3,564	4,003	1,234	8,802
R1E	4,962	5,775	2,366	13,103	0	188	14	202	4,962	5,964	2,380	13,305
T6S R1W	0	0	0	0	2,790	7,554	3,182	13,525	2,790	7,554	3,182	13,525
R1E	305	981	189	1,476	78	1,829	957	2,864	383	2,811	1,146	4,340
TOTALS[2]	5,960	8,080	2,930	16,970	5,740	12,250	5,010	23,000	11,700	20,330	7,940	39,970
% OF TOTAL	15	20	7	42	14	31	12	58	29	51	20	100

1 Entries may not add to totals due to rounding.
2 Totals rounded to nearest 10 acres.

Over the service area combined class 1 and 2 lands are 80% of the total gross acreage of nearly 40,000 acres, representing an excellent quality land base. As mentioned previously, the above values are "gross" acreages. Lands developed for non-agricultural purposes such as areas in within the cities of Silverton and Mt Angel are not included in productive lands. No allowance was made for public rights of way or nonproductive farmland such as farmsteads, farm lanes, etc, however. It is normal practice to approximate the amount of land in public rights of way using a factor of 4% of gross lands, and to allow about 10% for farmsteads and related uses. Thus the above should be reduced about 14% to approximate "net" productive lands. Table II-4 lists net lands, rounded to the nearest 10 acres, for all entries.

TABLE II-4
NET PRODUCTIVE LAND IN SERVICE AREA
(ACRES)

LOCA TION	CLACKAMAS				MARION				TOTAL			
	Class 1	Class 2	Class 3	TOTAL	Class 1	Class 2	Class 3	TOTAL	Class 1	Class 2	Class 3	TOTAL
T5S R1W	590	1,140	320	2,050	2,470	2,300	740	5,510	3,060	3,440	1,060	7,560
R1E	4,270	4,970	2,030	11,270	0	160	10	170	4,270	5,130	2,040	11,440
T6S R1W	0	0	0	0	2,400	6,500	2,740	11,640	2,400	6,500	2,740	11,640
R1E	260	840	160	1,260	70	1,570	820	2,460	330	2,410	980	3,720
TOTALS	5,120	6,950	2,510	14,580	4,940	10,530	4,310	19,780	10,060	17,480	6,820	34,360
% OF TOTAL	15%	20%	7%	42%	14%	31%	13%	58%	29%	51%	20%	100%

CURRENTLY IRRIGATED LANDS

Some lands in the probable service area are irrigated from surface and groundwater sources. The following paragraphs describe the estimated amounts of this use from each source. Irrigated lands are based on OWRD data. It should be noted that these data list acreages irrigated under permits and certificates only; pending applications are not included in OWRD tabulations.

Irrigation in the Pudding Basin is evaluated using OWRD water rights data for major streams in the basin. Appendix A contains detailed listings of surface water rights by stream, and a listing of rights from groundwater. Table II-5 lists summarized data, for lands irrigated in Clackamas and Marion Counties over the entire Pudding Basin and over the probable service area.

TABLE II-5

SURFACE WATER RIGHTS
(ACRES)

	PUDDING RIVER BASIN			PROBABLE SERVICE AREA		
STREAM	CLACKAMAS	MARION	TOTAL	CLACKAMAS	MARION	TOTAL
PUDDING RIVER	1,134	6,472	7,606		2,575	2,575
ROCK CREEK	555		555	311		311
BUTTE CREEK	1,771	2,584	4,355	1,412	2,183	3,595
ABIQUA CREEK		3,398	3,398		2,771	2,771
SILVER CREEK		870	870		570	570
DRIFT CREEK		238	238			
TOTALS	3,460	13,562	17,022	1,723	8,099	9,822

Table II-6 lists the acreage irrigated from groundwater sources in the probable service area by county.

Table II-6

GROUNDWATER RIGHTS
(ACRES)

	CLACKAMAS	MARION	TOTAL
PERMITS	1,652	3,405	5,057
CERTIFICATES	2,973	5,013	7,986
TOTALS	4,625	8,418	13,043

In addition, about 640 acres are irrigated from groundwater without permits within the Mt Angel Groundwater Limited Area. About 1,100 acres in this area are irrigated under pending permits that, because of the designation, may not be granted certificates.

POTENTIAL SERVICE AREA ACREAGE

The amount of irrigable land in the potential service area without an irrigation water supply then is the remainder of the amount of net productive land less the lands for which surface and groundwater rights have been obtained. Table II-7 lists these values:

Table II-7

POTENTIAL IRRIGATION SERVICE
(ACRES)

NET PRODUCTIVE LAND	34,360
IRRIGATED FROM SURFACE WATER	9,822
IRRIGATED FROM GROUNDWATER	13,043
POTENTIAL IRRIGATION SERVICE	11,495

ASSOCIATION SELECTED SERVICE AREA

Upon review of the above information and results of preliminary formulation analyses, to be discussed later, the Association decided that the project service area should include the following lands.

The Association decided to include the acreage within the Groundwater Limited Areas that have permits and for which applications have been filed, amounting to about 2,100 acres. Some irrigation wells are deep with high water costs. Were water supplies from a proposed project be less costly, these users would be prone to purchase a water supply from the project, and the Association decided that about 900 acres should be included to represent this possibility. Additionally, a water supply for 4,500 acres of irrigable but not now irrigated lands should be included.

The selected service area then would include a total of 7,500 acres that would need full-season supplies for irrigation.

CHAPTER III

WATER

CHAPTER III

WATER

GROUNDWATER OCCURENCE

Hydrogeologic Setting

Groundwater in the Pudding River Basin study area occurs in two principal and identifiable aquifers. An unconsolidated to semi-consolidated sedimentary aquifer overlies a deeper basalt aquifer.

The sedimentary aquifer includes recent and older alluvial deposits and Troutdale formation deposits. It is comprised of fine to coarse sand and gravel with interspersed lenses and layers of clay and silt occurring more frequently with depth. The coarsest grained and more permeable aquifer materials thicken in wedge shape from east to west. This aquifer ranges in thickness from zero along portions of the southeasterly boundary of the study area to as much as 650 feet near Aurora. This aquifer is the primary source of high capacity wells in the western portion of the area. Based on a review of selected water well driller's reports for wells drilled in this aquifer, it appears that the alluvial aquifer is unconfined and probably receives recharge from local sources and infiltration of direct precipitation. As depth in the aquifer increases and starting near the southeasterly side, the quantity of clays and silt or claystone predominate and their combined hydraulic integrity probably forms an aquatard[3] above the basalt aquifer below. The storage capability of the sedimentary aquifer is comparatively large due to it's coarse texture, although much of it has become dewatered.

The basalt aquifer produces groundwater from fractures and interflow zones scattered through the rock mass. The basalt aquifer was the source for a 50-75 gpm flowing artesian well reported in the city of Mt. Angel in the mid-to-late 1950's. Anecdotal evidence suggests that locally these type conditions still occur but at much reduced flow rates. Recent data also show that in at least some areas, the piezometric head in the basalt aquifer is lower than that in the alluvial aquifer by several tens of feet or more. Based on the confined condition of this aquifer, it is likely that recharge to this hydrogeologic unit probably occurs somewhere outside the drainage area to the east.

Quantity

Well yields in the study area vary considerably from only a few gpm to in excess of 1,500 gpm for the most productive wells. The highest producing wells are those drilled deep into the basalt aquifer, and shallower wells constructed in the sedimentary aquifer in the western portion of the area. High yielding basalt aquifer wells often are more than 500 feet in depth while alluvial aquifer wells in the western area supply sufficient volumes for both municipal and irrigation wells from depths of 250 to 300 feet.

The Oregon Water Resources Department (OWRD) has designated two areas in this drainage area as Groundwater Limited. The Mt Angel Groundwater Limited Area surrounds the community of Mt Angel and the Stayton-Sublimity Groundwater Limited Area lies at the southern extreme of the drainage area, as shown on Plate 1. In both cases, OWRD concluded that there was sufficient evidence of adverse groundwater level decline to warrant the designation. One piece of evidence used has been an increase in the reported number of wells deepened in these areas. The bulk of these have been domestic wells, 902 out of a total of 1,026 since 1956. Figure 1 "Number of Wells Deepened in Entire Project Area by Year", shows that the annual total number of well deepenings increased significantly in the mid 1980's and continued through at least 1992. OWRD has not made any distinction between water level declines in individual aquifers. Also

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[3] A layer of low permeability that prevents or retards flow to a lower aquifer.

no long term water level monitoring data have been made available to show how groundwater levels in these areas are responding to extractions.

Well production and water level data for the City of Mt. Angel confirms that localized water level declines have occurred during the late 1980's and have resulted in declining well production rates. On the other hand, wells located elsewhere in the drainage area and west of the Pudding River, for instance City of Woodburn wells, have not experienced serious water level declines. An ongoing well-planned water level monitoring program in both the sedimentary aquifer and the basalt aquifer is important for long term water management planning in the area.

The long-term availability of groundwater within the drainage area is controlled by the rate of annual recharge to the alluvial and/or basalt aquifers. The alluvial aquifers receive recharge by deep percolation of precipitation falling mostly on the northern, low-lying portion of the area. The basalt aquifers are recharged primarily in the Cascade Foothills. The average annual recharge to the alluvial aquifers is estimated at more than 43,000 acre-feet(AF). Average annual recharge to the basalt aquifers is estimated at more than 30,000 AF.

Assuming a specific yield of 15% over the approximate 51,500 acre portion study area underlain by the sedimentary aquifer, each 50 feet of saturated thickness would provide about 386,000 acre-feet (AF) of water during extended drought years. The storage capability of the basalt aquifer is limited. Assuming a specific yield of 1%, a 50 foot saturated thickness of the basalt aquifer over the 251,000 acre drainage area would store about 125,500 AF. From a practical standpoint, probably only about one-half the stored volume is available, however.

Quality

Studies conducted in the late 1960's found that groundwater quality in general in the study area was mostly good with a few exceptions. Locally, some wells have experienced high concentrations of dissolved salts and hydrogen sulfide. These problems have been identified in the easterly portion of the drainage area and not enough data has been compiled to map the extent accurately. One problem constituent has been iron content. The cities of Gervais and Hubbard treat their supplies to remove iron and manganese, and rural residents typically either treat their domestic well water for iron problems or use cleaning or bleaching agents to remove stains caused by their presence. Typical total dissolved solids concentrations in groundwater are reported to be less than 250 mg/l. To form an accurate picture of water quality variations and possible problem areas, a program of water quality data collection and tracking should be initiated.

SURFACE WATER

Occurence and Quantity

The major stream in the Pudding Basin is the Pudding River, being a tributary of the Molalla River about 5 stream-miles north of the Marion-Clackamas county line. Major tributaries of the Pudding in Marion County include, in upstream order:

Mill Creek	Abiqua Creek
Butte Creek	Silver Creek
Zollner Creek	Drift Creek
Little Pudding River	Beaver Creek

Although stream gages have been operated in the basin, none have been active since 1985. Pertinent recorded data are summarized in Table III-1.

Table III-1

SUMMARY OF GAGE RECORDS

GAGE	PERIOD OF RECORD	AVERAGE ANNUAL DISCHARGE		EXTREMES	
				MAXIMUM	MINIMUM
		ACRE-FEET	CFS	CFS	
PUDDING RIVER NEAR MT ANGEL	Oct. 1939 to Mar. 1966	514,700	711	16,700	2.4
PUDDING RIVER AT AURORA	Oct. 1928 to Sep. 1964	881,100	1,217	25,400	26
BUTTE CREEK AT MONITOR	Jan. to Dec. 1936; Oct. 1940 to Sep. 1952;	160,100	221	7,310	0.04
SILVER CREEK AT SILVERTON	Oct. 1963 to Sep. 1968; Oct. 1970 to Sep. 1979	150,700	208	5,900	2.0

Source: STATISTICAL SUMMARIES OF STREAMFLOW DATA IN OREGON, USGS, Open File Report 84-454

Figure III-1 illustrates mean monthly streamflows for Silver and Butte Creeks and for Pudding River near Mt Angel. Table III-2, overleaf, lists the values, along with values for the gage Pudding River at Aurora. Between 85 and 87 percent of the annual discharge occurs between the months of November through April in these streams. Discharges in July and August are each 1 percent or less of the annual total.

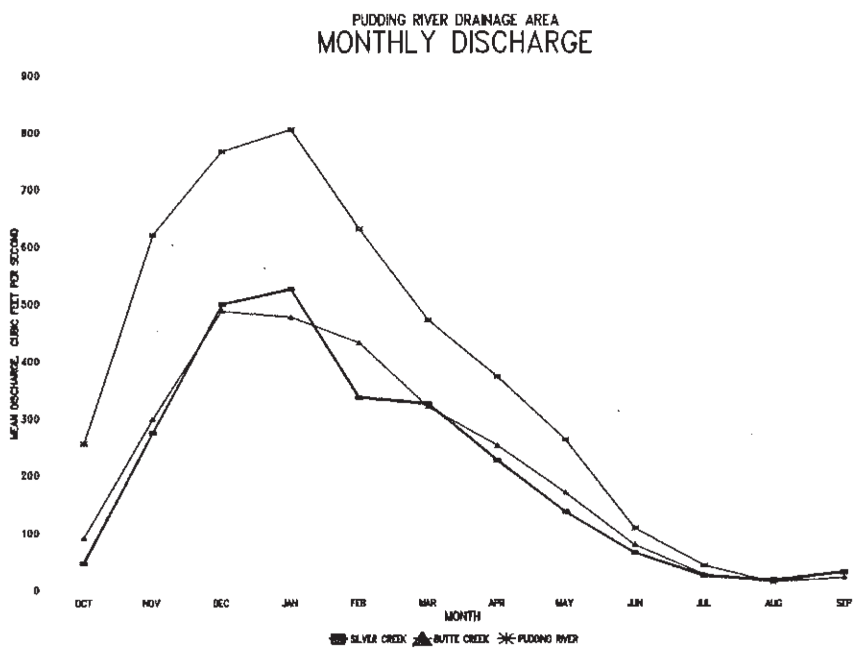


FIGURE III-1

Table III-2

MONTHLY DISCHARGE

Month	Silver Creek at Silverton Mean Discharge CFS	Silver Creek at Silverton Percent of Annual	Pudding River nr Mt Angel Mean Discharge CFS	Pudding River nr Mt Angel Percent of Annual	Butte Creek at Monitor Mean Discharge CFS	Butte Creek at Monitor Percent of Annual	Pudding River at Aurora Mean Discharge CFS	Pudding River at Aurora Percent of Annual
Oct	46	1.9	254	3.0	90	3.4	340	2.3
Nov	274	10.9	620	10.9	298	11.2	1,387	9.4
Dec	498	19.9	766	17.0	488	18.3	2,355	16.0
Jan	526	21.0	805	17.8	477	17.9	2,693	18.3
Feb	336	13.4	630	17.5	431	16.2	2,642	18.0
Mar	324	12.9	472	13.1	320	12.0	2,094	14.3
Apr	226	9.0	372	9.9	252	9.5	1,563	10.6
May	136	5.4	263	6.3	170	6.4	881	6.0
Jun	64	2.6	107	2.8	79	3.0	419	2.9
Jul	25	1.0	42	0.9	26	1.0	151	1.0
Aug	17	0.7	14	0.4	13	0.5	72	0.5
Sep	31	1.2	31	0.5	21	0.8	91	0.6
Totals	208	100	711	100	221	100	1,217	100

Source: STATISTICAL SUMMARIES OF STREAMFLOW DATA IN OREGON, USGS, Open File Report 84-454

Surface Water Quality

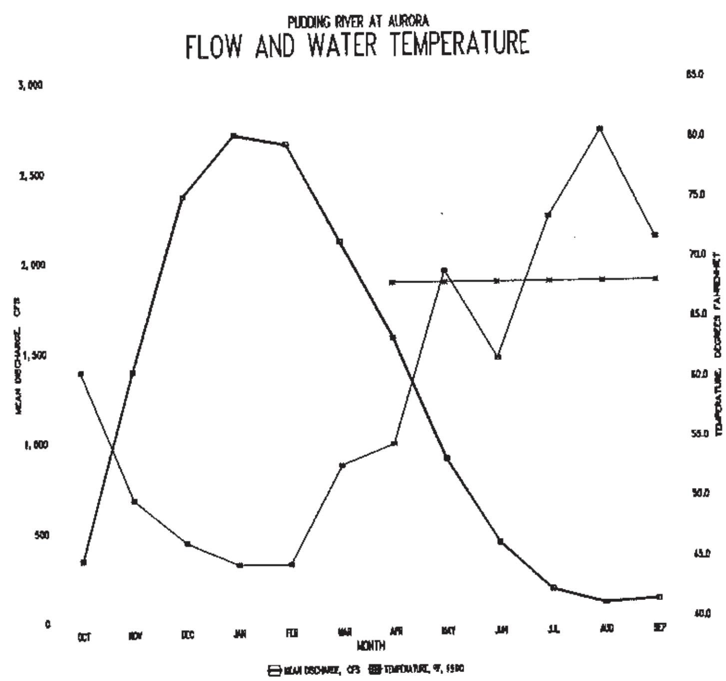


FIGURE III-2

Water quality in the Pudding Drainage Area is affected by both point and nonpoint source discharges. Point sources include several municipal wastewater treatment plants, as well as industrial sites including food-processing facilities. Major nonpoint sources include runoff from both agricultural and forestry activities. Pudding River is classified as a "Water Quality Limited Stream" by the Department of Environmental Quality (DEQ) as a result of unacceptable temperature, nutrient and turbidity levels. This classification indicates that the limit of the capability of Pudding River to assimilate wastes and continue to be a source of water for out-of-stream or instream uses has been reached or exceeded. Table III-3 summarizes point source data in the drainage area.

Table III-3

SUMMARY OF POINT SOURCES

SOURCE	RECEIVING STREAM	DISCHARGE QUANTITY	TYPE of WASTE
		MUNICIPAL	
Silverton STP	Silver Creek	1.0 mgd	Domestic Sewage
Hubbard STP	Mill Creek	0.34 mgd	Domestic Sewage
Woodburn STP	Pudding River	3.1 mgd	Domestic Sewage
Gervais STP	Pudding River	No Summer Discharge Permitted	Domestic Sewage
Mt Angel STP	Pudding River	No Summer Discharge Permitted	Domestic Sewage
		INDUSTRIAL	
Agripac, Inc. (Woodburn)	Pudding River	2.0 mgd	Fruit/Vegetable Waste
Mt Angel Meat		No Discharge Permitted	Processing Waste
		AGRICULTURAL	
Mallorie's Dairy (Silverton)		No Discharge Permitted	Manure, Milk-Processing Waste

Source: WATER QUALITY REPORT, APPENDIX D, DEQ, Revised August, 1993: via Campbell-Craven

DEQ maintains five ambient water quality monitoring sites in the basin, four on Pudding River and one on Zollner Creek. All are monitored on a monthly schedule. Figure III-2 illustrates mean monthly flow over the period of record and water temperature during 1990 in the Pudding River at Aurora. The horizontal line at 68°F is the upper temperature of the "comfort range" of anadromous fish. This temperature is exceeded from about mid-July through September.

DEQ has mandated that Silverton and Woodburn prepare programs to allow them to forego summer discharge of treated wastes to Pudding River or tributaries. Alternatives could range from lagoons to store treated effluent for discharge during high flow periods to use of treated effluents for irrigation.

WATER REQUIREMENTS

Water requirements include the amount of water that will be required for full-season irrigation service and an amount of water that is estimated to provide supplies to the city of Mt Angel for municipal purposes.

Irrigation Service

There is a wide range of crops grown in the service area. Oregon State University Extension Service Crop Report for 1992 lists crops and acreages for Marion County, and also indicates that the county has the highest value of agricultural production in Oregon. Estimated acreages are listed by crop category for the last three years and are tabulated below.

ESTIMATED ACREAGES

CROP	1990	1991	1992
Grains	26,800	21,500	19,500
Hay & Forage	27,200	29,600	30,500
Grass & Legume Seed	66,920	70,290	66,000
Field Crops	16,980	16,706	17,659
Tree Fruits & Nuts	7,720	7,835	8,025
Small Fruits & Berries	5,135	4,475	5,190
Veg. & Truck Crops	40,115	39,640	38,750
Specialty Hort. Crops	1,400	1,500	1,475
All Crops	192,270	191,546	187,099

The report lists acreages for specific crops within the above categories. The distribution of acreages for the county is assumed to represent the distribution within the proposed project service area.

The Extension Service has prepared Irrigation Requirement data[4] for a number of crops for climatic zones in Oregon. For those crops not listed, Soil Conservation Service[5] values for irrigation system design have been used to augment the data. Values for hops were provided by members of the Board of the Association. Based on these, a weighted average farm delivery requirement has been estimated for the service area and amounts to 18.96 inches per year. The calculation is included in Appendix B.

There will be losses from evaporation and seepage that will occur between a storage facility and farms in the service area. An allowance of 10% has been included to cover these, so that releases from a reservoir will amount to a total of about 21.06 inches, or 1.8 acre feet per acre. The monthly distribution of this amount is listed in Table III-4, below:

TABLE III-4

THEORETICAL UNIT IRRIGATION DEMAND ON STORAGE
(ACRE-FEET/ACRE)

	APR	MAY	JUN	JUL	AUG	SEP	TOTAL
DEMAND ON STORAGE	.02	.15	.44	.62	.37	.16	1.80

Selected Irrigation Requirement

4 OREGON CROP WATER USE AND IRRIGATION REQUIREMENTS, Extension Miscellaneous 8530, October 1992

5 OREGON IRRIGATION GUIDE, Soil Conservation Service, July 1973

Selected Irrigation Requirement

In November, 1993 a questionnaire was furnished to Association members to obtain information on well costs and use of water for irrigation. Responses provided data pertinent to 735 acres over the service area. Many responses noted that reported acreage is included in a rotation program, indicating what amounts to a three year rotation program. Responses indicated estimated water use and ranged from 3 to 12 inches per acre, with the majority reporting 8 to 9 inches annually. The three inch figure was reported as a range of from 3 to 9 inches, while the 12 inch value was the upper limit of a reported 9 to 12 inch range. The average of all reported values in 7.8 inches. The weighted average value is 8.1 inches.

For use in project sizing a value of 9 inches is taken as the farm delivery requirement. To allow for losses in storage and transmission, 12 inches per acre per year is used. Thus, the project service area of 7,500 acres would require that an alternate water supply provide a reliable supply of 7,500 acre-feet annually. Table III-5 lists monthly values for reservoir sizing.

Table III-5

UNIT IRRIGATION DEMAND FOR RESERVOIR SIZING

	APR	MAY	JUN	JUL	AUG	SEP	TOTAL
DEMAND ON STORAGE, ACFT/ACRE	.01	.08	.25	.35	.21	.09	1.00
DEMAND ON STORAGE, ACFT, ROUNDED	90	645	1,875	2,648	1,575	668	7,500

Municipal/Industrial Service

The City of Mt Angel reports that it must pump 24 hours to meet the next day's demand during peak periods. The city provided monthly water use records for the last four years, which are averaged and listed in Table III-6 in the "PRESENT WATER USE" row. Given the limitation above, the water use listed for the month of August is taken as the capability of the existing system. Mount Angel's representative population is estimated by Portland State University Center for Population Research and Census as 2,778 and the long-term future population is estimated in the Marion County Water Management Plan as 6,026 persons. At an average annual rate of 200 GPCD, the future need would be 1,350 acre-feet, or 439,898 Mgals. The future water need of the city is then the estimated future monthly water use less the peak capacity of the existing system. On an annual basis, the future water need is about 816 acre-feet.

Table III-6

MT ANGEL REPRESENTATIVE WATER USE

1990 POPULATION = 2,778

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	ANNUAL
PRESENT WATER USE, Mgals	13,384	13,354	13,842	13,124	12,244	13,439	13,406	14,610	14,460	18,729	18,998	14,266	173,856
PER CAPITA USE, GPCD	155	155	161	152	142	156	156	170	168	217	221	166	168
FUTURE WATER USE, Mgals	33,872	33,872	35,192	33,432	30,793	33,872	33,872	36,951	36,512	47,509	47,949	36,072	439,898
FUTURE WATER NEED, Mgals	14,874	14,874	16,194	14,434	11,795	14,874	14,874	17,953	17,514	28,511	28,951	17,074	266,042
FUTURE WATER NEED, Acre-feet	46	46	50	44	36	46	46	55	54	87	89	52	816

Instream Rights/Minimum Stream Flows

Material in the Natural Resources Appendix describes conditions in the Pudding River Drainage Area. The following discussion is a summary of that material pertaining to water use by aquatic life.

There are resident species in the Pudding Drainage Area that inhabit the mainstem of Pudding River and lower sections of its major tributaries. These include largemouth bass, black and white crappie, bluegill, pumpkinseed, warmouth, green sunfish, yellow perch, brown bullhead, channel catfish, sand rollers, redside shiner, northern squawfish, sculpin, dace and suckers. Rainbow and cutthroat trout reside in Abiqua, North and South Fork Silver, Drift, East Fork Drift, Butte, Beaver, Coal, Fall and South Fork Fall Creeks.

Anadromous species do not spawn in the mainstem of Pudding River, but utilize the watersheds of Butte, Abiqua and Silver Creeks. Winter steelhead and Coho salmon use all three watersheds, as listed in Table III-7. Spring chinook may use Abiqua Creek.

Table III-7

SPAWNING AND REARING LOCATION SUMMARY

STREAM	WINTER STEELHEAD REACH	SPRING CHINOOK REACH	COHO SALMON REACH
		RIVER MILE	
BUTTE CREEK	0 - 25.8		7.0 - 19.5
ABIQUA CREEK	9.9 - 20.5	7 - 13.5	10.0 - 20.6
DAVIS CREEK			0.0 - 3.0
POWERS CREEK	0.0 - 2.0		0.0 - 4.0
LITTLE ABIQUA	0.0 - 3.0		0.0 - 4.0
SILVER CREEK	0.9 - 16.4		0.9 - 16.4
DRIFT CREEK			0.0 - 10.7
EAST FORK DRIFT CREEK			0.0 - 2.0
WEST FORK DRIFT CREEK			0.0 - 3.5

Water use for natural resources is described in terms of the amounts of streamflow committed to aquatic life purposes through instream water rights. Table III-8, overleaf, lists pertinent data.

The total annual volume of water committed to this use is 185,125 acre-feet, considering flows at the mouth of Pudding River (48,497 acft), Butte Creek (43,334 acft), Abiqua Creek (40,801 acft), Silver Creek (34,545 acft) and Drift Creek (17,950 acft).

Table III-8

INSTREAM WATER RIGHTS
(CFS)

		PUDDING RIVER			BUTTE CREEK	ABIQUA CREEK	SILVER CREEK	DRIFT CREEK
		AURORA TO MOUTH	MT ANGEL TO AURORA	ABOVE MT ANGEL	SCOTTS MILLS TO MOUTH	ABIQUA CREEK @ MOUTH	SILVERTON TO MOUTH	@ MOUTH
PRIORITY DATE		7/13/1989	6/22/1964	6/22/1964	12/22/1988	11/3/1983	11/3/1983	10/18/90
MONTH	DAY							
OCT	1-15	60	35	10	75	40	23	3
	16-31	60	35	10	75	60	60	10
NOV	1-15	80	35	10	75	75	60	20
	16-30	80	35	10	75	75	60	40
DEC	1-15	80	35	10	75	75	60	40
	16-31	80	35	10	75	75	60	40
JAN	1-15	80	35	10	75	75	60	40
	16-31	80	35	10	75	75	60	40
FEB	1-15	80	35	10	75	75	60	40
	16-28	80	35	10	75	75	60	40
MAR	1-15	80	35	10	75	75	60	40
	16-31	80	35	10	75	75	60	40
APR	1-15	80	35	10	75	75	60	40
	16-30	80	35	10	75	75	60	40
MAY	1-15	80	35	10	75	75	60	40
	16-31	80	35	10	75	75	60	40
JUN	1-15	60	35	10	75	60	50	20
	16-30	60	35	10	50	40	35	5
JUL	1-15	50	35	10	25	25	23	3
	16-31	40	35	10	25	20	23	3
AUG	1-15	40	35	10	12	15	23	2
	16-31	40	35	10	12	15	23	2
SEP	1-15	40	35	10	20	15	23	2
	16-30	40	35	10	20	15	23	2

Source: OWRD, ADMINISTRATIVE RULES, CHAPTER 690, DIVISION 502, WILLAMETTE BASIN PROGRAM, August 28, 1992

Exchange/Augmentation Concept

It would be desireable that a project to provide for meeting irrigation and other consumptive uses should also include water for flow augmentation, to the degree that would be financially feasible for the Association and could be legally accomplished. Water may be legally stored in a basin reservoir to augment streamflows. In consideration of importation of water from Detroit Reservoir however, supplies may be purchased for irrigation uses only, not specifically for streamflow augmentation.

Water from Detroit could be used for "exchange" purposes, however. That is, to provide full season supplies to lands currently irrigated from streamflows. If such were done, those currently irrigating would be provided water from the proposed project at their existing diversion and then would agree to leave natural flows they customarily divert instream. If this concept were applied to streams both within and without the suggested service area, natural flows that would irrigate about 15,857 acres could remain instream in tributaries and Pudding River to its mouth. This number differs from irrigated lands in the service area, as it includes lands irrigated on the west side of Pudding River and lands irrigated from Butte and Rock Creeks from Highway

211 to their confluences with Pudding River. In summary, lands with surface water rights subject to exchange under this approach are listed in Table III-9.

Table III-9

LAND APPROPRIATE FOR EXCHANGE
(Acres)

STREAM	COUNTY		TOTAL
	CLACK	MARION	
PUDDING RIVER,	1,134	6,472	7,605
SILVER CREEK		570	570
ABIQUA CREEK		2,771	2,771
BUTTE CREEK, HWY 213	1,771	2,584	4,355
ROCK CREEK & TRIBS,	555		555
TOTALS	3,460	12,397	15,857

SOURCE: OWRD Water Rights Listing

The combined acreages to be served from an alternate project are listed in Table III-10.

Table III-10

TOTAL ACREAGE FOR ALTERNATE SIZING
(Acres)

STREAM	EXCHANGE/ AUGMENTATION	SERVICE AREA	TOTAL
PUDDING RIVER	7,605		7,605
SILVER CREEK	570	300	870
ABIQUA CREEK	2,771	300	3,071
ZOLLNER CREEK		2,600	2,600
BUTTE CREEK	4,355	1,050	5,405
ROCK CREEK TRIBUTARIES	555		555
MUDDY CREEK		1,900	1,900
GARRET CREEK		1,350	1,350
TOTALS	15,857	7,500	23,357

PROJECT WATER REQUIREMENT

The annual irrigation water requirement of 12" per acre is used throughout the analysis. Thus, the total annual water requirement for the project amounts to 23,357 acre-feet annually and becomes the amount of water to be provided annually either from a storage facility of from a system to deliver water purchased from Detroit Reservoir. A monthly distribution is listed in Table III-11, overleaf.

Table III-11

PROJECT IRRIGATION WATER REQUIREMENT

	UNITS	APR	MAY	JUN	JUL	AUG	SEP	TOTAL
	PERCENT	1.2	8.6	25.0	35.3	21.0	8.9	
EXCHANGE/ AUGMENTATION	ACRE-FEET/ MONTH	190	1,364	3,964	5,598	3,330	1,411	15,857
	AVERAGE CFS	3.2	22.2	66.6	91.0	54.2	23.7	
NEW LANDS	ACRE-FEET/ MONTH	90	645	1,875	2,648	1,575	668	7,500
	AVERAGE CFS	1.6	10.5	31.6	43.0	25.6	11.1	
TOTAL	AVERAGE CFS	4.8	32.7	98.2	134.0	79.8	34.8	

During July, the peak irrigation month, water that could be diverted for existing rights from Pudding River tributaries as discussed above amounts to about 91 CFS. With a proposed project, an equivalent flow will remain instream from the mouth of Rock Creek to the mouth of Pudding River, more than doubling the representative flow at the gage at Mt Angel during the same month. At this stage in project evaluation, it appears the concept will result in benefits to more than aquatic life. Enhancement of water quality conditions and a greatly improved recreation potential also may be visualized in Pudding River downstream of the mouth of Silver Creek.

CHAPTER IV

FACILITIES AND COST ESTIMATES

CHAPTER IV

FACILITIES AND COST ESTIMATES

GROUNDWATER RECHARGE ALTERNATE

Groundwater recharge is deemed currently infeasible for three reasons:

- Use of the aquifers for seasonal storage would require a surface water source with accompanying diversion structure or storage reservoir. Before injection, water treatment would be needed in order to meet state-mandated non-degradation standards. The cost of treatment facilities would be excessively high.
- In order to meet the demands for an injection well recharge system, several wells would be required. Each injection well must be connected to the diversion or surface storage reservoir, requiring a network of pipes or canals.
- The capacity of the basalt aquifer to receive and transport injected water to points of use is presently unknown. Insufficient hydrogeological data exist to answer the many questions that arise in consideration of this topic.
- Quantifiable benefits are uncertain for the cost of implementing a recharge program.

WATER FROM STORAGE ALTERNATE

Reservoir Site Screening

A number of potential sites in the Pudding River drainage area have been identified in previous studies by a number of agencies including the Corps of Engineers, Bureau of Reclamation, Soil Conservation Service and others. An initial group of sites was taken from Appendix M, PLAN FORMULATION, WILLAMETTE BASIN COMPREHENSIVE STUDY, WATER AND RELATED LAND RESOURCES, 1969 prepared by the Willamette Basin Task Force, Pacific Northwest River Basins Commission. Thirty-eight sites that are in close proximity to the service area are taken from the above material and screened as to suitability for meeting the Association's needs. The details of the screening process are described in Appendix E, Reservoir Site Screening, bound at the back of this report.

Criteria used in the screening process are tabulated below:

- Location relative to service area
- Storage yield
- Storage capacity
- Existing land use and ownership
- Environmental impact
- Geological conditions
- Construction cost

The screening process resulted in three sites being deemed appropriate for further consideration. These are:

- Lower Grange, at about stream-mile 8 on Silver Creek
- Camp Creek, at about stream-mile 14 on Abiqua Creek
- Del Aire Ranch, at about stream-mile 18 on Butte Creek

Dam height and volume was estimated and used as the basis for an abbreviated cost estimate at each site to provide a basis for comparison. Estimates included those for an appropriate distribution system. The cost of the Lower Grange site is high because of the distribution system needed to transport water from reservoir into the service area. A ridge along the north side of Silver Creek requires that water be pumped from about elevation 300 to the ridge top at about elevation 500 for delivery to the Abiqua Creek and areas to the north. Feasibility of the Abiqua Creek site is limited by topographic conditions and associated embankment requirements to meet storage needs. Because of a the width of the canyon at the dam site, the embankment volume is the greatest of the three sites, and construction costs would be high.

The Del Aire Ranch site best meets the screening criteria. Reconnaissance-level geological observations were conducted on the site to identify the types of materials exposed in abutment and foundation area outcrops. The observations indicate the presence of moderately to well indurated sandstone materials at outcrop locations. Butte Creek has been incised into hard sandstone material at the dam site, reflecting generally competent foundation conditions for a dam. Basalt boulders also were noted, suggesting the possibility of basalt materials in the site area. Reconnaissance observations suggest that a Roller Compacted Concrete (RCC) structure likely would be feasible at the site.

Selected Site

Consideration of storage to provide a total water requirement of 23,357 acre-feet annually will entail a storage structure and pipeline system to distribute water to Pudding River tributaries in the service area. The storage site considered is the Del Aire Ranch site on Butte Creek, about six miles upstream of Scotts Mills.

An abbreviated operation study to determine the required reservoir size was prepared, and results in a reservoir with a total capacity of 36,266 acre-feet being necessary to provide a reliable supply. Within that total, 21,068 acre-feet is the amount necessary to regulate monthly inflows in a "normal" year and about 14,698 acre-feet is necessary for "carry-over" storage to meet demands in years when flows are less than "normal". An allowance of 500 acre-feet for dead or inactive storage and future sedimentation also is included.

Examination of surface geology indicates that site conditions and configuration are acceptable for an RCC (roller compacted concrete) structure. Site topography will result in a dam height of 260 ft to acheive the desired reservoir capacity, with a 10 foot freeboard. Cost estimate amounts include an allowance for a multiple-level intake to allow control over the quality and temperature of releases. A distribution pipeline is included that will divert water from Butte Creek about 1 1/4 miles east of Highway 213 such that water will flow by gravity to discharge points on Zollner and Abiqua Creeks to the south and north to the vicinity of Marquam, where water will be discharged into Muddy and Garrett Creeks, tributaries of Rock Creek.

Required distribution pipe sizes are tabulated below:

DIAMETER (Inches)	LENGTH (Feet)
18	2,000
24	3,900
30	8,400
51	11,200
54	4,000
60	4,000

Estimated construction costs for the project are listed in Table IV-1, below:

Table IV-1

DAM & RESERVOIR CONSTRUCTION COSTS

ITEM	UNITS	QUANTITY	UNIT COST	ESTIMATED COST	COST W/ CONTIN-GENCIES
				($1,000's)	
RCC DAM	LS			27,360	32,832
DIST PIPELINE	LS			4,939	5,927
ROADS, ACCESS & RELOCATION	MILES	2	2,000	4,000	4,800
RECREATION FEA-TURES	LS			500	600
RIGHTS OF WAY	ACRES	640	5	3,200	3,840
SUBTOTAL				39,999	47,999
ENGINEERING & ADMIN-ISTRATION @ 12%					5,760
PROJECT TOTAL					53,759

As releases are being made to meet downstream needs, it would be logical to pass flows through a powerhouse at the base of the dam to maximize beneficial use of releases. However, the project then would be considered a "hydro-project" under current interpretation by Oregon resource management agencies, and necessary permits for project construction could not be obtained. It would be possible to construct the project with no hydro-generation facilities and "retro-fit" this equipment following project completion. If such were to be considered, generation and related equipment would cost about $1,406,000 including engineering and administration.

Annual operation and maintenance costs are estimated to be about $60,000 for the dam. If installation of generation facilities occurs, operation of the plant is estimated to result in an annual income of $519,000.

WATER FROM IMPORTATION ALTERNATE

As discussed earlier water for irrigation and for a supply to exchange existing diversions for streamflow augmentation may be purchased from Detroit Reservoir. Purchased water would be released on the service area's requested irrigation schedule. From examination of topography in the vicinity of likely diversion points along the North Santiam River, it is concluded that the most efficient means of transporting water into the Pudding Basin would be by pumping at a peak rate of about 153 CFS from a location slightly east of Stayton. From the pumping plant, 38,700 feet of 66" diameter and 8,800 feet of 54" diameter pipeline would be routed along public roads to the north side of Sublimity and then would follow the Cascade Highway a distance of about 5 miles to the Pudding River, the pipeline terminus.

There is interest in obtaining water from the pipeline in the vicinity of Sublimity, and water for irrigation of 850 acres is included in diversion quantities. About 5 CFS would be released for irrigation in the Sublimity area. The terminus would include a small hydro plant to generate power from pipeline flows which are under about 75 feet of head after crossing over a saddle to the south. Annual revenues from generation are expected to amount to about $99,000. The discharge will occur at about stream mile 59 on the Pudding

River. Flows would remain in Pudding River until stream mile 49, a short distance downstream from the mouth of Silver Creek.

At this location, a pumping plant would be constructed to lift 90 CFS into the service area for irrigation and exchange/augmentation water in Pudding River tributaries. About 47 CFS would be left in Pudding River for exchange/augmentation purposes. From the pumping plant a pipeline would extend along public roads around the north of Silverton along Hobart Road to Meridian Road. At the junction of Meridian and Abiqua Creek Roads, a branch line would extend along Abiqua Creek Road to Hiway 213 and to its crossing of Abiqua Creek, for discharge for irrigation and exchange/augmentation in Abiqua Creek.

The mainline would extend along Meridian Road to the Mt Angel-Scotts Mills Road, and thence east to Hiway 213. A turnout would be provided to discharge water into Zollner Creek to serve irrigation needs. The pipeline would follow Hiway 213 to Butte Creek, where water would be released to Butte Creek for irrigation and exchange/augmentation. From Butte Creek the pipeline would extend to Marquam. At that point, one branch would extend west to discharge into Muddy Creek, while another branch would extend to the east to supply water to Garret or Marquam Creek. Both these streams are tributaries of Rock Creek. Flows would be released for irrigation and exchange/augmentation purposes.

Pipe sizes are summarized below:

DIAMETER (Inches)	LENGTH (Feet)
18	1,700
21	2,000
27	6,500
30	7,100
45	5,700
51	9,200
57	33,800

Construction costs are estimated for these facilities and are listed in Table IV-2, below:

Table IV-2

IMPORTATION SYSTEM CONSTRUCTION COSTS

ITEM	SANTIAM DIVERSION		DISTRIBUTION SYSTEM	
	ESTIMATED COST	COST W/CONTINGENCIES	ESTIMATED COST	COST W/CONTINGENCIES
	($1,000's)			
RIGHTS OF WAY		60		60
PUMPING PLANT	5,374	6,449	4,272	5,066
PIPELINE	11,100	13,320	10,897	13,076
HYDRO PLANT	400	480		
SUBTOTAL		20,309		18,203
ENGINEERING & ADMINISTRATION @ 12%		2,437		2,184
PROJECT TOTAL		22,746		20,387

Estimated annual costs for this alternate include purchase of water from Detroit Reservoir, amounting to about $48,410 and the cost of energy for pumping, amounting to nearly $540,000 per year. Revenue from the generation plant at the Pudding River terminus is estimated to amount to $98,980.

CHAPTER V

FINANCING AND WATER COSTS

CHAPTER V

FINANCING AND WATER COSTS

Although a large contribution would be required during the construction period, the Bureau of Reclamation's SMALL RECLAMATION PROJECT ACT program (PL 84-984) offers an attractive financing "package" for a project such as this. The PL 984 program has been in existence since 1956 and has provided loans and grants for construction of hundreds of small water projects throughout the west. The program is administered through the Bureau of Reclamation and currently is under review by the Clinton administration. Prior to this review, the program required contribution of 25% of project costs during the construction period, and loans and grants for the remainder of project costs. Loan repayment could extend over a 40 year period, and the portion attributable to "commercial" irrigation could be repaid without interest, although subsidy considerations could result in a shorter term for the interest free portion of the loan.

Estimated project costs are slightly above the current ceiling (set at $50,000,000) for fiscal year 1992-93. However, the ceiling is adjusted annually and future estimates of costs may be relatively lower as the previous estimates include a generous contingency allowance that may be reduced as more detailed studies are accomplished, as well as the probability that direct cost savings may be identified as well. It is possible then that future changes will bring the storage alternate to within program cost limitations.

STORAGE ALTERNATE

With a project of this type, a separable-cost remaining benefits allocation should be prepared. Some of the information necessary to prepare such an allocation will only be available after more detailed studies are prepared, however. As a close approximation, an allocation based on the measure of use of project facilities for irrigation and for natural resources is included.

As listed previously, the annual demand for irrigation is 7,500 acre-feet. The annual use for exchange/augmentation, is 15,857 acre-feet, for a total annual use of 23,357 acre-feet. The proportion of use is then 32.11% for irrigation and 67.89% for natural resources purposes. Costs for facilities that are used jointly are allocated using these percentages, while some facilities, such as those for recreation are assigned in their entirety to Natural Resources. The allocation is listed in Table V-1.

Table V-1

DAM & RESERVOIR COST ALLOCATION

ITEM	IRRIGATION	NATURAL RESOURCES	TOTAL
		($1,000's)	
DAM & APPURTENANCES	10,542	22,290	32,832
DISTRIBUTION PIPELINE	1,903	4,024	5,927
ROADS	1,541	3,259	4,800
RECREATION FACILITIES		600	600
RIGHTS OF WAY	1,233	2,607	3,840
SUBTOTALS	15,220	32,779	47,999
PROPORTION	0.317	0.683	1.000
ENGINEERING & ADMINIS-TRATION	1,826	3,933	5,760
TOTALS	17,046	36,712	53,759

Figures in the TOTALS row show that about $17 million is allocated to irrigation and about $36.7 million is allocated to exchange/augmentation purposes. This latter amount is the basis for estimates of grant amounts, to be discussed subsequently.

Additional studies will be necessary to develop information and final design must be completed prior to construction. To illustrate these needs, an overall schedule between the time of writing and project completion, a construction schedule is listed in Table V-2.

Table V-2

DAM & RESERVOIR CONSTRUCTION SCHEDULE

	($1,000's)					
ITEM	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	TOTALS
RCC DAM				13,133	19,699	32,832
DISTRIB PIPELINE					5,927	5,927
ROADS, ACCESS & RELOCATION			1,600	3,200		4,800
REC FACILITIES					600	600
RIGHTS OF WAY			3,840			3,840
ENGNRING & ADMIN	150	250	250	3,066	2,044	5,760
TOTALS	150	250	5,690	19,399	28,270	53,759

Expenditures listed for Engineering in Years 1, 2 and 3 are for more detailed definition of the project service area, detailed project formulation and preliminary design, environmental analyses and coordination with permitting agencies, and preparation of funding application report(s). These activities may be compressed into a shorter period or extended, depending on the availability of funds. Rights of way acquisition and road construction are shown starting in year 3 to ensure that dam site access will be possible when dam construction is started in year 4.

The schedule assumes that construction funds will become available during year 3 or very early in year 4. Once available, final design and construction of all facilities may be completed. If bond sales are to provide project funding, the sale should be completed by the beginning of year 3, to fund rights of way acquisition and road construction, as necessary.

With a total project cost of $53.759 million, the required 25% contribution would be about $13.440 million. The cost of rights of way acquisition normally is credited toward the 25%. Additionally, funds expended prior to application approval are, in most cases, credited toward the contribution requirement. Another opportunity would be from participation in the project by either, or both, Clackamas and/or Marion counties. Road relocation and access road design could be provided by existing county staffs, and the counties may be able to provide construction as well. It would also be appropriate for recreation facilities to be developed (and operated) by the county. These expenditures then may be credited toward the contribution requirement. For this analysis it is assumed that maximum county participation will occur. A contribution schedule is shown in Table V-3.

Table V-3

DAM & RESERVOIR CONTRIBUTION SCHEDULE

(&1,000's)						
	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	TOTAL
CONTRIBUTED ROADS			1,600	3,200		4,800
CONTRIBUTED RECREATION FACILITIES					600	600
OTHER CONTRIBUTIONS	150	250	250	887	2,662	4,200
CONTRIBUTED RIGHTS OF WAY			3,840			3,840
TOTAL CONTRIBUTIONS	150	250	5,690	4,087	3,262	13,440

In the past, grants for enhancement of anadromous fish habitat and for development of recreation features have been available in the amount of 50% of allocated costs. Legislation has been passed by Congress for other water resource programs that equate the amount of grants to the costs, particularly in instances where threatened and/or endangered species are involved. It is assumed that the administration's current review of the PL 84-984 program will result in making grant percentages common to other federal programs. Optional financial analyses are included, one assuming 100% grants and one assuming 50% grants, to illustrate either eventuality, however.

The amount to be financed is the construction cost less contributions and grants. Estimated amounts to be financed are derived in Table V-4.

Table V-4

AMOUNTS TO BE FINANCED

($1,000's)						
	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	TOTALS
TOTAL CONSTRUCTION EXPENDITURES	150	250	5,690	19,399	28,270	53,759
TOTAL CONTRIBUTIONS	150	250	5,690	4,087	3,262	13,440
GRANT @ 100%				14,940	21,772	36,712
AMOUNT TO BE FINANCED				371	3,235	3,607
GRANT @ 50%				7,470	10,886	18,356
AMOUNT TO BE FINANCED				7,841	14,122	21,963

Under the PL 984 program, once financing is approved, final design and construction may begin. As costs for construction are incurred, federal funds are advanced and interest on the advanced funds is accumulated. Upon completion of the project this accrued interest then becomes part of the loan to be repaid.

With Federal funds being advanced from year 3 of the construction schedule, the accumulated compound interest at 5% at the completion of the project would total $2,926,000. Using proportions derived from amounts contributed, the amount of interest during construction (IDC) attributable to Natural Resources amounts to $1,998,000, that attributable to contributions is $731,000 resulting in the value of the IDC to be incorporated with the loan of $196,000.

With the grant portion at 100%, the total amount to be repaid would then be $3,607,000 plus the IDC of $196,000, for a total $3,803,000. Over a forty year term, and at 5% interest, the water cost would amount to $29.55 per acre for the PL84-984 loan.

To meet the contribution requirement, it is assumed that bonds would be sold for the amount remaining after the costs of roads and the recreation facilities are contributed. This would amount to $7,406,000. The cost of the hydro plant also should be included, which would increase the proceeds needed from a bond sale to $9,046,000. It is assumed the sale would occur in the year prior to project completion, and the bond amount would include funds necessary to meet the first year's bond debt service, and the cost of the bond sale. The resulting bond issue would be $9,758,000. At 6% and over a 40 year term, bond repayment net cost, after subtracting hydro revenue, would amount to $17.33 per acre. The total per acre cost of the project over the 7,500 acres of new lands would be $54.88, including $8.00 per acre for OM&R.

With a 50% grant, amounts to be financed would change radically. The contribution requirement would remain constant, but the amount of construction expenditures to be repaid would increase to a total of $21,936,000. The amount of IDC to be paid with the loan also would increase to $1,195,000. Based on proportions of use, the total loan, including IDC, for irrigation purposes would be $11,152,000, to be repaid at 5% over 30 years. The total loan, including IDC, for natural resources would be $12,007,000. Repayment costs would amount to $90.51 per acre for irrigation purposes and $52.29 per acre for natural resources. The per acre cost for contribution and hydro bond repayment would remain the same at $17.33 per acre. The total per acre cost for irrigation would amount to $107.84.

A recap of the above water cost information is summarized in Table V-5, below.

Table V-5

DAM & RESERVOIR WATER COST SUMMARY

	100% GRANT		50% GRANT	
	ANNUAL ($1,000's)	UNIT $/ACRE	ANNUAL ($1,000's)	UNIT $/ACRE
LOAN DEBT SERVICE	222	29.55	1,448	136.99
CONTRIBUTION BOND REPAYMENT	649	86.47	649	86.47
ESTIMATED OM&R	60	8.00	60	5.81
TOTAL	931	124.02	2,157	229.17
HYDRO REVENUE	519	69.14	519	69.14
NET WATER COST	412	54.88	1,638	160.13

IMPORTATION ALTERNATE

The total construction cost for the combined import and distribution system is about $43,133,000, under the PL 984 ceiling in effect for fiscal year 1992-93.

It is standard practice to allocate costs for projects not involving storage on the basis of use. For the portion of the pipeline south of the Pudding River terminus the pipeline will contain irrigation water for lands in the Pudding Basin service area, 7,500 acres, and for an estimated 850 acres in the vicinity of Sublimity for a total of 8,350 acres. Water for exchange/augmentation purposes will amount to 15,857 acres. The proportions for this section of the system are 65.5% for exchange/augmentation and 34.5% for irrigation. In the distribution system in the service area water will be provided for 7,500 acres of irrigation and for 15,857 of exchange/augmentation. Proportions to be used for this portion of the system then are 32.1% for irrigation and 67.9% for exchange/augmentation. Allocated costs are listed in Table V-6.

Table V-6

PIPELINE COST ALLOCATION

ITEM	SANTIAM DIVERSION			DISTRIBUTION FACILITIES		
	IRRIGATION	NATURAL	TOTAL ($1,000's)	IRRIGATION	NATURAL	TOTAL
PROPORTIONS	34.5%	65.5%		32.1%	67.9%	
RIGHTS OF WAY	21	39	60	19	41	60
PUMPING PLANT	2,224	4,224	6,449	1,627	3,440	5,066
PIPE LINE	4,595	8,725	13,320	4,199	8,878	13,076
HYDRO PLANT	480		480			
SUBTOTAL	7,320	12,989	20,309	5,845	12,358	18,203
ENGINEERING & ADMINISTRATION	878	1,559	2,437	701	1,483	2,184
TOTALS	8,198	14,548	22,746	6,546	13,841	20,387

As shown previously for the storage alternative, a construction/expenditure schedule is shown in Table V-7.

Table V-7

PIPELINE CONSTRUCTION SCHEDULE

	ITEM	YEAR 1	YEAR 2	($1,000's) YEAR 3	YEAR 4	TOTAL
SANTIAM DIVERSION	RIGHTS OF WAY			60		60
	PUMPING PLANT & PIPELINE			12,149	8,100	20,249
	ENGINEERING & ADMINISTRATION	50	75	1,219	1,094	2,437
	SUBTOTAL	50	75	13,428	9,193	22,746
	CONTRIBUTION @ 25%	50	75	3,417	2,145	5,686
	GRANT ELIGIBLE @ 100%			8,588	5,960	14,548
	AMOUNT TO BE FINANCED			1,423	1,089	2,512
DISTRIBUTION SYSTEM	RIGHTS OF WAY			60		60
	PUMPING PLANT & PIPELINE			10,886	7,257	18,143
	ENGINEERING & ADMINISTRATION	150	250	1,092	692	2,184
	SUBTOTAL	150	250	12,038	7,949	20,387
	CONTRIBUTION @ 25%	150	250	3,069	1,627	5,097
	GRANT ELIGIBLE @ 100%			8,172	5,668	13,841
	AMOUNT TO BE FINANCED			796	654	1,450

With Federal funds being advanced over a two year period, the total IDC would amount to $1,254,000 for the Santiam Diversion and $1,117,000 for the Distribution System. Using proportions based on amounts expended over the construction period, IDC amounts are distributed as shown below:

	SANTIAM DIVERSION ($1,000's)	DISTRIBUTION SYSTEM ($1,000's)
IDC ASSOCIATED WITH NATURAL RESOURCES	802	758
IDC ASSOCIATED WITH THE LOCAL CONTRIBUTION	313	279
AMOUNT TO BE FINANCED	138	79
TOTAL IDC	1,254	1,117

As stated earlier, under the 984 program Federal funds are advanced during the construction period. At the conclusion of construction an allocation of final costs is prepared that identifies the interest that has accrued during construction and the amounts of the loan and grant. No provision exists for further grant funding. A major portion of this alternate's operating costs will be for pumping energy, a portion of which conceivably could be grant eligible.

To estimate the grant potential, the energy cost is capitalized. Annual pumping costs are estimated to be $314,600 at the Santiam Diversion and $225,200 at Pudding River for the distribution system. Capitalized values over the repayment period and at the repayment rate, amount to $6,244,000 for the Santiam Diversion and $4,470,000 for the Distribution System. The capitalized values are allocated between irrigation and natural resources, and at the Santiam Diversion, with a 100 % grant, $4,090,000 would be grant eligible, and for the Distribution System, $3,035,000 would be grant eligible. It is assumed these funds would be placed in an interest earning account and the income used to offset actual annual energy costs during project operation.

An additional operating cost of this alternative will be for purchasing the water supply from Detroit Reservoir storage. This analysis uses $2.00 per acre-foot as the purchase price. The unit price would be added to the cost of water for service to lands in the Sublimity area. The amount of water to be purchased for use in the service area would amount to 7,500 acre-feet for direct irrigation use and 15,857 acre-feet for exchange purposes. The annual cost would be $48,414. It is assumed that none of this cost is grant eligible, as all water will be used for irrigation, ostensibly. The cost per acre would be $6.46.

Annual hydro revenue from the plant to be installed at the terminus of the Santiam Diversion pipeline in Pudding River is estimated to amount to $98,975.

Assuming a 100% grant for natural resource function costs, the total amounts to be repaid would then be as listed in Table V-8.

Table V-8

PIPELINE WATER COST SUMMARY

	SANTIAM DIVERSION	DISTRIBUTION SYSTEM
CONSTRUCTION COST TO BE FINANCED, $1,000's	2,512	1,450
IDC TO BE FINANCED, $1,000's	138	79
TOTAL LOAN, $1,000's	2,650	1,529
REPAYMENT COST, $/ACRE, 5%, 40 YR TERM	18.50	11.88
NET PUMPING COST, $/ACRE	22.98	17.89
WATER PURCHASE, $/ACRE	2.00	6.46
HYDRO REVENUE, $/ACRE		13.18
TOTAL LOAN REPAYMENT & OPERATING COST, $/ACRE	43.48	23.04

Water costs for these items would total $64.52 per acre within the Pudding River Service Area and $43.48 per acre in the Sublimity area.

To meet the contribution requirement, it is assumed that bonds would be sold for the amount needed. The total necessary is 25% of construction costs, or $5,562,000 for the Santiam Diversion portion of the project and $4,696,000 for the Distribution System portion, for a total of $10,258,000. It is assumed the sale would occur at the beginning of year 3 in the construction schedule, and the bond amount would therefore include two years of debt service payments and the cost of the bond sale. The total amount of the issue would then amount to $11,726,000. At a repayment rate of 6% and over a 40 year term, debt service for the bonds would amount to $93.33/acre over the 8,350 acres included in the Pudding River Service Area and lands served in the Sublimity area.

Were the contribution bond debt service cost to be spread over lands receiving exchange supplies as well as all other lands, amounting to 24,207 acres, the cost would amount to $32.18/acre.

WATER COST SCHEDULE

Material in Chapter III shows that, under consistent administration of surface water rights in the project area, there would normally be irrigation shortages that vary in severity with priority date. The more junior the right, then the more interest, and value derived, from purchasing water from a project. This situation suggests a graduated water cost schedule would be appropriate.

Table V-9 lists acreages and representative shortage categories.

Table V-9

ACREAGE OF SHORTAGE CATEGORIES

STREAM	PRIORITY	SHORTAGE CATEGORY RARE	ONE MONTH	TWO/THREE MONTHS	NO SURFACE SUPPLY
		(ACRES)			
PUDDING	PRE 1955	2,600			
	PRE 1964		1,728		
	POST 1964			3,277	
BUTTE CREEK	PRE 1945	722			
	POST 1945		3,633		
SILVER CREEK	PRE 1983	480			
	POST 1983		90		
ABIQUA	PRE 1983	2,647			
	POST 1983			124	
ROCK CREEK	PRE 1945	297			
	POST 1945		258		
NEW OR CONVERTED LANDS					7,500
TOTALS		6,746	5,709	3,401	7,500

An example rate schedule for these lands might be as follows:

Lands with rare shortages	$2.00 per acre per year
Lands with one month shortages	$7.50 per acre per year
Lands with two/three month shortages	$20.00 per acre per year
Lands with not surface water rights	$40.00 per acre per year

With these rates, and acreages estimated in Table V-9, annual revenues would be as listed in Table V-10.

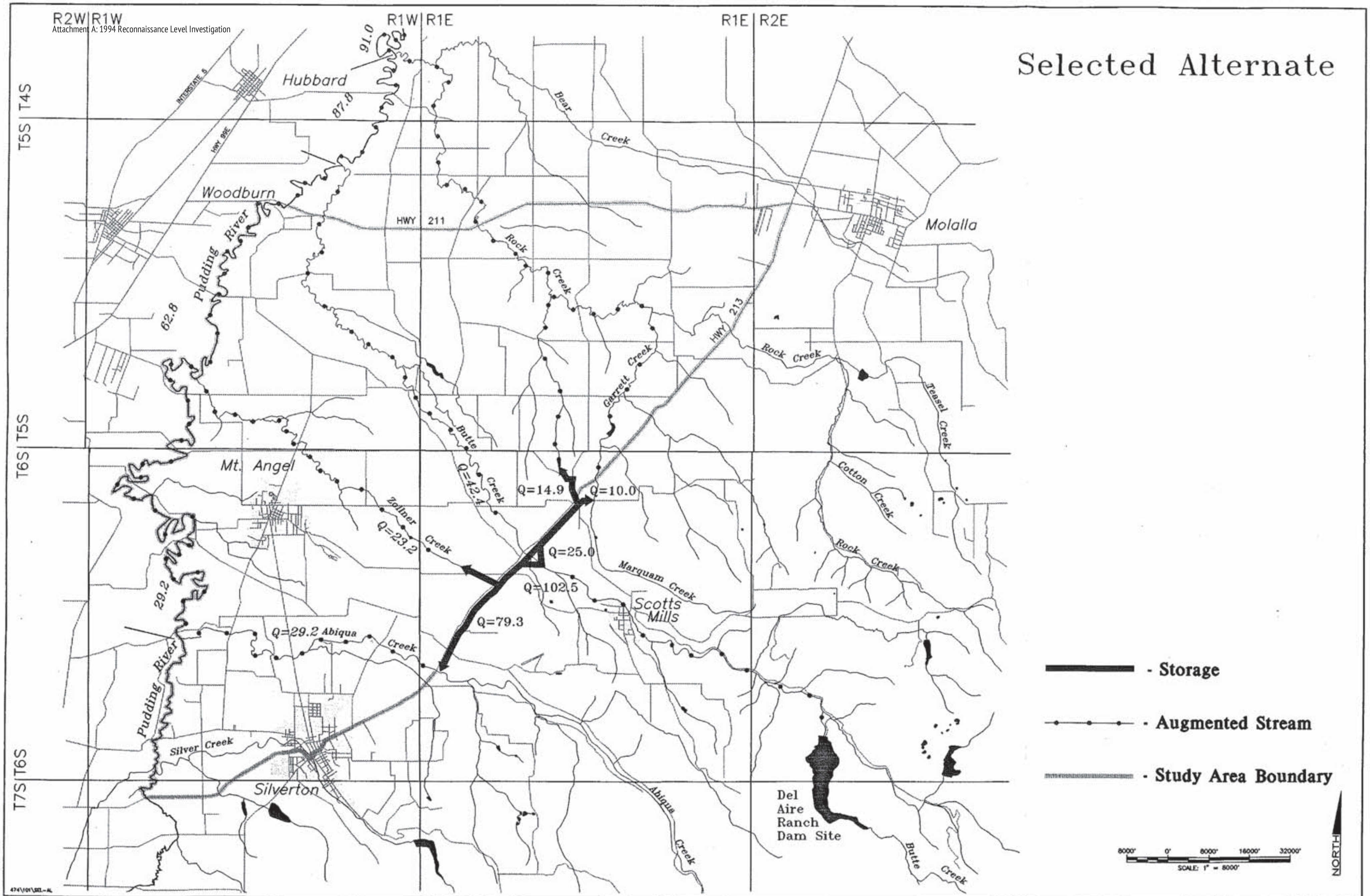
Table V-10

REVENUES WITH ASSUMED RATE SCHEDULE

CATEGORY	LANDS (ACRES)	RATE ($/ACRE)	REVENUE ($1,000)
LANDS W/ RARE SHORTAGES	6,746	2.00	13.5
LANDS W/ ONE MONTH SHORTAGES	5,709	7.50	42.8
LANDS W/ TWO-THREE MONTH SHORTAGES	3,401	20.00	68.0
LANDS W/ NO SURFACE WATER RIGHTS	7,500	40.00	300.0
TOTAL	23,357		424.3

With repayment conditions reflecting 100% grant for natural resources enhancement purposes and County participation for roads and recreation facilities, annual costs, including an allowance for operation and maintenance costs total about $930,000 annually. After installation of a hydro plant, annual revenues from generation are expected to total about $519,000. If this revenue were applied to annual costs, the amount to be made up from water service charges would be about $412,000 annually. Revenues at the rate schedule shown above would satisfy this requirement.

Selected Alternate



CHAPTER VI

PROGRAM AND ORGANIZATION

CHAPTER VI

PROGRAM AND ORGANIZATION

This Chapter contains material describing activities necessary to implement the Association's project. There is a need to coordinate Association activities with both Clackamas and Marion Counties, a need to maintain use of groundwater for some users in the interim until the project is completed and a work program to further define the project is included to illustrate specific follow-on activities.

COORDINATION WITH CLACKAMAS AND MARION COUNTIES

Since the project will include lands in both counties, successful implementation will require close coordination of activities of the Association with each county. Coordination will be required in five areas as the project develops.

- DAM AND RESERVOIR SITE PROTECTION

  The reservoir site will need to be protected in each County Comprehensive Land Use Plan. This may be accomplished by requesting the Planning Commission in each county to designate a "water impoundment" overlay on the prospective site. The overlay would include sufficient area to accommodate the dam, reservoir, recreation areas and all wildlife mitigation/enhancement areas.

  During final design and prior to construction, the Association will be required to request a zone change from the current zoning of the lands to be purchased to the "water impoundment" zone. This will be an administrative action and will require considerable information on the project before such a zone change request may be processed. This step is not unlike processing an Environmental Impact Statement.

- DISTRICT FORMATION

  Prior to construction of facilities, the Association will need to form a Water Control District to administer construction and operation of the project. Approval of both Clackamas and Marion County Commissioners will be required to form the district.

- ROAD CONSTRUCTION

  Modification of the existing road system in the vicinity of the dam and reservoir will be necessary to accommodate construction and to serve the selected recreation areas. It will be necessary to obtain road construction approvals from both counties. Given sufficient notice, the counties may be able to accomplish the required road construction within existing budgets. This would significantly lower the amount of "up front" funds the Association/District would need to acquire.

- RECREATION AREA DEVELOPMENT

  There will be significant recreation potential for both counties. The Association will need to coordinate potential recreation developments with each county to identify those potential sites which will suit their respective county recreation goals. It may be advantageous to have a recreation facility managed jointly by each county's recreation department.

- SERVICE AREA

  It may be necessary to obtain several permits to deliver water to all the service area. For example, when the Application to Appropriate Water from the project is submitted to the Oregon Water Resources Department, it will be necessary to obtain approval of the service area from each county's planning department.

INTERIM GROUNDWATER USE

Development and implementation of a long-term water supply project will require time, perhaps 5 to 10 years. During this period there remains a need for water and interim measures may be required in order to continue to use existing sources. Interim measures, in this context, may apply primarily to groundwater users in the groundwater limited areas.

Groundwater evaluations in connection with this report indicate that while water level declines are evident in some wells, there remains a groundwater resource that, in our opinion, can continue to be used. In order to acquire a permit, OWRD will probably require groundwater monitoring and management program as a permit condition.

OWRD may need a basis to grant permits for groundwater uses in the groundwater limited areas. In this regard, it may be necessary for applicants to have technical support while meeting with OWRD staff to present them with the results of groundwater evaluations.

Groundwater monitoring for this project would consist primarily of periodic water level measurements and provision of the data to OWRD on an annual basis. The data would provide information on water level trends which would be useful for refining estimates of aquifer capability for water supply.

Monitoring work has been accomplished recently for selected wells. This work represents a cost to the Association, or to individual members, that should be accounted for in budget planning. Budget allowance should also be made in the event a proposal to OWRD is necessary to allow continued groundwater uses.

RECOMMENDED 1994-1995 WORK PROGRAM

To prepare for final design and to better define project feasibility, additional information is necessary. This section discusses activities that are recommended to be accomplished as soon as funding can be obtained. More detailed description of work program items is listed in Appendix F, Grant Application for 1994-1995 Work Program.

General work areas include work at the dam and reservoir, in the service area and efforts to coordinate participants and agencies. Work at the dam will include preliminary geologic and topographic mapping of the damsite and review of seismic considerations necessary to select the appropriate types of dam. A more detailed estimate of construction cost will be prepared, if the Bureau of Reclamation is able to provide the service.

Hydrologic analyses will be performed to better define streamflows at the reservoir and to prepare reservoir operation studies using flows over the period of record.

Work in the service area will include detailed analysis of water rights in cooperation with water right holders to ensure that water use described herein is correct. In addition, SCS will be requested to provide creek channel evaluations to identify problems that could be created by use of the smaller creeks to distribute project releases.

Total cost of the proposed program is estimated to total $110,550. Of this amount, $7,350 is to come from the Association, $20,000 is estimated to be the value of work requested from USBR, $17,500 is estimated to be the value of work requested from SCS and $65,700 is planned to come from Economic Development grant funds.

APPENDIX A

SURFACE WATER RIGHTS

ABIQUA CREEK
SURFACE WATER RIGHTS LISTING

PRIORITY			USE	DIVERSION			ACRES	RATE	ACFT	PERMIT	CERTIF	WEST OF 213		CUMULATIVE	
MO	DAY	YEAR		SEC	TWNS	RNG						ACRES	CFS	ACFT	CFS
5	24	1916	MU	34	6S	1E		10.000		3226					
7	1	1924	IR	22	6S	1W	30.00	0.380	75.00	6384	6088	30.00	0.38	30.00	0.38
2	19	1937	IR	29	6S	1E	33.90	0.430	84.75	12647	46237			30.00	0.38
2	19	1937	IR	28	6S	1E	1.00	0.010	2.50	12647	57204			30.00	0.38
8	22	1938	IR	21	6S	1W	5.50	0.070	13.75	13235	14441	5.50	0.07	35.50	0.45
1	4	1939	IR	21	6S	1W	25.00	0.310	62.50	13395	14454	25.00	0.31	60.50	0.76
4	25	1939	IR	23	6S	1W	184.00	2.300	460.00	13619	48479	184.00	2.3	244.50	3.06
8	31	1939	IR	23	6S	1W	18.60	0.240	46.50	14020	14666	18.60	0.24	263.10	3.30
11	28	1939	IR	22	6S	1W	22.80	0.285	57.00	14084	20574	22.80	0.285	285.90	3.59
1	29	1940	IR	23	6S	1W	27.80	0.350	69.50	14180	15419	27.80	0.35	313.70	3.94
1	30	1940	IR	24	6S	1W	15.00	0.190	37.50	14182	15096	15.00	0.19	328.70	4.13
6	11	1940	IR	23	6S	1W	56.60	0.710	141.50	14421	15429	56.60	0.71	385.30	4.84
6	24	1940	IR	29	6S	1E	28.87	0.363	72.18	14449	36490			385.30	4.84
6	24	1940	IR	29	6S	1E	2.13	0.030	5.33	14449	42170			385.30	4.84
12	21	1940	IR	23	6S	1W	53.80	0.680	134.50	14718	14512	53.80	0.68	439.10	5.52
4	7	1941	IR	22	6S	1W	4.20	0.060	10.50	14829	15594	4.20	0.06	443.30	5.58
7	8	1942	IR	21	6S	1W	16.70	0.210	41.75	15329	32393	16.70	0.21	460.00	5.79
7	16	1942	IR	24	6S	1W	30.00	0.380	75.00	15334	16873	30.00	0.38	490.00	6.17
2	25	1943	IR	24	6S	1W	150.00	1.640	375.00	15435	57719	150.00	1.64	640.00	7.81
5	10	1943	IR	24	6S	1W	11.30	0.141	28.25	15485	16694	11.30	0.141	651.30	7.95
7	20	1944	IR	23	6S	1W	47.80	0.600	119.50	15866	16890	47.80	0.6	699.10	8.55
8	5	1944	IR	24	6S	1W	24.50	0.310	61.25	15913	16724	24.50	0.31	723.60	8.86
8	8	1944	IR	19	6S	1E	20.00	0.250	50.00	15894	15776			723.60	8.86
10	23	1944	IR	19	6S	1E	20.00	0.250	50.00	16033	15784			723.60	8.86
1	19	1945	IR	24	6S	1W	3.00	0.038	7.50	16316	17086	3.00	0.038	726.60	8.89
6	7	1945	IR	24	6S	1W	48.20	0.600	120.50	16364	16767	48.20	0.6	774.80	9.49
1	4	1946	IR	24	6S	1W	17.00	0.212	42.50	16786	16934	17.00	0.212	791.80	9.71
6	5	1946	IR	24	6S	1W	7.00	0.088	17.50	17094	16816	7.00	0.088	798.80	9.79
6	27	1946	IR	2	6S	1W	25.20	0.253	63.00	17119	16820	25.20	0.253	824.00	10.05
7	25	1946	IR	24	6S	1W	13.90	0.170	34.75	17337	22456	13.90	0.17	837.90	10.22
2	17	1947	IR	24	6S	1W	17.80	0.220	44.50	17554	16834	17.80	0.22	855.70	10.44
3	27	1947	IR	24	6S	1W	12.00	0.150	30.00	17640	20172	12.00	0.15	867.70	10.59
8	29	1947	IR	19	6S	1W	31.00	0.390	77.50	18005	20072	31.00	0.39	898.70	10.98
5	19	1947	IR	21	6S	1W	14.00	0.175	35.00	18816	20502	14.00	0.175	912.70	11.15
12	12	1949	IR	22	6S	1W	40.00	0.500	100.00	19133	22478	40.00	0.5	952.70	11.65
4	21	1950	IR	21	6S	1W	18.80	0.140	47.00	19652	20544	18.80	0.14	971.50	11.79
7	7	1950	IR	24	6S	1W	70.20	0.187	175.50	19695	26290	70.20	0.187	1,041.70	11.98
7	20	1950	IR	21	6S	1W	18.80	0.095	47.00	19652	20544	18.80	0.095	1,060.50	12.07
8	2	1950	IR	29	6S	1E	24.00	0.150	60.00	20495	28117			1,060.50	12.07

PRIORITY			USE	DIVERSION			ACRES	RATE	ACFT	PERMIT	CERTIF	WEST OF 213		CUMULATIVE	
MO	DAY	YEAR		SEC	TWNS	RNG						ACRES	CFS	ACFT	CFS
8	4	1950	IR	24	6S	1W	70.20	0.188	175.50	19695	26290	70.20	0.188	1,130.70	12.26
8	29	1950	IR	30	6S	1E	35.00	0.440	87.50	19957	44991			1,130.70	12.26
8	29	1950	IR	30	6S	1E	6.80	0.080	17.00	19957	55535			1,130.70	12.26
1	10	1951	IR	2	7S	1E	12.60	0.160	31.50	20513	23151			1,130.70	12.26
10	16	1951	IR	34	6S	1E	3.20	0.040	8.00	20816	24225			1,130.70	12.26
1	11	1952	IR	23	6S	1W	26.00	0.320	65.00	21039	29046	26.00	0.32	1,156.70	12.58
3	18	1952	IR	22	6S	1W	5.20	0.070	13.00	21193	22568	5.20	0.07	1,161.90	12.65
5	6	1952	IR	23	6S	1W	19.20	0.240	48.00	21354	24231	19.20	0.24	1,181.10	12.89
12	11	1952	IR	30	6S	1E	69.50	0.870	173.75	21980	26434			1,181.10	12.89
4	8	1953	IR	24	6S	1W	24.80	0.310	62.00	22241	22396	24.80	0.31	1,205.90	13.20
4	16	1953	IR	2	7S	1E	10.90	0.140	27.25	22265	27045			1,205.90	13.20
3	12	1954	IR	24	6S	1W	51.50	0.640	128.75	22857	24145	51.50	0.64	1,257.40	13.84
8	13	1954	IR	26	6S	1W	99.40	1.040	248.50	23217	28247	99.40	1.04	1,356.80	14.88
4	1	1955	IR	21	6S	1W	6.10	0.080	15.25	23526	22556	6.10	0.08	1,362.90	14.96
3	26	1956	IR	21	6S	1W	51.90	0.330	129.75	24119	29413	51.90	0.33	1,414.80	15.29
10	2	1956	IR	21	6S	1W	23.70	0.300	59.25	24486	28037	23.70	0.3	1,438.50	15.59
12	14	1956	IR	25	6S	1W	20.60	0.260	51.50	24627	27710	20.60	0.26	1,459.10	15.85
3	25	1957	IR	19	6S	1E	56.20	0.700	140.50	24772	27879			1,459.10	15.85
2	20	1958	IR	15	7S	1E	11.00	0.130	27.50	25367	29757			1,459.10	15.85
1	8	1959	IR	23	6S	1W	18.10	0.230	45.25	25912	28255	18.10	0.23	1,477.20	16.08
3	30	1959	IR	24	6S	1W	48.40	0.600	121.00	26093	30412	48.40	0.6	1,525.60	16.68
12	14	1959	IR	24	6S	1W	54.00	0.500	135.00	26476	29425	54.00	0.5	1,579.60	17.18
2	9	1960	IR	22	6S	1W	10.30	0.130	25.75	26580	30630	10.30	0.13	1,589.90	17.31
4	12	1960	IR	24	6S	1W	54.50	0.500	136.25	26694	29428	54.50	0.5	1,644.40	17.81
2	16	1961	IR	28	6S	1E	19.20	0.105	48.00	27207	33093			1,644.40	17.81
5	26	1961	IR	19	6S	1E	5.60	0.070	14.00	27418	55718			1,644.40	17.81
7	17	1961	IR	24	6S	1W	8.00	0.100	20.00	27494	30736	8.00	0.1	1,652.40	17.91
6	20	1962	IR	12	7S	1E	28.60	0.360	71.50	28132	31806			1,652.40	17.91
7	13	1962	IR	22	6S	1W	72.90	0.910	182.25	28157	34694	72.90	0.91	1,725.30	18.82
8	10	1962	IR	34	6S	1E	42.00	0.290	105.00	28299	35994			1,725.30	18.82
2	4	1963	IR	26	6S	1W	15.00	0.190	37.50	28611	33961	15.00	0.19	1,740.30	19.01
2	14	1963	IR	24	6S	1W	27.40	0.260	68.50	28621	36097	27.40	0.26	1,767.70	19.27
5	27	1963	IR	28	6S	1E	5.00	0.070	12.50	28850				1,767.70	19.27
5	27	1963	IR	28	6S	1E	68.80	0.860	172.00	28850	50344			1,767.70	19.27
6	6	1963	IR	21	6S	1W	6.00	0.080	15.00	28861	37459	6.00	0.08	1,773.70	19.35
6	18	1964	IR	34	6S	1E	18.80	0.240	47.00	29744	38580			1,773.70	19.35
11	9	1965	IR	6	7S	1E	36.60		91.50	30731	48548			1,773.70	19.35
1	13	1966	IR	23	6S	1W	28.00	0.350	70.00	31185	37971	28.00	0.35	1,801.70	19.70
1	25	1966	IR	24	6S	1W	34.40	0.430	86.00	31300	36116	34.40	0.43	1,836.10	20.13
7	21	1966	IR	24	6S	1W	112.00	1.400	280.00	31793	40135	112.00	1.4	1,948.10	21.53
8	9	1967	IR	28	6S	1E	3.00	0.040	7.50	32822	40313			1,948.10	21.53

PRIORITY			USE	DIVERSION			ACRES	RATE	ACFT	PERMIT	CERTIF	WEST OF 213		CUMULATIVE	
MO	DAY	YEAR		SEC	TWNS	RNG						ACRES	CFS	ACFT	CFS
1	11	1968	IR	23	6S	1W	98.00	1.230	245.00	33157	40032	98.00	1.23	2,046.10	22.76
5	15	1969	IR	24	6S	1W	7.40	0.090	18.50	34385	40147	7.40	0.09	2,053.50	22.85
2	18	1970	IR	28	6S	1E	0.20	0.010	0.50	34914	45557			2,053.50	22.85
5	26	1971	IR	30	6S	1E	28.80	0.360	72.00	27418	48683			2,053.50	22.85
7	21	1971	IR	29	6S	1E	2.40	0.030	6.00	36376	46797			2,053.50	22.85
2	12	1973	IR	21	6S	1W	51.60	0.650	129.00	37618	46909	51.60	0.65	2,105.10	23.50
8	13	1974	IR	23	6S	1W	48.60	0.610	121.50	37531	46715	48.60	0.61	2,153.70	24.11
5	13	1975	IR	24	6S	1W	17.60	0.220	44.00	38605	47001	17.60	0.22	2,171.30	24.33
6	18	1975	IR	30	6S	1E	13.70	0.170	34.25	38639	55536			2,171.30	24.33
8	19	1975	IR	2	7S	1E	1.00	0.013	2.50	40322	47426			2,171.30	24.33
2	19	1976	IR	24	6S	1W	161.20	2.020	403.00	40232	50849	161.20	2.02	2,332.50	26.35
8	11	1976	IR	22	6S	1W	20.50	0.260	51.25	41005	49205	20.50	0.26	2,353.00	26.61
4	11	1977	IR	24	6S	1W	55.00	0.690	137.50	41696	60993	55.00	0.69	2,408.00	27.30
9	16	1977	IR	24	6S	1W	55.00	0.690	137.50	41874		55.00	0.69	2,463.00	27.99
6	28	1978	IR	24	6S	1W	62.60	0.780	156.50	43312	53246	62.60	0.78	2,525.60	28.77
8	12	1980	IR	34	6S	1E	0.30	0.005	0.75	45196	61943			2,525.60	28.77
3	23	1981	IR	22	6S	1W	37.30	0.470	93.25	46219	67686	37.30	0.47	2,562.90	29.24
3	3	1982	IR	24	6S	1W	61.60	0.760	154.00	46747	62172	61.60	0.76	2,624.50	30.00
4	12	1982	IR	22	6S	1W	22.20	0.280	55.50	46542	61873	22.20	0.28	2,646.70	30.28
10	30	1985	IR	23	6S	1W	18.70	0.230	46.75	49561	55119	18.70	0.23	2,665.40	30.51
5	22	1987	IR	29	6S	1E	17.00	0.210	42.50	50011				2,665.40	30.51
11	12	1987	IR	22	6S	1W	106.00	1.320	265.00	50440	64713	106.00	1.32	2,771.40	31.83
									0.00						
TOTALS							3,397.50	48.708	8493.75			2,771.40			

ROCK CREEK
SURFACE WATER RIGHTS LISTING

PRIORITY MO	DAY	YEAR	USE	DIVERSION SEC	TWNS	RNG	ACRES	RATE	ACFT	PERMIT	CERTIF	WITHIN SRVCE AREA
6	2	1924	IR	24	5S	1E	30.00	0.380	75.00	7321	9703	30.00
7	2	1928	IR	30	4S	1E	15.00	0.200	37.50	7791	10140	
3	5	1934	IR	31	4S	1E	20.00	0.250	50.00	11196	15049	
7	6	1938	IR	8	5S	1E	32.50	0.270	81.25	13105	19489	32.50
12	29	1938	IR	31	4S	1E	18.60	0.240	46.50	13391	15064	
2	14	1939	IR	7	5S	1E	74.20	0.590	185.50	13485	14460	74.20
4	17	1939	IR	21	5S	1E	11.80	0.150	29.50	13592	15401	11.80
9	16	1940	IR	7	5S	1E	30.00	0.380	75.00	14618	15119	30.00
5	16	1941	IR	3	4S	1E	10.40	0.030	26.00	14927	15458	
12	7	1942	IR	31	4S	1E	28.50	0.360	71.25	15406	37357	
7	29	1944	IR	29	5S	2E	12.00	0.150	30.00	15880	19436	
8	26	1944	IR	29	5S	2E	14.20	0.178	35.50	15948	19443	
3	8	1945	IR	17	5S	1E	18.80	0.235	47.00	16203	20387	18.80
1	15	1946	IR	21	5S	1E	49.60	0.310	124.00	17074	20720	49.60
1	24	1946	IR	14	5S	1E	10.00	0.130	25.00	16799	23143	10.00
2	4	1946	IR	6	5S	1E	71.00	0.890	177.50	16775	20396	
10	3	1949	IR	27	5S	2E	5.20	0.060	13.00	20184	23847	
3	21	1950	IR	7	5S	1E	12.00	0.150	30.00	19460	22672	12.00
4	24	1950	IR	28	5S	2E	20.00	0.250	50.00	19645	24064	
7	24	1950	IR	32	5S	2E	8.00	0.100	20.00	19720	23213	
8	29	1950	IR	8	6S	2E	7.60	0.095	19.00	19810	20353	
10	20	1950	IR	9	5S	1E	42.00	0.500	105.00	21234	23354	42.00
11	12	1953	IR	10	6S	1E	13.80	0.170	34.50	22750	24712	
TOTALS							555.20	6.068	1388.00			310.90

SILVER CREEK
SURFACE WATER RIGHTS LISTING

PRIORITY			USE	DIVERSION			ACRES	RATE	ACFT	PERMIT	CERTIF	BELOW GAGE CFS	CUMULATIVE CFS	PRE 11/3/83 CFS	WEST OF 213 ACRES
MO	DAY	YEAR		SEC	TWNS	RNG									
3	16	1911	MU	18	7S	1E		5.000		622	2400				
11	3	1930	IR	34	6S	1W	0.50	0.010	1.25	9927	9088	0.010	0.010	0.010	0.50
6	24	1940	IR	32	6S	1W	50.00	0.252	125.00	14448	14304	0.252	0.262	0.252	50.00
7	11	1940	IR	32	6S	1W	23.20	0.220	58.00	14483	18849	0.220	0.482	0.220	23.20
7	11	1940	IR	32	6S	1W	11.80	0.148	29.50	14483	18849	0.148	0.630	0.148	11.80
7	19	1940	IR	33	6S	1W	29.00	0.363	72.50	14492	18859	0.363	0.993	0.363	29.00
8	21	1940	IR	33	6S	1W	58.20	0.730	145.50	14560	16857	0.730	1.723	0.730	58.20
5	1	1941	IR	34	6S	1W	10.40	0.130	26.00	14897	20466	0.130	1.853	0.130	10.40
13	31	1942	IR	2	7S	1W	1.50	0.020	3.75	15411	15150		1.853		
12	28	1943	IR	2	7S	1W	3.00	0.038	7.50	15685	15622		1.853		
12	1	1944	IR	34	6S	1W	5.00	0.063	12.50	16086	16742	0.063	1.916	0.063	5.00
12	27	1944	IR	33	6S	1W	24.50	0.310	61.25	16130	16901	0.310	2.226	0.310	24.50
2	23	1945	IR	34	6S	1W	3.50	0.044	8.75	16210	16905	0.044	2.270	0.044	3.50
8	17	1945	IR	2	7S	1W	1.00	0.013	2.50	16525	15672		2.270		
11	27	1945	IR	33	6S	1W	29.00	0.370	72.50	16703	16793	0.370	2.640	0.370	29.00
2	14	1946	IR	34	6S	1W	20.00	0.250	50.00	16780	20473	0.250	2.890	0.250	20.00
3	8	1946	IR	2	7S	1W	0.50	0.007	1.25	16922	16810		2.890		
3	31	1947	IR	2	7S	1W	1.10	0.014	2.75	17648	19860		2.890		
5	6	1947	IR	34	6S	1E	12.80	0.160	32.00	17877	20434		2.890		
5	21	1947	IR	32	6S	1W	41.00	0.520	102.50	17759	16974	0.520	3.410	0.520	41.00
6	3	1947	IR	1	7S	1W	1.20	0.015	3.00	17971	19466		3.410		
6	4	1947	IR	2	7S	1W	0.80	0.020	2.00	17972	20071		3.410		
3	10	1948	IR	2	7S	1W	6.40	0.080	16.00	18416	19603		3.410		
4	13	1948	IR	34	6S	1W	0.30	0.004	0.75	18224	17374	0.004	3.414	0.004	0.30
6	1	1948	IR	33	6S	1W	16.00	0.200	40.00	18341	33393	0.200	3.614	0.200	16.00
5	10	1949	ID	2	7S	1W	0.50	0.010	1.25	18880	21397		3.614		
8	1	1949	IR	32	6S	1W	3.60	0.050	9.00	18915	23201	0.050	3.664	0.050	3.60
8	25	1949	IR	33	6S	1W	20.80	0.260	52.00	19102	22475	0.260	3.924	0.260	20.80
5	3	1950	IR	2	7S	1W	8.50	0.110	21.25	19481	22183		3.924		
9	20	1951	IR	21	7S	1E	12.10	0.150	30.25	21004	23163		3.924		
7	7	1952	DO	19	7S	1E		0.010					3.924		
7	7	1952	IR	19	7S	1E	2.50	0.030	6.25	21590	28246		3.924		
2	6	1953	IR	2	8S	1E	14.20	0.180	35.50	22559	26639		3.924		
6	4	1953	DO	7	7S	1E		0.010					3.924		
6	4	1953	IR	7	7S	1E	7.30	0.060	18.25	22499	27870		3.924		
6	19	1953	IR	2	7S	1W	1.00	0.013	2.50	22327	22238		3.924		
9	30	1954	IR	2	7S	1W	1.30	0.010	3.25	23244	23708		3.924		
7	12	1955	IR	2	7S	1W	0.65	0.007	1.63	23780	44538		3.924		

PRIORITY MO	DAY	YEAR	USE	DIVERSION SEC	TWNS	RNG	ACRES	RATE	ACFT	PERMIT	CERTIF	BELOW GAGE CFS	CUMULATIVE CFS	PRE 11/3/83 CFS	WEST OF 213 ACRES
7	12	1955	IR	2	7S	1W	0.25	0.003	0.63	23780	45194		3.924		
5	24	1957	IR	34	6S	1W	5.40	0.070	13.50	24968	26357	0.070	3.994	0.070	5.40
1	29	1958	IR	12	7S	1W	23.40	0.290	58.50	25329	34067		3.994		
10	7	1958	IR	4	7S	1W	7.60	0.100	19.00	25806	30817		3.994		
6	30	1959	IR	32	6S	1W	20.60	0.200	51.50	26248	29421	0.200	4.194	0.200	20.60
12	27	1959	IR	12	7S	1W	2.10	0.030	5.25	19641	26108		4.194		
12	27	1959	AH					0.040					4.194		0.00
3	14	1960	IR	2	7S	1W	2.00	0.030	5.00	26650	29427		4.194		
5	12	1960	IR	32	6S	1W	12.50	0.150	31.25	26767	33982	0.150	4.344	0.150	12.50
6	20	1960	IR	1	7S	1W	1.10	0.010	2.75	26838	30730		4.344		
12	30	1960	IR	33	6S	1W	26.80	0.340	67.00	27124	33751	0.340	4.684	0.340	26.80
5	5	1961	IR	33	6S	1W	40.00	0.500	100.00	27374	45685	0.500	5.184	0.500	40.00
7	7	1961	IR	2	7S	1W	0.50	0.010	1.25	27484	32006		5.184		
11	28	1961	DO	34	7S	1E		0.005		27924	34192		5.184		
5	15	1963	IR	34	6S	1W	2.00	0.030	5.00	28842	33761	0.030	5.214	0.030	2.00
5	16	1963	DO	1	7S	1W		0.010		28843	35996		5.214		
7	30	1963	IR	2	7S	1W	6.00	0.080	15.00	28914	34588		5.214		
7	30	1963	DO	2	7S	1W		0.005					5.214		
1	11	1965	IR	2	8S	1E	111.10	1.130	277.75	30372	36008		5.214		
12	30	1965	IR	1	8S	1E	34.90	0.290	87.25	31165	36104		5.214		
12	30	1965	IR	12	8S	1E	26.90	0.290	67.25	31166	36106		5.214		
7	8	1966	IR	1	7S	1W	0.40	0.010	1.00	31676	39920		5.214		
6	6	1968	IR	1	7S	1W	0.30	0.010	0.75	33660	40034		5.214		
2	29	1973	IR	34	6S	1W	0.50	0.010	1.25	37632	44877	0.010	5.224	0.010	0.50
4	1	1974	IR	34	6S	1W	16.60	0.210	41.50	39015	46799	0.210	5.434	0.210	16.60
4	18	1974	IR	33	6S	1W	2.90	0.040	7.25	39039	50847	0.040	5.474	0.040	2.90
7	13	1977	IR	2	7S	1W	0.40	0.010	1.00	42109	51035		5.474		
2	29	1980	IR	33	6S	1W	5.40	0.070	13.50	44896	61625	0.070	5.544	0.070	5.40
5	17	1982	IR	1	7S	1W	1.70	0.020	4.25	46993	63760		5.544		
7	9	1990	IR	29	7S	1W	5.00	0.073	12.50	51376			5.544		
8	20	1990	IR	34	6S	1W	90.00	1.120	225.00	51400		1.120	6.664		90.00
TOTALS							869.50	15.067	2,173.75			6.664		5.544	569.50

BUTTE CREEK
WATER RIGHTS LISTING

PRIORITY			USE	DIVERSION			ACRES	RATE	ACFT	PERMIT	CERTIF	CTY	CLACK ACRES	MARION ACRES	BELOW GAGE (CFS)	PRE 12/22/88 (CFS)	SERVICE AREA ACRES CLKMS	SERVICE AREA ACRES MARION
MO	DAY	YEAR		SEC	TWNS	RNG												
10	15	1929	IR	23	5S	1W	12.00	0.150	30.00	9315	11590	C	12.00		0.150	0.150	12.00	
12	5	1930	DO	29	5S	2E	0.00	0.010	10.00	9991	9281	M		0.00				0.00
8	29	1935	IR	8	6S	1E	54.20	0.680	135.50	11846	14372	M		54.20				54.20
9	29	1936	IR	9	6S	1E	25.00	0.310	62.50	12393	14391	C	25.00					
10	1	1937	IR	11	5S	1W	22.00	0.280	55.00	13136	14627	M		22.00	0.280	0.280		
8	2	1938	IR	8	6S	1E	23.50	0.590	58.75	13184	55852	C	23.50				23.50	
4	6	1939	IR	23	5S	1W	15.30	0.200	38.25	13551	15400	C	15.30		0.200	0.200	15.30	
1	25	1940	IR	2	5S	1W	15.40	0.095	38.50	14177	20340	C	15.40		0.095	0.095		
6	22	1940	IR	22	5S	1W	77.00	0.970	192.50	14443	16659	M		77.00	0.970	0.970		77.00
7	3	1940	IR	25	5S	1W	24.00	0.150	60.00	14464		C	24.00		0.150	0.150	24.00	
7	3	1940	IR	25	5S	1W	98.30	0.610	245.75	14464	43544	C	98.30		0.610	0.610	98.30	
7	5	1940	IR	5	6S	1E	20.90	0.270	52.25	14470	15112	M		20.90				20.90
7	22	1940	IR	2	5S	1W	98.30	0.620	245.75	14464	43544	C	98.30		0.620	0.620		
8	19	1940	IR	5	6S	1E	12.50	0.160	31.25	14552	19435	M		12.50				12.50
9	12	1940	IR	15	6S	1E	16.40	0.200	41.00	15309	22155	M		16.40				
3	13	1942	IR	36	5S	1W	6.40	0.080	16.00	15213	14727	M		6.40				6.40
5	19	1942	IR	25	5S	1W	26.00	0.325	65.00	15279	19437	C	26.00		0.325	0.325	26.00	
4	23	1943	IR	16	6S	1E	4.70	0.059	11.75	15476	17119	M		4.70				
6	8	1943	IR	25	5S	1W	27.00	0.340	67.50	15523	16880	C	27.00		0.340	0.340	27.00	
11	17	1943	IR	25	5S	1W	28.20	0.353	70.50	15644	19439	C	28.20		0.353	0.353	28.20	
3	23	1944	IR	25	5S	1W	27.20	0.340	68.00	15716	21150	M		27.20	0.340	0.340		27.20
3	23	1944	IR	26	5S	1W	45.20	0.570	113.00	15717	21372	M		45.20	0.570	0.570		45.20
4	6	1944	IR	36	5S	1W	18.10	0.226	45.25	15743	38648	M		18.10				18.10
5	16	1944	IR	25	5S	1W	3.00	0.043	7.50	15924	16892	M		3.00	0.043	0.043		3.00
11	24	1944	IR	11	5S	1W	21.50	0.270	53.75	16081	16741	M		21.50	0.270	0.270		
8	17	1945	IR	31	5S	1E	30.00	0.380	75.00	16524	16778	M		30.00				30.00
2	18	1946	IR	23	5S	1W	24.50	0.310	61.25	16804	17125	M		24.50	0.310	0.310		24.50
5	4	1946	IR	23	5S	1W	53.40	0.670	133.50	16978	21162	M		53.40	0.670	0.670		53.40
7	17	1946	IR	5	6S	1E	10.00	0.125	25.00	17336	47683	C	10.00				10.00	

PRIORITY			USE	DIVERSION			ACRES	RATE	ACFT	PERMIT	CERTIF	CTY	CLACK ACRES	MARION ACRES	BELOW GAGE (CFS)	PRE 12/22/88 (CFS)	SERVICE AREA CLKMS (ACRES)	SERVICE AREA MARION (ACRES)
MO	DAY	YEAR		SEC	TWNS	RNG												
8	12	1946	IR	24	6S	1E	23.20	0.290	58.00	17197	20726	M		23.20				
6	6	1947	IR	5	6S	1E	30.00	0.380	75.00	17973	47684	C	30.00				30.00	
12	5	1947	IR	30	6S	2E	8.60	0.108	21.50	18124	20737	M		8.60				
1	19	1948	IR	25	5S	1W	12.60	0.160	31.50	18101	21386	M		12.60	0.160	0.160		12.60
8	12	1948	IR	15	6S	1E	4.00	0.050	10.00	18450	22464	M		4.00				
10	13	1948	IR	23	5S	1W	33.90	0.420	84.75	18574	33028	M		33.90	0.420	0.420		33.90
3	15	1949	IR	25	5S	1W	10.00	0.125	25.00	18873	19438	C	10.00		0.125	0.125	10.00	
6	14	1949	IR	23	5S	1W	56.60	0.550	141.50	18894	33027	M		56.60	0.550	0.550		56.60
7	13	1949	IR	25	5S	1W	13.00	0.163	32.50	18837	19440	C	13.00		0.163	0.163	13.00	
11	22	1949	IR	16	6S	1E	10.00	0.125	25.00	19050	22003	M		10.00				
12	19	1949	IR	23	5S	1W	30.00	0.380	75.00	19089	22174	M		30.00	0.380	0.380		30.00
1	3	1950	IR	25	5S	1W	29.60	0.370	74.00	19236	23019	M		29.60	0.370	0.370		29.60
3	8	1950	IR	23	5S	1W	30.00	0.200	75.00	19646	33245	M		30.00	0.200	0.200		30.00
4	27	1950	IR	6	6S	1E	19.20	0.180	48.00	19926	22769	M		19.20				19.20
7	3	1950	IR	25	5S	1W	29.80	0.370	74.50	21500	23212	C	29.80		0.370	0.370	29.80	
8	2	1950	IR	25	5S	1W	29.20	0.360	73.00	20496	24008	M		29.20	0.360	0.360		29.20
9	1	1950	IR	25	5S	1W	9.00	0.110	22.50	19816		M		9.00	0.110	0.110		9.00
10	24	1950	IR	23	5S	1W	30.00	0.180	75.00	19646	33245	M		30.00	0.180	0.180		30.00
11	28	1950	IR	6	6S	1E	64.00	0.800	160.00	20021	22773	M		64.00				64.00
11	28	1950	IR	5	6S	1E	23.00	0.290	57.50	20022	22774	M		23.00				23.00
11	28	1950	IR	14	5S	1W	42.70	0.350	106.75	20023	22775	M		42.70	0.350	0.350		42.70
11	30	1950	IR	23	5S	1W	29.00	0.350	72.50	20024	31534	M		29.00	0.350	0.350		29.00
12	1	1950	IR	25	5S	1W	9.30	0.120	23.25	19816	66904	M		9.30	0.120	0.120		9.30
1	26	1951	IR	15	5S	1W	30.00	0.380	75.00	20226	33029	M		30.00	0.380	0.380		30.00
2	21	1951	IR	6	6S	1E	19.20	0.060	48.00	19926	22769	M		19.20				19.20
3	30	1951	IR	31	5S	1E	28.60	0.360	71.50	20521	28295	C	28.60				28.60	
4	25	1951	IR	36	5S	1W	27.00	0.340	67.50	20307	24120	M		27.00				27.00
8	14	1951	IR	16	6S	1E	42.00	0.530	105.00	20655	22047	M		42.00				
9	7	1951	IR	22	6S	1E	27.00	0.330	67.50	20719	26418	M		27.00				
2	1	1952	IR	23	5S	1W	28.00	0.350	70.00	21072	22610	C	28.00		0.350	0.350	28.00	

PRIORITY MO	DAY	YEAR	USE	DIVERSION SEC	TWNS	RNG	ACRES	RATE	ACFT	PERMIT	CERTIF	C T Y	CLACK ACRES	MARION ACRES	BELOW GAGE (CFS)	PRE 12/22/88 (CFS)	SERVICE AREA CLKMS (ACRES)	SERVICE AREA MARION (ACRES)
6	27	1952	IR	15	6S	1E	10.00	0.130	25.00	21550	22226	M		10.00				
7	7	1952	IR	5	6S	1E	14.20	0.180	35.50	21616	24027	M		14.20				14.20
7	25	1952	IR	15	6S	1E	19.80	0.250	49.50	21641	26123	C	19.80					
9	30	1952	IR	8	6S	1E	29.70	0.370	74.25	21806	23256	C	29.70				29.70	
10	6	1952	IR	22	6S	1E	2.60	0.019	6.50	22481	22147	M		2.60				
2	17	1950	IR	15	6S	1E	2.80	0.040	7.00	22131	22234	M		2.80				
4	6	1953	IR	16	6S	1E	11.40	0.140	28.50	22233	26311	M		11.40				
4	15	1953	IR	15	6S	1E	30.00	0.380	75.00	22262	27754	C	30.00					
6	1	1953	IR	32	6S	2E	21.90	0.170	54.75	22303	30995	M		21.90				
3	29	1954	IR	11	5S	1W	36.40	0.380	91.00	22704	26452	M		36.40	0.380	0.380		
6	10	1954	IR	25	5S	1W	0.42	0.005	1.05	22956	21509	C	0.42		0.005	0.005	0.42	
6	11	1954	IR	5	6S	1E	60.00	0.750	150.00	23008	44418	M		60.00				60.00
6	28	1954	MU	22	6S	1E		0.250	0.00	23023	24146	M		0.00				
7	26	1954	IR	6	6S	1E	50.90	0.640	127.25	23129	47681	C	50.90				50.90	
9	17	1954	IR	15	6S	1E	12.50	0.160	31.25	23192	22250	M		12.50				
11	3	1955	IR	8	6S	1E	25.30	0.320	63.25	23891	41645	M		25.30				25.30
12	30	1955	IR	8	6S	1E	9.80	0.120	24.50	24015	26167	C	9.80				9.80	
8	14	1956	IR	5	6S	1E	28.10	0.350	70.25	24396	29819	C	28.10				28.10	
2	19	1952	IR	23	5S	1W	21.80	0.270	54.50	24735	24153	M		21.80	0.270	0.270		21.80
4	4	1958	IR	36	5S	1W	100.00	0.800	250.00	25428	28466	M		100.00				100.00
4	22	1958	IR	8	6S	1E	13.30	0.170	33.25	25457	27298	M		13.30				13.30
8	7	1958	IR	15	6S	1E	5.30	0.070	13.25	25700	30629	M		5.30				
1	21	1959	IR	16	6S	1E	66.10	0.580	165.25	25959	29339	C	66.10					
2	25	1959	IR	6	6S	1E	45.20	0.570	113.00	26022	28122	M		45.20				45.20
4	30	1959	IR	8	6S	1E	18.10	0.180	45.25	26152	31832	C	18.10				18.10	
2	10	1960	IR	31	5S	1E	15.60	0.200	39.00	26584	32519	C	15.60				15.60	
8	1	1960	IR	26	5S	1E	10.70	0.200	26.75	27094	34690	M		10.70				10.70
11	15	1960	IR	36	5S	1W	85.40	0.870	213.50	27068	30732	M		85.40				85.40
11	29	1960	IR	31	5S	1E	14.80	0.190	37.00	27079	33753	M		14.80				14.80
1	9	1961	IR	25	5S	1W	24.80	0.310	62.00	27130	30733	M		24.80	0.310	0.310		24.80

PRIORITY			USE	DIVERSION			ACRES	RATE	ACFT	PERMIT	CERTIF	CTY	CLACK ACRES	MARION ACRES	BELOW GAGE	PRE 12/22/88	SERVICE AREA ACRES	
MO	DAY	YEAR		SEC	TWNS	RNG									CFS		CLKMS	MARION
1	27	1961	IR	31	5S	1E	46.10	0.580	115.25	27159	34219	C	46.10				46.10	
2	6	1961	IR	8	6S	1E	67.80	0.800	169.50	27172	33092	M		67.80				67.80
2	27	1961	IR	31	5S	1E	36.80	0.460	92.00	27221	33671	M		36.80				36.80
4	12	1961	IR	36	5S	1W	34.90	0.370	87.25	27334	38649	M		34.90				34.90
4	24	1961	IR	16	6S	1E	27.70	0.350	69.25	27352	34692	M		27.70				
6	23	1961	IR	15	6S	1E	5.00	0.060	12.50	27450	34580	M		5.00				
6	29	1961	IR	16	6S	1E	39.70	0.500	99.25	27454	33326	M		39.70				
9	8	1961	IR	8	6S	1E	18.70	0.230	46.75	27581	34581	M		18.70				18.70
11	7	1961	IR	36	6S	1E	2.50	0.030	6.25	27681	33548	M		2.50				
11	24	1961	IR	31	5S	1E	17.40	0.220	43.50	27779	34539	C	17.40				17.40	
12	14	1961	IR	31	5S	1E	51.20	0.640	128.00	27755	34017	C	51.20				51.20	
5	2	1962	IR	16	6S	1E	10.50	0.130	26.25	28042	34693	M		10.50				
7	31	1962	IR	15	6S	1E	8.10	0.100	20.25	28228	41620	M		8.10				
7	31	1962	IR	15	6S	1E	11.50	0.140	28.75	28228	41621	M		11.50				
5	8	1963	IR	8	6S	1E	74.90	0.430	187.25	28831	43785	M		74.90				74.90
5	8	1963	IR	8	6S	1E	35.60	0.200	89.00	28831	57353	M		35.60				35.60
5	16	1963	IR	16	6S	1E	66.80	0.670	167.00	28844	41394	C	66.80					
4	14	1964	IR	15	6S	1E	13.30	0.170	33.25	29559	34632	M		13.30				
6	22	1964	IR	5	6S	1E	75.00	0.650	187.50	29785	43809	C	75.00				75.00	
7	15	1964	IR	6	6S	1E	15.00	0.190	37.50	29866	47682	C	15.00				15.00	
12	7	1964	IR	25	5S	1W	63.70	0.800	159.25	30158	34541	C	63.70		0.800	0.800	63.70	
2	8	1965	IR	31	5S	1E	78.40	0.980	196.00	30229	36418	M		78.40				78.40
3	29	1965	IR	31	5S	1E	43.40	0.480	108.50	30318	35420	C	43.40				43.40	
10	14	1965	IR	22	5S	1W	51.80	0.650	129.50	30983	38582	M		51.80	0.650	0.650		51.80
5	19	1965	IR	23	5S	1W	24.10	0.300	60.25	31582	36422	M		24.10	0.300	0.300		24.10
12	22	1966	IR	31	5S	1E	15.30	0.190	38.25	32236	43677	M		15.30				15.30
6	29	1967	IR	5	6S	1E	28.80	0.360	72.00	32150	44419	M		28.80				28.80
12	28	1967	IR	36	5S	1W	14.50	0.190	36.25	33116	40031	M		14.50				14.50
2	27	1968	IR	25	5S	1W	9.00	0.110	22.50	33311		M		9.00	0.110	0.110		9.00
3	3	1969	IR	8	6S	1E	10.40	0.130	26.00	34195	41619	M		10.40				10.40

PRIORITY MO	DAY	YEAR	USE	DIVERSION SEC	TWNS	RNG	ACRES	RATE	ACFT	PERMIT	CERTIF	CTY	CLACK ACRES	MARION ACRES	BELOW GAGE CFS	PRE 12/22/88 CFS	SERVICE AREA CLKMS ACRES	SERVICE AREA MARION ACRES
8	19	1970	IR	14	5S	1W	41.50	0.340	103.75	35542	40467	M		41.50	0.340	0.340		41.50
8	16	1973	IR	25	5S	1W	0.50	0.010	1.25	38541	53023	C	0.50		0.010	0.010	0.50	
7	12	1974	IR	31	5S	1E	19.00	0.240	47.50	39290	45261	C	19.00				19.00	
8	15	1974	IR	5	6S	1E	16.80	0.210	42.00	39352	45603	C	16.80				16.80	
7	10	1975	IR	31	6S	1E	38.00	0.480	95.00	39745	47382	C	38.00					
7	11	1975	IR	6	6S	1E	40.00	0.500	100.00	39746	47942	M		40.00				40.00
7	11	1975	IR	31	5S	1E	42.30	0.530	105.75	39747	51601	M		42.30				42.30
7	23	1975	IR	25	5S	1W	11.20	0.140	28.00	39870	51124	C	11.20		0.140	0.140	11.20	
7	31	1975	IR	31	5S	1E	75.00	0.500	187.50	39791	47576	C	75.00				75.00	
3	2	1977	IR	8	6S	1E	33.90	0.420	84.75	41538	51427	C	33.90				33.90	
3	27	1978	IR	8	6S	1E	59.70	0.130	149.25	42996	51364	C	59.70				59.70	
8	29	1978	IR	5	6S	1E	43.00	0.540	107.50	43511	55733	C	43.00				43.00	
6	6	1979	IR	14	5S	1W	22.90	0.290	57.25	44302	55070	C	22.90		0.290	0.290	22.90	
5	13	1980	IR	31	5S	1E	21.70	0.270	54.25	45031	54671	C	21.70				21.70	
5	13	1980	IR	8	6S	1E	131.70	1.650	329.25	45090	64872	M		131.70				131.70
1	5	1981	IR	15	5S	1W	18.40	0.230	46.00	45672	55071	C	18.40		0.230	0.230	18.40	
5	26	1981	IR	8	6S	1E	33.70	0.210	84.25	47801		M		33.70				33.70
5	26	1981	IR	8	6S	1E	81.00	0.520	202.50	47801	65143	M		81.00				81.00
4	16	1982	MU	22	6S	1E			0.00	46816	62210	M		0.00				
6	7	1982	IC	8	6S	1E	61.00	0.760	152.50	46857	64380	C	61.00				61.00	
9	20	1983	IC	8	6S	1E	127.30	1.600	318.25	47800	62395	C	127.30				127.30	
4	1	1985	IR	5	6S	1E	12.55	0.160	31.38	49279	67229	C	12.55				12.55	
1	15	1986	IR	8	6S	1E	21.00	0.260	52.50	49627		C	21.00				21.00	
TOTALS							4,355.47		10888.6				1,771.47	2,584.00	15.069	15.069	1,412.07	2,183.40

PUDDING RIVER
WATER RIGHTS LISTING

PRIORITY MO	PRIORITY DAY	PRIORITY YEAR	USE	DIVERSION SEC	DIVERSION TWNS	DIVERSION RNG	ACRES	RATE	ACFT	PERMIT	CERTIF	CTY	CLACK ACRES	MARION ACRES	BELOW GAGE CFS	PRE 6/22/64 CFS	SOUTH OF 211 ACRES	NORTH OF 213 ACRES	EAST OF PUDDING ACRES
8	11	1924	IR	3	8S	1W	20.00	0.250	50.00	6499	8071	M		20.00			20.00		
7	21	1926	IR	3	8S	1W	45.00	0.560	112.50	7490	8508	M		45.00			45.00		
7	21	1926	IR	8	6S	1W	24.64	0.310	61.60	7464	9197	M		24.64			24.64	24.64	
7	28	1926	ID	8	4S	1E	3.50	0.100	8.75	7900	8097	C	3.50		0.100	0.100			
9	9	1930	IR	5	7S	1W	1.00	0.020	2.50	9829	10745	M		1.00			1.00	1.00	
9	27	1930	IR	16	5S	1W	6.30	0.080	15.75	9891	11893	M		6.30	0.080	0.080	6.30	6.30	6.30
8	3	1931	IR	9	5S	1W	5.00	0.060	12.50	10280	9557	M		5.00	0.060	0.060	5.00	5.00	
6	16	1933	IR	2	5S	1W	100.00	1.250	250.00	10906	12243	M		100.00	1.250	1.250			
8	17	1935	IR	31	3S	1E	11.80	0.150	29.50	11819	12361	C	11.80		0.150	0.150			
8	20	1935	IR	29	6S	1W	12.00	0.150	30.00	12322	13492	M		12.00			12.00	12.00	12.00
6	11	1937	IR	13	4S	1W	17.20	0.215	43.00	12712	19952	M		17.20	0.215	0.215			
11	30	1938	IR	8	6S	1W	6.20	0.080	15.50	13375	15063	M		6.20			6.20	6.20	6.20
4	4	1939	IR	36	4S	1W	78.50	0.982	196.25	13550	16648	C	78.50		0.982	0.982			
7	19	1939	IR	20	6S	1W	20.00	0.250	50.00	13931	14490	M		20.00			20.00	20.00	20.00
7	20	1939	IR	32	5S	1W	20.40	0.260	51.00	13936		M		20.40	0.260	0.260	20.40	20.40	
7	20	1939	IR	32	5S	1W	9.60	0.120	24.00	13936	65137	M		9.60	0.120	0.120	9.60	9.60	
8	15	1939	IR	30	3S	1E	8.40	0.110	21.00	13974	15413	C	8.40		0.110	0.110			
1	25	1940	IR	2	5S	1W	15.40	0.095	38.50	14177	20340	C	15.40		0.095	0.095			
1	30	1940	IR	29	6S	1W	13.20	0.170	33.00	14181	15098	M		13.20			13.20	13.20	13.20
3	11	1940	IR	25	4S	1W	9.70	0.130	24.25	14198	15100	C	9.70		0.130	0.130			
5	31	1940	IR	16	5S	1W	28.70	0.360	71.75	14360	14499	M		28.70	0.360	0.360	28.70	28.70	
6	6	1940	IR	6	7S	1W	2.10	0.030	5.25	14365	15105	M		2.10			2.10		
6	24	1940	IR	32	6S	1W	50.00	0.378	125.00	14448	14304	M		50.00			50.00	50.00	50.00
7	8	1940	IR	17	6S	1W	33.00	0.420	82.50	14475	35912	M		33.00			33.00	33.00	
7	23	1940	IR	20	6S	1W	20.00	0.250	50.00	14385	15114	M		20.00			20.00	20.00	20.00
8	5	1940	IR	8	7S	1W	34.60	0.380	86.50	14522	48566	M		34.60			34.60		
8	6	1940	IR	5	7S	1W	30.00	0.380	75.00	14527	15113	M		30.00			30.00	30.00	
8	12	1940	IR	36	3S	1W	24.80	0.310	62.00	14538	15438	C	24.80		0.310	0.310			
9	25	1940	IR	29	6S	1W	24.30	0.304	60.75	14630	33901	M		24.30			24.30	24.30	24.30
9	25	1940	IR	29	6S	1W	12.90	0.161	32.25	14630	48295	M		12.90			12.90	12.90	
3	18	1941	IR	1	4S	1W	50.00	0.630	125.00	14806	17270	C	50.00		0.630	0.630			

PRIORITY MO	DAY	YEAR	USE	DIVERSION SEC	TWNS	RNG	ACRES	RATE	ACFT	PERMIT	CERTIF	CTY	CLACK ACRES	MARION ACRES	BELOW GAGE (CFS)	PRE 6/22/64 (CFS)	SOUTH OF 211 (ACRES)	NORTH OF 213 (ACRES)	EAST OF PUDDING (ACRES)
4	9	1941	IR	32	5S	1W	25.00	0.310	62.50	14835	30890	M		25.00	0.310	0.310	25.00	25.00	
5	1	1941	IR	21	5S	1W	26.30	0.330	65.75	14899	15456	M		26.30	0.330	0.330	26.30	26.30	26.30
6	9	1941	IR	20	6S	1W	12.20	0.160	30.50	14945	15169	M		12.20			12.20	12.20	12.20
11	22	1941	IR	36	4S	1W	48.70	0.610	121.75	15150	22629	M		48.70	0.610	0.610			
1	16	1942	IR	16	6S	1W	58.50	0.740	146.25	15184	15268	M		58.50			58.50	58.50	58.50
8	25	1942	IR	8	7S	1W	15.00	0.190	37.50	15356	16687	M		15.00			15.00		
11	30	1942	IR	29	5S	1W	54.20	0.364	135.50	15399	16877	M		54.20	0.364	0.364	54.20	54.20	
11	30	1942	IR	32	5S	1W	32.00	0.216	80.00	15399	16879	M		32.00	0.216	0.216	32.00	32.00	
8	16	1944	IR	32	5S	1W	54.80	0.230	137.00	15908	20832	M		54.80	0.230	0.230	54.80	54.80	
9	16	1944	IR	16	6S	1W	51.00	0.640	127.50	15981	16735	M		51.00			51.00	51.00	51.00
10	19	1944	IR	10	5S	1W	8.60	0.107	21.50	16032	16896	M		8.60	0.107	0.107	8.60	8.60	
3	1	1945	IR	21	5S	1W	4.20	0.052	10.50	16312	20631	M		4.20	0.052	0.052	4.20	4.20	4.20
5	7	1945	IR	21	5S	1W	18.90	0.237	47.25	16298	48894	M		18.90	0.237	0.237	18.90	18.90	18.90
5	16	1945	IR	29	6S	1W	6.20	0.080	15.50	16333		M		6.20			6.20	6.20	6.20
7	18	1945	IR	6	7S	1W	1.50	0.020	3.75	16427	16913	M		1.50			1.50		
9	4	1945	IR	32	6S	1W	15.20	0.190	38.00	16563	39845	M		15.20			15.20	15.20	15.20
10	1	1945	IR	6	6S	1W	30.00	0.380	75.00	16614	16923	M		30.00	0.380	0.380	30.00	30.00	
4	15	1946	IR	32	6S	1W	20.00	0.250	50.00	16903	33895	M		20.00			20.00	20.00	20.00
5	7	1946	IR	6	6S	1W	18.20	0.230	45.50	16991	22304	M		18.20	0.230	0.230	18.20	18.20	
5	22	1946	IR	21	5S	1W	192.00	2.400	480.00	17014	20016	M		192.00	2.400	2.400	192.00	192.00	192.00
6	4	1946	IR	8	7S	1W	10.00	0.130	25.00	17042	21640	M		10.00			10.00		
6	24	1946	IR	10	5S	1W	18.00	0.230	45.00	17112	16818	M		18.00	0.230	0.230	18.00	18.00	
6	27	1946	IR	20	6S	1W	25.20	0.057	63.00	17119	16820	M		25.20			25.20	25.20	25.20
8	8	1946	IR	10	5S	1W	4.50	0.056	11.25	17191	50394	M		4.50	0.056	0.056	4.50	4.50	4.50
9	30	1946	IR	6	7S	1W	11.80	0.148	29.50	17297	20065	M		11.80			11.80		
10	25	1946	IR	10	5S	1W	5.80	0.073	14.50	17363	16827	M		5.80	0.073	0.073	5.80	5.80	
12	5	1946	IR	21	5S	1W	30.10	0.380	75.25	17428	22457	M		30.10	0.380	0.380	30.10	30.10	30.10
1	20	1947	IR	10	5S	1W	20.00	0.250	50.00	17477	16830	M		20.00	0.250	0.250	20.00	20.00	
2	14	1947	IR	8	6S	1W	59.60	0.800	149.00	17548	22450	M		59.60			59.60	59.60	59.60
3	17	1947	IR	32	5S	1W	20.00	0.250	50.00	17614	20174	M		20.00	0.250	0.250	20.00	20.00	
5	14	1947	IR	25	4S	1W	28.10	0.352	70.25	17910	20496	C	28.10		0.352	0.352			
3	8	1948	IR	24	7S	2W	14.60	0.183	36.50	18206	20074	M		14.60			14.60		

PRIORITY			USE	DIVERSION			ACRES	RATE	ACFT	PERMIT	CERTIF	CTY	CLACK ACRES	MARION ACRES	BELOW GAGE	PRE 6/22/64	SOUTH OF 211	NORTH OF 213	EAST OF PUDDING
MO	DAY	YEAR		SEC	TWNS	RNG									CFS		ACRES		
4	5	1948	IR	16	6S	1W	30.60	0.380	76.50	18218	20984	M		30.60			30.60	30.60	30.60
4	22	1948	IR	24	7S	2W	12.40	0.150	31.00	18234	22647	M		12.40			12.40		
10	5	1948	IR	9	5S	1W	22.40	0.280	56.00	18510	21078	M		22.40	0.280	0.280	22.40	22.40	
3	1	1949	IR	8	6S	1W	16.40	0.205	41.00	18691	20092	M		16.40			16.40	16.40	16.40
3	9	1949	IR	24	7S	2W	18.00	0.230	45.00	18694	41625	M		18.00			18.00		
6	23	1949	IR	16	5S	1W	162.40	1.400	406.00	19180	44989	M		162.40	1.400	1.400	162.40	162.40	162.40
8	3	1949	IR	8	6S	1W	64.80	0.810	162.00	19098	22660	M		64.80			64.80	64.80	
8	15	1949	IR	1	5S	1W	22.60	0.283	56.50	18935	20508	C	22.60		0.283	0.283			
9	7	1949	IR	13	7S	2W	3.80	0.050	9.50	18968	40396	M		3.80			3.80		
9	13	1949	IR	25	4S	1W	149.50	1.250	373.75	18981	20110	M		149.50	1.250	1.250			
9	14	1949	IR	20	6S	1W	19.90	0.250	49.75	18987	22657	M		19.90			19.90	19.90	19.90
10	28	1949	IR	16	5S	1W	162.40	0.470	406.00	19180	44989	M		162.40	0.470	0.470	162.40	162.40	
12	23	1949	IR	25	4S	1W	149.50	0.620	373.75	18981	20110	M		149.50	0.620	0.620			
1	24	1950	IR	36	4S	1W	8.00	0.100	20.00	19193	39842	M		8.00	0.100	0.100			
1	24	1950	IR	36	4S	1W	9.40	0.120	23.50	19193	41790	M		9.40	0.120	0.120			
2	7	1950	IR	28	5S	1W	102.10	0.380	255.25	19262	22321	M		102.10	0.380	0.380	102.10	102.10	102.10
2	20	1950	IR	21	5S	1W	31.00	0.390	77.50	19206	22482	M		31.00	0.390	0.390	31.00	31.00	31.00
3	9	1950	IR	8	7S	1W	5.50	0.070	13.75	19914	23880	M		5.50			5.50		
3	21	1950	IR	28	5S	1W	102.10	0.030	255.25	19262	22321	M		102.10	0.030	0.030	102.10	102.10	102.10
4	3	1950	IR	12	4S	1W	7.00	0.088	17.50	19369	20542	C	7.00		0.088	0.088			
4	19	1950	IR	31	3S	1E	365.00	2.000	912.50	19470	53301	C	365.00		2.000	2.000			
5	1	1950	IR	20	6S	1W	30.00	0.190	75.00	19400	22670	M		30.00			30.00	30.00	30.00
6	5	1950	IR	29	6S	1W	43.30	0.540	108.25	19930	22683	M		43.30			43.30	43.30	43.30
7	21	1950	IR	28	5S	1W	69.50	0.394	173.75	19713	20865	M		69.50	0.394	0.394	69.50	69.50	69.50
8	30	1950	IR	8	7S	1W	25.80	0.250	64.50	19811	22191	M		25.80			25.80		
9	25	1950	IR	32	5S	1W	16.60	0.210	41.50	19973	22332	M		16.60	0.210	0.210	16.60	16.60	
10	23	1950	IR	3	5S	1W	56.50	0.710	141.25	22728	26055	M		56.50	0.710	0.710	56.50	56.50	
11	14	1950	IR	21	5S	1W	35.60	0.450	89.00	20217	22342	M		35.60	0.450	0.450	35.60	35.60	35.60
3	13	1951	IR	8	6S	1W	71.50	0.460	178.75	20256	22344	M		71.50			71.50	71.50	
6	26	1951	IR	5	7S	1W	28.10	0.380	70.25	21919	26918	M		28.10			28.10	28.10	
8	21	1951	IR	17	7S	1W	30.00	0.300	75.00	20668	23156	M		30.00			30.00		
9	10	1951	IR	32	5S	1W	23.20	0.290	58.00	20720		M		23.20	0.290	0.290	23.20	23.20	

PRIORITY MO	DAY	YEAR	USE	DIVERSION SEC	TWNS	RNG	ACRES	RATE	ACFT	PERMIT	CERTIF	CTY	CLACK ACRES	MARION ACRES	BELOW GAGE CFS	PRE 6/22/64 CFS	SOUTH OF 211 ACRES	NORTH OF 213 ACRES	EAST OF PUDDING ACRES
10	31	1951	IR	36	4S	1W	31.70	0.350	79.25	20836	47884	C	31.70		0.350	0.350			
10	31	1951	IR	1	5S	1W	35.70	0.450	89.25	20836	56081	C	35.70		0.450	0.450			
1	23	1952	IR	25	7S	2W	22.20	0.280	55.50	21053	24282	M		22.20			22.20		
2	15	1992	IR	29	6S	1W	27.00	0.340	67.50	21099	22371	M		27.00			27.00	27.00	27.00
4	28	1952	IR	29	6S	1W	29.95	0.370	74.88	21332	22377	M		29.95			29.95	29.95	
5	14	1952	IR	17	6S	1W	152.60	0.890	381.50	21522	28364	M		152.60			152.60	152.60	
5	23	1952	IR	20	6S	1W	69.50	0.800	173.75	21420	28460	M		69.50			69.50	69.50	69.50
5	29	1952	IR	7	7S	1W	11.70	0.150	29.25	21442	22223	M		11.70			11.70		
2	2	1953	IR	8	6S	1W	9.70	0.120	24.25	22075	22391	M		9.70			9.70	9.70	9.70
2	26	1953	IR	16	5S	1W	14.00	0.180	35.00	22152	24038	M		14.00	0.180	0.180	14.00	14.00	14.00
2	26	1953	IR	16	5S	1W	23.20	0.290	58.00	22151	26441	M		23.20	0.290	0.290	23.20	23.20	23.20
3	2	1953	IR	24	4S	1W	25.60	0.320	64.00	22163	45731	C	25.60		0.320	0.320			
1	12	1954	IR	29	5S	1W	10.70	0.130	26.75	22781	26323	M		10.70	0.130	0.130	10.70	10.70	
3	22	1954	IR	2	5S	1W	80.30	1.000	200.75	22913	27061	M		80.30	1.000	1.000			
12	8	1954	IR	16	5S	1W	29.40	0.250	73.50	23308	22976	M		29.40	0.250	0.250	29.40	29.40	29.40
12	28	1954	IR	21	5S	1W	12.50	0.150	31.25	23347	28118	M		12.50	0.150	0.150	12.50	12.50	12.50
12	31	1954	IR	32	6S	1W	6.80	0.080	17.00	23918	28929	M		6.80			6.80	6.80	6.80
3	17	1955	IR	32	5S	1W	63.20	0.790	158.00	23511	24559	M		63.20	0.790	0.790	63.20	63.20	
5	16	1955	IR	20	6S	1W	20.10	0.250	50.25	23757	28017	M		20.10			20.10	20.10	20.10
5	19	1955	IR	8	7S	1W	4.00	0.050	10.00	23629	22255	M		4.00			4.00		
12	16	1955	IR	21	5S	1W	40.20	0.500	100.50	24001	26475	M		40.20	0.500	0.500	40.20	40.20	40.20
1	11	1956	IR	24	7S	2W	30.40	0.380	76.00	23801	24361	M		30.40			30.40		
2	14	1956	IR	13	4S	1W	58.20	0.730	145.50	24051	27877	M		58.20	0.730	0.730			
7	20	1956	IR	6	6S	1W	81.00	1.010	202.50	24352	27709	M		81.00	1.010	1.010	81.00	81.00	
8	15	1956	IR	5	7S	1W	50.10	0.240	125.25	24540	28365	M		50.10			50.10	50.10	
1	22	1957	IR	7	7S	1W	11.70	0.150	29.25	24660	27084	M		11.70			11.70		
2	26	1957	IR	21	5S	1W	20.00	0.250	50.00	24743	27294	M		20.00	0.250	0.250	20.00	20.00	20.00
2	27	1957	IR	5	6S	1W	18.40	0.230	46.00	24832	44322	M		18.40	0.230	0.230	18.40	18.40	18.40
8	12	1957	IR	21	5S	1W	11.40	0.140	28.50	25053	29564	M		11.40	0.140	0.140	11.40	11.40	11.40
2	21	1958	IR	24	4S	1W	27.20	0.340	68.00	25352	29323	C	27.20		0.340	0.340			
7	21	1958	IR	10	5S	1W	12.00	0.150	30.00	25640	28933	M		12.00	0.150	0.150	12.00	12.00	12.00
9	18	1958	IR	8	7S	1W	3.60	0.050	9.00	25755	32224	M		3.60			3.60		

PRIORITY MO	PRIORITY DAY	PRIORITY YEAR	USE	DIVERSION SEC	DIVERSION TWNS	DIVERSION RNG	ACRES	RATE	ACFT	PERMIT	CERTIF	CTY	CLACK ACRES	MARION ACRES	BELOW GAGE (CFS)	PRE 6/22/64 (CFS)	SOUTH OF 211 (ACRES)	NORTH OF 213 (ACRES)	EAST OF PUDDING (ACRES)
12	16	1958	IR	5	6S	1W	26.60	0.330	66.50	25898	33755	M		26.60	0.330	0.330	26.60	26.60	26.60
3	26	1959	IR	2	8S	1W	7.60	0.100	19.00	26091	33750	M		7.60			7.60		
6	15	1959	IR	20	6S	1W	20.10	0.250	50.25	26214	39846	M		20.10			20.10	20.10	20.10
2	13	1960	IR	2	5S	1W	17.00	0.210	42.50	26569	30772	C	17.00		0.210	0.210			
5	4	1960	IR	8	6S	1W	26.00	0.330	65.00	26815	29429	M		26.00			26.00	26.00	
6	13	1960	IR	6	7S	1W	27.80	0.350	69.50	26788	33748	M		27.80			27.80		
10	11	1960	IR	9	6S	1W	42.00	0.530	105.00	27029	33759	M		42.00			42.00	42.00	42.00
12	19	1960	IR	1	4S	1W	9.70	0.120	24.25	27110	33645	M		9.70	0.120	0.120			
3	7	1961	IR	5	7S	1W	9.00	0.110	22.50	27235	30734	M		9.00			9.00	9.00	
4	24	1961	IR	16	5S	1W	56.70	0.710	141.75	27353	33460	M		56.70	0.710	0.710	56.70	56.70	
5	22	1962	IR	36	4S	1W	19.80	0.250	49.50	28076	35499	M		19.80	0.250	0.250			
7	18	1962	IR	29	6S	1W	121.20	1.520	303.00	28207	31695	M		121.20			121.20	121.20	
4	11	1963	IR	6	6S	1W	16.70	0.210	41.75	28758	35995	M		16.70	0.210	0.210	16.70	16.70	
5	17	1963	IR	33	7S	1W	6.20	0.080	15.50	28788	33353	M		6.20			6.20		
2	24	1964	IR	20	6S	1W	71.70	0.900	179.25	29413	33754	M		71.70			71.70	71.70	71.70
6	22	1964	IR	17	6S	1W	36.40	0.460	91.00	29791	36002	M		36.40			36.40	36.40	
7	20	1964	IR	5	7S	1W	28.00	0.630	70.00	29752	62118	M		28.00			28.00	28.00	
8	18	1964	IR	32	5S	1W	27.00	0.340	67.50	29944	36109	M		27.00	0.340		27.00	27.00	
9	2	1964	IR	17	6S	1W	71.00	0.890	177.50	30009	35883	M		71.00			71.00	71.00	
9	9	1964	IR	24	4S	1W	88.00	0.830	220.00	30017	35299	C	88.00		0.830				
11	2	1964	IR	12	4S	1W	27.00	0.340	67.50	30126	43102	C	27.00		0.340				
4	7	1964	IR	16	5S	1W	42.50	0.530	106.25	30339	36419	M		42.50	0.530	0.530	42.50	42.50	42.50
4	15	1965	IR	32	6S	1W	17.50	0.220	43.75	30355	35884	M		17.50			17.50	17.50	17.50
7	26	1965	IR	30	7S	1W	74.70	0.930	186.75	30671	36113	M		74.70			74.70		
10	8	1965	IR	19	7S	1W	15.40	0.190	38.50	30961	40132	M		15.40			15.40		
11	29	1965	IR	24	7S	2W	8.30	0.100	20.75	31216	42241	M		8.30			8.30		
1	13	1966	IR	29	6S	1W	44.60	0.560	111.50	31184	40133	M		44.60			44.60	44.60	
1	14	1966	IR	33	7S	1W	1.00	0.010	2.50	31282	40134	M		1.00			1.00		
1	31	1966	IR	24	4S	1W	8.00	0.100	20.00	31307	40531	C	8.00		0.100				
2	24	1966	IR	10	5S	1W	28.80	0.360	72.00	31378	40311	M		28.80	0.360		28.80	28.80	28.80
7	13	1966	IR	4	8S	1W	6.80	0.050	17.00	31766	39928	M		6.80			6.80		
9	28	1966	IR	29	5S	1W	61.20	0.650	153.00	32032	40026	M		61.20	0.650		61.20	61.20	

PRIORITY MO	DAY	YEAR	USE	DIVERSION SEC	TWNS	RNG	ACRES	RATE	ACFT	PERMIT	CERTIF	CTY	CLACK ACRES	MARION ACRES	BELOW GAGE PRE 6/22/64 CFS	SOUTH OF 211 ACRES	NORTH OF 213 ACRES	EAST OF PUDDING ACRES
1	10	1967	IR	29	5S	1W	103.90	1.300	259.75	32284	50513	M		103.90	1.300	103.90	103.90	
2	3	1967	IR	32	6S	1W	20.10	0.250	50.25	32331	48063	M		20.10		20.10	20.10	20.10
2	10	1967	IR	2	5S	1W	21.40	0.270	53.50	32338	44452	C	21.40		0.270			
5	10	1967	IR	33	7S	1W	0.50	0.010	1.25	32588	36124	M		0.50		0.50		
5	26	1967	IR	5	7S	1W	8.00	0.100	20.00	32639	36018	M		8.00		8.00	8.00	
10	27	1967	IR	16	6S	1W	46.80	0.350	117.00	33026	40304	M		46.80		46.80	46.80	46.80
1	2	1968	IR	20	6S	1W	7.00	0.090	17.50	33138	39922	M		7.00		7.00	7.00	7.00
1	17	1968	IR	12	4S	1W	15.90	0.200	39.75	33293	72317	M		15.90	0.200			
2	1	1968	IR	6	6S	1W	56.90	0.620	142.25	33243	39923	M		56.90	0.620	56.90	56.90	
3	1	1968	IR	36	4S	1W	129.40	1.620	323.50	33319	38823	M		129.40	1.620			
3	13	1968	IR	5	6S	1W	50.90	0.640	127.25	33378	42235	M		50.90	0.640	50.90	50.90	50.90
4	19	1968	IR	20	6S	1W	20.00	0.250	50.00	33509	39924	M		20.00		20.00	20.00	20.00
5	13	1968	IR	32	6S	1W	63.00	0.790	157.50	33568	40143	M		63.00		63.00	63.00	63.00
5	23	1968	IR	29	6S	1W	45.70	0.570	114.25	33616	40316	M		45.70		45.70	45.70	45.70
7	10	1968	IR	10	5S	1W	14.00	0.180	35.00	33737	40145	M		14.00	0.180	14.00	14.00	
7	10	1968	IR	10	5S	1W	13.10	0.160	32.75	33738	40462	M		13.10	0.160	13.10	13.10	
7	12	1968	IR	16	5S	1W	20.70	0.260	51.75	33752	40804	M		20.70	0.260	20.70	20.70	20.70
7	12	1968	IR	24	4S	1W	76.90	0.960	192.25	33751	44986	M		76.90	0.960			
7	31	1968	IR	17	6S	1W	31.60	0.400	79.00	33795	40317	M		31.60		31.60	31.60	
12	12	1969	IR	5	7S	1W	19.40	0.260	48.50	34818	62138	M		19.40		19.40	19.40	
12	29	1972	IR	21	5S	1W	14.20	0.180	35.50	37564	62033	M		14.20	0.180	14.20	14.20	14.20
3	29	1973	IR	5	6S	1W	45.00	0.560	112.50	37880	44320	M		45.00	0.560	45.00	45.00	45.00
6	2	1973	IR	36	4S	1W	15.10	0.190	37.75	37879	46083	M		15.10	0.190			
6	11	1973	IR	29	6S	1W	13.60	0.160	34.00	38258	52079	M		13.60		13.60	13.60	
1	22	1974	IR	16	6S	1W	5.70	0.070	14.25	38933	46609	M		5.70		5.70	5.70	5.70
4	11	1974	IR	30	3S	1E	55.20	0.690	138.00	39026	54224	C	55.20		0.690			
4	25	1974	IC	29	6S	1W	38.00	0.480	95.00	39044	57315	M		38.00		38.00	38.00	
8	14	1974	IR	16	5S	1W	6.50	0.080	16.25	39351	55407	M		6.50	0.080	6.50	6.50	6.50
1	13	1975	IR	5	6S	1W	90.80	1.100	227.00	38223	44321	M		90.80	1.100	90.80	90.80	90.80
3	19	1975	IR	25	4S	1W	23.00	0.290	57.50	39901	47154	C	23.00		0.290			
4	17	1975	IR	6	6S	1W	21.50	0.270	53.75	40012	56056	M		21.50	0.270	21.50	21.50	
12	4	1975	IR	10	5S	1W	11.10	0.140	27.75	40161	56376	M		11.10	0.140	11.10	11.10	

PRIORITY			USE	DIVERSION			ACRES	RATE	ACFT	PERMIT	CERTIF	CTY	CLACK ACRES	MARION ACRES	BELOW GAGE (CFS)	PRE 6/22/64 (CFS)	SOUTH OF 211 (ACRES)	NORTH OF 213 (ACRES)	EAST OF PUDDING (ACRES)
MO	DAY	YEAR		SEC	TWNS	RNG													
2	25	1977	IR	8	7S	1W	5.30	0.070	13.25	41799	57869	M		5.30			5.30		
3	1	1977	IR	8	7S	1W	8.00	0.100	20.00	43297	64470	M		8.00			8.00		
5	3	1977	IR	21	5S	1W	20.00	0.250	50.00	41780	48984	M		20.00	0.250		20.00	20.00	20.00
5	16	1977	IR	2	5S	1W	65.20	0.820	163.00	42234	57994	M		65.20	0.820				
10	3	1977	IR	8	6S	1W	30.00	0.380	75.00	42008	50851	M		30.00			30.00	30.00	
3	22	1978	IR	32	5S	1W	6.00	0.080	15.00	42992		M		6.00	0.080		6.00	6.00	
4	3	1978	IR	17	7S	1W	30.50	0.380	76.25	42999	60581	M		30.50			30.50		
7	31	1978	IR	24	7S	2W	21.50	0.270	53.75	43447	64500	M		21.50			21.50		
9	18	1978	IR	18	7S	1W	130.40	1.000	326.00	43766	51933	M		130.40			130.40		
1	2	1979	IR	1	4S	1W	96.90	1.210	242.25	43863	64507	C	96.90		1.210				
1	23	1979	IR	36	4S	1W	52.00	0.650	130.00	43869	64511	C	52.00		0.650				
2	26	1979	IR	10	5S	1W	29.90	0.370	74.75	43965	64515	M		29.90	0.370		29.90	29.90	
11	29	1983	IR	28	5S	1W	32.70	0.410	81.75	48167	54077	M		32.70	0.410		32.70	32.70	32.70
8	14	1984	IC	8	6S	1W	18.30	0.230	45.75	48763	64080	M		18.30			18.30	18.30	18.30
4	16	1985	IR	29	6S	1W	125.00	1.560	312.50	50736		M		125.00			125.00	125.00	125.00
7	15	1986	IR	24	4S	1W	56.00	0.700	140.00	49761	65738	M		56.00	0.700				
9	18	1986	IC	21	5S	1W	60.40	0.760	151.00	49880	67257	M		60.40	0.760		60.40	60.40	60.40
12	27	1989	IR	36	4S	1W	31.00	0.390	77.50	50875		M		31.00	0.390				
TOTALS							7,605.69	81.040					1,133.50	6,472.19	48.964	30.994	5,432.39	4,754.69	2,575.00

APPENDIX B

UNIT IRRIGATION REQUIREMENT

UNIT IRRIGATION REQUIREMENT DATA

CATEGORY	REPORTED ACREAGE	IRRIGATED ACREAGE	PERCENT	ANNUAL USE		IRRIGATION REQUIREMENT APR	MAY	JUN	JUL	AUG	SEP	SUM
CEREAL GRAINS	19,500	0										
					Distrib	3.2%	11.7%	20.3%	28.5%	23.1%	13.2%	1.00
HAY & FORAGE [1]	30,500	9,500	15.8%	18.00	Inches	0.58	2.11	3.65	5.13	4.16	2.38	18.00
					Wtd	0.09	0.33	0.58	0.81	0.66	0.38	
GRASS & LEGUME SEED	66,000											
					Distrib	5.5%	13.8%	21.5%	31.7%	22.2%	5.3%	1.00
Red clover [1]		1,300	2.2%	17.00	Inches	0.94	2.35	3.66	5.39	3.77	0.90	17.00
					Wtd	0.02	0.05	0.08	0.12	0.08	0.02	
SPECIALTY FIELD CROPS	17,659											
					Distrib	0.9%	23.1%	38.5%	37.5%			1.00
Mint [1]		6,150	10.2%	12.00	Inches	0.11	2.77	4.62	4.50			12.00
					Wtd	0.01	0.28	0.47	0.46			
					Distrib							
Hops [2]		6,890	11.5%	12.00	Inches	0.00	0.00	3.00	3.00	3.00	3.00	12.00
					Wtd	0.00	0.00	0.34	0.34	0.34	0.34	
					Distrib		3.4%	16.5%	34.7%	29.0%	15.9%	1.00
Sgr bts [1]		2,419	4.0%	20.50	Inches	0.00	0.70	3.38	7.11	5.95	3.26	20.40
					Wtd	0.00	0.03	0.14	0.29	0.24	0.13	
VEGETABLE & TRUCK CROPS	38,750											
					Distrib		8.9%	43.5%	47.6%			1.00
Snap beans [1]		12,175	20.3%	9.77	Inches		0.87	4.25	4.65			9.77
					Wtd		0.18	0.86	0.94			
					Distrib		3.3%	18.8%	39.5%	31.9%	6.5%	1.00
Sweet corn [1]		15,640	26.1%	17.64	Inches		0.59	3.31	6.97	5.63	1.14	17.64
					Wtd		0.15	0.86	1.82	1.47	0.30	
					Distrib	19.1%	50.3%	30.6%				1.00
Peas [1]		2,745	4.6%	6.18	Inches	1.18	3.11	1.89				6.18
					Wtd	0.05	0.14	0.09				
TREE FRUITS & NUTS	8,025		0.0%									
SMALL FRUITS	5,190											
					Distrib		7.4%	18.9%	32.6%	26.6%	14.5%	1.00
Strawberries [1]		2,050	3.4%	13.30	Inches		0.98	2.52	4.33	3.54	1.93	13.30
					Wtd		0.03	0.09	0.15	0.12	0.07	
					Distrib		7.4%	18.9%	32.6%	26.6%	14.5%	1.00
Blackberries [1]		1,150	1.9%	13.30	Inches		0.98	2.52	4.33	3.54	1.93	13.30
					Wtd		0.02	0.05	0.08	0.07	0.04	
SPECIALTY HORTICULTURE & FORESTRY	NA											
Nursery crops			0.0%									
TOTALS	185,624	60,019										

[1] Oregon Crop Water Use and Irrigation Requirements, OSU Extension Service, Extension Miscellaneous 8530, October, 1992

[2] Pudding River Basin Water Resources Development Association, Board of Directors

PROJECT IRRIGATION REQUIREMENT

	APR	MAY	JUN	JUL	AUG	SEP	SUM
Total Weighted Irrigation Requirment, Inches	0.18	1.22	3.56	5.01	2.98	1.27	14.22
Monthly Distribution, percent	1.2%	8.6%	25.0%	35.2%	21.0%	8.9%	100.0%
Farm Delivery, 75% Efficiency	0.24	1.63	4.74	6.68	3.97	1.70	18.96
Demand on Storage, 90% Efficiency, Inches	0.26	1.81	5.27	7.42	4.41	1.88	21.06
Demand on Storage, 90% Efficiency, Feet	0.02	0.15	0.44	0.62	0.37	0.16	1.80

APPENDIX C

IRRIGATION WATER COST FROM WELLS

April 8, 1994

PUDDING RIVER BASIN WATER RESOURCES DEVELOPMENT ASSOCIATION

ESTIMATE OF CURRENT IRRIGATION WATER COST

In November, 1993 a questionnaire was developed and furnished to the members of the Association board. A blank questionnaire is included as the last page. Responses from five board members were received, providing useable data for 14 wells. Water cost calculations for these fourteen wells result in a weighted average cost of $47.36 per irrigated acre, including interest on well investment, pump replacement and the cost of electricity. The range is from almost $31 to nearly $97 per acre. The weighted average value is equivalent to a cost of about $ 70.15 per acre-foot.

WELLS, PUMPS AND MOTORS

Well depths reported ranged from a maximum of over 820 feet to a minimum of 166 feet. Estimated reported yields ranged from a minimum of 250 GPM (gallons per minute) to 2,000 GPM. Most respondents reported well-head pressures of 80 PSI (pounds per square inch), the maximum being 120 PSI with the minimum being 60 PSI. The great majority of motors installed are 40 or 50 HP (horsepower) units; the maximum being 80 HP and the minimum being 25 HP.

ANNUAL COSTS

Investment costs for wells and pumps were made at various times. The earliest well and pump cost provided was for 1968, with the latest being in 1992. Costs are adjusted to October, 1993 levels using USBR composite cost indeces, as appropriate. Interest on adjusted well investment is calculated at 3%. Estimated service life of pumps, motors and electrical gear was noted on the questionnaire, and an annual sinking fund amount is calculated, again at 3%, to estimate the annual cost for these items. Service life entries ranged from 20 years to 8 years. Annual energy costs were reported for all but two pumps, for which energy costs are estimated. Estimated total annual costs range from a maximum of nearly $4,200 to a minimum of $1,300.

IRRIGATED ACREAGE AND WATER USE

A total of about 735 acres is irrigated annually. Many responses noted that all reported acreage is that included in a rotation program, indicating what amounts to a three year rotation. The acreage included in water rate estimates is that to which water is applied, not the total acreage reported.

Per-acre water use reported ranged from 3 to 12 inches per acre, with most reporting either 8 or 9 inches. The three inch figure was reported as a range of from 3 to 9 inches, while the 12 inch value also was reported as a range of 9 to 12 inches. The average of all ranges and values reported is 7.8 inches. The weighted average value is 8.1 inches.

April 8, 1994

GROUNDWATER IRRIGATION UNIT WATER COST ESTIMATE USBR COMPOSITE COST INDEX: OCT. 1993 = 194												
YEAR OF CONST =	1968	INDEX	49	FACTOR	3.96	YEAR OF CONST =	1979	INDEX	121	FACTOR =	1.60	
COST OF WELL =	3,000	CURRENT COST =	11,878			COST OF WELL =	15,000	CURRENT COST =	24,050			
COST OF PUMP =	6,600	CURRENT COST =	26,131			COST OF PUMP =	8,000	CURRENT COST =	12,826			
SERVICE LIFE, YRS =	20	RATE =	3%			SERVICE LIFE, YRS =	15	RATE =	3%			
		INTEREST COST OF WELL =			356			INTEREST COST OF WELL =			721	
FACTOR = 0.037216		ANN COST OF PUMP =			972	FACTOR = 0.053767		ANN COST OF PUMP & MOTOR			690	
		ANN ENERGY COST =			530			ANN ENERGY			950	EST
		TOTAL			1,859			TOTAL			2,361	
ACREAGE IRRIGATED =		40				ACREAGE IRRIGATED =		56				
ACRE INCHES/ACRE	8	ACRE FEET/ACRE =	0.67			ACRE INCHES/ACRE	8	ACRE FEET/ACRE =	0.67			
		COST PER ACRE =	$46.47					COST PER ACRE =	$42.16			
YEAR OF CONST =	1978	INDEX	109	FACTOR	1.78	YEAR OF CONST =	1980	INDEX	135	FACTOR =	1.44	
COST OF WELL =	5,000	CURRENT COST =	8,899			COST OF WELL =	10,000	CURRENT COST =	14,370			
COST OF PUMP =	8,000	CURRENT COST =	14,239			COST OF PUMP =	6,000	CURRENT COST =	8,622			
SERVICE LIFE, YRS =	8	RATE =	3%			SERVICE LIFE, YRS =	18	RATE =	3%			
		INTEREST COST OF WELL =			267			INTEREST COST OF WELL =			431	
FACTOR = 0.112456		ANN COST OF PUMP &			1,601	FACTOR = 0.042709		ANN COST OF PUMP & MOTOR			368	
		ANN ENERGY			670			ANN ENERGY			700	EST
		TOTAL			2,538			TOTAL			1,499	
ACREAGE IRRIGATED =		50				ACREAGE IRRIGATED =		40				
ACRE INCHES/ACRE	8	ACRE FEET/ACRE =	0.67			ACRE INCHES/ACRE	8	ACRE FEET/ACRE =	0.67			
		COST PER ACRE =	$50.76					COST PER ACRE =	$37.48			
YEAR OF CONST =	1985	INDEX	158	FACTOR	1.23	YEAR OF CONST =	1990	INDEX	180	FACTOR =	1.08	
COST OF WELL =	8,000	CURRENT COST =	9,823			COST OF WELL =	16,211	CURRENT COST =	17,472			
COST OF PUMP =	6,000	CURRENT COST =	7,367			COST OF PUMP =	12,672	CURRENT COST =	13,658			
SERVICE LIFE, YRS =	10	RATE =	3%			SERVICE LIFE, YRS =	10	RATE =	3%			
		INTEREST COST OF WELL =			295			INTEREST COST OF WELL =			524	
FACTOR = 0.087231		ANN COST OF PUMP &			643	FACTOR = 0.087231		ANN COST OF PUMP & MOTOR			1,191	
		ANN ENERGY			530			ANN ENERGY			2,468	
		TOTAL			1,467			TOTAL			4,184	
ACREAGE IRRIGATED =		30				ACREAGE IRRIGATED =		104				
ACRE INCHES/ACRE	8	ACRE FEET/ACRE =	0.67			ACRE INCHES/ACRE	9	ACRE FEET/ACRE =	0.75			
		COST PER ACRE =	$48.91					COST PER ACRE =	$40.23			
YEAR OF CONST =	1987	INDEX	162	FACTOR	1.20	YEAR OF CONST =	1984	INDEX	155	FACTOR =	1.25	
COST OF WELL =	12,000	CURRENT COST =	14,370			COST OF WELL =	14,043	CURRENT COST =	17,576			
COST OF PUMP =	4,000	CURRENT COST =	4,790			COST OF PUMP =	11,492	CURRENT COST =	14,384			
SERVICE LIFE, YRS =	8	RATE =	3%			SERVICE LIFE, YRS =	10	RATE =	3%			
		INTEREST COST OF WELL =			431			INTEREST COST OF WELL =			527	
FACTOR = 0.112456		ANN COST OF PUMP &			539	FACTOR = 0.087231		ANN COST OF PUMP & MOTOR			1,255	
		ANN ENERGY			330			ANN ENERGY			1,478	
		TOTAL			1,300			TOTAL			3,260	
ACREAGE IRRIGATED =		30				ACREAGE IRRIGATED =		64				
ACRE INCHES/ACRE	8	ACRE FEET/ACRE =	0.67			ACRE INCHES/ACRE	9	ACRE FEET/ACRE =	0.75			
		COST PER ACRE =	$43.33					COST PER ACRE =	$50.94			

April 8, 1994

GROUNDWATER IRRIGATION UNIT WATER COST ESTIMATE

USBR COMPOSITE COST INDEX: OCT, 1993 = 194

YEAR OF CONST =	1982	INDEX	152	FACTOR	1.28	YEAR OF CONST =	1979	INDEX	121	FACTOR =	1.60
COST OF WELL =	10,920	CURRENT COST =	13,937			COST OF WELL =	11,595	CURRENT COST =	18,590		
COST OF PUMP =	9,722	CURRENT COST =	12,408			COST OF PUMP =	7,273	CURRENT COST =	11,661		
SERVICE LIFE, YRS =	10	RATE =	3%			SERVICE LIFE, YRS =	20	RATE =	3%		
		INTEREST COST OF WELL =			418			INTEREST COST OF WELL =			558
FACTOR = 0.087231		ANN COST OF PUMP &			1,082	FACTOR = 0.037216		ANN COST OF PUMP & MOTOR			434
		ANN ENERGY			1,263			ANN ENERGY			1,550
		TOTAL			2,764			TOTAL			2,542
ACREAGE IRRIGATED =		62				ACREAGE IRRIGATED =		83			
ACRE INCHES/ACRE	9	ACRE FEET/ACRE =	0.75			ACRE INCHES/ACRE	9	ACRE FEET/ACRE =	0.75		
		COST PER ACRE =	$44.57					COST PER ACRE =	$30.62		
YEAR OF CONST =	1971	INDEX	59	FACTOR	3.29	YEAR OF CONST =	1987	INDEX	161	FACTOR =	1.20
COST OF WELL =	7,273	CURRENT COST =	23,915			COST OF WELL =	13,346	CURRENT COST =	16,082		
COST OF PUMP =	4,777	CURRENT COST =	15,707			COST OF PUMP =	8,959	CURRENT COST =	10,795		
SERVICE LIFE, YRS =	20	RATE =	3%			SERVICE LIFE, YRS =	20	RATE =	3%		
		INTEREST COST OF WELL =			717			INTEREST COST OF WELL =			482
FACTOR = 0.037216		ANN COST OF PUMP &			585	FACTOR = 0.037216		ANN COST OF PUMP & MOTOR			402
		ANN ENERGY			1,030			ANN ENERGY			1,230
		TOTAL			2,332			TOTAL			2,114
ACREAGE IRRIGATED =		50				ACREAGE IRRIGATED =		50			
ACRE INCHES/ACRE	9	ACRE FEET/ACRE =	0.75			ACRE INCHES/ACRE	9	ACRE FEET/ACRE =	0.75		
		COST PER ACRE =	$46.64					COST PER ACRE =	$42.28		
YEAR OF CONST =	1981	INDEX	157	FACTOR	1.24	YEAR OF CONST =	1989	INDEX	173	FACTOR =	1.12
COST OF WELL =	18,000	CURRENT COST =	22,242			COST OF WELL =	38,087	CURRENT COST =	42,710		
COST OF PUMP =	12,740	CURRENT COST =	15,742			COST OF PUMP =	15,598	CURRENT COST =	17,491		
SERVICE LIFE, YRS =	10	RATE =	3%			SERVICE LIFE, YRS =	10	RATE =	3%		
		INTEREST COST OF WELL =			667			INTEREST COST OF WELL =			1,281
FACTOR = 0.087231		ANN COST OF PUMP &			1,373	FACTOR = 0.087231		ANN COST OF PUMP & MOTOR			1,526
		ANN ENERGY			870			ANN ENERGY			870
		TOTAL			2,910			TOTAL			3,677
ACREAGE IRRIGATED =		38				ACREAGE IRRIGATED =		38			
ACRE INCHES/ACRE	9	ACRE FEET/ACRE =	0.75			ACRE INCHES/ACRE	9	ACRE FEET/ACRE =	0.75		
		COST PER ACRE =	$76.59					COST PER ACRE =	$96.77		

April 8, 1994

WELL IDENT	1	2	3	4	5	6	7	8
YEAR DRILLED/DEEPENED								
DEPTH OF WELL[1]								
TOTAL COST OF WELL[2]								
TYPICAL WELL YIELD, IN GPM								
TOTAL COST OF PUMP & MOTOR NOW USED[3]								
COST OF ELEC. HOOK-UP[4]								
EXISTING MOTOR HORSEPOWER/kW[5]								
ESTIMATED SERVICE LIFE OF PUMP & MOTOR, IN YRS								
WELL-HEAD PRESSURE OBTAINED IN PSI								
ACREAGE IRRIGATED FROM WELL								
ANNUAL ACRE-INCHES PER ACRE								
"NORMAL" OR "BUDGETED" ANNUAL ENERGY COST								

1 Please note depth of original well and aquifer tapped, if known. Same info for deepening. Please use B for basalt: T for Troutdale: O for other. Suggested format: 1975,250'/T/1977,400'/B.

2 Cost should include drilling, casing, gravel packing, sand filters or screens and any other costs of well less pump and riser pipe.

3 Please note total cost of pump, motor and riser pipe. Please do not include cost of pipe away from the general well-head area or any sprinkler lines. Just the cost of getting water to the surface at the needed pressure.

4 Please list cost of panels and controls, utility hookup charge and any other electrical costs at time of installation.

5 Please list nameplate HP and demand kW as noted on PGE statements.

APPENDIX D

GROUNDWATER

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- Columbia River Group
- Troutdale Formation and Willamette Silt

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- Groundwater Level Fluctuations-General Study Area
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INTRODUCTION

The Pudding River Basin Water Resources Development Association project area is located in the central portion of the middle Willamette River drainage basin. The area occupies the central portion of the transitional slope and valley plain physiographic provinces as described in Hampton, (1972). The general area location is shown on Plate D-1, "Study Area Map". East of the area, the foothills of the Cascade Range form another physiographic province that is important from the standpoint of being a groundwater recharge area for the deeper rocks and source for rainfall runoff to the lower valley area.

Portions of two Oregon Water Resources Department (OWRD, 1993), defined groundwater limited areas are included in the 72 square mile area of investigation. In the northeast corner, the Glad Tidings Groundwater Limited Area occupies roughly 12 square miles. In the south-central area the Mt. Angel Groundwater Limited Area occupies about 16 square miles. These groundwater limited designations can potentially severely restrict agricultural groundwater use in the study area, especially for those with pending water rights applications.

Farmers in the study area have concerns about the long term impacts on their businesses resulting from the groundwater limited designations. They are interested in finding ways to obtain assurances that their businesses can continue to thrive by implementing some form of cooperative water resources planning; possibly including recharge projects, surface water development and groundwater management.

PURPOSE AND SCOPE OF WORK

The purpose of this investigation has been to describe existing groundwater conditions, determine existing and future groundwater needs, evaluate the feasibility of artificial groundwater recharge to augment current water demands and evaluate a plan for groundwater management. In order to accomplish this scope of work, the following tasks have been completed.

- Review existing hydrogeologic reports.
- Compile and review selected water well logs.
- Obtain and query State water well and groundwater rights databases.
- Obtain, plot and analyze water level monitoring and well production data.
- Interview agencies with groundwater or related information.

CONCLUSIONS

- There are two principal aquifers in the study area. An upper aquifer, the Troutdale aquifer and a deeper aquifer the basalt aquifer. The basalt aquifer is confined throughout the project area by silts and clays at the base of the Troutdale aquifer, while water in the Troutdale aquifer is unconfined.

- Well yields in the Troutdale aquifer are generally in the range of 50-300 gpm, while the basalt aquifer can often yield volumes greater than 500 gpm.

- Groundwater in storage in the Troutdale aquifer is significantly greater than the basalt aquifer.

- Groundwater use in 1966 is estimated at about 3400 acre-feet (A)F. Current demand on groundwater supplies is estimated at 15,790 AF. The largest present groundwater user is irrigated agriculture, with an estimated annual demand of 13,000 AF currently.

- Groundwater recharge to the Troutdale aquifer is estimated to be between 19,000 AF and 70,000 AF while recharge to the basalt aquifer is at least 13,000 AF. There appears to be sufficient recharge to aquifers within the project area to satisfy the water demands for at least all current uses without "mining" the resource.

- Groundwater levels in the basalt aquifer of the Mt. Angel Groundwater Limited Area have declined in response to groundwater pumping. Available historic data indicate that water level decline has been 30-50 feet in irrigation wells. In most cases there has been a reduced rate of fall season water level decline and no spring water level decline since 1990.

- The 100 feet of decline, and reduced production from Mt. Angel Well #5, appears to be an anomaly and might not be related to declining water levels in the region.

- Water level declines in the basalt aquifer of the Glad Tidings Groundwater Limited Area have been documented with available data. Between five feet and 60 feet of decline has been recorded by wells penetrating this aquifer.

- Wells in the extreme western and northwestern portion of the Pudding River study area which are typically producing from the Troutdale aquifer alone or from both the Troutdale and basalt aquifers have not shown water level declines.

- The bulk of the wells deepened in the study area are domestic wells. They probably were originally drilled to shallower depths and over the years their supply has dwindled due to declining water levels. Irrigation wells have generally been deepened in order to increase yield to expand irrigation.

- Continued pumping from the basalt aquifer should not impact water levels in wells tapping the Troutdale aquifer. Any impacts resulting from irrigation pumping would probably affect irrigators not residential supplies. However, not enough information is available to defend this argument and further monitoring and testing is necessary to determine actual hydraulic relationships between the Troutdale and underlying basalt aquifers.

- It is estimated that artificial groundwater recharge using injection wells in the Troutdale aquifer could provide at least 150-300 AF of recharge per well annually (November to May).

- Artificial groundwater recharge in the basalt aquifer should not be considered at this time due to the present lack of knowledge of the structure and orientation of permeable zones and other aquifer characteristics for this aquifer.

- An ongoing well planned water level monitoring program in both the Troutdale aquifer and underlying basalt aquifer throughout the study area is important for long term water management planning in the area. Data collection and evaluation over the next five to seven years will permit the preparation and implementation of a detailed groundwater management strategy.

- Enough is known now to design and implement a groundwater monitoring program with the objective of developing a groundwater management strategy that will enable managed use of the available groundwater resource. The Oregon Water Resources Commission would be requested to allow continued pumping from wells with permits or water rights applications pending on an interim 5-7 year basis.

- Managed, continued use of groundwater in the project area would be intended to be an interim solution while a long term water supply solution is developed.

RECOMMENDED MONITORING PROGRAM

The objectives of a groundwater monitoring program would be to permit continued pumping while developing a management program that would ensure the resource is not overexploited. Ultimately the program would identify mechanisms that when triggered would require specific actions on the part of groundwater pumpers. These triggering mechanisms might include, for instance, an increasing rate of water level decline or water level declines exceeding specified elevations. Actions by groundwater users might include curtailment of pumping based on water rights priority dates.

The scope of such a monitoring program might include the following.

- Immediately begin water level monitoring of all the Buell wells and wells in the Gladtidings Groundwater Limited area that have been measured in the past by the State on a semi-monthly basis.

- Hold discussions with OWRD staff regarding the findings of this study and outlining an approach for an ongoing monitoring program and management plan.

- Make formal presentations to the Water Resources Commission, if necessary, to describe findings and to outline scope and objectives of a monitoring plan that would permit continued pumping on an interim basis for 5-7 years.

- Identify additional wells to monitor beyond the limits of the Groundwater Limited areas that meet specified criteria so that the entire study area is represented by the collected data. New well selection criteria might include strategic locations geographically, completion depth intervals in basalt or Troutdale aquifers, and at depths which would aid in identification of vertical stratification of individual aquifer zones if appropriate.

- Conduct controlled pumping tests in the basalt aquifer to define hydraulic relationships between the basalt and Troutdale aquifers and to calculate aquifer characteristics.

- At the end of the second year of monitoring, specific pumping reduction triggering mechanisms would be identified. Results of subsequent years monitoring would be continuously compared to the accepted triggering mechanisms and provide for longer range planning should it become apparent that groundwater supplies cannot meet the irrigation demands for the area.

GEOLOGY AND WATER BEARING CHARACTERISTICS

There are four general water bearing earth units within the area of investigation. From oldest to youngest they include the marine sedimentary rocks, Columbia River Group of basalts, Troutdale Formation and the Willamette Silt. The general geologic and hydrogeologic characteristics of each of these are described below.

Marine Rocks

According to mapping by Hampton (1972), the marine rocks do not outcrop within the study area. They are exposed to the east in the Cascade Range foothills, however, and underlie the entire area at depth. These rocks are composed of materials deposited in a marine embayment adjacent to an area of active volcanism. They are composed of tuff (shale), tuffaceous sandstone and sandstone. Un-weathered portions of this unit are typically buff to light brown or cream colored and where layers with abundant shell fragments are present the material and enclosing layers are chocolate brown and likely to be logged as "brown shale" by well drillers.

The sandstone in this unit is generally composed of volcanic rock fragments that are cemented by clays derived from volcanic glass and are consequently poorly permeable. Locally, however, a few sandstone beds are moderately permeable where the sand is composed largely of quartz and feldspar cemented by either silica or calcite. This unit is more important in the foothill areas where modest quantities of water can be supplied for stock watering and individual domestic needs. Within the study area this unit typically yields water that is salty because percolation and dilution with recharge from precipitation has not had opportunity to remove salt water entrapped in the formation. This unit is not considered to be a potential useful aquifer for agricultural purposes.

Columbia River Group

The Columbia River Group of basalt lava flows was deposited on top of the marine rocks. Because the marine rock surface had been eroded prior to the Columbia River flows, the thickness of this unit can vary considerably, up to 600 feet, where topographic depressions such as relict stream valleys occur. Typically, individual flows within the Columbia River group exhibit a basal part that is rubbly, a central part that is massive and an upper portion that is usually vesicular, rubbly and brecciated. The zones that include the basal rubbly portion of an overlying flow and the upper vesicular portion of the bottom flow is called an interflow zone and form the main aquifers in this unit. The thicker and more rubbly an interflow zone, the more water it will transmit and yield. A single well can tap several flows and therefore several interflow zones. These wells are the highest producing wells in the area.

Surficial exposures of the unit occur immediately east of Highway 213 at Rock Creek, Butte Creek, Abiqua Creek, and the hillsides surrounding Silverton. Other notable exposures of the Columbia River group rocks occur northwest of Mt. Angel in the easterly half of section four, and on Mt. Angel itself.

In the northeast corner of the study area, Columbia River Group rocks are at depths of more that 500 feet in sections 13, 14, and 15. Depth to the top of this unit generally is greater in the western and northern portion of the study area. In the northeast quarter of section three (T6S/R1W), Columbia River group rocks occur at depths on the order of 300 feet while in sections 13 and 18 southeast of Mt. Angel, depth to these basalt rocks is only 100-200 feet. Moving southwest of Mt. Angel, faulting which trends northwest-southeast has down dropped the basalt contact at the northeast corner of section 15 to a depth of about 450 feet.

The basalt aquifer is presently the principal source of irrigation water in the study area. Well yields from this aquifer are often greater than 500 gpm. Yields in excess of 1000 gpm are not uncommon.

Troutdale Formation and Willamette Silt

Overlying the basalt is the Troutdale Formation which is composed of nonmarine sediments ranging from sand and gravel to clays and silts. Generally, the coarser grained most permeable materials are distributed more abundantly in the upper portions of the formation while the finer grained silts and clays are deeper in the section.

Well drillers logs reviewed during this study were not sufficiently detailed to permit definition of the contact between the Troutdale and the Willamette Silt. However, work conducted previously by Hampton (1972), indicates that the silt varies in thickness from about 40 to 80 feet northeast of Mt. Angel and from 20 to 100 feet to the southwest. The Willamette Silt is composed of alternating eight to ten inch thick layers of sand and silt, with occasional thin layers of clay. It's importance to the hydrogeology of the region is it's ability to transmit infiltrating rainwater to water bearing units below. Many of the earliest wells in the area were completed in the Willamette Silt.

Surficial exposures of the Troutdale Formation occur in the northeast portion of the study area, west of Molalla. Throughout the balance of the region it lies below the Willamette Silt and recent alluvium which occupies creek and stream channels. It reaches a maximum thickness in the western and northern portion of the study area and southwest of Mt. Angel. During review of wells drillers logs, it became apparent that the area northeast of Mt. Angel in the vicinity of sections 28 and 29, the Troutdale had a considerable amount of clay or claystone logged throughout the interval. The fine grained portion at the base of the unit forms an aquitard above the Columbia River Group basalt aquifer.

At the time Hampton, was doing his work the Troutdale Formation was the principal aquifer with hundreds of wells tapping it. Typical yields from the Troutdale aquifer are considerably less than the basalt, around 50 to 300 gpm.

A history of groundwater development in the study area is graphically portrayed in Figure D-1, "Number of New Wells Drilled By Year". A steady and rapid increase in the annual number of wells drilled occurred between about 1954 through 1971. Then it peaks in 1973 and begins a tapering off until a somewhat more uniform number of new wells are drilled beginning in 1985 to the present. Records indicate that about 1830 wells have been drilled in the project area; approximately one-quarter of which have been irrigation wells.

GROUNDWATER OCCURRENCE AND MOVEMENT

Groundwater in the study area occurs in both confined and unconfined conditions. Generally, water in the Troutdale and Willamette Silt aquifers is unconfined and receives recharge locally in the form of infiltrating rainwater. Where groundwater levels are deep enough, seepage through the bottoms of streams and creeks also recharge the unit. Groundwater in the basalt aquifer, however, appears to be confined by the poorly permeable to impermeable layers of clay and silt in the lower parts of the Troutdale formation. These layers prevent downward percolation of water in the study area. Recharge to the basalt aquifers, therefore, must occur outside the region where the rocks are exposed at the surface. The recharge area for the basalt aquifer is to the east of the transitional slope in the foothills of the Cascade Range.

The effectiveness of the Troutdale aquifer confining layers is evidenced by the presence of flowing wells which had been drilled into the basalt aquifer prior to the 1960's. In the mid to late 1950's a 492 foot deep basalt aquifer well in the City of Mt. Angel was flowing at 75 gpm. The hydraulic head on this flow was measured at more than an equivalent of 10 feet above ground level. Anecdotal evidence suggests that locally these type conditions still occur but at much reduced flow rates.

Groundwater flow is directed from areas of recharge to areas of discharge such as wells, springs and gaining streams or swamps for the upper aquifers, and heavily pumped wells in the deeper aquifer. In the area of investigation, this means that flow is generally directed to the northwest in the Troutdale aquifer. Movement in the deeper basalt aquifer is dependent on pumping patterns in the region that are controlled by irrigation and municipal well production. On a regional basis groundwater flow in the basalt is directed from the Cascade foothills to areas most heavily pumped.

Storage of groundwater in aquifers beneath the study area is controlled by total volume of drainable void space in the aquifer material, termed specific yield, and the thickness of the saturated section. On a volume for volume basis, the Troutdale aquifer can store much larger volumes than the basalt aquifer. Assuming a specific yield of 15% in the Troutdale aquifer and a 50 foot thick saturated section throughout the 46,500 acre study area, the volume of stored groundwater would be about 384,000 acre-feet (AF). On the other hand, the storage capability of the basalt is more limited with a specific yield on the order of 1%. A similar 50 foot depth of saturated thickness would provide only 23,000 AF of groundwater storage. Groundwater in storage is available for use from time to time during drought years when recharge is insufficient. Long Term recharge must be sufficient to replace short term draws on storage in order to prevent overdraft or mining of the system.

Groundwater Water Level Fluctuations-General Study Area

Historic water level fluctuations in the area are generally poorly documented. The work performed by Hampton (1972), included a detailed water level canvas on wells completed in the Troutdale aquifer but no basalt aquifer water levels were recorded on a broad scale. No perennial water level declines in the Troutdale aquifer were noted in the Hampton study. No follow-up work has been done to document what changes there might have been in this aquifer since that time. Neither Hampton or the Willamette Basin Task Force (1969), identified any perennial water declines in the study area basalt aquifer.

Two wells within the area have been monitored by the state since the mid to late 1960's. One, state well number 614 (T6S/R1W-6N), was completed only in the Troutdale aquifer and is located just west of the Pudding River. A hydrograph for this well is shown on Figure D-2, "Jebousek and Butsch Well Hydrographs". The hydrograph indicates that no significant water level declines have occurred in the vicinity of this well since measurements began in 1968. Water levels have remained at about elevation 130 feet or roughly 15 to 20 feet below ground surface.

A second well, the Butsch well, state well number 613 (T6S/R1W-1G), is 700 feet deep and extends through the basalt aquifer into what appears to be marine rocks. Water levels recorded for this well also do not show any significant decline over the long term as shown on Figure D-2. However, this well is completed in multiple aquifers and provides a composite water level representative of the combined aquifers penetrated. Typically over the past several years, water levels have been at about elevation 190 feet or 30 feet below ground surface. Outside of the study area, in the City of Woodburn, water level data for wells penetrating only the Troutdale aquifer or alluvium do not indicate any water level declines in this portion of the basin.

Other information that might indicate water level fluctuations is data contained in the OWRD "Water Rights Information System" (WRIS), a computer database containing well construction and water rights information. It includes tabulations of wells which have been deepened. Figure D-3, "Number of Wells Deepened By Year", shows that beginning in the late 1960's there was an ongoing effort taking place to deepen wells. A more dramatic impact can be seen in the mid 1980's through 1992. Of the total 226 wells represented in this figure, 164 are domestic wells, 59 are irrigation wells and the balance were municipal or unknown use wells. The percentage of irrigation wells deepened and domestic wells deepened is nearly equal at about 13 percent of each type of well drilled.

According to interviews with farmers, irrigation well deepenings were primarily conducted in order to produce higher yields in response to increasing water demands not necessarily due to declining groundwater levels. That is probably not the case with the domestic wells, however. Intuitively it appears probable that domestic wells were deepened because of declining water levels and loss of supply. Although no actual data was generated during this investigation, it is presumed that most of the domestic wells were originally completed at shallower depth in the Troutdale aquifer or Willamette Silt, suggesting that water levels in this aquifer have declined as well.

Groundwater Limited Areas

Two areas within this project area have been designated by Oregon Water Resources Department as Groundwater Limited (Oregon Water Resources Department, Administrative Rules, Chapter 690, Division 502, Willamette Basin Program, adopted August 28, 1992). These Groundwater Limited Areas (GLA's) are Mt. Angel and Gladtidings and are shown on Plate D-1. These areas have experienced groundwater level declines in the Columbia River basalt group aquifer.

The Mt. Angel groundwater limited area, located near the center of the county, occupies an area of 16 square miles. There are approximately 12 square miles of the Gladtidings GLA within the project area. The designation of an area as groundwater limited allows the OWRD to restrict additional pumping to a few designated uses. For both the Mt. Angel and Gladtidings GLA's this means that the basalt aquifer is classified for exempt uses only (those which do not require water rights). These uses include stock watering, irrigation of less than 1/2 acre, domestic use of less than 15,000 gpd, single industrial or commercial purposes not exceeding 5,000 gpd and down-hole heat exchange uses.

Groundwater rights applications pending on October 4, 1991 will be processed according to the classifications in effect on the date the application was filed. Permits may be issued for not more than five year periods and will contain special provisions, and can be extended for additional five year periods if the OWRD Director finds that the groundwater resource can probably support the extended use. Applications may be rejected or permit or certificate extensions may be denied if the aquifer displays adverse impacts as defined in OAR 690-08. Applications submitted after October 4, 1991 would be processed according to the requirements of rules and classifications described, and within two years of permit issuance the applicant must prepare a plan for the Water Resources Commission indicating the steps the permittee will take to obtain an alternate long-term water supply.

The largest water users affected by these designations are the agricultural interests. An informal survey conducted by the OWRD in December 1990 indicated that in an agricultural area of the Willamette Valley, about 20% of the wells larger than 8-inches in diameter were irrigating lands without water rights. The state believes that these illegal users might be contributing significantly to water level decline problems in the Willamette Valley (DRAFT-Willamette Basin Report, dated May 21, 1991).

Groundwater Level Fluctuations-Mt. Angel GW Limited Area

Historic groundwater level data in the Mt. Angel Groundwater Limited Area is generally limited to a few years record. Water level measurements for eight irrigation wells tapping the basalt aquifer plus the City of Mt. Angel well #5 were used to prepare hydrographs. Each of the hydrographs is shown on Plate D-2, "Well Hydrographs for Mt. Angel Groundwater Limited Area". Table D-1, "Water Level Data Summary" shows details of hydrograph interpretations.

With the exception of the City of Mt. Angel well, available data includes a single measurement when a well was drilled and then spring and fall measurements for the years 1990, 1991, 1992 and the spring of 1993. Overall the data indicates a water level decline throughout the area of about 30 to 50 feet since about 1971. Wells drilled more recently, including Kraemer #2, Kraemer Nursery and Bucholz well, show no spring declines since 1990. In most cases there has been a reduced rate of declining levels or no decline during the most recent period of record. The table also shows that the rate of decline varies on any given well from none to possibly as high as 8.9 ft/yr. This rate varies depending on which measurements are used, either spring before pumping season starts, or fall after the pumping season is over. This emphasizes the need for additional and longer term water level data collection.

Interpretation of the hydrographs is complicated by large fluctuations recorded annually on a seasonal basis. For the eight wells studied these fluctuations range from a low of 5 to 30 feet in Kraemer #2 to a high of 35 to 45 feet in Dickman #3 and #5. Because so few data points have been collected, they might not have recorded the extreme high and low levels. This lack of detailed record limits the ability to interpret and define longer term water level changes in the regional aquifer system caused by the drought and more recently the exceptionally wet 1992-93 winter.

TABLE D-1, WATER LEVEL DATA SUMMARY

WELL	DECLINE (FT/YR)	AVG. 1990'S W.L. (ft)	SEASONAL CHANGE (ft)	DECLINE (ft) OVER RECORD
Kraemer #1	0-2.9	85	20-30	30 since 1971
Lone Pine	4.5-7.1	83	30	48 since 1980
Dickman #3 and #5	0-3.1	74	35-45	35 since 1974
Esch	0-3.1	106	20-30	30 since 1982
Kraemer #2	0-4.7	95	5-30	0 since 1990
Kraemer Nursery	0-7.6	99	25-45	0 since 1990
Norb	0-3.5	111	20-30	50 since 1971

Bucholz	0-8.9	127	30-40	0 since 1990
City of Mt. Angel	8.3	450	-	100 since 1981

What appears to be the best record is data from City of Mt. Angel well number five. The hydrograph and pumping rate for Mt. Angel Well No. 5, shows that as the static water level declined from roughly 340 feet in 1981 to 454 feet in 1993, well production dropped from about 600 gpm to 250 gpm. Production by this well is from the basalt aquifer, indicating that water levels have declined significantly over the past 13 years at this location. This is not indicative of the nature of water level decline throughout this area however. The Kraemer Nursery well located 3500 feet to the northeast records a water level of about 100 feet in the spring of 1993. Comparison of water levels for the Mt. Angel well and irrigation wells in the area suggests that there might be other unknown complicating factors associated with the water level and production rate decline in this well. More detailed analysis of the available record and well logs appears to be warranted.

Groundwater Level Fluctuations-Glad Tidings GW Limited Area

Several wells have been monitored by OWRD in the Glad Tidings Groundwater Limited Area from about 1987 to 1989 and the present. Additional data occasionally dates back to the 1960's and 1970's. These wells, completed in the basalt aquifer, have typically shown water level declines of five feet to 60 feet. Hydrographs for six of these wells are shown on Plate D-3, "Well Hydrographs for Gladtidings Groundwater Limited Area".

GROUNDWATER USE

The principal groundwater user in the study area today, as in the past, is irrigated agriculture. Studies conducted in 1966 (Hampton, 1972), estimated groundwater irrigation use at 8600 AF annually, 2300 AF of which was probably occurring in the project area. Municipal use in the City of Mt. Angel was 380 AF, and rural domestic use in the Hampton report, for the project area, was estimated at 700 AF (75 gpd/person). Project area groundwater demand in 1966, therefore, is estimated to be about 3400 AF annually.

Water use in the area has grown substantially since 1966. Based on the OWRD WRIS data base, groundwater rights are attached to about 13,000 acres. Although we recognize that there could be as much as 2.5 AF per acre permitted under legal constraints, current cropping patterns and interviews with farmers (Tuscon Myers & Associates, personal communication, January 1994) only justify a 1.0 AF/acre use. This translates into a groundwater irrigation demand of 13,000 AF. Data from the City of Mt. Angel indicates that current water use is approximately 530 AF annually. The 1990 census data for the Pudding River Basin, prorated for the area of investigation, indicates a population density of about 140 persons per square mile, or 10,080 people requiring service by domestic wells (Tuscon Myers & Associates, personal communication 1993). At a demand rate of 200 gpd, a groundwater use of 2260 AF is calculated. Current total groundwater demand in the study area, therefore, is estimated at about 15,790 AF, a five fold increase over 1966 levels. Most of this demand is occurring in the basalt aquifers.

NATURAL GROUNDWATER RECHARGE

Estimates of recharge for aquifers in the study area can be made using conclusions presented by Hampton (1972), and the Willamette Basin Task Force (1969). They both quote from Price (1967), and approximate recharge of about 1.5 AF/Acre for areas underlain by Troutdale formation aquifers. If this estimate is reliable, the Troutdale aquifer in the study area receives nearly 70,000 AF annually. Gonthier (1983), in studying the Dallas-Monmouth Area estimated recharge of alluvial sediments at about 8 to 15 inches annually. At this rate the Troutdale aquifer within the study area would receive recharge between 19,000 AF and 58,000 AF.

Groundwater recharge to the basalt aquifer occurs in the foothills of the Cascades east of the area and must flow underground laterally to reach the project area. Estimates of recharge directly to this particular rock type have been estimated by the Oregon State Engineer (1974), at 1.5 inches and were inferred to be two to five inches by Gonthier (1983). Tributary areas of Columbia River Group volcanics east of the project area potentially contributing to underflow total about 103,700 acres (Willamette Basin Task force, 1969, area D-1 on Map IV-11). At recharge rates of between 1.5 inches and five inches, potential underflow into the project area is between 13,000 AF and 43,000 AF.

These estimates indicate that at least 32,000 AF of groundwater recharge is available to the project area.

GROUNDWATER QUALITY

A broad based water quality survey was included in the Willamette Basin Study (Willamette Basin Task Force, 1969), which provided a generalized indication of groundwater quality. No large databases are available to expand that work to include current conditions. However, the U.S. Geological Survey is currently conducting a water quality study, including groundwater, of the Willamette Basin. Their report might be available by the end of 1994. While some water quality changes probably have occurred since the 1969 study was conducted, they are not anticipated to be significant to this investigation. A general indicator of water quality is total dissolved solids of TDS. Throughout the area, TDS was found at concentrations less than 250 milligrams per liter (mg/l) in wells drilled in the Troutdale and basalt aquifers. Locally, TDS levels exceeding drinking water standards occurs in wells tapping the marine rocks aquifer or those which are hydraulically connected to this aquifer. The City of Mt. Angel has also experienced problems with hydrogen sulfide in one of their basalt wells. These problems have occurred in the easterly portion of the area studied and not enough data has been compiled to map the extent of the problem accurately.

One water quality issue common throughout the area has been excessive iron content. This causes staining of porcelain fixtures and clothes. The cities of Gervais and Hubbard to the west of the study area treat their supplies to remove iron and manganese, and rural residents typically either treat their domestic well water for iron problems or use cleaning or bleaching agents to remove stains caused by their presence. It is not uncommon for the iron content of groundwater in the project area to exceed 0.35 mg/l (Willamette Basin Task force, 1969).

Of 19 samples analyzed for irrigation water quality suitability within the entire Molalla-Salem slope study area of Hampton (1972), 16 were found to be generally suitable for irrigation of most crops on most soil. These analytical data indicate that by and large, groundwater in this study area is suitable for agricultural purposes.

ARTIFICIAL GROUNDWATER RECHARGE POTENTIAL

The feasibility of artificial recharge depends on the availability of suitable quality water, and aquifer characteristics conducive from a permeability and storage capability standpoint to receive, store and transmit the recharge water to points of future extraction. Specific issues associated with water quality considerations include source and aquifer water temperature and chemistry; source water dissolved air content and clarity, that is, a sediment free source of water. All of these quality issues relate to the potential clogging the receiving aquifer.

The ideal aquifer for artificial recharge is one that is deep and is composed of materials that are uniformly highly permeable. The aquifer should be relatively free of interbedded silt and clay layers so that recharged water can move freely from the point of application or injection to the point of extraction or use. There should be a sufficient volume of unsaturated material available prior to recharge such that significant volumes of water can be applied and stored for use in later months or years when the need arises.

One potential aquifer which might satisfy these conditions is the Troutdale. Typical yields from this aquifer and the extensive clay zones identified in wells located in the area between the Gladtidings and Mt. Angel groundwater limited areas suggest, however, that the success of an artificial recharge program in this aquifer is highly dependant on local variations of aquifer hydraulic characteristics. Siting potential injection wells would be subject to identifying the most permeable areas that are situated close to potential points of use. Assuming an injection rate of 200-400 gpm, a Troutdale aquifer well could conceivably recharge about 25-50 AF per month. With a six month recharge "season", a single well would be capable, therefore, of about 150-300 AF. Some increase in volume of recharge during a season might be realized if higher injection pressures were used or more highly permeable aquifer zones were identified.

As discussed previously, the basalt aquifer has a limited storage capability compared to the Troutdale aquifer. While some areas of this aquifer yield considerable volumes of groundwater, it must rely on a constant source of recharge from the east for replenishment. The structure and orientation of permeable zones in this aquifer are also irregular and presently unknown, therefore making it difficult to predict where recharged water could be extracted. For these reasons, it is not considered a likely candidate for artificial recharge activity.

GROUNDWATER MANAGEMENT WORK PROGRAM

This program is intended to develop a basis for continued use of groundwater while development of long-term water supply is underway. Long-term water supply development will require at least 5 to 7 years for implementation. However, some means of water supply must be available on an interim basis while long-term solutions are being developed.

This program concept is tracking of water level changes on a monthly basis for a 2-year period and identification of specific thresholds that when exceeded, will trigger specific management actions that affect groundwater use. For instance, if water levels in monitoring wells drop below a specified elevation, pumping rates could be reduced or stopped in a given well in order to prevent groundwater depletions.

Detailed work items and budget estimates for the next three years (January 1994 to January 1997) are presented below. Monitoring and reporting would likely extend beyond the periods identified below. Work activities and budgets for monitoring after January 1997 would be developed during the period ending in January 1997.

A. <u>Work Items for Completion for the Period January 1994 to January 1995</u>

1. Prepare groundwater management program and present it to Oregon Water Resources Department (OWRD) staff and identify needs to obtain permits for groundwater use in Groundwater Limited Areas.

   Budget Estimate $ 4,000

2. Based on results of item 1, present groundwater management program to Oregon Water Resources Commission (OWRC).

   Budget Estimate $ 4,700

3. Develop groundwater monitoring program and initiate well measurements, including: 1) identification of new wells to monitor, 2) preparation of data base for storing and evaluating monitoring results, and 3) coordination of monitoring with personnel that will perform water level measurements.

   Budget Estimate $ 5,100

4. Perform monthly water level measurements in monitoring well network and perform monthly evaluations of measurements.

   Budget Estimate $ 18,100

5. Prepare and submit annual report of monitoring results, conclusions and

recommendations to Pudding River Basin Water Resources Development Association (PRBWRDA) and OWRD. Present report at annual PRBWRDA meeting.

Budget Estimate $ 5,500

TOTAL BUDGET ESTIMATE 1994-1995 $ 37,400

B. Work Items to be completed for the Period January 1995 to January 1996

1. Perform monthly water level measurements in monitoring well network and perform monthly evaluations of measurements.

Budget Estimate $ 20,000

2. During November-December, 1995, identify water use thresholds and triggering mechanisms that would activate adjustments in groundwater use, if necessary, based on monitoring results and trends over the 2-year period January 1994 through January 1996. Prepare report of findings, conclusions and recommendations for PRBWRDA and OWRD. Present report at annual PRBWRDA meeting.

Budget Estimate $ 8,500

TOTAL BUDGET ESTIMATE 1995-1996 $ 28,500

C. Work Items to be completed for the Period January 1996 to January 1997

1. Perform monthly water level measurements in monitoring well network and perform monthly evaluations of measurements.

Budget Estimate $ 21,000

2. During November-December, 1996, evaluate monitoring results with respect to thresholds and triggering mechanisms, identify adjustments in groundwater use or monitoring that may be necessary, prepare and present report to PRBWRDA and OWRD.

Budget Estimate $ 6,000

TOTAL BUDGET ESTIMATE 1996-1997 $ 27,000

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FIGURE D-1 NUMBER OF NEW WELLS DRILLED BY YEAR

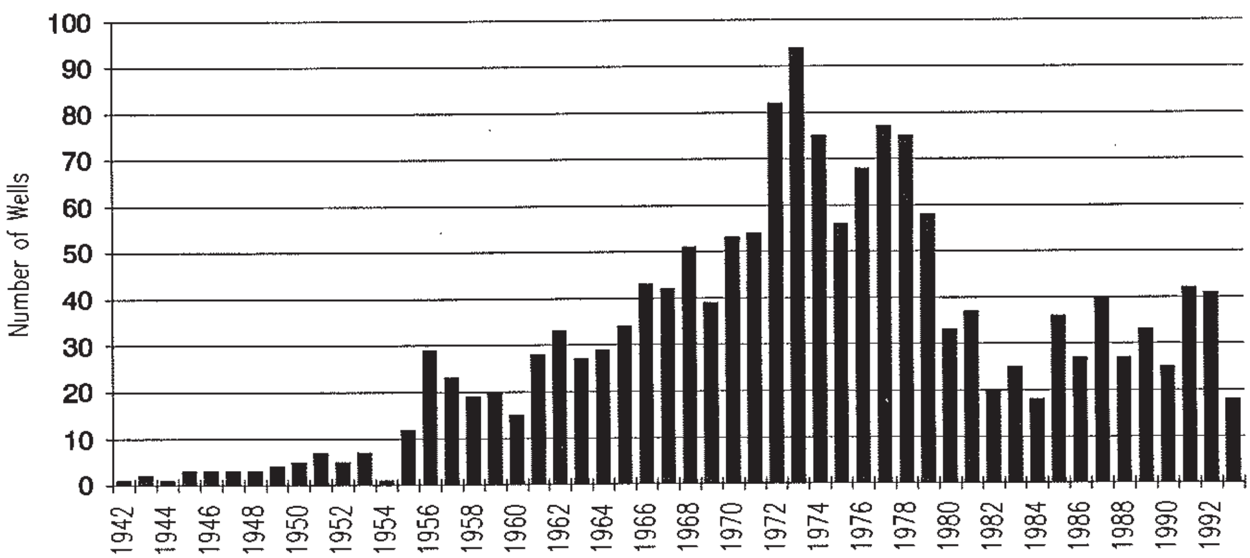
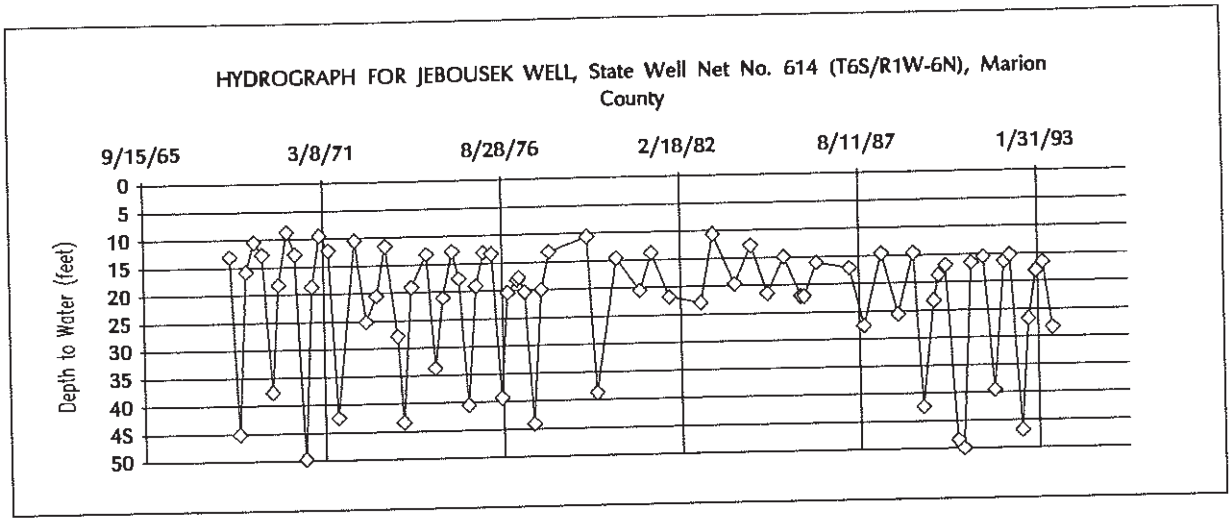


FIGURE D-2 JEBOUSEK AND BUTSCH WELL HYDROGRAPHS



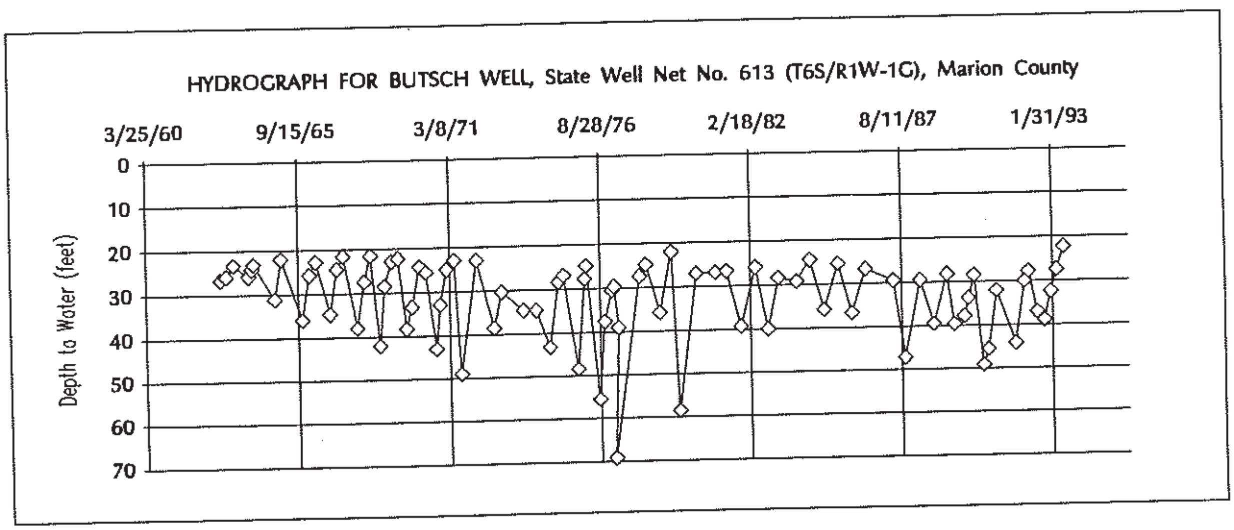
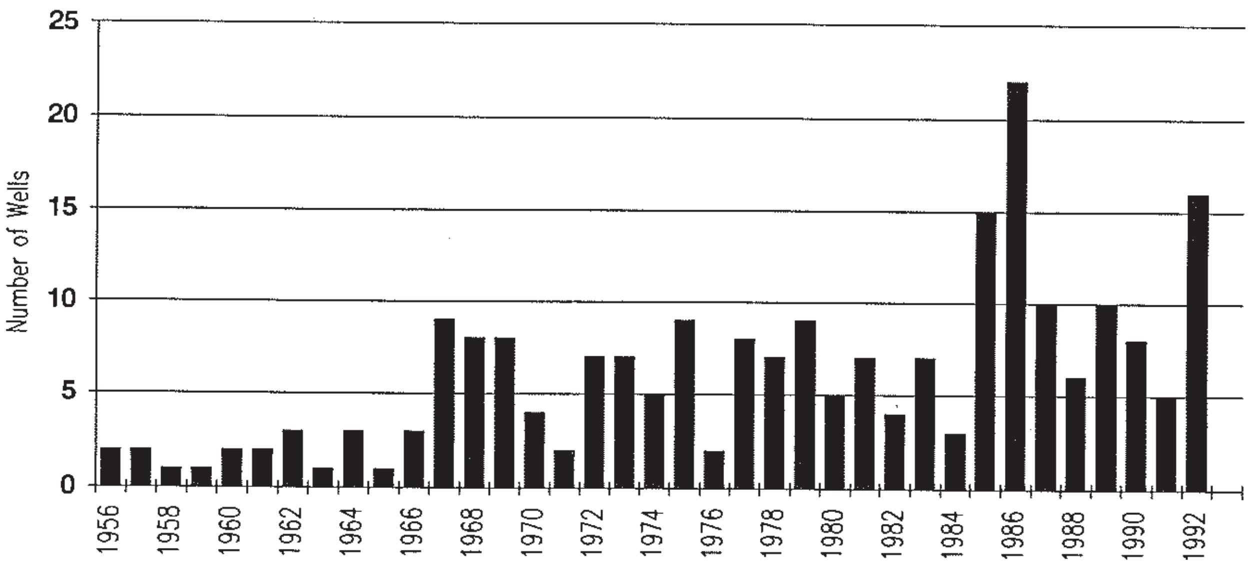


FIGURE D-3 NUMBER OF WELLS DEEPENED BY YEAR



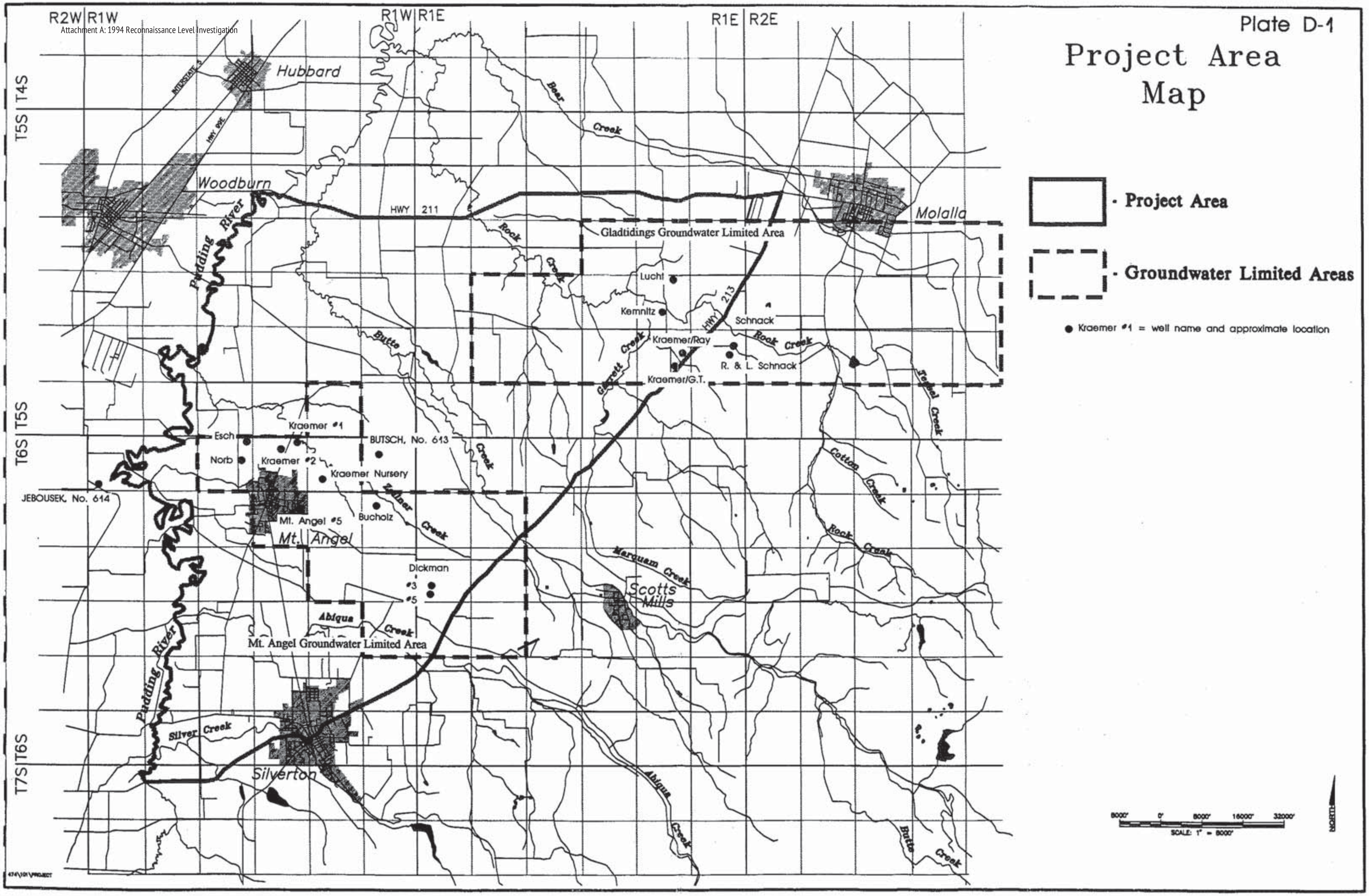
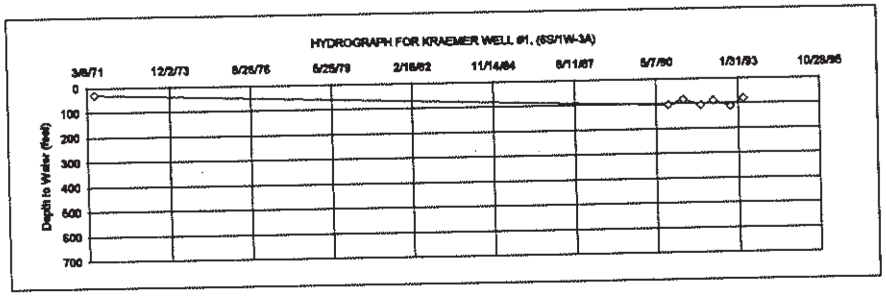
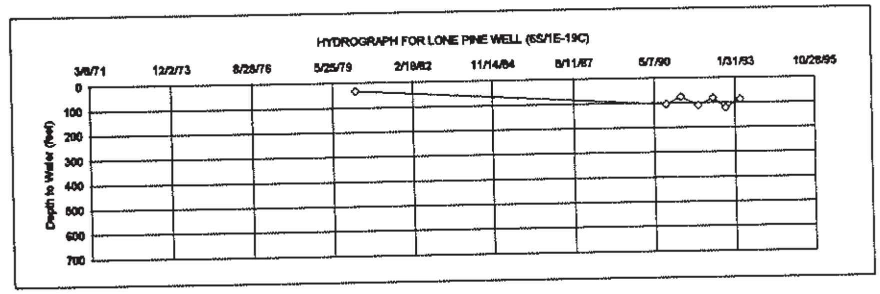
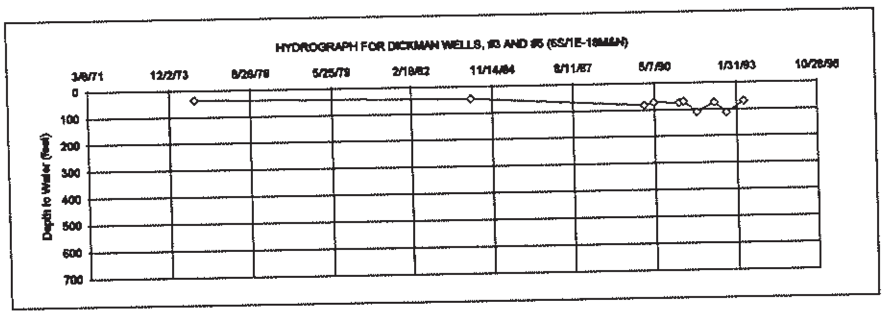


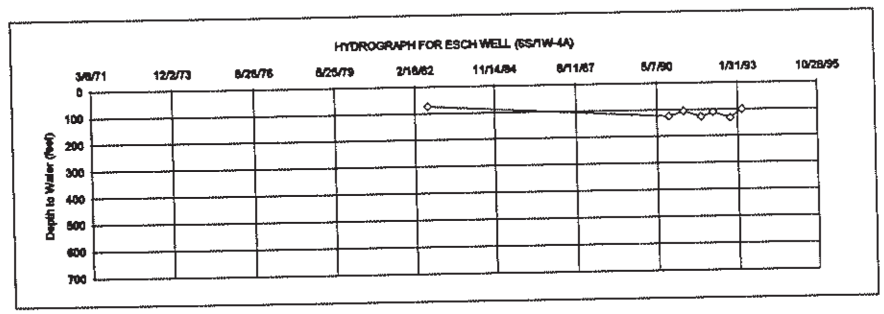
Plate D-1
Project Area Map
Project Area
Groundwater Limited Areas
● Kraemer #1 = well name and approximate location
R2W R1W
R1W R1E
R1E R2E
T4S T5S
T5S T6S
T6S T7S
Hubbard
Woodburn
Molalla
Mt. Angel
Scotts Mills
Silverton
HWY 211
HWY 213
Gladtidings Groundwater Limited Area
Mt. Angel Groundwater Limited Area
Pudding River
Bear Creek
Rock Creek
Butte Creek
Zollner Creek
Abiqua Creek
Silver Creek
Garrett Creek
Marquam Creek
Cotton Creek
Teasel Creek
Lucht
Kemnitz
Schnack
Kraemer/Ray
R. & L. Schnack
Kraemer/G.T.
Kraemer #1
Kraemer #2
Esch
Norb
BUTSCH, No. 613
Kraemer Nursery
Mt. Angel #5
Bucholz
JEBOUSEK, No. 614
Dickman
#3
#5
SCALE: 1" = 8000'
NORTH

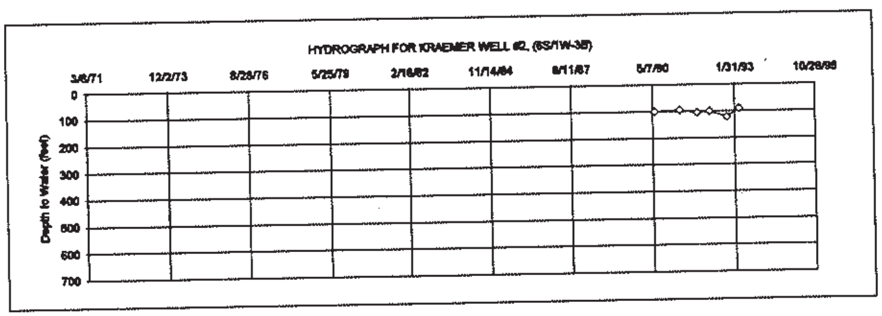
PLATE D-2 WELL HYDROGRAPHS FOR MT. ANGEL GROUNDWATER LIMITED AREA (1 of 2)











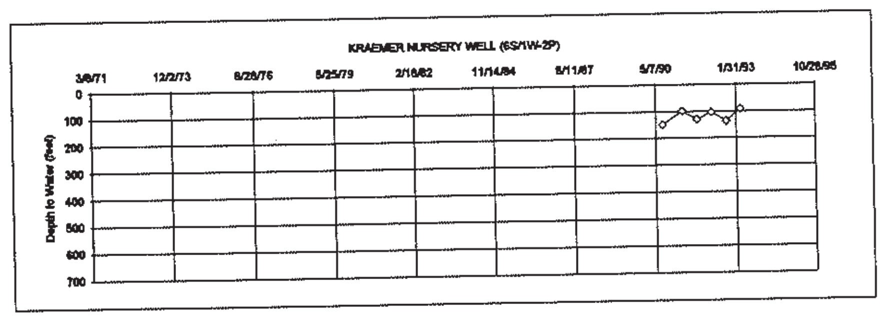
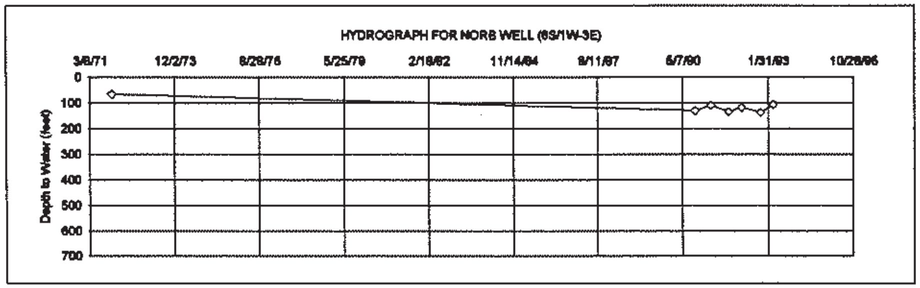
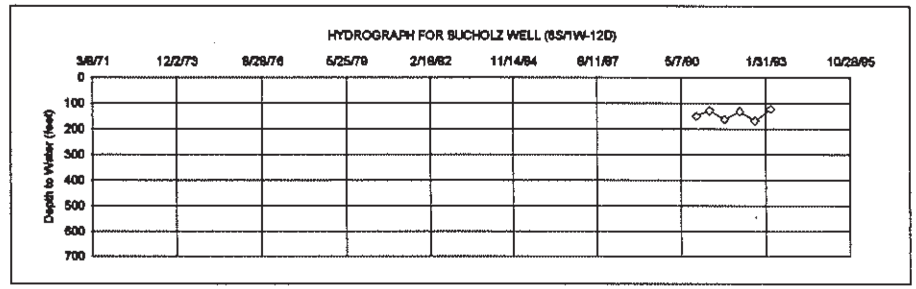


PLATE D-2 WELL HYDROGRAPHS FOR MT. ANGEL GROUNDWATER LIMITED AREA (2 of 2)





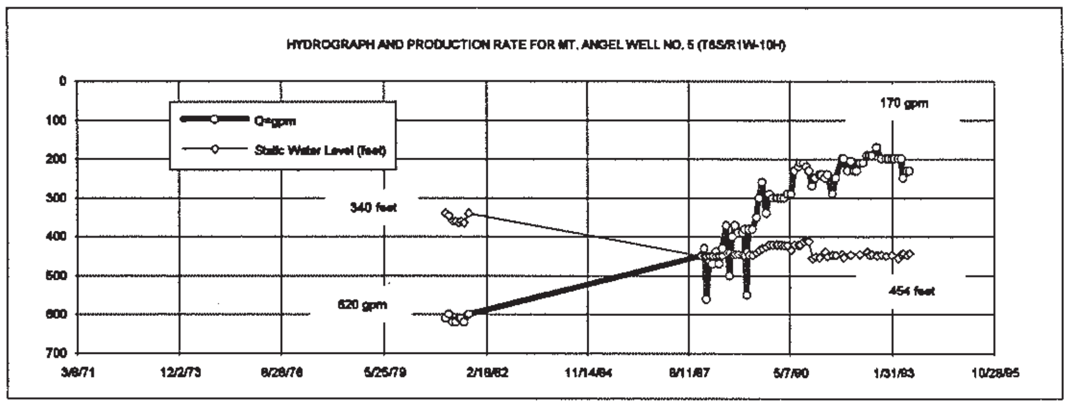
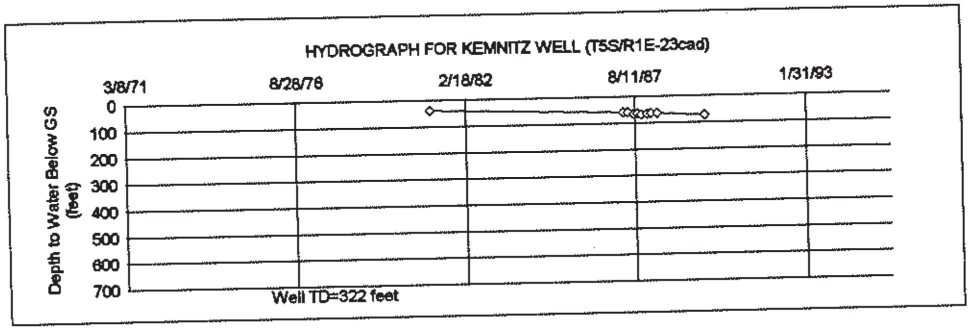
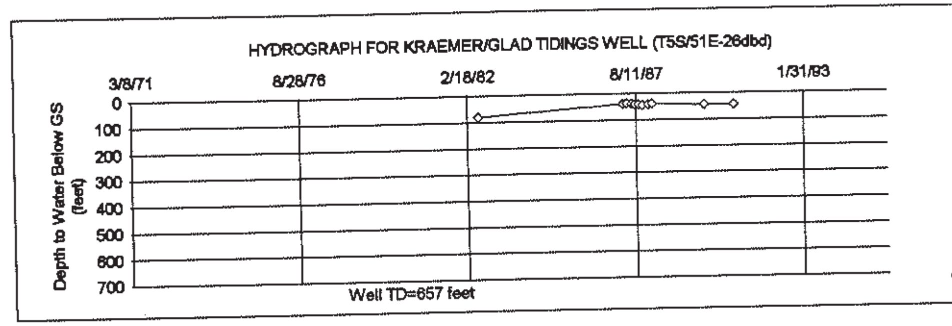
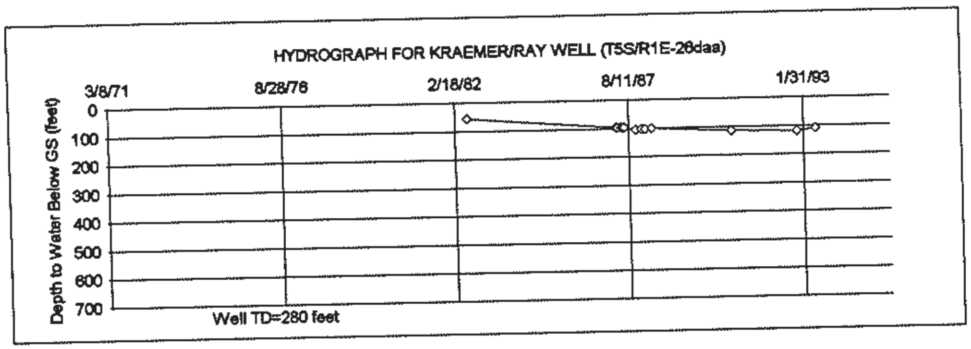
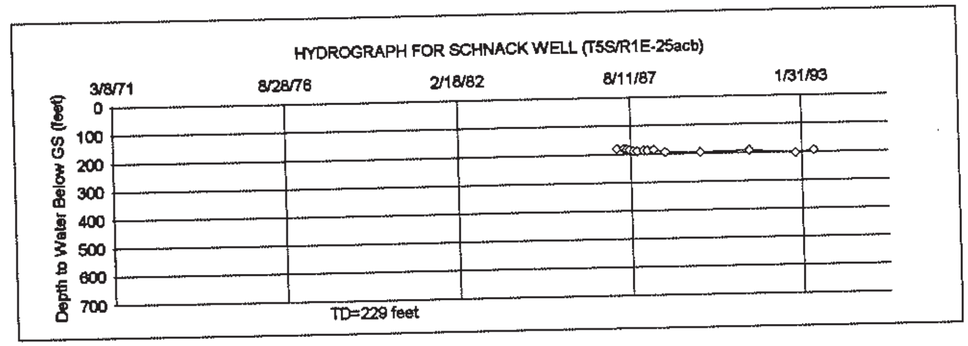


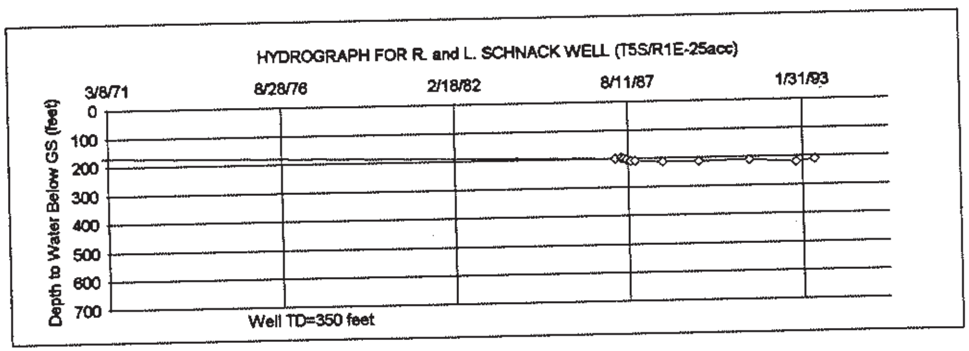
PLATE D-3 WELL HYDROGRAPHS FOR GLADTIDINGS GROUNDWATER LIMITED AREA

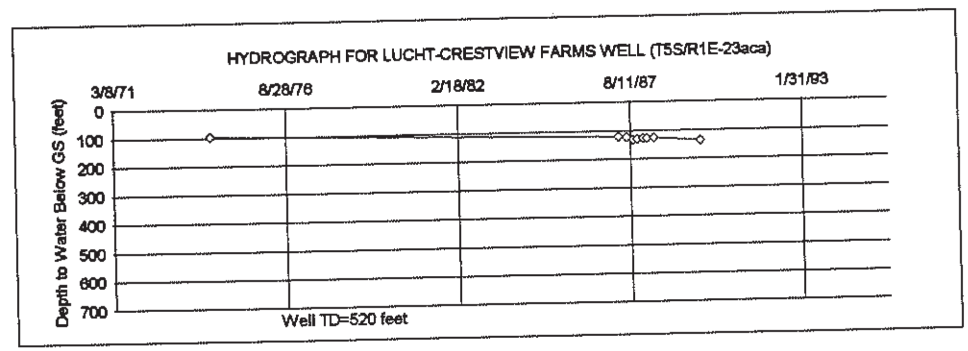












APPENDIX E

RESERVOIR SITE SCREENING

PUDDING RIVER BASIN WATER RESOURCES DEVELOPMENT ASSOCIATION

APPENDIX E
RESERVOIR SITE SCREENING

The need for a reliable source of additional water was established in Chapter 3. Of the possible alternative sources of water, the construction of one or more reservoirs deserves a thorough analysis. Not only would a reservoir provide the water needed for irrigation and M&I, but other benefits would be realized as well. Water quality would be improved, with streamflows being enhanced in the streams. Water quality in the Pudding River basin is a concern with both the Department of Environmental Quality and the Department of Fish and Wildlife. Recreational benefits would also be created with a reservoir. These could include such activities as boating, fishing, water skiing, and camping.

PROCESS OF EVALUATION

The process by which possible sites were marked for evaluation included the identification of previously identified dam sites, and then looking further for possible new sites. Several criteria were used in the evaluation of sites. All of the criteria must have been met for any further analysis. The criteria used are by no means extensive, but are adequate at this level for narrowing the possibilities to a few which could be evaluated further. The criteria are listed below, in the order in which all sites were evaluated.

- location relative to service area
- storage yield
- storage capacity
- existing land use and ownership
- environmental impact
- construction cost estimate

Location Relative to Service Area

Before any further evaluation, the location of the site had to lend itself well to the existing and future service area. The cost of constructing and maintaining an extensive distribution system can easily overcome the benefits of a lower cost dam. When the reservoir is outside of the service area basin, there is an additional cost of pumping the water into the basin, where additional pumping may still be needed. Therefore, by locating dam sites relative to the service area, several previously identified sites surrounding the service area were eliminated.

Storage Yield

The size of a watershed, the amount of precipitation it receives, and the characteristics of the watershed will determine the amount of runoff it will generate (or yield). Annual yields have been estimated previously for most of the sites considered. Dam sites with watershed areas not large enough to yield the amount of storage desired were considered unsuitable for further analysis in this study. Although a combination of smaller reservoirs would, in concept, be feasible, the capital costs would likely be considerably more than for one larger reservoir, even with the accompanying distribution system. Therefore, the minimum storage considered for a single site would be the total volume required for irrigation and M & I for the entire service area.

Storage Capacity

Some sites may have a large enough watershed to yield the needed volume of water, but not have the capacity to hold that volume. These sites might be suitable for a multiple site analysis. Storage capacities of the sites were determined, either through existing information or by looking at USGS topographic maps.

Existing Land Use and Ownership

The existing land use and ownership of the property on which a site might be considered is crucial to the feasibility of the site. The displacement of a population, for instance, must be weighed against the feasibility of another site. Also, different governmental regulations could apply, depending on ownership of the property. State and federal land ownership was determined from an Oregon Department of Forestry map.

Environmental Impacts

Some environmental impacts are to be expected with the construction of a dam. The degree of these impacts, the potential for mitigation, and the possibilities for environmental enhancement, all need to be considered in evaluating a site. Environmental impacts could include impacts to any sensitive, threatened, or endangered species, impacts to wetlands, or impacts to designated natural resource land uses.

Construction Cost Estimate

Once a site has been evaluated for all of the above factors, and it deserves further consideration, the cost to construct a dam at the site should be roughly estimated. The initial cost estimate is based on an estimated volume of material needed to obtain the storage desired. This is in recognition that the total cost will be influenced primarily by the amount of material needed.

DAM SITES

Reports from which previously identified dam sites were taken include the "Willamette Basin Comprehensive Study" (produced in 1969 by a task force comprised of various state and federal agencies), and a 1962 report produced by the Soil Conservation Service. Sites are identified below by names and numbers given in the 1969 report, unless they are only identified in the 1962 report. No sites were found that merited further evaluation outside of those identified in these reports. Table E1 summarizes pertinent information from each dam site evaluated.

SITE 337 on BEAVER CREEK (tributary of Butte Creek) @ R.M. 2
This site has insufficient storage capacity and the watershed is too small.

SITE 340 (Camp Creek) on ABIQUA CREEK @ R.M. 13.8
This site was considered feasible enough for a cost estimate. The cost per dam height and storage is summarized in Table E2. This site would displace at least 12 structures, based on the 1985 U.S.G.S. topographic quadrangle.

SITE 346 (Crooked Finger) on BUTTE CREEK @ R.M. 20.3
This is an adequate site; however, it is included in the area for Site 347 which is also an adequate site with a narrower embankment.

SITE 347 (Del Aire Ranch) on BUTTE CREEK @ R.M. 17.6
From the information gathered, this site is most viable of all the sites considered thus far. The cost per dam height and storage is summarized in Table E2. The land use is not known, but from the 1985 U.S.G.S. topographic quadrangle, the site would displace 4 structures.

TABLE E1
PUDDING RIVER
DAM SITE EVALUATION

SITE NO.	NAME	STREAM	RIVER MILE	Sec-T-R LOCATION	ANNUAL YIELD (ac-ft)	REMARKS
337	BEAVER CREEK	BEAVER CREEK	2	17 6S 2E	6,000	WATERSHED TOO SMALL & INSUFFICIENT STORAGE CAPACITY
340	CAMP CREEK	ABIQUA CREEK	13.8	13 7S 1E	84,600	EVALUATED FURTHER (SEE TABLE II)
344	COLEMAN	PUDDING RIVER	59	4 8S 1W	6,100	SOUTH OF SERVICE AREA
346	CROOKED FINGER	BUTTE CREEK	20.3	4 7S 2E	50,000	INCLUDED IN AREA FOR SITE 347
347	DEL AIRE RANCH	BUTTE CREEK	17.6	32 6S 2E	59,000	EVALUATED FURTHER (SEE TABLE II)
350	EBNER	PUDDING RIVER	--	10 8S 1W	8,800	SOUTH OF SERVICE AREA
351	FISHER	DRIFT CREEK	--	6 8S 1E	26,600	SOUTH OF SERVICE AREA
352	GRANGE	SILVER CREEK	9.3	19 7S 1E	77,000	INCLUDED IN AREA FOR SITE 363
355	HEADWATERS	ABIQUA CREEK	20.8	2 8S 2E	47,300	EVALUATED FURTHER (SEE TABLE II)
360	LOWER ABIQUA	ABIQUA CREEK	6.5	30 6S 1E	--	NOT SUITABLE - LARGE EMBANKMENT & DISPLACE TOO MANY PEOPLE
363	LOWER GRANGE	SILVER CREEK	8	18 7S 1E	112,000	EVALUATED FURTHER (SEE TABLE II)
366	MIDDLE ABIQUA	ABIQUA CREEK	7.3	28 6S 1E	--	NOT SUITABLE - LARGE EMBANKMENT & DISPLACE TOO MANY PEOPLE
384	SCOTTS MILLS	BUTTE CREEK	14.5	24 6S 1E	78,000	NOT SUITABLE - LARGE SLIDES AT SITE
385	SCOTTS MILLS	BUTTE CREEK	21.2	9 7S 2E	--	LONG EMBANKMENT
386	SELAH	PUDDING RIVER	50.5	5 7S 1W	95,000	SOUTH OF SERVICE AREA
389	SILVER CREST	SILVER CREEK	11.4	29 7S 1E	106,100	INCLUDED IN AREA FOR SITE 363
398	--	ABIQUA CREEK	12.2	11 7S 1E	85,000	NOT SUITABLE - LARGE EMBANKMENT & DISPLACE TOO MANY PEOPLE
402	--	ABIQUA CREEK	15.2	19 7S 2E	60,000	NOT SUITABLE - LARGE EMBANKMENT & POOR STORAGE
409	UPPER ABIQUA	ABIQUA CREEK	14	13 7S 1E	--	INCLUDED IN AREA FOR SITE 340
410	VICTOR POINT	DRIFT CREEK	--	36 7S 1W	42,200	SOUTH OF SERVICE AREA
569	COAL CREEK	BUTTE CREEK	15.8	30 6S 2E	86,000	NOT AS SUITABLE AS, SITE 347 - DISPLACES 24 STRUCTURES
583	--	BEAVER CREEK	2.4	20 6S 2E	6,000	WATERSHED TOO SMALL
586	--	COAL CREEK	2	4 7S 2E	--	WATERSHED TOO SMALL
588	--	UN-NAMED TRIB	1	26 6S 1E	--	WATERSHED TOO SMALL
590	--	FALL CREEK	1.5	14 7S 2E	--	WATERSHED TOO SMALL
4	BEAR CREEK	BEAR CREEK	--	29 4S 1E	18,900	WATERSHED TOO SMALL
5	NEEDY	NOT NAMED	--	32 4S 1E	4,000	WATERSHED TOO SMALL
6	ROCK CREEK	ROCK CREEK	--	17 5S 1E	71,000	AT NORTH END OF SERVICE AREA & INSUFFICIENT CAPACITY
7	TEASEL CREEK	TEASEL CREEK	--	28 5S 2E	5,300	ALREADY BUILT
8	WILHOIT, LOWER	ROCK CREEK	--	8 6S 2E	7,000	WOULD DISPLACE COMMUNITY
14	HAZEL GREEN	LITTLE PUDDING	7.5	33 6S 2W	30,300	SOUTH OF SERVICE AREA
15	MERIDIAN, LOWER	SILVER CREEK	6.5	12 7S 1W	125,000	ALREADY BUILT
18	LOWER DRIFT CK.	DRIFT CREEK	--	15 7S 1W	47,400	SOUTH OF SERVICE AREA, EXISTING RESERVOIR
21	HANSON	"	--	8 8S 1E	9,400	SOUTH OF SERVICE AREA
22	LOWER BEAVER C	BEAVER CREEK	--	17 7S 1W	9,700	SOUTH OF SERVICE AREA
23	RICHES	"	--	21 7S 1W	4,900	SOUTH OF SERVICE AREA
24	PRATUM	PUDDING RIVER	54	13 7S 2W	36,300	SOUTH OF SERVICE AREA
33	ZOLLNER CREEK	ZOLLNER CREEK	1.7	34 5S 1W	9200	WATERSHED TOO SMALL

H:\474\101\DAMS\SITABL1

SITE 352 (Grange) on SILVER CREEK @ R.M. 9.3
This site was considered feasible enough for consideration. Initial cost estimates were not prepared, as the site was considered very similar to Site 363 (Lower Grange), where cost estimates were prepared.

SITE 355 (Headwaters) on ABIQUA CREEK @ R.M. 20.8
This site was considered feasible enough for a cost estimate. The cost per dam height and storage is summarized in Table E2. To obtain the desired volume behind the dam, the height of the dam would have to be quite high, as there is a steep gradient in the creek at this point. This site is upstream of developed areas. Part of the reservoir would be within the Santiam State Forest.

SITE 360 (Lower Abiqua) on ABIQUA CREEK @ R.M. 6.5
This site is not suitable as the embankment would be excessively large and it would displace too many structures and people.

SITE 363 (Lower Grange) on SILVER CREEK @ R.M. 8.0
This site was considered feasible enough for a cost estimate. The costs per dam height and storage are summarized in Table E2. This site is very similar to Sites 352 and 389.

SITE 366 (Middle Abiqua) on ABIQUA CREEK @ R.M. 7.3
This site is not suitable as the embankment would be excessively large and it would displace too many structures and people.

SITE 384 (Scotts Mills 2) on BUTTE CREEK @ R.M. 14.5
This site is not suitable, based on a site visit which revealed that there are a series of large slides at the site.

SITE 385 (Scotts Mills 1) on BUTTE CREEK @ R.M. 21.2
This site is adequate, but the embankment would be excessively long, requiring much material.

SITE 389 (Silver Crest) on SILVER CREEK @ R.M. 11.4
This site was considered feasible enough for consideration. Initial cost estimates were not prepared, as the site was considered very similar to Site 363 (Lower Grange), for which cost estimates were prepared.

SITE 398 on ABIQUA CREEK @ R.M. 12.2
This site is not suitable as it would require extensive embankment and also displace too many persons.

SITE 402 on ABIQUA CREEK @ R.M. 15.2
This site has a poor storage area and would require extensive embankment.

SITE 409 (Upper Abiqua) on ABIQUA CREEK @ R.M. 14.0
This site has similar and next to Site 340, which has a cost estimate summarized in Table E2.

SITE 569 (Coal Creek) on BUTTE CREEK @ R.M. 15.8
This site was considered adequate, but not as suitable as Site 347, which is a mile upstream from this site. The reservoir would also inundate at least 24 structures.

SITE 583 on BEAVER CREEK (tributary of Butte Creek) @ R.M. 2.4
This site has insufficient storage capacity and the watershed is too small.

SITE 586 on COAL CREEK (tributary of Butte Creek) @ R.M. 2
This site is not suitable as it would require extensive embankment and the watershed is too small.

SITE 588 on unnamed trib. of BUTTE CREEK (confluence @ R.M. 13.4) This site has insufficient storage capacity and the watershed is too small.

SITE 590 on FALL CREEK (tributary of Butte Creek) @ R.M. 1.5
This site has insufficient storage capacity and the watershed is too small.

SITE 4 (Bear Creek) on BEAR CREEK
This site has poor storage capacity and is north of the service area, which would require a more extensive pumping and distribution system than sites within or upstream of the service area.

SITE 5 (Needy) on unnamed trib. of BEAR CREEK
This site has poor storage capacity, low annual yield, and is north of the service area, which would require a more extensive pumping and distribution system than sites within or upstream of the service area.

SITE 6 (Rock Creek) on ROCK CREEK @ 0.5 to 1.5 miles upstream of Highway 211
This site is at the north end of the service area and does not have the storage capacity required to serve the entire service area. This site appears suitable as part of a multiple site analysis.

SITE 7 (Teasel Creek) on TEASEL CREEK
A reservoir appears to be already built at this site. Expansion would not be feasible.

SITE 8 (Wilhoit, Lower) on ROCK CREEK
A reservoir at this site would displace almost the entire community of Wilhoit, and was not considered further.

SITE 15 (Meridian, Lower) on SILVER CREEK @ R.M. 6.5
This reservoir has been built for the City of Silverton. Expansion does not appear feasible.

SITE 33 (Zollner Creek) on ZOLLNER CREEK @ R.M. 1.7
This site does not have the capacity required to serve the entire service area, and the watershed is too small.

Dam Sites South of Service Area

Eleven sites on the Little Pudding River, Drift Creek, Beaver Creek (a tributary of Pudding River), and Pudding River were evaluated with a requirement that a site would have to rate very well using all the criteria described above, except location. The location of these sites, draining to the Pudding River south of the service area, places their feasibility at a low level. Pumping and distribution costs would most likely eliminate these sites as potential sites for further evaluation. None of the eleven sites met the above requirement that would justify further consideration. These sites include:

SITE 14 (Hazel Green) on LITTLE PUDDING RIVER @ R.M. 7.5
SITE 18 (Lower Drift Creek) on DRIFT CREEK
SITE 21 (Hanson) on DRIFT CREEK
SITE 22 (Lower Beaver Creek) on BEAVER CREEK
SITE 23 (Riches) on BEAVER CREEK
SITE 24 (Pratum) on PUDDING RIVER @ R.M. 54
SITE 344 (Coleman) on PUDDING RIVER @ R.M. 59
SITE 350 (Ebner) on PUDDING RIVER
SITE 351 (Fisher) on DRIFT CREEK
SITE 386 (Selah) on PUDDING RIVER @ R.M. 50.5
SITE 410 (Victor Point) on DRIFT CREEK

CONSTRUCTION COST ESTIMATES

Four of the more feasible sites were evaluated for construction costs, using a rather rough estimate of $100/cubic yard (c.y.) of embankment material for roller compacted concrete (RCC). The basis for this estimate is a recent engineers estimate for a similar RCC dam, which will require approximately 190,000 c.y. of concrete. The estimate includes outlet works, etc., and a lower cost per c.y. should be anticipated for larger embankments. For the purpose of a feasibility level estimate, however, the rough estimates given in Table E2 are adequate, given the uncertainties which exist at this level (geologic conditions, environmental mitigation, etc.).

Table E2
ESTIMATED DAM CONSTRUCTION COSTS

SITE NO.	DAM SITE	DAM HEIGHT (feet)	TOTAL STORAGE (ac-ft)	DRAINAGE AREA (sq miles)	DAM CONSTRUCTION COSTS
340	CAMP CREEK	80	6600	42.3	$22,000,000
		160	25600		$55,000,000
		200	44800		$88,000,000
347	DEL AIRE RANCH	140	12400	27.0	$13,000,000
		150	15000		$15,000,000
		220	36000		$34,000,000
355	HEADWATERS	240	13000	18.2	$55,000,000
		360	39000		$144,000,000
363	LOWER GRANGE	120	10800	42.0	$23,000,000
		160	22000		$36,000,000
		200	39000		$56,000,000

ABBREVIATED OPERATION STUDIES

Monthly yields at the two most feasible dam sites (Del Aire Ranch and Grange) were estimated and compared with monthly project needs. Mean (average) monthly flow rates and mean daily flow rates which are exceeded 50%, 80%, and 90% of the time, were obtained from USGS Open-File Report 90-118 for Butte Creek at Monitor and Silver Creek at Silverton. These flow rates were used to estimate monthly and annual yields (volumes of discharge) for the indicated percent of time at the stream gages. Monthly yields at the two dam sites were then estimated by multiplying monthly yields at the gage sites by factors estimated from an isogram of runoff patterns (Map IV-2 from Willamette Basin Study).

Del Aire Ranch

Preliminary results of the abbreviated operation study for the Del Aire Ranch site on Butte Creek indicate that some carryover volume may be needed to consistently meet the projected demand. During some months, the instream water right will not be met. In that case, it is assumed that only what enters the reservoir will be released from the reservoir. The projected total irrigation demand, which would include existing water rights as a result of committing these rights to flow augmentation, would be about 23,357 ac-ft. This would require some carryover volume, if irrigation demands are to be met 80% of the time. Table E3 summarizes these findings.

Table E3
DEL AIRE RANCH ON BUTTE CREEK
RUNOFF VOLUME (acre-feet)

MONTH	W.R. & DEMAND (ac-ft)	50% EXCEEDENCE		80% EXCEEDENCE		90% EXCEEDENCE	
		yield	net avail.	yield	net avail.	yield	net avail.
OCT	3689	1,358	0	588	0	430	0
NOV	3570	7,970	4,400	3,153	0	2,058	0
DEC	3689	16,427	12,737	8,191	4,501	5,113	1,424
JAN	3689	13,078	9,389	7,059	3,370	4,932	1,243
FEB	3332	12,139	8,807	5,967	2,635	4,046	714
MAR	3689	11,675	7,986	6,652	2,963	5,295	1,605
APR	3851	10,072	6,222	6,350	2,499	5,036	1,186
MAY	5698	6,607	909	3,982	0	3,258	0
JUN	8791	2,934	0	1,752	0	1,314	0
JUL	9475	950	0	453	0	262	0
AUG	5495	407	0	181	0	131	0
SEP	3031	569	0	302	0	206	0
TOTAL	58,000	84,187	50,449	44,630	15,969	32,083	6,172

Grange Site

Carryover volume may also be needed at the Grange site on Silver Creek to meet the projected demand. The preliminary operation study for this site indicates that instream water rights would not be met in some months. As with the Del Aire site, when inflow to the reservoir is less than the instream right, only the inflow will be released. The projected total irrigation demand, which would include existing water rights as a result of committing these rights to flow augmentation, would again be about 23,357 ac-ft. This would require some carryover volume, if irrigation demands are to be met 90% of the time. Table E4 summarizes these findings.

Table E4
GRANGE SITE ON SILVER CREEK
RUNOFF VOLUME (acre-feet)

MONTH	W.R. & DEMAND (ac-ft)	50% EXCEEDENCE		80% EXCEEDENCE		90% EXCEEDENCE	
		yield	net avail.	yield	net avail.	yield	net avail.
OCT	3579	1,371	0	715	0	513	0
NOV	3463	9,577	6,114	3,000	0	1,962	0
DEC	3579	22,534	18,956	9,658	6,079	4,411	833
JAN	3579	22,475	18,896	12,400	8,821	7,452	3,873
FEB	3232	14,000	10,767	8,938	5,706	5,923	2,691
MAR	3579	21,700	18,121	9,479	5,900	6,617	3,039
APR	3743	11,365	7,622	7,384	3,641	6,058	2,314
MAY	5587	6,856	1,268	4,471	0	3,517	0
JUN	8321	3,000	0	1,788	0	1,500	0
JUL	9617	1,252	0	775	0	531	0
AUG	6277	584	0	322	0	244	0
SEP	3406	808	0	340	0	300	0
TOTAL	57,962	115,521	81,744	59,271	30,147	39,027	12,749

CONCLUSION

Based upon the above site screening process, the Del Aire Ranch site is recommended as being the most feasible of the sites, warranting more detailed evaluation and examination of funding alternatives. It is the most cost effective and located centrally with regard to the service area.

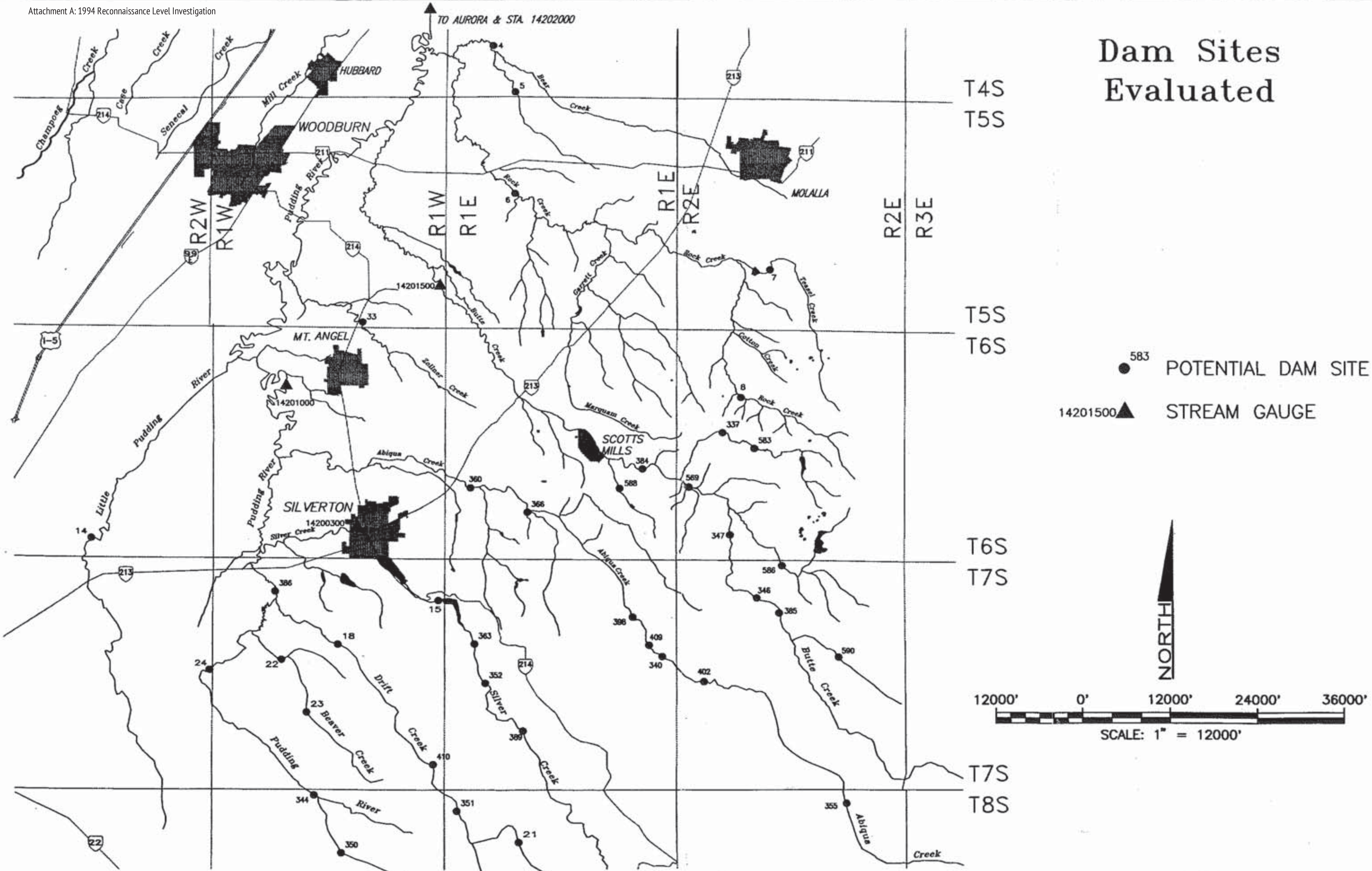

Dam Sites
Evaluated
583 POTENTIAL DAM SITE
14201500 STREAM GAUGE
NORTH
12000' 0' 12000' 24000' 36000'
SCALE: 1" = 12000'
TO AURORA & STA. 14202000
T4S
T5S
T6S
T7S
T8S
R2W
R1W
R1E
R2E
R3E
HUBBARD
WOODBURN
MOLALLA
MT. ANGEL
SCOTTS MILLS
SILVERTON
Champoeg Creek
Case Creek
Senecal Creek
Mill Creek
Pudding River
Little Pudding River
Bear Creek
Rock Creek
Butte Creek
Zollner Creek
Garrett Creek
Marquam Creek
Tenzel Creek
Cotton Creek
Abiqua Creek
Silver Creek
Drift Creek
Beaver Creek
14201500
14201000
14200300

Figure E1

APPENDIX F

GRANT APPLICATION AND WORK PROGRAM DESCRIPTION FOR 1994

PUDDING RIVER BASIN WATER RESOURCES DEVELOPMENT ASSOCIATION
P.O. BOX 851
MT ANGEL, OR, 97362

GRANT APPLICATION AND
WORK PROGRAM DESCRIPTION FOR 1994

PROJECT DESCRIPTION

This is a grant application for $65,700 to assist in implementation studies for a water storage project for multiple purpose uses to be implemented by the Pudding River Basin Water Resources Development Association, or its successor organization. During 1993 the Association, entirely with its own funding, retained a consultant team to prepare a formulation study to identify the most efficient alternative to develop a water supply for the Association service area, bounded on the west by Pudding River from Silverton on the south to Hiway 211 on the north and bounded on the east by Hiway 213. The Association adopted the following work program at its meeting of February 28, 1994.

The project will provide an irrigation water supply to 4,500 acres of land not now irrigated, to about 2,000 acres of land with unreliable ground and surface water supplies and to about 1,000 acres of land now irrigated with groundwater from deep wells that may find project water to be of less cost than existing sources. The project also will include storage for municipal supplies for future needs for the City of Mt Angel. Additionally, the project will include about 16,000 acre feet that will be used to augment streamflows in Pudding River tributaries and in Pudding River from the mouth of Abiqua Creek downstream to the mouth of Pudding River.

The funds requested herein will be used to develop more specific technical information about the damsite and service area than was developed during the above preliminary study. The products will be useable during final design of the project.

JUSTIFICATION

To approximate an economic gain attributable to the project, assuming the 4,500 of lands not now irrigated are "dry-farmed" and produce wheat or tall fescue, annual gross return would be low, using "Estimates of 1993 Gross Farm Income For Marion County", January 31,1994, Oregon State University Extension Service. With construction of the project, the 4,500 acres could produce a number of higher value crops. For discussion purposes, these may include sweet corn, snap beans, cauliflower and strawberries. Average gross returns are estimated below:

TYPICAL "DRY-FARMED" CROPS					TYPICAL IRRIGATED CROPS				
CROP	1993 ACREAGE IN MARION COUNTY	1993 PRICE	AVERAGE PRODUCTION (/ACRE)	GROSS RETURN ($)	CROP	1993 ACRE-AGE IN MARION COUNTY	1993 PRICE (/TON)	AVERAGE PRODUC-TION (/ACRE)	GROSS RETURN ($)
WHEAT	20,000	$3.20/BUSHEL	70 BUSHELS	4,500,000	SWEET CORN	15,730	$88.00	8.5 TONS	11,797,500
TALL FESCUE	10,500	$35.00/ CWT	15 CWT	5,512,500	SNAP BEANS	11,180	$195.00	5 TONS	10,900,500
					CAULIFLOWER	1,960	$388.50	5 TONS	3,822,000
					STRAWBERRIES	2,100	$860.00	4 TONS	7,350,000
WEIGHTED AVERAGE, $/ACRE				330					1,100

Thus, gross income from 4,500 acres of "dry-farmed" lands in the service area at the weighted average would be about $1,485,000. Gross income with the project, using the weighted average for irrigated crops would amount to $4,950,000 annually, for a gain of $3,465,000. Additionally, assuming one-half the increase in gross return from the 3,000 acres now irrigated but with unreliable or undesirable supplies, a further gain of $1,732,500 would result from project water service, for a total gain of $5,197,500.

Assuming 60% of the gain would be spent for annual operating costs, such as farm machinery, fuel, seed, fertilizer and hired labor, over $3,118,500 would be added to the annual economic circulation in Marion and Clackamas Counties, and using a factor of 5, would increase circulation in the two counties by nearly $15,600,000 annually.

Products from dry-farmed operations are exported from the area with minimal processing. Production from irrigated lands are processed locally, however, and increased production of irrigated crops for processing would entail increased hiring by the food processing industry. Additionally, a representative value for hired farm labor is one full-time position per 500 acres for a dry farm operation. With irrigated farms one full-time employee is required for 150 to 200 acres, about a three-fold increase. Thus project water would generate 12 to 20 full time jobs in the service area. Seasonal employment would require about 5 people/acre for harvest, etc., or about 900 persons.

SPECIFIC WORK PROGRAM DESCRIPTION

The following material describes work items proposed to be undertaken during the year to further implementation of the Association's storage project at the Del Aire site on Butte Creek. It follows the outline presented to the Association at its February 18, 1994 meeting.

DAM AND RESERVOIR

a. Preliminary Geologic Mapping

Geologic literature review and reconnaissance-level site observations have been done to characterize regional geology and provide information on the types of geologic formations present at the site. This information was used as indicators of the general suitability of the site for a dam. Geologic mapping work for this year's budget is intended to document significant geologic features at the damsite on a map and to provide more detailed information regarding types of geologic formations present at the site, soundness of rock materials, resistance to weathering and erosion, fracture and bedding characteristics, foundation support capability and conditions that will arise relative to excavation at the site. This work also will include location and brief exploration of potential sources of construction materials with focus on existing sources. This information will be generated by observing existing exposures at the site. A preliminary definition of seismic conditions will be accomplished. The information will be plotted on the topographic map to be developed for the site under item b.

Budget: $3,600

b. Topographic Mapping

This work consists of preparing a topographic map of the damsite and abutments utilizing aerial photogrammetric methods. The map will center on the axis of the dam, and extend 800 feet upstream and 700 feet downstream. The area of coverage will include the east and west abutment areas to an elevation of 1000 feet above sea level (USGS datum). The approximate area of coverage is 40 acres. The contour interval will be 5 feet. The mapping will reflect more detailed illustration of abutment and valley floor shape and steepness, more accurate elevation information for the valley floor and the top of the east abutment ridge at the damsite. There is a saddle atop the ridge forming the east abutment that could limit the height of the dam that could be constructed without causing overflow through the saddle. Mapping work will give special attention to this area. The mapping data will provide for improvement in the accuracy of an area-capacity curve to be developed as part of the Association's program.

Budget: $25,000

c. Seismic Considerations

Review of geologic and seismic information from the Department of Geology and Mineral Industries (DOGAMI), and seismic design criteria used for dam design and analysis in Oregon over the last 10 years. The results of this review will assist in selection of appropriate types of dam structures at the site. A report will be prepared to accompany the geologic map from item a.

Budget: $6,000

d. Cost Estimates for Dam

An improved estimate of costs should be prepared for both a rockfill dam and an RCC dam at the Del Aire site. The estimate would best be prepared by USBR, if the work can be accomplished within USBR's budget limitations. This is being pursued, and an estimate of costs is listed here.

Budget: $20,000

Total for work at Damsite: $54,600

HYDROLOGIC ANALYSIS

a. Damsite Streamflow Estimate

Flows at the Del Aire Ranch site were estimated for the completed reconnaissance study on the basis of estimated drainage areas and unit area-runoff coefficients. A more accurate relationship between the flow in Butte Creek at the site and flow measured at the gage at Monitor is necessary. A "rated" channel section will be established at the site and one at the Monitor gage. Ten staff gage readings, at various flow conditions, will be taken simultaneously at the two sites and will be used to develop rating curves at the two locations. From these data a relationship between flow at the site versus flow at the gage may be developed and used to adjust gage records to reflect flow conditions at the site over the period of record.

b. Refined Area-Capacity Curve

Prepare refined area-capacity curve using dam axis topographic map .

c. Monthly operation and sizing study for reservoir.

Using estimated monthly streamflows and refined area-capacity curve, prepare and run reservoir operation study to determine conservation and carry-over storage to meet service area demands. Estimate reservoir evaporation and seepage losses. The results of the operation study also may be used to develop a better estimate of hydro production.

Total for Hydrologic Analysis: $15,000

SERVICE AREA INVESTIGATIONS

a. Creek Channel Investigations

East of the Hiway 213/Butte Creek crossing, some project releases would be diverted from Butte Creek into a gravity pipeline. The pipeline will parallel Hiway 213 and extend both to the south and north of Butte Creek. A lateral will extend about 1/2 mile to the west to deliver water to Zollner Creek. To the south, the pipeline will extend to Abiqua Creek where water will be released for flow augmentation and/or subsequent diversion. The northern branch of the pipeline would fork at the town of Marquam, with one branch following a road going east to a terminus at Marquam Creek and one branch following a road going northwest to terminate at an unnamed tributary of Rock Creek.

The reconnaissance study did not evaluate the capability of Zollner and Marquam Creeks and the unnamed tributary to contain proposed flows without erosion, nor was effort expended to identify the most "efficient" Rock Creek tributary. The capabilities of road culverts and other tributary cross-drainage structures to pass planned flows also needs to be identified.

Maximum planned releases to the subject streams are tabulated below:

STREAM	LOW CASE	HIGH CASE
	(CFS)	
ZOLLNER CREEK	15	23
MARQUAM CREEK	8	12
UNNAMED ROCK CRK TRIB	11	16

The above described work is needed to identify conditions unforeseen in the reconnaissance investigation and to estimate the costs of preventing undesirable conditions from arising due to project operation. The work would best be performed by SCS.

Creek channel capacities and distribution water quality control costs: $17,500

As this work is underway, there will be a need to coordinate the efforts with other ongoing work in the service area. We have estimated the costs for coordinate and management at $2,500.

b. Verification of Existing Water Use with OWRD water rights plot.

Plots of points of diversion, place and extent of use and water source in the proposed project service area are being obtained from OWRD. The plots will be reviewed to identify existing irrigation in the service area for all uses. In addition, recent satellite imagery will be obtained to provide an additional "check" on the OWRD plots. Errors and anomalies on the OWRD plots will be identified and provided to OWRD for their use.

Plot acquisition:	$ 250
Verification:	$2,500
Satellite imagery acquisition:	$1,500

Working with farmers in the service area and the corrected water rights plots, lands for which applications have been filed for irrigation will be identified. This work also will identify lands for which water service from the storage project is desired.

Identify application/new lands: $2,500

Once the above is identified, a service area map will be prepared showing current irrigation, pending irrigation and lands to be served from the project.

Service area map preparation: $3,600

COORDINATION/PROJECT MANAGEMENT

As this work progresses there will be a need for coordination among the parties and with the Association to ensure that all work is compatible and will be useable in subsequent activities. With introduction of grant funds into the process, a report covering activity results will need to be prepared, both to the Association and to the granting agency. Additionally, exploration of funding mechanisms for project construction should be initiated with Congressional and agency offices. Funds are provided to support team members and for Association travel costs, as well.

Allowances for each team member are listed below:

Tucson Myers & Associates	$10,000
Richard Craven	5,000
M. John Youngquist	5,000

Travel costs (2 people to Washington DC) are listed at $5,600

SUMMARY OF PROPOSED EXPENDITURES

ITEM	COST, $	
	"CASH"	"IN-KIND"
DAM & RESERVOIR	34,600	
COST ESTIMATES		20,000
HYDROLOGY	15,000	
SERVICE AREA	12,850	17,500
COORDINATION/PROJECT MANAGEMENT	25,600	
TOTALS	73,050	37,500
GRAND TOTAL	110,550	

EXPENDITURE PLAN FOR 1994

The proposed work for 1994 will be supported by Association funds, "in-kind" services provided by other agencies and grant funds from Economic Development Department grant funds. To justify the grant funds, prior Association expenditures are used to show the level of contribution already made to the project.

Association expenditure data show that $27,666.75 was expended for project formulation purposes during 1993. This amount is composed of the following:

ITEM	AMOUNT
MARION COUNTY	$ 61.75
OTHER CONSULTANTS	3,605.00
PROJECT FORMULATION TEAM	24,000.00
TOTAL	$ 27,666.75

The Association has spent an additional $16,000 during calendar year 1994 for completion of the project formulation study, for a total expenditure to date of $43,666.75.

GRANT AMOUNT TARGET

The total funding requirement for the described work is $110,550 for 1994. Of this amount, $37,500 is from "in-kind" services, planned to be provided by SCS and USBR, leaving $73,050 to come from Association and grant funds.

Items that the Association are to fund include estimated travel costs, at $5,600, and the costs for acquisition of OWRD printouts ($250) and satellite imagery ($1,500), for a total of $7,350. This leaves $65,700 to be funded by Economic Development grant.

A summary table is shown below:

YEAR	ASSOCIATION	USBR	SCS	ECON DEVEL	TOTAL
1993	$27,666.75				$27,666.75
1994 YTD	16,000.00				$16,000.00
1994	7,350.00	20,000.00	17,500.00	65,700.00	$110,550.00
TOTALS	$51,016.75	$20,000.00	$17,500.00	$65,700.00	$154,216.75

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Appendix A - Environmental Checklist

East Valley Water District

Drift Creek Dam:
Agriculture Economic Value Analysis

April 2013

Prepared by:
Bill Anderson, Dr. Penelope Diebel, Clark Seavert
M.S. Graduate Student, Associate Professor, Professor

Agricultural and Resource Economics
Oregon State University

This report was funded by the East Valley Water District in conjunction with Oregon State University.

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East Valley Water District

Drift Creek Dam: Agriculture Economic Value Analysis

Introduction

The East Valley Water District (EVWD) is an irrigation district formed in 2002 for the purpose of supplying irrigation water to its members' lands and associated agricultural operations in Marion and Clackamas Counties in the state of Oregon (Figure 1). The District service area is approximately 15,000 acres extending northerly from Silverton to just south of Woodburn and Molalla, between the Pudding River on the west and the Cascade Mountain foothills on the east (Figure 2). The District's approximately 75 members are currently served by a combination of individual farm wells and direct withdrawals from local surface waters. Limited surface water supplies and lowering groundwater levels make the development of a new surface water source an imperative.

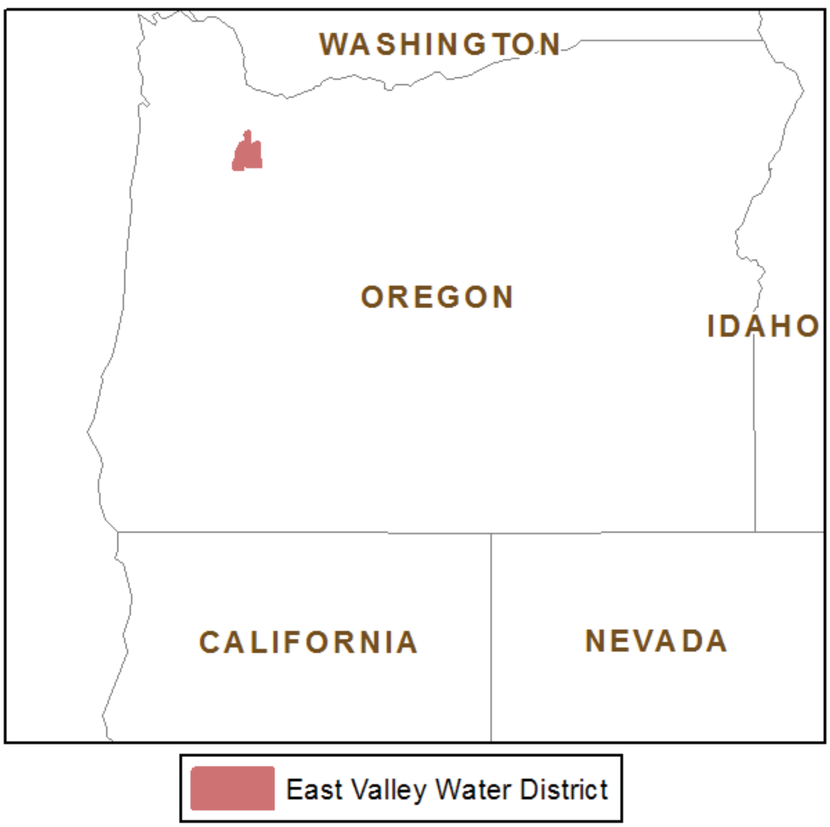

Figure 1: **East Valley Water District Regional Map.**

The District is considering the development of a new water reservoir impoundment on Drift Creek, a tributary to the Pudding River. The intended reservoir site is located approximately six miles southeast of Silverton in Marion County, and the facility would be the cornerstone of a new surface water supply system for the District. Stored winter water would be released during the summertime months and conveyed downstream to the District's service area via either a new raw water pipeline or by natural channel flow along Drift Creek and possibly the Pudding River. Supplied water would be used for irrigation purposes and would require the development of a new water distribution piping system for delivery of irrigation water to served members.

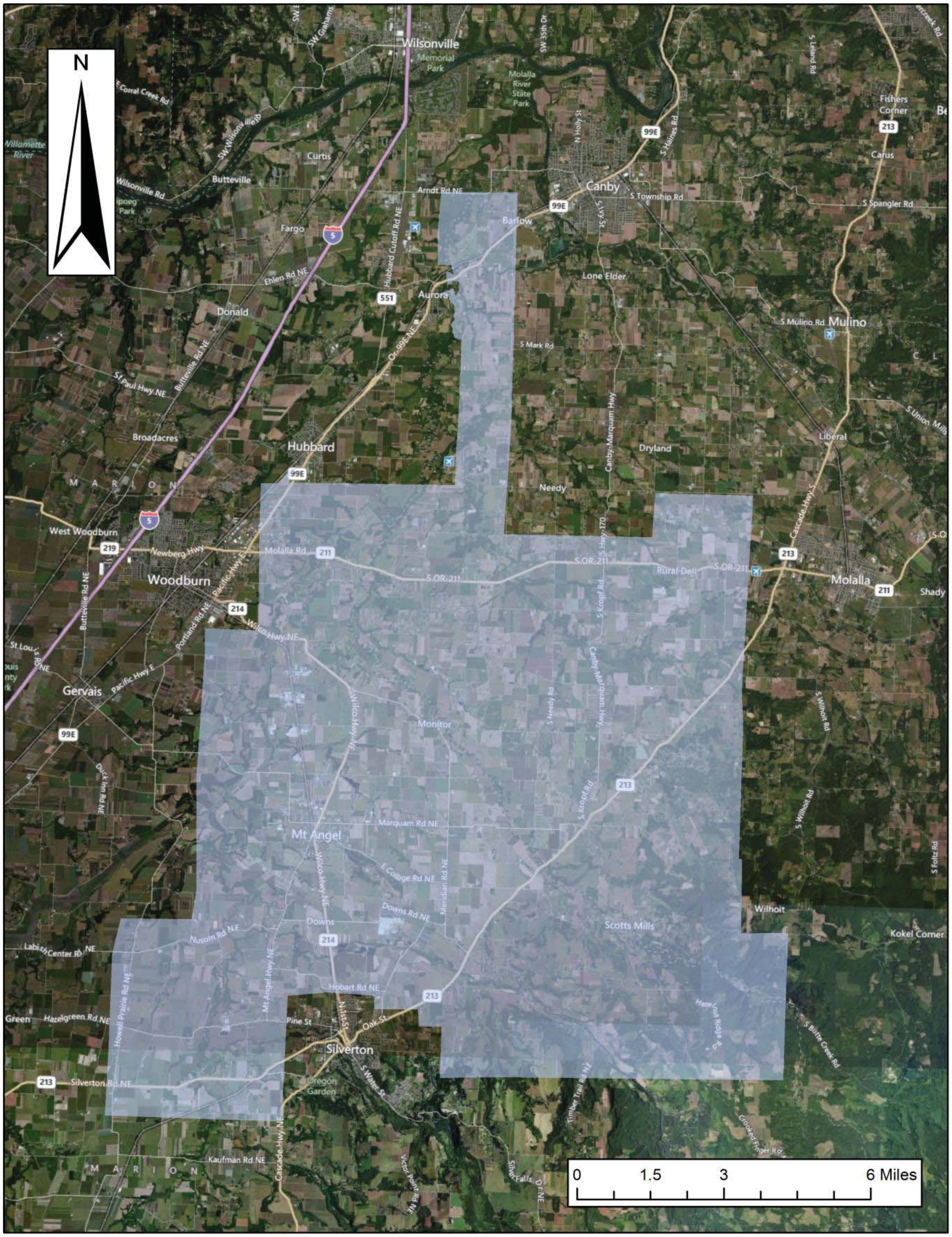

Figure 2: **Proposed District Boundary (GIS Credit: Andrew Wentworth).**

The goal of the associated project is to provide the needed long-term stable water supply for the District farms through the development of an on-channel reservoir in the upper Pudding watershed on Drift Creek. The proposed reservoir, an impervious earth-fill embankment, would impound at least 12,000 acre-feet of water and will relieve pressure in the three limited groundwater areas in the District's service area.

Background Information

The East Valley Water District has completed a significant number of studies toward development of the Drift Creek Reservoir site and this report was the result of a request made for services from Oregon State University's Agricultural and Resource Economics Department.

The following report presents a payment capacity analysis that was conducted in order to ascertain the financial ability of the District and its members to support the project costs. In order to secure project funding, the Secretary of the Interior will have to determine that the suitability of the land can bear the burden of cost according to its productive value.

Guidelines from the Bureau of Reclamation's (BOR) economic analysis program informed this review. In particular, the 2004 BOR report *Technical Guidance for Irrigation Ability to Pay and Irrigation Payment Capacity* provided an outline to assess the District's financial capability to pay for the infrastructure development. The analysis determines the farm-level payment capacity aggregated to the entire District level, less existing obligations, operation and maintenance costs and reserve fund requirements. The components of the payment capacity are examined in this report.

Analytical Methodologies and Tools (A)

The BOR report lists a variety of methodological tools that can be selected to provide the financial analysis, including "crop enterprise or whole farm budgeting, linear programming, quadratic programming, and econometric modeling." (BOR 2004) Of these methods, the crop enterprise or whole farm budgeting approach was selected. This method is able to employ existing enterprise budgetary data developed by university research and extension faculty and do so in a timelier manner when compared to the other methods.

The crop enterprise approach will utilize two programs from AgTools™, a set of financial tools developed by Oregon State University, Washington State University and the Universities of Arizona, Idaho and California-Davis. In particular, AgProfit™ and AgFinance™ will be used to conduct the payment capacity analysis and are referred to throughout the report. A description of each, which can be found directly from the website www.agtools.org, is provided.

AgProfit™ is a computer program designed to assist agricultural producers make long-run decisions when implementing technologies to a specific crop or analyzing cropping systems. AgProfit™ estimates machinery, labor, and production input costs as well as fruit size, grade, and total yield for calculating returns for crops with multiple establishment and production years. The program allows you to inflate specific return and input cost items over time to analyze the net present value, internal rate of return, and financial feasibility when implementing a particular technology, making minor changes to returns or input costs, or comparing cropping systems.

AgFinance™ is a computer program designed to assist agricultural producers make long-run decisions on a whole farm and ranch basis. You can load scenario files from AgProfit™ and AgLease™ into

AgFinance™ to analyze your farm's financial ratios and performance measures, which include working liquidity, solvency, profitability, debt repayment capacity, and efficiency. You can change the number of units in each scenario and observe the financial effects of implementing technologies, adding value to your products, conservation practices, changing cropping systems or livestock enterprises, or leasing additional land.

Datasets and Limitations

Data for the analysis will come predominantly from the Farm Service Agency (FSA) and the Oregon Agricultural Information Network (OAIN). The FSA data provides crop representation for the EVWD but only documents crop information for those farm operations that receive FSA financial support. These geographically referenced FSA data were matched against the District boundary and account for roughly 47% of acreage within the boundary (Figure 2), or just under half. Therefore, the eventual District payment capacity for this report will reflect that for approximately half of the acres within the boundary.

In this report, payment capacity is calculated for both the EVWD and for Marion County. Motivating the analysis for payment capacity beyond the District to the Marion County level is partly due to the aforementioned 47% representation. Additionally, the BOR report specifies that "all enterprises of the typical operator should be represented, whether within irrigation district boundaries or not." (BOR 2004) Therefore, the analysis is extended to represent Marion County at large.

OAIN data is used for the Marion County level analysis. Information on prices and yields from OAIN are also used with FSA District acreage data to determine payment capacity for the EVWD. The major limitation of the OAIN is that some data remain unpublished for anonymity reasons. Therefore, some crops including fresh vegetables are left out of the County analysis, despite their inclusion at the EVWD level. This will underestimate the County's overall payment capacity.

Characteristics of Representative Farms (B)

According to the BOR report, the "analysis should model operatorships, not ownerships." Operatorships are preferred because they provide more details in terms of cropping patterns and farm types and sizes. In approaching this task, enterprise budgets are used to reflect future income in the project area.

Cropping Pattern (B.3)

In the analysis of cropping patterns, two separate sources are drawn upon to provide a representative outlook on crops grown in the District. Both the Oregon Agricultural Information Network (OAIN) and Farm Service Agency (FSA) data are referenced to detail cropping pattern.

EVWD. The FSA crop data are applied to the district boundary line in Figure 2 and the summary results are presented in Table 1. These data are the most geographically refined data that exist for this region. However, these surveys are administered solely to those receiving financial support from the FSA and thus do not pertain to the entire District. The entire boundary consists of approximately 77,306 cropland acres, for which 36,160 acres had a 2012 FSA acreage report on file. As previously mentioned, this represents 47% coverage of the entire boundary.

Table 1: **EVWD Crop Acreage Reported to FSA (continued to next page).**

Crop	Acres	Percentage of EVWD (36160 acres)
Alfalfa	257.4	0.71%
Barley	21.3	0.06%
Beans	1,598.2	4.42%
Beets	108.1	0.30%
Blueberries	283.9	0.79%
Broccoli	243.4	0.67%
Buckwheat	55.7	0.15%
Cabbage	30.8	0.09%
Canary Seed	8.4	0.02%
Caneberries	1,195.4	3.31%
Cauliflower	390.2	1.08%
Cherries	2.8	0.01%
Chicory	104.9	0.29%
Christmas Trees	699.1	1.93%
Clover	721.0	1.99%
Corn	2,201.3	6.09%
CRP	38.7	0.11%
Cucumbers	30.2	0.08%
Fallow	568.4	1.57%
Flowers	852.7	2.36%
Garlic	91.4	0.25%
Grapes	671.1	1.86%
Grass	14,111.2	39.02%
Greens	36.9	0.10%
Hazelnuts	921.9	2.55%
Herbs	25.8	0.07%
Home Garden	1.7	0.00%
Hops	1,129.0	3.12%
Kiwi Fruit	6.6	0.02%
Kohlrabi	13.7	0.04%
Meadow Foam	37.7	0.10%
Mixed Hay / Forage	1,339.9	3.71%
Mustard	22.3	0.06%
Nursery	1,256.1	3.47%
Oats	297.9	0.82%
Olives	4.8	0.01%

Onions	509.4	1.41%
Parsnip	6.0	0.02%
Peas	695.3	1.92%
Peppers	77.3	0.21%
Potatoes	42.6	0.12%
Pumpkins	58.5	0.16%
Radishes	259.6	0.72%
Rhubarb	134.6	0.37%
Squash	174.4	0.48%
Strawberries	230.8	0.64%
Sugar Beets	225.3	0.62%
Trees	28.8	0.08%
Watercress	7.0	0.02%
Wheat	4,299.5	11.89%
Wildlife Food Plot	31.0	0.09%
TOTAL	36,160.0	100.00%

As it is not practical to incorporate all the crops grown within an irrigation district as diverse as the EVWD, some crops grown on a small percentage of total District acres are ignored. For example, watercress and olives are two crops that are excluded from the analysis for this reason. Other small percentage crops will be combined to represent more extensively grown crop acreage, such as grouping alfalfa, mixed hay and forage together. These three enterprises are represented by the alfalfa enterprise budget. Additionally, blueberries/caneberries are represented by blueberries, grass/clover by grass and wheat/oats by wheat. These enterprise combinations are shown in the Table 2. All District and County combinations are disclosed as enterprise budgets and are presented in Table 6.

Table 2**: Selected** A**creage of Major Combined EVWD Crops Reported to Farm Service Agency (as shown in Table 1) (FSA).**

Crop	Acres	Percentage of EVWD (36160 acres)
Alfalfa/Mixed Hay/Forage	1,597.3	4.42%
Beans/Broccoli/Cauliflower/Corn/Peas	5,128.4	14.18%
Blueberries/Caneberries	1,479.3	4.09%
Grass/Clover	14,832.2	41.02%
Greens/Radishes/Onions/Misc.	1,422.8	3.93%
Hazelnuts	921.9	2.55%
Hops	1,129.0	3.12%
Nursery	1,256.1	3.47%
Wheat/Oats	4,597.4	12.71%
TOTAL	32,346.4	89.50%

Marion County. The OAIN dataset, although pertaining solely to Marion County and thus geographically less refined than the FSA data, contains annually published crop acreages for several county crops. As a result, five-year cropping patterns are averaged from 2007 to 2011 (Note: 2011 is the most up-to-date year on record).

Table 3: **Total Harvested Crop Acres in Marion County Including Non-Disclosed Acreage (OAIN).**

2007	2008	2009	2010	2011
178,182	178,211	178,953	178,385	183,229

To calculate crop-specific percentages, harvested acreages for each crop was first divided by the corresponding total harvested acreage for that year. Then, these five-year crop percentages were averaged. For example, harvested acres for hazelnuts were 5,800 tons in 2007, 6,000 tons in 2008, 2009, 2010 and 6,200 tons in 2011. These numbers were divided into the corresponding year's acreage listed in Table 3 and then averaged to provide a summary percentage. All enterprise percentages are shown in Table 4.

In the case of processed vegetables, FSA reports for the District contained acreage for processed cauliflower, broccoli and peas. At the County level, these three processed vegetables are omitted as they were not available through OAIN. Grass represents acreage for both perennial ryegrass and tall fescue but the averages for price and yield are used from perennial ryegrass, as it is the dominant grass crop. Alfalfa hay represents acreage for "other hay" as well but yields and prices from alfalfa hay are used.

The hops data from OAIN is for the Willamette Valley. This is a reasonable assumption, given that Marion County hops accounts for 94% of the production in the Willamette Valley. Additionally, processed sweet corn acreage represents Willamette Valley sweet corn. However, there is no way to differentiate Marion County from the Willamette Valley because there are no published OAIN data. Therefore, Willamette Valley sweet corn is treated as Marion County corn.

Table 4: **Selected Crop Acreage of Combined Major Marion County Crops (OAIN).**

Crop	Harvest (acres)	Percentage of Marion County
Alfalfa Hay	10,360	5.77%
Blueberries	1,466	0.82%
Grass	51,280	28.61%
Hazelnuts	6,000	3.34%
Hops	5,232	2.92%
Snap Beans	12,349	6.62%
Sweet Corn	13,880	7.74%
Wheat	16,800	9.33%
Total	117,367	65.15%

<u>Irrigated Crop Acreage</u>

An important aspect for payment capacity is irrigation. Irrigation data is available at the County level through the USDA Census of Agriculture. According to the 2007 Census, Marion County had 96,382 acres in irrigated land. Within this irrigated land, there were 949 farms that irrigated 92,817 acres of harvested cropland. Given that there were 199,832 total acres of harvested cropland according to the 2007

Census (in slight contrast to OAIN), this yields a 46.4% irrigation rate for harvested cropland within Marion County. This information is summarized in Table 5.

Table 5: **Marion County Cropland, Irrigation (USDA 2007).**

Marion County Cropland and Irrigation	Acres
Total Harvested Cropland	199,832
Irrigated Land	96,382
Harvested Cropland within Irrigated Land	92,817
Pastureland and other land under Irrigation	3,565

Farm Type (B.1)

Major enterprises within the District and County were included and crops representing only a small portion of the total district acres were excluded (or modeled on the basis of more extensive crops). However, in the case of nurseries and greenhouses, which represent only a fraction of the District area, their value is sufficiently high to warrant inclusion.

For this project analysis, only croplands were considered and livestock were omitted. In general, cropland is the dominant farm land type in both Marion County (Figure 3) and more precisely the East Valley Water District.

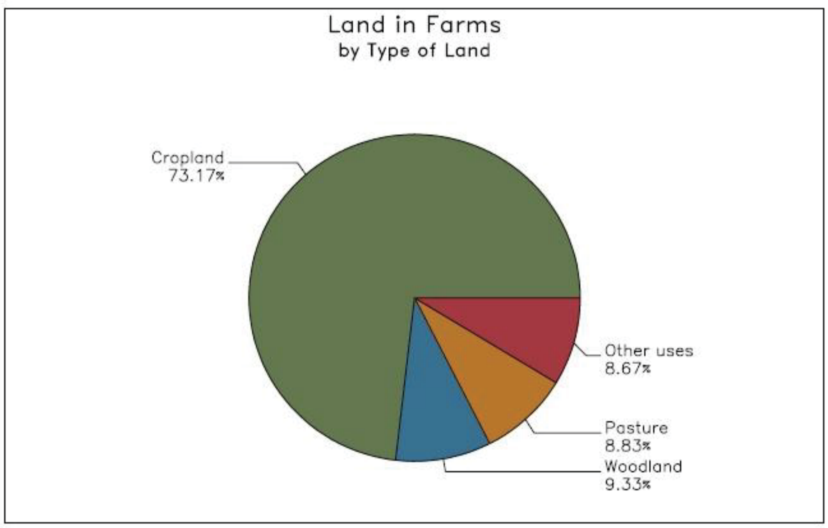

Figure 3: **Marion County Farmland Percentages (USDA 2007).**

It is important to note that the report specifies that "all enterprises of the typical operator should be represented, whether within [the] irrigation district boundaries or not." Therefore, there is some flexibility in considering the characteristics of the representative farms. Payment capacity, as previously mentioned, will thus reflect acreage data from within the boundary (FSA) and across Marion County as a whole (OAIN) and will built upon the use of the enterprise budgets. It is important that these budgets are well-defined, as they are fundamental in this analysis, and so a description is provided below:

Enterprise Budgets

A whole farm analysis was used to determine the repayment capacity. Enterprise budgets are used in this analysis to provide return and cost information for a particular crop.

Enterprise budgets are detailed lists of revenues and expenses for a specific enterprise(s) or common rotation over a one-year period, typically designated on a per-acre basis. For crops like wheat, which are typically grown in rotations, it is assumed that one-half acre is devoted to wheat production and the other half to fallow. Revenues are calculated by multiplying crop prices by their respective market quantities. Expenses for an entire enterprise include packaging, processing, value-added, non-harvest (i.e. fertilizers, chemical pesticides), harvest (i.e. specific machinery, labor) and capital investment costs (i.e. equipment and facilities replacement costs/depreciation). Each budget is regionally specific and represents an estimate of typical costs and returns to the producer in that area. University research faculty, agricultural specialists, local extension agents and economists collaborate with growers and farm suppliers on these budgets, working together to establish a set of guidelines. In general, budgets are designed to reflect common agricultural practices. For practical reasons, they are intended to be a helpful guide in estimating a grower's actual costs and as a result, the budgets do not represent any particular farm or operation. The budgets used in this report are included in Section B of the Appendix.

For this agricultural value analysis, enterprise budgets were used and referenced from several different university-related Extension offices, including the universities of Oregon State, Washington, Idaho and California. These publications are all available online and referenced with links in the Appendix of this report.

By default, nurseries and greenhouses are inherently diverse operations. For example, not only do nurseries differ in their production practices (pot-in-pot, container, bare root, balled and burlapped, protected or any combination), they differ significantly in what they grow as a result. Greenhouses are similar in this sense, each growing unique crops with different requirements. Few enterprise budgets have been developed for these operations. Consequently, production cost and expense information could only be gleaned from publications based in other regions or from Oregon industry experts.

Farm Size (B.2)

As noted by the BOR report, it is important that "farm size should reflect the actual typical farm operations" and furthermore, "should be at least large enough to provide reasonably full employment for the farm operator based on the amount of investment and management expected for the type of farm represented." Figure 4 contains the Census figures for average farm size in Marion County.

Table 6: **Marion County Highlights (USDA 2007).**

	2007	2002	% change
Number of Farms	2,670	3,203	- 17
Land in Farms	307,647 acres	341,051 acres	- 10
Average Size of Farm	115 acres	106 acres	+ 8
Market Value of Products Sold	$586,743,000	$430,666,000	+ 36
Crop Sales $484,818,000 (83 percent) Livestock Sales $101,926,000 (17 percent)			
Average Per Farm	$219,754	$134,457	+ 63

In our decision regarding representative farm choice and farm size, the USDA averages were not used. The enterprise budgets were determined to more accurately reflect actual farm size in that they reflect the typical operation in that region large enough to provide full employment. The Census report data only allow mean size calculations for crop-specific farm size, which are not necessarily indicative of the typical operation due to influence from very small and large sized farms. Due to the fact that we will be basing farm sizes off of the cropping pattern percentages already discussed, farm size is effectively accounted for without the Census. The typical farm sizes extracted from the enterprise budgets, as well as a general description are provided in Table 6.

Table 7: **Representative Farm Sizes, Descriptions, Assumptions and Abbreviations.**

Representative Farm	Description (Enterprise Budgets and FSA)	Representative Farm Abbreviation
Alfalfa Hay	The alfalfa hay farm is based off of 320 acres in the Klamath Basin and is adapted for the Willamette Valley. From the FSA District data, alfalfa will also represent mixed hay and forage acreage. From the OAIN County data, alfalfa hay will also represent other hay acreage.	**A**
Blueberries	The typical blueberry farm will be 20-acres in the Willamette Valley, OR. From the FSA data, blueberries will also represent caneberry acreage. However, they will solely represent blueberry acreage for the OAIN County data.	**B**
Fresh Vegetables	The typical fresh vegetable farm will be 100-acres of rotational lettuce and radishes in the Willamette Valley, OR. From the FSA District data, fresh vegetables will represent acreage from greens, radishes, cabbage, cucumbers, onions, parsnips, peppers, squash, pumpkin and garlic. Unfortunately, due to a lack of data available, fresh vegetables will be excluded from the County payment capacity.	**FV**
Greenhouse	N/A	**GH**
Grass	Due to complementary machinery and implements, the grass budget was developed using machinery from wheat. Therefore, the two were constructed together but are divided out by their respective percentages in the District. The grass budget is modeled after perennial ryegrass. From the FSA District data, this farm will also represent clover. From the OAIN County data, grass will represent perennial ryegrass and tall fescue acreage. Prices and yields for perennial ryegrass are used.	**G**
Hops	The typical hop farm is developed from 660-acres in Yakima Valley, WA.	**H**
Hazelnuts	The typical hazelnut farm is 100-acres in the Willamette Valley, OR. Low yields from OAIN data indicated acres coming into establishment. As a result, yields increase 10% annually.	**HZ**
Nursery	N/A	**N**
Processed Vegetables*	The entire processed vegetable farm is 600-acres in the Willamette Valley. Of that total, 280-acres are sweet corn, 160-acres snap beans, 80-acres broccoli and 80-acres cauliflower. From the FSA data, processed vegetable farm will represent acreage from peas as well. For the OAIN County data, processed vegetables will solely represent Marion County snap beans and Willamette Valley sweet corn.	**PV**
Wheat	The wheat budget was adapted from 2,000 acres in the North Central Region to fit the typical winter wheat farm of 1200 acres in the Willamette Valley Region. From the FSA data, this farm will also represent oat acreage, but wheat prices are used. For the OAIN County data, it will solely represent wheat.	**W**

Nursery and Greenhouse

Nurseries and greenhouses represent the two most diverse enterprises grown within the irrigation district. These industries typically occupy a small acreage amount but generate significant total sales, and thus are included in the payment capacity.

In general, there is a lack of clear data available on nursery and greenhouse characteristics. The only data that exist for these farm types at the County level is aggregate sales value. As a result, a more broad approach will have to be used to include payment capacity by the greenhouse and nursery. This approach will make use of information available from Northwest Farm Credit Services (NFCS). In particular, operating expense ratio and profit margin data will be used in place of the methods followed by other crop enterprises. This margin will be applied to the sales value data to calculate overall payment capacity.

This broad approach is necessary, particularly in the nursery industry, which has faced substantial negative setbacks due to the financial crisis and ensuing drop in new housing units (Northwest Farm Credit Services 2012). Industry averages for Bare Root and Container/Balled & Burlapped nurseries are provided in Tables 7 and 8 as evidence of these impacts.

Nurseries. For Bare Root nurseries, pre-tax profit margins are negative from 2009 – 2011 and for Container/Balled and Burlapped nurseries, the margin is negative from 2008 – 2011. However, the nursery industry currently appears to be on a recovery path and will have the future ability to contribute toward the project costs (Northwest Farm Credit Services 2012). If it's assumed that this recovery will return the industry to its 2006-2007 average operating expense ratio, a pre-tax profit margin can be applied to County specific sales values data from the OAIN to determine its potential contribution.

Table 8: **Bare Root Nursery Industry Overview (NFCS).**

Bare Root Nursery						
Year	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Average Sales	$5,260,996	$4,975,109	$4,667,314	$3,473,495	$2,871,893	$2,851,855
Operating Expense Ratio	88.78 %	91.73 %	98.55 %	105.74 %	118.96 %	111.77 %
Pre-Tax Profit Margin	11.22 %	8.27 %	1.45 %	(5.74) %	(18.96) %	(11.77) %

Table 9: **Container/Balled & Burlapped Nursery Industry Overview (NFCS).**

Container/Balled & Burlapped Nursery						
Year	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Average Sales	$9,195,057	$10,307,949	$9,572,833	$8,411,389	$7,772,421	$7,861,136
Operating Expense Ratio	86.53 %	95.21 %	101.09 %	104.97 %	116.45 %	101.87 %
Pre-Tax Profit Margin	13.47 %	4.79 %	(1.09) %	(4.97) %	(16.45) %	(1.87) %

Table 10: **2010 Oregon Nursery and Greenhouse Survey (OASS).**

Gross Wholesale Sales by Plant Material	
Plant Materials	**Sales Dollars**
Container/Balled & Burlapped	$ 376,300,000
Bare Root	115,000,000
Greenhouse	129,300,000
Other	55,400,000
TOTAL	$ 676,000,000

With different operating expense ratios faced by Bare Root and Container/B&B nurseries, percentage contributions of state sales will be calculated and then applied at the Marion County Level. From Table 10, Container/B&B wholesale sales represent approximately 75% of total wholesale sales when combined with Bare Root nursery sales. Consequently, Bare Root sales contribute the remaining 25% to this category. These percentages will prove useful in application to the OAIN data, which aggregates total nursery sales. OAIN data for nursery sales is provided in Table 11.

Table 11: **Marion County Aggregate Nursery Sales (OAIN).**

Nursery Crops in Marion County (2007 - 2011)	
Year	**Value of Sales**
2007	$ 143,944,000
2008	115,155,000
2009	111,240,000
2010	133,861,000
2011	134,700,000
Average	$ 127,780,000

Using the sales contribution averages, the value of sales can be broken apart into two separate categories, which will enable different pre-tax profit margins to be applied in assessing payment capacity. The data are separated in Table 12.

Table 12: **Segregated Marion County Nursery Sales Data for Bare Root and Container/B&B based on Assumptions from Table 10.**

Nursery Crops in Marion County (2007-2011)			
Year	**Bare Root**	**Container/B&B**	**Total**
2007	$ 35,986,000	$ 107,958,000	$ 143,944,000
2008	28,788,750	86,366,250	115,155,000
2009	27,810,000	83,430,000	111,240,000
2010	33,465,250	100,395,750	133,861,000
2011	33,675,000	101,025,000	134,700,000
Average	$ 31,945,000	$ 95,835,000	$ 127,780,000

Greenhouses. Table 14 summarizes the most recent sales data for the Marion County greenhouse industry. For these five most recent years of data, $37.1 million was the sales value average.

While the nursery industry was heavily impacted by the financial and housing crisis, the greenhouse industry proved more salient. Using greenhouse industry averages provided by Northwest Farm Credit Services, a payment capacity proxy can be calculated using an average pre-tax profit margin on the OAIN Marion County sales data. Due to the industry buoyancy (compared to the nursery industry), the five years from 2007 to 2011 will be used for this average and are show in Table 13.

Table 13: **Greenhouse Industry Overview (NFCS).**

Greenhouse Industry						
Year	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Average Sales	$5,562,451	$6,251,346	$5,812,142	$5,811,144	$6,012,115	$6,124,468
Operating Expense Ratio	91.85%	91.02%	90.96%	89.26%	90.69%	92.64%
Pre-Tax Profit Margin	8.15%	8.98%	9.04%	10.74%	9.31%	7.36%

The 2007-2011 average pre-tax profit margin was approximately 9.086%.

Table 14: **Marion County Aggregate Greenhouse Sales (OAIN).**

Greenhouse Crops in Marion County (2007 - 2011)	
Year	**Value of Sales**
2007	$ 39,478,000
2008	31,582,000
2009	33,824,000
2010	40,139,000
2011	40,790,000
Average	$ 37,162,600

Crop Yields and Prices Received (B.4 and C)

To develop crop yields and prices received, the most recent five years of crop yield and price data from OAIN were averaged. This five-year arithmetic mean (2007-2011) for both yields and farm-gate prices received was then used to project for the five-year period this analysis examines, 2013-2017. **It is important to note that prices and yields are thus held constant over the five-year project period. Later, this consideration will become important because in contrast to yields and prices received, project costs will be inflated over time and consequently, will not remain constant. Overall, with total revenues fixed over time and costs inflating, payment capacity will decrease over time.**

In cases where data from this network were not available or incomplete, data location and assumptions used are noted.

Crop information on broccoli, cauliflower, radishes and spinach are unavailable through OAIN. Consequently, these numbers were pulled directly from recent enterprise budget publications. These are referenced at the end of this report and included in Section B of the Appendix.

Due to incomplete or non-published data through OAIN, hops and sweet corn production are assumed to be equivalent to the Willamette Valley. Hops in Marion County represent approximately 94% of production within the Willamette Valley and this assumption is very reasonable. There is no such approximation for sweet corn production.

Additionally, average hazelnut per-acre yields from the OAIN database were significantly lower than the yields from the hazelnut enterprise budget. This reflects how yields of new orchards, which increased by 400 acres over the past five years (2007-2011), are not fully productive yet. It takes a newly established hazelnut orchard roughly seven years before it reaches full production. To try and account for this acreage reaching heightened productivity, hazelnut yields are increased 10% annually over this five-year analysis.

Table 15: **Price, Yield, Production and Sales Data for Selected Crops Analyzed (OAIN).**

Crop	Unit	Yield (unit/acre)	Price ($/unit)	Value Sales ($)
Alfalfa Hay	**tons**	5.3	186.00	$ 1,734,200
Blueberries	**lbs**	8420.0	1.15	14,113,400
Broccoli	**tons**	5.0	500.00	-
Cauliflower	**tons**	6.0	350.00	-
Greenhouse	**-**	-	-	37,163,000
Hazelnuts	**lbs**	1090.0	0.92	592,640
Hops	**lbs**	1748.0	3.28	29,782,600
Leaf Lettuce	**cartons**	900.0	8.00	-
Nursery	**-**	-	-	127,780,000
Perennial Ryegrass	**lbs**	1640.0	0.61	36,674,800
Radishes	**cartons**	700.0	9.00	-
Snap Beans	**tons**	6.7	206.97	16,502,000
Sweet Corn	**tons**	10.1	107.49	15,064,400
Wheat	**BU**	104.0	5.99	$ 10,816,600

Investment Values (D)

Land Value (D.1)

For this agricultural value analysis, it is assumed that all representative farmland is owned rather than leased. The average market value for land growing grass seed, wheat, alfalfa and mixed hay is $5,000 per acre and all other land $10,000 per acre. Irrigation water cost is excluded from these land investment values.

Buildings, Other Improvements, Orchards, Vineyards, Permanent Crops and Machinery and Equipment (D.2, D.3 and D.4)

Enterprise budgets were used in order to obtain market values for intermediate (10 years or less) and long-term assets (greater than 10 years). Percentages were then developed to represent the composition of intermediate-term assets to the entire asset base (intermediate plus long-term), as well as for the long-term assets to the entire asset base. These percentages were then applied to calculate annual depreciation costs, described more in Section E.4.

Livestock (D.5)

Livestock are not included in this agricultural value analysis.

Farm Expenses (E)

Input Levels (E.1)

Extension Service studies were used in determining the amount of input levels. The Extension published enterprise budgets reflect common practices, not necessarily optimum practices. Input levels are consistent with yield levels and other representative farm practices. Fertilizers, pesticides and other chemicals are aggregated in the enterprise budgets included in the Appendix of this report. To view them individually, please reference the corresponding website link(s) included under each budget.

Input levels are held constant in this analysis due to the fact that yields are held constant. Hazelnuts are the one exception, where per-acre yields increase 10% annually. In this instance, input levels are adjusted accordingly to reflect the higher yields.

Prices Paid (E.2)

The prices for input items were taken during the development of the enterprise budget. As the majority was published between two and four years ago, these budgets reflect up-to-date accounts of revenues and market expenses faced by producers. In instances where an enterprise budget was older, as the case with the Alfalfa budget, production practices were assumed to be the same but equipment prices were taken from recent budget publications for other enterprises. In the rare instance that this was not possible and a viable substitute could not be located, the price of the item was inflated over time to reflect the current cost.

All input prices are inflated 3% annually across this five-year analysis. In other words, each budget line item's price increases 3% from the previous year for all five-years. As noted previously, prices are held constant initially and will be increased in a sensitivity analysis.

Diesel and gasoline are two important inputs in this analysis. Fuel usage was calculated using the machinery application within AgProfit™, and starting prices for these fuel types were $3.60/gallon and $4.00/gallon, respectively. Fuel prices are inflated 3% annually across the duration of this analysis.

Interest Costs (E.3)

In this report, interest expenses reflect annual operating capital. Interest on annual operating capital is applied to each enterprise budget using the following assumptions:

- Interest Rate: 8%
- Percent of Costs Borrowed: 80%
- Number of Months to Borrow: 6

Depreciation (E.4)

Using the suite of AgTools™ software programs, depreciation costs are calculated annually for each representative farm from crop budgets. These costs represent the reduction in asset value over time, especially due to wear and tear. Depreciation costs for machinery (i.e. tractors and coinciding implements), buildings and other capital investment are divided into two categories: intermediate and long-term assets. Intermediate assets have a useful life of 10 or less years while long-term assets greater than10 years. Asset values for both reflect current market values described in (D.2, D.3 and D.4).

Replacement Costs

There are times however when the value of intermediate and long-term capital assets decline over time on the balance sheet. This may imply that there are insufficient principal payments from loans and capital purchases from cash to replace those assets in a timely manner. In these instances, replacement costs are included to make certain sufficient cash dollars are available to replace longer-term assets that depreciate. These replacement costs are taken from annual cash flows. Intermediate and long-term assets are inflated 2% annually and 1.5%, respectively, across the duration of this analysis.

This step reduces the loan arrangement complications and ensures that aging capital investments will be replaced responsibly, so that the payment capacity will not comprise income that should've been diverted toward reinvestment. However, it does not enable meaningful divisions between debt and equity to be made.

Taxes (E.5)

Property taxes are included as a line item expense in each budget. Per-acre property tax charges for each representative farm are $20 per acre. Other taxes, including workers' compensation and payroll taxes, are covered under hired labor expenses and are not incorporated as an individual budget expense. Approximately 30 percent of per hour wages was added to the wage to cover these taxes.

Insurance (E.6)

Property insurance costs are included as an aggregate budget cost in the payment capacity analysis. On average, these costs are approximately $35 per acre and represent a blanket policy that lumps vehicle, fire, theft, machinery and equipment insurance costs together.

Per-acre property insurance charges for each representative farm are $30 for Alfalfa Hay, Blueberries, Hazelnuts, Hops, Processed Vegetables and $35 per-acre for Fresh Vegetables and Wheat and Perennial Ryegrass.

Repair Costs (E.7)

The repair costs for each piece of machinery and equipment were estimated with coefficients derived by the American Society of Agricultural Engineers. Machinery costs input into this program application were obtained from relevant machinery publications and enterprise budgets cited in both the reference section and within the Appendix. Repair costs appear under the more general per acre machinery cost for each piece of equipment. Repair and maintenance costs are inflated 3% annually across the duration of this analysis.

Hired Labor Expenses (E.8)

Labor expenses were developed during the enterprise budget construction phase. As a result, they reflect the labor associated with the typical farm growing a particular enterprise. Regional wage rates were used in determining labor expenses. No secondary data was specifically referenced in this payment capacity report due to the fact that this information had previously been referenced in the enterprise budget development phase. All labor costs, including harvest and non-harvest, are inflated 3% annually across the duration of this analysis. Additionally, associated labor housing costs are increased 3% annually where applicable.

Custom Expenses (E.9)

There were no custom expenses for farm enterprises included in the analysis.

Nonproject water expenses (E.10)

Nonproject water expenses are not considered in this payment capacity report. All potential project water is treated as replacement water for individually owned wells and groundwater. Irrigation infrastructure for irrigated crops is assumed to be already established and only the associated maintenance and repairs for irrigation systems are considered as farm level expense items. Consequently, the payment capacity will represent the residual income available for project water charges, including electricity pumping costs and the water itself.

Returns to Operator's Factors of Production (F)

Return to Labor (F.1)

Farm operator's labor is valued at the current wage rate for supervisory and hired labor in the representative farm region. Labor performed by the operator's family is valued at the same wage rate as hired farm labor. These returns to labor are included as budget expense items. The representative farm types developed from the enterprise budgets include farmer operator labor in addition to other labor necessary for the operation.

Return to management (F.2)

An allowance of 10% of net farm income is made for the farm operator's management ability over and above the supervisory labor rate (BOR 2004). This return to management represents an opportunity cost to the farm operator.

The payment capacity analysis utilizes both AgProfit™ and AgFinance™ programs. Individual per-acre budgets are developed for each enterprise using AgProfit™. The output serves as an input to AgFinance™, where each representative farm is built. The net income calculated from the program subtracts annual farm costs, which includes the returns to labor mentioned above, from gross income. The 10% allowance is calculated from this net income. In developing the payment capacity, it is later subtracted alongside the return to equity to find the residual income available for project funding.

Return to equity (F.3)

The return to equity is an allowance for the farm operator's equity subtracted from net farm income. A rate of 3% is applied to the equity (non-debt) share of farm investment and annual operating capital in computing this allowance (BOR 2004). Within the AgFinance™ program, equity appears as net worth. Three percent of this total net worth, which varies from year to year, is subtracted from net farm income.

Payment Capacity for Representative Farms

Gross farm income is derived from crop sales data and from the AgFinance balance sheets. Farm/ranch income is calculated according to the following formula:

Farm/Ranch Gross Income = Total returns from each budget file loaded in this analysis

Farm expenses are subtracted out to determine net farm income. With net farm income, which already accounts for the family's labor contribution, the returns to equity and farm management are subtracted out to yield overall payment capacity, or the measure of the District's repayment capabilities for the project costs. This payment capacity calculation is visually detailed in Attachment 3 of the BOR report and all spreadsheets are provided in Section C of the Appendix.

Payment capacity will drop with each subsequent future year. As previously mentioned, this is in part due to the fact that total revenues remain constant over time since yields and prices received do not change over the project period. With costs inflating, this will cause the future payment capacity to trend downward. Additionally, depreciation and replacement costs will exaggerate this trend with some representative farms, depending on the quantity of depreciable assets and composition of intermediate and long-term assets. For example, per-acre blueberry payment capacity contribution decreases over time largely due to inflating costs. The typical blueberry farm has a relatively low asset base, so its replacement costs are minimal in comparison to other representative farms. For example, the typical hops farm has a large asset base and replacement costs for intermediate and long-term assets are considerable. Consequently, with these costs simultaneously inflating over time, replacement costs are significant in some instances. The Beginning Balance Sheet in the Appendix shows the aggregate asset numbers for intermediate and long-term assets used for each representative farm.

In defending the assumption of constant total revenues (gross income), its effect on payment capacity over time and why this declining trend in ability to pay may not occur exactly as demonstrated here, some visual examples are helpful. The motivation for holding total revenues constant is evidenced in Figures 5 and 7. There have been noticeable and unpredictable fluctuations in farm gate prices received over time, in contrast to the general trend of increasing costs. Conceding this, a historical five-year average arguably provides more reliability in projecting out future prices than other methods. It is worth noting that in some instances, extrapolating future prices using linear regression methods would actually produce future farm gate price estimates that are lower than the five-year OAIN averages used here.

The difference between gross income and annual costs, or the payment capacity, also differs between representative farm types, as shown in Figures 6 and 8. The payment capacity for blueberries, a less capital intensive operation, declines marginally relative to the representative farm growing grass and wheat, an operation with significantly more capital use. This analysis cannot account for the fact these more capital intensive operations may experience technological innovations that will not only reduce production costs but possibly even extend the capital life of the equipment, thus reducing the equipment replacement rate over time. These efficiency changes are especially difficult to model in this short term five-year analysis but would alter the slopes of the red cost lines in a downward direction.

Furthermore, variation in both farm gate prices and input prices in the short term adds insight as to why the decline in payment capacity may not definitively occur as depicted in this analysis. In the short run, fluctuating prices received could increase more than costs due to integration or introduction into new markets or value-added processes. Again, these changes are hard to account for in the five-year analysis. However, these changes along with general increases in demand would tend to alter the blue gross income lines in the upward direction away from the red cost lines, increasing the overall net ability to pay for future project debt. The assumptions used here therefore are more conservative, producing a lower bound for the District's payment capacity. These will later be overturned in the sensitivity analysis, where farm-gate prices will be inflated over time using 1%, 3% and 5% rates will be considered in addition to other factors.

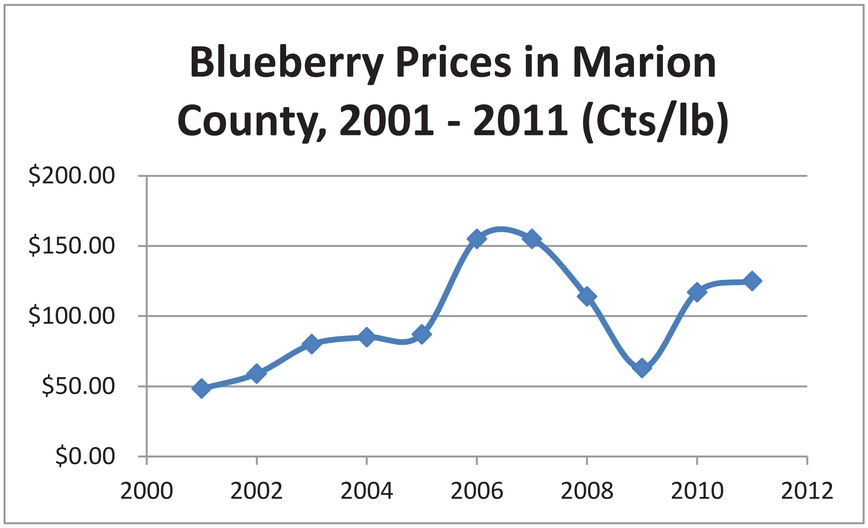

Figure 5: **OAIN Historical Price Data for Blueberries in Marion County.**

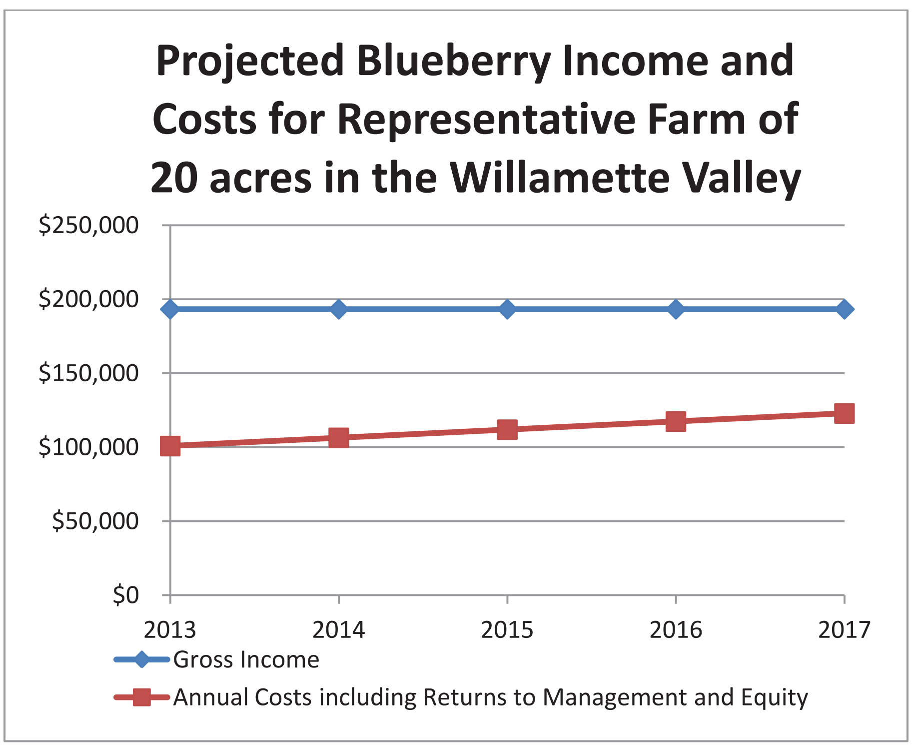

Figure 6: **Projected Gross Income and Costs with Constant 5-Year Averaged Prices for the Representative Blueberry Operation in the Willamette Valley through the years 2013 – 2017.**

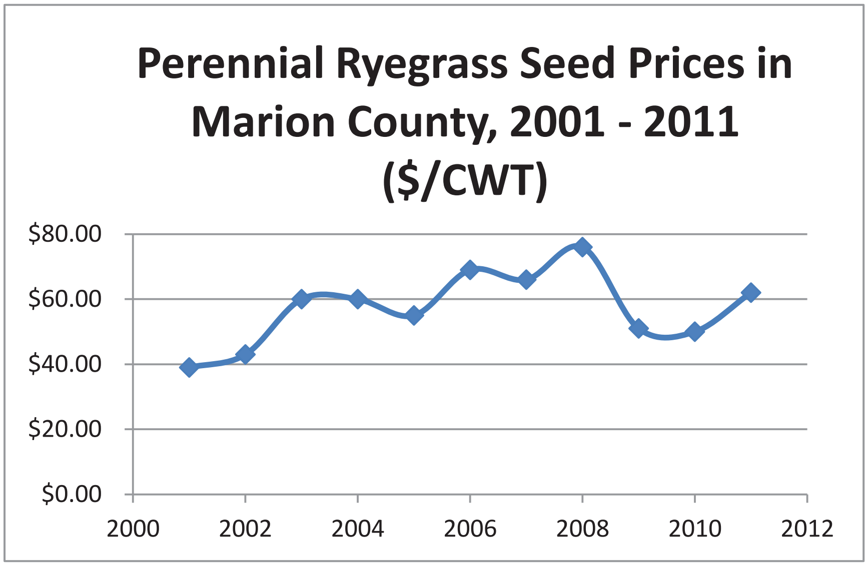

Figure 7: **OAIN Historical Price Data for Perennial Ryegrass Seed in Marion County.**

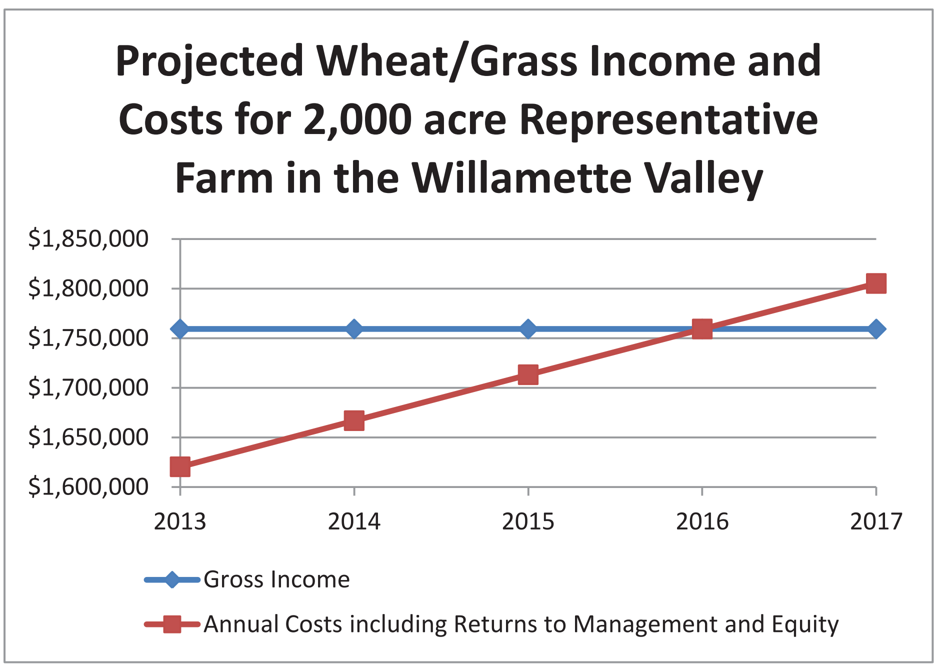

Figure 8: **Projected Income and Costs with Constant 5-Year Averaged Prices for the Representative Wheat/Grass Operation in the Willamette Valley through the years 2013 – 2017.**

Results

Table 16 breaks down the per-acre contributions from each representative farm for all five project years. These per-acre payments will be applied to acreage data from Table 18 to estimate payment capacity for the District and for Marion County at large.

The totals do not sum up to 100% because only the major crops are accounted for, not all crops. It is important to remember that the 89.5% coverage is for the 36,160 acres from FSA records, which represents approximately 47% of the total EVWD boundary of 77,306 acres. The 65.15% coverage represents accountability for the total harvested acres in Marion (Table 3).

For the first project year, $14.8 million is the estimated payment capacity for the EVWD's representative farm. In Section G, total payment capacity for the EVWD, which includes contributions from nurseries and greenhouses, is calculated.

For Marion County's representative farms, the first project year payment capacity is an estimated $24.1 million. In Section G, total payment capacity for Marion County, which includes contributions from nurseries and greenhouses, is calculated. This estimate will be revised upward significantly due to the nursery and greenhouse industry presence in Marion County.

Table 16: **Per-Acre Representative Farm Payment Capacity at 10% Return to Management and 3% Return to Equity ($/acre).**

Representative Farm	2013	2014	2015	2016	2017
A	$ 253	$ 231	$ 209	$ 187	$ 165
B	4,623	4,347	4,071	3,795	3,520
FV	2,938	2,604	2,271	1,940	1,609
G	69	46	23	(0)	(23)
H	958	811	665	520	376
HZ	(3)	53	107	158	206
PV	188	129	70	12	(45)
W	69	46	23	(0)	(23)

Table 17: **Representative Farm Payment Capacity for EVWD at 10% Return to Management and 3% Return to Equity, Excluding Nursery and Greenhouse Contributions ($/total acreage).**

Representative Farm	Acres	2013	2014	2015	2016	2017
A	**1,597.3**	$ 404,811	$ 368,891	$ 333,341	$ 298,177	$ 263,409
B	**1,479.3**	6,838,804	6,430,180	6,022,108	5,614,662	5,207,725
FV	**1,422.8**	4,180,717	3,705,465	3,231,770	2,759,677	2,289,233
G	**14,832.2**	1,029,813	685,044	341,729	-	-
H	**1,129.0**	1,081,840	916,021	751,136	587,212	424,288
HZ	**921.9**	-	49,057	98,610	145,486	189,700
PV	**5,128.4**	961,590	660,636	361,300	63,611	-
W	**4,597.4**	319,202	212,337	105,923	-	-
TOTAL	**32,364.4**	$ 14,816,776	$ 13,027,631	$ 11,245,917	$ 9,468,825	$ 8,374,354

Table 18: **Representative Farm Payment Capacity for Marion County at 10% Return to Management and 3% Return to Equity, Excluding Nursery and Greenhouse Contributions ($/total acreage).**

Representative Farm	Acres	2013	2014	2015	2016	2017
A	**10,360**	$2,625,585	$2,392,604	$2,162,031	$1,933,957	$1,708,454
B	**1,466**	6,777,318	6,372,368	5,967,965	5,564,182	5,160,903
FV	**-**	-	-	-	-	-
G	**51,280**	3,560,416	2,368,432	1,181,476	-	-
H	**5,232**	5,013,451	4,245,017	3,480,904	2,721,253	1,966,230
HZ	**6,000**	-	319,277	641,786	946,865	1,234,625
PV	**26,229**	4,918,013	3,378,795	1,847,856	325,338	-
W	**16,800**	1,166,439	775,929	387,067	-	-
TOTAL	**117,367**	$24,061,222	$19,852,422	$15,669,085	$11,491,595	$10,070,213

Payment Capacity for Nurseries and Greenhouses

As previously emphasized in this report, nurseries and greenhouses receive will receive a payment capacity treatment different than that calculated for the representative farms. Both OAIN data at the Marion County level as well as finance structural information from Farm Credit Services will be used to derive the payment capacity.

Nurseries. For both nursery types (Bare Root and Container/B&B), the representative pre-tax profit margin from 2006 and 2007 will be applied to the County sales data. The 2006-2007 average margin will be used due to the fact the industry was severely impacted from the Great Recession. This two year window is more representative of a healthy nursery industry, which is plausible with the current recovery.

The 2006-2007 pre-tax profit margins for Bare Root and Container/B&B nurseries are 9.745% and 9.13%, respectively. These margins will be applied to the average 2007-2011 sales value data for Marion County from OAIN.

At the County level, Marion has a total nursery payment capacity of approximately $12.97 million per year. However, this payment capacity does not reflect the EVWD's ability to pay down future debt. In order to approximate this capacity, we will assume that 20% of nursery sales are concentrated in the District. This number, which will be applied to greenhouse sales data as well, reflects informed opinions from several EVWD Board members.

The EVWD has an estimated yearly nursery payment capacity of $2.6 million. With limited data available, this estimate is projected outward for the five years of this analysis.

Table 19: **Marion County Nursery Payment Capacity.**

Nursery Crop Payment Capacity			
Year	**Bare Root**	**Container/B&B**	**TOTAL**
2013	$ 3,113,040	$ 9,856,565	$ 12,969,606
2014	3,113,040	9,856,565	12,969,606
2015	3,113,040	9,856,565	12,969,606
2016	3,113,040	9,856,565	12,969,606
2017	3,113,040	9,856,565	12,969,606

Table 20: **EVWD Nursery Payment Capacity (20% of Marion County Payment Capacity).**

Nursery Crop Payment Capacity			
Year	**Bare Root**	**Container/B&B**	**TOTAL**
2013	$ 622,608	$ 1,971,313	$ 2,593,921
2014	622,608	1,971,313	2,593,921
2015	622,608	1,971,313	2,593,921
2016	622,608	1,971,313	2,593,921
2017	622,608	1,971,313	2,593,921

Greenhouses. The greenhouse industry proved more resilient and did not suffer from the same problems that confounded nurseries in 2007 and later years. As a result, we will use the 2007-2011 five year period to calculate the mean pre-tax profit margin. This average margin for the greenhouse industry during this period was 9.086%. By multiplying the 2007-2011 average greenhouse County sales value data by the average pre-tax profit margin, payment capacity will be determined. This result is projected over the future five year period.

At the County level, Marion has a total greenhouse payment capacity of approximately $3.78 million per year. However, as previously mentioned, this payment capacity does not reflect the EVWD's ability to pay down future debt for the project costs. In order to approximate this capacity, we will assume that 20% of greenhouse sales are applicable to the District. This number reflects informed opinions from EVWD Board members.

The EVWD has an estimated yearly greenhouse payment capacity of $675,319. With limited data available, this estimate is projected outward for the five years of this analysis.

Table 21: **Marion County Greenhouse Payment Capacity.**

Marion County Greenhouse Payment Capacity	
Year	**Payment Capacity**
2013	$ 3,376,594
2014	3,376,594
2015	3,376,594
2016	3,376,594
2017	3,376,594

Table 22: **EVWD Greenhouse Payment Capacity (20% of Marion County Payment Capacity).**

EVWD Greenhouse Payment Capacity	
Year	**Payment Capacity**
2013	$ 675,319
2014	675,319
2015	675,319
2016	675,319
2017	675,319

Total Payment Capacity for EVWD and Marion County (G)

The total payment capacity incorporates the nursery and greenhouse contribution with the contribution to pay down debt from the representative farms.

Total payment capacity for the EVWD for the first project year is estimated to be $18.1 million. This contribution takes into account farm investment, expenses and returns to management, equity and labor. Payment capacity diminishes over time due to inflation and replacement costs incurred for depreciated capital. It is important to remember that total revenues are held constant over time, with the aforementioned hazelnut case as the sole exception. This assumption also contributes to this temporal result.

Total payment capacity for Marion County for the first project year is estimated to be $40.4 million. This contribution takes into account farm investment, expenses and returns to management, equity and labor. Payment capacity diminishes over time due to inflation and replacement costs incurred for depreciated capital. It is important to remember that total revenues are held constant over time, with the aforementioned hazelnut case as the sole exception. This assumption also contributes to this temporal result.

No county level data were available through OAIN for fresh vegetables. Therefore, this number will underestimate Marion County's total payment capacity.

Table 23: **Total Payment Capacity for EVWD at 10% Return to Management and 3% Return to Equity, Including Nursery and Greenhouse Contributions ($/total acreage).**

Representative Farm	2013	2014	2015	2016	2017
Alfalfa	$ 404,811	$ 368,891	$ 333,341	$ 298,177	$ 263,409
Blueberries	6,838,804	6,430,180	6,022,108	5,614,662	5,207,725
Fresh Vegetables	4,180,717	3,705,465	3,231,770	2,759,677	2,289,233
Greenhouse	675,319	675,319	675,319	675,319	675,319
Grass	1,029,813	685,044	341,729	-	-
Hops	1,081,840	916,021	751,136	587,212	424,288
Hazelnuts	-	49,057	98,610	145,486	189,700
Nursery	2,593,921	2,593,921	2,593,921	2,593,921	2,593,921
Processed Vegetables	961,590	660,636	361,300	63,611	-
Wheat	319,202	212,337	105,923	-	-
TOTAL	$ 18,086,016	$ 16,296,871	$ 14,515,157	$ 12,738,065	$ 11,643,594

Table 24: **Total Payment Capacity for Marion County at 10% Return to Management and 3% Return to Equity, Including Nursery and Greenhouse Contributions ($/total acreage).**

Representative Farm	2013	2014	2015	2016	2017
Alfalfa	$ 2,625,585	$ 2,392,604	$ 2,162,031	$ 1,933,957	$ 1,708,454
Blueberries	6,777,318	6,372,368	5,967,965	5,564,182	5,160,903
Fresh Vegetables	-	-	-	-	-
Greenhouse	3,376,594	3,376,594	3,376,594	3,376,594	3,376,594
Grass	3,560,416	2,368,432	1,181,476	-	-
Hops	5,013,451	4,245,017	3,480,904	2,721,253	1,966,230
Hazelnuts	-	319,277	641,786	946,865	1,234,625
Nursery	12,969,606	12,969,606	12,969,606	12,969,606	12,969,606
Processed Vegetables	4,918,013	3,378,795	1,847,856	325,338	-
Wheat	1,166,439	775,929	387,067	-	-
TOTAL	$ 40,407,422	$ 36,198,622	$ 32,015,285	$ 27,837,795	$ 26,416,413

Sensitivity Analysis with Adjustments to Return to Equity, Return to Management and Farm-Gate Prices Received

Sensitivity analysis is a technique used to predict outcomes where input values are subject to change. It is useful to understand how scenario outcomes will differ when these input variables take on new values.

Return to Equity. Most representative farm per-acre payment contributions were positive across this 5-year analysis. However, in some instances, including hazelnuts in the first year and processed vegetables, grass and wheat in the final years, these numbers were negative. This inability to contribute was the conglomeration of a few factors, including low data predicated yield estimates, inflation, depreciation and the corresponding replacement costs. In more capital intensive farm operations like the processed vegetables, these costs also accumulated more quickly than in lower intensive operations like blueberries. Furthermore, the return to equity was substantial in cases with high observable net worth.

If the return to equity is slightly adjusted downward to 2% from 3% (Table 25), all per-acre farm contributions are positive throughout. Per-acre returns from Table 25 are applied to acreage data from Table 18 to complete this sensitivity analysis. Tables 26 and 27 show the analysis for EVWD and Marion County, respectively. Unfortunately, given limited data for nurseries and greenhouses, there was no meaningful way to account for this change. As a result, their contribution is not altered.

At the EVWD level, payment capacity using a 2% return to equity exceeds $21 million for the first project year. This compares to the $18.1 million estimate using the 3% return to equity (Table 23).

At the Marion County level, payment capacity using a 2% return to equity exceeds $51 million for the first project year. This compares to the $40.4 million estimate using the 3% return to equity (Table 24).

Table 25: **Per-Acre Representative Farm Payment Capacity at 10% Return to Management and 2% Return to Equity ($/acre).**

Representative Farm	2013	2014	2015	2016	2017
A	$ 323	$ 303	$ 284	$ 265	$ 246
B	4,944	4,730	4,514	4,299	4,082
FV	3,131	2,805	2,504	2,201	1,897
G	128	107	86	64	43
H	1,195	1,062	929	795	661
HZ	157	220	280	339	395
PV	313	259	205	150	95
W	128	107	86	64	43

Table 26: **Total Payment Capacity for EVWD at 10% Return to Management and 2% Return to Equity, Including Nursery and Greenhouse Contributions ($/total acreage).**

Representative Farm	2013	2014	2015	2016	2017
Alfalfa	$ 515,516	$ 484,766	$ 454,059	$ 423,400	$ 392,788
Blueberries	7,313,852	6,996,502	6,678,167	6,358,873	6,038,454
Fresh Vegetables	4,454,540	3,990,270	3,562,184	3,131,799	2,699,043
Greenhouse	675,319	675,319	675,319	675,319	675,319
Grass	1,892,493	1,581,405	1,268,851	954,781	639,159
Hops	1,349,401	1,199,443	1,048,925	897,830	746,147
Hazelnuts	144,775	202,579	258,463	312,411	364,436
Nursery	2,593,921	2,593,921	2,593,921	2,593,921	2,593,921
Processed Vegetables	1,605,979	1,328,527	1,049,853	769,898	488,656
Wheat	586,599	490,174	393,294	295,945	198,114
TOTAL	$ 21,132,394	$ 19,542,907	$ 17,983,037	$ 16,414,177	$ 14,836,037

Table 27: **Total Payment Capacity for Marion County at 10% Return to Management and 2% Return to Equity, Including Nursery and Greenhouse Contributions ($/total acreage).**

Representative Farm	2013	2014	2015	2016	2017
Alfalfa	$ 3,343,609	$ 3,144,165	$ 2,945,004	$ 2,746,150	$ 2,547,602
Blueberries	7,248,095	6,933,598	6,618,125	6,301,702	5,984,164
Fresh Vegetables	-	-	-	-	-
Greenhouse	3,376,594	3,376,594	3,376,594	3,376,594	3,376,594
Grass	6,542,998	5,467,461	4,386,853	3,301,005	2,209,791
Hops	6,253,381	5,558,447	4,860,917	4,160,716	3,457,788
Hazelnuts	942,240	1,318,447	1,682,152	2,033,263	2,371,858
Nursery	12,969,606	12,969,606	12,969,606	12,969,606	12,969,606
Processed Vegetables	8,213,714	6,794,700	5,369,434	3,937,612	2,499,211
Wheat	2,143,572	1,791,212	1,437,190	1,081,452	723,956
TOTAL	$ 51,033,808	$ 47,354,230	$ 43,645,876	$ 39,908,101	$ 36,140,569

Return to Management. Instead of altering the return to equity, additional sensitivity analysis considers what happens with a 5% return to management in lieu of the previous 10% return. Often, farmers pay themselves less in years with reduced yields or higher costs and as a result, this alteration is plausible.

Per-acre returns from Table 28 are applied to acreage data from Table 18 to complete this sensitivity analysis. Tables 28 and 29 show the analysis for EVWD and Marion County, respectively. Unfortunately, given limited data for nurseries and greenhouses, there was no meaningful way to account for this change. As a result, their contribution is not altered.

At the EVWD level, payment capacity using a 5% return to management is $19.4 million for the first project year (Table 29). This compares to the $18.1 million estimate using the 10% return to equity (Table 23).

At the Marion County level, payment capacity using a 5% return to management is $43.5 million for the first project year (Table 30). This compares to the $40.4 million estimate using the 10% return to equity (Table 24).

Table 28: **Per-Acre Representative Farm Payment Capacity at 5% Return to Management and 3% Return to Equity ($/acre).**

Representative Farm	2013	2014	2015	2016	2017
A	$ 279	$ 256	$ 233	$ 210	$ 188
B	4,933	4,652	4,371	4,090	3,810
FV	3,158	2,782	2,436	2,091	1,746
G	83	59	35	11	(13)
H	1,051	898	746	595	444
HZ	23	84	142	197	249
PV	219	158	97	36	(24)
W	83	59	35	11	(13)

Table 29: **Total Payment Capacity for EVWD at 5% Return to Management and 3% Return to Equity, <u>Including</u> Nursery and Greenhouse Contributions ($/total acreage).**

Representative Farm	2013	2014	2015	2016	2017
Alfalfa	$ 445,752	$ 408,697	$ 371,980	$ 335,613	$ 299,606
Blueberries	7,297,912	6,881,799	6,466,013	6,050,623	5,635,498
Fresh Vegetables	4,492,763	3,958,792	3,466,381	2,975,013	2,484,714
Greenhouse	675,319	675,319	675,319	675,319	675,319
Grass	1,230,805	872,496	515,235	159,049	-
Hops	1,186,536	1,014,148	842,497	671,605	501,503
Hazelnuts	21,314	77,369	130,731	181,389	229,362
Nursery	2,593,921	2,593,921	2,593,921	2,593,921	2,593,921
Processed Vegetables	1,122,410	808,653	496,131	184,860	
Wheat	381,501	270,439	159,703	49,299	-
TOTAL	$ 19,448,232	$ 17,561,634	$ 15,717,910	$ 13,876,691	$ 12,419,922

Table 30: **Total Payment Capacity for Marion County at 5% Return to Management and 3% Return to Equity, Including Nursery and Greenhouse Contributions ($/total acreage).**

Representative Farm	2013	2014	2015	2016	2017
Alfalfa	$ 2,891,121	$ 2,650,787	$ 2,412,639	$ 2,176,765	$ 1,943,226
Blueberries	7,232,298	6,819,927	6,407,879	5,996,224	5,584,830
Fresh Vegetables	-	-	-	-	-
Greenhouse	3,376,594	3,376,594	3,376,594	3,376,594	3,376,594
Grass	4,255,314	3,016,517	1,781,343	549,889	-
Hops	5,498,631	4,699,756	3,904,290	3,112,344	2,324,058
Hazelnuts	138,720	503,543	850,835	1,180,535	1,492,754
Nursery	12,969,606	12,969,606	12,969,606	12,969,606	12,969,606
Processed Vegetables	5,740,520	4,135,823	2,537,445	945,458	
Wheat	1,394,097	988,250	583,591	180,151	-
TOTAL	$ 43,496,901	$ 39,160,802	$ 34,824,222	$ 30,487,565	$ 27,691,069

Farm Gate Prices. Using the original return to equity and management charges, sensitivity analysis can also consider the case when farm-gate prices received inflate over time. Prior to this analysis, all farm-gate prices received were assumed to be held constant. Now, prices will be examined using inflation rates of 1%, 3% and 5%.

Per-acre returns with prices received inflated 1% over time from Table 31 are applied to acreage data from Table 18 to complete this sensitivity analysis. Tables 32 and 33 show the analysis for EVWD and Marion County, respectively. Unfortunately, given limited data for nurseries and greenhouses, there was no meaningful way to account for this change. As a result, their contribution is not altered.

At the EVWD level, payment capacity using 1% farm-gate price inflation under the original BOR conditions is roughly $18.7 million for the first project year (Table 32). This compares to the original $18.1 million estimate (Table 23).

At the Marion County level, payment capacity using 1% farm-gate price inflation under the original BOR conditions is roughly $41.9 million for the first project year (Table 33). This compares to the original $40.4 million estimate (Table 24).

Table 31: **Per-Acre Representative Farm Payment Capacity at 10% Return to Management, 3% Return to Equity and 1% Farm-Gate Price Inflation ($/acre).**

Representative Farm	2013	2014	2015	2016	2017
A	$ 262	$ 248	$ 234	$ 220	$ 206
B	4,707	4,513	4,317	4,119	3,920
FV	3,056	2,836	2,615	2,392	2,167
G	77	61	45	29	13
H	1,008	910	811	712	613
HZ	6	74	140	205	269
PV	208	170	131	92	53
W	77	61	45	29	13

Table 32: **Total Payment Capacity for EVWD at 10% Return to Management, 3% Return to Equity and 1% Farm-Gate Price Inflation, Including Nursery and Greenhouse Contributions ($/total acreage).**

Representative Farm	2013	2014	2015	2016	2017
Alfalfa	$ 418,513	$ 395,955	$ 373,431	$ 350,949	$ 328,515
Blueberries	6,963,192	6,675,953	6,386,156	6,093,898	5,799,013
Fresh Vegetables	4,347,825	4,035,590	3,720,774	3,403,391	3,083,454
Greenhouse	675,319	675,319	675,319	675,319	675,319
Grass	1,143,323	909,280	673,885	437,155	199,102
Hops	1,138,156	1,027,274	915,933	804,148	691,940
Hazelnuts	5,680	68,153	129,317	189,136	247,599
Nursery	2,593,921	2,593,921	2,593,921	2,593,921	2,593,921
Processed Vegetables	1,067,933	870,726	672,504	473,283	273,098
Wheat	354,385	281,841	208,878	135,501	61,714
TOTAL	$ 18,708,246	$ 17,534,012	$ 16,350,118	$ 15,156,700	$ 13,953,674

Table 33: **Total Payment Capacity for Marion County at 10% Return to Management, 3% Return to Equity and 1% Farm-Gate Price Inflation, Including Nursery and Greenhouse Contributions ($/total acreage).**

Representative Farm	2013	2014	2015	2016	2017
Alfalfa	$ 2,714,450	$ 2,568,143	$ 2,422,050	$ 2,276,233	$ 2,130,730
Blueberries	6,900,587	6,615,931	6,328,740	6,039,109	5,746,875
Fresh Vegetables	-	-	-	-	-
Greenhouse	3,376,594	3,376,594	3,376,594	3,376,594	3,376,594
Grass	3,952,860	3,143,691	2,329,853	1,511,393	688,363
Hops	5,274,431	4,760,583	4,244,609	3,726,572	3,206,582
Hazelnuts	36,967	443,563	841,637	1,230,953	1,611,446
Nursery	12,969,606	12,969,606	12,969,606	12,969,606	12,969,606
Processed Vegetables	5,461,900	4,453,292	3,439,495	2,420,588	1,396,747
Wheat	1,295,009	1,029,914	763,290	495,152	225,517
TOTAL	$ 41,982,403	$ 39,361,318	$ 36,715,874	$ 34,046,202	$ 31,352,460

Per-acre returns with prices received inflated 3% over time from Table 34 are applied to acreage data from Table 18 to complete this sensitivity analysis. Tables 31 and 32 show the analysis for EVWD and Marion County, respectively. Unfortunately, given limited data for nurseries and greenhouses, there was no meaningful way to account for this change. As a result, their contribution is not altered.

At the EVWD level, payment capacity using 3% farm-gate price inflation under the original BOR conditions is roughly $19.9 million for the first project year. This compares to the original $18.1 million estimate (Table 23). Here, prices received are held at the same inflation rate as budget expense items. Under this scenario, payment capacity continually increases across the duration of the project.

At the Marion County level, payment capacity using 3% farm-gate price inflation under the original BOR conditions is roughly $45.2 million for the first project year. This compares to the original $40.4 million estimate (Table 24). Here, prices received are held at the same inflation rate as budget expense items. Under this scenario, payment capacity continually increases across the duration of the project.

Table 34: **Per-Acre Representative Farm Payment Capacity at 10% Return to Management, 3% Return to Equity and 3% Farm-Gate Price Inflation ($/acre).**

Representative Farm	2013	2014	2015	2016	2017
A	$ 279	$ 282	$ 286	$ 289	$ 292
B	4,875	4,850	4,824	4,799	4,770
FV	3,291	3,307	3,324	3,339	3,354
G	92	92	92	91	91
H	1,108	1,110	1,112	1,115	1,117
HZ	25	116	209	304	402
PV	250	253	256	260	263
W	92	92	92	91	91

Table 35: **Total Payment Capacity for EVWD at 10% Return to Management, 3% Return to Equity and 3% Farm-Gate Price Inflation, Including Nursery and Greenhouse Contributions ($/total acreage).**

Representative Farm	2013	2014	2015	2016	2017
Alfalfa	$ 445,910	$ 450,900	$ 456,074	$ 461,441	$ 466,998
Blueberries	7,212,034	7,174,964	7,136,642	7,099,488	7,056,567
Fresh Vegetables	4,682,040	4,705,865	4,728,925	4,751,217	4,772,694
Greenhouse	675,319	675,319	675,319	675,319	675,319
Grass	1,370,337	1,364,557	1,358,661	1,352,641	1,346,501
Hops	1,250,788	1,253,158	1,255,682	1,258,365	1,261,218
Hazelnuts	23,373	106,916	192,620	280,522	370,698
Nursery	2,593,921	2,593,921	2,593,921	2,593,921	2,593,921
Processed Vegetables	1,280,631	1,297,295	1,314,109	1,331,048	1,348,154
Wheat	424,751	422,959	421,131	419,266	417,363
TOTAL	$ 19,959,104	$ 20,045,854	$ 20,133,085	$ 20,223,227	$ 20,309,433

Table 36: **Total Payment Capacity for Marion County at 10% Return to Management, 3% Return to Equity and 3% Farm-Gate Price Inflation, Including Nursery and Greenhouse Contributions ($/total acreage).**

Representative Farm	2013	2014	2015	2016	2017
Alfalfa	$ 2,892,150	$ 2,924,514	$ 2,958,071	$ 2,992,884	$ 3,028,925
Blueberries	7,147,192	7,110,456	7,072,479	7,035,659	6,993,123
Fresh Vegetables	-	-	-	-	-
Greenhouse	3,376,594	3,376,594	3,376,594	3,376,594	3,376,594
Grass	4,737,725	4,717,742	4,697,355	4,676,543	4,655,317
Hops	5,796,389	5,807,370	5,819,067	5,831,501	5,844,725
Hazelnuts	152,118	695,840	1,253,632	1,825,720	2,412,610
Nursery	12,969,606	12,969,606	12,969,606	12,969,606	12,969,606
Processed Vegetables	6,549,738	6,634,965	6,720,961	6,807,590	6,895,080
Wheat	1,552,141	1,545,594	1,538,915	1,532,097	1,525,143
TOTAL	$ 45,173,653	$ 45,782,682	$ 46,406,679	$ 47,048,193	$ 47,701,122

Building on this, Figures 6 and 8 are now reexamined when the assumption of constant total revenues is dropped. In allowing farm-gate prices received to increase at the same rate as inflation, gross income now increases over time. Furthermore, gross income always exceeds annual farms costs plus the payment returns to management and equity, as evidenced by Figures 9 and 10.

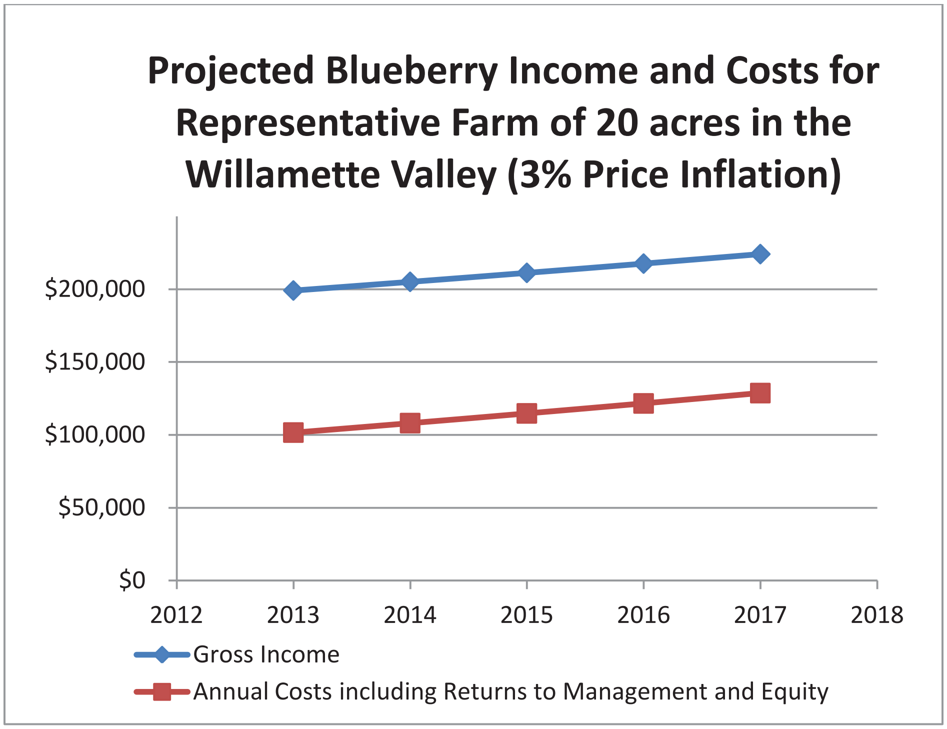

Figure 9: **Projected Income and Costs for the Representative Blueberry Operation in the Willamette Valley through the years 2013 – 2017 (3% Farm-Gate Price Inflation).**

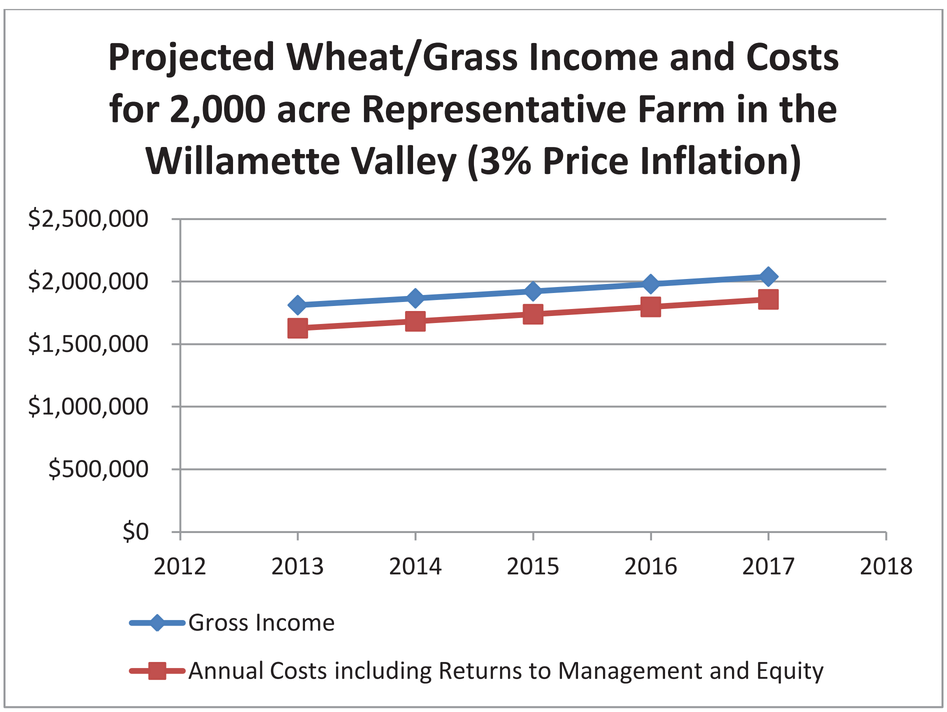

Figure 10: **Projected Income and Costs for the Representative Wheat/Grass Operation in the Willamette Valley through the years 2013 – 2017 (3% Farm-Gate Price Inflation).**

Per-acre returns with prices received inflated 5% over time from Table 37 are applied to acreage data from Table 18 to complete this sensitivity analysis. Tables 31 and 32 show the analysis for EVWD and Marion County, respectively. Unfortunately, given limited data for nurseries and greenhouses, there was no meaningful way to account for this change. As a result, their contribution is not altered.

At the EVWD level, payment capacity using 5% farm-gate price inflation under the original BOR conditions is roughly $21.2 million for the first project year. This compares to the original $18.1 million estimate (Table 23). When prices received are inflated at 5%, an inflation rate higher than that applied to budget expense items, payment capacity continually increases over time and at a rate greater than that of 3%.

At the Marion County level, payment capacity using 5% farm-gate price inflation under the original BOR conditions is roughly $48.3 million for the first project year. This compares to the original $40.4 million estimate (Table 24). When prices received are inflated at 5%, an inflation rate higher than that applied to budget expense items, payment capacity continually increases over time and at a rate greater than that of 3%.

Table 37: **Per-Acre Representative Farm Payment Capacity at 10% Return to Management, 3% Return to Equity and 5% Farm-Gate Price Inflation ($/acre).**

Representative Farm	2013	2014	2015	2016	2017
A	$ 296	$ 317	$ 339	$ 362	$ 386
B	5,043	5,194	5,352	5,518	5,691
FV	3,526	3,788	4,061	4,345	4,641
G	108	123	140	157	175
H	1,208	1,314	1,425	1,542	1,664
HZ	45	159	280	410	547
PV	291	338	386	437	490
W	108	123	140	157	175

Table 38: **Total Payment Capacity for EVWD at 10% Return to Management, 3% Return to Equity and 5% Farm-Gate Price Inflation, Including Nursery and Greenhouse Contributions ($/total acreage).**

Representative Farm	2013	2014	2015	2016	2017
Alfalfa	$ 473,308	$ 506,944	$ 542,071	$ 578,754	$ 617,063
Blueberries	7,460,807	7,683,882	7,917,613	8,162,623	8,419,282
Fresh Vegetables	5,016,256	5,389,509	5,777,935	6,182,246	6,603,227
Greenhouse	675,319	675,319	675,319	675,319	675,319
Grass	1,597,344	1,828,913	2,071,182	2,324,656	2,589,879
Hops	1,363,419	1,483,548	1,609,195	1,740,625	1,878,110
Hazelnuts	41,066	146,457	258,488	377,527	504,030
Nursery	2,593,921	2,593,921	2,593,921	2,593,921	2,593,921
Processed Vegetables	1,493,330	1,732,384	1,981,704	2,241,784	2,513,136
Wheat	495,114	566,891	641,985	720,552	802,761
TOTAL	$ 21,209,884	$ 22,607,768	$ 24,069,413	$ 25,598,006	$ 27,196,728

Table 36: **Total Payment Capacity for Marion County at 10% Return to Management, 3% Return to Equity and 5% Farm-Gate Price Inflation, Including Nursery and Greenhouse Contributions ($/total acreage).**

Representative Farm	2013	2014	2015	2016	2017
Alfalfa	$ 3,069,851	$ 3,288,012	$ 3,515,845	$ 3,753,766	$ 4,002,238
Blueberries	7,393,728	7,614,798	7,846,428	8,089,235	8,343,587
Fresh Vegetables	-	-	-	-	-
Greenhouse	3,376,594	3,376,594	3,376,594	3,376,594	3,376,594
Grass	5,522,567	6,323,179	7,160,787	8,037,134	8,954,098
Hops	6,318,340	6,875,041	7,457,316	8,066,384	8,703,518
Hazelnuts	267,271	953,183	1,682,314	2,457,058	3,280,376
Nursery	12,969,606	12,969,606	12,969,606	12,969,606	12,969,606
Processed Vegetables	7,637,576	8,860,209	10,135,347	11,465,514	12,853,337
Wheat	1,809,265	2,071,556	2,345,968	2,633,070	2,933,480
TOTAL	$ 48,364,799	$ 52,332,178	$ 56,490,206	$ 60,848,361	$ 65,416,833

Summary

The preceding payment capacity assembled for the East Valley Water District (EVWD) utilized data and information available from the Farm Service Agency (FSA), Oregon Agriculture Information Network (OAIN), university extension publications and the U.S. Department of Agriculture 2007 Census Report. As in all reports of this nature, the data are imperfect and certain assumptions must be used to facilitate the analysis. It is worth summarizing this report by discussing the limitations once more.

The EVWD, as well as Marion County, are highly diversified agricultural regions and consequently, difficult to comprehensively assess. From one year to the next, crop acreages grown in wheat and grass can increase or decrease significantly depending on relative prices, leading to substitution with other crops. It would be near impossible to develop a different sensitivity analysis to try and account for these variable conditions that would affect the District and County's payment capacity. In this regard, the Bureau of Reclamation's (BOR) emphasis on averages helps provide a guide post for analysis. It is noteworthy that acreages for blueberries, hazelnuts and hops all require establishment periods and thus are not subject to change as readily as wheat and grass acres. For this, the analysis works particularly well.

The FSA data on selected crop acreage are used to analyze the EVWD's crop acreage and composition. These data are reported to farms receiving financial support from the FSA and do not apply to all operations within the District boundaries. From the proposed District boundary (Figure 2), 47% of the acreage is accounted for through FSA reporting requirements. The payment capacity numbers in this report all reflect that 47% representation.

The OAIN data are generally from the County level. This is particularly beneficial in trying to establish accurate numbers for prices, yields and acreages. These data interfaced well with crop acreage numbers from the FSA data and provided the basis for the County level analysis. However, not all crop information is published for anonymity reasons. In some instances, there were strong numbers from recent enterprise budget publications to use instead, as in the processed cauliflower and broccoli cases. In other instances, crops were left entirely out of the analysis, as in the fresh vegetable exclusion from the Marion County payment capacity.

Overall, this report makes best use of data available and employs transparent methods to develop an agriculture economic value analysis for the EVWD.

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Appendix

A. OAIN Data

Alfalfa Hay

Forage can be grown for hay, haylage, grass silage and greenchop purposes. However, hay, which includes alfalfa and other tame, small grains, accounts for 13,775 acres of the total 15,552 forage acres. Over a third of these total acres are irrigated, though only 185 out of 560 farms irrigate. The mean non-irrigated forage farm is 34.7 acres and the mean non-irrigated hay farm is 26.0 acres.

Table A.1: **Alfalfa Overview, Marion County (OAIN)**

Alfalfa Hay Production in Marion County (2007 - 2011)						
Year	**Harvest (acres)**	**Yield (tons/acre)**	**Production (tons)**	**Price ($/ton)**	**Value Sales (000)**	**% of Total County**
2007	1,900	5.5	10,450	$ 180.00	$ 1,881	1.07%
2008	1,500	5.0	7,500	$ 190.00	$ 1,425	0.84%
2009	1,700	5.5	9,350	$ 160.00	$ 1,496	0.95%
2010	1,800	5.2	9,360	$ 160.00	$ 1,498	1.01%
2011	1,900	5.2	9,880	$ 240.00	$ 2,371	1.04%
Average	1,760	5.3	9,308	$ 186.00	$ 1,734.20	0.98%

Alfalfa hay is also used to represent other hay acreage at the County level. The production of other hay is shown below:

Table A.2: **Other Hay Overview, Marion County (OAIN)**

Other Hay Production in Marion County (2007 - 2011)					
Year	**Harvest (acres)**	**Yield (tons/acre)**	**Production (tons)**	**Price ($/ton)**	**Value Sales (000)**
2007	9,500	2.8	26,600	$ 160.00	$ 1,277
2008	8,000	2.8	22,400	$ 170.00	$ 3,808
2009	8,500	2.5	21,250	$ 140.00	$ 2,975
2010	8,500	2.3	19,550	$ 130.00	$ 2,542
2011	8,500	2.3	19,550	$ 150.00	$ 2,932
Average	8,600	2.5	21,870	$ 150.00	$ 2,706.80

Blueberries

Blueberry enterprise budget data are based on a 20-acre blueberry field with plants spaced at 3' x 10' for a total of 1,452 plants/acre. In 2007, the mean blueberry farm size was 12.1 acres.

Table A.3: **Blueberry Overview, Marion County (OAIN)**

Blueberry Production in Marion County (2007 - 2011)						
Year	**Harvest (acres)**	**Yield (lbs/acre)**	**Production (000 lbs)**	**Price (cts/lb)**	**Value Sales (000)**	**% of Total County**
2007	1,153	9,000	10,377	$ 155.00	$ 16,084	0.65%
2008	1,243	8,200	10,193	$ 114.00	$ 11,620	0.70%
2009	1,305	8,300	10,832	$ 63.00	$ 6,824	0.73%
2010	1,630	8,300	13,529	$ 117.00	$ 15,289	0.91%
2011	2,000	8,300	16,600	$ 125.00	$ 20,750	1.09%
Average	1,466	8,420	12,306	$ 114.80	$ 14,113.40	0.82%

Hazelnuts

Hazelnuts are assumed to be non-irrigated. Their per-acre costs and returns are based on a 100-acre orchard with a 109 trees/acre density and 20' x 20' spacing.
In 2007, the mean hazelnut farm size was 50.3 acres.

Table A.4: **Hazelnut Overview, Marion County (OAIN)**

Hazelnut Production in Marion County (2007 - 2011)						
Year	**Harvest (acres)**	**Yield (lbs/acre)**	**Production (tons)**	**Price ($/lb)**	**Value Sales (000)**	**% of Total County**
2007	5,800	1,190	3,451	$ 0.90	$ 6,212	3.26%
2008	6,000	1,100	3,300	$ 0.76	$ 5,016	3.37%
2009	6,000	1,320	3,960	$ 0.75	$ 5,940	3.35%
2010	6,000	790	2,370	$ 1.05	$ 4,977	3.36%
2011	6,200	1,050	3,255	$ 1.15	$ 7,487	3.38%
Average	6,000	1,090	3,267	$ 0.92	$ 5,926.40	3.34%

Hops

Within the OAIN database, there are three years of existing data for hops. However, due to the specific agricultural conditions necessary for their growth and production, the majority of Willamette Valley hops are grown specifically in Marion County, averaging between 93% and 94% for the years 2008 through 2010. Consequently, due to the more robust data released at the regional level, Willamette Valley data will be used in place of Marion County.

Hops are assumed to have drip-irrigation. Their costs and returns based on 660-acres devoted to hop production in Yakima Valley, WA. The drip irrigation system, hop trellis system and hop plants have a 4-year life expectancy. In 2002, the mean hop farm size was 143.5 acres.

Table A.5: **Hops Overview, Marion County (OAIN)**

Hops Production in Marion County (2008 – 2011)							
Year	**Harvest (acres)**	**Yield (lbs/acre)**	**Production (000 lbs)**	**Price ($/lb)**	**Value Sales (000)**	**Harvest (acres)**	**Percentage of WV Harvest (acres)**
2008	5,500	1,580.0	8,690	$ 3.80	$ 33,022	5,900	93.22%
2009	5,600	1,700.0	9,520	$ 2.75	$ 26,180	6,000	93.33%
2010	4,600	1,800.0	8,280	$ 3.75	$ 31,050	4,860	94.65%

Table A.6: **Hops Overview, Willamette Valley (OAIN)**

Hops Production in Willamette Valley (2007 - 2011)						
Year	**Harvest (acres)**	**Yield (lbs/acre)**	**Production (000 lbs)**	**Price ($/lb)**	**Value Sales (000)**	**% of Total County**
2007	5,200	1,800.0	9,360	$ 3.12	$ 29,203	2.92%
2008	5,900	1,570.0	9,290	$ 3.80	$ 35,302	3.31%
2009	6,000	1,690.0	10,140	$ 2.81	$ 28,505	3.35%
2010	4,860	1,780.0	8,670	$ 3.75	$ 32,512	2.72%
2011	4,200	1,900.0	7,980	$ 2.93	$ 23,391	2.29%
Average	5,232	1,748.0	9,088	$ 3.28	$ 29,782.60	2.92%

Perennial Ryegrass

The two major grass varieties grown within Marion include Fescue and Ryegrass. According the 2007 Census of Agriculture, approximately one-third of grass and field crops were irrigated. For fescue, there are 171 farms with 38,035 acres (69 farms with 8,205 acres irrigated) for a 222.43 acre mean total. For ryegrass, there are 237 farms with 56,039 acres (111 farms, 22,497 acres irrigated) for a 236.45 acre mean total.

Table A.7: **Perennial Ryegrass Overview, Marion County (OAIN)**

Perennial Ryegrass Production in Marion County (2007 - 2011)						
Year	**Harvest (acres)**	**Yield (lbs/acre)**	**Production (000 lbs)**	**Price ($/CWT)**	**Value Sales (000)**	**% of Total County**
2007	48,000	1,600	76,800	$ 66.00	$ 50,688	26.94%
2008	37,000	1,500	55,500	$ 76.00	$ 42,180	20.76%
2009	33,000	1,600	52,800	$ 51.00	$ 26,928	18.44%
2010	30,500	1,750	53,375	$ 50.00	$ 26,688	17.10%
2011	34,000	1,750	59,500	$ 62.00	$ 36,890	18.56%
Average	36,500	1,640	59,595	$ 61.00	$ 36,674.80	20.36%

Table A.8: **Tall Fescue Overview, Marion County (OAIN)**

Tall Fescue Production in Marion County (2007 – 2011)						
Year	**Harvest (acres)**	**Yield (lbs/acre)**	**Production (000 lbs)**	**Price ($/CWT)**	**Value Sales (000)**	**% of Total County**
2007	18,000	1,700	30,600	$ 75.00	$ 22,950	10.10%
2008	18,000	1,600	28,800	$ 67.00	$ 19,296	10.10%
2009	16,000	1,800	28,800	$ 35.00	$ 10,080	8.94%
2010	10,800	1,850	19,980	$ 31.00	$ 6,194	6.05%
2011	11,100	1,850	20,535	$ 48.80	$ 10,021	6.06%
Average	14,780	1,760	25,743	$ 51.36	$13,708.20	8.25%

Snap/Bush Beans (Processed)

The historical OAIN dataset has not published consistent snap bean data for Marion County over the past five years. Of the past five years, only two years worth of County level snap bean data have been published for Marion. However, with two additional years of data from 2000 and 2001, we can see that snap bean production hasn't significantly changed. These numbers are reasonable to use instead of assuming that Marion bean production is equal to that of the Willamette Valley. In 2009 and in 2011, Marion bean production averaged approximately 74% and 66% of total production within Willamette Valley, respectively. Here, data from both are provided but only Marion County is used in the analysis

Processed vegetables included are sweet corn and snap/bush beans. Conventional production practices are assumed for both and costs and returns are on a per-acre basis. The mean processed snap/bush bean farm size was 128.1 acres and thee mean processed sweet corn farm size was 106.8 acres.

Table A.9: **Snap Bean Overview, Marion County (OAIN)**

Snap Bean Production in Marion County (2000-2001, 2009, 2011)						
Year	**Harvest (acres)**	**Yield (tons/acre)**	**Production (tons)**	**Price ($/ton)**	**Value Prod. (000)**	**% of Total County**
2000	13,300	6.3	83,840	$ 185.88	$ 15,584	-
2001	12,140	6.2	75,238	$ 185.97	$ 13,992	-
2009	12,715	6.2	79,224	$ 215.91	$ 17,105	7.11%
2011	11,240	7.1	80,284	$ 198.03	$ 15,899	6.13%
2-Year Average	11,978	6.7	79,754	$ 206.97	$ 16,502	6.62%

The years 2000 and 2001 are not included in the calculation of averages.

Table A.10: **Snap Bean Overview, Willamette Valley (OAIN)**

Snap Bean Production in Willamette Valley (2007 - 2011)					
Year	**Harvest (acres)**	**Yield (tons/acre)**	**Production (tons)**	**Price ($/ton)**	**Value Sales (000)**
2007	18,815	6.4	120,493	$ 199.31	$ 24,015
2008	16,900	6.2	104,076	$ 235.72	$ 24,533
2009	17,820	6.1	108,553	$ 216.12	$ 23,461
2010	16,755	6.7	112,185	$ 178.31	$ 20,004
2011	16,425	6.9	113,186	$ 202.61	$ 22,933
Average	17,343	6.5	111,699	$ 206.41	$ 22,989.20

Sweet Corn (Processed)

No processed sweet corn data were published at the county level, solely statewide. However, the majority of this crop is grown within the Willamette Valley. Although we have no data to suggest the percentage contribution of Marion sweet corn to the total Willamette Valley production, using Willamette Valley sweet corn data is the best county level proxy available.

Table A.11: **Sweet Corn Overview, Willamette Valley (OAIN)**

Sweet Corn Production in Willamette Valley (2007 - 2011)						
Year	**Harvest (acres)**	**Yield (tons/acre)**	**Production (tons)**	**Price ($/ton)**	**Value Sales (000)**	**% of Total County**
2007	13,500	10.1	136,147	$ 93.04	$ 12,667	7.58%
2008	12,090	10.1	122,060	$ 120.02	$ 14,650	6.78%
2009	16,240	9.9	161,376	$ 116.91	$ 18,866	9.08%
2010	13,150	10.3	136,042	$ 86.68	$ 11,792	7.37%
2011	14,420	10.0	143,624	$ 120.78	$ 17,347	7.87%
Average	13,880	10.1	139,850	$ 107.49	$ 15,064	7.74%

Wheat

The wheat enterprise information is based on spring wheat grown on 3000 dryland acres utilizing minimum tillage practices. In 2007, for grain-producing wheat farms, the mean farm size was 54.2 acres.

Table A.12: **Wheat Overview, Marion County (OAIN)**

Wheat Production in Marion County (2007 - 2011)						
Year	**Harvest (acres)**	**Yield (BU/acre)**	**Production (BU)**	**Price ($/BU)**	**Value Sales (000)**	**% of Total County**
2007	1,000	95	95,000	$ 6.00	$ 570	0.56%
2008	13,000	90	1,170,000	$ 6.90	$ 8,073	7.29%
2009	15,000	110	1,650,000	$ 5.20	$ 8,580	8.38%
2010	26,000	110	2,860,000	$ 5.60	$ 16,016	14.58%
2011	29,000	115	3,335,000	$ 6.25	$ 20,844	15.83%
Average	16,800	104	1,822,000	$ 5.99	$ 10,816.60	9.33%

For the following crops included in this analysis, the best data available were sparse. For fresh market vegetables, nursery and greenhouse crops, only the number of acres harvested and the value of both production and sales were available through the OAIN database. Due to categorical diversity and aggregation, no price or yield data were available.

Fresh Market Vegetables

Fresh vegetables include farms growing spinach and leaf lettuce greens in annual rotations, as well as farms with either leaf lettuce and radishes or spinach and radish rotations. For all of these vegetables, conventional production practices are assumed. There are 2 spinach farms and 6 leaf lettuce farms (no total acres) and 7 radish farms representing a total of 70 acres.

Table A.13: **Fresh Market Vegetable Overview, Marion County (OAIN)**

Fresh Market Vegetables in Marion County (2006 - 2008)			
Year	**Harvest (acres)**	**Value Prod. (000)**	**Value Sales (000)**
2006	25,252	$ 32,981	$ 32,981
2007	23,460	$ 34,886	$ 34,886
2008	23,027	$ 39,734	$ 39,734
Average	23,913	$ 35,867	$ 35,867

Nursery Crops

Nurseries grow a diverse variety of floricultural crops. Potted flowering plants including poinsettias and geraniums, as well as petunia and marigold flats are assumed to represent the general nursery producing floriculture crops. The mean square footage farm size is 85,200 acres under glass or other protection.

Table A.14: **Nursery Crop Overview, Marion County (OAIN)**

Nursery Crops in Marion County (2007 - 2011)		
Year	**Value Prod. (000)**	**Value Sales (000)**
2007	$ 143,944	$ 143,944
2008	$ 115,155	$ 115,155
2009	$ 111,240	$ 111,240
2010	$ 133,861	$ 133,861
2011	$ 134,700	$ 134,700
Average	$ 127,780	$ 127,780

Greenhouse Crops

Table A.15: **Greenhouse Crop Overview, Marion County (OAIN)**

Greenhouse Crops in Marion County (2007 - 2011)		
Year	**Value Prod. (000)**	**Value Sales (000)**
2007	$ 39,478	$ 39,478
2008	$ 31,582	$ 31,582
2009	$ 33,824	$ 33,824
2010	$ 40,139	$ 40,139
2011	$ 40,790	$ 40,790
Average	$ 37,163	$ 37,163

B. Enterprise Budgets

Alfalfa Hay

Alfalfa Production (Marion County)

Budget Unit acre

Returns

Name	Unit	$/Unit	Quantity	Value
Alfalfa Hay	ton	$186.00	5.3	$985.80

Packing Processing and Value Added Costs

Name	Unit	$/Unit	Quantity	Value
Interest on Operating Capital		$0.00	0.03	$0.00

Harvest Costs

Name	Unit	$/Unit	Quantity	Value
Swather (Self-propelled windrower)(3x)	acre	$11.19	1	$11.19
Swather (Self-propelled windrower)(3x) (Labor)	hours	$24.00	0.44	$10.62
Self-Propelled Bale Wagon (3x)	acre	$34.38	1	$34.38
Self-Propelled Bale Wagon (3x) (Labor)	hours	$24.00	0.74	$17.67
Interest on Operating Capital		$73.86	0.03	$2.36

Non-Harvest Costs

Name	Unit	$/Unit	Quantity	Value
-- CHEMICALS --		$0.00	0	$0.00
Fertilizer (Alfalfa Hay)	acre	$18.91	1	$18.91
Chemical Pest Control (Alfalfa Hay)	acre	$49.14	1	$49.14
-- OTHER COSTS --		$0.00	0	$0.00
Alfalfa Irrigation Repairs	acre	$6.60	1	$6.60
General Overhead (Alfalfa Hay)	acre	$19.79	1	$19.79
Land Lease	acre	$131.95	1	$131.95
Hay Shed - Repairs & Maintenance (Alfal)	acre	$3.71	1	$3.71
-- MACHINERY --		$0.00	0	$0.00
Tractor #1 (Implement: Gopher Machine)	acre	$9.57	1	$9.57
Tractor #1 (Implement: Gopher Machine) (Labor)	hours	$36.30	0.32	$11.52
Tractor #2 (Implement: Spring Tooth Harrow)	acre	$0.86	1	$0.86
Tractor #2 (Implement: Spring Tooth Harrow) (Labor)	hours	$36.30	0.0868	$3.15
Tractor #2 (Implement: Side Delivery Rake)(3x)	acre	$3.03	1	$3.03
Tractor #2 (Implement: Side Delivery Rake)(3x) (Labor)	hours	$36.30	0.26	$9.36
Tractor #2 (Implement: Baler)(3x)	acre	$10.95	1	$10.95
Tractor #2 (Implement: Baler)(3x) (Labor)	hours	$36.30	0.52	$18.72
ATV	acre	$0.32	1	$0.32

ATV (Labor)	hours	$22.00	0.05	$1.10
Pickup	acre	$20.87	1	$20.87
Pickup (Labor)	hours	$24.00	0.68	$16.40
Property taxes (Alfalfa)	acre	$20.00	1	$20.00
Property Insurance (Alfalfa)	acre	$30.00	1	$30.00
Interest on Operating Capital		$385.95	0.03	$12.35

Capital Investment

Name	Unit	$/Unit	Quantity	Value
Swather (Self-propelled windrower)(3x)	acre	$16.74	1	$16.74
Tractor #1 (Implement: Gopher Machine)	acre	$3.87	1	$3.87
Tractor #2 (Implement: Spring Tooth Harrow)	acre	$1.23	1	$1.23
Tractor #2 (Implement: Side Delivery Rake)(3x)	acre	$3.54	1	$3.54
Tractor #2 (Implement: Baler)(3x)	acre	$17.01	1	$17.01
Self-Propelled Bale Wagon (3x)	acre	$42.69	1	$42.69
ATV	acre	$0.08	1	$0.08
Pickup	acre	$7.79	1	$7.79
-- OTHER --		$0.00	0	$0.00
Amortized Establishment Costs	acre	$62.68	1	$62.68
Irrigation Depreciation and Interest	acre	$35.00	1	$35.00
Total Annual Costs				**$665.15**
Returns minus Total Annual Costs				**$320.65**

Eleveld, Bart, Rodney Todd, and William Riggs. 1998. *Alfalfa Establishment, Klamath Basin Area*. Klamath Basin Area: Oregon State University Extension Service. http://arec.oregonstate.edu/oaeb/files/pdf/EM8431.pdf.

Orloff, Steve, Karen Klonsky, and Kabir Tumber. 2012. *Sample Costs to Establish and Produce Alfalfa Hay: Intermountain - Siskiyou County*. UC Cooperative Extension. http://coststudies.ucdavis.edu/files/2012/Alfalfa_IM_Scott2012.pdf.

Painter, Kathleen. 2009. *Organic Alfalfa Management Guide*. Washington State University Extension. http://www.webpages.uidaho.edu/~kpainter/OrgAlf/EB2039E.pdf.

Silberstein, Tom, Bart Eleveld, Bill Young, and Emily Lahmann. 2010. *Tall Fescue Seed, Establishment and Production, North Willamette Valley Region*. Oregon State University Extension Service. http://arec.oregonstate.edu/oaeb/files/pdf/AEB0010.pdf.

Notes: Assets developed using AgProfit. Budget built using Klamath Basin, altered using more up-to-date costs on machinery and equipment. All intermediate assets (equipment) valued at $398,400.

Blueberry, Machine Harvest

Blueberries Full Production Machine Harvest

Budget Unit	acre

Returns

Name	Unit	$/Unit	Quantity	Value
Blueberries Processed Market	pound	$1.15	16000	$18,400.00

Packing Processing and Value Added Costs

Name	Unit	$/Unit	Quantity	Value
Commission Fees (Bl)	pound	$0.04	16000	$640.00
Interest on Operating Capital		$640.00	0	$0.00

Harvest Costs

Name	Unit	$/Unit	Quantity	Value
Machine Harvest Rental (Bl)	pound	$0.12	16000	$1,920.00
Labor - Load & Shipping (Bl)	pound	$0.03	16000	$480.00
Interest on Operating Capital		$2,400.00	0.04	$96.00

Non-Harvest Costs

Name	Unit	$/Unit	Quantity	Value
Prune & Rake (Bl)	hour	$13.50	25	$337.50
4 wd Tractor & Fungicide(6x) Insecticide(1x) Appl.	acre	$75.90	1	$75.90
4 wd Tractor & Fungicide(6x) Insecticide(1x) Appl. (Labor)	hours	$22.00	3.3	$72.60
Fungicides (Bl)	appl/acre	$10.00	5	$50.00
Insecticides (Bl)	appl/acre	$10.00	1	$10.00
4 wd Tractor & Fertilizer Application - Sidedress (3x)	acre	$28.86	1	$28.86
4 wd Tractor & Fertilizer Application - Sidedress (3x) (Labor)	hours	$22.00	1.77	$38.88
Fertilizer (Bl)	appl/acre	$50.00	3	$150.00
Bee Hives (Bl)	hive	$50.00	3	$150.00
4 wd Tractor & Flail Mower (10x)	acre	$86.00	1	$86.00
4 wd Tractor & Flail Mower (10x) (Labor)	hours	$22.00	4.85	$106.80
4 wd Tractor & Herbicide Application (1x)	acre	$4.09	1	$4.09
4 wd Tractor & Herbicide Application (1x) (Labor)	hours	$22.00	0.24	$5.34
Herbicides - Spot Spray (Bl)	acre	$12.00	2	$24.00
Herbicides (Bl)	acre	$15.00	1	$15.00
Sawdust Loader - Rental (Bl)	acre	$700.00	0.33	$231.00
Sawdust Mulch (Bl)	ton	$40.00	3.63	$145.20
Irrigation - Labor (Bl)	hour	$13.50	3	$40.50
Irrigation - Repair & Maintenance (Bl)	acre	$25.00	1	$25.00

Trellis - Labor (Bl)	hour	$13.50	2	$27.00
Trellis - Repairs & Maintenance (Bl)	acre	$17.00	1	$17.00
Tissue Analysis (Bl)	acre	$7.00	1	$7.00
Bird Control (Bl)	acre	$50.00	1	$50.00
4 wd Tractor & Wagon	acre	$32.50	1	$32.50
4 wd Tractor & Wagon (Labor)	hours	$36.30	2	$72.60
1/2 Ton Pickup	acre	$101.88	1	$101.88
ATV	acre	$56.00	1	$56.00
Property Insurance (ABC)	acre	$30.00	1	$30.00
Property taxes (ABC)	acre	$20.00	1	$20.00
Miscellaneous & Overhead (ABC)	acre	$200.00	1	$200.00
Interest on Operating Capital		$2,210.65	0.04	$88.43

Capital Investment

Name	Unit	$/Unit	Quantity	Value
4 wd Tractor & Fungicide(6x) Insecticide(1x) Appl.	acre	$32.34	1	$32.34
4 wd Tractor & Flail Mower (10x)	acre	$54.30	1	$54.30
4 wd Tractor & Fertilizer Application - Sidedress (3x)	acre	$20.94	1	$20.94
4 wd Tractor & Wagon	acre	$16.26	1	$16.26
1/2 Ton Pickup	acre	$15.56	1	$15.56
ATV	acre	$19.40	1	$19.40
4 wd Tractor & Herbicide Application (1x)	acre	$1.65	1	$1.65

Total Annual Costs	**$5,595.53**
Returns minus Total Annual Costs	**$12,804.47**

Eleveld, Bart, Bernadine Strik, Karen DeVries, and Wei Yang. 2005. *Blueberry Economics: The Costs of Establishing and Producing Blueberries in the Willamette Valley*. Oregon State University. http://arec.oregonstate.edu/oaeb/files/pdf/EM8526.pdf.

Broccoli, Processed

Broccoli Conventional Processed Market Oregon

Budget Unit acre

Returns

Name	Unit	$/Unit	Quantity	Value
Broccoli	ton	$500.00	5	$2,500.00

Packing Processing and Value Added Costs

Name	Unit	$/Unit	Quantity	Value
Interest on Operating Capital		$0.00	0	$0.00

Harvest Costs

Name	Unit	$/Unit	Quantity	Value
Hand Harvest (Br)	hour	$12.00	45	$540.00
Hauling (2 Trucks)	acre	$22.42	1	$22.42
Hauling (2 Trucks) (Labor)	hours	$20.00	1	$20.00
Forklift	acre	$21.86	1	$21.86
Forklift (Labor)	hours	$22.00	2	$44.00
2 wd Tractor#4 & Trailer	acre	$37.44	1	$37.44
2 wd Tractor#4 & Trailer (Labor)	hours	$22.00	2	$44.00
4 wd Tractor#3 & 36' Conveyor	acre	$51.42	1	$51.42
4 wd Tractor#3 & 36' Conveyor (Labor)	hours	$22.00	2	$44.00
Interest on Operating Capital		$825.14	0.03	$26.40

Non-Harvest Costs

Name	Unit	$/Unit	Quantity	Value
Soil test (AVC)	acre	$2.00	1	$2.00
Lime application (AVC)	acre	$75.00	1	$75.00
4 wd Tractor#1 & Tandem Disk (2x)	acre	$11.06	1	$11.06
4 wd Tractor#1 & Tandem Disk (2x) (Labor)	hours	$22.00	0.21	$4.52
4 wd Tractor#1 & Moldboard Plow (1x)	acre	$6.81	1	$6.81
4 wd Tractor#1 & Moldboard Plow (1x) (Labor)	hours	$22.00	0.13	$2.85
4 wd Tractor#2 & Harrow/Roller Packer (1x)	acre	$4.23	1	$4.23
4 wd Tractor#2 & Harrow/Roller Packer (1x) (Labor)	hours	$22.00	0.0923	$2.03
Pre-plant Fertilizer (Br)	acre	$65.00	1	$65.00
4 wd Tractor#2 & Field Cultivator (2x)	acre	$4.10	1	$4.10
4 wd Tractor#2 & Field Cultivator (2x) (Labor)	hours	$22.00	0.1	$2.26
4 wd Tractor#2 & Rotovator (1x)	acre	$11.96	1	$11.96
4 wd Tractor#2 & Rotovator (1x) (Labor)	hours	$22.00	0.23	$5.08
Herbicides (Br)	acre	$20.00	1	$20.00

2 wd Tractor#4 & Broccoli Planter (1x)	acre	$7.21	1	$7.21
2 wd Tractor#4 & Broccoli Planter (1x) (Labor)	hours	$22.00	0.18	$3.91
Seed (Br)	acre	$150.00	1	$150.00
Insecticides (Br)	acre	$20.00	1	$20.00
Side Dress Fertilizer (Br)	acre	$70.00	1	$70.00
4 wd Tractor#2 & Row Cultivator (1x)	acre	$2.05	1	$2.05
4 wd Tractor#2 & Row Cultivator (1x) (Labor)	hours	$22.00	0.0514	$1.13
Hand Weeding Labor (AVC)	hour	$12.00	14	$168.00
4 wd Tractor#3 & Fertilizer Spreader (1x)	acre	$1.09	1	$1.09
4 wd Tractor#3 & Fertilizer Spreader (1x) (Labor)	hours	$22.00	0.0423	$0.93
Top Dress Fertilizer (Br)	acre	$65.00	1	$65.00
Self-Propelled Boom Sprayer (2x)	acre	$5.72	1	$5.72
Self-Propelled Boom Sprayer (2x) (Labor)	hours	$22.00	0.1	$2.30
Insecticides by Boom Sprayer (Br)	acre	$40.00	1	$40.00
4 wd Tractor#2 & Flail Chop (1x)	acre	$4.58	1	$4.58
4 wd Tractor#2 & Flail Chop (1x) (Labor)	hours	$22.00	0.0982	$2.16
Irrigation Labor (AVC)	hour	$12.00	5	$60.00
Irrigation Pumping Costs (AVC)	acre/inch	$3.50	10	$35.00
Irrigation Repairs & Maintenance (AVC)	acre	$25.00	1	$25.00
Pickup	acre	$52.00	1	$52.00
ATV (4-Wheeler)	acre	$5.56	1	$5.56
Property Insurance (AVC)	acre	$35.00	1	$35.00
Property taxes (AVC)	acre	$20.00	1	$20.00
Miscellaneous & Overhead (AVC)	acre	$75.00	1	$75.00
Interest on Operating Capital		$1,068.54	0.03	$34.19

Capital Investment

Name	Unit	$/Unit	Quantity	Value
4 wd Tractor#1 & Tandem Disk (2x)	acre	$3.14	1	$3.14
4 wd Tractor#1 & Moldboard Plow (1x)	acre	$2.30	1	$2.30
Self-Propelled Boom Sprayer (2x)	acre	$5.74	1	$5.74
4 wd Tractor#2 & Rotovator (1x)	acre	$1.77	1	$1.77
4 wd Tractor#2 & Flail Chop (1x)	acre	$0.84	1	$0.84
4 wd Tractor#2 & Field Cultivator (2x)	acre	$0.48	1	$0.48
4 wd Tractor#2 & Row Cultivator (1x)	acre	$0.24	1	$0.24
4 wd Tractor#2 & Harrow/Roller Packer (1x)	acre	$1.08	1	$1.08
4 wd Tractor#3 & Fertilizer Spreader (1x)	acre	$0.41	1	$0.41
2 wd Tractor#4 & Broccoli Planter (1x)	acre	$1.44	1	$1.44
Hauling (2 Trucks)	acre	$24.88	1	$24.88
Pickup	acre	$21.16	1	$21.16
ATV (4-Wheeler)	acre	$4.23	1	$4.23
4 wd Tractor#3 & 36' Conveyor	acre	$31.84	1	$31.84

2 wd Tractor#4 & Trailer	acre	$8.16	1	$8.16
Forklift	acre	$12.88	1	$12.88
Total Annual Costs				**$2,074.87**
Returns minus Total Annual Costs				**$425.13**

Julian, Jim, Clark Seavert, Dan McGrath, Robert McReynolds, and Ed Peachey. 2010. *Broccoli, Processed Market, Willamette Valley Region*. Oregon State University Extension Service. http://arec.oregonstate.edu/oaeb/files/pdf/AEB0003.pdf.

Cauliflower

Cauliflower Conventional Processed Market Oregon

Budget Unit	acre			

Returns

Name	Unit	$/Unit	Quantity	Value
Cauliflower	ton	$350.00	6	$2,100.00

Packing Processing and Value Added Costs

Name	Unit	$/Unit	Quantity	Value
Interest on Operating Capital		$0.00	0	$0.00

Harvest Costs

Name	Unit	$/Unit	Quantity	Value
Hand Harvesting (Ca)	hour	$12.00	36	$432.00
Hauling (2 Trucks)	acre	$22.42	1	$22.42
Hauling (2 Trucks) (Labor)	hours	$22.00	1	$22.00
2 wd Tractor#4 & Trailer	acre	$56.16	1	$56.16
2 wd Tractor#4 & Trailer (Labor)	hours	$22.00	3	$66.00
4 wd Tractor#3 & 36' Conveyor	acre	$49.90	1	$49.90
4 wd Tractor#3 & 36' Conveyor (Labor)	hours	$22.00	2	$44.00
Interest on Operating Capital		$692.48	0.03	$22.16

Non-Harvest Costs

Name	Unit	$/Unit	Quantity	Value
Soil test (AVC)	acre	$2.00	1	$2.00
Lime application (AVC)	acre	$75.00	1	$75.00
4 wd Tractor#1 & Tandem Disk (2x)	acre	$11.06	1	$11.06
4 wd Tractor#1 & Tandem Disk (2x) (Labor)	hours	$22.00	0.21	$4.52
4 wd Tractor #1 & Moldboard Plow (1x)	acre	$6.81	1	$6.81
4 wd Tractor #1 & Moldboard Plow (1x) (Labor)	hours	$22.00	0.13	$2.85
4 wd Tractor#2 & Harrow/Roller Packer (1x)	acre	$4.23	1	$4.23
4 wd Tractor#2 & Harrow/Roller Packer (1x) (Labor)	hours	$22.00	0.0923	$2.03
Pre-plant Fertilizer (Ca)	acre	$65.00	1	$65.00
4 wd Tractor#2 & Field Cultivator (1x)	acre	$2.05	1	$2.05
4 wd Tractor#2 & Field Cultivator (1x) (Labor)	hours	$22.00	0.0514	$1.13
4 wd Tractor#2 & Rotovator (1x)	acre	$11.96	1	$11.96
4 wd Tractor#2 & Rotovator (1x) (Labor)	hours	$22.00	0.23	$5.08
Herbicide (Ca)	acre	$20.00	1	$20.00
Custom Transplanting (Ca)	acre	$150.00	1	$150.00
Cauliflower Transplants (Ca)	acre	$250.00	1	$250.00

4 wd Tractor#2 & Row Cultivator (2x)	acre	$4.10	1	$4.10
4 wd Tractor#2 & Row Cultivator (2x) (Labor)	hours	$22.00	0.1	$2.26
4 wd Tractor#3 & Fertilizer Spreader (2x)	acre	$2.18	1	$2.18
4 wd Tractor#3 & Fertilizer Spreader (2x) (Labor)	hours	$22.00	0.0845	$1.86
Top Dress Fertilizer (Ca)	acre	$65.00	1	$65.00
Self-propelled Boom Sprayer (1x)	acre	$2.79	1	$2.79
Self-propelled Boom Sprayer (1x) (Labor)	hours	$22.00	0.0523	$1.15
Insecticides (Ca)	acre	$20.00	1	$20.00
Irrigation Labor (AVC)	hour	$12.00	5	$60.00
Irrigation Pumping Costs (AVC)	acre/inch	$3.50	12	$42.00
Irrigation Repairs & Maintenance (AVC)	acre	$25.00	1	$25.00
Pickup	acre	$52.00	1	$52.00
ATV	acre	$5.73	1	$5.73
Property taxes (AVC)	acre	$20.00	1	$20.00
Property Insurance (AVC)	acre	$35.00	1	$35.00
Interest on Operating Capital		$952.79	0.03	$30.49

Capital Investment

Name	Unit	$/Unit	Quantity	Value
4 wd Tractor#1 & Tandem Disk (2x)	acre	$3.14	1	$3.14
4 wd Tractor #1 & Moldboard Plow (1x)	acre	$2.30	1	$2.30
4 wd Tractor#2 & Rotovator (1x)	acre	$1.77	1	$1.77
4 wd Tractor#2 & Field Cultivator (1x)	acre	$0.24	1	$0.24
4 wd Tractor#2 & Row Cultivator (2x)	acre	$0.48	1	$0.48
4 wd Tractor#2 & Harrow/Roller Packer (1x)	acre	$1.08	1	$1.08
4 wd Tractor#3 & Fertilizer Spreader (2x)	acre	$0.82	1	$0.82
Hauling (2 Trucks)	acre	$25.48	1	$25.48
Pickup	acre	$15.56	1	$15.56
ATV	acre	$0.85	1	$0.85
Self-propelled Boom Sprayer (1x)	acre	$2.87	1	$2.87
2 wd Tractor#4 & Trailer	acre	$12.24	1	$12.24
4 wd Tractor#3 & 36' Conveyor	acre	$44.08	1	$44.08

Total Annual Costs	**$1,808.83**
Returns minus Total Annual Costs	**$291.17**

Julian, Jim, Clark Seavert, Dan McGrath, Robert McReynolds, and Ed Peachey. 2010. *Cauliflower, Processed Market, Willamette Valley Region*. Oregon State University Extension Service. http://arec.oregonstate.edu/oaeb/files/pdf/AEB0005.pdf.

Hazelnuts

Hazelnuts Full Production Years

Budget Unit acre

Returns

Name	Unit	$/Unit	Quantity	Value
Hazelnuts	pound	$0.70	2800	$1,960.00

Packing Processing and Value Added Costs

Name	Unit	$/Unit	Quantity	Value
Wash & Dry Nuts (Hz)	pound	$0.05	2800	$128.80
Interest on Operating Capital		$128.80	0	$0.00

Harvest Costs

Name	Unit	$/Unit	Quantity	Value
Self-propelled nut sweeper (1x)	acre	$8.66	1	$8.66
Self-propelled nut sweeper (1x) (Labor)	hours	$22.00	0.63	$13.92
4-wheel drive tractor & nut harvester (1x)	acre	$8.58	1	$8.58
4-wheel drive tractor & nut harvester (1x) (Labor)	hours	$22.00	0.47	$10.37
2-wheel drive tractor & front-end loader to loading totes	acre	$9.22	1	$9.22
2-wheel drive tractor & front-end loader to loading totes (Labor)	hours	$22.00	1	$22.00
Interest on Operating Capital		$72.75	0.02	$1.55

Non-Harvest Costs

Name	Unit	$/Unit	Quantity	Value
Self-propelled power lift to production prune	acre	$16.47	1	$16.47
Self-propelled power lift to production prune (Labor)	hours	$22.00	1.2	$26.40
Maintenance pruning (Hz)	hour	$14.00	1.5	$21.00
2-wheel drive tractor & brush rake (1x)	acre	$2.27	1	$2.27
2-wheel drive tractor & brush rake (1x) (Labor)	hours	$22.00	0.24	$5.34
2-wheel drive tractor & fertilizer spreader (2x)	acre	$1.18	1	$1.18
2-wheel drive tractor & fertilizer spreader (2x) (Labor)	hours	$22.00	0.12	$2.66
Fertilizer - Urea (Hz)	acre	$51.79	1	$51.79
Fertilzer - Potash (Hz)	acre	$19.66	1	$19.66
Lime (Custom) (Hz)	acre	$121.00	0.2	$24.20
4-wheel drive tractor & blast sprayer (3.25x)	acre	$16.15	1	$16.15
4-wheel drive tractor & blast sprayer (3.25x) (Labor)	hours	$22.00	0.74	$16.38
Boron Spray Materials (Hz)	acre	$4.80	1	$4.80
Filbert Worm Spray Materials (Hz)	acre	$13.65	1	$13.65
Aphid/Leafroller Spray Materials (Hz)	acre	$16.64	1	$16.64
IPM Scout Labor (Hz)	hour	$14.00	1	$14.00

IPM Scout Materials (Hz)	acre	$2.57	1	$2.57
Nutrient Analysis (Hz)	acre	$0.58	1	$0.58
2-wheel drive tractor & weed sprayer (4x)	acre	$7.08	1	$7.08
2-wheel drive tractor & weed sprayer (4x) (Labor)	hours	$22.00	0.73	$16.12
Herbicide Strip Sprays (Hz)	acre	$5.10	1	$5.10
Sucker Control Material (Hz)	acre	$9.50	1	$9.50
4-wheel drive tractor & flail mower (3x)	acre	$10.71	1	$10.71
4-wheel drive tractor & flail mower (3x) (Labor)	hours	$22.00	0.73	$16.02
Rodent Control Labor (Hz)	hour	$14.00	1	$14.00
Rodent Control Materials (Hz)	acre	$7.00	1	$7.00
4-wheel drive tractor & level blade (1x)	acre	$2.25	1	$2.25
4-wheel drive tractor & level blade (1x) (Labor)	hours	$22.00	0.16	$3.56
Pickup - 1/2 ton 4x4	acre	$52.00	1	$52.00
Shop	acre	$6.92	1	$6.92
Property Insurance (ANC)	acre	$35.00	1	$35.00
Property Taxes (ANC)	acre	$20.00	1	$20.00
Miscellaneous & Overhead Charge	percent	$447.39	0.08	$35.79
Interest on Operating Capital		$496.79	0.02	$10.56

Capital Investment

Name	Unit	$/Unit	Quantity	Value
Self-propelled nut sweeper (1x)	acre	$12.16	1	$12.16
4-wheel drive tractor & nut harvester (1x)	acre	$20.59	1	$20.59
2-wheel drive tractor & front-end loader to loading totes	acre	$4.38	1	$4.38
Self-propelled power lift to production prune	acre	$18.64	1	$18.64
2-wheel drive tractor & brush rake (1x)	acre	$1.49	1	$1.49
2-wheel drive tractor & fertilizer spreader (2x)	acre	$2.36	1	$2.36
4-wheel drive tractor & blast sprayer (3.25x)	acre	$16.87	1	$16.87
2-wheel drive tractor & weed sprayer (4x)	acre	$3.68	1	$3.68
4-wheel drive tractor & flail mower (3x)	acre	$10.56	1	$10.56
4-wheel drive tractor & level blade (1x)	acre	$1.98	1	$1.98
Pickup - 1/2 ton 4x4	acre	$15.56	1	$15.56

Total Annual Costs	**$818.71**
Returns minus Total Annual Costs	**$1,141.29**

Julian, James, Clark Seavert, and Jeff Olsen. 2008. *Orchard Economics: The Costs and Returns of Establishing and Producing Hazelnuts in the Willamette Valley*. Oregon State University Extension Service. http://arec.oregonstate.edu/oaeb/files/pdf/EM8748-E.pdf.

Notes: Acres harvested averaged to 6,000 acres annually with per-acre yields 1,090 lbs at a price of $0.92/lb. For the representative hazelnut farm, yields were cumulatively increased 10%. Due to the fact that full production yields can produce upwards of 2,800 pounds per-acre, this assumption seems reasonable. Additionally, this conservative estimate should help account for renewal and expansion rates.

Hops

Hops Standard Trellis Drip Irrigation Mature

Budget Unit	acre

Returns

Name	Unit	$/Unit	Quantity	Value
Hops	pound	$2.50	2600	$6,500.00

Packing Processing and Value Added Costs

Name	Unit	$/Unit	Quantity	Value
Interest on Operating Capital		$0.00	0	$0.00

Harvest Costs

Name	Unit	$/Unit	Quantity	Value
Packaging (Hops)	bale	$5.50	13	$71.50
Kiln Fuel (Hops)	bale	$14.00	13	$182.00
Hop Dryer & Baler (Hops)	bale	$10.00	13	$130.00
Interest on Operating Capital		$383.50	0.02	$8.15

Non-Harvest Costs

Name	Unit	$/Unit	Quantity	Value
Seasonal Labor (Hops)	hour	$10.00	150	$1,500.00
Fertilizer & Leaf Feed (Hops FP)	acre	$250.00	1	$250.00
Chemicals (Hops FP)	acre	$450.00	1	$450.00
Parts & Repairs (Hops)	acre	$310.00	1	$310.00
Fuel & Oil (Hops)	acre	$200.00	1	$200.00
Trellis Repair (Hops)	acre	$40.00	1	$40.00
Irrigation Repairs (Hops)	acre	$50.00	1	$50.00
Facility Repairs (Hops)	acre	$50.00	1	$50.00
Supplies (Hops)	acre	$150.00	1	$150.00
Utilities (Hops)	acre	$90.00	1	$90.00
Consulting & Custom Hire (Hops)	acre	$20.00	1	$20.00
Insurance all farm (Hops)	acre	$190.00	1	$190.00
Land & Property Taxes (Hops)	acre	$82.50	1	$82.50
Interest on Operating Capital		$3,382.50	0.02	$71.88

Capital Investment

Name	Unit	$/Unit	Quantity	Value
Equipment & Building Replacement (Hops)	acre	$500.00	1	$500.00

Total Annual Costs	**$4,346.03**

Returns minus Total Annual Costs	**$2,153.97**

Galinato, Suzette, Ann George, and Herbert Hinman. 2011. *2010 Estimated Cost of Producing Hops in the Yakima Valley, Washington*. Washington State University Extension Service. http://cru.cahe.wsu.edu/CEPublications/FS028E/FS028E.pdf.

Leaf Lettuce and Radish, Conventional

Leaf Lettuce and Radishes Conventional Fresh Market Oregon

Budget Unit	acre

Returns

Name	Unit	$/Unit	Quantity	Value
Leaf Lettuce	carton	$8.00	900	$7,200.00
Radishes	carton	$9.00	700	$6,300.00

Packing Processing and Value Added Costs

Name	Unit	$/Unit	Quantity	Value
-- LEAF LETTUCE --		$0.00	0	$0.00
Boxes (AVC)	carton	$1.30	900	$1,170.00
-- RADISHES --		$0.00	0	$0.00
Packing Labor (AVC)	carton	$1.00	700	$700.00
Boxes paper & Ice (AVC)	carton	$1.60	700	$1,120.00
Packing Shed & Equipment (AVC)	carton	$0.15	700	$105.00
-- COMMON COSTS --		$0.00	0	$0.00
Hydo-cooling (AVC)	carton	$0.10	1600	$160.00
Refrigeration (AVC)	carton	$0.10	1600	$160.00
Delivery to Market (AVC)	carton	$0.08	1600	$128.00
Interest on Operating Capital		$3,543.00	0.02	$70.86

Harvest Costs

Name	Unit	$/Unit	Quantity	Value
-- LEAF LETTUCE --		$0.00	0	$0.00
Harvest Labor (Ll)	carton	$1.30	900	$1,170.00
-- RADISHES --		$0.00	0	$0.00
Harvest Labor (Ra)	carton	$1.50	700	$1,050.00
Field Crates 20/acre (AVC)	times/acre	$13.00	0.5	$6.50
-- COMMON OPERATION --		$0.00	0	$0.00
4 wd Tractor & Trailer (2x)	acre	$136.12	1	$136.12
4 wd Tractor & Trailer (2x) (Labor)	hours	$14.30	13	$185.90
Interest on Operating Capital		$2,548.52	0.02	$50.97

Non-Harvest Costs

Name	Unit	$/Unit	Quantity	Value
-- COMMON OPERATIONS --		$0.00	0	$0.00
Lime Application (AVC)	acre	$300.00	0.5	$150.00

4 wd Tractor & Deep Chisel (1x)	acre	$10.04	1	$10.04
4 wd Tractor & Deep Chisel (1x) (Labor)	hours	$14.30	0.61	$8.67
4 wd Tractor & Moldboard Plow (2x)	acre	$29.22	1	$29.22
4 wd Tractor & Moldboard Plow (2x) (Labor)	hours	$14.30	1.62	$23.14
4 wd Tractor & Disk (2x)	acre	$9.68	1	$9.68
4 wd Tractor & Disk (2x) (Labor)	hours	$14.30	0.57	$8.20
4 wd Tractor & Fertilize Spreader (2x)	acre	$3.46	1	$3.46
4 wd Tractor & Fertilize Spreader (2x) (Labor)	hours	$14.30	0.3	$4.22
4 wd Tractor & Rotary Tiller (2x)	acre	$35.22	1	$35.22
4 wd Tractor & Rotary Tiller (2x) (Labor)	hours	$13.00	1.62	$21.02
4 wd Tractor & Cultivator (1.5x)	acre	$7.78	1	$7.78
4 wd Tractor & Cultivator (1.5x) (Labor)	hours	$14.30	1.03	$14.74
2 wd Tractor & Sidedressing Fertilizer (1x)	acre	$5.82	1	$5.82
2 wd Tractor & Sidedressing Fertilizer (1x) (Labor)	hours	$13.00	1.15	$14.90
4 wd Tractor & Insecticide Sprayer (2x)	acre	$6.20	1	$6.20
4 wd Tractor & Insecticide Sprayer (2x) (Labor)	hours	$14.30	0.51	$7.26
4 wd Tractor & Weed Sprayer (4x)	acre	$12.72	1	$12.72
4 wd Tractor & Weed Sprayer (4x) (Labor)	hours	$13.00	1.02	$13.20
-- LEAF LETTUCE --		$0.00	0	$0.00
Fertilizer (Ll)	acre	$90.00	1	$90.00
4 wd Tractor & Transplanter (1x)	acre	$48.06	1	$48.06
4 wd Tractor & Transplanter (1x) (Labor)	hours	$14.30	2.12	$30.25
Planting Labor (Ll)	hour	$10.00	18	$180.00
Lettuce Transplants (Ll)	transplant	$0.03	28000	$840.00
Insecticides (Li)	acre	$100.00	1	$100.00
Herbicides (Ll)	acre	$72.00	1	$72.00
-- RADISHES --		$0.00	0	$0.00
Fertilizer (Ra)	acre	$45.00	1	$45.00
4 wd Tractor & Planter (1x)	acre	$12.06	1	$12.06
4 wd Tractor & Planter (1x) (Labor)	hours	$14.30	0.74	$10.53
Radish Seed (Ra)	acre	$800.00	1	$800.00
Insecticides (Ra)	acre	$75.00	1	$75.00
Herbicides (Ra)	acre	$72.00	1	$72.00
-- COMMON COSTS --		$0.00	0	$0.00
Irrigation Labor Handlines (AVC)	set	$7.50	6	$45.00
Irrigation Electricity (AVC)	set	$10.00	6	$60.00
Irrigation Pipe Rental (AVC)	acre	$110.00	1	$110.00
Pickup #1	acre	$82.67	1	$82.67
Pickup #2	acre	$44.33	1	$44.33
Truck	acre	$158.00	1	$158.00
ATV	acre	$11.20	1	$11.20
Property taxes (AVC)	acre	$20.00	1	$20.00

Property Insurance (AVC)	acre	$35.00	1	$35.00
Field Sanitation Equipment (AVC)	acre	$30.00	1	$30.00
Miscellaneous & Overhead (AVC)	acre	$75.00	1	$75.00
Interest on Operating Capital		$3,431.59	0.02	$68.63

Capital Investment

Name	Unit	$/Unit	Quantity	Value
-- COMMON OPERATIONS & COSTS --		$0.00	0	$0.00
4 wd Tractor & Deep Chisel (1x)	acre	$9.01	1	$9.01
4 wd Tractor & Moldboard Plow (2x)	acre	$15.32	1	$15.32
4 wd Tractor & Disk (2x)	acre	$6.14	1	$6.14
4 wd Tractor & Fertilize Spreader (2x)	acre	$1.58	1	$1.58
4 wd Tractor & Cultivator (1.5x)	acre	$2.48	1	$2.48
4 wd Tractor & Insecticide Sprayer (2x)	acre	$1.90	1	$1.90
4 wd Tractor & Trailer (2x)	acre	$15.10	1	$15.10
Pickup #1	acre	$18.67	1	$18.67
Pickup #2	acre	$2.13	1	$2.13
Truck	acre	$10.60	1	$10.60
ATV	acre	$3.88	1	$3.88
2 wd Tractor & Sidedressing Fertilizer (1x)	acre	$2.15	1	$2.15
4 wd Tractor & Transplanter (1x)	acre	$10.66	1	$10.66
4 wd Tractor & Planter (1x)	acre	$7.83	1	$7.83
4 wd Tractor & Weed Sprayer (4x)	acre	$2.56	1	$2.56
4 wd Tractor & Rotary Tiller (2x)	acre	$18.80	1	$18.80
Total Annual Costs				**$9,842.39**
Returns minus Total Annual Costs				**$3,657.61**

Seavert, Clark, Robert McReynolds, Chip Bubl, Nick Andrews, and Jenny Freeborn. 2007. *Leaf Lettuce, Conventional, Fresh Market, Willamette Valley Region*. Oregon State University Extension Service. http://arec.oregonstate.edu/oaeb/files/pdf/EM8932.pdf.

Perennial Ryegrass

Perennial Ryegrass (Marion County)

Budget Unit acre

Returns

Name	Unit	$/Unit	Quantity	Value
Perennial Ryegrass Seed	lb	$0.54	1700	$918.00

Packing Processing and Value Added Costs

Name	Unit	$/Unit	Quantity	Value
Commission Assessment + Seed Purity Test	acre	$5.61	1	$5.61
Seed Clean and Bag (PrR)	acre	$136.00	1	$136.00
Interest on Operating Capital		$141.61	0	$0.00

Harvest Costs

Name	Unit	$/Unit	Quantity	Value
Seed Clean & Bag (NV)(PrR) Yield Propor.	lb	$0.08	1700	$136.00
Commission Assessment Fees (Proportionl)	lb	$0.00	1700	$2.04
Seed Test Pur/Ger (Proportional)	lb	$0.00	1700	$3.57
-- MACHINERY --		$0.00	0	$0.00
Hillside Combine w/ 30' Header	acre	$2.07	1	$2.07
Hillside Combine w/ 30' Header (Labor)	hours	$22.00	0.0573	$1.26
Tractor rubber tracked with Bankout Wagon	acre	$3.78	1	$3.78
Tractor rubber tracked with Bankout Wagon (Labor)	hours	$22.00	0.0632	$1.39
Semi Truck and Trailer	acre	$2.80	1	$2.80
Semi Truck and Trailer (Labor)	hours	$22.00	0.075	$1.65
2 1/2 Ton Truck older	acre	$1.59	1	$1.59
2 1/2 Ton Truck older (Labor)	hours	$22.00	0.06	$1.32
Interest on Operating Capital		$157.47	0.02	$2.68

Non-Harvest Costs

Name	Unit	$/Unit	Quantity	Value
Seed Crop Inspection Flat Rate (PrR)	acre	$3.00	1	$3.00
-- FERTILIZER --		$0.00	0	$0.00
Fertilizer (PrR)	acre	$141.20	1	$141.20
-- CHEMICALS --		$0.00	0	$0.00
Chemical Pesticide & Spray (PrR)	acre	$107.71	1	$107.71
-- LAND PREPARATION --		$0.00	0	$0.00
Tractor rubber tracked with 40' Chisel Plow (1x)	acre	$3.82	1	$3.82
Tractor rubber tracked with 40' Chisel Plow (1x) (Labor)	hours	$22.00	0.0573	$1.26
-- CROP PRODUCTION --		$0.00	0	$0.00

Tractor rubber tracked with 36' Grain Drill (1x)	acre	$5.28	1	$5.28
Tractor rubber tracked with 36' Grain Drill (1x) (Labor)	hours	$22.00	0.0718	$1.58
Miscellaneous Business Expenses (Wh)	acre	$30.00	1	$30.00
Tractor rubber tracked with 90' Field Sprayer (2x)	acre	$3.52	1	$3.52
Tractor rubber tracked with 90' Field Sprayer (2x) (Labor)	hours	$22.00	0.0482	$1.06
3/4 Ton Pickup (2)	acre	$10.06	1	$10.06
250 HP Tractor with Disk (3x)	acre	$15.66	1	$15.66
250 HP Tractor with Disk (3x) (Labor)	hours	$22.00	0.29	$6.42
-- OTHER --		$0.00	0	$0.00
Miscellaneous Business Expenses (PrR)	acre	$30.00	1	$30.00
Interest on Operating Capital		$360.57	0.02	$6.13

Capital Investment

Name	Unit	$/Unit	Quantity	Value
Hillside Combine w/ 30' Header	acre	$5.05	1	$5.05
Tractor rubber tracked with Bankout Wagon	acre	$2.12	1	$2.12
Tractor rubber tracked with 40' Chisel Plow (1x)	acre	$2.51	1	$2.51
Tractor rubber tracked with 90' Field Sprayer (2x)	acre	$2.40	1	$2.40
Tractor rubber tracked with 36' Grain Drill (1x)	acre	$2.15	1	$2.15
Semi Truck and Trailer	acre	$1.62	1	$1.62
2 1/2 Ton Truck older	acre	$0.38	1	$0.38
3/4 Ton Pickup (2)	acre	$2.48	1	$2.48
250 HP Tractor with Disk (3x)	acre	$4.47	1	$4.47

Total Annual Costs	**$691.64**
Returns minus Total Annual Costs	**$226.36**

Seavert, Clark, Steven Petrie, and Sandy Macnab. 2012. *Wheat (Winter) Following a Non-cereal Crop, Conservation Tillage, Annual Cropping System, 18-24 Inch Precipitation Zone, North Central Region*. Oregon State University Extension Service. http://arec.oregonstate.edu/oaeb/files/pdf/AEB0039.pdf.

Silberstein, Tom, Bart Eleveld, Bill Young, and Emily Lahmann. 2010. *Perennial Ryegrass Seed, Establishment and Production North Williamette Valley Region*. Oregon State University Extension Service. http://arec.oregonstate.edu/oaeb/files/pdf/AEB0008.pdf.

Snap/Bush Beans

Bush Beans Conventional Processed Market Oregon

Budget Unit	acre			

Returns

Name	Unit	$/Unit	Quantity	Value
Beans 1's and 2's	ton	$215.00	6.1	$1,311.50

Packing Processing and Value Added Costs

Name	Unit	$/Unit	Quantity	Value
Interest on Operating Capital		$0.00	0	$0.00

Harvest Costs

Name	Unit	$/Unit	Quantity	Value
Bush Bean Harvester (1x)	acre	$52.56	1	$52.56
Bush Bean Harvester (1x) (Labor)	hours	$22.00	1.18	$25.93
Hauling (2 Trucks)	acre	$22.42	1	$22.42
Hauling (2 Trucks) (Labor)	hours	$22.00	1	$22.00
Interest on Operating Capital		$122.91	0.03	$3.93

Non-Harvest Costs

Name	Unit	$/Unit	Quantity	Value
Soil test (AVC)	acre	$2.00	1	$2.00
Lime application (AVC)	acre	$75.00	1	$75.00
4 wd Tractor#1 & Tandem Disk (1x)	acre	$5.53	1	$5.53
4 wd Tractor#1 & Tandem Disk (1x) (Labor)	hours	$22.00	0.1	$2.26
4 wd Tractor#1 & Moldboard Plow (1x)	acre	$6.81	1	$6.81
4 wd Tractor#1 & Moldboard Plow (1x) (Labor)	hours	$22.00	0.13	$2.85
4 wd Tractyor#2 & Harrow/Roller Packer (1x)	acre	$4.23	1	$4.23
4 wd Tractyor#2 & Harrow/Roller Packer (1x) (Labor)	hours	$22.00	0.0923	$2.03
Fertilizer - Pre-plant (Bb)	acre	$65.00	1	$65.00
4 wd Tractor#2 & Field Cultivator (1x)	acre	$2.05	1	$2.05
4 wd Tractor#2 & Field Cultivator (1x) (Labor)	hours	$22.00	0.0514	$1.13
4 wd Tractor#2 & Rotovator (1x)	acre	$11.96	1	$11.96
4 wd Tractor#2 & Rotovator (1x) (Labor)	hours	$22.00	0.23	$5.08
2 wd Tractor#4 & Bean Planter (1x)	acre	$6.26	1	$6.26
2 wd Tractor#4 & Bean Planter (1x) (Labor)	hours	$22.00	0.15	$3.38
Bean Seed (Bb)	acre	$200.00	1	$200.00
Side Dress Fertilizer (Bb)	acre	$50.00	1	$50.00
4 wd Tractor#2 & Row Cultivator (1x)	acre	$2.05	1	$2.05
4 wd Tractor#2 & Row Cultivator (1x) (Labor)	hours	$22.00	0.0514	$1.13

Self-propelled Boom Sprayer (2x)	acre	$5.72	1	$5.72
Self-propelled Boom Sprayer (2x) (Labor)	hours	$22.00	0.1	$2.30
Herbicides (Bb)	acre	$50.00	1	$50.00
Fungicides (Bb)	acre	$50.00	1	$50.00
Insecticide (Bb)	acre	$5.00	1	$5.00
4 wd Tractor#2 & Flail Chop (.5x)	acre	$2.29	1	$2.29
4 wd Tractor#2 & Flail Chop (.5x) (Labor)	hours	$22.00	0.0491	$1.08
Irrigation Labor (AVC)	hour	$12.00	5	$60.00
Irrigation Pumping Costs (AVC)	acre/inch	$3.50	12	$42.00
Irrigation Repairs & Maintenance (AVC)	acre	$25.00	1	$25.00
Pickup	acre	$52.00	1	$52.00
ATV	acre	$5.56	1	$5.56
Property taxes (AVC)	acre	$20.00	1	$20.00
Property Insurance (AVC)	acre	$35.00	1	$35.00
Miscellaneous & Overhead (AVC)	acre	$75.00	1	$75.00
Interest on Operating Capital		$879.70	0.03	$28.15

Capital Investment

Name	Unit	$/Unit	Quantity	Value
Bush Bean Harvester (1x)	acre	$54.40	1	$54.40
4 wd Tractor#1 & Tandem Disk (1x)	acre	$1.57	1	$1.57
4 wd Tractor#1 & Moldboard Plow (1x)	acre	$2.30	1	$2.30
4 wd Tractor#2 & Rotovator (1x)	acre	$1.77	1	$1.77
4 wd Tractor#2 & Flail Chop (.5x)	acre	$0.42	1	$0.42
4 wd Tractor#2 & Field Cultivator (1x)	acre	$0.24	1	$0.24
4 wd Tractor#2 & Row Cultivator (1x)	acre	$0.24	1	$0.24
4 wd Tractyor#2 & Harrow/Roller Packer (1x)	acre	$1.08	1	$1.08
2 wd Tractor#4 & Bean Planter (1x)	acre	$1.24	1	$1.24
Hauling (2 Trucks)	acre	$16.98	1	$16.98
Pickup	acre	$21.16	1	$21.16
ATV	acre	$4.23	1	$4.23
Self-propelled Boom Sprayer (2x)	acre	$5.74	1	$5.74

Total Annual Costs	**$1,146.06**
Returns minus Total Annual Costs	**$165.44**

Julian, Jim, Clark Seavert, Dan McGrath, Robert McReynolds, and Ed Peachey. 2010. *Bush Beans, Processed Market, Willamette Valley Region*. Oregon State University Extension Service. http://arec.oregonstate.edu/oaeb/files/pdf/AEB0004.pdf.

Spinach and Leaf Lettuce, Conventional Fresh

Spinach and Leaf Lettuce Conventional Fresh Market Oregon

Budget Unit	acre

Returns

Name	Unit	$/Unit	Quantity	Value
Spinach	carton	$9.00	750	$6,750.00
Leaf Lettuce	carton	$8.00	900	$7,200.00

Packing Processing and Value Added Costs

Name	Unit	$/Unit	Quantity	Value
-- SPINACH --		$0.00	0	$0.00
Packing Labor (AVC)	carton	$1.00	750	$750.00
Packing Shed & Euipment (AVC)	carton	$0.15	750	$112.50
-- LEAF LETTUCE --		$0.00	0	$0.00
-- COMMON COSTS --		$0.00	0	$0.00
Boxes (AVC)	carton	$1.30	1650	$2,145.00
Hydo-cooling (AVC)	carton	$0.10	1650	$165.00
Refrigeration (AVC)	carton	$0.10	1650	$165.00
Delivery to Market (AVC)	carton	$0.08	1650	$132.00
Interest on Operating Capital		$3,469.50	0.02	$69.39

Harvest Costs

Name	Unit	$/Unit	Quantity	Value
-- SPINACH --		$0.00	0	$0.00
Harvesting Labor (Sp)	carton	$2.00	750	$1,500.00
Field Crates 20/acre (Sp)	times/acre	$13.00	0.5	$6.50
-- LEAF LETTUCE --		$0.00	0	$0.00
Harvest Labor (Ll)	carton	$1.30	900	$1,170.00
-- COMMON OPERATIONS --		$0.00	0	$0.00
4 wd Tractor & Trailer (2x)	acre	$136.12	1	$136.12
4 wd Tractor & Trailer (2x) (Labor)	hours	$14.30	13	$185.90
Interest on Operating Capital		$2,998.52	0.02	$59.97

Non-Harvest Costs

Name	Unit	$/Unit	Quantity	Value
-- COMMON OPERATIONS --		$0.00	0	$0.00
Lime Application (AVC)	acre	$300.00	0.5	$150.00
4 wd Tractor & Deep Chisel (1x)	acre	$10.04	1	$10.04
4 wd Tractor & Deep Chisel (1x) (Labor)	hours	$14.30	0.61	$8.67
4 wd Tractor & Weed Sprayer (4x)	acre	$12.72	1	$12.72

4 wd Tractor & Weed Sprayer (4x) (Labor)	hours	$14.30	1.02	$14.52
4 wd Tractor & Moldboard Plow (2x)	acre	$29.22	1	$29.22
4 wd Tractor & Moldboard Plow (2x) (Labor)	hours	$14.30	1.62	$23.14
4 wd Tractor & Disk (2x)	acre	$9.68	1	$9.68
4 wd Tractor & Disk (2x) (Labor)	hours	$14.30	0.57	$8.20
4 wd Tractor & Fertilize Spreader (2x)	acre	$3.46	1	$3.46
4 wd Tractor & Fertilize Spreader (2x) (Labor)	hours	$14.30	0.3	$4.22
4 wd Tractor & Rotary Tiller (2x)	acre	$35.22	1	$35.22
4 wd Tractor & Rotary Tiller (2x) (Labor)	hours	$14.30	1.62	$23.14
2 wd Tractor & Sidedressing Fertilizer (1x)	acre	$5.82	1	$5.82
2 wd Tractor & Sidedressing Fertilizer (1x) (Labor)	hours	$14.30	1.15	$16.39
4 wd Tractor & Cultivator (3x)	acre	$15.57	1	$15.57
4 wd Tractor & Cultivator (3x) (Labor)	hours	$14.30	2.06	$29.49
4 wd Tractor & Insecticide Sprayer (2x)	acre	$6.20	1	$6.20
4 wd Tractor & Insecticide Sprayer (2x) (Labor)	hours	$14.30	0.51	$7.26
-- SPINACH --		$0.00	0	$0.00
Fertilizer (Sp)	acre	$100.00	1	$100.00
4 wd Tractor & Planter (1x)	acre	$12.06	1	$12.06
4 wd Tractor & Planter (1x) (Labor)	hours	$14.30	0.74	$10.53
Spinach Seed (Sp)	acre	$400.00	1	$400.00
Insecticides (Sp)	acre	$75.00	1	$75.00
Herbicides (Sp)	acre	$72.00	1	$72.00
-- LEAF LETTUCE --		$0.00	0	$0.00
Fertilizer (Ll)	acre	$90.00	1	$90.00
4 wd Tractor & Transplanter (1x)	acre	$48.06	1	$48.06
4 wd Tractor & Transplanter (1x) (Labor)	hours	$14.30	2.12	$30.25
Planting Labor (Ll)	hour	$10.00	18	$180.00
Lettuce Transplants (Ll)	transplant	$0.03	28000	$840.00
Insecticides (Li)	acre	$100.00	1	$100.00
Herbicides (Ll)	acre	$72.00	1	$72.00
-- COMMON COSTS --		$0.00	0	$0.00
Irrigation Labor Handlines (AVC)	set	$7.50	6	$45.00
Irrigation Electricity (AVC)	set	$10.00	6	$60.00
Irrigation Pipe Rental (AVC)	acre	$110.00	1	$110.00
Pickup #1	acre	$82.67	1	$82.67
Pickup #2	acre	$44.33	1	$44.33
Truck	acre	$158.00	1	$158.00
ATV	acre	$11.20	1	$11.20
Property taxes (AVC)	acre	$20.00	1	$20.00
Property Insurance (AVC)	acre	$35.00	1	$35.00
Field Sanitation Equipment (AVC)	acre	$30.00	1	$30.00
Miscellaneous & Overhead (AVC)	acre	$75.00	1	$75.00

Interest on Operating Capital		$3,114.06	0.02	$62.28

Capital Investment

Name	Unit	$/Unit	Quantity	Value
-- COMMON OPERATIONS & COSTS --		$0.00	0	$0.00
4 wd Tractor & Deep Chisel (1x)	acre	$4.91	1	$4.91
4 wd Tractor & Moldboard Plow (2x)	acre	$15.32	1	$15.32
4 wd Tractor & Disk (2x)	acre	$6.14	1	$6.14
4 wd Tractor & Fertilize Spreader (2x)	acre	$1.58	1	$1.58
4 wd Tractor & Cultivator (3x)	acre	$4.95	1	$4.95
4 wd Tractor & Insecticide Sprayer (2x)	acre	$1.90	1	$1.90
4 wd Tractor & Trailer (2x)	acre	$15.10	1	$15.10
Pickup #1	acre	$18.67	1	$18.67
Pickup #2	acre	$2.13	1	$2.13
Truck	acre	$10.60	1	$10.60
ATV	acre	$3.88	1	$3.88
2 wd Tractor & Sidedressing Fertilizer (1x)	acre	$2.15	1	$2.15
4 wd Tractor & Transplanter (1x)	acre	$10.66	1	$10.66
4 wd Tractor & Planter (1x)	acre	$7.83	1	$7.83
4 wd Tractor & Rotary Tiller (2x)	acre	$18.80	1	$18.80
4 wd Tractor & Weed Sprayer (4x)	acre	$2.56	1	$2.56

Total Annual Costs	**$9,900.90**
Returns minus Total Annual Costs	**$4,049.10**

Seavert, Clark, Robert McReynolds, Chip Bubl, Nick Andrews, and Jenny Freeborn. *Spinach, Conventional, Fresh Market, Willamette Valley Region*. Oregon State University Extension Service, March 2007. http://arec.oregonstate.edu/oaeb/files/pdf/EM8928.pdf.

Seavert, Clark, Robert McReynolds, Chip Bubl, Nick Andrews, and Jenny Freeborn. 2007. *Leaf Lettuce, Conventional, Fresh Market, Willamette Valley Region*. Oregon State University Extension Service. http://arec.oregonstate.edu/oaeb/files/pdf/EM8932.pdf.

Spinach and Radish, Conventional

Spinach and Radishes Conventional Fresh Market Oregon

Budget Unit	acre

Returns

Name	Unit	$/Unit	Quantity	Value
Spinach	carton	$9.00	750	$6,750.00
Radishes	carton	$9.00	700	$6,300.00

Packing Processing and Value Added Costs

Name	Unit	$/Unit	Quantity	Value
-- SPINACH --		$0.00	0	$0.00
Boxes (AVC)	carton	$1.30	750	$975.00
-- RADISHES --		$0.00	0	$0.00
Boxes paper & Ice (AVC)	carton	$1.60	700	$1,120.00
-- COMMON COSTS --		$0.00	0	$0.00
Packing Labor (AVC)	carton	$1.00	1450	$1,450.00
Hydo-cooling (AVC)	carton	$0.10	1450	$145.00
Refrigeration (AVC)	carton	$0.10	1450	$145.00
Delivery to Market (AVC)	carton	$0.08	1450	$116.00
Packing Shed & Equipment (AVC)	carton	$0.15	1450	$217.50
Interest on Operating Capital		$4,168.50	0.02	$83.37

Harvest Costs

Name	Unit	$/Unit	Quantity	Value
-- SPINACH --		$0.00	0	$0.00
Harvesting Labor (Sp)	carton	$2.00	750	$1,500.00
Field Crates 20/acre (AVC)	times/acre	$13.00	0.5	$6.50
-- RADISHES --		$0.00	0	$0.00
Harvest Labor (Ra)	carton	$1.50	700	$1,050.00
Field Crates 20/acre (AVC)	times/acre	$13.00	0.5	$6.50
-- COMMON OPERATIONS --		$0.00	0	$0.00
4 wd Tractor & Trailer (2x)	acre	$136.12	1	$136.12
4 wd Tractor & Trailer (2x) (Labor)	hours	$14.30	13	$185.90
Interest on Operating Capital		$2,885.02	0.02	$57.70

Non-Harvest Costs

Name	Unit	$/Unit	Quantity	Value
-- COMMON OPERATIONS --		$0.00	0	$0.00
Lime Application (AVC)	acre	$300.00	0.5	$150.00
4 wd Tractor & Deep Chisel (1x)	acre	$10.04	1	$10.04

4 wd Tractor & Deep Chisel (1x) (Labor)	hours	$14.30	0.61	$8.67
4 wd Tractor & Disk (2x)	acre	$9.68	1	$9.68
4 wd Tractor & Disk (2x) (Labor)	hours	$14.30	0.57	$8.20
4 wd Tractor & Moldboard Plow (2x)	acre	$29.22	1	$29.22
4 wd Tractor & Moldboard Plow (2x) (Labor)	hours	$14.30	1.62	$23.14
4 wd Tractor & Fertilize Spreader (2x)	acre	$3.46	1	$3.46
4 wd Tractor & Fertilize Spreader (2x) (Labor)	hours	$14.30	0.3	$4.22
4 wd Tractor & Rotary Tiller (2x)	acre	$35.22	1	$35.22
4 wd Tractor & Rotary Tiller (2x) (Labor)	hours	$14.30	1.62	$23.14
4 wd Tractor & Cultivator (1.5x)	acre	$7.78	1	$7.78
4 wd Tractor & Cultivator (1.5x) (Labor)	hours	$14.30	1.03	$14.74
4 wd Tractor & Insecticide Sprayer (2x)	acre	$6.20	1	$6.20
4 wd Tractor & Insecticide Sprayer (2x) (Labor)	hours	$14.30	0.51	$7.26
4 wd Tractor & Planter (2x)	acre	$24.12	1	$24.12
4 wd Tractor & Planter (2x) (Labor)	hours	$14.30	1.47	$21.06
4 wd Tractor & Weed Sprayer (4x)	acre	$12.72	1	$12.72
4 wd Tractor & Weed Sprayer (4x) (Labor)	hours	$14.30	1.02	$14.52
-- SPINACH --		$0.00	0	$0.00
Fertilizer (Sp)	acre	$100.00	1	$100.00
Spinach Seed (Sp)	acre	$400.00	1	$400.00
Insecticides (Sp)	acre	$75.00	1	$75.00
Herbicides (Sp)	acre	$72.00	1	$72.00
-- RADISHES --		$0.00	0	$0.00
Fertilizer (Ra)	acre	$45.00	1	$45.00
Radish Seed (Ra)	acre	$800.00	1	$800.00
Insecticides (Ra)	acre	$75.00	1	$75.00
Herbicides (Ra)	acre	$72.00	1	$72.00
-- COMMON COSTS --		$0.00	0	$0.00
Irrigation Labor Handlines (AVC)	set	$7.50	6	$45.00
Irrigation Electricity (AVC)	set	$10.00	6	$60.00
Irrigation Pipe Rental (AVC)	acre	$110.00	1	$110.00
Pickup #1	acre	$82.67	1	$82.67
Pickup #2	acre	$44.33	1	$44.33
Truck	acre	$158.00	1	$158.00
ATV	acre	$11.20	1	$11.20
Property taxes (AVC)	acre	$20.00	1	$20.00
Property Insurance (AVC)	acre	$35.00	1	$35.00
Field Sanitation Equipment (AVC)	acre	$30.00	1	$30.00
Miscellaneous & Overhead (AVC)	acre	$75.00	1	$75.00
Interest on Operating Capital		$2,723.59	0.02	$54.47

Capital Investment

Name	Unit	$/Unit	Quantity	Value
-- COMMON OPERATIONS& COSTS --		$0.00	0	$0.00
4 wd Tractor & Deep Chisel (1x)	acre	$4.91	1	$4.91
4 wd Tractor & Moldboard Plow (2x)	acre	$15.32	1	$15.32
4 wd Tractor & Disk (2x)	acre	$6.14	1	$6.14
4 wd Tractor & Fertilize Spreader (2x)	acre	$1.58	1	$1.58
4 wd Tractor & Cultivator (1.5x)	acre	$2.48	1	$2.48
4 wd Tractor & Insecticide Sprayer (2x)	acre	$1.90	1	$1.90
4 wd Tractor & Trailer (2x)	acre	$15.10	1	$15.10
Pickup #1	acre	$18.67	1	$18.67
Pickup #2	acre	$2.13	1	$2.13
Truck	acre	$10.60	1	$10.60
ATV	acre	$3.88	1	$3.88
4 wd Tractor & Planter (2x)	acre	$15.66	1	$15.66
4 wd Tractor & Rotary Tiller (2x)	acre	$18.80	1	$18.80
4 wd Tractor & Weed Sprayer (4x)	acre	$2.60	1	$2.60
Total Annual Costs				**$10,092.43**
Returns minus Total Annual Costs				**$2,957.57**

Seavert, Clark, Robert McReynolds, Chip Bubl, Nick Andrews, and Jenny Freeborn. 2007. *Spinach, Conventional, Fresh Market, Willamette Valley Region*. Oregon State University Extension Service. http://arec.oregonstate.edu/oaeb/files/pdf/EM8928.pdf.

Seavert, Clark, Robert McReynolds, Chip Bubl, Nick Andrews, and Jenny Freeborn. 2007. *Radishes, Conventional, Fresh Market, Willamette Valley Region*. Oregon State University Extension Service. http://arec.oregonstate.edu/oaeb/files/pdf/EM8930.pdf.

Sweet Corn, Conventional Processed

Sweet Corn Conventional Processed Market Oregon

Budget Unit	acre			

Returns

Name	Unit	$/Unit	Quantity	Value
Sweet Corn	ton	$147.20	7	$1,030.40

Packing Processing and Value Added Costs

Name	Unit	$/Unit	Quantity	Value
Interest on Operating Capital		$0.00	0.03	$0.00

Harvest Costs

Name	Unit	$/Unit	Quantity	Value
Corn Picker (1x)	acre	$36.69	1	$36.69
Corn Picker (1x) (Labor)	hours	$20.00	0.33	$6.55
Hauling (2 Trucks)	acre	$22.42	1	$22.42
Hauling (2 Trucks) (Labor)	hours	$20.00	1	$20.00
Interest on Operating Capital		$85.66	0.03	$2.74

Non-Harvest Costs

Name	Unit	$/Unit	Quantity	Value
Soil test (AVC)	acre	$2.00	1	$2.00
Lime application (AVC)	acre	$75.00	1	$75.00
4 wd Tractor#1 & V-Ripper (1x)	acre	$7.63	1	$7.63
4 wd Tractor#1 & V-Ripper (1x) (Labor)	hours	$22.00	0.15	$3.39
4 wd Tractor#2 & Harrow/Roller Packer (2x)	acre	$8.46	1	$8.46
4 wd Tractor#2 & Harrow/Roller Packer (2x) (Labor)	hours	$22.00	0.18	$4.06
Pre-plant Fertilizer (Sc)	acre	$65.00	1	$65.00
4 wd Tractor#1 & Tandem Disk (1x)	acre	$5.53	1	$5.53
4 wd Tractor#1 & Tandem Disk (1x) (Labor)	hours	$22.00	0.1	$2.26
2 wd Tractor#4 & Corn Planter (1x)	acre	$6.26	1	$6.26
2 wd Tractor#4 & Corn Planter (1x) (Labor)	hours	$22.00	0.15	$3.38
Seed (Sc)	acre	$100.00	1	$100.00
Sidedress Fertilizer (Sc)	acre	$70.00	1	$70.00
4 wd Tractor#2 & Row Cultivator (1x)	acre	$2.05	1	$2.05
4 wd Tractor#2 & Row Cultivator (1x) (Labor)	hours	$22.00	0.0514	$1.13
Self-propelled Boom Sprayer (2x)	acre	$6.58	1	$6.58
Self-propelled Boom Sprayer (2x) (Labor)	hours	$22.00	0.12	$2.72
Herbicides (Sc)	acre	$30.00	1	$30.00
Insecticides (Sc)	acre	$40.00	1	$40.00

4 wd Tractor#3 & Fertilizer Spreader (1x)	acre	$1.09	1	$1.09
4 wd Tractor#3 & Fertilizer Spreader (1x) (Labor)	hours	$22.00	0.0423	$0.93
Fertilizer - Top Dress (Sc)	acre	$60.00	1	$60.00
Topping - Custom (Sc)	acre	$10.00	1	$10.00
4 wd Tractor#2 & Disk (2x)	acre	$8.86	1	$8.86
4 wd Tractor#2 & Disk (2x) (Labor)	hours	$22.00	0.22	$4.74
Irrigation Labor (AVC)	hour	$12.00	3	$36.00
Irrigation Pumping Costs (AVC)	acre/inch	$3.50	10	$35.00
Irrigation Repairs & Maintenance (AVC)	acre	$25.00	1	$25.00
Pickup	acre	$52.00	1	$52.00
ATV	acre	$5.73	1	$5.73
Property Insurance (AVC)	acre	$35.00	1	$35.00
Property taxes (AVC)	acre	$20.00	1	$20.00
Miscellaneous & Overhead (AVC)	acre	$75.00	1	$75.00
Interest on Operating Capital		$804.80	0.03	$25.75

Capital Investment

Name	Unit	$/Unit	Quantity	Value
4 wd Tractor#1 & Tandem Disk (1x)	acre	$1.57	1	$1.57
4 wd Tractor#2 & Disk (2x)	acre	$2.38	1	$2.38
4 wd Tractor#2 & Row Cultivator (1x)	acre	$0.24	1	$0.24
4 wd Tractor#3 & Fertilizer Spreader (1x)	acre	$0.41	1	$0.41
2 wd Tractor#4 & Corn Planter (1x)	acre	$1.24	1	$1.24
Hauling (2 Trucks)	acre	$25.48	1	$25.48
Corn Picker (1x)	acre	$3.31	1	$3.31
4 wd Tractor#1 & V-Ripper (1x)	acre	$1.94	1	$1.94
ATV	acre	$0.85	1	$0.85
Pickup	acre	$15.56	1	$15.56
Self-propelled Boom Sprayer (2x)	acre	$6.76	1	$6.76
4 wd Tractor#2 & Harrow/Roller Packer (2x)	acre	$2.16	1	$2.16

Total Annual Costs	**$980.85**
Returns minus Total Annual Costs	**$49.55**

Julian, Jim, Clark Seavert, Dan McGrath, Robert McReynolds, and Ed Peachey. 2010. *Sweet Corn, Processed Market, Willamette Valley Region*. Oregon State University Extension Service. http://arec.oregonstate.edu/oaeb/files/pdf/AEB0006.pdf.

Winter Wheat

Conventional Winter Wheat (Marion County)

Budget Unit acre

Returns

Name	Unit	$/Unit	Quantity	Value
Winter Wheat	bushel	$6.00	100	$600.00

Packing Processing and Value Added Costs

Name	Unit	$/Unit	Quantity	Value
Transport to PDX (Yield Proportional)	bushel	$0.27	100	$27.00
Wheat Commission (Wh)	bushel	$0.05	100	$5.00
Interest on Operating Capital		$32.00	0	$0.00

Harvest Costs

Name	Unit	$/Unit	Quantity	Value
Hillside Combine w/ 30' Header	acre	$2.07	1	$2.07
Hillside Combine w/ 30' Header (Labor)	hours	$22.00	0.0573	$1.26
Tractor rubber tracked with Bankout Wagon	acre	$3.78	1	$3.78
Tractor rubber tracked with Bankout Wagon (Labor)	hours	$22.00	0.0632	$1.39
Semi Truck and Trailer	acre	$2.80	1	$2.80
Semi Truck and Trailer (Labor)	hours	$22.00	0.075	$1.65
2 1/2 Ton Truck older	acre	$1.59	1	$1.59
2 1/2 Ton Truck older (Labor)	hours	$22.00	0.06	$1.32
Interest on Operating Capital		$15.86	0.02	$0.27

Non-Harvest Costs

Name	Unit	$/Unit	Quantity	Value
Treated W.Wheat Seed (Winter Wheat)	acre	$20.00	1	$20.00
-- FERTILIZER --		$0.00	0	$0.00
Fertilizer (Winter Wheat)	acre	$82.10	1	$82.10
-- CHEMICALS --		$0.00	0	$0.00
Chemical Pesticide (Insect Herb Fungi)	acre	$51.05	1	$51.05
-- LAND PREPARATION --		$0.00	0	$0.00
Tractor rubber tracked with 40' Chisel Plow (1x)	acre	$3.82	1	$3.82
Tractor rubber tracked with 40' Chisel Plow (1x) (Labor)	hours	$22.00	0.0573	$1.26
-- CROP PRODUCTION --		$0.00	0	$0.00
Tractor rubber tracked with 36' Grain Drill (1x)	acre	$5.28	1	$5.28
Tractor rubber tracked with 36' Grain Drill (1x) (Labor)	hours	$22.00	0.0718	$1.58
Miscellaneous Business Expenses (Wh)	acre	$30.00	1	$30.00
Tractor rubber tracked with 90' Field Sprayer (2x)	acre	$3.52	1	$3.52

Tractor rubber tracked with 90' Field Sprayer (2x) (Labor)	hours	$22.00	0.0482	$1.06
3/4 Ton Pickup (2)	acre	$10.06	1	$10.06
250 HP Tractor with Disk (3x)	acre	$15.66	1	$15.66
250 HP Tractor with Disk (3x) (Labor)	hours	$22.00	0.29	$6.42
Interest on Operating Capital		$231.81	0.02	$3.94

Capital Investment

Name	Unit	$/Unit	Quantity	Value
Hillside Combine w/ 30' Header	acre	$5.05	1	$5.05
Tractor rubber tracked with Bankout Wagon	acre	$2.12	1	$2.12
Tractor rubber tracked with 40' Chisel Plow (1x)	acre	$2.51	1	$2.51
Tractor rubber tracked with 90' Field Sprayer (2x)	acre	$2.40	1	$2.40
Tractor rubber tracked with 36' Grain Drill (1x)	acre	$2.15	1	$2.15
Semi Truck and Trailer	acre	$1.62	1	$1.62
2 1/2 Ton Truck older	acre	$0.38	1	$0.38
3/4 Ton Pickup (2)	acre	$2.48	1	$2.48
250 HP Tractor with Disk (3x)	acre	$4.47	1	$4.47

Total Annual Costs	**$307.06**
Returns minus Total Annual Costs	**$292.94**

Mellbye, Mark, Bart Eleveld, Tom Silberstein, Mike Flowers, and Emily Lahmann. 2010. *Winter Wheat, Conventional Tillage and No-Till, Willamette Valley Region*. Oregon State University Extension Service. http://arec.oregonstate.edu/oaeb/files/pdf/AEB0015.pdf.

Seavert, Clark, Steven Petrie, and Sandy Macnab. 2012. *Wheat (Winter) Following a Non-cereal Crop, Conservation Tillage, Annual Cropping System, 18-24 Inch Precipitation Zone, North Central Region*. Oregon State University Extension Service. http://arec.oregonstate.edu/oaeb/files/pdf/AEB0039.pdf.

Notes: Utilized AgProfit to calculate assets—original wheat budget using Clark's modified for WM, used that for assets but included assets added from other WM wheat budget (Clark's budget based on 2,000 acres, WM one based on 1,200)

C. AgFinance Beginning Balance Sheets and Calculated Payment Capacities

Table C.1: **Alfalfa Hay**

Balance Sheet Information (Beginning)	
Crop and Abbreviation	**Alfalfa Hay (A)**
Description	320-acre farm
Assets	
Current Assets	
Cash balance:	$25,000
Prepaid expenses and supplies:	$1,000
Products on hand or not sold:	$0
Invest in growing crops:	$5,000
Accounts receivable:	$0
Other current assets:	$0
Intermediate Assets	(All equipment 10 years and under)
Market value of equipment and breeding livestock:	$281,700
Long term Assets	(All equipment 11 years and above, including hay shed)
Market value of facilities and other improvements:	$196,700
Market value of real estate/acre	$5,000
Market value of real estate:	$1,600,000
Total Assets:	$2,112,400
Liabilities	
Current Liabilities	
Accrued interest:	$0
Accounts payable and accrued expenses:	$1,500
Intermediate Liabilities	
Value of loans on intermediate assets:	$0
Long Term Liabilities	
Value of loans on long term assets:	$0
Total Liabilities:	$1,500
Net Worth:	
Depreciation/Replacement Costs (No loans)	
Depreciation Calculated by AgFinance	$36,038
Percentage Allocated to Intermediate Assets	78%
Percentage Allocated to Long-Term Assets	22%
Replacement Costs for Intermediate Assets (Year 1)	$28,170
Replacement Costs for Long-Term Assets (Year 1)	$7,868

Table C.2: **Blueberries**

Balance Sheet Information (Beginning)	
Crop and Abbreviation	**Blueberries (B)**
Description	20-acre farm
Assets	
Current Assets	
Cash balance:	$25,000
Prepaid expenses and supplies:	$1,000
Products on hand or not sold:	$0
Invest in growing crops:	$5,000
Accounts receivable:	$0
Other current assets:	$0
Intermediate Assets	(Equipment 10 years and under)
Market value of equipment and breeding livestock:	$27,500
Long term Assets	(Equipment 11 year and above plus plants @ 3.50 plant, 1452 trees/acre, 20 acres total)
Market value of facilities and other improvements:	$259,840
Market value of real estate/acre	$10,000
Market value of real estate:	$200,000
Total Assets:	$521,340
Liabilities	
Current Liabilities	
Accrued interest:	$0
Accounts payable and accrued expenses:	$1,500
Intermediate Liabilities	
Value of loans on intermediate assets:	$0
Long Term Liabilities	
Value of loans on long term assets:	$0
Total Liabilities:	$1,500
Net Worth:	
Depreciation/Replacement Costs (No loans)	
Depreciation Calculated by AgFinance	$13,144
Percentage Allocated to Intermediate Assets	21%
Percentage Allocated to Long-Term Assets	79%
Replacement Costs for Intermediate Assets (Year 1)	$2,750
Replacement Costs for Long-Term Assets (Year 1)	$10,394

Table C.3: **Fresh Vegetables**

Balance Sheet Information (Beginning)	
Crop and Abbreviation	**Fresh Vegetables: Lettuce and Radishes (FV)**
Description	100-acre farm
Assets	
Current Assets	
Cash balance:	$25,000
Prepaid expenses and supplies:	$1,000
Products on hand or not sold:	$0
Invest in growing crops:	$5,000
Accounts receivable:	$0
Other current assets:	$0
Intermediate Assets	(Equipment at 10 years or less)
Market value of equipment and breeding livestock:	$50,500
Long term Assets	(Equipment 11 years and above)
Market value of facilities and other improvements:	$201,500
Market value of real estate/acre	$10,000
Market value of real estate:	$1,000,000
Total Assets:	$1,286,000
Liabilities	
Current Liabilities	
Accrued interest:	$0
Accounts payable and accrued expenses:	$1,500
Intermediate Liabilities	
Value of loans on intermediate assets:	$0
Long Term Liabilities	
Value of loans on long term assets:	$0
Total Liabilities:	$1,500
Net Worth:	
Depreciation/Replacement Costs (No loans)	
Depreciation Calculated by AgFinance	$13,110
Percentage Allocated to Intermediate Assets	39%
Percentage Allocated to Long-Term Assets	61%
Replacement Costs for Intermediate Assets (Year 1)	$5,050
Replacement Costs for Long-Term Assets (Year 1)	$8,060

Table C.4: **Grass and Wheat**

Balance Sheet Information (Beginning)	
Crop and Abbreviation	**Grass and Wheat (G/W)**
Description	2000-acre farm: 640 wheat (32%) & 1360 grass (68%)
Assets	
Current Assets	
Cash balance:	$25,000
Prepaid expenses and supplies:	$1,000
Products on hand or not sold:	$0
Invest in growing crops:	$5,000
Accounts receivable:	$0
Other current assets:	$0
Intermediate Assets	(All equipment 10 years and under)
Market value of equipment and breeding livestock:	$400,050
Long term Assets	(All equipment 11 years and above)
Market value of facilities and other improvements:	$710,600
Market value of real estate/acre	$5,000
Market value of real estate:	$10,000,000
Total Assets:	$11,144,650
Liabilities	
Current Liabilities	
Accrued interest:	$0
Accounts payable and accrued expenses:	$1,500
Intermediate Liabilities	
Value of loans on intermediate assets:	$0
Long Term Liabilities	
Value of loans on long term assets:	$0
Total Liabilities:	$1,500
Net Worth:	
Depreciation/Replacement Costs (No loans)	
Depreciation Calculated by AgFinance	$68,429
Percentage Allocated to Intermediate Assets	58%
Percentage Allocated to Long-Term Assets	42%
Replacement Costs for Intermediate Assets (Year 1)	$40,005
Replacement Costs for Long-Term Assets (Year 1)	$28,424

Table C.5: **Hops**

Balance Sheet Information (Beginning)	
Crop and Abbreviation	**Hops (H)**
Description	660 acres (Yakima Valley, WA)
Assets	
Current Assets	
Cash balance:	$25,000
Prepaid expenses and supplies:	$1,000
Products on hand or not sold:	$0
Invest in growing crops:	$5,000
Accounts receivable:	$0
Other current assets:	$0
Intermediate Assets	(General equipment as listed in budget)
Market value of equipment and breeding livestock:	$1,500,000
Long term Assets	(Picker, kiln, shop, baler, office as listed in budget)
Market value of facilities and other improvements:	$6,500,000
Market value of real estate/acre	$10,000
Market value of real estate:	$6,600,000
Total Assets:	$14,634,000
Liabilities	
Current Liabilities	
Accrued interest:	$0
Accounts payable and accrued expenses:	$1,500
Intermediate Liabilities	
Value of loans on intermediate assets:	$0
Long Term Liabilities	
Value of loans on long term assets:	$0
Total Liabilities:	$1,500
Net Worth:	
Depreciation/Replacement Costs (No loans)	
Depreciation Calculated by AgFinance	$410,000
Percentage Allocated to Intermediate Assets	37%
Percentage Allocated to Long-Term Assets	63%
Replacement Costs for Intermediate Assets (Year 1)	$150,000
Replacement Costs for Long-Term Assets (Year 1)	$260,000

Table C.6: **Hazelnuts**

Balance Sheet Information (Beginning)	
Crop and Abbreviation	**Hazelnuts (HZ)**
Description	100 acres (Willamette Valley)
Assets	
Current Assets	
Cash balance:	$25,000
Prepaid expenses and supplies:	$1,000
Products on hand or not sold:	$0
Invest in growing crops:	$5,000
Accounts receivable:	$0
Other current assets:	$0
Intermediate Assets	
Market value of equipment and breeding livestock:	$172,900
Long term Assets	
Market value of facilities and other improvements:	$350,000
Market value of real estate/acre	$10,000
Market value of real estate:	$1,000,000
Total Assets:	$1,556,900
Liabilities	
Current Liabilities	
Accrued interest:	$0
Accounts payable and accrued expenses:	$1,500
Intermediate Liabilities	
Value of loans on intermediate assets:	$0
Long Term Liabilities	
Value of loans on long term assets:	$0
Total Liabilities:	$1,500
Net Worth:	$1,555,400
Depreciation/Replacement Costs (No loans)	
Depreciation Calculated by AgFinance	$31,290
Percentage Allocated to Intermediate Assets	55%
Percentage Allocated to Long-Term Assets	45%
Replacement Costs for Intermediate Assets (Year 1)	$17,290
Replacement Costs for Long-Term Assets (Year 1)	$14,000

Table C.7: **Processed Vegetables**

Balance Sheet Information (Beginning)	
Crop and Abbreviation	**Sweet Corn, Snap Beans, Broccoli, Cauliflower (PV)**
Description	375 acres (Willamette Valley)
Assets	
Current Assets	
Cash balance:	$25,000
Prepaid expenses and supplies:	$1,000
Products on hand or not sold:	$0
Invest in growing crops:	$5,000
Accounts receivable:	$0
Other current assets:	$0
Intermediate Assets	(4 crops average and only listing equipment/machinery with a lifespan of 10 years or less)
Market value of equipment and breeding livestock:	$172,950
Long term Assets	(4 crop average, equipment with 11-year or more lifespan)
Market value of facilities and other improvements:	$567,450
Market value of real estate/acre	$10,000
Market value of real estate:	$3,750,000
Total Assets:	$4,524,400
Liabilities	
Current Liabilities	
Accrued interest:	$0
Accounts payable and accrued expenses:	$1,500
Intermediate Liabilities	
Value of loans on intermediate assets:	$0
Long Term Liabilities	
Value of loans on long term assets:	$0
Total Liabilities:	$1,500
Net Worth:	
Depreciation/Replacement Costs (No loans)	
Depreciation Calculated by AgFinance	$39,993
Percentage Allocated to Intermediate Assets	43%
Percentage Allocated to Long-Term Assets	57%
Replacement Costs for Intermediate Assets (Year 1)	$17,295
Replacement Costs for Long-Term Assets (Year 1)	$22,698

Table C.8: **Alfalfa Hay Payment Capacity**

Representative Farm:	Alfalfa Hay (320 acres)							
Year	**Gross Income**	**Annual Farm Costs**	**Net Income**	**Return to Management (10%)**	**Net Worth/Equity**	**Return to Equity (3%)**	**Total Payment Capacity**	**Per-Acre Payment Capacity**
2013	$ 315,456	$ 151,418	$ 164,038	$ 16,404	$ 2,217,835	$ 66,535	$ 81,099	$ 253
2014	$ 315,456	$ 155,961	$ 159,495	$ 15,950	$ 2,321,422	$ 69,643	$ 73,903	$ 231
2015	$ 315,456	$ 160,640	$ 154,816	$ 15,482	$ 2,418,451	$ 72,554	$ 66,781	$ 209
2016	$ 315,456	$ 165,459	$ 149,997	$ 15,000	$ 2,508,706	$ 75,261	$ 59,736	$ 187
2017	$ 315,456	$ 170,423	$ 145,033	$ 14,503	$ 2,591,964	$ 77,759	$ 52,771	$ 165
Year	**Gross Income**	**Annual Farm Costs**	**Net Income**	**Return to Management (10%)**	**Net Worth/Equity**	**Return to Equity (2%)**	**Total Payment Capacity**	**Per-Acre Payment Capacity**
2013	$ 315,456	$ 151,418	$ 164,038	$ 16,404	$ 2,217,835	$ 44,357	$ 103,278	$ 323
2014	$ 315,456	$ 155,961	$ 159,495	$ 15,950	$ 2,321,422	$ 46,428	$ 97,117	$ 303
2015	$ 315,456	$ 160,640	$ 154,816	$ 15,482	$ 2,418,451	$ 48,369	$ 90,965	$ 284
2016	$ 315,456	$ 165,459	$ 149,997	$ 15,000	$ 2,508,706	$ 50,174	$ 84,823	$ 265
2017	$ 315,456	$ 170,423	$ 145,033	$ 14,503	$ 2,591,964	$ 51,839	$ 78,690	$ 246
Year	**Gross Income**	**Annual Farm Costs**	**Net Income**	**Return to Management (5%)**	**Net Worth/Equity**	**Return to Equity (3%)**	**Total Payment Capacity**	**Per-Acre Payment Capacity**
2013	$ 315,456	$ 151,418	$ 164,038	$ 8,202	$ 2,217,835	$ 66,535	$ 89,301	$ 279
2014	$ 315,456	$ 155,961	$ 159,495	$ 7,975	$ 2,321,422	$ 69,643	$ 81,878	$ 256
2015	$ 315,456	$ 160,640	$ 154,816	$ 7,741	$ 2,418,451	$ 72,554	$ 74,522	$ 233
2016	$ 315,456	$ 165,459	$ 149,997	$ 7,500	$ 2,508,706	$ 75,261	$ 67,236	$ 210
2017	$ 315,456	$ 170,423	$ 145,033	$ 7,252	$ 2,591,964	$ 77,759	$ 60,022	$ 188

C.9: **Alfalfa Payment Capacity (1% Farm-Gate Price Increase)**

Representative Farm:	Alfalfa Hay (320 acres)							
Year	Gross Income	Annual Farm Costs	Net Income	Return to Management (10%)	Net Worth/Equity	Return to Equity (3%)	Total Payment Capacity	Per-Acre Payment Capacity
2013	$ 318,611	$ 151,418	$ 167,193	$ 16,719	$ 2,220,990	$ 66,630	$ 83,844	$ 262
2014	$ 321,797	$ 155,961	$ 165,836	$ 16,584	$ 2,330,917	$ 69,928	$ 79,325	$ 248
2015	$ 325,015	$ 160,640	$ 164,375	$ 16,438	$ 2,437,505	$ 73,125	$ 74,812	$ 234
2016	$ 328,265	$ 165,459	$ 162,806	$ 16,281	$ 2,540,568	$ 76,217	$ 70,308	$ 220
2017	$ 331,547	$ 170,423	$ 161,124	$ 16,112	$ 2,639,918	$ 79,198	$ 65,814	$ 206
Year	Gross Income	Annual Farm Costs	Net Income	Return to Management (10%)	Net Worth/Equity	Return to Equity (2%)	Total Payment Capacity	Per-Acre Payment Capacity
2013	$ 318,611	$ 151,418	$ 167,193	$ 16,719	$ 2,220,990	$ 44,420	$ 106,054	$ 331
2014	$ 321,797	$ 155,961	$ 165,836	$ 16,584	$ 2,330,917	$ 46,618	$ 102,634	$ 321
2015	$ 325,015	$ 160,640	$ 164,375	$ 16,438	$ 2,437,505	$ 48,750	$ 99,187	$ 310
2016	$ 328,265	$ 165,459	$ 162,806	$ 16,281	$ 2,540,568	$ 50,811	$ 95,714	$ 299
2017	$ 331,547	$ 170,423	$ 161,124	$ 16,112	$ 2,639,918	$ 52,798	$ 92,213	$ 288
Year	Gross Income	Annual Farm Costs	Net Income	Return to Management (5%)	Net Worth/Equity	Return to Equity (3%)	Total Payment Capacity	Per-Acre Payment Capacity
2013	$ 318,611	$ 151,418	$ 167,193	$ 8,360	$ 2,220,990	$ 66,630	$ 92,204	$ 288
2014	$ 321,797	$ 155,961	$ 165,836	$ 8,292	$ 2,330,917	$ 69,928	$ 87,617	$ 274
2015	$ 325,015	$ 160,640	$ 164,375	$ 8,219	$ 2,437,505	$ 73,125	$ 83,031	$ 259
2016	$ 328,265	$ 165,459	$ 162,806	$ 8,140	$ 2,540,568	$ 76,217	$ 78,449	$ 245
2017	$ 331,547	$ 170,423	$ 161,124	$ 8,056	$ 2,639,918	$ 79,198	$ 73,870	$ 231

C.10: **Alfalfa Payment Capacity (3% Farm-Gate Price Increase)**

Representative Farm:	Alfalfa Hay (320 acres)							
Year	**Gross Income**	**Annual Farm Costs**	**Net Income**	**Return to Management (10%)**	**Net Worth/Equity**	**Return to Equity (3%)**	**Total Payment Capacity**	**Per-Acre Payment Capacity**
2013	$ 324,920	$ 151,418	$ 173,502	$ 17,350	$ 2,227,299	$ 66,819	$ 89,333	$ 279
2014	$ 334,667	$ 155,961	$ 178,706	$ 17,871	$ 2,350,097	$ 70,503	$ 90,332	$ 282
2015	$ 344,707	$ 160,640	$ 184,067	$ 18,407	$ 2,476,377	$ 74,291	$ 91,369	$ 286
2016	$ 355,049	$ 165,459	$ 189,590	$ 18,959	$ 2,606,224	$ 78,187	$ 92,444	$ 289
2017	$ 365,700	$ 170,423	$ 195,277	$ 19,528	$ 2,739,726	$ 82,192	$ 93,558	$ 292
Year	**Gross Income**	**Annual Farm Costs**	**Net Income**	**Return to Management (10%)**	**Net Worth/Equity**	**Return to Equity (2%)**	**Total Payment Capacity**	**Per-Acre Payment Capacity**
2013	$ 324,920	$ 151,418	$ 173,502	$ 17,350	$ 2,227,299	$ 44,546	$ 111,606	$ 349
2014	$ 334,667	$ 155,961	$ 178,706	$ 17,871	$ 2,350,097	$ 47,002	$ 113,833	$ 356
2015	$ 344,707	$ 160,640	$ 184,067	$ 18,407	$ 2,476,377	$ 49,528	$ 116,133	$ 363
2016	$ 355,049	$ 165,459	$ 189,590	$ 18,959	$ 2,606,224	$ 52,124	$ 118,507	$ 370
2017	$ 365,700	$ 170,423	$ 195,277	$ 19,528	$ 2,739,726	$ 54,795	$ 120,955	$ 378
Year	**Gross Income**	**Annual Farm Costs**	**Net Income**	**Return to Management (5%)**	**Net Worth/Equity**	**Return to Equity (3%)**	**Total Payment Capacity**	**Per-Acre Payment Capacity**
2013	$ 324,920	$ 151,418	$ 173,502	$ 8,675	$ 2,227,299	$ 66,819	$ 98,008	$ 306
2014	$ 334,667	$ 155,961	$ 178,706	$ 8,935	$ 2,350,097	$ 70,503	$ 99,268	$ 310
2015	$ 344,707	$ 160,640	$ 184,067	$ 9,203	$ 2,476,377	$ 74,291	$ 100,572	$ 314
2016	$ 355,049	$ 165,459	$ 189,590	$ 9,480	$ 2,606,224	$ 78,187	$ 101,924	$ 319
2017	$ 365,700	$ 170,423	$ 195,277	$ 9,764	$ 2,739,726	$ 82,192	$ 103,321	$ 323

C.11: **Alfalfa Payment Capacity (5% Farm-Gate Price Increase)**

Representative Farm:	Alfalfa Hay (320 acres)							
Year	Gross Income	Annual Farm Costs	Net Income	Return to Management (10%)	Net Worth/Equity	Return to Equity (3%)	Total Payment Capacity	Per-Acre Payment Capacity
2013	$ 331,229	$ 151,418	$ 179,811	$ 17,981	$ 2,233,608	$ 67,008	$ 94,822	$ 296
2014	$ 347,790	$ 155,961	$ 191,829	$ 19,183	$ 2,369,529	$ 71,086	$ 101,560	$ 317
2015	$ 365,180	$ 160,640	$ 204,540	$ 20,454	$ 2,516,282	$ 75,488	$ 108,598	$ 339
2016	$ 383,439	$ 165,459	$ 217,980	$ 21,798	$ 2,674,519	$ 80,236	$ 115,946	$ 362
2017	$ 402,611	$ 170,423	$ 232,188	$ 23,219	$ 2,844,932	$ 85,348	$ 123,621	$ 386
Year	Gross Income	Annual Farm Costs	Net Income	Return to Management (10%)	Net Worth/Equity	Return to Equity (2%)	Total Payment Capacity	Per-Acre Payment Capacity
2013	$ 331,229	$ 151,418	$ 179,811	$ 17,981	$ 2,233,608	$ 44,672	$ 117,158	$ 366
2014	$ 347,790	$ 155,961	$ 191,829	$ 19,183	$ 2,369,529	$ 47,391	$ 125,256	$ 391
2015	$ 365,180	$ 160,640	$ 204,540	$ 20,454	$ 2,516,282	$ 50,326	$ 133,760	$ 418
2016	$ 383,439	$ 165,459	$ 217,980	$ 21,798	$ 2,674,519	$ 53,490	$ 142,692	$ 446
2017	$ 402,611	$ 170,423	$ 232,188	$ 23,219	$ 2,844,932	$ 56,899	$ 152,071	$ 475
Year	Gross Income	Annual Farm Costs	Net Income	Return to Management (5%)	Net Worth/Equity	Return to Equity (3%)	Total Payment Capacity	Per-Acre Payment Capacity
2013	$ 331,229	$ 151,418	$ 179,811	$ 8,991	$ 2,233,608	$ 67,008	$ 103,812	$ 324
2014	$ 347,790	$ 155,961	$ 191,829	$ 9,591	$ 2,369,529	$ 71,086	$ 111,152	$ 347
2015	$ 365,180	$ 160,640	$ 204,540	$ 10,227	$ 2,516,282	$ 75,488	$ 118,825	$ 371
2016	$ 383,439	$ 165,459	$ 217,980	$ 10,899	$ 2,674,519	$ 80,236	$ 126,845	$ 396
2017	$ 402,611	$ 170,423	$ 232,188	$ 11,609	$ 2,844,932	$ 85,348	$ 135,231	$ 423

Table C.12: **Blueberry Payment Capacity**

Representative Farm:	Blueberries (20 acres)							
Year	**Gross Income**	**Annual Farm Costs**	**Net Income**	**Return to Management (10%)**	**Net Worth/Equity**	**Return to Equity (3%)**	**Total Payment Capacity**	**Per-Acre Payment Capacity**
2013	$ 193,323	$ 69,181	$ 124,142	$ 12,414	$ 642,260	$ 19,268	$ 92,460	$ 4,623
2014	$ 193,323	$ 71,206	$ 122,117	$ 12,212	$ 765,662	$ 22,970	$ 86,935	$ 4,347
2015	$ 193,323	$ 73,292	$ 120,031	$ 12,003	$ 886,985	$ 26,610	$ 81,418	$ 4,071
2016	$ 193,323	$ 75,440	$ 117,883	$ 11,788	$ 1,006,166	$ 30,185	$ 75,910	$ 3,795
2017	$ 193,323	$ 77,654	$ 115,669	$ 11,567	$ 1,123,138	$ 33,694	$ 70,408	$ 3,520
Year	**Gross Income**	**Annual Farm Costs**	**Net Income**	**Return to Management (10%)**	**Net Worth/Equity**	**Return to Equity (2%)**	**Total Payment Capacity**	**Per-Acre Payment Capacity**
2013	$ 193,323	$ 69,181	$ 124,142	$ 12,414	$ 642,260	$ 12,845	$ 98,883	$ 4,944
2014	$ 193,323	$ 71,206	$ 122,117	$ 12,212	$ 765,662	$ 15,313	$ 94,592	$ 4,730
2015	$ 193,323	$ 73,292	$ 120,031	$ 12,003	$ 886,985	$ 17,740	$ 90,288	$ 4,514
2016	$ 193,323	$ 75,440	$ 117,883	$ 11,788	$ 1,006,166	$ 20,123	$ 85,971	$ 4,299
2017	$ 193,323	$ 77,654	$ 115,669	$ 11,567	$ 1,123,138	$ 22,463	$ 81,639	$ 4,082
Year	**Gross Income**	**Annual Farm Costs**	**Net Income**	**Return to Management (5%)**	**Net Worth/Equity**	**Return to Equity (3%)**	**Total Payment Capacity**	**Per-Acre Payment Capacity**
2013	$ 193,323	$ 69,181	$ 124,142	$ 6,207	$ 642,260	$ 19,268	$ 98,667	$ 4,933
2014	$ 193,323	$ 71,206	$ 122,117	$ 6,106	$ 765,662	$ 22,970	$ 93,041	$ 4,652
2015	$ 193,323	$ 73,292	$ 120,031	$ 6,002	$ 886,985	$ 26,610	$ 87,420	$ 4,371
2016	$ 193,323	$ 75,440	$ 117,883	$ 5,894	$ 1,006,166	$ 30,185	$ 81,804	$ 4,090
2017	$ 193,323	$ 77,654	$ 115,669	$ 5,783	$ 1,123,138	$ 33,694	$ 76,191	$ 3,810

Table C.13: **Blueberry Payment Capacity (1% Farm-Gate Price Increase)**

Representative Farm:	Blueberries (20 acres)							
Year	**Gross Income**	**Annual Farm Costs**	**Net Income**	**Return to Management (10%)**	**Net Worth/Equity**	**Return to Equity (3%)**	**Total Payment Capacity**	**Per-Acre Payment Capacity**
2013	$ 195,256	$ 69,181	$ 126,075	$ 12,608	$ 644,193	$ 19,326	$ 94,142	$ 4,707
2014	$ 197,209	$ 71,206	$ 126,003	$ 12,600	$ 771,481	$ 23,144	$ 90,258	$ 4,513
2015	$ 199,181	$ 73,292	$ 125,889	$ 12,589	$ 898,662	$ 26,960	$ 86,340	$ 4,317
2016	$ 201,173	$ 75,440	$ 125,733	$ 12,573	$ 1,025,692	$ 30,771	$ 82,389	$ 4,119
2017	$ 203,185	$ 77,654	$ 125,531	$ 12,553	$ 1,152,526	$ 34,576	$ 78,402	$ 3,920
Year	**Gross Income**	**Annual Farm Costs**	**Net Income**	**Return to Management (10%)**	**Net Worth/Equity**	**Return to Equity (2%)**	**Total Payment Capacity**	**Per-Acre Payment Capacity**
2013	$ 195,256	$ 69,181	$ 126,075	$ 12,608	$ 644,193	$ 12,884	$ 100,584	$ 5,029
2014	$ 197,209	$ 71,206	$ 126,003	$ 12,600	$ 771,481	$ 15,430	$ 97,973	$ 4,899
2015	$ 199,181	$ 73,292	$ 125,889	$ 12,589	$ 898,662	$ 17,973	$ 95,327	$ 4,766
2016	$ 201,173	$ 75,440	$ 125,733	$ 12,573	$ 1,025,692	$ 20,514	$ 92,646	$ 4,632
2017	$ 203,185	$ 77,654	$ 125,531	$ 12,553	$ 1,152,526	$ 23,051	$ 89,927	$ 4,496
Year	**Gross Income**	**Annual Farm Costs**	**Net Income**	**Return to Management (5%)**	**Net Worth/Equity**	**Return to Equity (3%)**	**Total Payment Capacity**	**Per-Acre Payment Capacity**
2013	$ 195,256	$ 69,181	$ 126,075	$ 6,304	$ 644,193	$ 19,326	$ 100,445	$ 5,022
2014	$ 197,209	$ 71,206	$ 126,003	$ 6,300	$ 771,481	$ 23,144	$ 96,558	$ 4,828
2015	$ 199,181	$ 73,292	$ 125,889	$ 6,294	$ 898,662	$ 26,960	$ 92,635	$ 4,632
2016	$ 201,173	$ 75,440	$ 125,733	$ 6,287	$ 1,025,692	$ 30,771	$ 88,676	$ 4,434
2017	$ 203,185	$ 77,654	$ 125,531	$ 6,277	$ 1,152,526	$ 34,576	$ 84,679	$ 4,234

Table C.14: **Blueberry Payment Capacity (3% Farm-Gate Price Increase)**

Representative Farm:	Blueberries (20 acres)							
Year	**Gross Income**	**Annual Farm Costs**	**Net Income**	**Return to Management (10%)**	**Net Worth/Equity**	**Return to Equity (3%)**	**Total Payment Capacity**	**Per-Acre Payment Capacity**
2013	$ 199,123	$ 69,181	$ 129,942	$ 12,994	$ 648,059	$ 19,442	$ 97,506	$ 4,875
2014	$ 205,097	$ 71,206	$ 133,891	$ 13,389	$ 783,235	$ 23,497	$ 97,005	$ 4,850
2015	$ 211,249	$ 73,292	$ 137,957	$ 13,796	$ 922,485	$ 27,675	$ 96,487	$ 4,824
2016	$ 217,587	$ 75,440	$ 142,147	$ 14,215	$ 1,064,929	$ 31,948	$ 95,984	$ 4,799
2017	$ 224,115	$ 77,654	$ 146,461	$ 14,646	$ 1,213,692	$ 36,411	$ 95,404	$ 4,770
Year	**Gross Income**	**Annual Farm Costs**	**Net Income**	**Return to Management (10%)**	**Net Worth/Equity**	**Return to Equity (2%)**	**Total Payment Capacity**	**Per-Acre Payment Capacity**
2013	$ 199,123	$ 69,181	$ 129,942	$ 12,994	$ 648,059	$ 12,961	$ 103,987	$ 5,199
2014	$ 205,097	$ 71,206	$ 133,891	$ 13,389	$ 783,235	$ 15,665	$ 104,837	$ 5,242
2015	$ 211,249	$ 73,292	$ 137,957	$ 13,796	$ 922,485	$ 18,450	$ 105,712	$ 5,286
2016	$ 217,587	$ 75,440	$ 142,147	$ 14,215	$ 1,064,929	$ 21,299	$ 106,634	$ 5,332
2017	$ 224,115	$ 77,654	$ 146,461	$ 14,646	$ 1,213,692	$ 24,274	$ 107,541	$ 5,377
Year	**Gross Income**	**Annual Farm Costs**	**Net Income**	**Return to Management (5%)**	**Net Worth/Equity**	**Return to Equity (3%)**	**Total Payment Capacity**	**Per-Acre Payment Capacity**
2013	$ 199,123	$ 69,181	$ 129,942	$ 6,497	$ 648,059	$ 19,442	$ 104,003	$ 5,200
2014	$ 205,097	$ 71,206	$ 133,891	$ 6,695	$ 783,235	$ 23,497	$ 103,699	$ 5,185
2015	$ 211,249	$ 73,292	$ 137,957	$ 6,898	$ 922,485	$ 27,675	$ 103,385	$ 5,169
2016	$ 217,587	$ 75,440	$ 142,147	$ 7,107	$ 1,064,929	$ 31,948	$ 103,092	$ 5,155
2017	$ 224,115	$ 77,654	$ 146,461	$ 7,323	$ 1,213,692	$ 36,411	$ 102,727	$ 5,136

Table C.15: **Blueberry Payment Capacity (5% Farm-Gate Price Increase)**

Representative Farm:	Blueberries (20 acres)							
Year	**Gross Income**	**Annual Farm Costs**	**Net Income**	**Return to Management (10%)**	**Net Worth/Equity**	**Return to Equity (3%)**	**Total Payment Capacity**	**Per-Acre Payment Capacity**
2013	$ 202,989	$ 69,181	$ 133,808	$ 13,381	$ 651,926	$ 19,558	$ 100,869	$ 5,043
2014	$ 213,139	$ 71,206	$ 141,933	$ 14,193	$ 795,144	$ 23,854	$ 103,885	$ 5,194
2015	$ 223,796	$ 73,292	$ 150,504	$ 15,050	$ 946,940	$ 28,408	$ 107,045	$ 5,352
2016	$ 234,986	$ 75,440	$ 159,546	$ 15,955	$ 1,107,783	$ 33,233	$ 110,358	$ 5,518
2017	$ 246,735	$ 77,654	$ 169,081	$ 16,908	$ 1,278,166	$ 38,345	$ 113,828	$ 5,691
Year	**Gross Income**	**Annual Farm Costs**	**Net Income**	**Return to Management (10%)**	**Net Worth/Equity**	**Return to Equity (2%)**	**Total Payment Capacity**	**Per-Acre Payment Capacity**
2013	$ 202,989	$ 69,181	$ 133,808	$ 13,381	$ 651,926	$ 13,039	$ 107,389	$ 5,369
2014	$ 213,139	$ 71,206	$ 141,933	$ 14,193	$ 795,144	$ 15,903	$ 111,837	$ 5,592
2015	$ 223,796	$ 73,292	$ 150,504	$ 15,050	$ 946,940	$ 18,939	$ 116,515	$ 5,826
2016	$ 234,986	$ 75,440	$ 159,546	$ 15,955	$ 1,107,783	$ 22,156	$ 121,436	$ 6,072
2017	$ 246,735	$ 77,654	$ 169,081	$ 16,908	$ 1,278,166	$ 25,563	$ 126,610	$ 6,330
Year	**Gross Income**	**Annual Farm Costs**	**Net Income**	**Return to Management (5%)**	**Net Worth/Equity**	**Return to Equity (3%)**	**Total Payment Capacity**	**Per-Acre Payment Capacity**
2013	$ 202,989	$ 69,181	$ 133,808	$ 6,690	$ 651,926	$ 19,558	$ 107,560	$ 5,378
2014	$ 213,139	$ 71,206	$ 141,933	$ 7,097	$ 795,144	$ 23,854	$ 110,982	$ 5,549
2015	$ 223,796	$ 73,292	$ 150,504	$ 7,525	$ 946,940	$ 28,408	$ 114,571	$ 5,729
2016	$ 234,986	$ 75,440	$ 159,546	$ 7,977	$ 1,107,783	$ 33,233	$ 118,335	$ 5,917
2017	$ 246,735	$ 77,654	$ 169,081	$ 8,454	$ 1,278,166	$ 38,345	$ 122,282	$ 6,114

Table C.16: **Fresh Vegetable Payment Capacity**

Representative Farm:	Fresh Vegetables (100 acres)							
Year	**Gross Income**	**Annual Farm Costs**	**Net Income**	**Return to Management (10%)**	**Net Worth/Equity**	**Return to Equity (3%)**	**Total Payment Capacity**	**Per-Acre Payment Capacity**
2013	$ 1,350,000	$ 968,363	$ 381,637	$ 38,164	$ 1,654,534	$ 49,636	$ 293,837	$ 2,938
2014	$ 1,350,000	$ 993,904	$ 356,096	$ 35,610	$ 2,001,722	$ 60,052	$ 260,435	$ 2,604
2015	$ 1,350,000	$ 1,020,211	$ 329,789	$ 32,979	$ 2,322,286	$ 69,669	$ 227,142	$ 2,271
2016	$ 1,350,000	$ 1,047,307	$ 302,693	$ 30,269	$ 2,615,424	$ 78,463	$ 193,961	$ 1,940
2017	$ 1,350,000	$ 1,075,216	$ 274,784	$ 27,478	$ 2,880,309	$ 86,409	$ 160,896	$ 1,609
Year	**Gross Income**	**Annual Farm Costs**	**Net Income**	**Return to Management (10%)**	**Net Worth/Equity**	**Return to Equity (2%)**	**Total Payment Capacity**	**Per-Acre Payment Capacity**
2013	$ 1,353,000	$ 968,363	$ 384,637	$ 38,464	$ 1,654,534	$ 33,091	$ 313,083	$ 3,131
2014	$ 1,350,000	$ 993,904	$ 356,096	$ 35,610	$ 2,001,722	$ 40,034	$ 280,452	$ 2,805
2015	$ 1,350,000	$ 1,020,211	$ 329,789	$ 32,979	$ 2,322,286	$ 46,446	$ 250,364	$ 2,504
2016	$ 1,350,000	$ 1,047,307	$ 302,693	$ 30,269	$ 2,615,424	$ 52,308	$ 220,115	$ 2,201
2017	$ 1,350,000	$ 1,075,216	$ 274,784	$ 27,478	$ 2,880,309	$ 57,606	$ 189,699	$ 1,897
Year	**Gross Income**	**Annual Farm Costs**	**Net Income**	**Return to Management (5%)**	**Net Worth/Equity**	**Return to Equity (3%)**	**Total Payment Capacity**	**Per-Acre Payment Capacity**
2013	$ 1,353,000	$ 968,363	$ 384,637	$ 19,232	$ 1,654,534	$ 49,636	$ 315,769	$ 3,158
2014	$ 1,350,000	$ 993,904	$ 356,096	$ 17,805	$ 2,001,722	$ 60,052	$ 278,240	$ 2,782
2015	$ 1,350,000	$ 1,020,211	$ 329,789	$ 16,489	$ 2,322,286	$ 69,669	$ 243,631	$ 2,436
2016	$ 1,350,000	$ 1,047,307	$ 302,693	$ 15,135	$ 2,615,424	$ 78,463	$ 209,096	$ 2,091
2017	$ 1,350,000	$ 1,075,216	$ 274,784	$ 13,739	$ 2,880,309	$ 86,409	$ 174,636	$ 1,746

Table C.17: **Fresh Vegetable Payment Capacity (1% Farm-Gate Price Increase)**

Representative Farm:	Fresh Vegetables (100 acres)							
Year	**Gross Income**	**Annual Farm Costs**	**Net Income**	**Return to Management (10%)**	**Net Worth/Equity**	**Return to Equity (3%)**	**Total Payment Capacity**	**Per-Acre Payment Capacity**
2013	$ 1,363,500	$ 968,363	$ 395,137	$ 39,514	$ 1,668,034	$ 50,041	$ 305,582	$ 3,056
2014	$ 1,377,135	$ 993,904	$ 383,231	$ 38,323	$ 2,042,357	$ 61,271	$ 283,637	$ 2,836
2015	$ 1,390,906	$ 1,020,211	$ 370,695	$ 37,070	$ 2,403,828	$ 72,115	$ 261,511	$ 2,615
2016	$ 1,404,815	$ 1,047,307	$ 357,508	$ 35,751	$ 2,751,781	$ 82,553	$ 239,204	$ 2,392
2017	$ 1,418,864	$ 1,075,216	$ 343,648	$ 34,365	$ 3,085,529	$ 92,566	$ 216,717	$ 2,167
Year	**Gross Income**	**Annual Farm Costs**	**Net Income**	**Return to Management (10%)**	**Net Worth/Equity**	**Return to Equity (2%)**	**Total Payment Capacity**	**Per-Acre Payment Capacity**
2013	$ 1,363,500	$ 968,363	$ 395,137	$ 39,514	$ 1,668,034	$ 33,361	$ 322,263	$ 3,223
2014	$ 1,377,135	$ 993,904	$ 383,231	$ 38,323	$ 2,042,357	$ 40,847	$ 304,061	$ 3,041
2015	$ 1,390,906	$ 1,020,211	$ 370,695	$ 37,070	$ 2,403,828	$ 48,077	$ 285,549	$ 2,855
2016	$ 1,404,815	$ 1,047,307	$ 357,508	$ 35,751	$ 2,751,781	$ 55,036	$ 266,722	$ 2,667
2017	$ 1,418,864	$ 1,075,216	$ 343,648	$ 34,365	$ 3,085,529	$ 61,711	$ 247,573	$ 2,476
Year	**Gross Income**	**Annual Farm Costs**	**Net Income**	**Return to Management (5%)**	**Net Worth/Equity**	**Return to Equity (3%)**	**Total Payment Capacity**	**Per-Acre Payment Capacity**
2013	$ 1,363,500	$ 968,363	$ 395,137	$ 19,757	$ 1,668,034	$ 50,041	$ 325,339	$ 3,253
2014	$ 1,377,135	$ 993,904	$ 383,231	$ 19,162	$ 2,042,357	$ 61,271	$ 302,799	$ 3,028
2015	$ 1,390,906	$ 1,020,211	$ 370,695	$ 18,535	$ 2,403,828	$ 72,115	$ 280,045	$ 2,800
2016	$ 1,404,815	$ 1,047,307	$ 357,508	$ 17,875	$ 2,751,781	$ 82,553	$ 257,079	$ 2,571
2017	$ 1,418,864	$ 1,075,216	$ 343,648	$ 17,182	$ 3,085,529	$ 92,566	$ 233,900	$ 2,339

Table C.18: **Fresh Vegetable Payment Capacity (3% Farm-Gate Price Increase)**

Representative Farm:	Fresh Vegetables (100 acres)							
Year	**Gross Income**	**Annual Farm Costs**	**Net Income**	**Return to Management (10%)**	**Net Worth/Equity**	**Return to Equity (3%)**	**Total Payment Capacity**	**Per-Acre Payment Capacity**
2013	$ 1,390,500	$ 968,363	$ 422,137	$ 42,214	$ 1,695,034	$ 50,851	$ 329,072	$ 3,291
2014	$ 1,432,215	$ 993,904	$ 438,311	$ 43,831	$ 2,124,437	$ 63,733	$ 330,747	$ 3,307
2015	$ 1,475,181	$ 1,020,211	$ 454,970	$ 45,497	$ 2,570,183	$ 77,105	$ 332,368	$ 3,324
2016	$ 1,519,437	$ 1,047,307	$ 472,130	$ 47,213	$ 3,032,758	$ 90,983	$ 333,934	$ 3,339
2017	$ 1,565,020	$ 1,075,216	$ 489,804	$ 48,980	$ 3,512,662	$ 105,380	$ 335,444	$ 3,354
Year	**Gross Income**	**Annual Farm Costs**	**Net Income**	**Return to Management (10%)**	**Net Worth/Equity**	**Return to Equity (2%)**	**Total Payment Capacity**	**Per-Acre Payment Capacity**
2013	$ 1,390,500	$ 968,363	$ 422,137	$ 42,214	$ 1,695,034	$ 33,901	$ 346,023	$ 3,460
2014	$ 1,432,215	$ 993,904	$ 438,311	$ 43,831	$ 2,124,437	$ 42,489	$ 351,991	$ 3,520
2015	$ 1,475,181	$ 1,020,211	$ 454,970	$ 45,497	$ 2,570,183	$ 51,404	$ 358,069	$ 3,581
2016	$ 1,519,437	$ 1,047,307	$ 472,130	$ 47,213	$ 3,032,758	$ 60,655	$ 364,262	$ 3,643
2017	$ 1,565,020	$ 1,075,216	$ 489,804	$ 48,980	$ 3,512,662	$ 70,253	$ 370,570	$ 3,706
Year	**Gross Income**	**Annual Farm Costs**	**Net Income**	**Return to Management (5%)**	**Net Worth/Equity**	**Return to Equity (3%)**	**Total Payment Capacity**	**Per-Acre Payment Capacity**
2013	$ 1,390,500	$ 968,363	$ 422,137	$ 21,107	$ 1,695,034	$ 50,851	$ 350,179	$ 3,502
2014	$ 1,432,215	$ 993,904	$ 438,311	$ 21,916	$ 2,124,437	$ 63,733	$ 352,662	$ 3,527
2015	$ 1,475,181	$ 1,020,211	$ 454,970	$ 22,749	$ 2,570,183	$ 77,105	$ 355,116	$ 3,551
2016	$ 1,519,437	$ 1,047,307	$ 472,130	$ 23,607	$ 3,032,758	$ 90,983	$ 357,541	$ 3,575
2017	$ 1,565,020	$ 1,075,216	$ 489,804	$ 24,490	$ 3,512,662	$ 105,380	$ 359,934	$ 3,599

Table C.19: **Fresh Vegetable Payment Capacity (5% Farm-Gate Price Increase)**

Representative Farm:	Fresh Vegetables (100 acres)							
Year	**Gross Income**	**Annual Farm Costs**	**Net Income**	**Return to Management (10%)**	**Net Worth/Equity**	**Return to Equity (3%)**	**Total Payment Capacity**	**Per-Acre Payment Capacity**
2013	$ 1,417,500	$ 968,363	$ 449,137	$ 44,914	$ 1,722,034	$ 51,661	$ 352,562	$ 3,526
2014	$ 1,488,375	$ 993,904	$ 494,471	$ 49,447	$ 2,207,597	$ 66,228	$ 378,796	$ 3,788
2015	$ 1,562,794	$ 1,020,211	$ 542,583	$ 54,258	$ 2,740,955	$ 82,229	$ 406,096	$ 4,061
2016	$ 1,640,933	$ 1,047,307	$ 593,626	$ 59,363	$ 3,325,026	$ 99,751	$ 434,513	$ 4,345
2017	$ 1,722,980	$ 1,075,216	$ 647,764	$ 64,776	$ 3,962,891	$ 118,887	$ 464,101	$ 4,641
Year	**Gross Income**	**Annual Farm Costs**	**Net Income**	**Return to Management (10%)**	**Net Worth/Equity**	**Return to Equity (2%)**	**Total Payment Capacity**	**Per-Acre Payment Capacity**
2013	$ 1,417,500	$ 968,363	$ 449,137	$ 44,914	$ 1,722,034	$ 34,441	$ 369,783	$ 3,698
2014	$ 1,488,375	$ 993,904	$ 494,471	$ 49,447	$ 2,207,597	$ 44,152	$ 400,872	$ 4,009
2015	$ 1,562,794	$ 1,020,211	$ 542,583	$ 54,258	$ 2,740,955	$ 54,819	$ 433,506	$ 4,335
2016	$ 1,640,933	$ 1,047,307	$ 593,626	$ 59,363	$ 3,325,026	$ 66,501	$ 467,763	$ 4,678
2017	$ 1,722,980	$ 1,075,216	$ 647,764	$ 64,776	$ 3,962,891	$ 79,258	$ 503,730	$ 5,037
Year	**Gross Income**	**Annual Farm Costs**	**Net Income**	**Return to Management (5%)**	**Net Worth/Equity**	**Return to Equity (3%)**	**Total Payment Capacity**	**Per-Acre Payment Capacity**
2013	$ 1,417,500	$ 968,363	$ 449,137	$ 22,457	$ 1,722,034	$ 51,661	$ 375,019	$ 3,750
2014	$ 1,488,375	$ 993,904	$ 494,471	$ 24,724	$ 2,207,597	$ 66,228	$ 403,520	$ 4,035
2015	$ 1,562,794	$ 1,020,211	$ 542,583	$ 27,129	$ 2,740,955	$ 82,229	$ 433,225	$ 4,332
2016	$ 1,640,933	$ 1,047,307	$ 593,626	$ 29,681	$ 3,325,026	$ 99,751	$ 464,194	$ 4,642
2017	$ 1,722,980	$ 1,075,216	$ 647,764	$ 32,388	$ 3,962,891	$ 118,887	$ 496,489	$ 4,965

Table C.20: **Hazelnut Payment Capacity**

Representative Farm:	Hazelnuts (100 acres)							
Year	**Gross Income**	**Annual Farm Costs**	**Net Income**	**Return to Management (10%)**	**Net Worth/Equity**	**Return to Equity (3%)**	**Total Payment Capacity**	**Per-Acre Payment Capacity**
2013	$ 110,308	$ 57,198	$ 53,110	$ 5,311	$ 1,604,750	$ 48,143	$ (344)	$ (3)
2014	$ 120,336	$ 58,914	$ 61,422	$ 6,142	$ 1,665,284	$ 49,959	$ 5,321	$ 53
2015	$ 130,364	$ 60,681	$ 69,683	$ 6,968	$ 1,733,942	$ 52,018	$ 10,696	$ 107
2016	$ 140,392	$ 62,502	$ 77,890	$ 7,789	$ 1,810,664	$ 54,320	$ 15,781	$ 158
2017	$ 150,420	$ 64,377	$ 86,043	$ 8,604	$ 1,895,387	$ 56,862	$ 20,577	$ 206
Year	**Gross Income**	**Annual Farm Costs**	**Net Income**	**Return to Management (10%)**	**Net Worth/Equity**	**Return to Equity (2%)**	**Total Payment Capacity**	**Per-Acre Payment Capacity**
2013	$ 110,308	$ 57,198	$ 53,110	$ 5,311	$ 1,604,750	$ 32,095	$ 15,704	$ 157
2014	$ 120,336	$ 58,914	$ 61,422	$ 6,142	$ 1,665,284	$ 33,306	$ 21,974	$ 220
2015	$ 130,364	$ 60,681	$ 69,683	$ 6,968	$ 1,733,942	$ 34,679	$ 28,036	$ 280
2016	$ 140,392	$ 62,502	$ 77,890	$ 7,789	$ 1,810,664	$ 36,213	$ 33,888	$ 339
2017	$ 150,420	$ 64,377	$ 86,043	$ 8,604	$ 1,895,387	$ 37,908	$ 39,531	$ 395
Year	**Gross Income**	**Annual Farm Costs**	**Net Income**	**Return to Management (5%)**	**Net Worth/Equity**	**Return to Equity (3%)**	**Total Payment Capacity**	**Per-Acre Payment Capacity**
2013	$ 110,308	$ 57,198	$ 53,110	$ 2,656	$ 1,604,750	$ 48,143	$ 2,312	$ 23
2014	$ 120,336	$ 58,914	$ 61,422	$ 3,071	$ 1,665,284	$ 49,959	$ 8,392	$ 84
2015	$ 130,364	$ 60,681	$ 69,683	$ 3,484	$ 1,733,942	$ 52,018	$ 14,181	$ 142
2016	$ 140,392	$ 62,502	$ 77,890	$ 3,895	$ 1,810,664	$ 54,320	$ 19,676	$ 197
2017	$ 150,420	$ 64,377	$ 86,043	$ 4,302	$ 1,895,387	$ 56,862	$ 24,879	$ 249

Table C.21: **Hazelnut Payment Capacity (1% Farm-Gate Price Increase)**

Representative Farm:	Hazelnuts (100 acres)							
Year	**Gross Income**	**Annual Farm Costs**	**Net Income**	**Return to Management (10%)**	**Net Worth/Equity**	**Return to Equity (3%)**	**Total Payment Capacity**	**Per-Acre Payment Capacity**
2013	$ 111,411	$ 57,198	$ 54,213	$ 5,421	$ 1,605,853	$ 48,176	$ 616	$ 6
2014	$ 122,755	$ 58,914	$ 63,841	$ 6,384	$ 1,668,806	$ 50,064	$ 7,393	$ 74
2015	$ 134,314	$ 60,681	$ 73,633	$ 7,363	$ 1,741,414	$ 52,242	$ 14,027	$ 140
2016	$ 146,092	$ 62,502	$ 83,590	$ 8,359	$ 1,823,837	$ 54,715	$ 20,516	$ 205
2017	$ 158,093	$ 64,377	$ 93,716	$ 9,372	$ 1,916,232	$ 57,487	$ 26,857	$ 269
Year	**Gross Income**	**Annual Farm Costs**	**Net Income**	**Return to Management (10%)**	**Net Worth/Equity**	**Return to Equity (2%)**	**Total Payment Capacity**	**Per-Acre Payment Capacity**
2013	$ 111,411	$ 57,198	$ 54,213	$ 5,421	$ 1,605,853	$ 32,117	$ 16,675	$ 167
2014	$ 122,755	$ 58,914	$ 63,841	$ 6,384	$ 1,668,806	$ 33,376	$ 24,081	$ 241
2015	$ 134,314	$ 60,681	$ 73,633	$ 7,363	$ 1,741,414	$ 34,828	$ 31,441	$ 314
2016	$ 146,092	$ 62,502	$ 83,590	$ 8,359	$ 1,823,837	$ 36,477	$ 38,754	$ 388
2017	$ 158,093	$ 64,377	$ 93,716	$ 9,372	$ 1,916,232	$ 38,325	$ 46,020	$ 460
Year	**Gross Income**	**Annual Farm Costs**	**Net Income**	**Return to Management (5%)**	**Net Worth/Equity**	**Return to Equity (3%)**	**Total Payment Capacity**	**Per-Acre Payment Capacity**
2013	$ 111,411	$ 57,198	$ 54,213	$ 2,711	$ 1,605,853	$ 48,176	$ 3,327	$ 33
2014	$ 122,755	$ 58,914	$ 63,841	$ 3,192	$ 1,668,806	$ 50,064	$ 10,585	$ 106
2015	$ 134,314	$ 60,681	$ 73,633	$ 3,682	$ 1,741,414	$ 52,242	$ 17,709	$ 177
2016	$ 146,092	$ 62,502	$ 83,590	$ 4,180	$ 1,823,837	$ 54,715	$ 24,695	$ 247
2017	$ 158,093	$ 64,377	$ 93,716	$ 4,686	$ 1,916,232	$ 57,487	$ 31,543	$ 315

Table C.22: **Hazelnut Payment Capacity (3% Farm-Gate Price Increase)**

Representative Farm:	Hazelnuts (100 acres)							
Year	**Gross Income**	**Annual Farm Costs**	**Net Income**	**Return to Management (10%)**	**Net Worth/Equity**	**Return to Equity (3%)**	**Total Payment Capacity**	**Per-Acre Payment Capacity**
2013	$ 113,617	$ 57,198	$ 56,419	$ 5,642	$ 1,608,060	$ 48,242	$ 2,535	$ 25
2014	$ 127,664	$ 58,914	$ 68,750	$ 6,875	$ 1,675,922	$ 50,278	$ 11,597	$ 116
2015	$ 142,452	$ 60,681	$ 81,771	$ 8,177	$ 1,756,668	$ 52,700	$ 20,894	$ 209
2016	$ 158,012	$ 62,502	$ 95,510	$ 9,551	$ 1,851,011	$ 55,530	$ 30,429	$ 304
2017	$ 174,378	$ 64,377	$ 110,001	$ 11,000	$ 1,959,691	$ 58,791	$ 40,210	$ 402
Year	**Gross Income**	**Annual Farm Costs**	**Net Income**	**Return to Management (10%)**	**Net Worth/Equity**	**Return to Equity (2%)**	**Total Payment Capacity**	**Per-Acre Payment Capacity**
2013	$ 113,617	$ 57,198	$ 56,419	$ 5,642	$ 1,608,060	$ 32,161	$ 18,616	$ 186
2014	$ 127,664	$ 58,914	$ 68,750	$ 6,875	$ 1,675,922	$ 33,518	$ 28,357	$ 284
2015	$ 142,452	$ 60,681	$ 81,771	$ 8,177	$ 1,756,668	$ 35,133	$ 38,461	$ 385
2016	$ 158,012	$ 62,502	$ 95,510	$ 9,551	$ 1,851,011	$ 37,020	$ 48,939	$ 489
2017	$ 174,378	$ 64,377	$ 110,001	$ 11,000	$ 1,959,691	$ 39,194	$ 59,807	$ 598
Year	**Gross Income**	**Annual Farm Costs**	**Net Income**	**Return to Management (5%)**	**Net Worth/Equity**	**Return to Equity (3%)**	**Total Payment Capacity**	**Per-Acre Payment Capacity**
2013	$ 113,617	$ 57,198	$ 56,419	$ 2,821	$ 1,608,060	$ 48,242	$ 5,356	$ 54
2014	$ 127,664	$ 58,914	$ 68,750	$ 3,438	$ 1,675,922	$ 50,278	$ 15,035	$ 150
2015	$ 142,452	$ 60,681	$ 81,771	$ 4,089	$ 1,756,668	$ 52,700	$ 24,982	$ 250
2016	$ 158,012	$ 62,502	$ 95,510	$ 4,776	$ 1,851,011	$ 55,530	$ 35,204	$ 352
2017	$ 174,378	$ 64,377	$ 110,001	$ 5,500	$ 1,959,691	$ 58,791	$ 45,710	$ 457

Table C.23: **Hazelnut Payment Capacity (5% Farm-Gate Price Increase)**

Representative Farm:	Hazelnuts (100 acres)							
Year	**Gross Income**	**Annual Farm Costs**	**Net Income**	**Return to Management (10%)**	**Net Worth/Equity**	**Return to Equity (3%)**	**Total Payment Capacity**	**Per-Acre Payment Capacity**
2013	$ 115,823	$ 57,198	$ 58,625	$ 5,863	$ 1,610,266	$ 48,308	$ 4,455	$ 45
2014	$ 132,670	$ 58,914	$ 73,756	$ 7,376	$ 1,683,134	$ 50,494	$ 15,886	$ 159
2015	$ 150,913	$ 60,681	$ 90,232	$ 9,023	$ 1,772,341	$ 53,170	$ 28,039	$ 280
2016	$ 170,647	$ 62,502	$ 108,145	$ 10,815	$ 1,879,318	$ 56,380	$ 40,951	$ 410
2017	$ 191,978	$ 64,377	$ 127,601	$ 12,760	$ 2,005,599	$ 60,168	$ 54,673	$ 547
Year	**Gross Income**	**Annual Farm Costs**	**Net Income**	**Return to Management (10%)**	**Net Worth/Equity**	**Return to Equity (2%)**	**Total Payment Capacity**	**Per-Acre Payment Capacity**
2013	$ 115,823	$ 57,198	$ 58,625	$ 5,863	$ 1,610,266	$ 32,205	$ 20,557	$ 206
2014	$ 132,670	$ 58,914	$ 73,756	$ 7,376	$ 1,683,134	$ 33,663	$ 32,718	$ 327
2015	$ 150,913	$ 60,681	$ 90,232	$ 9,023	$ 1,772,341	$ 35,447	$ 45,762	$ 458
2016	$ 170,647	$ 62,502	$ 108,145	$ 10,815	$ 1,879,318	$ 37,586	$ 59,744	$ 597
2017	$ 191,978	$ 64,377	$ 127,601	$ 12,760	$ 2,005,599	$ 40,112	$ 74,729	$ 747
Year	**Gross Income**	**Annual Farm Costs**	**Net Income**	**Return to Management (5%)**	**Net Worth/Equity**	**Return to Equity (3%)**	**Total Payment Capacity**	**Per-Acre Payment Capacity**
2013	$ 115,823	$ 57,198	$ 58,625	$ 2,931	$ 1,610,266	$ 48,308	$ 7,386	$ 74
2014	$ 132,670	$ 58,914	$ 73,756	$ 3,688	$ 1,683,134	$ 50,494	$ 19,574	$ 196
2015	$ 150,913	$ 60,681	$ 90,232	$ 4,512	$ 1,772,341	$ 53,170	$ 32,550	$ 326
2016	$ 170,647	$ 62,502	$ 108,145	$ 5,407	$ 1,879,318	$ 56,380	$ 46,358	$ 464
2017	$ 191,978	$ 64,377	$ 127,601	$ 6,380	$ 2,005,599	$ 60,168	$ 61,053	$ 611

Table C.24: **Hops Payment Capacity**

Representative Farm:	Hops (660 acres)							
Year	**Gross Income**	**Annual Farm Costs**	**Net Income**	**Return to Management (10%)**	**Net Worth/Equity**	**Return to Equity (3%)**	**Total Payment Capacity**	**Per-Acre Payment Capacity**
2013	$ 3,784,070	$ 2,559,992	$ 1,224,078	$ 122,408	$ 15,641,314	$ 469,239	$ 632,431	$ 958
2014	$ 3,784,070	$ 2,636,792	$ 1,147,278	$ 114,728	$ 16,568,499	$ 497,055	$ 535,495	$ 811
2015	$ 3,784,070	$ 2,715,895	$ 1,068,175	$ 106,818	$ 17,408,420	$ 522,253	$ 439,105	$ 665
2016	$ 3,784,070	$ 2,797,372	$ 986,698	$ 98,670	$ 18,158,362	$ 544,751	$ 343,277	$ 520
2017	$ 3,784,070	$ 2,881,293	$ 902,777	$ 90,278	$ 18,815,523	$ 564,466	$ 248,034	$ 376
Year	**Gross Income**	**Annual Farm Costs**	**Net Income**	**Return to Management (10%)**	**Net Worth/Equity**	**Return to Equity (2%)**	**Total Payment Capacity**	**Per-Acre Payment Capacity**
2013	$ 3,784,070	$ 2,559,992	$ 1,224,078	$ 122,408	$ 15,641,314	$ 312,826	$ 788,844	$ 1,195
2014	$ 3,784,070	$ 2,636,792	$ 1,147,278	$ 114,728	$ 16,568,499	$ 331,370	$ 701,180	$ 1,062
2015	$ 3,784,070	$ 2,715,895	$ 1,068,175	$ 106,818	$ 17,408,420	$ 348,168	$ 613,189	$ 929
2016	$ 3,784,070	$ 2,797,372	$ 986,698	$ 98,670	$ 18,158,362	$ 363,167	$ 524,861	$ 795
2017	$ 3,784,070	$ 2,881,293	$ 902,777	$ 90,278	$ 18,815,523	$ 376,310	$ 436,189	$ 661
Year	**Gross Income**	**Annual Farm Costs**	**Net Income**	**Return to Management (5%)**	**Net Worth/Equity**	**Return to Equity (3%)**	**Total Payment Capacity**	**Per-Acre Payment Capacity**
2013	$ 3,784,070	$ 2,559,992	$ 1,224,078	$ 61,204	$ 15,641,314	$ 469,239	$ 693,635	$ 1,051
2014	$ 3,784,070	$ 2,636,792	$ 1,147,278	$ 57,364	$ 16,568,499	$ 497,055	$ 592,859	$ 898
2015	$ 3,784,070	$ 2,715,895	$ 1,068,175	$ 53,409	$ 17,408,420	$ 522,253	$ 492,514	$ 746
2016	$ 3,784,070	$ 2,797,372	$ 986,698	$ 49,335	$ 18,158,362	$ 544,751	$ 392,612	$ 595
2017	$ 3,784,070	$ 2,881,293	$ 902,777	$ 45,139	$ 18,815,523	$ 564,466	$ 293,172	$ 444

Table C.24: **Hops Payment Capacity (1% Farm-Gate Price Increase)**

Representative Farm:	Hops (660 acres)							
Year	**Gross Income**	**Annual Farm Costs**	**Net Income**	**Return to Management (10%)**	**Net Worth/Equity**	**Return to Equity (3%)**	**Total Payment Capacity**	**Per-Acre Payment Capacity**
2013	$ 3,821,911	$ 2,559,992	$ 1,261,919	$ 126,192	$ 15,679,154	$ 470,375	$ 665,352	$ 1,008
2014	$ 3,860,130	$ 2,636,792	$ 1,223,338	$ 122,334	$ 16,682,399	$ 500,472	$ 600,532	$ 910
2015	$ 3,898,732	$ 2,715,895	$ 1,182,837	$ 118,284	$ 17,636,982	$ 529,109	$ 535,444	$ 811
2016	$ 3,937,719	$ 2,797,372	$ 1,140,347	$ 114,035	$ 18,540,572	$ 556,217	$ 470,095	$ 712
2017	$ 3,977,096	$ 2,881,293	$ 1,095,803	$ 109,580	$ 19,390,758	$ 581,723	$ 404,500	$ 613
Year	**Gross Income**	**Annual Farm Costs**	**Net Income**	**Return to Management (10%)**	**Net Worth/Equity**	**Return to Equity (2%)**	**Total Payment Capacity**	**Per-Acre Payment Capacity**
2013	$ 3,821,911	$ 2,559,992	$ 1,261,919	$ 126,192	$ 15,679,154	$ 313,583	$ 822,144	$ 1,246
2014	$ 3,860,130	$ 2,636,792	$ 1,223,338	$ 122,334	$ 16,682,399	$ 333,648	$ 767,356	$ 1,163
2015	$ 3,898,732	$ 2,715,895	$ 1,182,837	$ 118,284	$ 17,636,982	$ 352,740	$ 711,814	$ 1,079
2016	$ 3,937,719	$ 2,797,372	$ 1,140,347	$ 114,035	$ 18,540,572	$ 370,811	$ 655,501	$ 993
2017	$ 3,977,096	$ 2,881,293	$ 1,095,803	$ 109,580	$ 19,390,758	$ 387,815	$ 598,408	$ 907
Year	**Gross Income**	**Annual Farm Costs**	**Net Income**	**Return to Management (5%)**	**Net Worth/Equity**	**Return to Equity (3%)**	**Total Payment Capacity**	**Per-Acre Payment Capacity**
2013	$ 3,821,911	$ 2,559,992	$ 1,261,919	$ 63,096	$ 15,679,154	$ 470,375	$ 728,448	$ 1,104
2014	$ 3,860,130	$ 2,636,792	$ 1,223,338	$ 61,167	$ 16,682,399	$ 500,472	$ 661,699	$ 1,003
2015	$ 3,898,732	$ 2,715,895	$ 1,182,837	$ 59,142	$ 17,636,982	$ 529,109	$ 594,586	$ 901
2016	$ 3,937,719	$ 2,797,372	$ 1,140,347	$ 57,017	$ 18,540,572	$ 556,217	$ 527,112	$ 799
2017	$ 3,977,096	$ 2,881,293	$ 1,095,803	$ 54,790	$ 19,390,758	$ 581,723	$ 459,290	$ 696

Table C.24: **Hops Payment Capacity (3% Farm-Gate Price Increase)**

Representative Farm:	Hops (660 acres)							
Year	**Gross Income**	**Annual Farm Costs**	**Net Income**	**Return to Management (10%)**	**Net Worth/Equity**	**Return to Equity (3%)**	**Total Payment Capacity**	**Per-Acre Payment Capacity**
2013	$ 3,897,593	$ 2,559,992	$ 1,337,601	$ 133,760	$ 15,754,836	$ 472,645	$ 731,196	$ 1,108
2014	$ 4,014,520	$ 2,636,792	$ 1,377,728	$ 137,773	$ 16,912,471	$ 507,374	$ 732,581	$ 1,110
2015	$ 4,134,956	$ 2,715,895	$ 1,419,061	$ 141,906	$ 18,103,278	$ 543,098	$ 734,057	$ 1,112
2016	$ 4,259,005	$ 2,797,372	$ 1,461,633	$ 146,163	$ 19,328,154	$ 579,845	$ 735,625	$ 1,115
2017	$ 4,386,775	$ 2,881,293	$ 1,505,482	$ 150,548	$ 20,588,019	$ 617,641	$ 737,293	$ 1,117
Year	**Gross Income**	**Annual Farm Costs**	**Net Income**	**Return to Management (10%)**	**Net Worth/Equity**	**Return to Equity (2%)**	**Total Payment Capacity**	**Per-Acre Payment Capacity**
2013	$ 3,897,593	$ 2,559,992	$ 1,337,601	$ 133,760	$ 15,754,836	$ 315,097	$ 888,744	$ 1,347
2014	$ 4,014,520	$ 2,636,792	$ 1,377,728	$ 137,773	$ 16,912,471	$ 338,249	$ 901,706	$ 1,366
2015	$ 4,134,956	$ 2,715,895	$ 1,419,061	$ 141,906	$ 18,103,278	$ 362,066	$ 915,089	$ 1,386
2016	$ 4,259,005	$ 2,797,372	$ 1,461,633	$ 146,163	$ 19,328,154	$ 386,563	$ 928,907	$ 1,407
2017	$ 4,386,775	$ 2,881,293	$ 1,505,482	$ 150,548	$ 20,588,019	$ 411,760	$ 943,173	$ 1,429
Year	**Gross Income**	**Annual Farm Costs**	**Net Income**	**Return to Management (5%)**	**Net Worth/Equity**	**Return to Equity (3%)**	**Total Payment Capacity**	**Per-Acre Payment Capacity**
2013	$ 3,897,593	$ 2,559,992	$ 1,337,601	$ 66,880	$ 15,754,836	$ 472,645	$ 798,076	$ 1,209
2014	$ 4,014,520	$ 2,636,792	$ 1,377,728	$ 68,886	$ 16,912,471	$ 507,374	$ 801,467	$ 1,214
2015	$ 4,134,956	$ 2,715,895	$ 1,419,061	$ 70,953	$ 18,103,278	$ 543,098	$ 805,010	$ 1,220
2016	$ 4,259,005	$ 2,797,372	$ 1,461,633	$ 73,082	$ 19,328,154	$ 579,845	$ 808,707	$ 1,225
2017	$ 4,386,775	$ 2,881,293	$ 1,505,482	$ 75,274	$ 20,588,019	$ 617,641	$ 812,567	$ 1,231

Table C.24: **Hops Payment Capacity (5% Farm-Gate Price Increase)**

Representative Farm:	Hops (660 acres)							
Year	**Gross Income**	**Annual Farm Costs**	**Net Income**	**Return to Management (10%)**	**Net Worth/Equity**	**Return to Equity (3%)**	**Total Payment Capacity**	**Per-Acre Payment Capacity**
2013	$ 3,973,274	$ 2,559,992	$ 1,413,282	$ 141,328	$ 15,830,517	$ 474,916	$ 797,038	$ 1,208
2014	$ 4,171,938	$ 2,636,792	$ 1,535,146	$ 153,515	$ 17,145,569	$ 514,367	$ 867,264	$ 1,314
2015	$ 4,380,534	$ 2,715,895	$ 1,664,639	$ 166,464	$ 18,581,955	$ 557,459	$ 940,716	$ 1,425
2016	$ 4,599,561	$ 2,797,372	$ 1,802,189	$ 180,219	$ 20,147,388	$ 604,422	$ 1,017,548	$ 1,542
2017	$ 4,829,539	$ 2,881,293	$ 1,948,246	$ 194,825	$ 21,850,017	$ 655,501	$ 1,097,921	$ 1,664
Year	**Gross Income**	**Annual Farm Costs**	**Net Income**	**Return to Management (10%)**	**Net Worth/Equity**	**Return to Equity (2%)**	**Total Payment Capacity**	**Per-Acre Payment Capacity**
2013	$ 3,973,274	$ 2,559,992	$ 1,413,282	$ 141,328	$ 15,830,517	$ 316,610	$ 955,343	$ 1,447
2014	$ 4,171,938	$ 2,636,792	$ 1,535,146	$ 153,515	$ 17,145,569	$ 342,911	$ 1,038,720	$ 1,574
2015	$ 4,380,534	$ 2,715,895	$ 1,664,639	$ 166,464	$ 18,581,955	$ 371,639	$ 1,126,536	$ 1,707
2016	$ 4,599,561	$ 2,797,372	$ 1,802,189	$ 180,219	$ 20,147,388	$ 402,948	$ 1,219,022	$ 1,847
2017	$ 4,829,539	$ 2,881,293	$ 1,948,246	$ 194,825	$ 21,850,017	$ 437,000	$ 1,316,421	$ 1,995
Year	**Gross Income**	**Annual Farm Costs**	**Net Income**	**Return to Management (5%)**	**Net Worth/Equity**	**Return to Equity (3%)**	**Total Payment Capacity**	**Per-Acre Payment Capacity**
2013	$ 3,973,274	$ 2,559,992	$ 1,413,282	$ 70,664	$ 15,830,517	$ 474,916	$ 867,702	$ 1,315
2014	$ 4,171,938	$ 2,636,792	$ 1,535,146	$ 76,757	$ 17,145,569	$ 514,367	$ 944,022	$ 1,430
2015	$ 4,380,534	$ 2,715,895	$ 1,664,639	$ 83,232	$ 18,581,955	$ 557,459	$ 1,023,948	$ 1,551
2016	$ 4,599,561	$ 2,797,372	$ 1,802,189	$ 90,109	$ 20,147,388	$ 604,422	$ 1,107,658	$ 1,678
2017	$ 4,829,539	$ 2,881,293	$ 1,948,246	$ 97,412	$ 21,850,017	$ 655,501	$ 1,195,333	$ 1,811

Table C.25: **Processed Vegetable Payment Capacity**

Representative Farm:	**Processed Vegetables (600 acres)**							
Year	**Gross Income**	**Annual Farm Costs**	**Net Income**	**Return to Management (10%)**	**Net Worth/Equity**	**Return to Equity (3%)**	**Total Payment Capacity**	**Per-Acre Payment Capacity**
2013	$ 893,854	$ 658,664	$ 235,190	$ 23,519	$ 4,711,914	$ 141,357	$ 70,314	$ 188
2014	$ 893,854	$ 677,387	$ 216,467	$ 21,647	$ 4,883,772	$ 146,513	$ 48,307	$ 129
2015	$ 893,854	$ 696,671	$ 197,183	$ 19,718	$ 5,034,854	$ 151,046	$ 26,419	$ 70
2016	$ 893,854	$ 716,535	$ 177,319	$ 17,732	$ 5,164,523	$ 154,936	$ 4,651	$ 12
2017	$ 893,854	$ 736,994	$ 156,860	$ 15,686	$ 5,272,120	$ 158,164	$ (16,990)	$ (45)
Year	**Gross Income**	**Annual Farm Costs**	**Net Income**	**Return to Management (10%)**	**Net Worth/Equity**	**Return to Equity (2%)**	**Total Payment Capacity**	**Per-Acre Payment Capacity**
2013	$ 893,854	$ 658,664	$ 235,190	$ 23,519	$ 4,711,914	$ 94,238	$ 117,433	$ 313
2014	$ 893,854	$ 677,387	$ 216,467	$ 21,647	$ 4,883,772	$ 97,675	$ 97,145	$ 259
2015	$ 893,854	$ 696,671	$ 197,183	$ 19,718	$ 5,034,854	$ 100,697	$ 76,768	$ 205
2016	$ 893,854	$ 716,535	$ 177,319	$ 17,732	$ 5,164,523	$ 103,290	$ 56,297	$ 150
2017	$ 893,854	$ 736,994	$ 156,860	$ 15,686	$ 5,272,120	$ 105,442	$ 35,732	$ 95
Year	**Gross Income**	**Annual Farm Costs**	**Net Income**	**Return to Management (5%)**	**Net Worth/Equity**	**Return to Equity (3%)**	**Total Payment Capacity**	**Per-Acre Payment Capacity**
2013	$ 893,854	$ 658,664	$ 235,190	$ 11,760	$ 4,711,914	$ 141,357	$ 82,073	$ 219
2014	$ 893,854	$ 677,387	$ 216,467	$ 10,823	$ 4,883,772	$ 146,513	$ 59,130	$ 158
2015	$ 893,854	$ 696,671	$ 197,183	$ 9,859	$ 5,034,854	$ 151,046	$ 36,278	$ 97
2016	$ 893,854	$ 716,535	$ 177,319	$ 8,866	$ 5,164,523	$ 154,936	$ 13,517	$ 36
2017	$ 893,854	$ 736,994	$ 156,860	$ 7,843	$ 5,272,120	$ 158,164	$ (9,147)	$ (24)

Table C.26: **Processed Vegetable Payment Capacity (1% Farm-Gate Price Increase)**

Representative Farm:	Processed Vegetables (600 acres)							
Year	**Gross Income**	**Annual Farm Costs**	**Net Income**	**Return to Management (10%)**	**Net Worth/Equity**	**Return to Equity (3%)**	**Total Payment Capacity**	**Per-Acre Payment Capacity**
2013	$ 902,792	$ 658,664	$ 244,128	$ 24,413	$ 4,720,853	$ 141,626	$ 78,090	$ 208
2014	$ 911,820	$ 677,387	$ 234,433	$ 23,443	$ 4,910,677	$ 147,320	$ 63,669	$ 170
2015	$ 920,938	$ 696,671	$ 224,267	$ 22,427	$ 5,088,844	$ 152,665	$ 49,175	$ 131
2016	$ 930,148	$ 716,535	$ 213,613	$ 21,361	$ 5,254,806	$ 157,644	$ 34,608	$ 92
2017	$ 939,449	$ 736,994	$ 202,455	$ 20,246	$ 5,408,000	$ 162,240	$ 19,970	$ 53
Year	**Gross Income**	**Annual Farm Costs**	**Net Income**	**Return to Management (10%)**	**Net Worth/Equity**	**Return to Equity (2%)**	**Total Payment Capacity**	**Per-Acre Payment Capacity**
2013	$ 902,792	$ 658,664	$ 244,128	$ 24,413	$ 4,720,853	$ 94,417	$ 125,298	$ 334
2014	$ 911,820	$ 677,387	$ 234,433	$ 23,443	$ 4,910,677	$ 98,214	$ 112,776	$ 301
2015	$ 920,938	$ 696,671	$ 224,267	$ 22,427	$ 5,088,844	$ 101,777	$ 100,063	$ 267
2016	$ 930,148	$ 716,535	$ 213,613	$ 21,361	$ 5,254,806	$ 105,096	$ 87,156	$ 232
2017	$ 939,449	$ 736,994	$ 202,455	$ 20,246	$ 5,408,000	$ 108,160	$ 74,050	$ 197
Year	**Gross Income**	**Annual Farm Costs**	**Net Income**	**Return to Management (5%)**	**Net Worth/Equity**	**Return to Equity (3%)**	**Total Payment Capacity**	**Per-Acre Payment Capacity**
2013	$ 902,792	$ 658,664	$ 244,128	$ 12,206	$ 4,720,853	$ 141,626	$ 90,296	$ 241
2014	$ 911,820	$ 677,387	$ 234,433	$ 11,722	$ 4,910,677	$ 147,320	$ 75,391	$ 201
2015	$ 920,938	$ 696,671	$ 224,267	$ 11,213	$ 5,088,844	$ 152,665	$ 60,388	$ 161
2016	$ 930,148	$ 716,535	$ 213,613	$ 10,681	$ 5,254,806	$ 157,644	$ 45,288	$ 121
2017	$ 939,449	$ 736,994	$ 202,455	$ 10,123	$ 5,408,000	$ 162,240	$ 30,092	$ 80

Table C.27: **Processed Vegetable Payment Capacity (3% Farm-Gate Price Increase)**

Representative Farm:	Processed Vegetables (600 acres)							
Year	**Gross Income**	**Annual Farm Costs**	**Net Income**	**Return to Management (10%)**	**Net Worth/Equity**	**Return to Equity (3%)**	**Total Payment Capacity**	**Per-Acre Payment Capacity**
2013	$ 920,669	$ 658,664	$ 262,005	$ 26,201	$ 4,738,730	$ 142,162	$ 93,643	$ 250
2014	$ 948,289	$ 677,387	$ 270,902	$ 27,090	$ 4,965,023	$ 148,951	$ 94,861	$ 253
2015	$ 976,738	$ 696,671	$ 280,067	$ 28,007	$ 5,198,990	$ 155,970	$ 96,091	$ 256
2016	$ 1,006,040	$ 716,535	$ 289,505	$ 28,951	$ 5,440,845	$ 163,225	$ 97,329	$ 260
2017	$ 1,036,221	$ 736,994	$ 299,227	$ 29,923	$ 5,690,810	$ 170,724	$ 98,580	$ 263
Year	**Gross Income**	**Annual Farm Costs**	**Net Income**	**Return to Management (10%)**	**Net Worth/Equity**	**Return to Equity (2%)**	**Total Payment Capacity**	**Per-Acre Payment Capacity**
2013	$ 920,669	$ 658,664	$ 262,005	$ 26,201	$ 4,738,730	$ 94,775	$ 141,030	$ 376
2014	$ 948,289	$ 677,387	$ 270,902	$ 27,090	$ 4,965,023	$ 99,300	$ 144,511	$ 385
2015	$ 976,738	$ 696,671	$ 280,067	$ 28,007	$ 5,198,990	$ 103,980	$ 148,081	$ 395
2016	$ 1,006,040	$ 716,535	$ 289,505	$ 28,951	$ 5,440,845	$ 108,817	$ 151,738	$ 405
2017	$ 1,036,221	$ 736,994	$ 299,227	$ 29,923	$ 5,690,810	$ 113,816	$ 155,488	$ 415
Year	**Gross Income**	**Annual Farm Costs**	**Net Income**	**Return to Management (5%)**	**Net Worth/Equity**	**Return to Equity (3%)**	**Total Payment Capacity**	**Per-Acre Payment Capacity**
2013	$ 920,669	$ 658,664	$ 262,005	$ 13,100	$ 4,738,730	$ 142,162	$ 106,743	$ 285
2014	$ 948,289	$ 677,387	$ 270,902	$ 13,545	$ 4,965,023	$ 148,951	$ 108,406	$ 289
2015	$ 976,738	$ 696,671	$ 280,067	$ 14,003	$ 5,198,990	$ 155,970	$ 110,094	$ 294
2016	$ 1,006,040	$ 716,535	$ 289,505	$ 14,475	$ 5,440,845	$ 163,225	$ 111,804	$ 298
2017	$ 1,036,221	$ 736,994	$ 299,227	$ 14,961	$ 5,690,810	$ 170,724	$ 113,541	$ 303

Table C.28: **Processed Vegetable Payment Capacity (5% Farm-Gate Price Increase)**

Representative Farm:	Processed Vegetables (600 acres)							
Year	**Gross Income**	**Annual Farm Costs**	**Net Income**	**Return to Management (10%)**	**Net Worth/Equity**	**Return to Equity (3%)**	**Total Payment Capacity**	**Per-Acre Payment Capacity**
2013	$ 938,546	$ 658,664	$ 279,882	$ 27,988	$ 4,756,607	$ 142,698	$ 109,196	$ 291
2014	$ 985,474	$ 677,387	$ 308,087	$ 30,809	$ 5,020,085	$ 150,603	$ 126,676	$ 338
2015	$ 1,034,747	$ 696,671	$ 338,076	$ 33,808	$ 5,312,060	$ 159,362	$ 144,907	$ 386
2016	$ 1,086,485	$ 716,535	$ 369,950	$ 36,995	$ 5,634,360	$ 169,031	$ 163,924	$ 437
2017	$ 1,140,809	$ 736,994	$ 403,815	$ 40,382	$ 5,988,913	$ 179,667	$ 183,766	$ 490
Year	**Gross Income**	**Annual Farm Costs**	**Net Income**	**Return to Management (10%)**	**Net Worth/Equity**	**Return to Equity (2%)**	**Total Payment Capacity**	**Per-Acre Payment Capacity**
2013	$ 938,546	$ 658,664	$ 279,882	$ 27,988	$ 4,756,607	$ 95,132	$ 156,762	$ 418
2014	$ 985,474	$ 677,387	$ 308,087	$ 30,809	$ 5,020,085	$ 100,402	$ 176,877	$ 472
2015	$ 1,034,747	$ 696,671	$ 338,076	$ 33,808	$ 5,312,060	$ 106,241	$ 198,027	$ 528
2016	$ 1,086,485	$ 716,535	$ 369,950	$ 36,995	$ 5,634,360	$ 112,687	$ 220,268	$ 587
2017	$ 1,140,809	$ 736,994	$ 403,815	$ 40,382	$ 5,988,913	$ 119,778	$ 243,655	$ 650
Year	**Gross Income**	**Annual Farm Costs**	**Net Income**	**Return to Management (5%)**	**Net Worth/Equity**	**Return to Equity (3%)**	**Total Payment Capacity**	**Per-Acre Payment Capacity**
2013	$ 938,546	$ 658,664	$ 279,882	$ 13,994	$ 4,756,607	$ 142,698	$ 123,190	$ 329
2014	$ 985,474	$ 677,387	$ 308,087	$ 15,404	$ 5,020,085	$ 150,603	$ 142,080	$ 379
2015	$ 1,034,747	$ 696,671	$ 338,076	$ 16,904	$ 5,312,060	$ 159,362	$ 161,810	$ 431
2016	$ 1,086,485	$ 716,535	$ 369,950	$ 18,498	$ 5,634,360	$ 169,031	$ 182,422	$ 486
2017	$ 1,140,809	$ 736,994	$ 403,815	$ 20,191	$ 5,988,913	$ 179,667	$ 203,957	$ 544

Table C.29: **Grass and Wheat Payment Capacity**

Representative Farm:	Grass and Wheat (2000 acres: 640 Wheat and 1360 Grass)							
Year	**Gross Income**	**Annual Farm Costs**	**Net Income**	**Return to Management (10%)**	**Net Worth/Equity**	**Return to Equity (3%)**	**Total Payment Capacity**	**Per-Acre Grass/Wheat Payment Capacity**
2013	$ 1,759,238	$ 1,217,196	$ 542,042	$ 54,204	$ 11,632,534	$ 348,976	$ 138,862	$ 69
2014	$ 1,759,238	$ 1,253,712	$ 505,526	$ 50,553	$ 12,086,695	$ 362,601	$ 92,373	$ 46
2015	$ 1,759,238	$ 1,291,323	$ 467,915	$ 46,792	$ 12,501,470	$ 375,044	$ 46,079	$ 23
2016	$ 1,759,238	$ 1,330,063	$ 429,175	$ 42,918	$ 12,875,658	$ 386,270	$ (12)	$ (0)
2017	$ 1,759,238	$ 1,369,965	$ 389,273	$ 38,927	$ 13,208,021	$ 396,241	$ (45,895)	$ (23)
Year	**Gross Income**	**Annual Farm Costs**	**Net Income**	**Return to Management (10%)**	**Net Worth/Equity**	**Return to Equity (2%)**	**Total Payment Capacity**	**Per-Acre Grass/Wheat Payment Capacity**
2013	$ 1,759,238	$ 1,217,196	$ 542,042	$ 54,204	$ 11,632,534	$ 232,651	$ 255,187	$ 128
2014	$ 1,759,238	$ 1,253,712	$ 505,526	$ 50,553	$ 12,086,695	$ 241,734	$ 213,240	$ 107
2015	$ 1,759,238	$ 1,291,323	$ 467,915	$ 46,792	$ 12,501,470	$ 250,029	$ 171,094	$ 86
2016	$ 1,759,238	$ 1,330,063	$ 429,175	$ 42,918	$ 12,875,658	$ 257,513	$ 128,744	$ 64
2017	$ 1,759,238	$ 1,369,965	$ 389,273	$ 38,927	$ 13,208,021	$ 264,160	$ 86,185	$ 43
Year	**Gross Income**	**Annual Farm Costs**	**Net Income**	**Return to Management (5%)**	**Net Worth/Equity**	**Return to Equity (3%)**	**Total Payment Capacity**	**Per-Acre Grass/Wheat Payment Capacity**
2013	$ 1,759,238	$ 1,217,196	$ 542,042	$ 27,102	$ 11,632,534	$ 348,976	$ 165,964	$ 83
2014	$ 1,759,238	$ 1,253,712	$ 505,526	$ 25,276	$ 12,086,695	$ 362,601	$ 117,649	$ 59
2015	$ 1,759,238	$ 1,291,323	$ 467,915	$ 23,396	$ 12,501,470	$ 375,044	$ 69,475	$ 35
2016	$ 1,759,238	$ 1,330,063	$ 429,175	$ 21,459	$ 12,875,658	$ 386,270	$ 21,447	$ 11
2017	$ 1,759,238	$ 1,369,965	$ 389,273	$ 19,464	$ 13,208,021	$ 396,241	$ (26,431)	$ (13)

Table C.30: **Grass and Wheat Payment Capacity (1% Farm-Gate Price Increase)**

Representative Farm:	Grass and Wheat (2000 acres: 640 Wheat and 1360 Grass)							
Year	**Gross Income**	**Annual Farm Costs**	**Net Income**	**Return to Management (10%)**	**Net Worth/Equity**	**Return to Equity (3%)**	**Total Payment Capacity**	**Per-Acre Grass/Wheat Payment Capacity**
2013	$ 1,776,831	$ 1,217,196	$ 559,635	$ 55,964	$ 11,650,126	$ 349,504	$ 154,168	$ 77
2014	$ 1,794,599	$ 1,253,712	$ 540,887	$ 54,089	$ 12,139,648	$ 364,189	$ 122,609	$ 61
2015	$ 1,812,545	$ 1,291,323	$ 521,222	$ 52,122	$ 12,607,730	$ 378,232	$ 90,868	$ 45
2016	$ 1,830,671	$ 1,330,063	$ 500,608	$ 50,061	$ 13,053,350	$ 391,601	$ 58,947	$ 29
2017	$ 1,848,977	$ 1,369,965	$ 479,012	$ 47,901	$ 13,475,452	$ 404,264	$ 26,847	$ 13
Year	**Gross Income**	**Annual Farm Costs**	**Net Income**	**Return to Management (10%)**	**Net Worth/Equity**	**Return to Equity (2%)**	**Total Payment Capacity**	**Per-Acre Grass/Wheat Payment Capacity**
2013	$ 1,776,831	$ 1,217,196	$ 559,635	$ 55,964	$ 11,650,126	$ 233,003	$ 270,669	$ 135
2014	$ 1,794,599	$ 1,253,712	$ 540,887	$ 54,089	$ 12,139,648	$ 242,793	$ 244,005	$ 122
2015	$ 1,812,545	$ 1,291,323	$ 521,222	$ 52,122	$ 12,607,730	$ 252,155	$ 216,945	$ 108
2016	$ 1,830,671	$ 1,330,063	$ 500,608	$ 50,061	$ 13,053,350	$ 261,067	$ 189,480	$ 95
2017	$ 1,848,977	$ 1,369,965	$ 479,012	$ 47,901	$ 13,475,452	$ 269,509	$ 161,602	$ 81
Year	**Gross Income**	**Annual Farm Costs**	**Net Income**	**Return to Management (5%)**	**Net Worth/Equity**	**Return to Equity (3%)**	**Total Payment Capacity**	**Per-Acre Grass/Wheat Payment Capacity**
2013	$ 1,776,831	$ 1,217,196	$ 559,635	$ 27,982	$ 11,650,126	$ 349,504	$ 182,149	$ 91
2014	$ 1,794,599	$ 1,253,712	$ 540,887	$ 27,044	$ 12,139,648	$ 364,189	$ 149,653	$ 75
2015	$ 1,812,545	$ 1,291,323	$ 521,222	$ 26,061	$ 12,607,730	$ 378,232	$ 116,929	$ 58
2016	$ 1,830,671	$ 1,330,063	$ 500,608	$ 25,030	$ 13,053,350	$ 391,601	$ 83,977	$ 42
2017	$ 1,848,977	$ 1,369,965	$ 479,012	$ 23,951	$ 13,475,452	$ 404,264	$ 50,798	$ 25

Table C.31: **Grass and Wheat Payment Capacity (3% Farm-Gate Price Increase)**

Representative Farm:	Grass and Wheat (2000 acres: 640 Wheat and 1360 Grass)							
Year	**Gross Income**	**Annual Farm Costs**	**Net Income**	**Return to Management (10%)**	**Net Worth/Equity**	**Return to Equity (3%)**	**Total Payment Capacity**	**Per-Acre Grass/Wheat Payment Capacity**
2013	$ 1,812,016	$ 1,217,196	$ 594,820	$ 59,482	$ 11,685,311	$ 350,559	$ 184,779	$ 92
2014	$ 1,866,376	$ 1,253,712	$ 612,664	$ 61,266	$ 12,246,610	$ 367,398	$ 183,999	$ 92
2015	$ 1,922,367	$ 1,291,323	$ 631,044	$ 63,104	$ 12,824,514	$ 384,735	$ 183,204	$ 92
2016	$ 1,980,038	$ 1,330,063	$ 649,975	$ 64,998	$ 13,419,501	$ 402,585	$ 182,392	$ 91
2017	$ 2,039,439	$ 1,369,965	$ 669,474	$ 66,947	$ 14,032,066	$ 420,962	$ 181,565	$ 91
Year	**Gross Income**	**Annual Farm Costs**	**Net Income**	**Return to Management (10%)**	**Net Worth/Equity**	**Return to Equity (2%)**	**Total Payment Capacity**	**Per-Acre Grass/Wheat Payment Capacity**
2013	$ 1,812,016	$ 1,217,196	$ 594,820	$ 59,482	$ 11,685,311	$ 233,706	$ 301,632	$ 151
2014	$ 1,866,376	$ 1,253,712	$ 612,664	$ 61,266	$ 12,246,610	$ 244,932	$ 306,465	$ 153
2015	$ 1,922,367	$ 1,291,323	$ 631,044	$ 63,104	$ 12,824,514	$ 256,490	$ 311,449	$ 156
2016	$ 1,980,038	$ 1,330,063	$ 649,975	$ 64,998	$ 13,419,501	$ 268,390	$ 316,587	$ 158
2017	$ 2,039,439	$ 1,369,965	$ 669,474	$ 66,947	$ 14,032,066	$ 280,641	$ 321,885	$ 161
Year	**Gross Income**	**Annual Farm Costs**	**Net Income**	**Return to Management (5%)**	**Net Worth/Equity**	**Return to Equity (3%)**	**Total Payment Capacity**	**Per-Acre Grass/Wheat Payment Capacity**
2013	$ 1,812,016	$ 1,217,196	$ 594,820	$ 29,741	$ 11,685,311	$ 350,559	$ 214,520	$ 107
2014	$ 1,866,376	$ 1,253,712	$ 612,664	$ 30,633	$ 12,246,610	$ 367,398	$ 214,633	$ 107
2015	$ 1,922,367	$ 1,291,323	$ 631,044	$ 31,552	$ 12,824,514	$ 384,735	$ 214,756	$ 107
2016	$ 1,980,038	$ 1,330,063	$ 649,975	$ 32,499	$ 13,419,501	$ 402,585	$ 214,891	$ 107
2017	$ 2,039,439	$ 1,369,965	$ 669,474	$ 33,474	$ 14,032,066	$ 420,962	$ 215,038	$ 108

Table C.32: **Grass and Wheat Payment Capacity (5% Farm-Gate Price Increase)**

Representative Farm:	Grass and Wheat (2000 acres: 640 Wheat and 1360 Grass)							
Year	**Gross Income**	**Annual Farm Costs**	**Net Income**	**Return to Management (10%)**	**Net Worth/Equity**	**Return to Equity (3%)**	**Total Payment Capacity**	**Per-Acre Grass/Wheat Payment Capacity**
2013	$ 1,847,200	$ 1,217,196	$ 630,004	$ 63,000	$ 11,720,496	$ 351,615	$ 215,389	$ 108
2014	$ 1,939,560	$ 1,253,712	$ 685,848	$ 68,585	$ 12,354,979	$ 370,649	$ 246,614	$ 123
2015	$ 2,036,538	$ 1,291,323	$ 745,215	$ 74,522	$ 13,047,054	$ 391,412	$ 279,282	$ 140
2016	$ 2,138,365	$ 1,330,063	$ 808,302	$ 80,830	$ 13,800,368	$ 414,011	$ 313,461	$ 157
2017	$ 2,245,284	$ 1,369,965	$ 875,319	$ 87,532	$ 14,618,777	$ 438,563	$ 349,224	$ 175
Year	**Gross Income**	**Annual Farm Costs**	**Net Income**	**Return to Management (10%)**	**Net Worth/Equity**	**Return to Equity (2%)**	**Total Payment Capacity**	**Per-Acre Grass/Wheat Payment Capacity**
2013	$ 1,847,200	$ 1,217,196	$ 630,004	$ 63,000	$ 11,720,496	$ 234,410	$ 332,594	$ 166
2014	$ 1,939,560	$ 1,253,712	$ 685,848	$ 68,585	$ 12,354,979	$ 247,100	$ 370,164	$ 185
2015	$ 2,036,538	$ 1,291,323	$ 745,215	$ 74,522	$ 13,047,054	$ 260,941	$ 409,752	$ 205
2016	$ 2,138,365	$ 1,330,063	$ 808,302	$ 80,830	$ 13,800,368	$ 276,007	$ 451,464	$ 226
2017	$ 2,245,284	$ 1,369,965	$ 875,319	$ 87,532	$ 14,618,777	$ 292,376	$ 495,412	$ 248
Year	**Gross Income**	**Annual Farm Costs**	**Net Income**	**Return to Management (5%)**	**Net Worth/Equity**	**Return to Equity (3%)**	**Total Payment Capacity**	**Per-Acre Grass/Wheat Payment Capacity**
2013	$ 1,847,200	$ 1,217,196	$ 630,004	$ 31,500	$ 11,720,496	$ 351,615	$ 246,889	$ 123
2014	$ 1,939,560	$ 1,253,712	$ 685,848	$ 34,292	$ 12,354,979	$ 370,649	$ 280,906	$ 140
2015	$ 2,036,538	$ 1,291,323	$ 745,215	$ 37,261	$ 13,047,054	$ 391,412	$ 316,543	$ 158
2016	$ 2,138,365	$ 1,330,063	$ 808,302	$ 40,415	$ 13,800,368	$ 414,011	$ 353,876	$ 177
2017	$ 2,245,284	$ 1,369,965	$ 875,319	$ 43,766	$ 14,618,777	$ 438,563	$ 392,990	$ 196

SECTION 6.0
WETLAND DELINATION

Under Reconnaissance I investigations Schott and Associates, Ecologists and Wetlands Specialists, completed the "Jurisdictional Wetland Determination and Delineation of Drift Creek Reservoir" and submit it and an application to the Division of State Lands in December 2009.
A copy of the delineation is available as an appendix item to the earlier grant. A total of 9.91 acres of wetlands were found within the reservoir footprint, primarily in a cow pasture at the lower end of the reservoir site. In addition 7.02 acres of open water habitat would be impacted.

Since the submittal of the application, there was change in the rules for review and the approval was delayed while additional information was sought by the agency from the consultant for the District.
In March of 2011 a specific list of questions was provided to Schott and Associates to supplement the earlier application. Agency staff indicated that once the review was accomplished, staff would visit the site and make a final determination. Since that time Schott and Associates has continued to request a response from the agency after submitting the information requested in March of 2011. Although a final review was to be received in June of 2013, no information or contact has been received. The District has expected a response but does not have one at the time this report is filed.

DRIFT CREEK
HYDROLOGIC REPORT UPDATE #4
(Based on Oct. 2008- Sep. 2014 Data)

JUNE 2015

Proposed Drift Creek Reservoir Site at S.E. Fox and S.E. Victor Point Junction

Report Prepared for

East Valley Water District
Mt. Angel, OR

by

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EXECUTIVE SUMMARY

1. This report pertains to a proposed irrigation project initiated by East Valley Water District (EVWD) at a site located on Drift Creek, a tributary of the Pudding River, at the junction of Victor Road and Fox Road. It is the fifth of its kind and uses stream flow data collected during the last six water years (October 2008 – September 2014) to review the hydrologic records at the site and help support the feasibility of the project under a wide range of possible runoff conditions – e.g., how the proposed reservoir would be operated, given its physical size, the expected inflow, the required downstream releases, the projected irrigation needs, etc.

2. The first half of the report deals with basic hydrologic analysis. It documents the availability and characteristics of hydrologic data collected at nearby streams and how those data correlate with data gathered at the project site. It also helps identify the shape and runoff volume of representative (low, average and high) hydrologic flow years.

3. New Oct. 2012- Sep. 2014 stream flow data available for the analysis documented in this report covers all the stations discussed in the previous reports, except for the Lower Drift Creek gauge at Hibbard Road. To date, stream flow data collected at the Hibbard Road station for that period are still in a coded format.

4. Stream flow data described in the previous (third) hydrology addendum released in October 2012 supported the classification of 2008 - 09 as a dry water year; 2009 - 10 as a slightly below average year, and 2010 - 11 as a high water year. This classification data remains practically unchanged, with the additional water years 2011-12 ranked as “high”, and 2012-13 and 2013-14 ranked as “slightly below average”.

5. Based on updated flow duration curves, stream flows during the reservoir release season, between spring and fall, are expected to increase from the current 25 cfs average to about 50 cfs during 50 percent of the time. This increase could have some impacts on bank erosion for the creek downstream from the dam.

6. Strong statistical correlation exists between the stream flows at the proposed project site and some of nearby streams (including the Lower Drift Creek) throughout the six water years. This is especially true for the Pudding River stations at Aurora and Woodburn, which also have the longest period of stream flow records of all the stations under review and, thus, become the primary focus of the hydrologic analysis.

7. The close relationship between Upper Drift Creek and Pudding River stream flow data allows for the extension of the 6-year (2008 - 2014) hydrologic actual records at the project site to a longer time span covering a wider range of runoff conditions, through the use of regression equations. Based on an updated runoff volume frequency curve using those extended numbers, the expectation for an October-April runoff volume of 12,000 acre-feet (AF) to be available for annual reservoir refill purposes continues to look reasonably good.

8. A comparison between two completely independent sets of data, the regression-based predictions using 2008-11 data and the 2011-14 observed stream flows at the proposed project site, is also provided. The results reflecting a reasonable close relationship between projected and actual stream flows during those years support the continued use of current statistical tools to extend stream flow records.

9. A sequential mass curve was prepared using the 2008-2014 observed stream flow data at Upper Drift Creek for double-checking the storage required to provide a given yield. This tool will be mostly helpful for future use in testing storage availability under detailed irrigation withdrawal scenarios.

10. The rainfall-runoff model approach was also explored as another tool to predict discharges in response to precipitation. This approach requires representative rainfall amounts over the basin, a requirement that a unique index station like Salem Airport cannot always meets. The six (2008-2014) years of stream flow data recorded so far were caused by rainfall; snowmelt, which usually created design floods in the region, has not been a major factor. Additional hydrologic data would further enhance the validity of the conclusions reached on project operations during high runoff conditions triggered by snowmelt.

11. While regression-based discharge predictions using Pudding River discharges are slightly more accurate than those obtained via rainfall-runoff modeling, both prediction tools still deserve further evaluation because of their complementary application potential. Rainfall-runoff modeling is also an absolute need when dealing with Probable Maximum Precipitation and Probable Maximum Flood, and real-time flood predictions.

12. Water availability tables posted on the Internet by Oregon Water Resources Department (OWRD) contain several categories of stream flow data needed to calculate net water availability, for each month of the year and the 50% and 80% exceedance frequencies. For Drift Creek, the information includes (1) natural stream flows for Drift Creek at its junction with Pudding River, (2) consumptive uses and storages, and (3) in-stream flow requirements. Data sets (2) and (3) are directly related to Drift Creek and, as such, were used to define if, when and how much of the incoming natural inflow can be stored in Drift Creek Reservoir. Since most recently updated consumptive uses and storages data now also include the monthly flows requested by EVWD; they should be treated differently in future model studies.

13. OWRD has no immediate plans to update current natural stream flows shown for Drift Creek, nor to add any other exceedance frequencies. To estimate monthly stream flows for the 90% and 95% exceedance frequencies, that appear to be of interest to the Project Team, a simplified procedure was used based on monthly flow duration curves of 2008-2014 observed daily flow data and necessary adjustments to match OWRD 80% exceedance monthly flows.

14. The second part of the report deals with potential reservoir operational scenarios using a daily time step reservoir model. Model input includes variable initial pool elevations, expected

runoff conditions, reservoir volume, outlet capacities, projected irrigation needs, and downstream release criteria to meet existing in-stream requirements. All the model runs have been updated to reflect the 677' elevation used as normal operating water surface elevation for the reservoir, per the Murray-Smith & Associates (MSA) Report. The water surface will be controlled at that elevation (which corresponds to the spillway crest elevation), using the automated outlet structure tower.

15. Modeling of daily reservoir operation covers two groups of stream flows. The first group consists of estimated representative flow years (low 1935-1936, average 1933-1934 and high 1947-1948 flow years) based on Pudding River near Aurora data. Reservoir refill during those years was assumed to start from an empty reservoir, at Elevation 620 feet msl. The second group refers to the more recent data covering the October 2002 – September 2014 period, which includes 6 years (2002 – 2008) of synthesized flow data and 6 years (2008- 2014) of actual flow data. October 2002 was the month the Pudding River gauge near Aurora was re-operated after several years of inactivity. The 2002-2008 inflow data to the project were developed through a regression equation, and the 2008-2014 inflow data are actually observed stream flows at the project site. Reservoir operation during those years starts from an empty reservoir on 1 October 2002 and extends from that day through a continuous, multi-year model simulation.

16. In the multi-year continuous model simulation, two basic reservoir operation criteria were tested. The first criteria affects the allowed contribution of the local inflow below the reservoir site in meeting water rights at the mouth of Drift Creek, assuming either 0 percent contribution or 100% contribution. The second criteria involves greater daily irrigation release requirements (new base volumes of 10,000 and 12,000 AF were added to the original volume of 8,000 AF). Pre- and post-project flow duration curves were developed for those three cases. The impacts of those two operating criteria were found to have limited negative impacts on the annual reservoir refill. Impacts of increased April- September discharges on bank erosion and mud flats need further, more specialized analyses.

17. Multi-year model simulation suggests that actual reservoir refill does not start exactly at the adopted start date because other in-stream requirements (e.g., minimum flows, water rights, flushing flows, etc.) also control the refill operation. In earlier model runs, the start date for the refill was not used as a direct check prior to allowing the reservoir to store any or all of the inflows. This was not as date-specific as current specified in the OWRD draft water use permit dated July 22, 2014, which specifies November 1 and April 30 as the start and end dates of the allowable reservoir refill. The July 2014 draft permit also specifies that all live flows must be released during May through October. Based on past exploratory model runs, both of those new, more date-specific provisions have not caused any significant impacts on reservoir refill and/or reservoir releases. Future hydrologic model runs will have to treat those new requirements exactly as stated in the draft permit. Downstream senior water rights will also be evaluated to determine if there is any need to add them to the model regarding the refill season (November – April). This likely will not be a necessary model revision.

18. Multi-year model simulation also highlights the role of the initial reservoir pool elevation at the start of the annual refill operation. Due to the relative sizes of the reservoir and the runoff, during a high runoff water year like 2010-2011, it appears that the project would fill even if it

started from empty on October 1 and had to meet 100 percent of the in-stream flow required at the mouth (without any local inflow credit).

19. A similar observation applies to the upper bound elevation, UL. When UL had to be changed from 680' to 677' to be compatible with the elevation previously used in the MSA's PMF study, the 3 foot elevation difference appears to have limited impact on final reservoir refill.

20. Post-project stream flows are predicted to significantly increase during the reservoir release season, from May through September of each year, from about 24 cfs up to as much as 60 cfs or higher. These increase would likely impact stream bank erosion and sediment deposition in the river reached downstream from the dam.

21. Evaporation losses during the 2008-2014 period are predicted to be negligible due to the relatively small size (about 310 acres) of the reservoir storage area subject to evaporation.

22. Impacts of climate changes to the flow regime of Drift Creek was also evaluated based on trend line analysis of long-term (1893-2014) precipitation and (1893-2014) air temperature data recorded at Salem, and on Pudding River (1928-2014) stream flow recorded at Aurora. Slightly warmer air temperature and slightly greater runoff trends were identified, but data are still missing to allow for more accurate and more detailed explanations for Drift Creek hydrographs shifts. Many of the climate changes signs seem to call for a wetter and warmer summer in the next 20 to 40 years. Results of a region climate change study conducted by a tri-agency work group were used to project the range of changes in Drift Creek's monthly stream flow in 2020 and 2040.

23. The appendix contains selected stream flow data mentioned in this report and the previous updates. A sample detailed listing of the reservoir model output is also provided based on the 2008-2009 water year. Other data used in the analysis are also available for the records.

24. The hydrologic analysis and the results described in this report are part of the usual process to support the feasibility of the proposed project. As stated earlier, provisions of the draft water use permit issued on July 22, 2014 will be modeled as called for in the draft. Additional tasks may be required in the near future to examine new information, explore other possible what-if conditions, develop more specific data needed for special engineering or economic studies, and to further enhance the conclusions reached. Tasks like dam-break analysis to delineate potential emergency flooding areas, downstream river bank erosion, etc. would be expected.

DRIFT CREEK SITE "A" NEAR SILVERTON, OREGON

DRIFT CREEK HYDROLOGIC REPORT

(UPDATE #4)

1. Introduction

This technical report is an update of the October 2012 report on hydrologic data collected on Drift Creek and nearby streams as part of a feasibility study of the Drift Creek irrigation project proposed by East Valley Water District (EVWD). The primary objective of the hydrologic analysis is to continue to evaluate the relationship between Drift Creek and other streams in terms of discharges, watershed characteristics, rainfall-runoff distribution, and to determine how best to use that information to develop the expected project inflow covering as long a period (and, thereby, as many runoff conditions) as possible. The report is a self-contained document based on five years of collected stream flow data covering the October 2008 – September 2013 period (instead of just the three years, October 2008 – September 2011, covered in the previous report, and updates the expected runoff yield at the proposed project site. It provides an indication of the accuracy of the regression-based predictions by comparing predicted vs. observed stream flows for the October 2011 – September 2103 period. The report also continues to re-evaluate the daily operation of the reservoir under several plausible scenarios controlled by reservoir inflow, mandatory release requirements, irrigation needs, etc. to help solidify an acceptable release strategy.

2. Project Background

EVWD is planning to build a reservoir to store the runoff of Drift Creek, a tributary of the Pudding River, to meet irrigation needs in that area. An application was submitted on February 21, 2013 to the Oregon Water Resources Department (OWRD) for the following water use permit:

- Amount of Water: 12,000 acre feet (AF)
- Use of Water: storage for irrigation and flow augmentation
- Appropriation season: October 1 through April 30

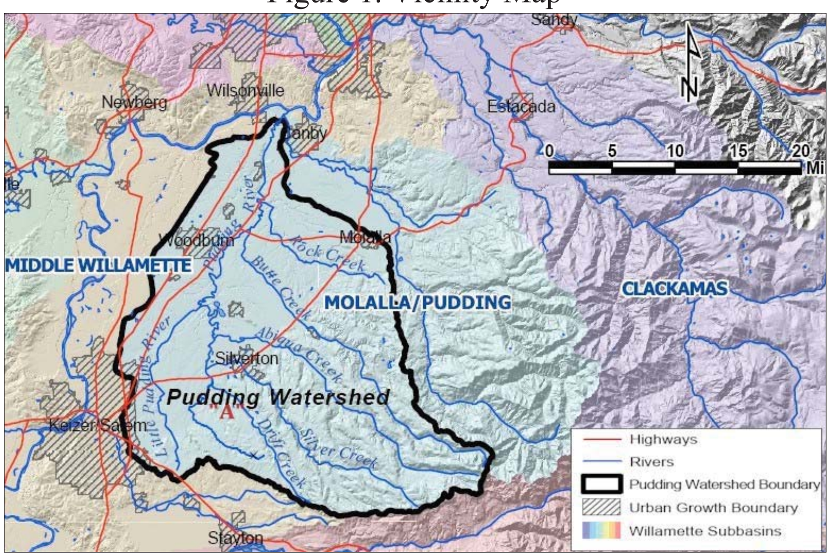
In response to the application and following the normal approval process, a proposed final order with OWRD recommendations to issue with conditions a draft permit was released on July 22, 2014. However, EVWD may not begin construction of the reservoir until the Department approves the engineering plans and specifications.

The proposed project site is located on Drift Creek, near the junction of Victor Road and Fox Road, south of Silverton. See Figure 1. It controls a drainage area of 15.4 square miles and has physically the potential of storing up to 12,000 AF of water.

The actual volume of water that could be stored in the reservoir each year, prior to the start of the irrigation season, depends on the Drift Creek run-off and the in-stream flow requirements during the preceding October through April reservoir refill period. This critical data needed for the assessment of the project's feasibility must be as reliable as possible and of sufficient length to provide a good picture of the long-term runoff conditions. It is usually provided by stream flows measurements at the project site, and/or reconstituted flows based on the observed data at comparable nearby streams with good records.

Up until 2008, Drift Creek was a stream with no recorded flow data. Actual, continuous daily stream flow measurements on the creek were only initiated in April 2008 by Marion Soil and Water Conservation District (Marion Co. SWCD). This occurred at two gauging sites. The first gauge was located at the project site, and referred to as "Upper Drift Creek Gauge" or "Victor Road Gauge". The second gauge was at lower stream location, at the Hibbard Road bridge-crossing near the confluence of Drift Creek with Pudding River, controlling a drainage area of 24.8 square miles. Stream gauging was conducted at the upper site by a contractor to EVWD, and at the lower site by a Marion SWCD flow monitoring specialist.

Figure 1. Vicinity Map



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The first hydrologic yield analysis report was prepared in February 2007 to provide estimates of the October through April run-off volume that could be expected at the proposed project site. At the time, no observed stream flow data were available for Drift Creek. As a result, the report only provided a review of existing hydro-meteorological records at nearby streams, and development of synthesized mean monthly discharges at various probability levels of occurrence. The report recommended discharge measurements on the creek to enhance the reliability of the runoff volume estimates.

Following the subsequent stream flow gauging during October 2008-September 2009, Update #1 examined the significance of the newly collected runoff data --a hydrologic year with low Drift Creek runoff-- on the previously estimated runoff volumes. It took into account the OWRD water availability data and irrigation and fisheries water rights listed for Drift Creek at the mouth. Daily stream flows were then developed for the dry year, average year, and wet year at the project site. A reservoir routing model was also set up to test how the runoff would be stored at and released from the project every day during those years to meet the required water rights and ecological flow triggers.

The February 2011 report, Update #2, was a direct continuation of the June 2010 report, focusing on stream flows data collected on Drift Creek and other near-by streams, using October 2009-September 2010 data. Data for this average flow year added a higher flow range to the previous year's data. The 2011 report updated earlier findings and strengthened the capabilities of the analytical tools used to generate historical runoff data and simulate the operation of the proposed reservoir. At that point, records for a low flow and an average flow year have been recorded.

The September 2012 report, Update #3, reviewed the runoff-yield analysis with one more year of stream flow data (Oct. 2008 – Sept. 2011 vs. Oct. 2008 – Sept. 2010). The October 2010 – September 2011 hydrologic year was an above average flow year for Drift Creek, and further extended the range of stream flows recorded so far on that stream.

The current October 2014 report, Update #4, is similar in many ways to the previous reports, except that it includes two additional years of stream flow records (instead of just one year), for a total of five years –from October 2008 through September 2013. The scope and format of the current study update include the following specific tasks:

1. Collect/retrieve stream flows and precipitation data for the October 2011 – September 2014 period;
2. Analyze stream flow data at Drift Creek and selected nearby streams for that six-year period, with particular reference to runoff magnitude, timing and correlation between the various sites, based on daily, monthly and statistical frequency data;
3. Update regression equations for daily and monthly stream flows;
4. Review prediction capabilities of Upper Drift Creek stream flows using (1) regression equations linking daily flows of Pudding River at Aurora with daily flows of Drift Creek at Victor Road, and (2) a rainfall-runoff model using daily precipitation at Salem Airport to develop Upper Drift Creek daily stream flows;
5. Compare predicted vs. observed October 2011 – September 2014 using the regression equations based on October 2008 – September 2011;
6. Update ranking and hydrographs of representative low, average and high runoff years;
7. Update the statistical frequency curve for the October – April runoff volume;
8. Develop inflow data for the 2002 – 2014 period and perform daily time-step modeling of daily reservoir operation for that period, assuming different levels of irrigation withdrawal levels and different schedules; and
9. Prepare report on findings and recommendations for future actions.

The tasks listed above are essentially the same as those included in the Grant Program application submitted to the Oregon Water Resource Department by East Valley Water District on 11/1/2013.

Additional tasks were performed in February 2015 at the request of the Project Manager involving the multi-year time step reservoir model simulations. The first new task required using the same reservoir upper bound elevation of 687 feet mean sea level (msl). as that used in the Murray-Smith's PMF Routing completed in May 2011 (instead of El. 680). This was to ensure full compatibility between reservoir data used during all study phases of Drift Creek Project. The second task affected the proposed irrigation daily releases, which so far were based on assumed full reservoir storage volume (FRSV) of 8,000 AF reached at the start of the reservoir release season. Two new FRSVs values, 10000 and 12000 AF, were used to specify higher irrigation releases and determine the impacts on those higher irrigation releases on the water surface and annual bank exposure.

3. Hydro-Met Data Available

3.1 Hydrologic Data

At the start of the Drift Creek hydrologic study in 2007, although there were no recorded stream flows at the project site itself, some gauging stations of relevance to the project did exist, as listed in Table 3.1. At that time, the longest stream gage records belong to Pudding River at Aurora with a combined total of 49 years of data, followed by Pudding River near Mt. Angel (28 years), Silver Creek at Silverton (16 years), Zollner Creek near Mt. Angel (13 years), Little Abiqua Creek near Scotts Mills (12 years), and Pudding River near Woodburn (9 years). Some of the periods of records overlap each other, but no stream gauge has records that span the entire 1928 - 2005 period uninterrupted.

Table 3.1 Stream Gages, Drainage Areas and Period of Available Records in 2007

Agency	Site Number	Site Name, Drainage Area, Record Period
USGS	14200300	Silver Creek At Silverton, OR F=47.9 sq. mi. (10/1963 - 09/1979)
USGS	14200400	Little Abiqua Creek Near Scotts Mills, OR F=9.81 sq. mi. (7/1993-9/2004)
USGS	14201000	Pudding River Near Mt. Angel, OR F=203 sq. mi. (10/1939-3/1966)
USGS	14201300	Zollner Creek Near Mt. Angel, OR F=15.0 sq. mi. (7/1993-9/2011 and 5/2012-9/2007)
USGS	14201340	Pudding River Near Woodburn, OR F=314 sq. mi. (10/1997-9/2007)
USGS	14202000	Pudding River Near Aurora, OR F=479 sq. mi., (10/1928-9/1964, 7/1993-9/1997 and 10/2002-9/2007)

Table 3.2 contains the monthly averages of the historical stream flows recorded at the various gauging stations as posted on the Internet at the start of this study. Pertinent monthly

values for each year of record are provided in the Appendix. All discharge values are expressed in cubic feet per second (cfs).

Table 3.2 Monthly Flow Averages Available at the Start of the Hydrologic Study (2007)

Sta.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
(1)	526	336	324	226	136	64	25	17	31	46	274	498
(2)	78	76	59	40	28	15	5.8	3.5	4	12	44	80
(3)	55	49	33	14	7.1	3	0.79	0.44	0.841	6.4	36	61
(4)	1,560	1,470	1,140	845	539	237	76	31	44	246	915	1,430
(5)	1,800	1,640	1,360	896	614	310	81	33	48	172	667	1,670
(6)	2,710	2,700	2,100	1,570	889	420	150	68	90	341	1,410	2,430

Stations:
(1): Silver Cr; 1963-68 and 1970-79;
(2): L. Abiqua nr Scotts Mills; 1993-2007
(3): Zollner nr. Mt Angel; 1993-2007;
(4): Pudding nr. Mt Angel; 1939-66
(5): Pudding nr. Woodburn; 1997-2007
(6): Pudding at Aurora 1928-64; 1993-97, and 2002-2007

Table 3.3 shows a diagram of the years when the other streams of interest were (or are) under stream gauging programs. Blue-shaded boxes refer to years of stream flow gauging activity.

Table 3.3 Records Length of Available Stream Flow Data in October 2007

N	Year	Pudding	Pudding	Pudding	Zollner	Silver	Abiqua	Butte
		Aurora	Woodb.	Mt. Angel	Mt. Angel	Silverton	Scotts M.	Monitor
1	1928	10/1928						
2	1929	x						
3	1930	x						
4	1931	x						
5	1932	x						
6	1933	x						
7	1934	x						
8	1935	x						
9	1936	x						x
10	1937	x						x
11	1938	x						x
12	1939	x		10/1939				x
13	1940	x		x				x
14	1941	x		x				x
15	1942	x		x				x
16	1943	x		x				x

17	1944	x		x				x
18	1945	x		x				x
19	1946	x		x				x
20	1947	x		x				x
21	1948	x		x				x
22	1949	x		x				x
23	1950	x		x				x
24	1951	x		x				x
25	1952	x		x				x
26	1953	x		x				x
27	1954	x		x				x
28	1955	x		x				x
29	1956	x		x				x
30	1957	x		x				x
31	1958	x		x				x
32	1959	x		x				x
33	1960	x		x				x
34	1961	x		x				x
35	1962	x		x				x
36	1963	x		x		10/1963		x
37	1964	09/1964		x		x		x
38	1965			x		x		x
39	1966			03/1966		x		x
40	1967					x		x
41	1968					09/1968		x
42	1969							x
43	1970					10/1970		x
44	1971					x		x
45	1972					x		x
46	1973					x		x
47	1974					x		x
48	1975					x		x
49	1976					x		x
50	1977					x		x
51	1978					x		x
52	1979					10/1979		x
53	1980							x
54	1981							x
55	1982							x
56	1983							x

N	Year	Pudding Aurora	Pudding Woodb.	Pudding Mt. Angel	Zollner Mt. Angel	Silver Silverton	Abiqua/ Scotts Mills	Butte Monitor
57	1984							x
58	1985							x
59	1986							
60	1987							
61	1988							
62	1989							
63	1990							
64	1991							
65	1992							
66	1993	07/1993			07/1993		07/1993	
67	1994	x			x		x	
68	1995	x			x		x	
69	1996	x			x		x	
70	1997	09/1997	10/1997		x		x	
71	1998		x		x		x	
72	1999		x		x		x	
73	2000		x		x		x	
74	2001		x		x		x	
75	2002	10/2002	x		x		x	
76	2003	x	x		x		x	
77	2004	x	x		x		09/2004	
78	2005	x	x		x			
79	2006	x	x		x			
80	2007	x	x		x			
Years in Operation		48	11	28	15	16	12	49

3.2 Meteorological Data

Daily precipitation (rainfall and snow) and air temperature were recorded at the Salem WSO Station near the airport from 1892 to 2012. See data on Tables 3.4 and 3.5 retrieved from the website hosted by Western Regional Climate Center, at: http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?or7500. Data more recent than March 2013 are currently not yet posted on that website, but can be retrieved from the National Weather Service Forecast Office, Portland, Oregon, as “Preliminary Monthly Climate Data” at
http://www.nws.noaa.gov/climate/index.php?wfo=pqr

Table 3.4 Precipitation at Salem Airport, OR (1892 to 2012)

	in.	in.		in.		1-day Maximum		Total snowfall		
	Mean	High	Year	Low	Year	in.	Date	Mean "	High "	Year
JAN	6.11	15.40	1953	0.24	1985	3.86	18/1911	2.9	32.8	1950
FEB	4.72	13.01	1996	0.34	1920	2.99	06/1985	1.6	25.2	1937
MAR	4.14	10.13	1894	0.59	1911	2.55	31/1943	0.4	10.9	1951
APR	2.57	7.68	1937	0.39	1939	2.21	13/1937	0	0.1	1972
MAY	2.07	5.56	1998	0.05	1992	1.76	17/1991	0	0	1906
JUN	1.32	4.61	1937	0.00	1918	1.63	06/1985	0	0	1915
JULY	0.39	2.72	1916	0.00	1893	1.80	18/1987	0	0	1898
AUG	0.52	4.17	1968	0.00	1894	1.14	31/1971	0	0	1906
SEP	1.53	4.84	1914	0.00	1975	2.11	05/1911	0	0	1906
OCT	3.21	11.17	1947	0.00	1895	2.71	31/1994	0.1	5	1935
NOV	6.12	16.99	1896	0.48	1936	3.60	08/1896	0.3	6.1	1977
DEC	6.69	17.54	1933	1.26	1976	4.30	06/1933	1.8	23	1919
Annual	39.38	66.96	1996	23.74	1985	4.30	12/06/33	7.1	33.5	1950
Winter	17.51	30.32	1956	4.97	1977	4.30	12/06/33	6.3	34.9	1969
Spring	8.78	16.05	1894	3.00	1924	2.55	03/31/43	0.4	10.9	1951
Summer	2.23	7.20	1983	0.21	1919	1.80	07/18/87	0	0	1915
Fall	10.86	21.25	1950	2.18	1936	3.60	11/08/61	0.3	6.1	1977
							M/D/YR			

According to the records listed above, the October-April snow precipitations in excess of 10 inches (snowy conditions) were somewhat infrequent. They occurred in the following 15 years: 1928, 1929, 1936, 1942, 1949, 1955, 1956, 1959, 1961, 1967, 1968, 1970, 1972, 1985 and 1992.

For the 30-year (1971-2000) period, the Salem WSO Station recorded October-April rainfall amounts in excess of 40 inches (average years) in 1931, 1932, 1937, 1942, 1947, 1950, 1955, 1960, 1970, 1973, 1981, 1982, 1994, 1995, 1996, 1998 and 2005. The same station recorded October-April rainfall amounts less than 20 inches (very dry years) in 1976 (11.57"), 2000 (16.89"), and 2004 (18.22"). For comparison purposes, data shown in Tables 3.6 through 3.10 are more directly related to the 30-year (1971-2000) period, instead of the entire 119-year (1892-2012) period.

Table 3.5 Air temperature at Salem WSO Airport, OR From 1892 to 2012

	Monthly Averages			Daily E				Monthly Extremes			
	Max	Min	Mean	High	Date	Low	Date	Highest	Year	Lowest	Year
	(F)	(F)	(F)	(F)		(F)		(F)		(F)	
JAN	46	33.4	39.7	68	07/1896	-10	31/1950	46.9	1953	27.4	1930
FEB	50.6	34.8	42.7	72	28/1968	-4	Mar-50	48.6	1991	34.7	1989
MAR	55.5	36.8	46.2	80	29/1923	12	Jan-71	52.3	1926	40.9	1951
APR	61.2	39.5	50.4	93	28/1926	23	13/1968	59.3	1926	44.6	1967
MAY	67.7	44.2	55.9	100	28/1983	25	Jan-54	61	1928	51.4	1962
JUN	73.8	49	61.4	105	22/1992	32	06/1899	67	1926	56.8	1976
JULY	81.8	52	66.9	108	23/1927	35	03/1899	72	1941	61.9	1963
AUG	81.7	51.9	66.8	108	Sep-81	30	30/1920	71.6	1967	62	1899
SEP	75.5	48	61.8	104	Feb-88	26	25/1934	66.6	2011	56.6	1893
OCT	64.2	42.5	53.3	93	Feb-70	19	27/1919	59.6	1901	46	1919
NOV	52.6	37.9	45.3	74	Mar-10	9	15/1955	51.1	1995	37.3	1985
DEC	46.7	34.8	40.7	72	Sep-29	-12	Aug-72	47.9	1917	33.2	1985
Annual	63.1	42.1	52.6	108	1.9E+07	-12	12/08/72	55.8	1926	49.8	1893
Winter	47.8	34.3	41.1	72	1.9E+07	-12	12/08/72	44.7	1958	35.9	1949
Spring	61.5	40.2	50.8	100	2E+07	12	03/01/71	56.6	1926	46.6	1955
Summer	79.1	51	65	108	1.9E+07	30	08/30/20	68.8	1958	60.9	1954
Fall	64.1	42.8	53.5	104	2E+07	9	11/15/55	56	1995	48.9	1985
							M/D/Y				

Table 3.6 Precipitation Monthly Averages (1971-2000)

Stations	ID	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann.
Salem WSO Airport	7500	5.8	5.1	4.2	2.8	2.1	1.5	0.6	0.7	1.4	3	6.39	6.46	40
Silver Creek Falls	7809	9.9	9.4	8.8	7	5	3.5	1.3	1.3	2.8	5.4	11.3	10.6	76.1
Silverton	7823	6.5	5.6	5	3.8	3	2.1	0.9	1	1.9	3.6	7.16	7.07	47.5

Table 3.7 Average number of Days with Selected Precipitation Amounts
Salem WSO Airport, 1971-2000

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
>.01"	17	16	17	14	11	8	3	4	7	11	18	18	144
>.10"	12	12	11	8	6	4	2	2	4	7	13	13	92.9
>.50"	4	3	2	1	1	1	0	0	1	2	4	5	24.7
>1.00"	1	1	0	0	0	0	0	0	0	0	1	2	6.1

Table 3.8 Monthly and Annual Average Temperatures 30-year average (1971-2000)
Salem WSO Airport (degrees F)

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean max	47.0	51.2	56.3	61.1	67.5	74.0	81.5	81.9	76.6	64.5	52.4	46.4	63.4
Mean min	33.5	34.7	36.6	38.8	43.6	48.4	52.0	52.1	47.7	41.3	37.9	33.9	41.7
Mean temp	40.3	43.0	46.5	50.0	55.6	61.2	66.8	67.0	62.2	52.9	45.2	40.2	52.6
Extreme max	65	71	77	85	100	105	103	108	104	92	71	68	108
Extreme min	6	-1	12	26	28	32	38	36	26	23	11	-12	-12

Mean number of days

Max >90	0	0	0	0	0.4	1.5	5.9	5.8	2.5	0.1	0	0	16.0
Min >32	13.4	10.5	8.1	4.4	0.6	0	0	0	0.1	2.4	7.3	13.0	59.9
Max <32	0.8	0.2	0	0	0	0	0	0	0	0	0.2	1.1	2.3
Min <0	0	0	0	0	0	0	0	0	0	0	0	0.2	0.2

Table 3.9 Snowfall, Monthly and Annual 30-year Averages (1971-2000), inches

Name	Station ID	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Salem WSO Airport	7500	1.3	2.1	0.1	0	0	0	0	0	0	0	0.4	2.0	6.0
Silver Creek Falls	7809	3.0	3.4	1.7	0.4	0	0	0	0	0	0	1.3	2.2	14.3
Silverton	7823	1.0	1.3	0	0	0	0	0	0	0	0	0.3	1.3	3.2

Table 3.10 Monthly and Annual Average Heating Degree Days (base 65°F), 1971-2000

Name	Number	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Salem WSO Airport	7500	769	623	576	451	301	140	39	35	116	376	596	771	4790
Silver Creek Falls	7809	844	711	700	564	410	244	121	124	218	480	702	863	5997
Silverton	7823	780	623	566	441	292	150	50	42	117	356	594	787	4795

Precipitation data recorded at Salem for the more recent October 2008 – September 2014 period are listed by water year in Tables 3.11 (daily values) and 3.12 (monthly values). Monthly average precipitation data for the longer 1892-2012 period are provided in Appendix. During the last six years, no snowfall was recorded at Salem Airport.

Table 3.11. Daily Precipitation Data at Salem Airport, 2008-2014

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Oct08,0.00,0.00,0.31,0.10,0.03,0.01,0.02,0.00,0.03,0.00,0.00,0.00,0.00,0.00,0.00
      0.01,0.00,0.07,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.37
Nov08,0.05,0.20,0.84,0.10,0.18,0.14,0.02,0.26,0.01,0.02,0.64,0.59,0.00,0.00,0.00
      0.00,0.00,0.00,0.00,0.45,0.04,0.00,0.00,0.00,0.04,0.00,0.01,0.00,0.00,0.03
Dec08,0.23,0.08,0.00,0.00,0.00,0.00,0.22,0.00,0.00,0.00,0.00,0.52,0.12,0.25,0.00
      0.00,0.22,0.12,0.03,0.88,0.68,0.47,0.00,0.47,0.09,0.16,0.27,0.18,0.84,0.09,0.10
Jan09,1.32,0.64,0.00,0.26,0.09,0.14,0.27,0.46,0.00,0.00,0.05,0.01,0.00,0.00,0.00
      0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.04,0.14,0.00,0.13,0.01,0.00,0.00,0.00
Feb09,0.00,0.00,0.00,0.00,0.04,0.40,0.00,0.00,0.03,0.13,0.13,0.02,0.02,0.00,0.08
      0.00,0.10,0.00,0.00,0.00,0.00,0.17,0.65,0.21,0.56,0.36,0.00,0.00
Mar09,0.21,0.50,0.12,0.00,0.07,0.00,0.08,0.07,0.04,0.00,0.00,0.00,0.00,0.58,0.62
      0.14,0.07,0.00,0.00,0.00,0.08,0.02,0.06,0.00,0.05,0.00,0.00,0.27,0.00,0.00,0.05
Apr09,0.13,0.16,0.03,0.00,0.00,0.00,0.00,0.02,0.14,0.00,0.00,0.37,0.17,0.01,0.00
      0.00,0.07,0.00,0.00,0.00,0.00,0.00,0.01,0.00,0.00,0.00,0.04,0.19,0.00,0.00
May09,0.24,0.35,0.15,0.80,0.06,0.59,0.06,0.00,0.00,0.01,0.00,0.02,0.45,0.02,0.00
      0.00,0.00,0.17,0.12,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00
Jun09,0.00,0.00,0.02,0.56,0.35,0.00,0.00,0.00,0.00,0.00,0.05,0.05,0.27,0.01,0.00
      0.00,0.00,0.03,0.00,0.01,0.04,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00
Jul09,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.68,0.00,0.00,0.00
      0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00
Aug09,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.09,0.00,0.00,0.00,0.00
      0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.03,0.00,0.00,0.05,0.00,0.00,0.00
Sep09,0.00,0.00,0.00,0.00,0.53,0.22,0.09,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00
      0.13,0.00,0.00,0.06,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.15,0.02
Oct09,0.00,0.06,0.00,0.08,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.40,0.38,0.03
      0.00,0.41,0.00,0.00,0.00,0.17,0.00,0.30,0.00,0.01,0.52,0.03,0.05,0.08,0,0.09
Nov09,0.00,0.00,0.00,0.00,0.21,0.78,0.85,0.64,0.41,0.21,0.42,0.54,0.35,0.00,0.08
      0.01,0.71,0.18,0.10,0.79,0.26,0.49,0.00,0.00,0.00,0.86,0.12,0.00,0.00,0.01
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Dec09,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.11,0.00,0.65,1.78
      0.55,0.09,0.00,0.07,0.49,0.38,0.07,0.00,0.00,0.00,0.00,0.02,0.00,0.37,0.33,1.23
Jan10,0.54,0.00,0.00,0.07,0.93,0.20,0.00,0.37,0.04,0.00,0.03,0.58,0.25,0.00,0.88
      0.23,0.42,0.00,0.00,0.07,0.00,0.18,0.00,0.78,0.12,0.07,0.00,0.00,0.00,0.08,0.01
Feb10,0.24,0.07,0.15,0.13,0.00,0.21,0.00,0.00,0.00,0.08,0.49,0.36,0.02,0.36,0.19
      0.04,0.00,0.00,0.00,0.00,0.00,0.00,0.78,0.25,0.10,0.60,0.00,0.00
Mar10,0.00,0.12,0.00,0.02,0.00,0.00,0.14,0.05,0.06,0.01,0.76,0.28,0.00,0.00,0.00
      0.00,0.01,0.00,0.00,0.00,0.11,0.00,0.00,0.25,0.62,0.51,0.00,1.00,1.06,0.14,0.00
Apr10,0.00,0.91,0.22,0.10,0.23,0.13,0.06,0.18,0.00,0.04,0.11,0.02,0.02,0.76,0.07
      0.00,0.00,0.00,0.07,0.10,0.00,0.00,0.00,0.00,0.00,0.69,0.44,0.14,0.04,0.02
May10,0.00,0.00,0.26,0.01,0.18,0.00,0.00,0.00,0.04,0.06,0.00,0.00,0.00,0.00,0.00
      0.00,0.33,0.14,0.34,0.37,0.96,0.10,0.04,0.00,0.18,0.22,0.00,0.00,0.00,0.03,0.21
Jun10,0.09,1.03,0.55,0.42,0.00,0.18,0.00,0.09,0.14,0.06,0.00,0.00,0.00,0.00,0.01
      0.01,0.00,0.00,0.00,0.06,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00
Jul10,0.02,0.02,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00
      0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00
Aug10,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.02,0.00,0.00,0.00,0.00,0.00,0.00,0.00
      0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.18,0.00
Sep10,0.00,0.00,0.00,0.00,0.00,0.00,0.18,0.12,0.00,0.00,0.00,0.00,0.00,0.00,0.27
      0.07,0.04,1.05,0.15,0.01,0.00,0.00,0.03,0.00,0.00,0.15,0.00,0.00,0.00,0.00
Oct10,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.02,0.40,0.83,0.00,0.00,0.00,0.00,0.00
      0.00,0.00,0.00,0.00,0.00,0.00,0.01,0.86,0.69,0.67,0.17,0.00,0.39,0.00,0.91,0.27
Nov10,0.16,0.00,0.00,0.00,0.00,1.05,0.15,0.11,0.66,0.07,0.02,0.00,0.08,0.01,0.00
      0.16,0.92,0.41,0.10,0.23,0.18,0.37,0.00,0.00,0.00,0.34,0.04,0.12,0.04,1.22
Dec10,0.33,0.00,0.00,0.00,0.00,0.05,0.15,1.18,1.12,0.14,0.77,0.22,0.34,0.59,0.15
      0.00,0.00,0.49,0.12,0.41,0.00,0.00,0.00,0.02,0.14,0.69,1.10,1.70,0.24,0.00,0.00
Jan11,0.00,0.00,0.00,0.00,0.08,0.00,0.04,0.06,0.04,0.00,0.08,0.34,0.63,0.00,0.72
      0.62,0.02,0.41,0.00,0.00,0.18,0.00,0.00,0.00,0.00,0.00,0.00,0.01,0.02,0.00,0.00
Feb11,0.00,0.00,0.00,0.02,0.04,0.05,0.11,0.00,0.00,0.00,0.00,0.51,0.07,0.46,0.60
      0.09,0.01,0.34,0.00,0.00,0.00,0.05,0.17,0.02,0.00,0.00,0.10,1.67
Mar11,0.55,0.14,0.18,0.30,0.01,0.00,0.06,0.14,0.34,0.89,0.00,0.10,0.72,0.70,0.54
      0.87,0.05,0.11,0.01,0.03,0.03,0.00,0.04,0.10,0.24,0.17,0.27,0.07,0.48,0.02,0.00
Apr11,0.15,0.05,0.00,0.17,0.06,0.22,0.09,0.00,0.00,0.30,0.04,0.00,0.22,0.26,0.63
      0.09,0.00,0.02,0.00,0.00,0.00,0.00,0.00,0.27,0.84,0.11,0.13,0.17,0.28,0.05
May11,0.00,0.07,0.00,0.00,0.02,0.23,0.02,0.19,0.00,0.00,0.34,0.00,0.00,0.00,0.19
      0.01,0.31,0.00,0.00,0.00,0.00,0.00,0.08,0.00,0.41,0.33,0.23,0.06,0.01,0.64,0.26
Jun11,0.29,0.23,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.15,0.07,0.00,0.00
      0.00,0.00,0.11,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.02,0.11,0.00,0.00
Jul11,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.13,0.00,0.00,0.00
      0.21,0.40,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00
Aug11,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00
      0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.11,0.00,0.00,0.00,0.00,0.00
Sep11,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00
      0.00,0.00,0.02,0.06,0.00,0.00,0.00,0.00,0.00,0.16,0.05,0.06,0.00,0.00,0.00
Oct11,0.32,0.13,0.24,0.31,0.01,0.00,0.03,0.00,0.07,0.25,0.36,0.04,0.03,0.06,0.00
      0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.08,0.05,0.12,0.05
Nov11,0.00,0.26,0.00,0.00,0.21,0.02,0.04,0.02,0.00,0.00,0.14,0.10,0.00,0.09,0.00
      0.52,0.66,0.44,0.11,0.00,0.63,1.01,0.69,0.53,0.00,0.00,0.45,0.00,0.01,0.03
Dec11,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00
      0.00,0.00,0.01,0.00,0.00,0.00,0.00,0.00,0.00,0.08,0.07,0.38,1.19,0.71,0.77,0.00
Jan12,0.00,0.10,0.00,0.35,0.04,0.05,0.00,0.00,0.21,0.03,0.00,0.00,0.00,0.20,0.04
      0.13,2.18,2.47,2.13,0.65,0.15,0.19,0.00,0.77,0.04,0.08,0.00,0.00,0.50,0.00,0.01
Feb12,0.05,0.00,0.00,0.00,0.00,0.00,0.03,0.54,0.11,0.14,0.00,0.12,0.10,0.11,0.00
      0.06,0.13,0.06,0.15,0.17,0.01,0.28,0.00,0.31,0.17,0.08,0.00,0.47,1.05
Mar12,0.21,0.00,0.00,0.00,0.38,0.03,0.00,0.00,0.00,0.26,0.31,1.26,0.45,0.69,0.93
      0.48,0.07,0.00,0.07,0.63,1.27,0.07,0.00,0.00,0.07,0.01,0.16,0.15,0.81,1.13,0.54
Apr12,0.24,0.00,0.27,0.08,0.19,0.00,0.00,0.00,0.00,0.13,0.15,0.06,0.10,0.00,0.11
      0.38,0.11,0.13,0.40,0.00,0.00,0.00,0.00,0.00,0.17,0.35,0.03,0.00,0.07,0.11
May12,0.02,0.21,0.50,0.13,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00
      0.00,0.00,0.00,0.00,0.07,0.57,0.27,0.01,0.27,0.26,0.00,0.00,0.00,0.00,0.00,0.00
Jun12,0.09,0.00,0.08,0.30,0.00,0.00,0.47,0.17,0.00,0.00,0.00,0.14,0.00,0.00,0.00
      0.00,0.00,0.00,0.01,0.00,0.00,0.22,0.22,0.06,0.14,0.02,0.00,0.00,0.00,0.28
Jul12,0.04,0.02,0.01,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00
      0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.08,0.00
Aug12,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00
      0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00
Sep12,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.02,0.00,0.00,0.00,0.00,0.00
      0.00,0.00,0.00,0.00,0.00,0.01,0.00,0.01,0.00,0.00,0.00,0.00,0.00,0.00,0.00
Oct12,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.96,0.02,0.67,0.80
      0.22,0.00,0.06,0.20,0.08,0.15,0.31,0.15,0.09,0.01,0.00,0.48,1.16,0.12,0.18,0.28
Nov12,0.30,0.19,0.14,0.00,0.00,0.02,0.01,0.02,0.27,0.00,0.21,0.59,0.00,0.05,0.00
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```
      0.00,1.22,0.75,1.92,1.12,0.51,0.00,0.57,0.15,0.00,0.00,0.00,0.02,0.26,0.60
Dec12,0.74,0.58,0.32,0.93,0.00,0.03,0.07,0.10,0.02,0.00,0.24,0.00,0.00,0.23,0.29
      0.53,0.36,0.04,0.03,1.09,0.12,0.20,0.63,0.05,0.77,0.01,0.01,0.00,0.01,0.00,0.00
Jan13,0.00,0.00,0.00,0.00,0.01,0.09,0.11,0.00,0.29,0.03,0.00,0.00,0.00,0.00,0.00
      0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.23,0.23,0.11,0.27,0.14,0.07,0.02,0.03,0.00
Feb13,0.00,0.00,0.00,0.00,0.12,0.10,0.13,0.00,0.07,0.00,0.00,0.00,0.00,0.00,0.00
      0.01,0.00,0.05,0.00,0.12,0.02,0.45,0.07,0.01,0.20,0.00,0.00,0.06
Mar13,0.00,0.00,0.00,0.00,0.00,0.30,0.32,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00
      0.24,0.00,0.00,0.68,0.56,0.03,0.01,0.00,0.00,0.00,0.04,0.02,0.01,0.00,0.00,0.00
Apr13,0.00,0.00,0.00,0.16,0.49,0.62,0.20,0.02,0.00,0.14,0.00,0.03,0.11,0.24,0.00
      0.00,0.00,0.05,0.28,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.05,0.00
May13,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.02,0.00,0.00,0.14
      0.10,0.00,0.05,0.04,0.00,0.73,0.19,0.25,0.01,0.24,0.04,0.59,0.24,0.19,0.02,0.00
Jun13,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.22,0.00,0.00
      0.00,0.00,0.02,0.16,0.01,0.00,0.00,0.11,0.02,0.33,0.15,0.00,0.00,0.00,0.00
Jul13,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00
      0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00
Aug13,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.02,0.00,0.00,0.00,0.00,0.00
      0.00,0.00,0.00,0.00,0.00,0.00,0.02,0.00,0.00,0.07,0.03,0.00,0.04,0.17,0.00,0.00
Sep13,0.00,0.00,0.00,0.00,0.18,0.52,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00
      0.00,0.00,0.00,0.00,0.10,0.05,0.22,0.36,0.40,0.01,0,0.18,1.33,1.64,0.42
Oct13,0.19,0.22,0.00,0.00,0.00,0.00,0.03,0.09,0.00,0.00,0.00,0.04,0.00,0.00,0.00
      0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0,00,0.00
Nov13,0.03,0.39,0.07,0.08,0.05,0.27,0.43,0.02,0.00,0.00,0.00,0.23,0.00,0.00,0.04
      0.03,0.01,0.44,0.59,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00
Dec13,0.49,0.35,0.00,0.00,0.00,0.03,0.00,0.00,0.00,0.00,0.00,0.11,0.02,0.00,0.09
      0.00,0.00,0.05,0.00,0.08,0.01,0.00,0.04,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00
Jan14,0.00,0.00,0.08,0.00,0.00,0.01,0.16,0.37,0.20,0.00,0.57,0.40,0.00,0.00,0.00
      0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.06,0.28,0.08,0.04,0.01
Feb14,0.01,0.00,0.00,0.02,0.00,0.22,0.54,0.45,0.01,0.11,0.79,0.52,0.36,0.76,0.86
      0.10,0.67,0.74,0.23,0.20,0.00,0.00,0.03,0.22,0.00,0.00,0.17,0.00
Mar14,0.07,0.34,0.40,0.01,1.46,0.51,0.00,0.74,0.22,0.01,0.00,0.00,0.00,0.22,0.00
      0.51,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.26,0.55,0.33,1.08,0.45,0.10,0.06
Apr14,0.02,0.00,0.17,0.01,0.08,0.00,0.00,0.03,0.01,0.00,0.00,0.00,0.00,0.00,0.01
      0.00,0.41,0.00,0.04,0.00,0.19,0.20,0.63,0.42,0.07,0.14,0.28,0.00,0.00,0.00
May14,0.00,0.00,0.31,0.07,0.05,0.00,0.00,0.59,0.46,0.04,0.00,0.00,0.00,0.00,0.00
      0.00,0.02,0.36,0.00,0.00,0.00,0.00,0.06,0.00,0.00,0.00,0.05,0.05,0.01,0.00,0.00
Jun14,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.08,0.00,0.00,0.03
      0.15,0.00,0.00,0.00,0.04,0.00,0.00,0.00,0.00,0.00,0.07,0.27,0.00,0.00,0.00
Jul14,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.06,0.00,0.00
      0.00,0.00,0.00,0.00,0.00,0.00,0.11,0.26,0.03,0.00,0.00,0.00,0.00,0.00,0.00,0.00
Aug14,0.15,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.13,0.00,0.00,0.00
      0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.07,0.00
Sep14,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00
      0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.47,0.57,0.08,0.00,0.00,0.00,0.04,0.03
```

Table 3.12 Monthly Average Precipitations at Salem Airport, 2008-2014

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Ann.
2008-09	0.95	3.62	6.02	3.56	2.9	3.03	1.34	3.04	1.39	0.68	0.17	1.20	27.9
2009-10	2.61	8.02	6.14	5.85	4.07	5.14	4.35	3.47	2.64	0.04	0.2	2.07	44.6
2010-11	5.22	6.44	9.95	3.25	4.31	7.16	4.15	3.40	0.98	0.74	0.11	0.35	46.06
2011-12	2.15	5.96	3.21	10.32	4.14	9.98	3.08	2.31	2.20	0.07	0.00	0.04	43.46
2012-13	5.94	8.92	7.40	1.63	1.41	2.21	2.39	2.85	1.02	0.00	0.35	5.41	39.53
2013-14	0.57	2.68	1.27	2.26	7.01	7.32	2.71	2.07	0.64	0.46	0.35	1.19	28.53
2008-14	*2.91*	*5.94*	*5.67*	*4.48*	*3.97*	*5.81*	*3.00*	*2.86*	*1.48*	*0.33*	*0.20*	*1.71*	*38.35*
1892-2012	*3.21*	*6.12*	*6.69*	*6.11*	*4.72*	*4.14*	*2.57*	*2.07*	*1.32*	*0.39*	*0.52*	*1.53*	*39.39*

Figure 3.1 is a plot of the monthly average precipitations and the cumulative precipitation amounts for the October 2008 – September 2014 period. Based on that plot, it appears that 2010-11 was the wettest of the six years, and 2008-09 the driest year.

Figure 3.1 Plot of Monthly Average Precipitation and Cumulative Amount

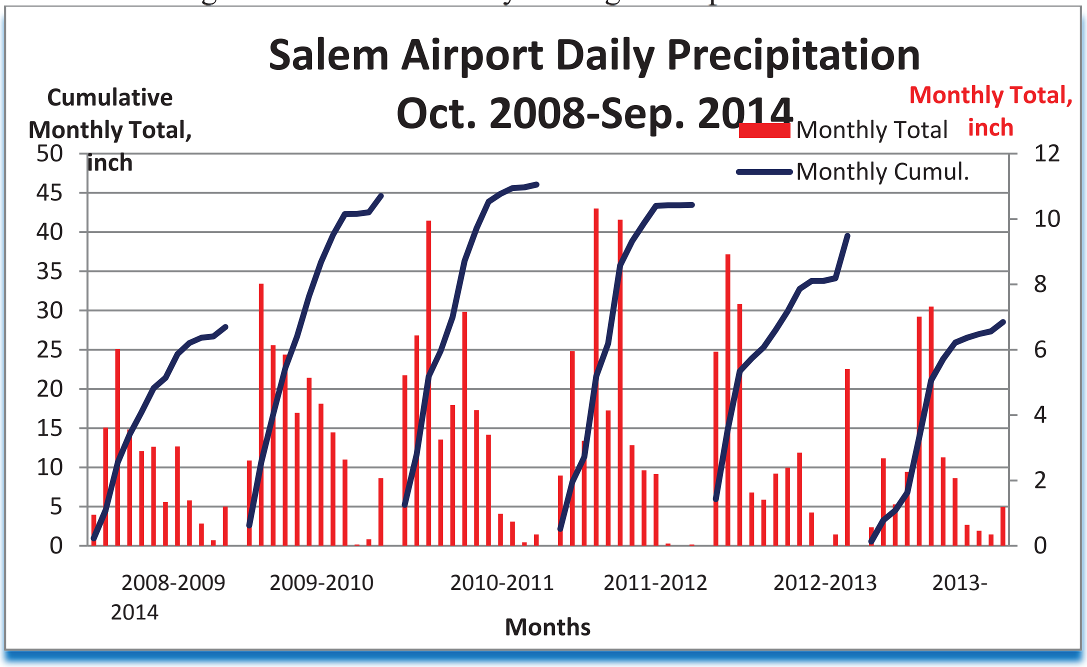
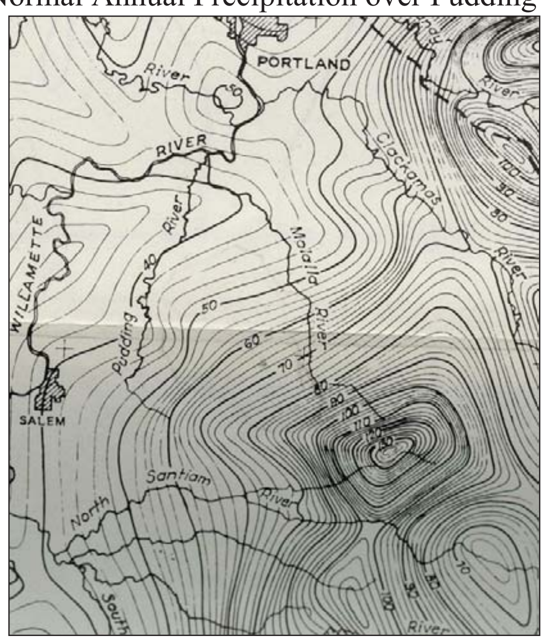


Figure 3.2 shows a map of normal annual precipitation over the Pudding River basin as excerpted from the U.S. Corps of Engineers report, “Procedure for Determination of Maximum Annual Flood Peak and Volume Frequencies for Portland District”, dated February 1969. Based on the isohyets shown on that map and the 1971-2000 average precipitation data listed in Table 3.6, Salem records about 40 inches of rain per year. As expected, this precipitation amount is a lot less than the rainfall over the Drift Creek watershed, which is located on much higher ground than Salem and receives as much as 120 inches of rainfall at its headwaters.

Figure 3.2 Normal Annual Precipitation over Pudding River Basin



4. Drift Creek's 2008-2014 Observed Stream Flows

Starting in 2008, Drift Creek's stream flow data were recorded both at the project site (Victor Road) and the Hibbard Rd. gauge located further downstream. The observed flow data at the project site (Upper Drift Creek) are listed below for each of the five hydrologic years (HY). Table 4.1 refers to HY 2008-09; Table 4.2 to HY 2009-10, Table 4.3 to HY2010-11, Table 4.4 to HY2011-12, Table 4.5 to HY2012-13 and Table 4.6 to HY2013-14. Corresponding stream flow data, at the lower Hibbard Rd. gauge, when available, are provided in the Appendix. When possible, runoff hydrographs are plotted together each year for the two stations for direct comparison purposes, with separate plots for daily and monthly flows. See Figures 4. 1, 4.2, 4.3, 4.4, 4.5, 4.6 and 4.7.

4.1 HY 2008-09

Stream flow data and related information (see Table 4.1 and Figures 4.1 and 4.2) were discussed in Report Update #1 and included the following:

- Daily stream flow data collected by Marion Soil and Water Conservation District (Marion SWCD) at two Drift Creek gauges: Victor Point (project site) and Hibbard Rd. (lower station below the project site). Those data were provided by Marion SWCD,
- Daily stream flow data collected by the U.S. Geological Survey (USGS) at six sites on the Pudding River and nearby streams. USGS data were retrieved via the Internet from pertinent websites,
- Ecological and flushing flows prepared by Ellis Ecological Service in March 2010; and
- Revised OWRD's Drift Creek flow availability data made available in April 2010.
-

Table 4.1 Observed Flows (in cfs) of Drift Creek at Victor Rd., HY **2008-09**

DATE	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	2008	2008	2008	2009	2009	2009	2009	2009	2009	2009	2009	2009
1	0.50	0.65	17.00	275.00	22.00	91.00	60.00	22.00	11.00	3.00	0.23	0.16
2	0.50	0.70	19.00	500.00	21.00	92.00	81.00	39.00	10.00	2.70	0.23	0.17
3	1.00	1.00	20.00	267.00	21.00	86.00	80.00	39.00	9.80	2.30	0.23	0.19
4	5.00	6.00	19.00	181.00	20.00	74.00	72.00	40.00	10.00	2.00	0.22	0.19
5	4.00	5.00	19.00	173.00	19.00	77.00	64.00	70.00	13.00	2.00	0.23	0.49
6	3.80	3.30	17.00	159.00	23.00	71.00	56.00	98.00	12.00	1.80	0.25	0.90
7	3.50	3.50	17.00	161.00	23.00	65.00	51.00	128.00	11.00	1.70	0.28	0.85
8	3.50	3.00	19.00	198.00	22.00	62.00	46.00	108.00	10.00	1.60	0.35	0.40
9	4.00	3.50	17.00	163.00	22.00	60.00	44.00	89.00	9.30	1.70	0.42	0.29
10	3.00	4.00	16.00	132.00	22.00	58.00	45.00	75.00	8.80	1.80	0.34	0.30
11	2.80	5.00	15.00	115.00	25.00	54.00	38.00	65.00	8.70	1.80	0.30	0.29
12	2.60	22.00	17.00	96.00	24.00	50.00	35.00	59.00	8.40	2.00	0.39	0.27
13	2.50	130.00	26.00	84.00	25.00	46.00	44.00	53.00	7.90	3.00	0.50	0.25
14	2.30	85.00	23.00	73.00	24.00	46.00	42.00	66.00	7.50	2.80	0.35	0.25

15	2.10	54.00	19.00	65.00	24.00	80.00	39.00	54.00	7.20	2.10	0.30	0.73
16	2.00	40.00	17.00	57.00	23.00	92.00	35.00	46.00	6.80	1.60	0.29	3.70
17	1.60	34.00	17.00	50.00	23.00	84.00	35.00	40.00	6.50	1.20	0.26	1.70
18	1.80	28.00	28.00	44.00	22.00	73.00	33.00	36.00	6.20	0.92	0.20	0.83
19	1.30	23.00	25.00	39.00	21.00	66.00	30.00	37.00	6.20	0.78	0.18	0.43
20	1.00	24.00	24.00	35.00	20.00	60.00	27.00	33.00	6.00	0.73	0.17	0.32
21	1.00	25.00	33.00	32.00	19.00	54.00	25.00	29.00	5.80	0.66	0.15	0.27
22	1.20	24.00	60.00	30.00	19.00	62.00	24.00	26.00	5.10	0.63	0.15	0.23
23	0.80	23.00	50.00	28.00	24.00	59.00	23.00	24.00	4.70	0.57	0.15	0.21
24	0.70	22.00	40.00	26.00	71.00	54.00	22.00	22.00	4.40	0.51	0.14	0.20
25	0.60	21.00	50.00	27.00	126.00	61.00	21.00	21.00	4.00	0.40	0.13	0.19
26	0.55	20.00	55.00	25.00	156.00	59.00	20.00	19.00	4.00	0.35	0.13	0.18
27	0.60	20.00	110.00	24.00	123.00	54.00	20.00	18.00	3.50	0.31	0.13	0.17
28	0.60	19.00	200.00	27.00	106.00	56.00	27.00	16.00	3.20	0.29	0.13	0.17
29	0.60	18.00	215.00	25.00		68.00	29.00	15.00	3.20	0.26	0.15	0.18
30	0.55	17.00	160.00	24.00		66.00	24.00	14.00	3.10	0.25	0.16	0.22
31	0.60		130.00	23.00		63.00		11.00		0.24	0.17	
COUNT	31	30	31	31	28	31	30	31	30	31	31	30
AVE, cfs	1.83	22.82	48.19	101.87	38.93	65.90	39.73	45.55	7.24	1.35	0.24	0.49
VOL, AF	112	1358	2963	6262	2161	4051	2364	2800	431	83	14	29
MONTH	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
	2008	**2008**	**2008**	**2009**	**2009**	**2009**	**2009**	**2009**	**2009**	**2009**	**2009**	**2009**

Annual Oct. 2008-Sep.09 runoff volume= 22,629 AF

Figure 4.1 Hydrographs for HY **2008-09** Upper Drift Creek Daily Flows

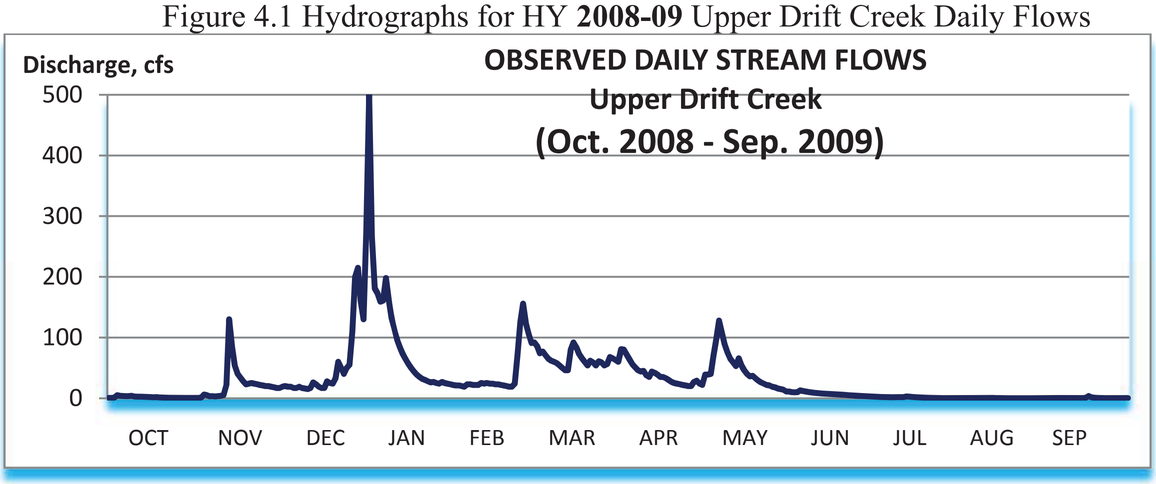
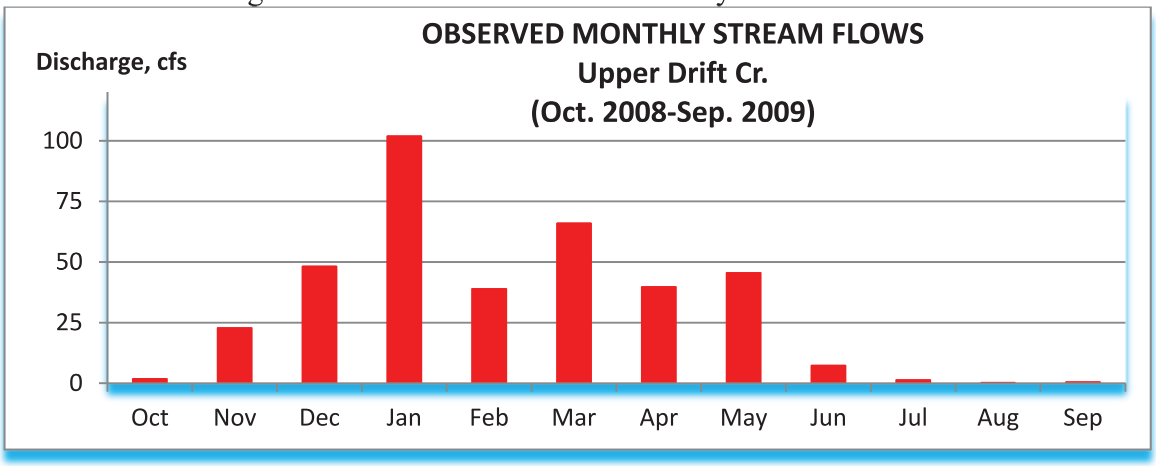


Figure 4.2 Plots of Drift Creek Monthly Flows for HY **2008-09**



4.2 HY 2009-10

Stream flows data for the 2009-10 hydrologic year (see Table 4.2 and Figures 4.3 and 4.4) were discussed in Report Update #2 and included the following:

- Daily stream flow data collected at the project site (Victor Point) by a contractor to EVWD (and provided via Ellis Ecological Service).
- Daily stream flow data at Hibbard Rd. below the project site collected by Marion SWCD. The District team also provided daily stream flows they recorded for Silver Creek at Silverton, Abiqua Creek above Gallon House Bridge, and Butte Creek at Monitor.
-
- Daily stream flow data collected by USGS for the Pudding River near Woodburn and near Aurora. USGS data were retrieved via the Internet.

The full 2009-2010 stream flow data at the project site (Victor Point) were collected, except for short gaps during the 1-4 October 2009 and 7-16 November 2009 periods. Those gaps were later filled with corresponding data for the lower site with selected drainage-based correction factors.

Table 4.2 Observed Flows (in cfs) of Drift Creek at Victor Rd., HY **2009-10**

DATE	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	2009	2009	2009	2010	2010	2010	2010	2010	2010	2010	2010	2010
1	0.70	10.79	54.39	187.27	45.19	51.35	171.98	70.85	68.46	14.77	3.19	1.00
2	0.70	8.59	48.26	165.74	45.43	47.56	166.41	62.56	136.61	15.78	3.03	1.32
3	0.70	6.66	41.19	132.53	44.04	44.84	181.37	63.13	195.20	15.30	2.80	1.12
4	0.70	5.42	35.61	113.88	44.32	42.01	162.35	56.63	218.07	13.73	2.71	0.77
5	0.79	4.78	31.07	130.90	43.94	37.53	142.77	52.36	174.99	13.06	2.65	0.51
6	5.78	5.08	27.47	191.81	40.61	34.17	129.91	47.98	143.78	12.24	2.40	0.43
7	2.87	36.28	24.13	157.00	38.22	31.81	113.09	43.37	127.85	11.35	2.11	1.13

8	1.42	55.48	21.00	132.48	35.25	35.16	112.58	39.85	100.15	10.54	2.05	2.24
9	0.67	52.93	18.39	124.22	33.35	30.86	92.67	36.46	90.73	9.99	2.60	1.98
10	0.30	46.11	17.07	104.58	31.71	30.79	86.88	38.71	101.39	9.27	2.31	1.51
11	0.14	51.62	16.81	91.60	32.79	32.37	79.64	34.80	106.54	8.93	2.23	1.20
12	0.05	70.48	17.13	99.40	39.27	61.17	74.54	31.07	90.62	8.43	1.96	0.93
13	0.01	66.70	17.46	97.79	45.29	83.26	68.17	28.35	77.12	8.15	1.60	0.76
14	0.41	62.52	16.84	90.21	55.18	72.85	63.26	26.15	67.57	7.40	1.25	0.65
15	0.95	50.95	55.29	91.97	63.16	64.35	99.46	24.13	61.91	6.73	1.05	4.38
16	0.85	41.70	114.32	155.85	68.98	57.41	85.35	22.61	56.13	6.46	0.99	3.89
17	0.91	65.84	103.93	155.43	64.85	52.17	74.17	25.01	48.52	6.12	0.81	2.88
18	2.26	60.65	89.10	143.91	59.67	46.22	65.93	29.70	40.54	6.04	0.61	4.27
19	1.72	52.80	82.03	122.95	54.35	41.64	59.30	29.28	33.76	6.00	0.72	9.06
20	1.07	54.80	80.05	104.39	49.01	37.87	55.28	27.45	32.08	6.06	0.78	8.42
21	1.06	67.07	119.79	91.33	43.59	40.14	60.96	28.51	30.63	5.70	0.69	7.00
22	1.35	79.67	135.69	81.97	38.99	43.58	50.16	53.49	25.78	5.42	0.65	4.66
23	2.09	71.38	110.51	73.89	36.92	37.75	45.01	54.12	25.48	5.12	0.56	3.51
24	4.89	59.61	93.72	70.91	46.62	34.79	43.31	51.45	23.87	4.83	0.44	3.15
25	3.68	50.82	81.40	93.90	50.28	43.75	39.20	51.19	20.65	4.56	0.33	2.76
26	6.11	51.31	70.00	83.75	56.25	94.43	37.25	81.95	18.78	4.26	0.31	2.60
27	10.53	108.69	60.92	73.38	61.95	96.52	62.12	86.80	17.54	3.89	0.51	2.80
28	6.52	89.71	53.72	63.59	55.78	93.94	89.32	75.31	16.39	3.81	0.40	2.42
29	5.80	74.28	48.54	59.02		232.61	94.04	68.72	15.39	3.83	0.24	2.10
30	10.91	62.44	62.75	54.70		263.37	82.19	60.16	14.59	3.64	0.30	1.86
31	12.15		100.94	50.00		215.25		68.22		3.51	0.54	
COUNT	31	30	31	31	28	31	30	31	30	31	31	30
AVE, cfs	2.84	50.84	59.66	109.37	47.32	68.76	89.62	47.43	72.70	7.90	1.38	2.71
VOL, AF	175	3024	3668	6723	2627	4227	5332	2916	4325	486	85	161
MONTH	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
	2009	**2009**	**2009**	**2010**	**2010**	**2010**	**2010**	**2010**	**2010**	**2010**	**2010**	

Annual Oct. 2009-Sep.10 runoff volume= 33,749 AF

Figure 4.3 Hydrographs for HY **2009-10** Drift Creek Daily Flows

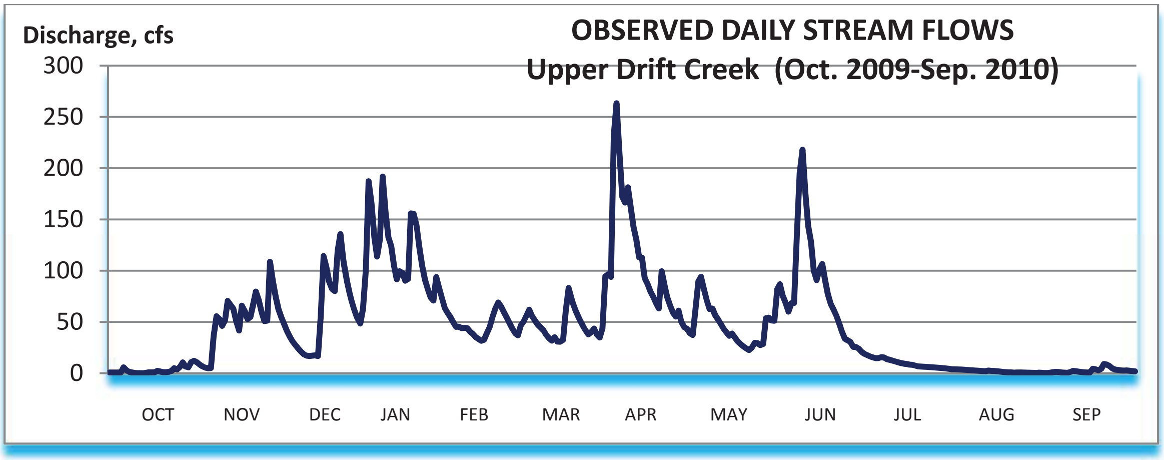
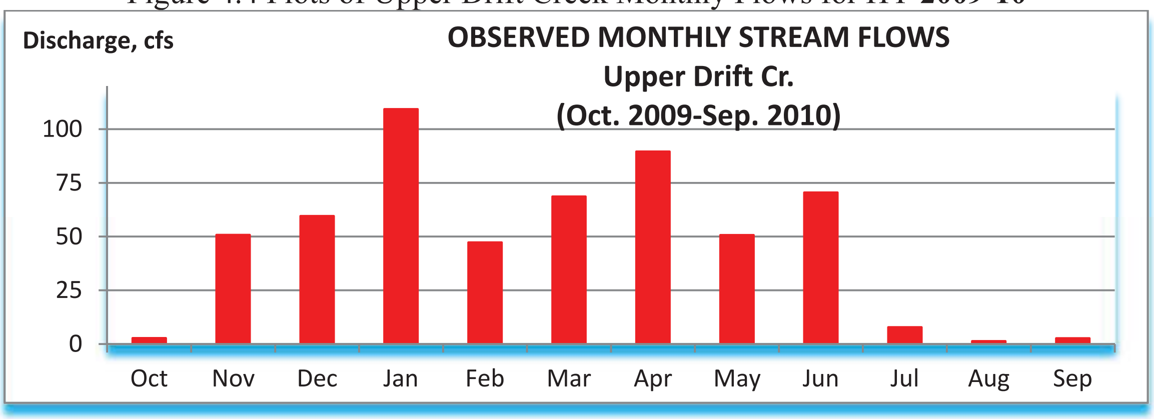


Figure 4.4 Plots of Upper Drift Creek Monthly Flows for HY **2009-10**



4.3 HY 2010-11

Stream flow data for the 2010-11 hydrologic year discussed in Report Update #3 include the following:

- Daily stream flow data collected at the project site (Victor Point) by a contractor to EVWD (and provided via Ellis Ecological Service).
- Daily stream flow data collected at Hibbard Rd. gage below the project site by Marion SWCD. The District made “provisional” data available in late April 2012, along with daily stream flow they recorded for Silver Creek at Silverton, Abiqua Creek above Gallon House Bridge, Butte Creek at Monitor, and Zollner Creek near Mt. Angel. Updated 2008-2009 stream flows data for Abiqua Creek were also received.
- Daily stream flow data collected by USGS for the Pudding River near Woodburn and near Aurora were available as usual through the Internet. Some minor changes were noticed between data posted in mid-January and mid-April 2012.

In general the 2010-11 flow meter readings for Drift Creek were within the level of accuracy generally expected for this type of discharge measurement and this relatively small size of catchment area. Data readings in August and September yielded flows slightly higher at the upper gauge than those recorded at the lower gauge of the creek. This difference involved flows of less than 0.1 cfs that last only a few days, and could be caused by irrigation withdrawal between the two stations.

Table 4.3 Observed Flows (in cfs) of Drift Creek at Victor Rd., HY **2010-11**

DATE	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	2010	2010	2010	2011	2011	2011	2011	2011	2011	2011	2011	2011
1	0.93	27.76	150.98	107.95	33.98	197.32	98.27	66.94	58.42	16.74	4.51	1.56
2	0.89	65.17	146.27	91.19	30.72	177.45	104.75	62.00	57.30	13.55	4.09	1.45
3	0.87	52.99	117.08	78.10	28.21	147.41	89.55	56.02	52.73	11.88	4.76	1.34
4	0.85	41.19	97.92	68.02	26.29	131.63	81.81	50.39	46.85	10.96	3.76	1.13
5	0.70	33.72	82.74	61.75	25.39	125.27	86.61	46.05	41.84	10.09	3.51	1.01
6	0.58	32.08	72.05	56.90	24.27	105.42	80.34	43.75	39.17	9.23	3.43	0.66
7	0.48	93.07	62.73	51.46	24.09	92.36	86.91	47.76	35.83	8.84	3.55	0.55
8	0.49	76.55	70.85	52.29	23.23	82.51	82.17	46.90	32.91	8.78	3.64	0.56
9	1.34	72.60	112.46	49.88	24.34	76.97	74.60	49.48	29.38	8.23	3.69	0.69
10	10.27	88.34	161.50	46.57	23.58	121.70	69.10	44.48	26.93	8.03	3.89	0.70
11	12.07	73.01	150.43	42.96	22.57	120.77	75.56	43.92	25.32	8.17	3.14	0.66
12	7.36	64.54	149.68	48.52	21.81	104.77	70.82	47.69	23.32	8.93	2.69	0.72
13	5.38	54.87	216.24	79.27	28.92	103.92	69.17	42.48	24.53	9.65	2.55	0.80
14	4.34	56.06	254.46	97.22	28.09	121.83	68.74	40.20	21.52	8.70	2.90	0.99
15	3.66	54.18	199.07	95.98	56.26	114.71	82.27	44.97	19.45	7.71	2.88	1.10
16	3.31	59.11	157.15	250.04	77.59	130.45	123.00	53.75	17.62	8.31	2.60	1.18
17	2.95	56.68	129.72	302.76	67.17	141.44	130.35	49.46	17.76	11.94	2.34	1.14
18	2.68	147.34	125.35	217.56	60.02	130.18	110.06	43.82	17.88	13.12	2.19	0.98
19	2.45	137.00	112.07	203.90	58.04	121.67	92.64	37.15	16.48	11.37	2.04	1.39
20	2.29	125.47	102.02	153.15	52.18	106.88	78.28	34.01	16.94	10.55	1.72	1.52
21	2.19	104.50	89.26	130.74	47.81	98.89	70.35	31.41	15.67	8.91	1.55	1.20
22	4.66	107.28	77.25	114.96	44.88	90.87	62.51	29.68	14.86	8.36	1.67	1.07
23	6.54	121.10	67.60	97.94	44.00	80.86	55.49	27.57	15.04	7.47	1.65	0.89
24	13.30	99.00	59.93	85.55	44.94	79.09	51.56	25.55	14.21	6.84	1.50	0.73
25	18.51	80.73	54.81	74.58	42.47	76.00	64.36	28.32	13.39	6.37	1.45	0.90
26	23.92	75.48	61.51	66.05	39.01	90.95	63.94	28.72	12.86	6.13	2.79	1.41
27	20.36	101.56	70.77	58.64	37.81	89.78	63.28	42.19	12.31	5.70	2.02	4.04
28	19.53	90.63	148.98	52.69	79.31	89.38	66.73	62.67	13.15	5.40	1.67	3.95
29	21.88	79.97	245.75	47.35		105.84	78.25	63.70	13.04	5.01	1.69	2.78
30	18.34	84.46	164.79	42.39		117.06	73.58	57.14	13.88	4.78	1.78	2.75
31	28.39		129.61	37.93		104.72		54.31		4.75	1.62	
COUNT	31	30	31	31	28	31	30	31	30	31	31	30
AVE, cfs	7.79	78.55	123.90	95.62	39.89	112.20	80.17	45.24	25.35	8.86	2.69	1.33

VOL, AF	479	4673	7617	5878	2215	6897	4769	2781	1508	544	165	79
MONTH	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	2010	2010	2010	2011	2011	2011	2011	2011	2011	2011	2011	2011

Annual (Oct. 2010-Sep. 2011) runoff volume= 37,606 AF

Figure 4.5 Hydrographs for HY **2010-11** Drift Creek Daily Flows

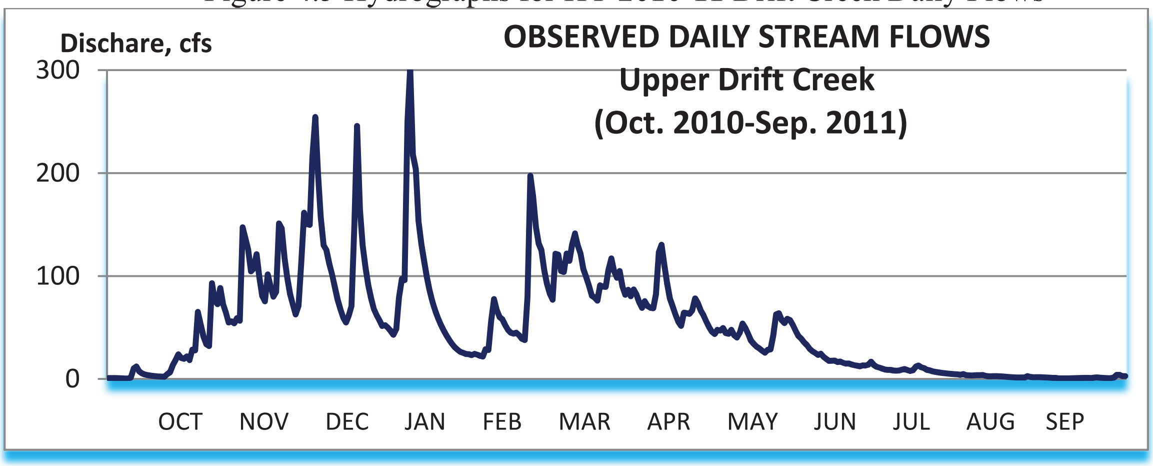
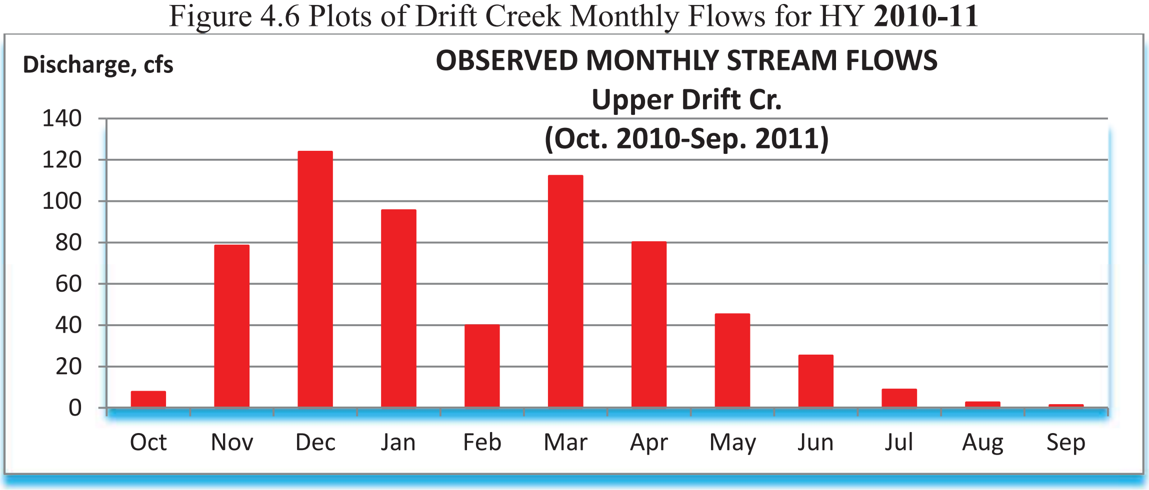


Figure 4.6 Plots of Drift Creek Monthly Flows for HY **2010-11**



4.4 HY 2011-12

Stream flow data for the 2011-12 hydrologic year were collected at the project site (Victor Point) by a contractor to EVWD, and later made available by Ellis Ecological Service. On the other hand, the daily stream flow data collected at the lower Hibbard Rd. gauge below the project site by Marion SWCD has been put on hold while the District Board reviewed the Stream flow Program and weighed whether to continue the program or not. As a result, those data are still not available in readable format at this time and, therefore, not included in the current hydrologic analysis.

Daily stream flow data collected by USGS for the Pudding River near Woodburn and near Aurora were available as usual through the Internet. However, as shown in Table 3.3, no data are available for the Pudding River nr. Mt. Angel, Silver Cr. nr. Silverton, and Albiqua Cr. nr. Scott Mills.

The 2011-12 flow meter readings for Upper Drift Creek went well, with only minor gaps during the 10/01/11 – 12/31/11 and 2/09/12 – 3/17/12 periods. Missing data for those two periods were reconstituted through the use of regression equations that correlate daily flows of Pudding River near Aurora and Upper Drift Creek for the same hydrologic year. The highest daily discharge for the 2011-12 hydrologic year (and also for the 6 years of records, October 2008-September 2013) initially was 809 cfs occurring on January 19, 2012. The wettest month for this water year was January 2012.

Slight revisions were made later, in October 2014, by Stillwater Sciences as reflected in Table 4.4. The annual runoff volume for 2011-12 has been updated to 36,178 AF.

Table 4.4 Observed Flows (in cfs) of Drift Creek at Victor Rd., HY **2011-12**

DATE	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	2011	2011	2011	2012	2012	2012	2012	2012	2012	2012	2012	2012
1	1.80	9.75	58.40	136.07	90.72	93.37	233.97	67.05	18.78	14.01	3.69	1.06
2	2.72	8.39	51.91	106.17	79.80	104.02	187.98	65.56	18.76	13.15	3.47	0.98
3	4.03	14.76	45.76	91.88	72.60	88.31	163.40	74.76	17.21	12.78	3.27	0.95
4	6.33	14.10	40.58	78.75	65.93	77.71	159.95	76.32	19.65	11.81	2.99	0.87
5	6.55	11.94	35.89	81.18	59.62	72.51	150.60	76.01	45.07	10.70	2.82	0.65
6	5.58	11.80	31.68	71.08	54.12	75.63	124.75	70.28	34.13	9.37	2.67	0.40
7	4.50	11.04	27.96	64.24	49.25	77.02	108.06	64.37	33.80	8.58	2.54	0.36
8	4.46	10.94	25.17	57.43	46.63	70.06	93.09	58.10	37.08	8.14	2.43	0.34
9	3.86	10.46	24.17	52.03	54.49	63.74	80.95	51.84	49.87	7.58	2.45	0.57
10	4.07	9.87	22.68	51.10	60.20	59.13	73.02	45.70	45.11	7.08	2.41	0.63
11	9.72	9.63	21.67	44.71	63.39	60.55	69.68	40.89	38.90	6.74	2.26	0.54
12	8.88	12.68	18.89	40.12	70.41	74.59	62.97	36.20	35.86	6.43	2.05	0.49
13	6.57	14.69	17.73	36.28	65.15	108.62	56.29	31.74	34.61	6.18	1.89	0.40
14	5.60	17.64	16.72	34.51	60.20	161.28	49.73	28.03	28.30	5.93	1.69	0.31
15	5.45	18.07	16.83	36.15	55.56	167.97	43.72	24.60	23.40	5.87	1.63	0.26
16	5.05	17.74	16.27	32.55	51.61	201.90	55.83	23.71	22.61	6.12	1.58	0.25
17	4.83	43.59	15.32	39.79	48.73	252.18	55.95	22.00	20.80	5.76	1.43	0.23
18	4.22	67.75	15.13	205.75	50.53	195.68	62.38	20.63	19.90	5.65	1.36	0.23
19	3.96	72.31	14.87	808.62	58.42	165.53	68.03	19.38	19.01	5.61	1.69	0.29
20	3.83	61.11	14.01	342.00	58.77	184.46	75.65	18.65	17.79	5.47	1.58	0.42
21	3.65	52.26	13.56	327.25	62.32	261.65	69.53	20.79	16.38	5.73	1.40	0.62
22	3.49	76.57	12.98	242.50	74.94	237.99	63.38	28.56	15.51	5.47	1.25	1.09
23	3.41	93.71	12.50	205.46	92.70	203.23	56.07	26.09	18.87	5.52	1.09	1.48

24	3.27	107.40	12.02	192.30	95.05	186.13	48.75	29.60	18.74	5.22	0.98	1.56
25	3.13	95.88	11.89	204.22	89.67	163.62	46.37	43.48	16.43	4.78	0.94	1.56
26	3.07	79.18	12.00	171.59	87.29	141.99	66.68	34.50	16.07	4.49	1.12	1.63
27	2.91	73.03	12.27	140.72	79.09	124.99	68.69	28.35	14.74	4.52	1.12	1.61
28	2.76	88.82	49.60	123.71	71.81	111.85	64.17	23.96	13.40	4.83	1.12	1.57
29	3.71	73.83	121.21	111.88	69.01	110.03	58.80	23.27	12.59	4.53	1.09	1.35
30	6.14	66.94	249.25	119.60		272.33	66.61	21.35	12.38	4.35	1.06	1.38
31	12.25		195.25	98.69		314.63		19.78		4.01	1.06	
COUNT	31	30	31	31	29	31	30	31	30	31	31	30
AVE, cfs	4.83	41.86	39.81	140.27	66.83	144.60	86.17	39.21	24.52	6.98	1.87	0.80
VOL, AF	297	2490	2447	8623	3843	8889	5126	2410	1459	429	115	48
MONTH	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
	2011	**2011**	**2011**	**2012**	**2012**	**2012**	**2012**	**2012**	**2012**	**2012**	**2012**	**2012**

Annual Oct. 2011-Sep.12 runoff volume= 36,178 AF

Figure 4.7 Hydrographs for HY **2011-12** Upper Drift Creek Daily Flows

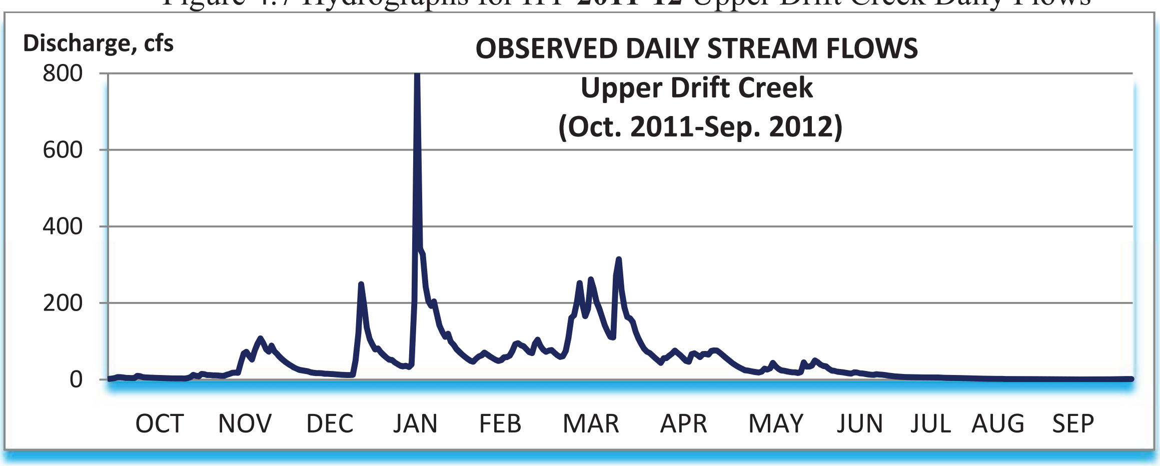
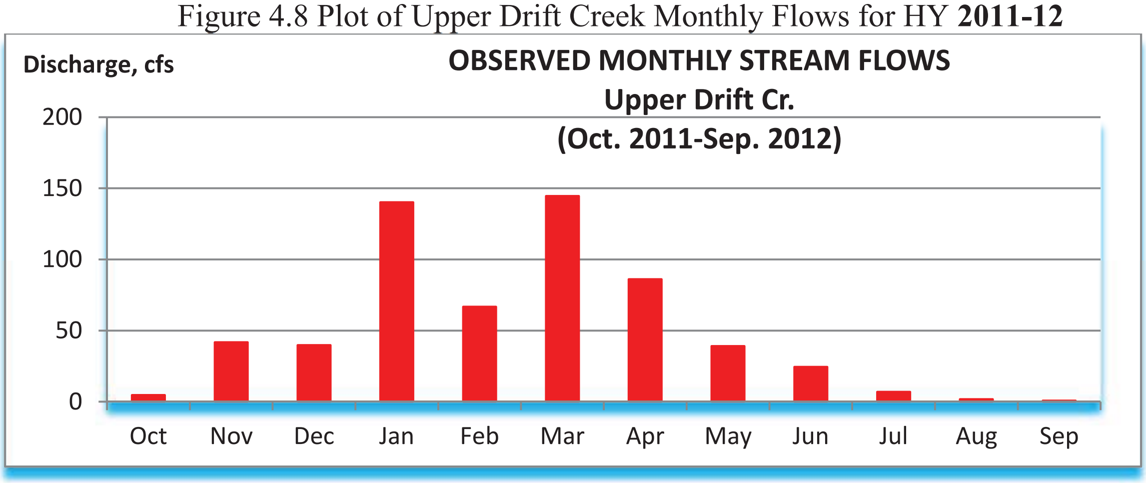


Figure 4.8 Plot of Upper Drift Creek Monthly Flows for HY **2011-12**



4.5 HY 2012-13

Stream flow data for the 2012-13 hydrologic year were collected at the project site (Victor Point) by a contractor to EVWD, and made available by Ellis Ecological Service. As mentioned earlier, the daily stream flow data collected at the lower Hibbard Rd. gauge below the project site by Marion SWCD are not available as of mid-October 2014 and, therefore, not included in the analysis documented in this report update #4.

Daily stream flow data collected by USGS for the Pudding River near Woodburn and near Aurora were available through the Internet but, like in the previous water year, no data are available for the Pudding River nr. Mt. Angel, Silver Cr. nr. Silverton, and Albiqua Cr. nr. Scott Mills.

The 2012-13 flow meter readings for Upper Drift Creek showed a minor gap between 8/06/13 and 8/17/13. Missing data for that 12-day period were reconstituted through the use of regression equations that correlate daily flows of Pudding River near Aurora and Upper Drift Creek for the same hydrologic year.

Table 4.5 Observed Flows (in cfs) of Drift Creek at Victor Rd., HY **2012-13**

DATE	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	2012	2012	2012	2013	2013	2013	2013	2013	2013	2013	2013	2013
1	2.03	40.72	97.97	67.67	143.61	46.07	23.02	17.69	42.50	10.78	2.15	1.08
2	1.95	40.21	143.66	59.44	121.15	43.50	21.61	16.76	36.81	9.98	2.61	1.05
3	1.92	42.08	141.51	52.59	102.24	42.11	19.43	15.73	31.86	9.28	2.53	1.17
4	1.85	40.44	178.28	47.87	87.76	38.73	19.24	14.82	27.49	8.66	2.07	1.03
5	1.78	35.02	181.20	43.58	79.73	37.26	19.78	13.91	23.87	7.84	1.93	3.14
6	1.61	30.52	141.43	40.17	73.63	45.40	34.42	13.33	20.76	7.47	3.51	23.75
7	1.58	29.64	125.95	41.62	68.67	50.61	50.35	12.90	18.19	7.25	3.22	14.50
8	1.59	26.63	111.14	41.41	62.23	45.69	49.34	12.55	17.15	6.98	3.08	9.74
9	1.70	23.90	101.09	46.90	55.45	41.54	44.09	12.20	17.17	6.56	3.03	7.58
10	1.72	25.33	89.00	63.22	50.94	37.72	41.76	11.43	16.00	6.21	2.98	6.22
11	1.80	25.61	85.72	62.21	46.32	35.50	39.41	10.89	15.29	5.89	3.08	5.22
12	2.67	38.17	98.58	56.13	45.40	33.49	36.26	10.67	14.78	5.63	3.22	4.61
13	6.13	47.86	85.66	50.93	41.50	30.70	38.72	11.32	16.30	5.40	3.22	4.28
14	5.98	43.91	78.82	46.37	37.89	26.13	35.92	10.74	15.24	5.03	3.17	4.18
15	10.89	39.18	73.43	43.06	35.16	24.24	35.70	10.44	13.06	4.67	3.03	4.02
16	17.61	35.25	80.94	39.86	33.54	25.73	32.89	11.20	12.04	4.58	2.93	4.14
17	12.42	44.06	108.52	37.05	32.40	31.71	30.28	12.24	11.43	4.97	3.17	3.99
18	11.02	95.11	111.59	34.55	30.19	27.18	28.18	10.18	12.38	4.67	1.09	6.57
19	8.21	152.95	102.25	32.05	29.20	25.77	33.53	11.54	13.41	4.18	1.13	9.08
20	9.43	364.40	148.92	29.75	27.98	49.17	33.81	10.53	14.94	3.96	1.14	5.88
21	9.19	328.25	160.18	27.65	30.04	56.51	30.69	12.47	16.52	3.79	0.90	4.67

22	9.94	230.55	138.54	25.95	35.05	52.63	28.55	23.38	13.76	3.63	0.83	4.83
23	12.60	175.09	140.80	25.88	54.63	48.36	26.19	29.80	13.42	3.37	1.35	7.88
24	14.21	218.49	161.01	27.13	52.45	44.18	24.21	40.66	17.32	3.12	1.69	11.15
25	16.63	164.96	162.39	46.67	54.46	40.81	22.40	35.88	16.44	2.81	1.74	16.86
26	14.46	133.15	174.77	60.62	51.95	37.97	20.71	33.83	17.92	2.48	2.09	15.29
27	14.24	108.97	142.90	69.87	46.46	34.82	19.05	42.88	16.83	2.24	1.77	12.33
28	32.91	90.71	123.61	107.25	44.39	31.88	17.60	61.00	14.45	2.19	1.60	15.62
29	63.04	81.26	105.14	210.04		29.22	17.92	65.12	12.92	2.22	1.58	69.21
30	48.69	74.71	90.73	207.69		26.66	17.33	59.32	11.71	2.22	1.58	109.21
31	39.84		79.96	183.62		24.64		50.08		2.20	1.30	
COUNT	31	30	31	31	28	31	30	31	30	31	31	30
AVE, cfs	12.25	94.24	121.47	62.22	56.23	37.16	29.75	22.76	18.07	5.17	2.22	12.94
VOL, AF	753	5606	7467	3825	3122	2312	1770	1399	1075	318	136	770
MONTH	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
	2012	**2012**	**2012**	**2013**	**2013**	**2013**	**2013**	**2013**	**2013**	**2013**	**2013**	**2013**

Annual Oct. 2012-Sep.13 runoff volume= 28,553 AF

Figure 4.9 Hydrograph of HY **2012-13** Upper Drift Creek Daily Flows

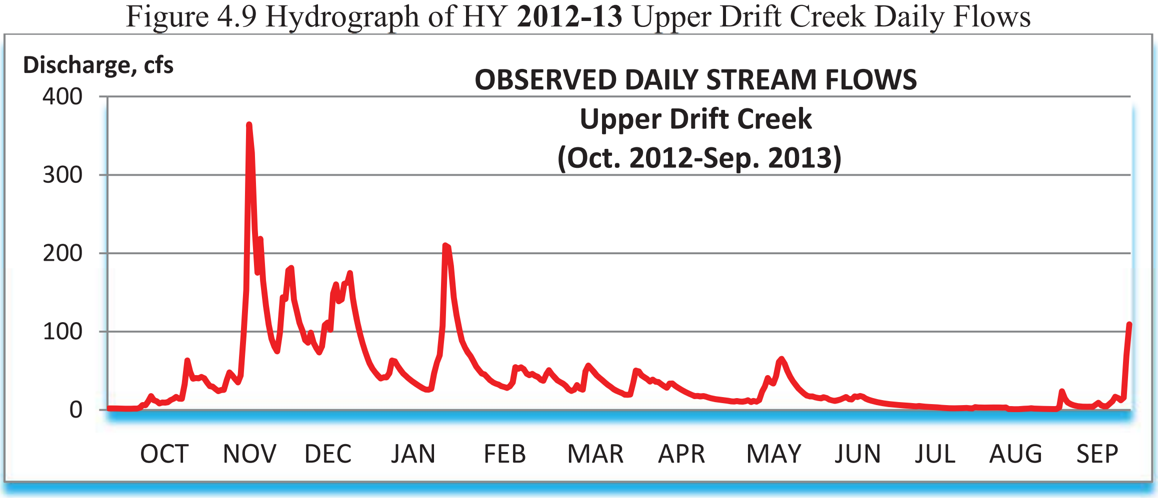
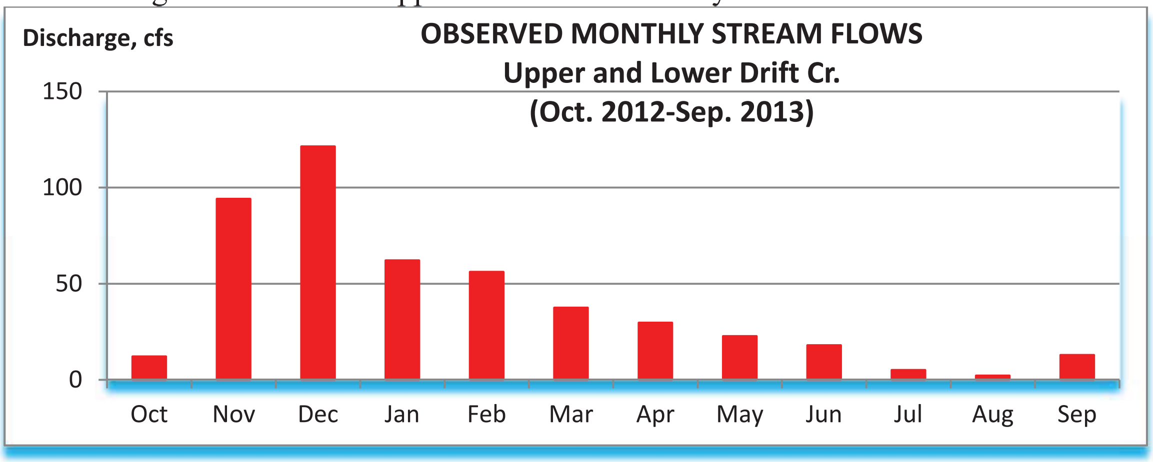


Figure 4.10 Plot of Upper Drift Creek Monthly Flows for HY **2012-13**



4.6 HY 2013-14

Stream flow data for the 2013-14 hydrologic year were collected at the project site (Victor Point) by Stillwater Sciences, a contractor to EVWD. Provisional data were received in early October 2014, followed by final data one week later. Data gap between January 9, 2014 and January 23, 2014 were filled using regression formulae linking daily flows of Pudding River at Aurora and Upper Drift Creek for the same water year. October 2013 started with higher discharges than usual, but those discharges quickly dropped a couple of weeks later.

Table 4.6 Observed Flows (in cfs) of Drift Creek at Victor Rd., HY **2013-14**

DATE	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	2013	2013	2013	2014	2014	2014	2014	2014	2014	2014	2014	2014
1	96.34	11.01	20.55	21.60	34.02	59.52	102.06	57.08	11.77	7.73	0.75	1.04
2	85.87	17.57	83.23	20.42	31.64	76.97	83.02	50.13	11.18	6.31	0.81	0.84
3	70.45	22.71	78.44	23.71	28.94	108.07	73.56	44.99	11.49	3.72	0.66	0.84
4	56.48	21.82	64.42	21.79	26.76	112.98	76.95	48.28	11.09	3.23	0.62	0.75
5	46.18	24.75	54.43	20.19	24.53	143.84	72.56	42.89	10.40	3.39	0.55	0.62
6	37.79	34.67	47.22	19.25	23.23	214.80	80.38	36.86	9.66	5.05	0.47	0.42
7	33.64	49.06	41.01	19.53	24.01	166.53	72.73	31.14	9.15	5.58	0.35	0.30
8	33.95	56.60	35.47	23.27	24.73	136.19	64.90	31.61	8.71	5.17	0.45	0.20
9	39.54	50.60	31.61	*26.12*	32.58	189.68	59.21	62.31	8.30	3.92	0.45	0.26
10	32.29	44.53	27.59	*39.55*	48.43	152.83	52.06	76.09	7.85	2.86	0.47	0.26
11	27.39	38.42	24.04	*49.60*	141.99	123.79	45.91	67.03	7.49	2.70	0.46	0.18
12	23.46	44.75	24.05	*72.18*	225.28	104.29	40.99	57.63	7.64	2.22	0.44	0.12
13	22.99	46.86	29.41	*95.01*	211.02	87.10	37.97	49.41	9.14	2.58	0.62	0.07
14	21.09	41.96	25.62	*102.72*	281.20	81.03	32.77	42.52	8.85	2.60	0.55	0.06
15	19.53	38.30	24.59	*92.32*	293.23	71.15	28.21	36.78	8.45	2.41	0.55	0.05
16	18.35	42.53	23.42	*78.22*	275.75	63.24	25.37	32.01	8.79	1.38	0.63	0.16

17	17.23	38.95	22.49	*64.94*	221.22	84.22	27.47	28.04	8.97	0.98	0.76	0.16
18	16.27	36.02	21.80	*54.52*	220.53	70.13	30.07	30.96	8.42	1.80	0.50	0.21
19	15.48	55.54	21.29	*47.17*	221.26	62.33	24.54	40.80	7.58	1.95	0.38	0.25
20	14.72	67.42	20.29	*41.54*	212.60	55.32	24.27	29.69	7.17	1.69	0.26	0.18
21	14.02	58.88	25.51	*37.57*	183.14	49.49	22.48	24.75	6.74	2.79	0.25	0.11
22	13.42	51.71	27.03	*34.07*	146.96	43.82	29.88	22.39	6.26	3.05	0.31	0.22
23	12.87	46.38	29.34	*31.26*	123.21	38.62	49.38	20.98	5.89	3.66	0.42	2.81
24	12.41	41.63	39.27	25.40	106.95	34.04	108.76	19.80	5.72	3.60	0.36	2.71
25	12.26	36.70	37.66	24.52	84.26	32.73	121.93	18.46	5.85	3.17	0.37	2.70
26	11.81	32.24	34.72	22.61	73.63	37.46	98.39	17.18	7.22	2.67	0.34	1.78
27	12.69	28.93	31.82	21.44	67.86	66.47	97.50	15.68	11.93	2.34	0.22	1.40
28	16.12	24.72	28.40	21.51	60.97	112.03	84.35	14.90	11.76	1.67	0.26	1.12
29	13.09	20.42	25.01	31.92		173.18	73.82	14.83	9.89	1.15	0.68	1.31
30	11.91	18.92	24.49	31.14		147.83	64.70	13.32	9.51	1.00	1.25	1.37
31	11.22		23.00	34.39		119.96		12.38		0.90	1.12	
COUNT	31	30	31	31	28	31	30	31	30	31	31	30
AVE, cfs	28.09	38.15	33.78	40.31	123.21	97.41	60.21	35.19	8.76	3.01	0.53	0.75
VOL, AF	1727	2270	2077	2478	6841	5988	3582	2163	521	185	32	45
MONTH	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
	2013	**2013**	**2013**	**2014**	**2014**	**2014**	**2014**	**2014**	**2014**	**2014**	**2014**	**2014**

Annual Oct. 2013-Sep.14 runoff volume= 27,908 AF

Figure 4.11 Hydrograph of HY **2013-14** Upper Drift Creek Daily Flows

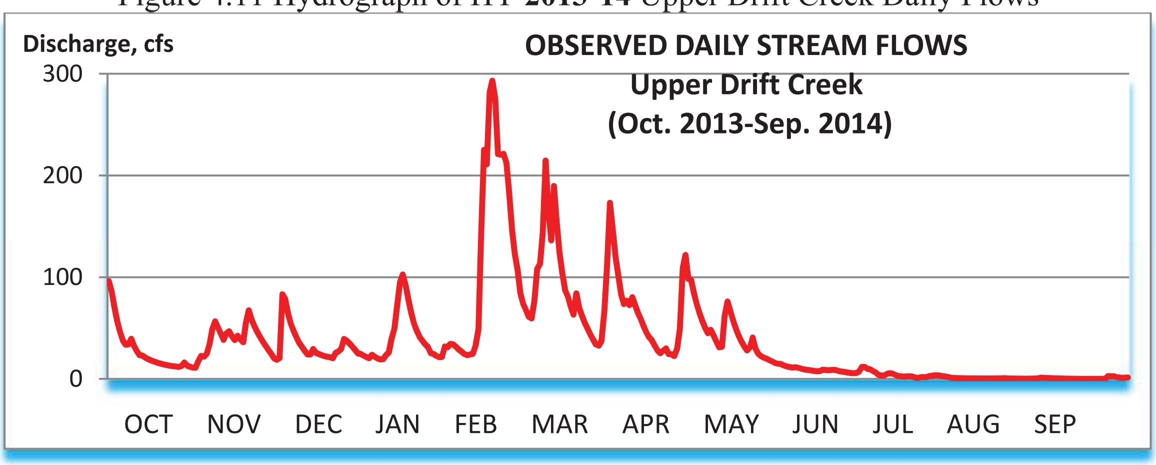
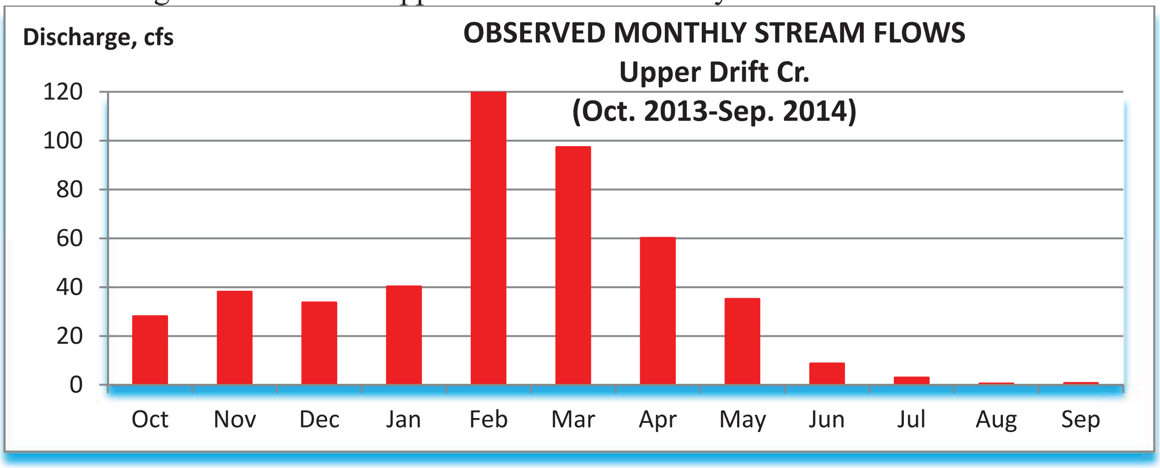


Figure 4.12 Plot of Upper Drift Creek Monthly Flows for HY **2013-14**



4.7 Comparison of HY 2008-14 Observed Stream Flow Data

The hydrographs for Upper Drift Creek's daily flows are shown for all six water years in Figure 4.13. Highest discharges are most prominent during December through March. The highest daily peak discharge of 809 cfs was recorded on January 19, 2012 followed by a daily peak discharge of close to 500 cfs on January 9, 2009.

Monthly flow variations during the six water years are listed in Table 4.7 and illustrated in Figure 4.14 on a month-by-month basis, and in Figure 4.15 on a year-by-year basis. During the raining season, the highest monthly flows occurred mostly during December through March, and the lowest monthly flows during July through September. The driest month for all 6 water years occurred in August 2009 (0.24 cfs monthly average), and the wettest month was March 2012 (144.60 cfs monthly average).

Figure 4.13 Hydrograph of HY 2008-14 Drift Creek Daily Flows

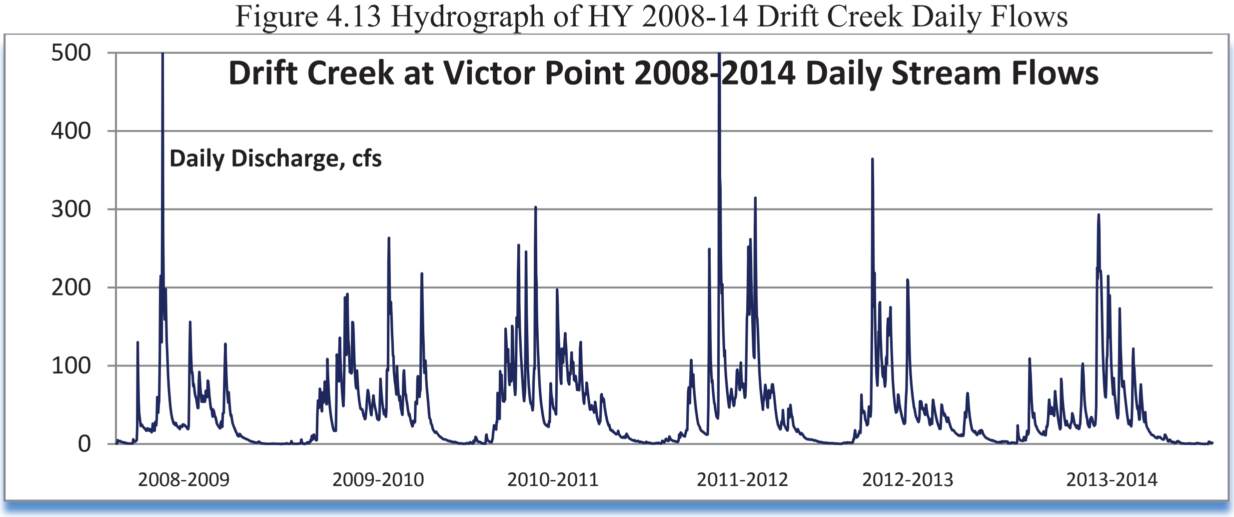


Table 4.7 Summary of HY 2008-14 Upper Drift Creek **Monthly** Flow, cfs

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Oct08-Sep09	1.83	22.82	48.19	101.87	38.93	65.90	39.73	45.55	7.24	1.35	0.24	0.49
Oct09-Sep10	2.84	50.84	59.66	109.37	47.32	68.76	89.62	47.43	72.70	7.90	1.38	2.71
Oct10-Sep11	7.79	78.55	123.90	95.62	39.89	112.20	80.17	45.24	25.35	8.86	2.69	1.33
Oct11-Sep12	4.83	41.86	39.81	140.27	66.83	144.60	86.17	39.21	24.52	6.98	1.87	0.80
Oct12-Sep13	12.25	94.24	121.47	62.22	56.23	37.61	29.75	22.76	18.07	5.17	2.22	12.94
Oct13-Sep14	28.09	38.15	33.78	40.31	123.21	97.41	60.21	35.19	8.76	3.01	0.53	0.75

Figure 4.14 Hydrograph of HY **2008-14** Drift Creek Monthly Flows (month-by-month)

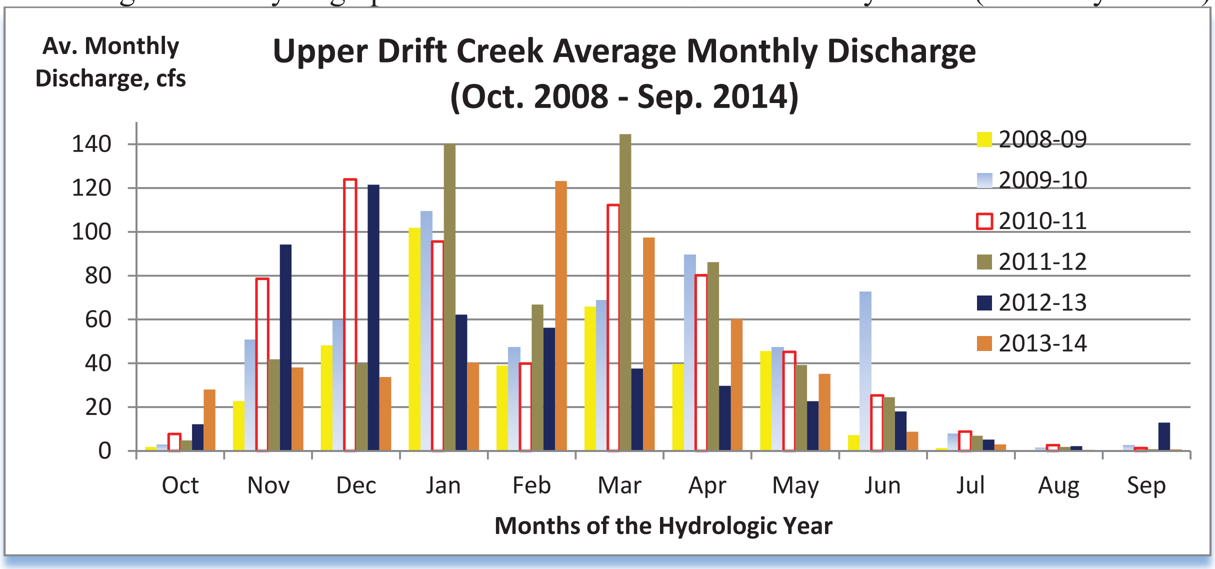
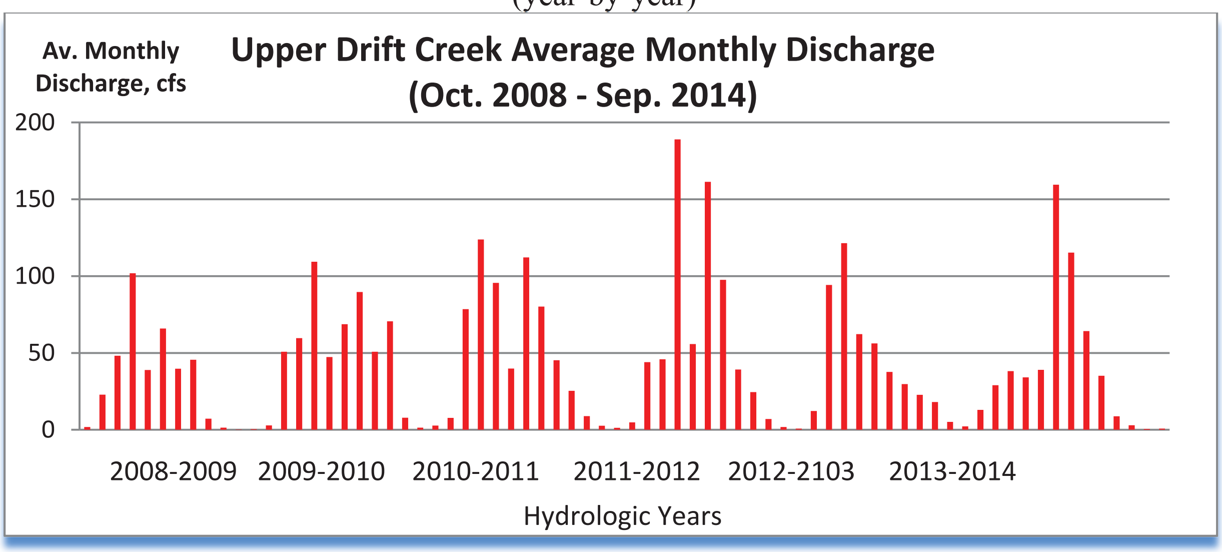
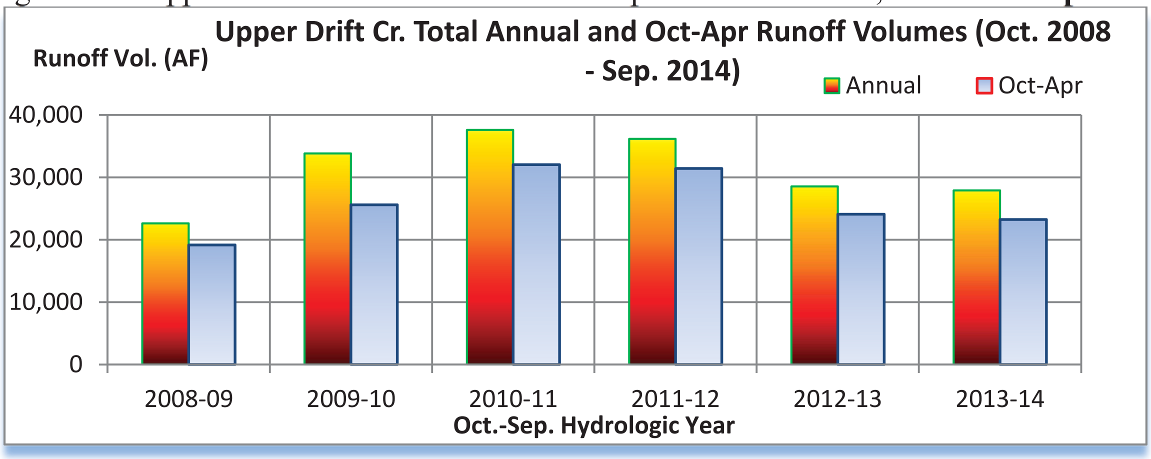


Figure 4.15 Hydrograph of HY **2008-14** Drift Creek Monthly Flows (year-by-year)



The runoff for both the hydrologic year and the October-April season in each of the six flow years is plotted in Figure 4.16.

Figure 4.16 Upper Drift Creek Annual and Oct.-Apr. Runoff Volume, **Oct. 2008-Sep. 2014**



The cumulative monthly runoff volumes for Upper Creek are listed in Table 4.8, and illustrated in Figure 4.17. Corresponding volumes for the October - April period are also listed/illustrated.

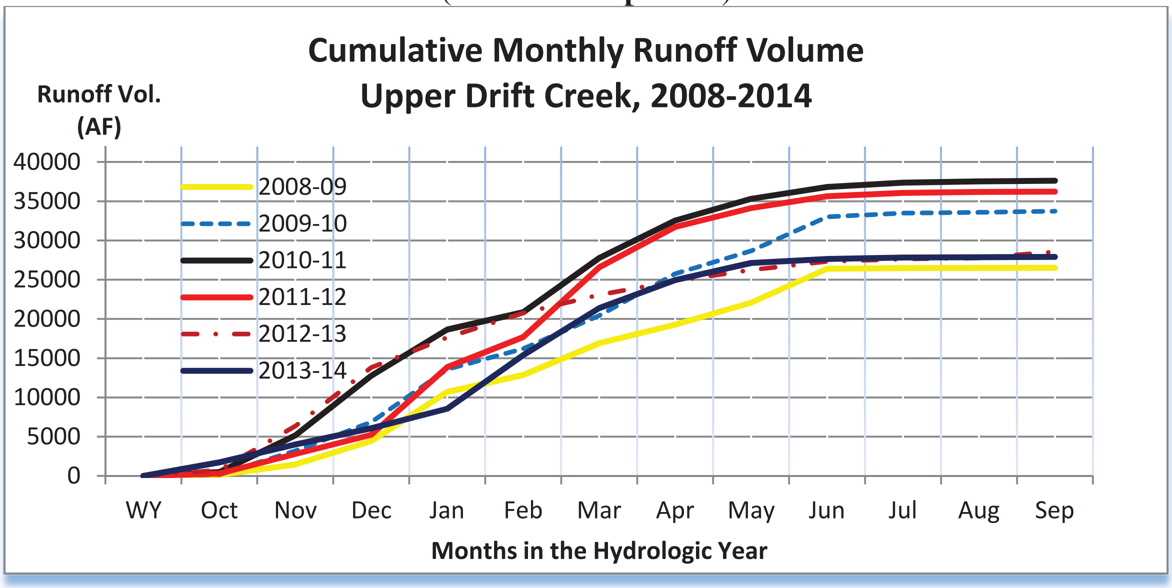
Over the last six years, the annual runoff volume ranges from 22,629 AF to 37,606 AF, with largest volume occurring during the October 2010 – September 2011 water year. It appears that 2009-10, 2010-11, and 2011-12 were high flow years; 2012-13 and 2013-14 were close to average runoff years; and 2008-09, a low flow year. The six year average annual runoff was 31,117 AF.

Based on the six 2008-2014 water years of records, the average runoff volume for the October – April projected reservoir refill period is 25,928 AF. The runoff volume of 20,000 AF would only be closely missed by one year (out of 6).

Table 4.8 Upper Drift Creek's Annual Runoff Volume

Water Year	Oct. - Sept. Volume, AF	Ranking		Oct. – Apr. Volume, AF	Ranking
Oct08-Sep09	22,629	6		19,159	6
Oct09-Sep10	33,749	3		25,601	3
Oct10-Sep11	37,606	1		32,049	1
Oct11-Sep12	36,178	2		31,419	2
Oct12-Sep13	28,553	4		24,102	4
Oct13-Sep14	27,908	5		23,235	5
Oct08-Sep14 Average	31,117			25,928	

Figure 4.17 Upper Drift Creek Cumulative Monthly Runoff
(**Oct. 2008-Sep. 2014**)



It should be noted that runoff in the Drift Creek basin was primarily driven by rainfall -- no detectable snowmelt impact —during all six water years (2008-2014). This is to be expected for most runoff years, since most of Drift Creek watershed lies below elevation 2000 feet. It also appears that rainfall recorded at the Salem Airport reasonably matches the shape of the Upper Drift's hydrographs, especially the timing of most of the peak discharges.

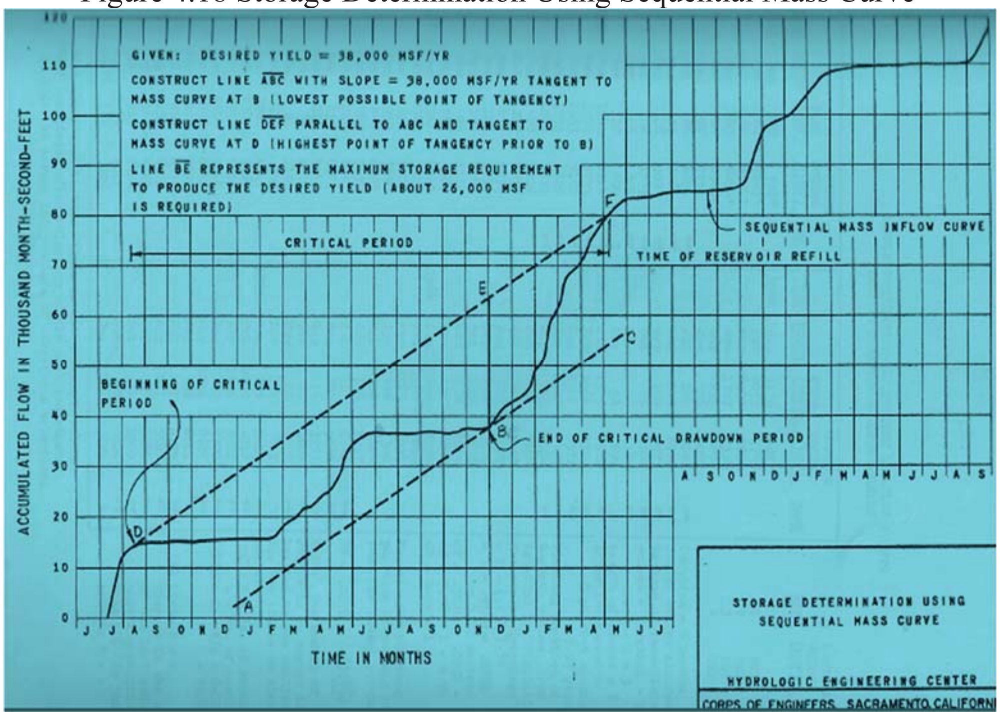
The availability of the Oct. 2008 – Sep. 2014 stream flow data should justify the removal of Drift Creek from the list of ungauged watersheds. These data provide a real picture of how the runoff is shaped during the six hydrologic years, including how the timing of its peak discharge is related to the peak rainfall recorded at Salem. However, these measurements still only reflect six of the many possible runoff conditions that could take place in the basin. Any practical conclusions reached so far would be more applicable to years with rainfall-runoff conditions similar to those years. Flow records pertaining to historical heavy precipitation and/or snowfall are still absent.

4.8 Sequential Mass Curve for Upper Drift Creek

A potentially useful piece of information to help estimate the storage required to provide a given yield is the sequential mass curve --also referred to as Rippl's curve. As stated in the Reservoir Storage Yield Procedures Manual prepared by the US Army Corps of Engineers Hydrologic Engineering Center in May 1967, "*the mass curve in month-cfs units is constructed by accumulating the inflows throughout the period of record and plotting the cumulative inflow versus the sequential time. The desired yield can be represented by a straight line with a slope equal to the desired yield rate in units corresponding to the flow units... The desired yield must include the average evaporation, and the net yield (yield remaining after evaporation) must represent the average demand for water during the critical period*".

The Corps of Engineers instructions further added, "*After the mass curve is drawn, lines are constructed parallel to the desired yield line and tangent to the mass curve at each low point and at the highest preceding tangent point. The vertical difference between these two lines represents the storage required to provide the desired yield during the time period between the two tangent points. The maximum difference in the period of records is often used to determine the required storage*". See Figure 4.18.

Figure 4.18 Storage Determination Using Sequential Mass Curve



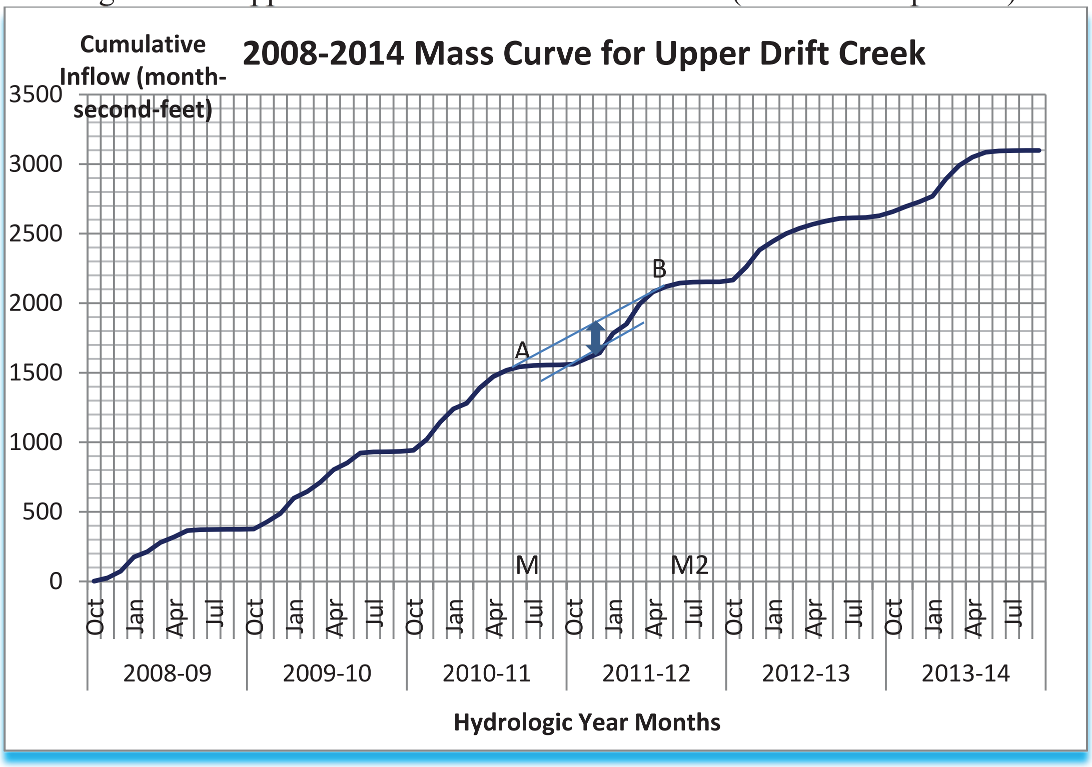
Sequential mass curve data developed per the above instructions for Upper Drift Creek station using the latest October 2008 - September 2014 stream flow records are listed in Table 4.9, and the corresponding mass curve plot is illustrated in Figure 4.19.

Table 4.9 Mass Curve for Oct. 2008 - Sep. 2014 Period, in month-second-feet

HY=	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14
Oct.	1.8	377.0	942.5	1561.1	2166.3	2657.1
Nov.	24.6	427.8	1021.0	1603.0	2260.5	2695.2
Dec.	72.8	487.5	1144.9	1642.8	2382.0	2729.0
Jan.	174.7	596.9	1240.6	1783.1	2444.2	2769.3
Feb.	213.6	644.2	1280.5	1849.9	2500.5	2892.5
Mar,	279.5	712.9	1392.6	1994.5	2538.1	2989.9
Apr.	319.3	802.6	1472.8	2080.7	2567.8	3050.1
May	364.8	850.0	1518.1	2119.9	2590.6	3085.3
Jun.	372.1	922.7	1543.4	2144.4	2608.6	3094.1
Jul.	373.4	930.6	1552.3	2151.4	2613.8	3097.1

Aug.	373.7	932.0	1555.0	2153.2	2616.0	3097.6
Sep.	374.2	934.7	1556.3	2154.1	2629.0	3098.4

Figure 4.19 Upper Drift Creek Runoff Mass Curve (Oct. 2008-Sep. 2014)



The slope of the mass curve at any point on the graph represents the flow rate at that instant. By connecting two points, A at month M1 and B at month M2, by a straight line, the slope of that line represents the average rate of flow that can be maintained between M1 and M2 if adequate storage is available at the reservoir.

The following material excerpted from the 2014 Guidelines issued by the Pennsylvania Department of Environmental Protection provides additional information on the mass curve and its possible applications in the future, if and when the need for such a tool arises to test the feasibility of special irrigation withdrawal scenarios.

"*Typically, a sag in the mass curve occurs during late summer and early fall base flow periods. A demand or draft rate (straight line for a constant draft rate) is superimposed on the runoff curve at a tangential point showing the rate at which water is withdrawn for [a given] use... Where the runoff (mass) curve is steeper than the draft line, the natural stream flow is at a higher rate of supply than the rate of draft. Consequently, some of the stream flow is available for storage or it will spill if the reservoir is already full. Where the mass curve has a flatter slope than the draft line, water will be withdrawn from storage in order to maintain the required rate of draft. The storage required to supply a given demand or draft rate is therefore the maximum intercept between the demand or draft line and the mass curve....The critical duration is defined* *as the length of time between the start of drawdown (tangent point of draft line) until the maximum drawdown is reached (maximum intercept) and recovery begins. The higher the demand or draft rate, the greater the drawdown and storage required, and the greater the critical duration before recovery and refill can begin. Therefore, based on Rippl mass diagram, steps taken towards water conservation early on in a drought occurrence can save significant amounts of reservoir storage and promote a much earlier recovery from the effects of the drought.*

4.9 Correlation between Upper and Lower Drift Creek Stream Flows

To date, stream flow data for Lower Drift Creek are only available for the three HY's 2008-09, 2009-10 and 2010-11. Data collection, originally conducted by Marion County Soil and Water Conservation Service, was taken over by USGS in May 2014. Unfortunately, as of mid-November 2014, the most recent three years have only raw, unanalyzed data, which prevented any updates for HY's 2011-12, 2012-13 and 2013-14. Therefore, data, text, tables and graphics shown below are basically the same as the material presented in the 2012 report update #3.

Figure 4.20 Hydrographs of Drift Creek Daily Stream Flows, **2008-2011**

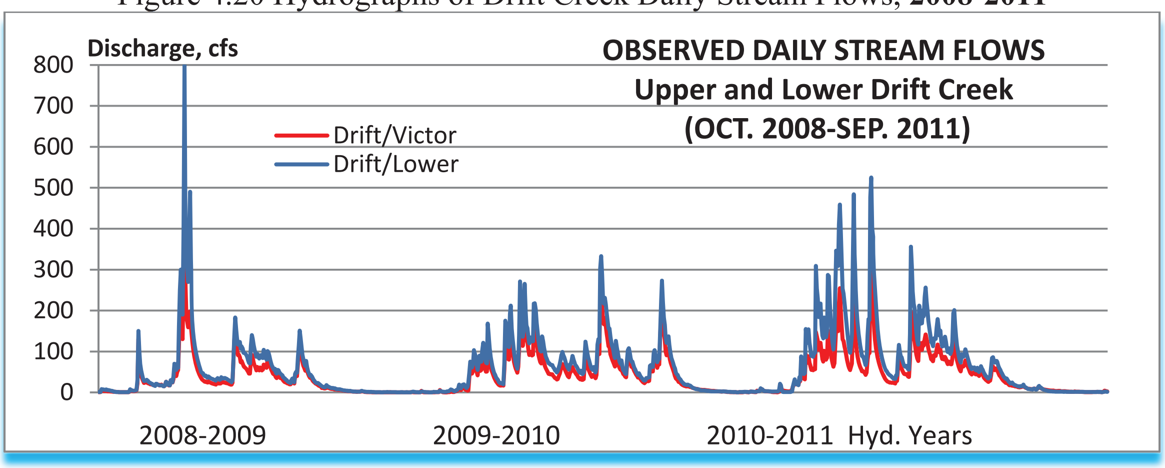


Figure 4.21 Hydrographs of Drift Creek Monthly Flows, **2008-2011**

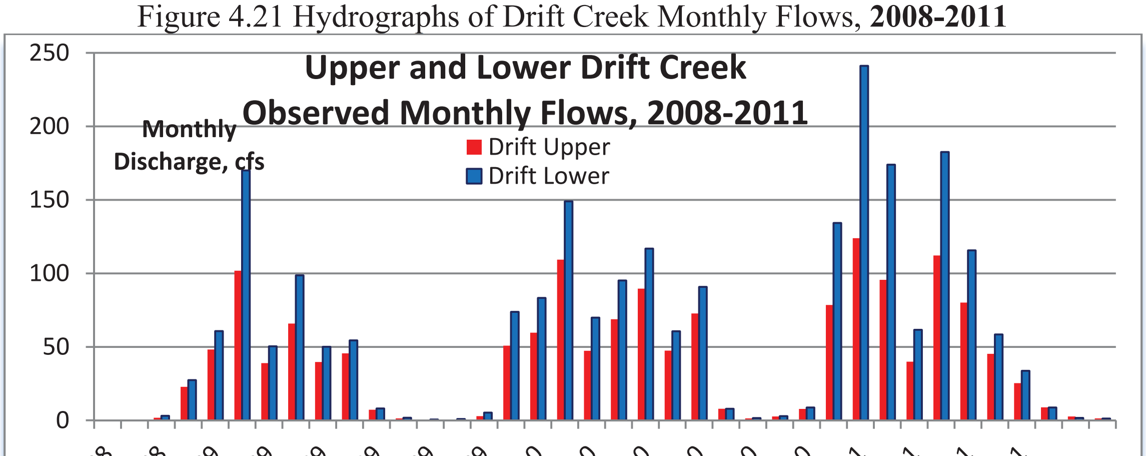


Table 4.9 provides a summary of monthly flow data at both the upper and lower gauging stations for the three HY's, including the monthly runoff volume ratio of the upper station over the lower station.

There is a strong correlation between both the daily and the monthly flow data at the two gauging stations in all three HY's. See Figures 4.22 through 4.25 for daily flows and Figures 4.26 through 4.29 for monthly flows. Table 4.10 presents a summary of the polynomial regression equations and the correlation factor R^2 linking Lower Drift Cr. (X) to Upper Drift Cr. (Y).

Table 4.9 Monthly Flows Data at Upper and Lower Drift Cr. (**2008-2011**)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Upper Drift												
2008-09	1.83	22.82	48.19	101.87	38.93	65.90	39.73	45.55	7.24	1.35	0.24	0.49
2009-10	2.84	50.84	59.66	109.37	47.32	68.76	89.62	47.43	72.70	7.90	1.38	2.71
2010-11	7.79	78.55	123.90	95.62	39.89	112.20	80.17	45.24	25.35	8.86	2.69	1.33
Lower Drift												
2008-09	3.08	27.38	60.77	170.00	50.39	98.68	50.07	54.45	8.15	1.83	0.59	0.88
2009-10	5.32	73.87	83.32	149.00	69.93	95.16	116.90	60.64	90.79	7.87	1.59	2.87
2010-11	8.82	134.30	241.26	174.00	61.64	182.58	115.67	58.48	33.77	8.73	1.73	1.27
Ratio Up/Lower												
2008-09	0.59	0.83	0.79	0.60	0.77	0.67	0.79	0.84	0.89	0.74	0.40	0.56
2009-10	0.53	0.69	0.72	0.73	0.68	0.72	0.77	0.78	0.80	1.00	0.87	0.95
2010-11	0.88	0.58	0.51	0.55	0.65	0.61	0.69	0.77	0.75	1.01	1.56	1.05

Correlation results for daily and monthly data are presented separately in the following paragraphs for better clarity.

<u>Daily Flows</u>

Figure 4.22 Upper and Lower Drift Cr. Daily Flow Correlation, HY **2008-09**

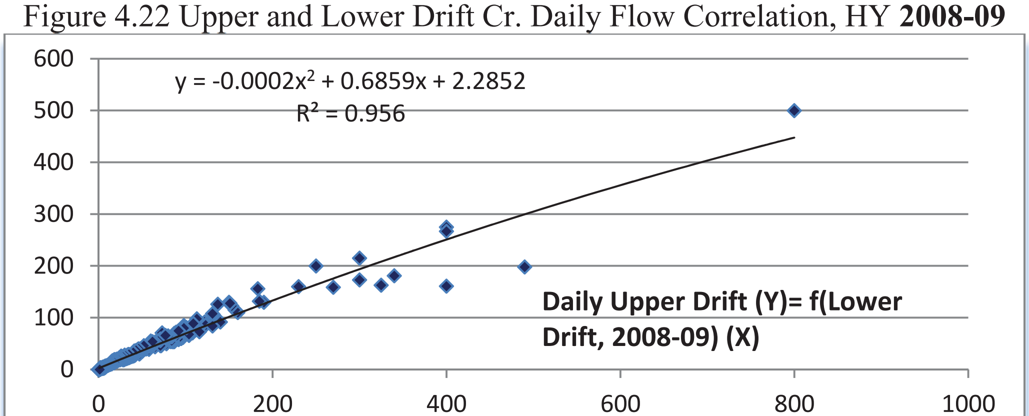


Figure 4.23 Upper and Lower Drift Cr. Daily Flow Correlation, HY **2009-10**

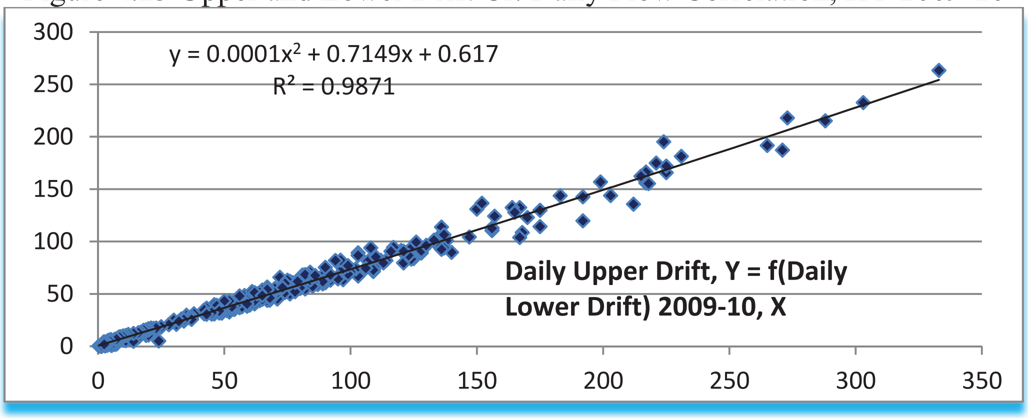


Figure 4.24 Upper and Lower Drift Cr. Daily Flow Correlation, HY **2010-11**

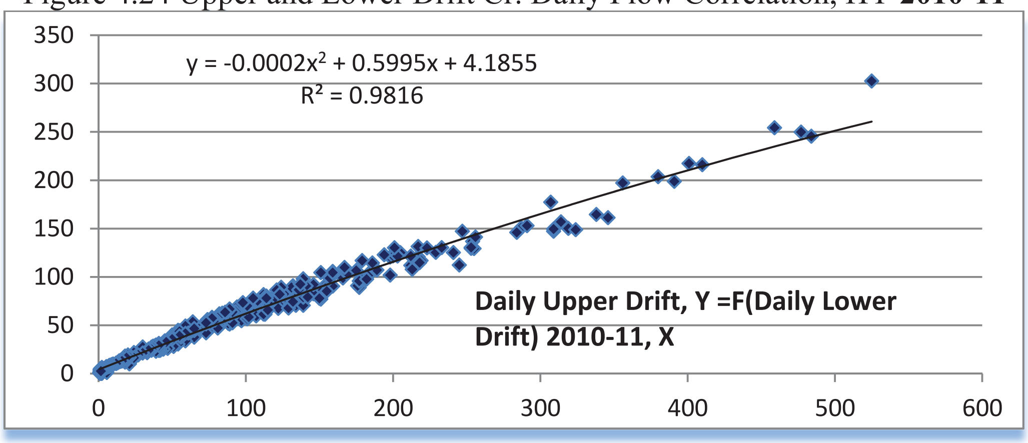
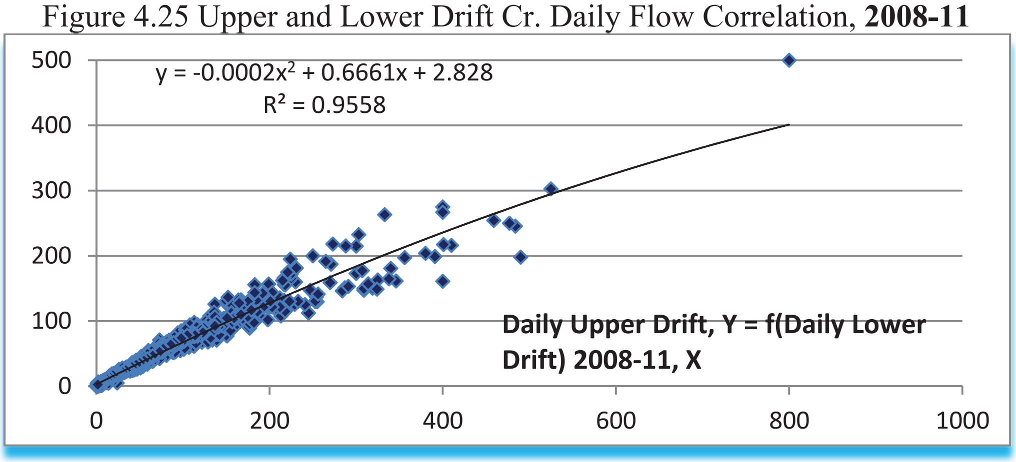


Figure 4.25 Upper and Lower Drift Cr. Daily Flow Correlation, **2008-11**



Monthly Flows

Figure 4.26 Upper and Lower Drift Cr. Monthly Flow Correlation, HY **2008-09**

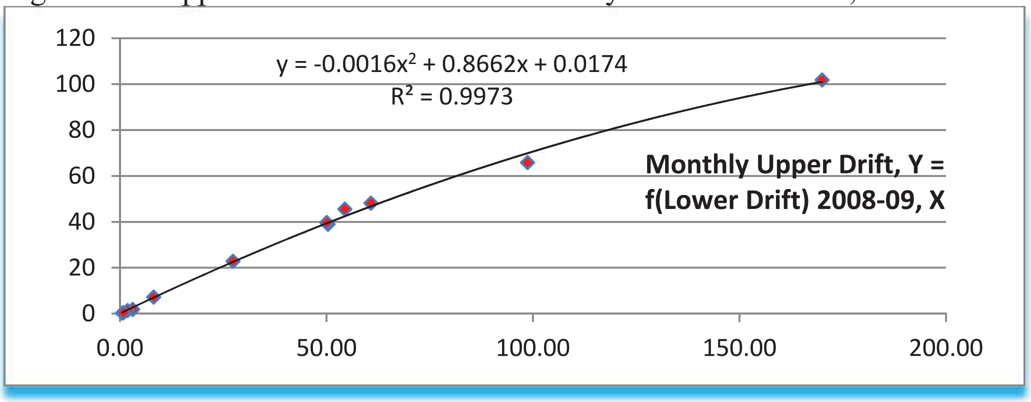


Figure 4.27 Upper and Lower Drift Cr. Monthly Flow Correlation, HY **2009-10**

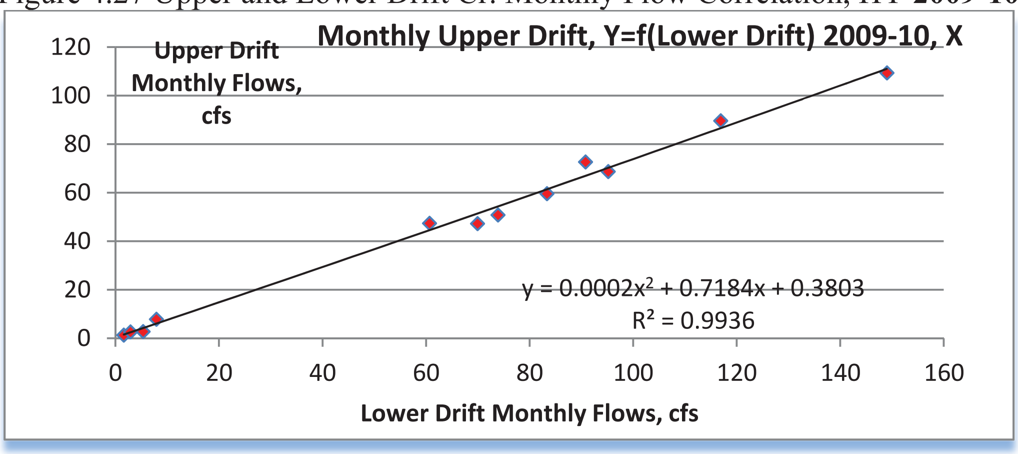


Figure 4.28 Upper and Lower Drift Cr. Monthly Flow Correlation, HY **2010-11**

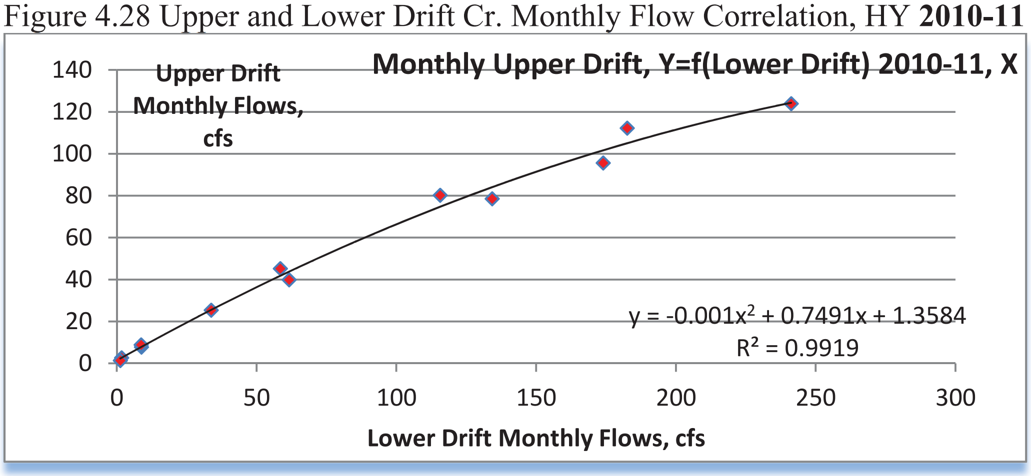


Figure 4.29 Upper and Lower Drift Cr. Monthly Flow Correlation, **2008-11**

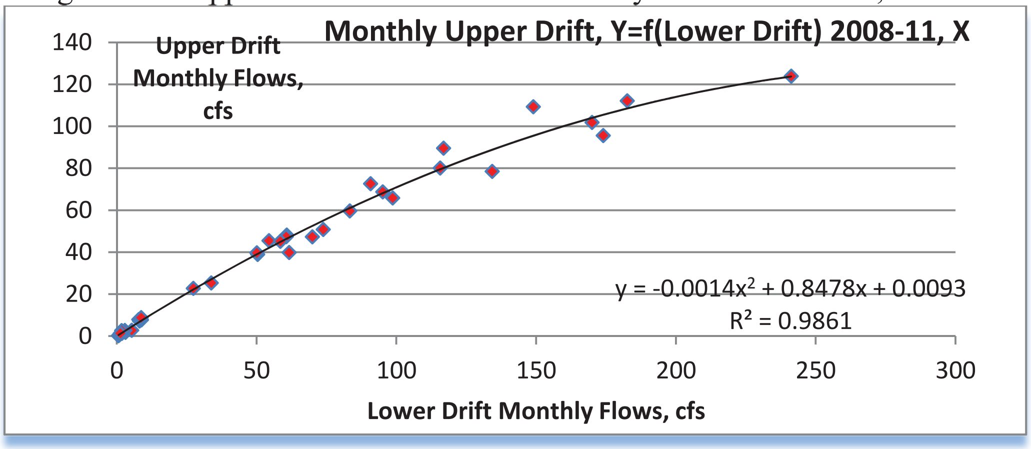


Table 4.10 Regression Equations Linking Lower Drift (X) to Upper Drift (Y)

Daily Flows	Regression Equation	R^2
2008-09	Y= -0.0002*X^2+0.6859*X+2.2852	0.956
2009-10	Y= -0.0001*X^2+0.7149*X+0.617	0.9871
2010-11	Y= -0.0002*X^2+0.599*X+4.1855	0.9861
2008-11	*Y= -0.0002*X^2+0.6661*X+2.828*	*0.9558*
Monthly Flows		
2008-09	Y= -0.0016*X^2+0.8661*X+0.00174	0.9973
2009-10	Y= 0.0002*X^2+0.7184*X+0.3803	0.9936
2010-11	Y= -0.001*X^2+0.7491*X+1.35840	0.9919
2008-10	*Y= -0.0014*X^2+0.8478*X+0.0093*	*0.9861*

Stream flow data recorded to date at both the upper and the lower gauging stations have been instrumental in firming up runoff estimates for Drift Creek. The two recording stations are the two nearest stations available on Drift Creek and, as such, provided the most reliable means to cross-check the stream flow readings. They also play a back-up role for one another, in case recordings at one of the stations are missing due to high flood events, equipment failures, and other unusual/unexpected circumstances. Flow records at those two sites should also provide a firmer basis for OWRD to revise their water availability data for the 50% and 80% exceedance frequencies at the mouth of Drift Creek.

5. Stream Flows at Nearby Streams

To provide the big picture of the runoff conditions that prevail in the region, stream flow data recorded at the following streams/gauging stations were analyzed: Pudding River at Aurora and at Woodburn, Silver Creek at Silverton, Abiqua Creek above Gallon House Bridge, Butte Creek at Monitor, and Zollner Creek near Mt. Angel. The needed data were available at all those stations between October 1, 2008 and September 30, 2011.

For the post-October 2011 period and as of October 19, 2014, the full stream flow data are only available on the USGS website for Upper Drift, Pudding River at Aurora and Woodburn, and Zollner Creek but are very limited or even non-existent for the other streams. Lower Drift and Silver Creek only have stream flow data from June 22, 2014 to October 19, 2014; Silver Creek has stream flow data for the same 2014 period (with gaps between August 15-26); Butte Creek has stream flow data from January 24, 2014 to October 19, 2014; Abiqua Creek only has gage height data from June 22, 2014 to October 19, 2014; and Lower Drift only has stream flow data from May 20, 2014 to October 19, 2014 posted on the Internet.

Table 5.1 lists the monthly flow data that are available during the October 2008 – September 2014 period.

Table 5.1 2008-2014 Monthly Flows at Drift Cr. and Nearby Streams (when available), cfs

Streams	Pudding	Pudding	Drift	Drift	Silver	Lo.Abiqua	Butte	Zollner
Gauges=	Woodburn	Aurora	Upper	Lower	Silverton	GH Bridge	Monitor	Mt. Angel
Sq.Mi.	314	479	15.8	24.8	47.9	75.7	58.7	15
Area Ratio	20.39	31.1	1	1.57	3.11	4.79	3.715	0.97
Oct08	74.16	132.58	1.83	3.08	25.71	37.29	31.45	0.90
Nov08	556.73	767.80	22.82	27.38	217.60	315.63	160.10	4.93
Dec08	821.84	1110.10	48.19	60.77	199.65	514.00	237.23	31.03
Jan09	2237.45	3281.81	101.87	170.00	413.52	883.23	578.74	58.67
Feb09	562.86	830.07	38.93	50.39	164.00	203.89	149.04	11.28
Mar09	1146.90	1810.32	65.90	98.68	345.00	458.77	318.00	26.29
Apr09	727.00	1174.83	39.73	50.07	222.30	313.27	238.90	8.99
May09	710.03	1117.77	45.55	54.45	215.48	295.32	223.68	10.47
Jun09	148.20	247.27	7.24	8.15	19.79	57.83	32.94	1.19
Jul09	38.97	57.84	1.35	1.83	15.74	11.68	5.00	0.34
Aug09	15.62	21.65	0.24	0.59	8.61	5.06	2.09	0.26
Sep09	20.23	36.93	0.49	0.88	6.72	12.49	5.58	0.25
Av 08-09	591.0	886.4	31.18	44.0	154.8	260.4	166.0	13.0
Vol Ratio	18.95	28.42	1.00	1.41	4.96	8.35	5.32	0.45
Vol, AF	427,771	641,582	22,629	31,880	112,077	188,487	120,131	9,407
Oct-Apr V	370,748	551,076	19,159	27,847	95,757	165,120	103,653	8,585
Oct09	61.19	99.84	2.84	5.32	22.04	58.90	19.33	0.97
Nov09	777.67	1179.60	50.84	73.87	222.97	343.93	226.80	24.43
Dec09	1007.00	1508.16	59.66	83.32	233.06	368.65	253.58	34.09
Jan10	1954.71	2843.55	109.37	149.00	429.39	628.65	412.16	71.42
Feb10	834.46	1287.64	47.32	69.93	189.46	292.00	177.11	30.14
Mar10	992.10	1452.06	68.76	95.16	298.29	408.39	298.84	24.18
Apr10	1432.77	2252.33	89.62	116.90	383.37	491.87	379.13	26.29
May10	663.55	1076.85	47.43	60.64	202.33	321.21	215.70	9.44
Jun10	1100.64	1676.93	72.70	90.79	306.61	402.57	310.18	24.31

Jul10	126.58	183.74	7.90	7.87	36.68	54.39	24.20	1.04
Aug10	42.39	49.32	1.38	1.59	15.05	12.09	5.41	0.69
Sep10	64.17	90.07	2.71	2.87	38.73	21.97	16.06	1.10
Av 09-10	753.1	1138.7	46.63	63.0	197.8	283.3	194.6	20.6
Vol. Ratio	16.09	24.33	1.00	1.35	4.23	6.05	4.16	0.44
Vol, AF	545,117	824,216	33,749	45,571	143,168	205,055	140,852	14,921
Oct-Apr V	424,646	638,574	25,601	35,690	107,005	155,967	106,365	12,664
Oct10	181.81	275.90	7.79	8.82	53.52	85.81	48.13	8.40
Nov10	1211.53	1857.27	78.55	134.30	310.70	456.73	298.37	45.40
Dec10	2720.65	4140.97	123.90	241.26	665.00	911.61	689.10	95.94
Jan11	2150.13	3344.19	95.62	174.00	506.39	675.74	498.29	51.68
Feb11	624.43	1109.64	39.89	61.64	152.57	235.21	154.75	18.85
Mar11	2233.87	3538.71	112.20	182.58	519.48	697.65	536.19	75.32
Apr11	1535.73	2467.00	80.17	115.67	424.00	589.67	425.67	32.26
May11	712.52	1184.65	45.24	58.48	202.81	342.29	253.77	8.13
Jun11	465.90	798.17	25.35	33.77	127.67	204.83	175.97	4.66
Jul11	133.19	207.94	8.86	8.73	39.81	50.45	33.61	1.75
Aug11	51.23	83.94	2.69	1.73	19.23	17.48	7.85	0.57
Sep11	31.70	50.60	1.33	1.27	17.63	12.11	7.02	0.61
Av 10-11	1009.6	1595.4	51.80	85.5	254.4	358.1	262.0	28.8
Vol. Ratio	19.49	30.80	1.00	1.65	4.91	6.91	5.06	0.56
Vol, AF	730,765	1,154,752	37,606	61,908	184,151	259,175	189,612	20,844
Oct-Apr V	646,026	1,013,493	32,049	55,586	159,411	221,051	160,577	19,372
Oct11	92.16	107.26	4.83					3.83
Nov11	668.87	950.13	41.86					24.83
Dec11	594.65	829.58	39.81					25.66
Jan12	3331.71	4723.16	140.27					119.13
Feb12	1419.69	1944.48	66.83					33.57
Mar12	2843.23	4085.48	144.60					115.65
Apr12	2175.67	3065.67	86.17					40.04
May12	777.03	1056.06	39.21					7.60
Jun12	451.43	596.03	24.52					3.54
Jul12	150.26	203.71	6.98					1.67
Aug12	39.52	66.74	1.87					31.01
Sep12	27.83	49.87	0.80					0.99
Av 11-12	1047.94	1473.88	49.81					31.60
Vol. Ratio	21.04	29.59	1.00					0.63
Vol, AF	760,573	1,069,775	36,178					22,936
Oct-Apr V	672,675	949,805	31,419					21,800

Oct12	258.52	307.19	12.25					8.65
Nov12	1894.40	2568.30	94.24					84.07
Dec12	2443.23	3330.97	121.47					96.81
Jan13	1090.48	1439.52	62.22					27.68
Feb13	1030.82	1441.75	56.23					15.96
Mar13	856.61	1221.77	37.61					13.43
Apr13	711.47	1028.83	29.75					8.99
May13	451.48	615.84	22.76					5.64
Jun13	338.73	455.93	18.07					2.83
Jul13	75.13	106.29	5.17					0.64
Aug13	22.71	32.74	2.22					0.32
Sep13	168.80	203.03	12.94					6.91
Av 12-13	776.46	1059.55	39.58					22.68
Vol. Ratio	19.62	26.77	1.00					0.57
Vol, AF	561,998	766,897	28,553					16,417
Oct-Apr V	498,036	681,291	24,102					14,900
Oct13	489.68	664.23	28.09					7.37
Nov13	600.43	844.30	38.15					13.85
Dec13	657.90	910.30	33.78					11.01
Jan14	732.10	1040.74	40.31					14.88
Feb14	2423.43	3492.25	123.21				615.68	85.64
Mar14	2040.16	2885.16	97.41				531.68	61.19
Apr14	1175.27	1640.40	60.21				290.00	12.88
May14	685.35	997.35	35.19				194.52	10.68
Jun14	162.70	253.93	8.76	10.54			43.07	1.20
Jul14	74.55	116.52	3.01	3.49	1.16		15.26	1.05
Aug14	19.77	32.74	0.53	0.56	0.90		4.35	0.84
Sep14	23.07	34.13	0.75	0.59	0.87		6.36	1.84
Av 13-14	746.26	1059.37	39.12					18.11
Vol. Ratio	19.07	27.08	1.000					0.46
Vol, AF	540,139	766,767	31,117					13,106
Oct-Apr V	481,159	679,144	25,928					11,699
Streams	Pudding	Pudding	Drift	Drift	Silver	Lo.Abiqua	Butte	Zollner
Gauges=	Woodburn	Aurora	Upper	Lower	Silverton	GH Bridge	Monitor	Mt. Angel

Figure 5.1 shows the hydrographs of the daily flows at all stations, while Figures 5.2, 5.2a, 5.2b and 5.2c focus on the smaller streams. The hydrologic years covered in each figure depend on data availability.

Figure 5.1 Daily Flow Hydrographs for All Streams, **2008-11**

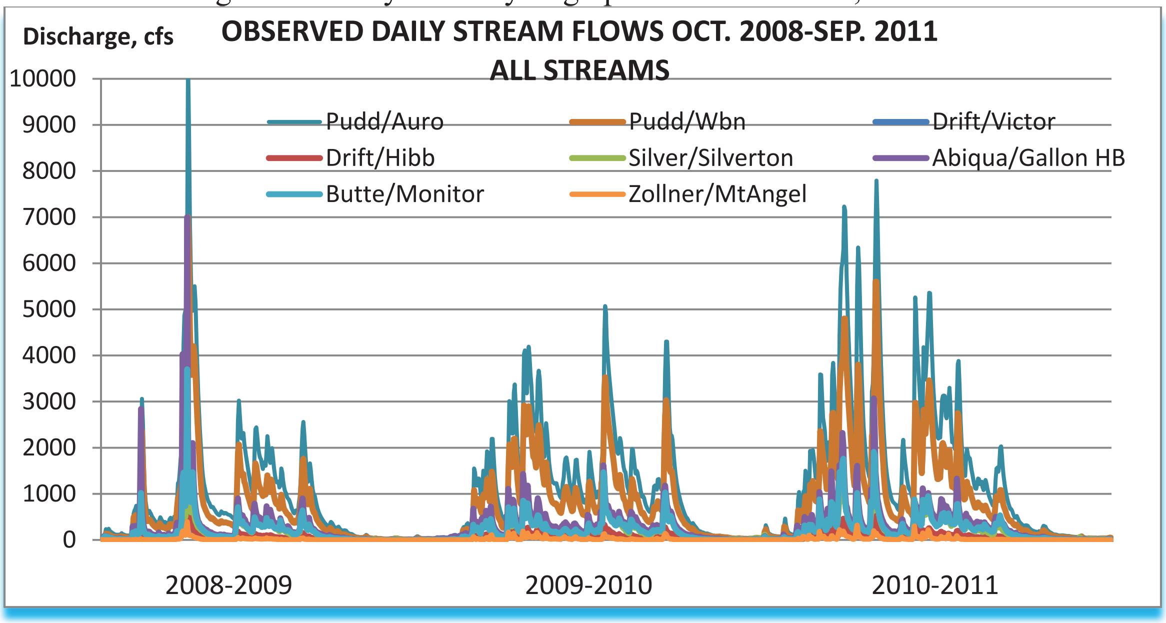


Figure 5.2 Daily Flow Hydrographs for Selected Streams, **2008-11**

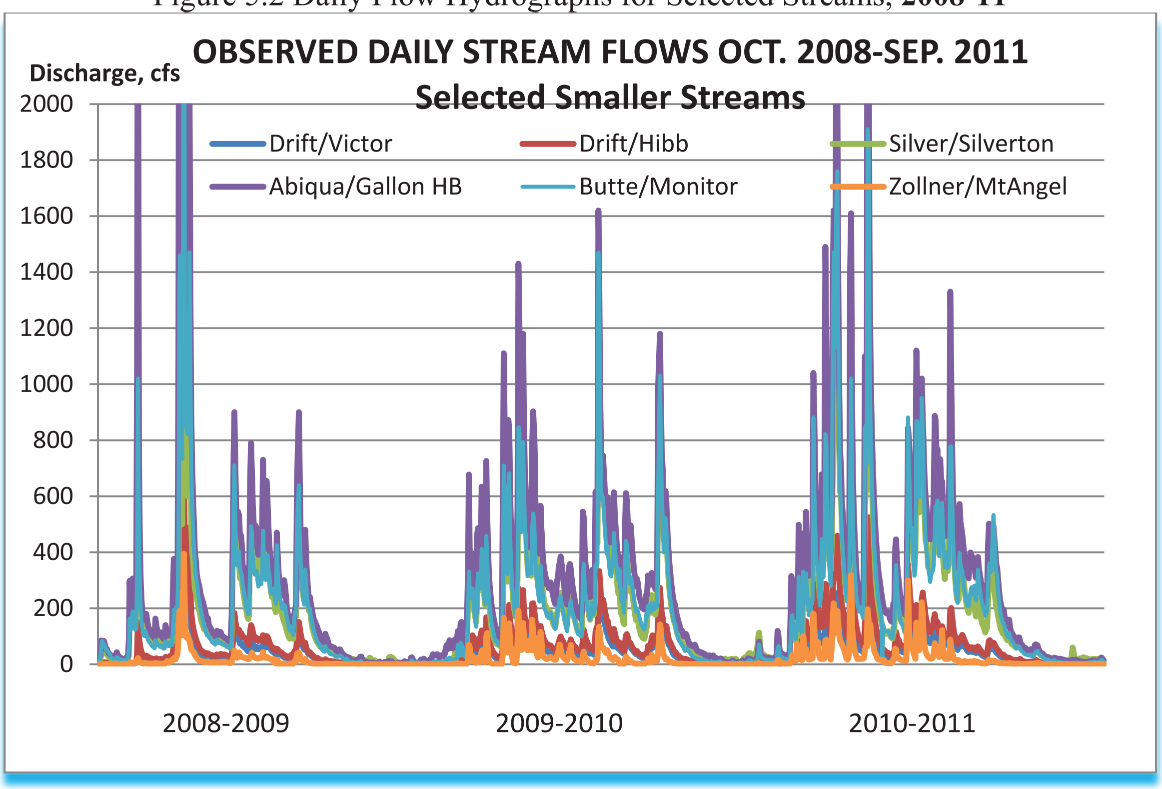


Figure 5.2a Daily Flow Hydrographs for Smaller Streams, **2008-09**

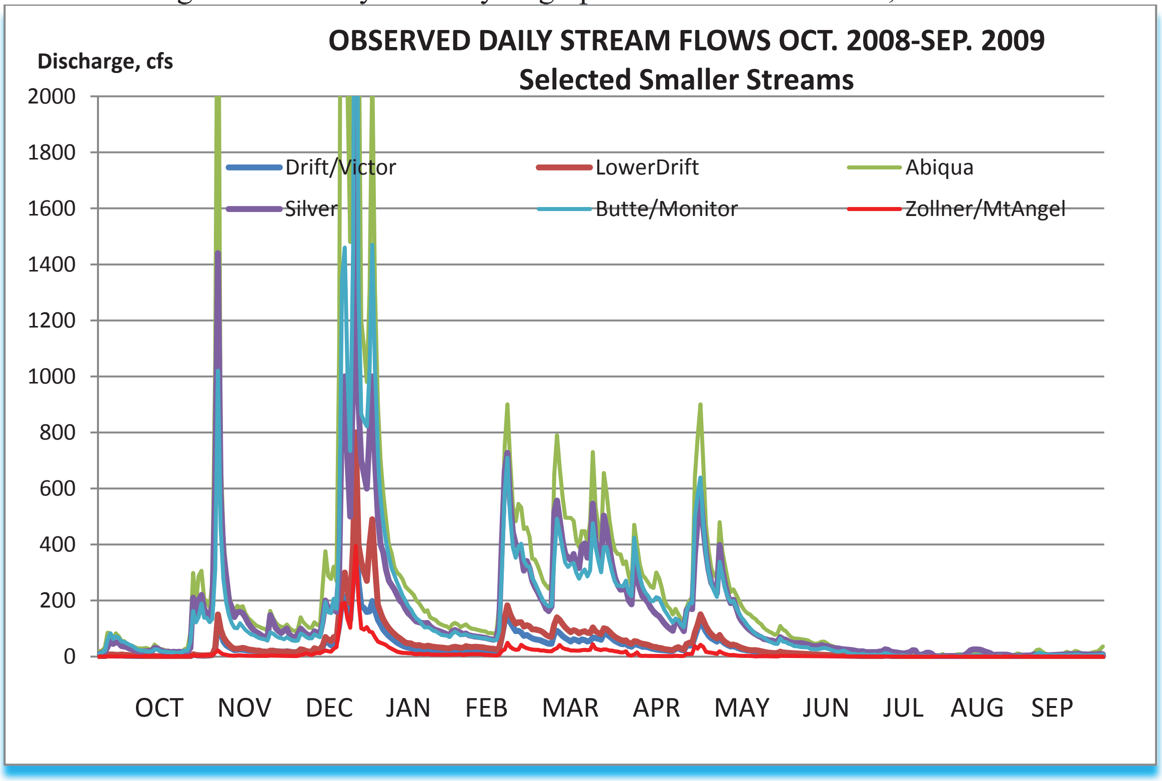


Figure 5.2b Daily Flow Hydrographs for Smaller Streams, **2009-10**

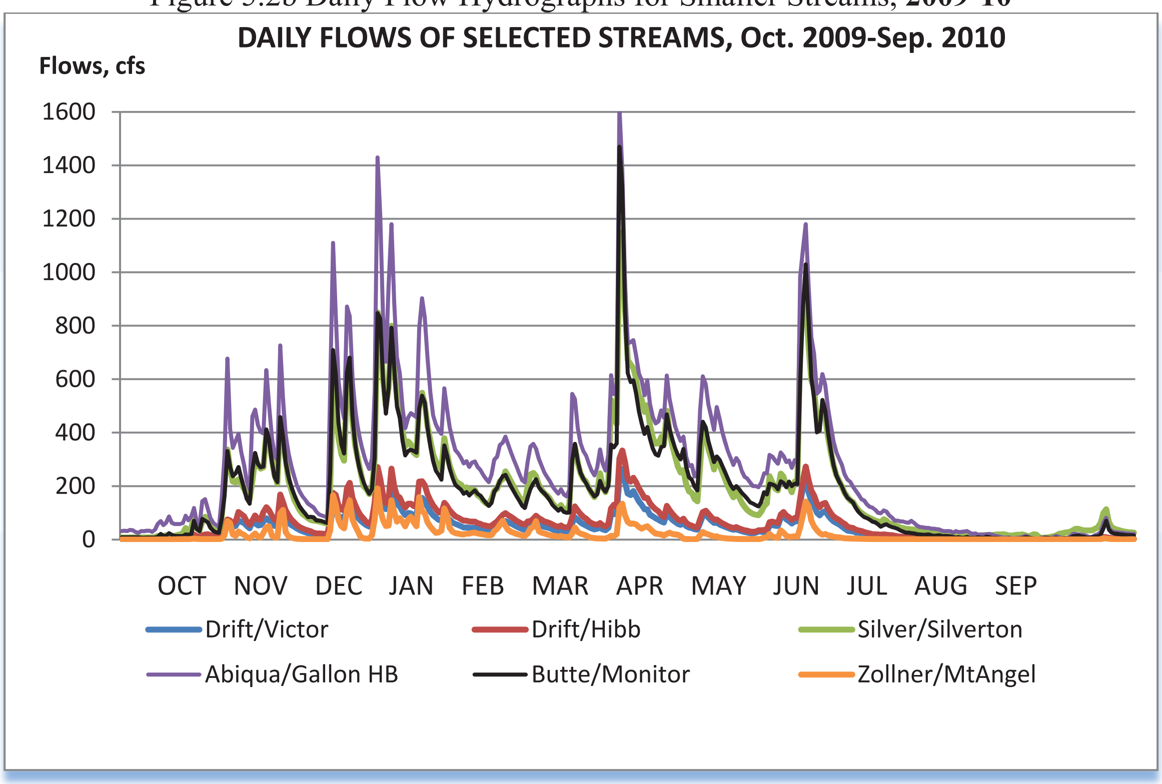
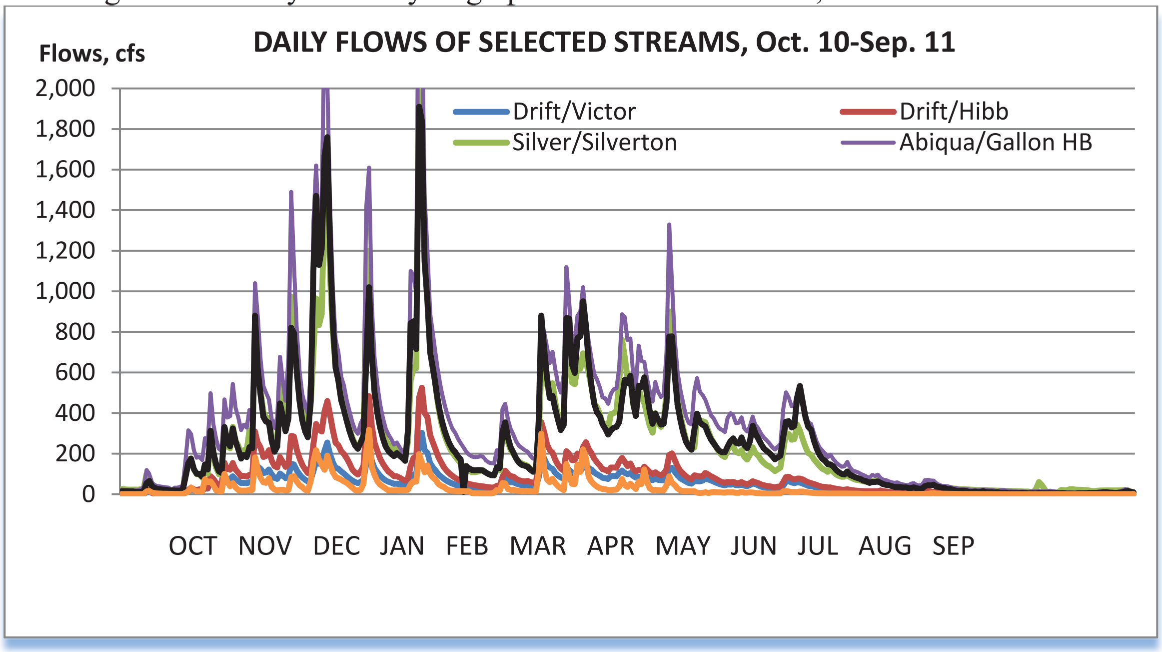


Figure 5.2c Daily Flow Hydrographs for Smaller Streams, **2010-11**



Figures 5.3 through 5.8 provide a closer, one-on-one comparison between Drift Creek flows and the flows at other nearby streams covering the three (2008-11) or six (2008-14) hydrologic years, depending on data availability.

Figure 5.3 Daily Flow Hydrograph of Upper Drift and Pudding @ Aurora, **2008-14**

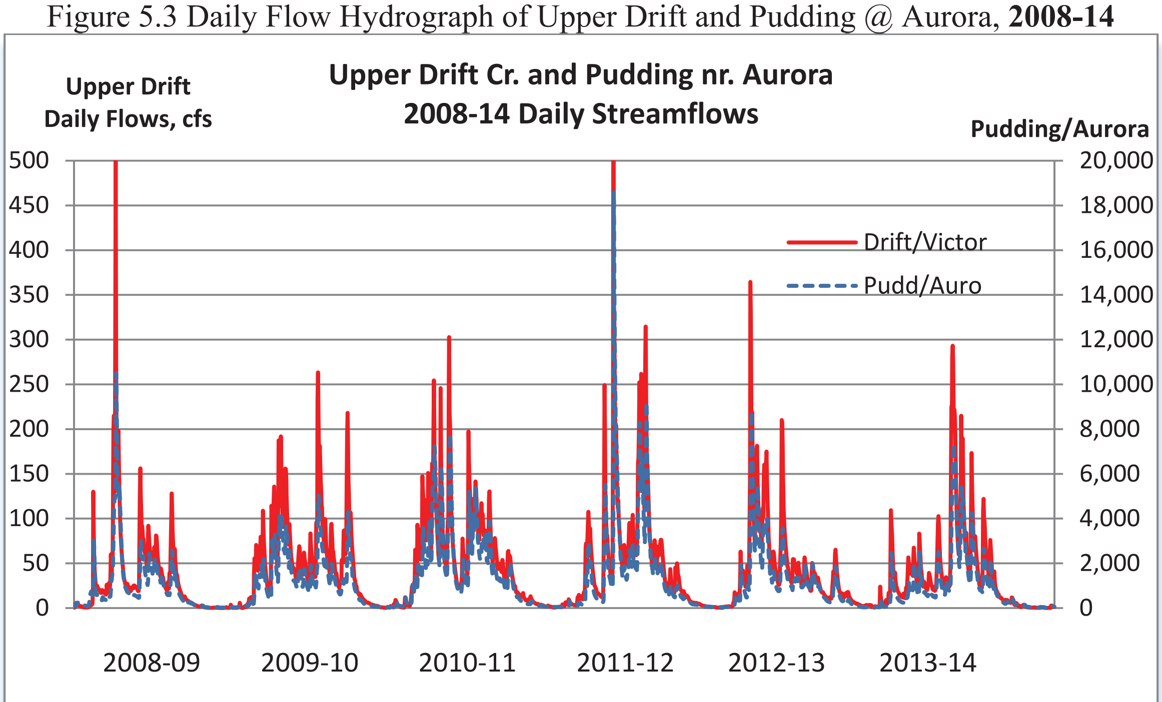


Figure 5.4 Daily Flow Hydrograph of Upper Drift and Pudding @ Woodburn **2008-14**

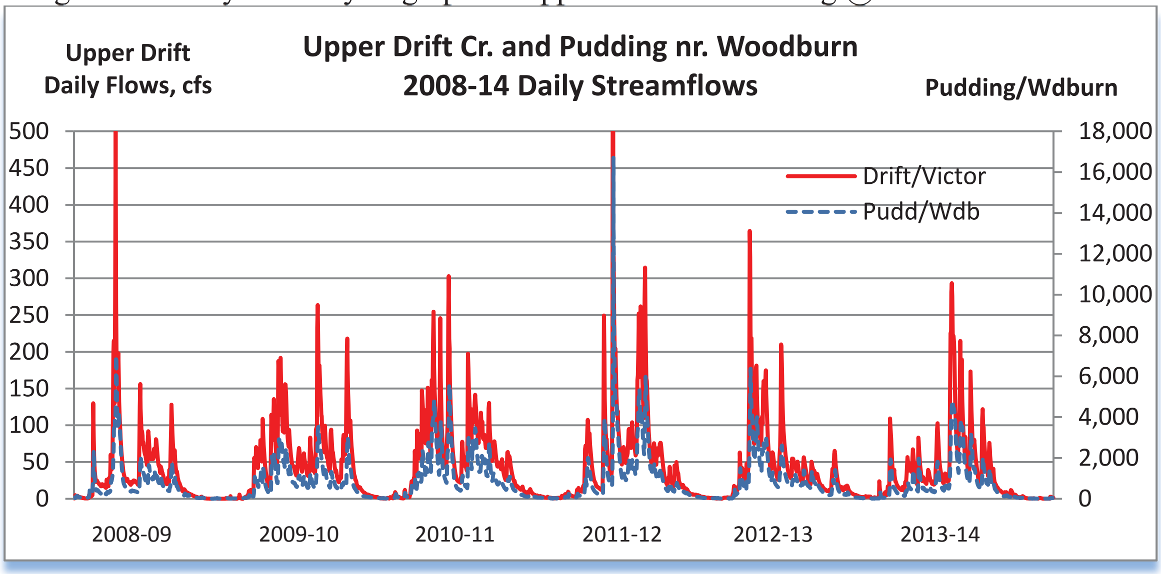


Figure 5.5 Daily Flow Hydrograph of Upper Drift and Silver Cr. @ Silverton, **2008-11**

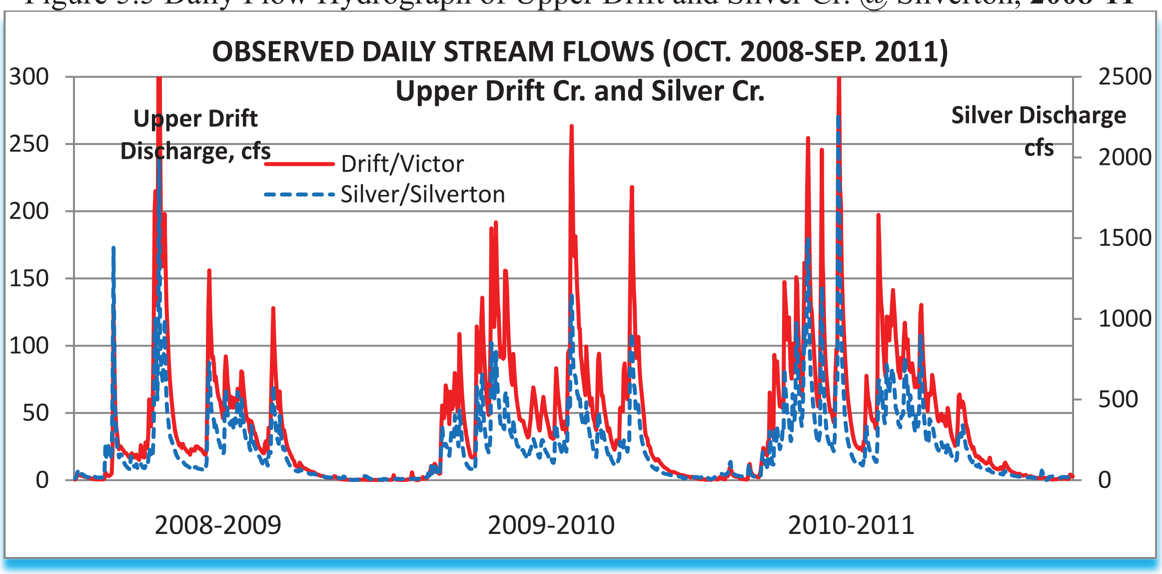


Figure 5.6 Daily Flow Hydrograph of Upper Drift and Abiqua @ Gallon House Bridge **2008-11**

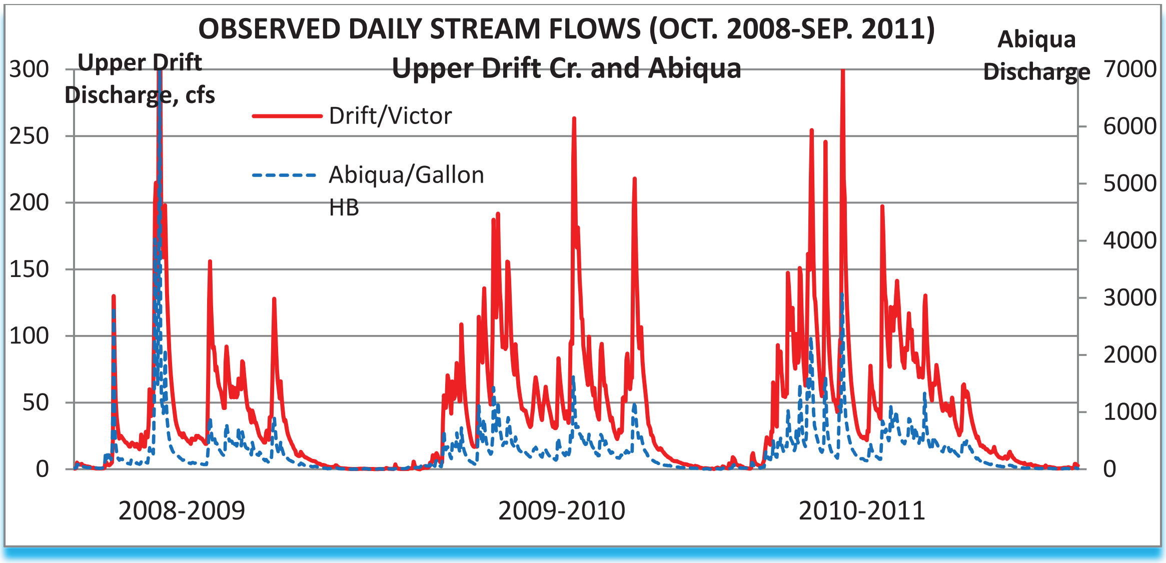


Figure 5.7 Daily Flow Hydrograph of Upper Drift and Butte @ Monitor **2008-11**

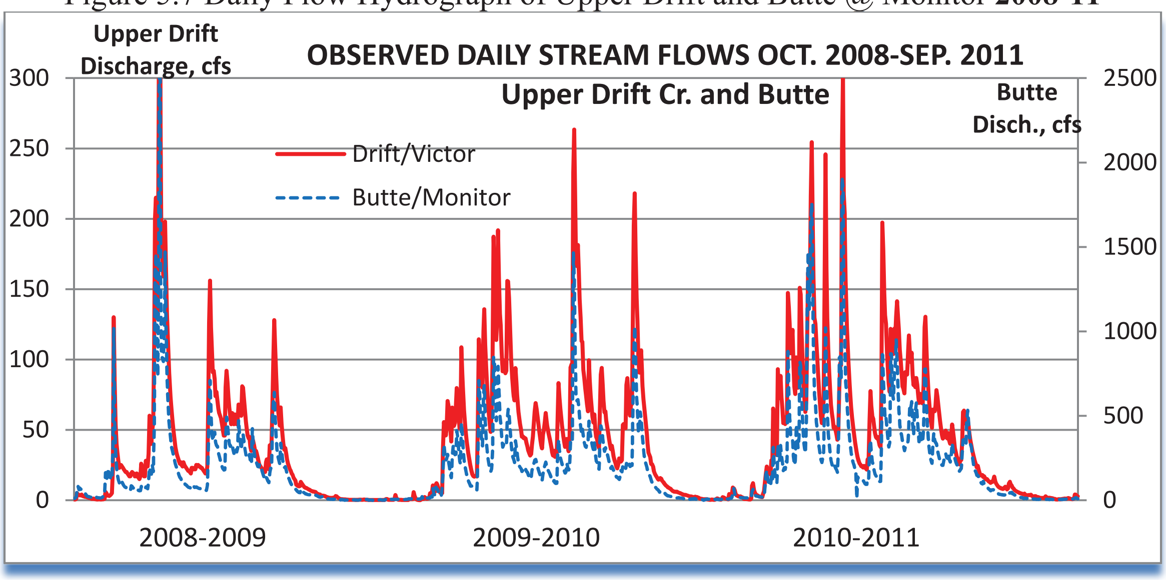
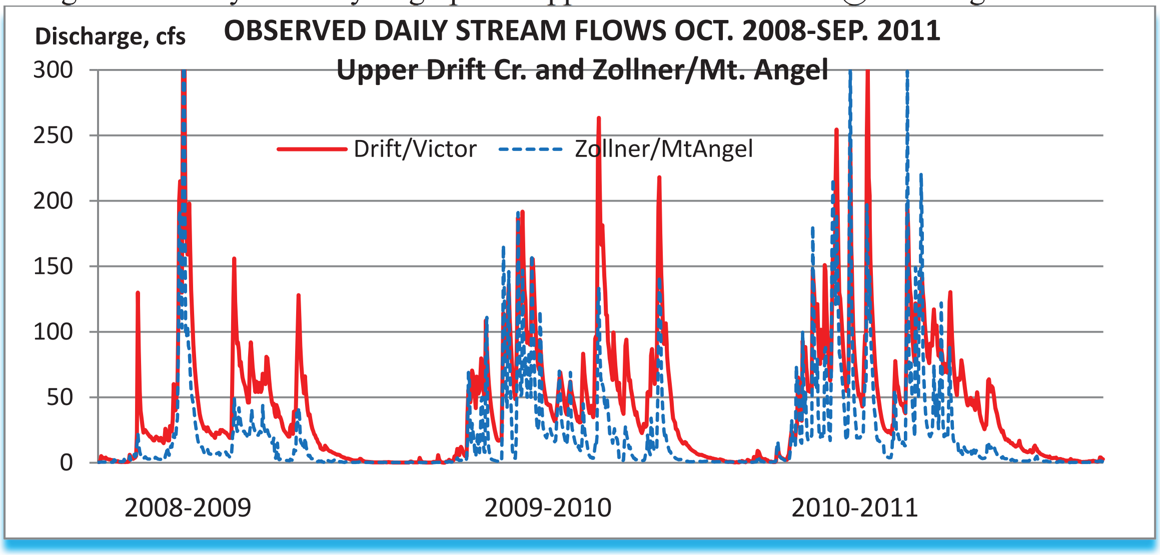


Figure 5.8 Daily Flow Hydrograph of Upper Drift and Zollner @ Mt. Angel **2008-11**



Figures 5.9 through 5.14 provide the same type of runoff information on a **monthly** basis. The plots also include the runoff volume ratios of the streams involved.

Figure 5.9 Plots of Monthly Flows of Upper Drift and Pudding @ Aurora **2008-14**

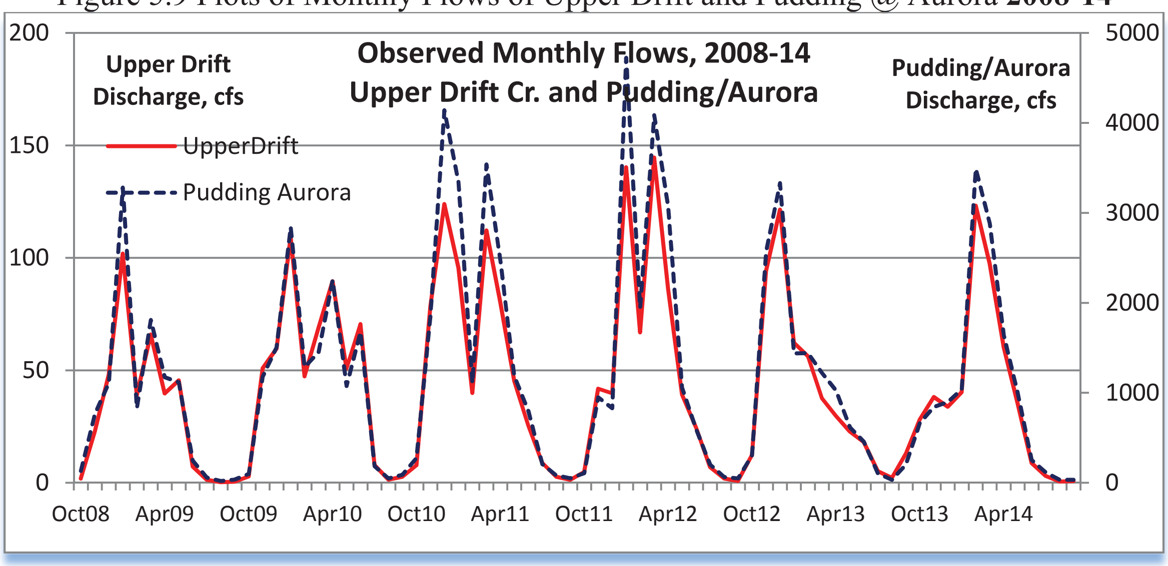


Figure 5.10 Plots of Monthly Flows of Upper Drift and Pudding @ Woodburn **2008-14**

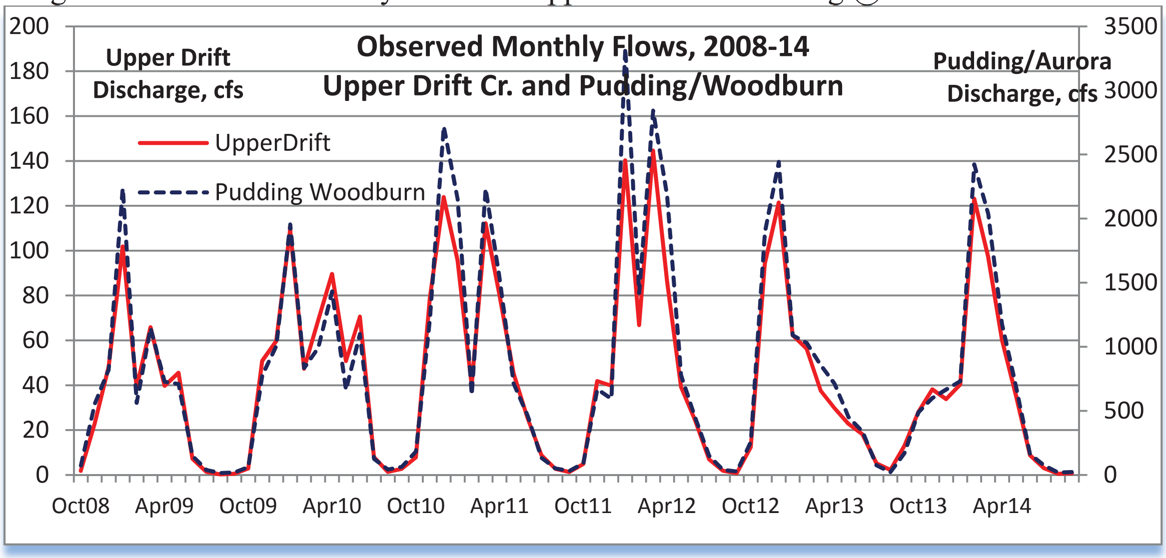


Figure 5.11 Plots of Monthly Flows of Upper Drift and Silver @ Silverton **2008-11**

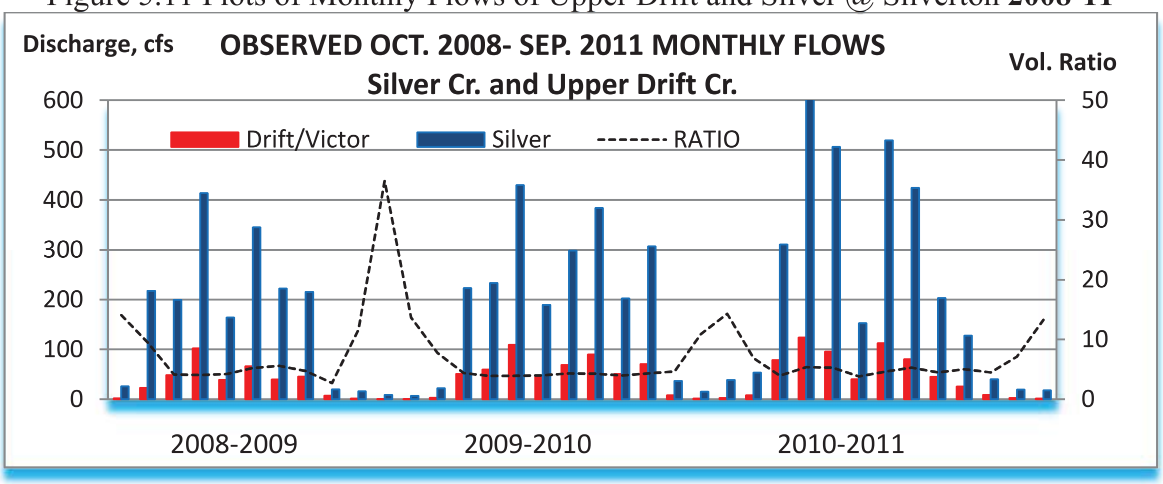


Figure 5.12 Plots of Monthly Flows of Upper Drift and Abiqua @ G. H. Bridge **2008-11**

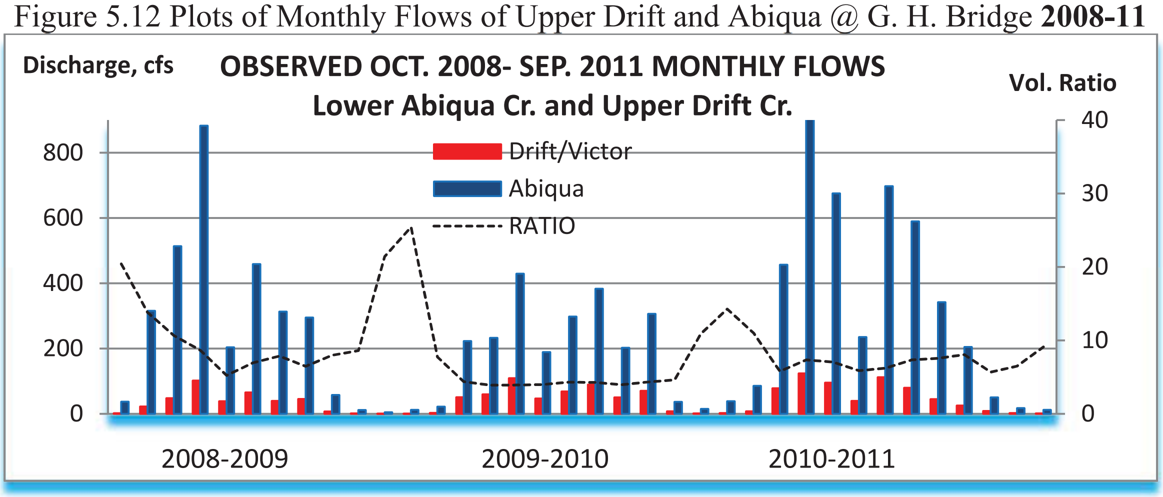


Figure 5.13 Plots of Monthly Flows of Upper Drift and Butte @ Monitor **2008-11**

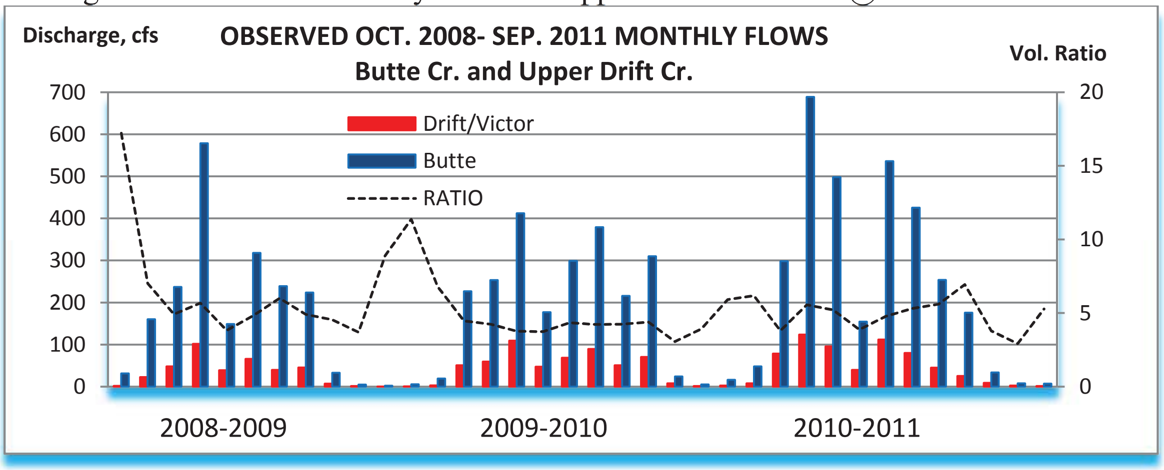
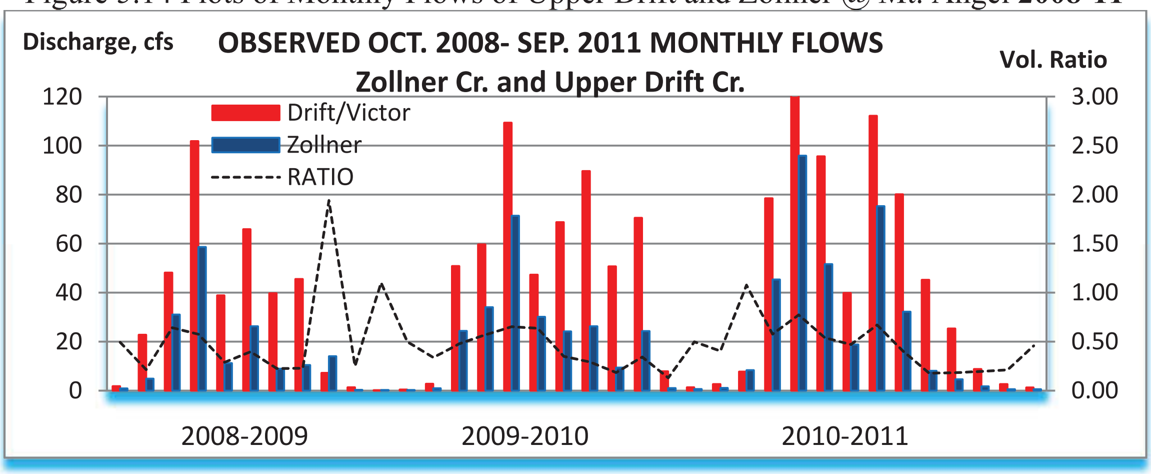


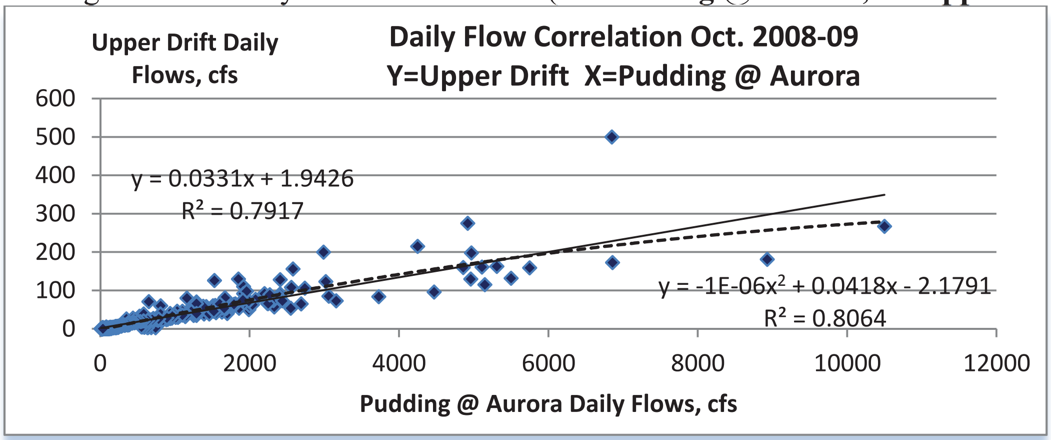
Figure 5.14 Plots of Monthly Flows of Upper Drift and Zollner @ Mt. Angel **2008-11**

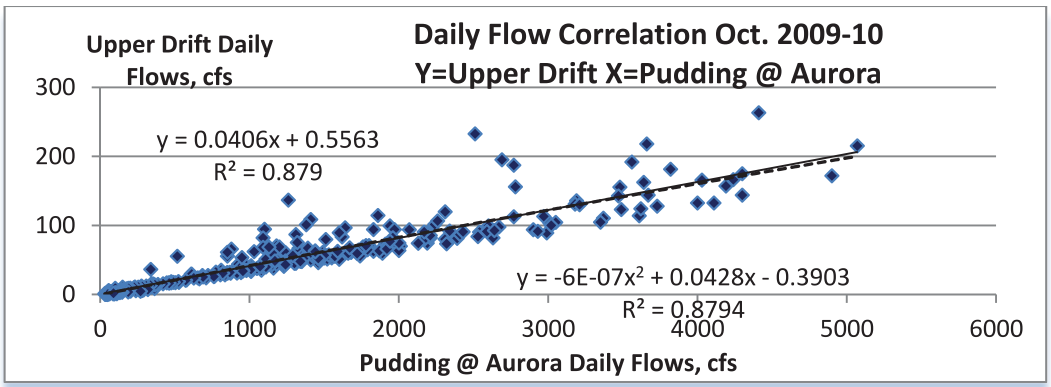


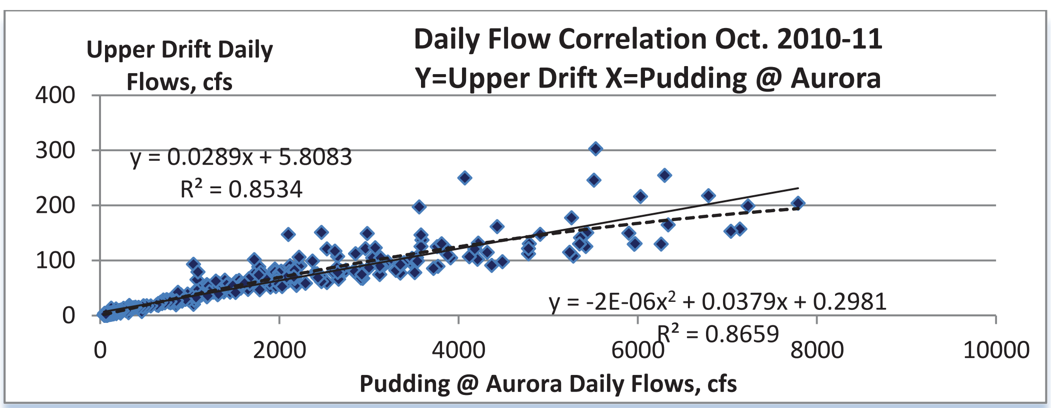
To provide the level of correlation between Upper Drift Creek flows and the corresponding flows at other streams, graphical scatter plots were performed. Those scatter plots define the polynomial regression equations relating the two parameters (X=Drift Creek flows vs. Y=corresponding flows from the other stream), as well as the correlation indicator, R^2. These plots were done separately for daily and monthly flows, and are shown in Figures 5.15 through 5.20 (daily flows) and Figures 5.21 through 5.26 (monthly flows). Each figure includes the plots for any and all hydrologic years (2008-14) depending on data availability.

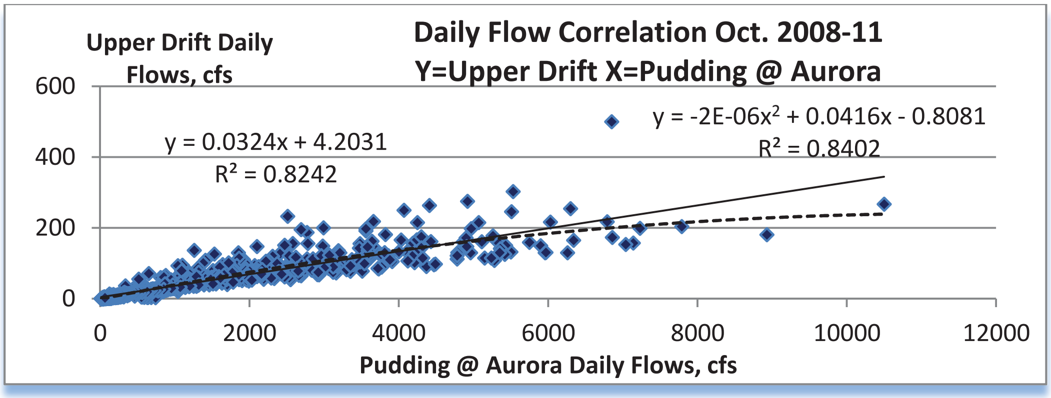
Note that some of the results may not match exactly those shown in previous report updates as some of the data used before had been modified later by the flow data collectors. Both the linear and order 2 polynomial trend/regression options are used to see which option yields the highest R^2 value.

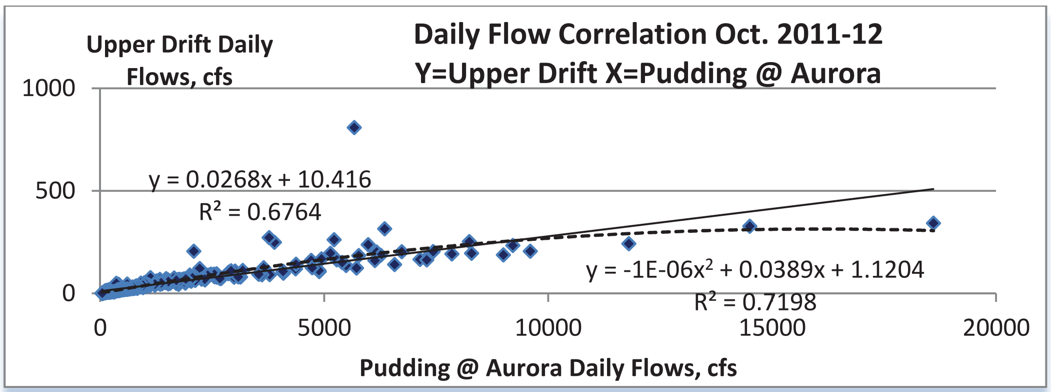
Figures 5.15 Daily Flow Scatter Plots (**X=Pudding @ Aurora, Y=Upper Drift**)

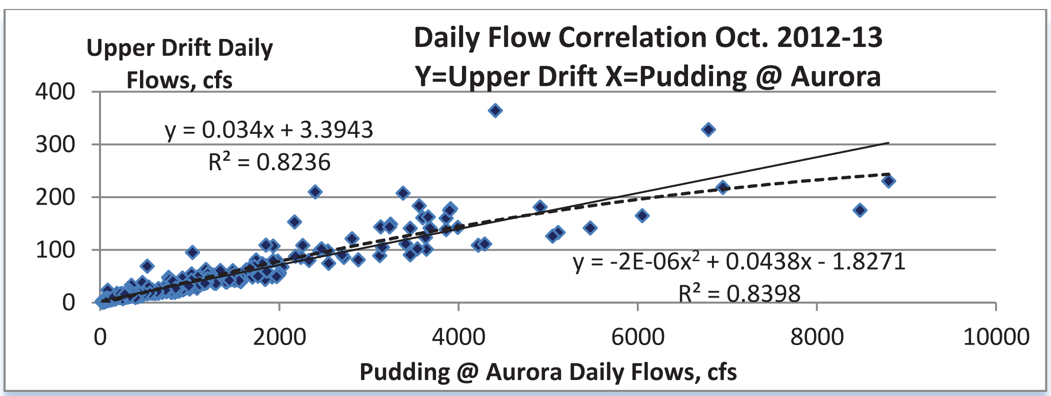


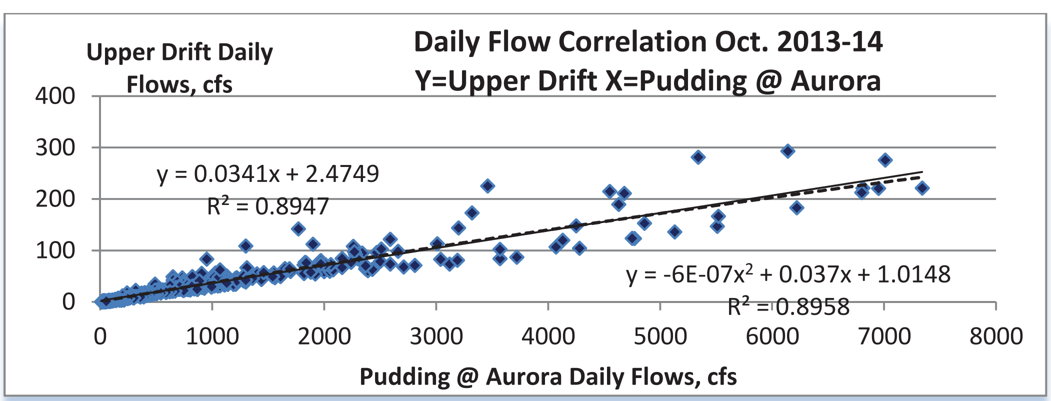


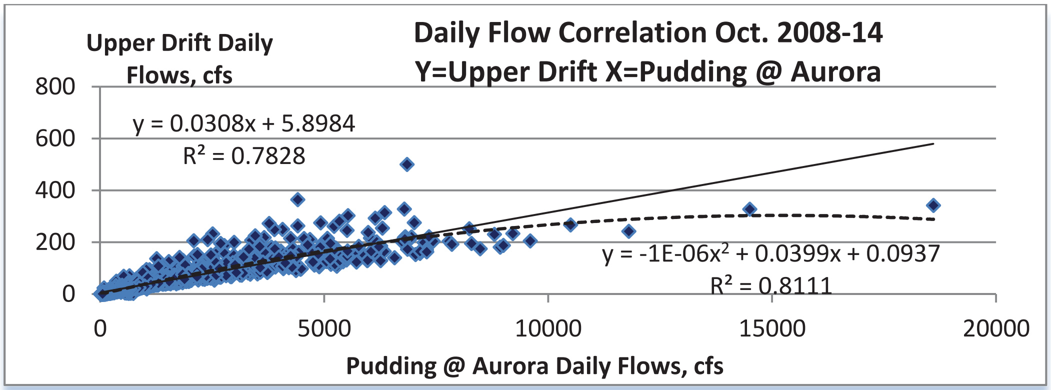



Daily Flow Correlation Oct. 2008-11
Y=Upper Drift X=Pudding @ Aurora
Upper Drift Daily Flows, cfs
600
400
200
0
y = 0.0324x + 4.2031
R² = 0.8242
y = -2E-06x² + 0.0416x - 0.8081
R² = 0.8402
0
2000
4000
6000
8000
10000
12000
Pudding @ Aurora Daily Flows, cfs

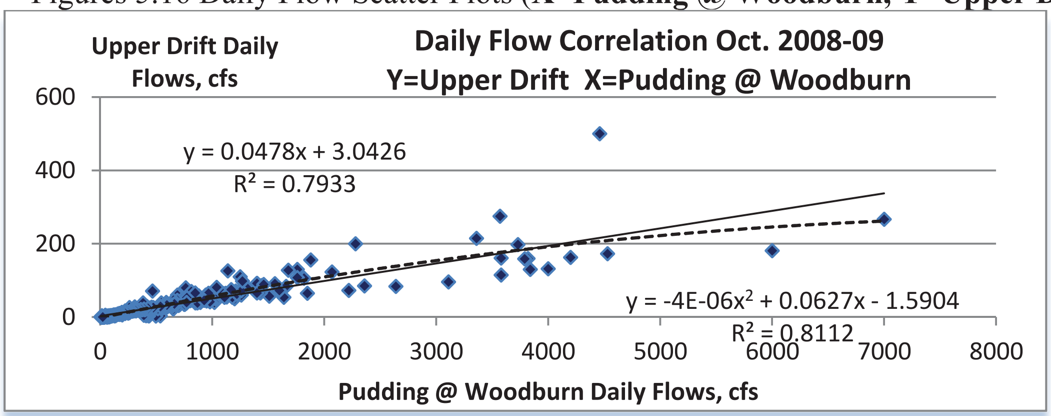

Daily Flow Correlation Oct. 2011-12
Y=Upper Drift X=Pudding @ Aurora
Upper Drift Daily Flows, cfs
1000
500
0
y = 0.0268x + 10.416
R² = 0.6764
y = -1E-06x² + 0.0389x + 1.1204
R² = 0.7198
0
5000
10000
15000
20000
Pudding @ Aurora Daily Flows, cfs

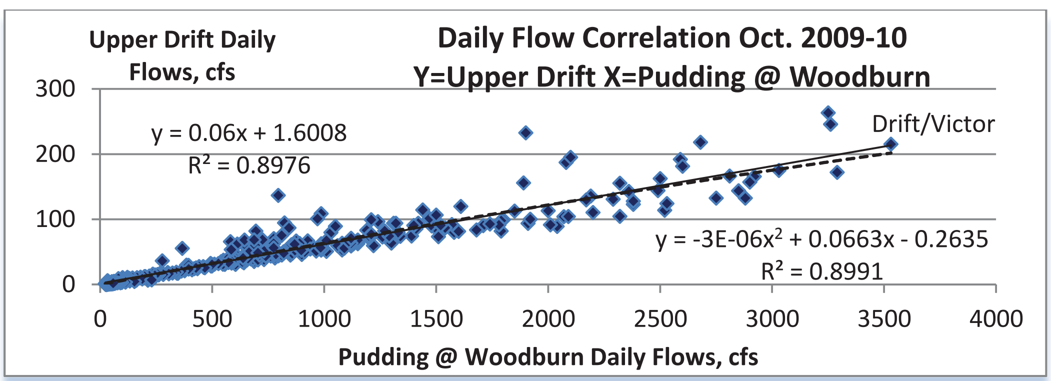

Daily Flow Correlation Oct. 2012-13
Y=Upper Drift X=Pudding @ Aurora
Upper Drift Daily Flows, cfs
400
300
200
100
0
y = 0.034x + 3.3943
R² = 0.8236
y = -2E-06x² + 0.0438x - 1.8271
R² = 0.8398
0
2000
4000
6000
8000
10000
Pudding @ Aurora Daily Flows, cfs

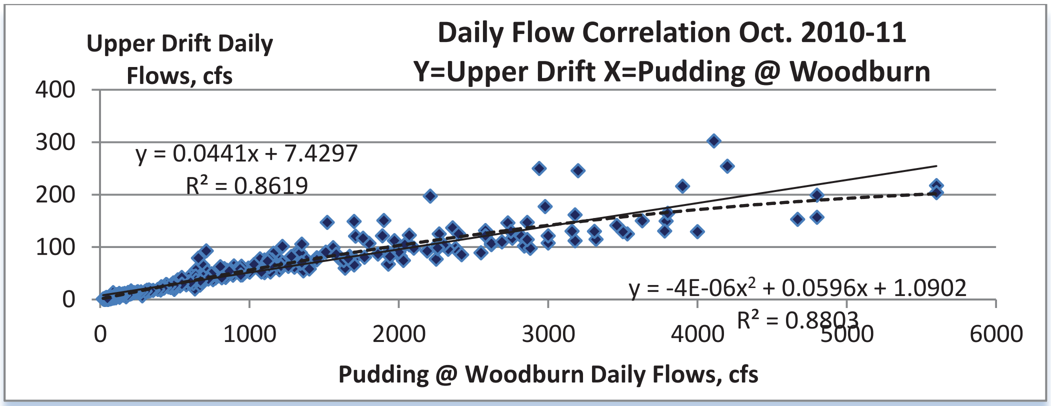

Daily Flow Correlation Oct. 2013-14
Y=Upper Drift X=Pudding @ Aurora
Upper Drift Daily Flows, cfs
400
300
200
100
0
y = 0.0341x + 2.4749
R² = 0.8947
y = -6E-07x² + 0.037x + 1.0148
R² = 0.8958
0
1000
2000
3000
4000
5000
6000
7000
8000
Pudding @ Aurora Daily Flows, cfs

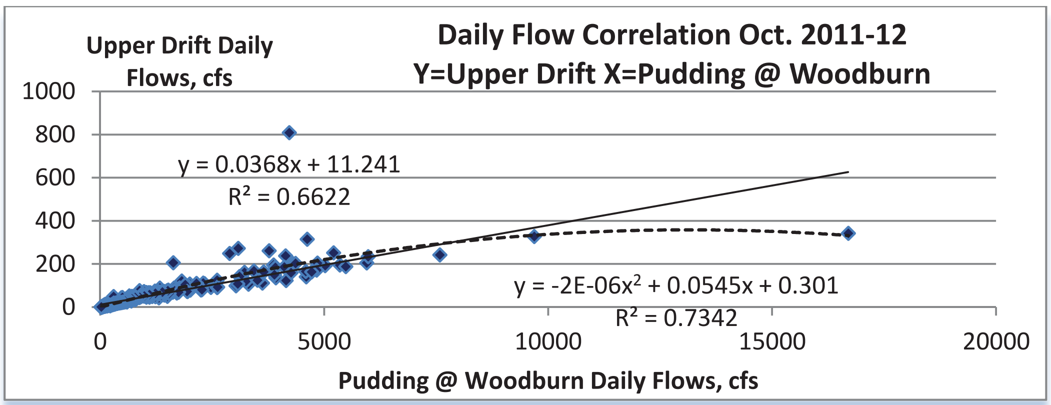


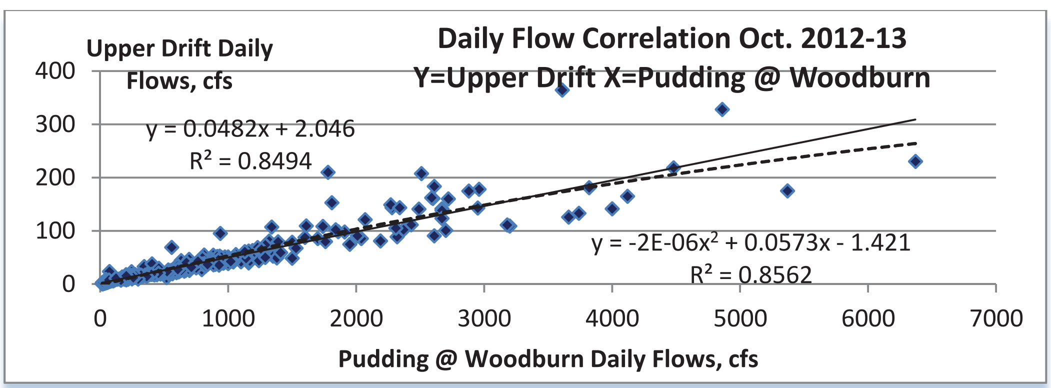
Figures 5.16 Daily Flow Scatter Plots (**X=Pudding @ Woodburn, Y=Upper Drift)**

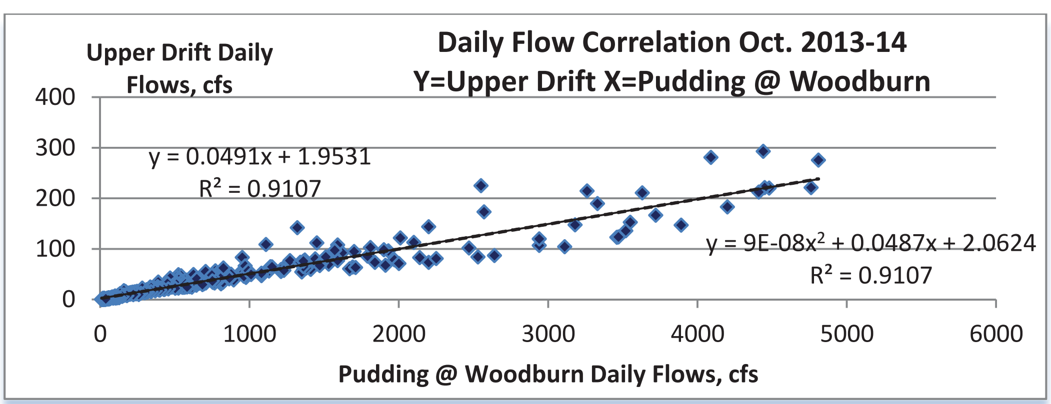


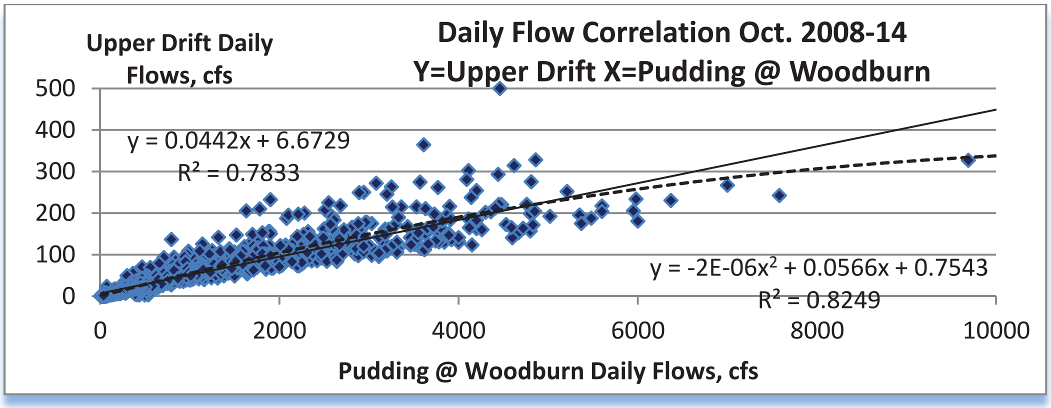



Daily Flow Correlation Oct. 2010-11
Y=Upper Drift X=Pudding @ Woodburn
Upper Drift Daily Flows, cfs
400
300
200
100
0
y = 0.0441x + 7.4297
R² = 0.8619
y = -4E-06x² + 0.0596x + 1.0902
R² = 0.8803
0
1000
2000
3000
4000
5000
6000
Pudding @ Woodburn Daily Flows, cfs

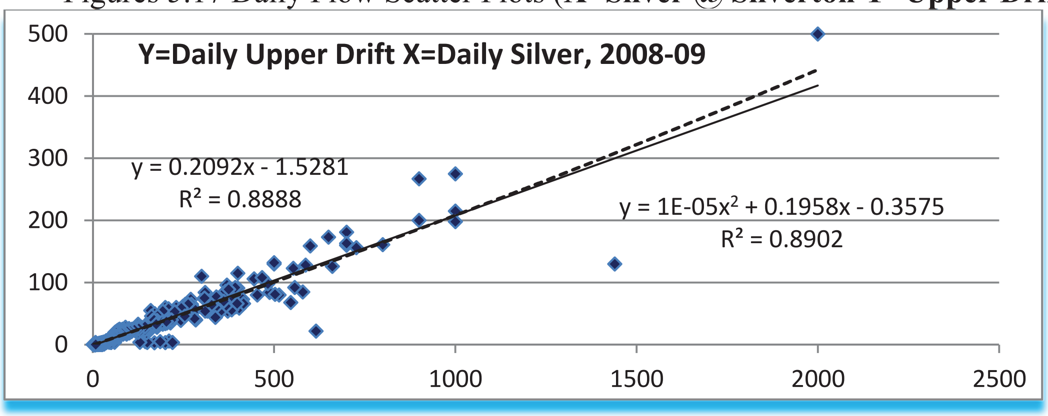

Daily Flow Correlation Oct. 2011-12
Y=Upper Drift X=Pudding @ Woodburn
Upper Drift Daily Flows, cfs
1000
800
600
400
200
0
y = 0.0368x + 11.241
R² = 0.6622
y = -2E-06x² + 0.0545x + 0.301
R² = 0.7342
0
5000
10000
15000
20000
Pudding @ Woodburn Daily Flows, cfs

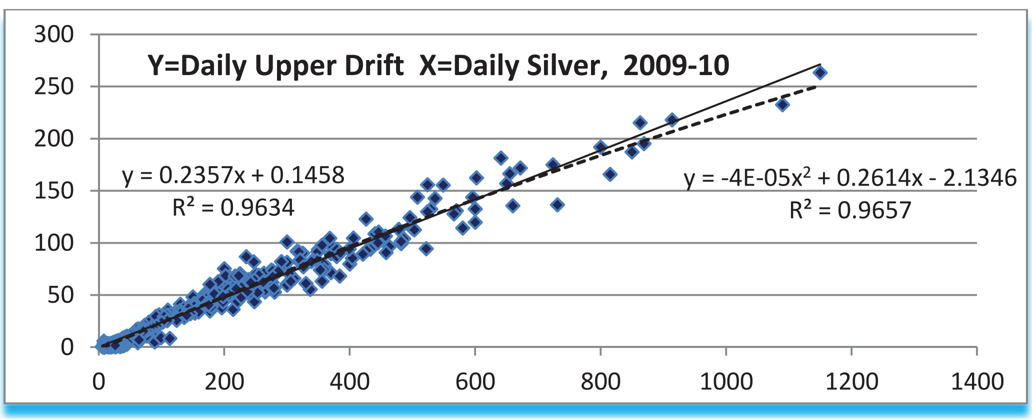

Daily Flow Correlation Oct. 2012-13
Y=Upper Drift X=Pudding @ Woodburn
Upper Drift Daily Flows, cfs
400
300
200
100
0
y = 0.0482x + 2.046
R² = 0.8494
y = -2E-06x² + 0.0573x - 1.421
R² = 0.8562
0
1000
2000
3000
4000
5000
6000
7000
Pudding @ Woodburn Daily Flows, cfs

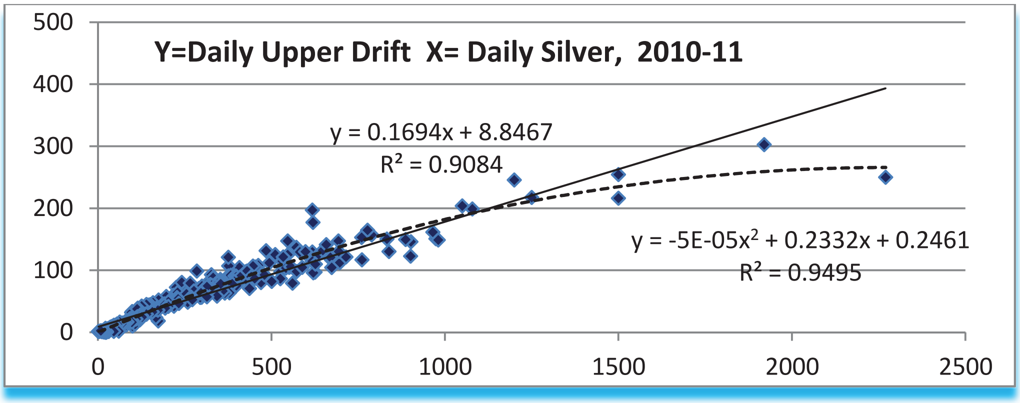

Daily Flow Correlation Oct. 2013-14
Y=Upper Drift X=Pudding @ Woodburn
Upper Drift Daily Flows, cfs
400
300
200
100
0
y = 0.0491x + 1.9531
R² = 0.9107
y = 9E-08x² + 0.0487x + 2.0624
R² = 0.9107
0
1000
2000
3000
4000
5000
6000
Pudding @ Woodburn Daily Flows, cfs

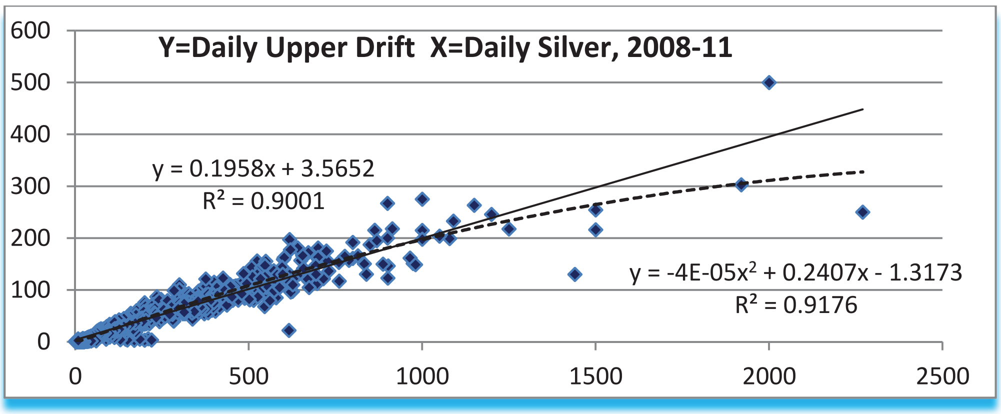


Figures 5.17 Daily Flow Scatter Plots (**X=Silver @ Silverton Y=Upper Drift)**

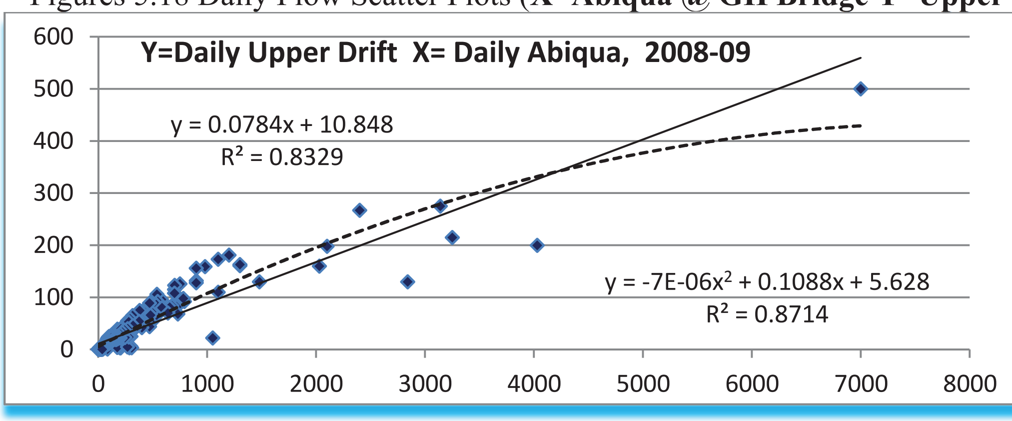


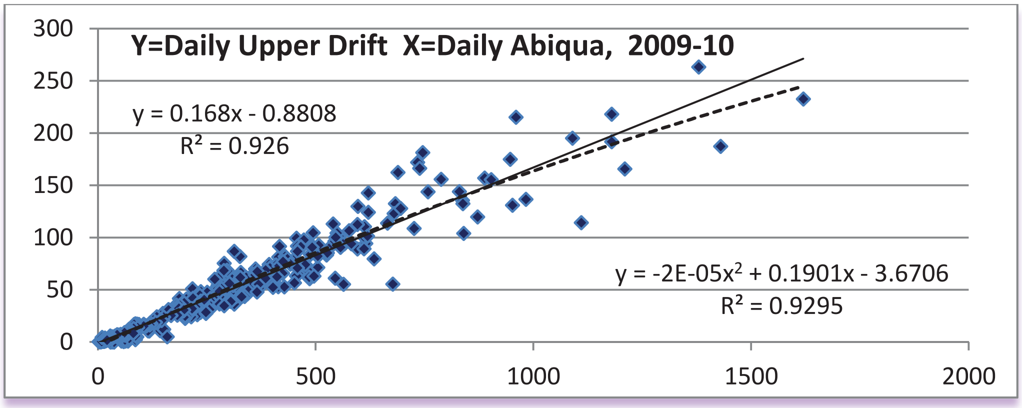


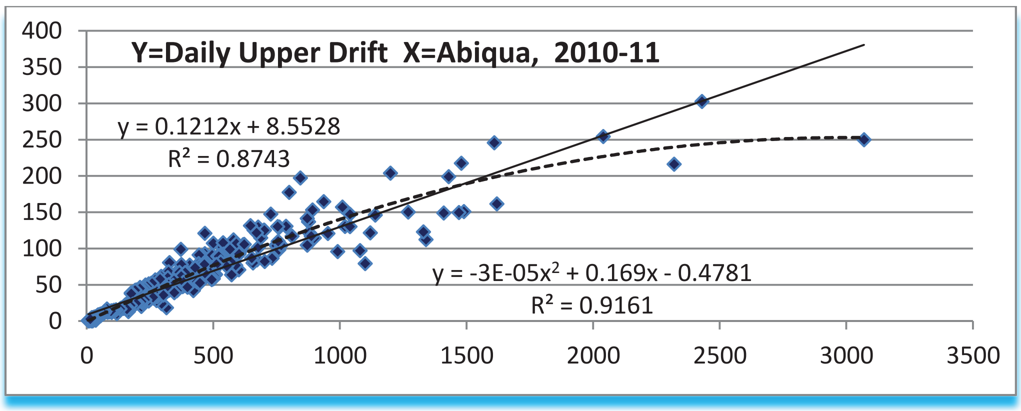


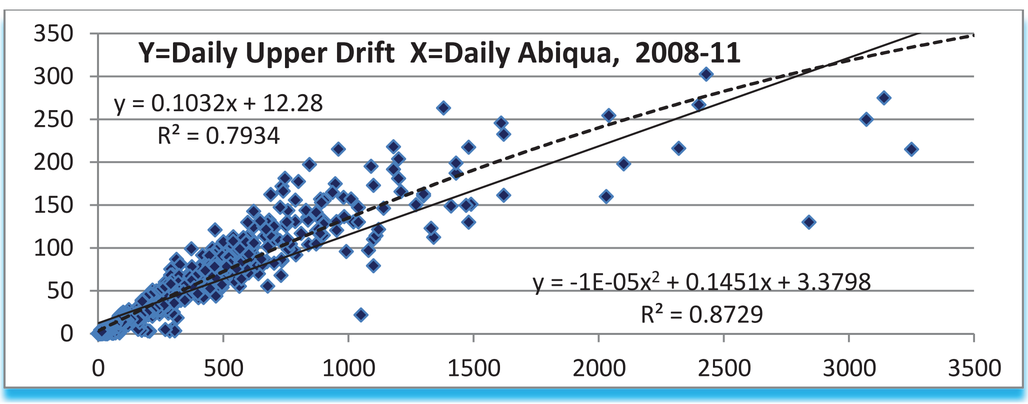


Figures 5.18 Daily Flow Scatter Plots (**X=Abiqua @ GH Bridge Y=Upper Drift)**

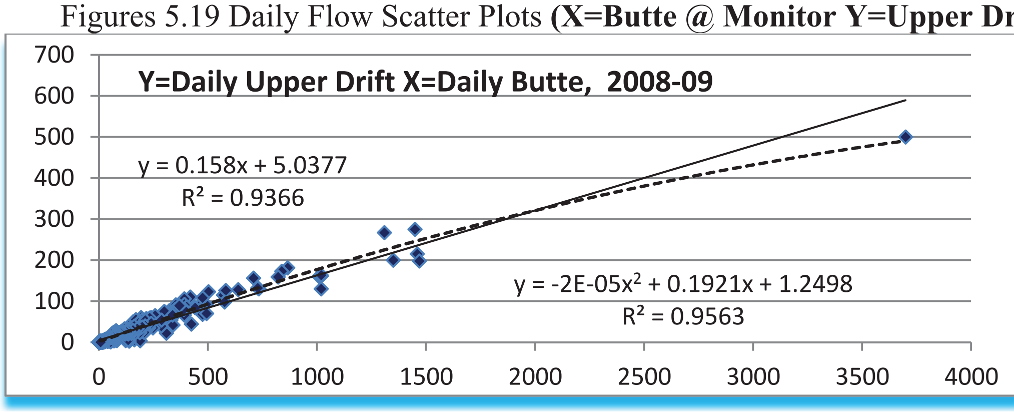


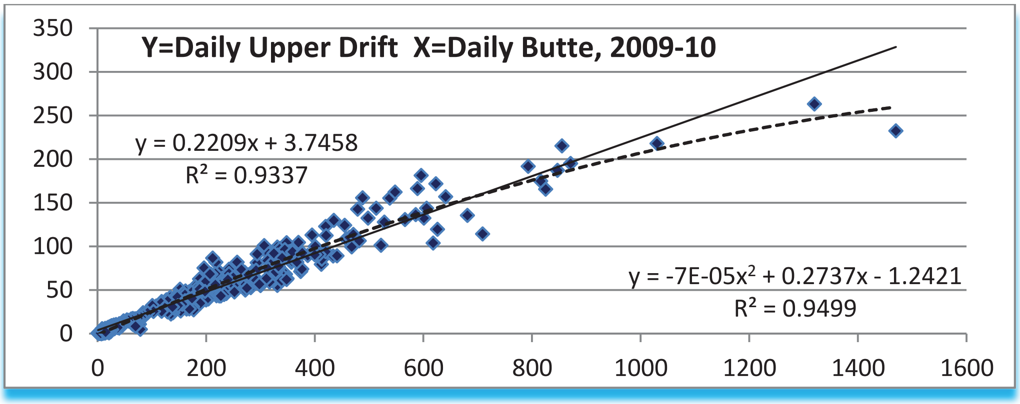


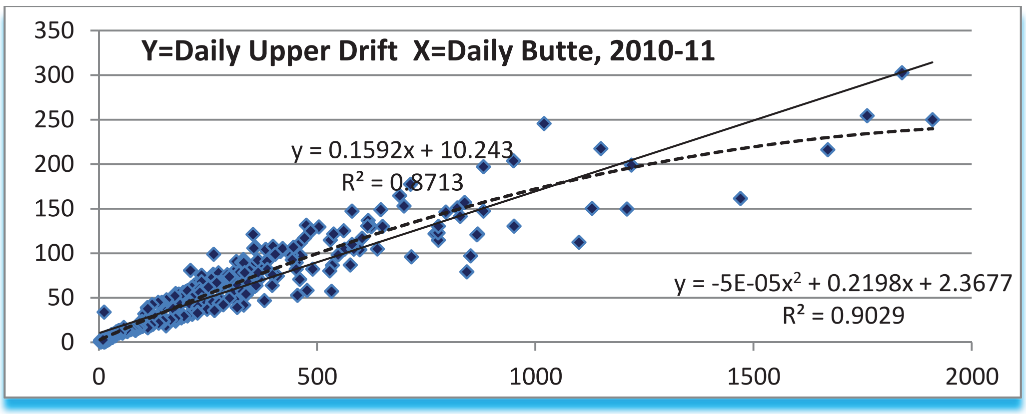


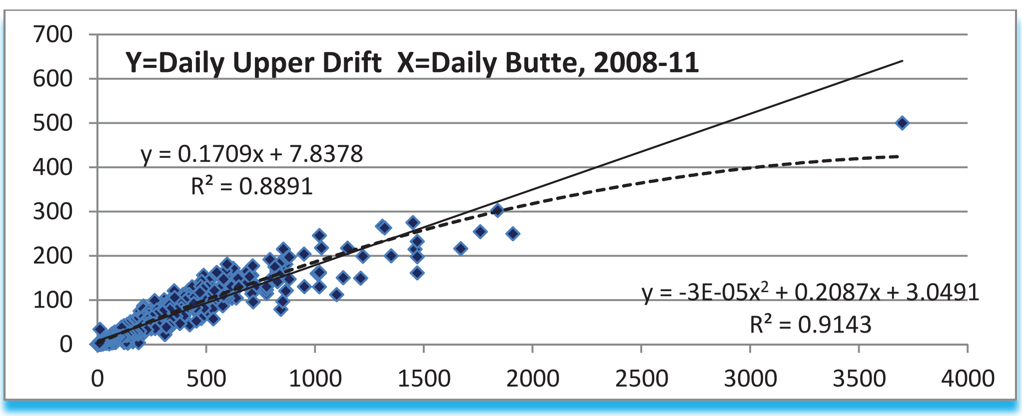


Figures 5.19 Daily Flow Scatter Plots **(X=Butte @ Monitor Y=Upper Drift)**

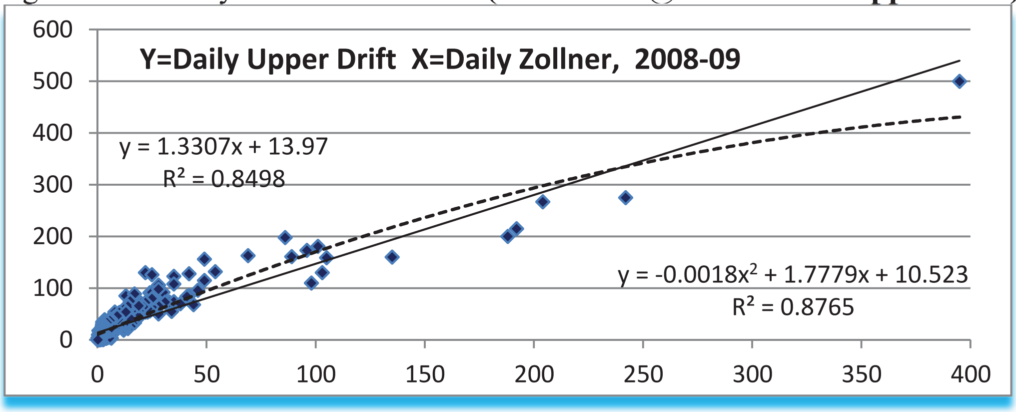


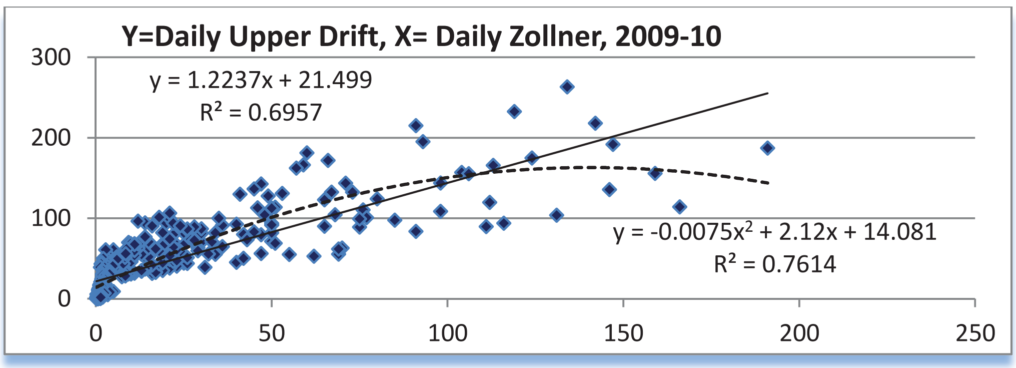

Y=Daily Upper Drift X=Daily Butte, 2009-10
y = 0.2209x + 3.7458
R² = 0.9337
y = -7E-05x² + 0.2737x - 1.2421
R² = 0.9499
0
50
100
150
200
250
300
350
0
200
400
600
800
1000
1200
1400
1600

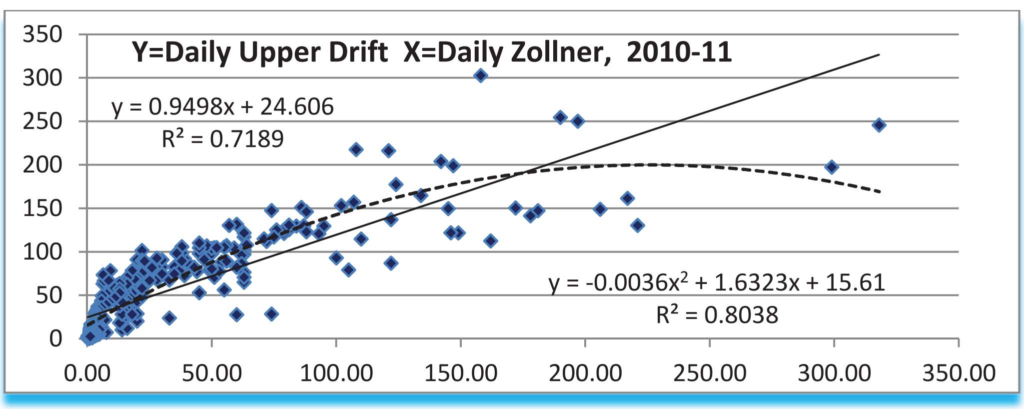

Y=Daily Upper Drift X=Daily Butte, 2010-11
y = 0.1592x + 10.243
R² = 0.8713
y = -5E-05x² + 0.2198x + 2.3677
R² = 0.9029
0
50
100
150
200
250
300
350
0
500
1000
1500
2000

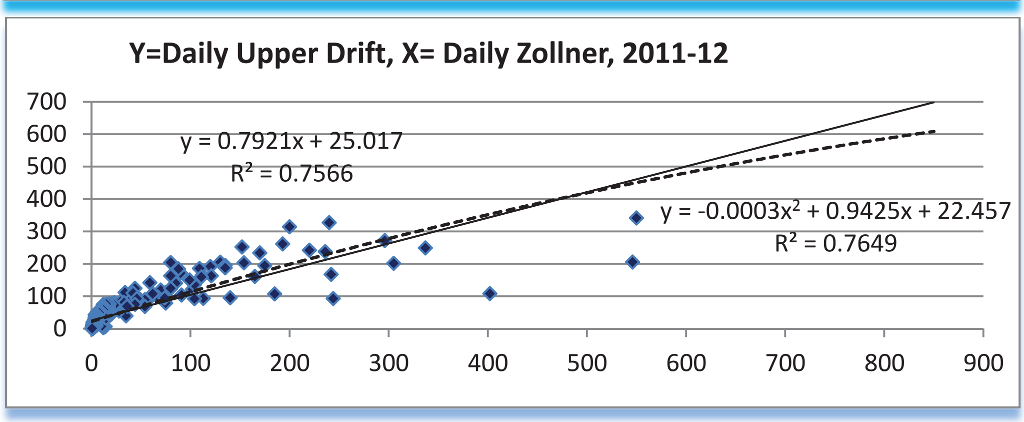

Y=Daily Upper Drift X=Daily Butte, 2008-11
y = 0.1709x + 7.8378
R² = 0.8891
y = -3E-05x² + 0.2087x + 3.0491
R² = 0.9143
0
100
200
300
400
500
600
700
0
500
1000
1500
2000
2500
3000
3500
4000

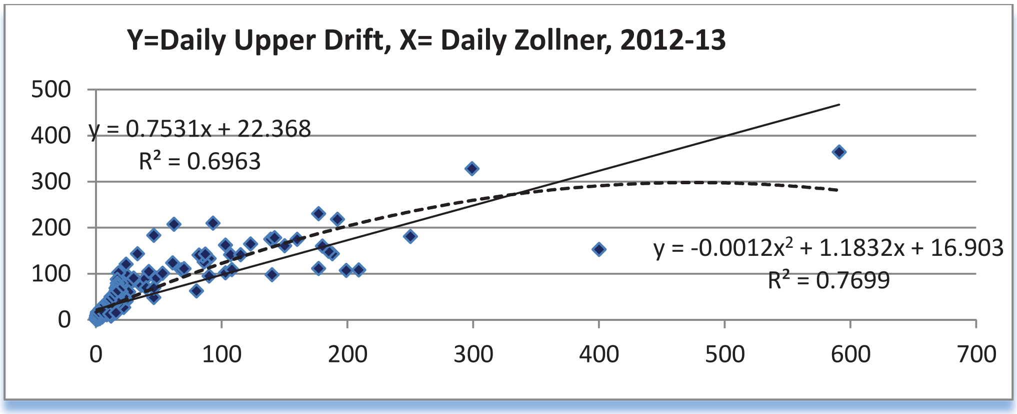
Figures 5.20 Daily Flow Scatter Plots **(X=Zollner @ Monitor Y=Upper Drift)**

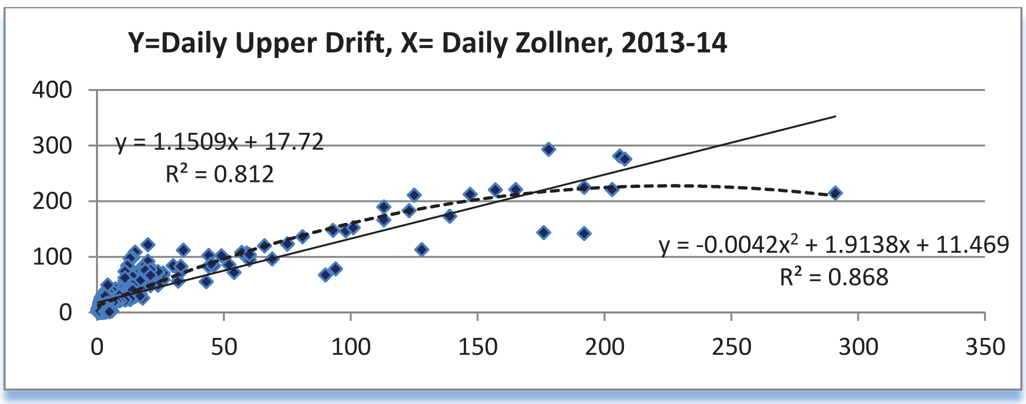


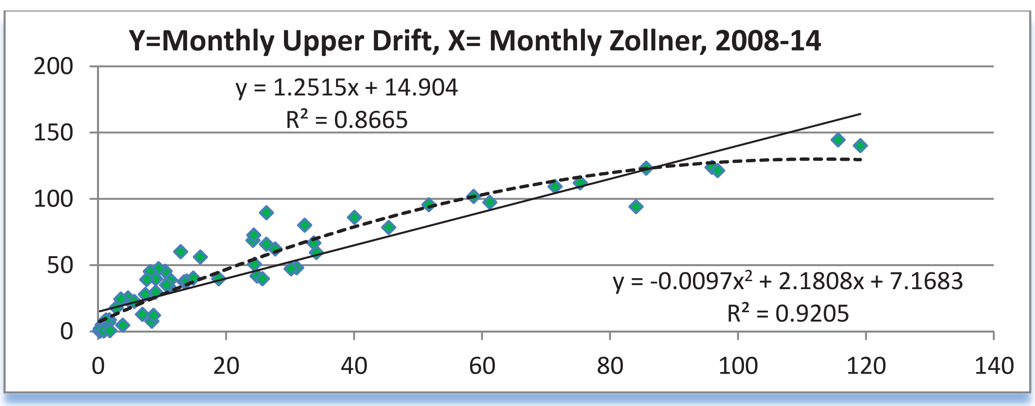




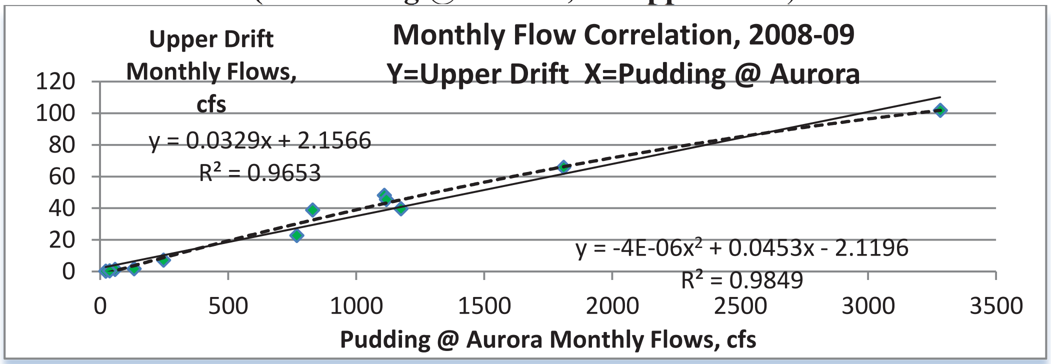


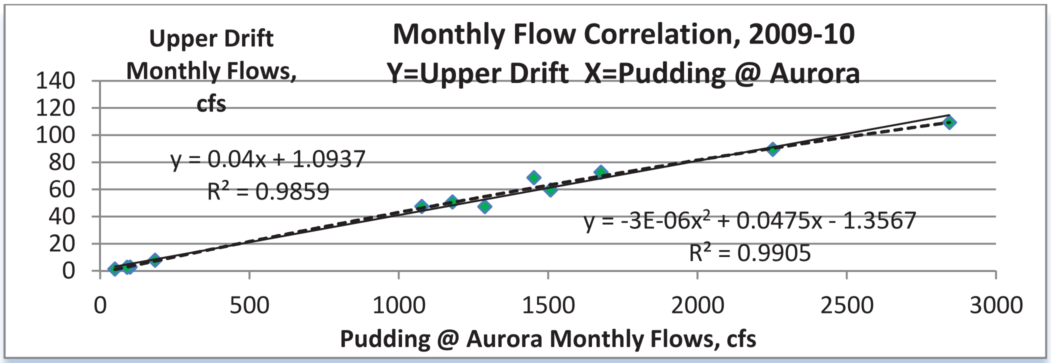

Y=Daily Upper Drift, X= Daily Zollner, 2012-13
y = 0.7531x + 22.368
R² = 0.6963
y = -0.0012x² + 1.1832x + 16.903
R² = 0.7699
500
400
300
200
100
0
0
100
200
300
400
500
600
700

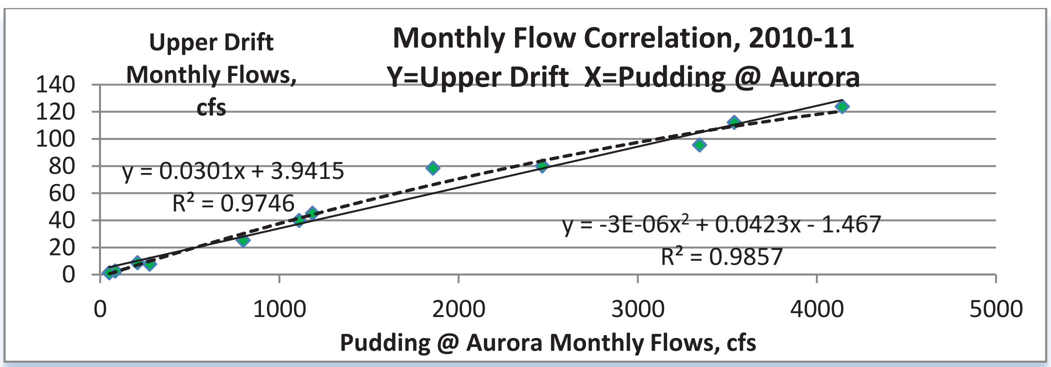

Y=Daily Upper Drift, X= Daily Zollner, 2013-14
y = 1.1509x + 17.72
R² = 0.812
y = -0.0042x² + 1.9138x + 11.469
R² = 0.868
400
300
200
100
0
0
50
100
150
200
250
300
350

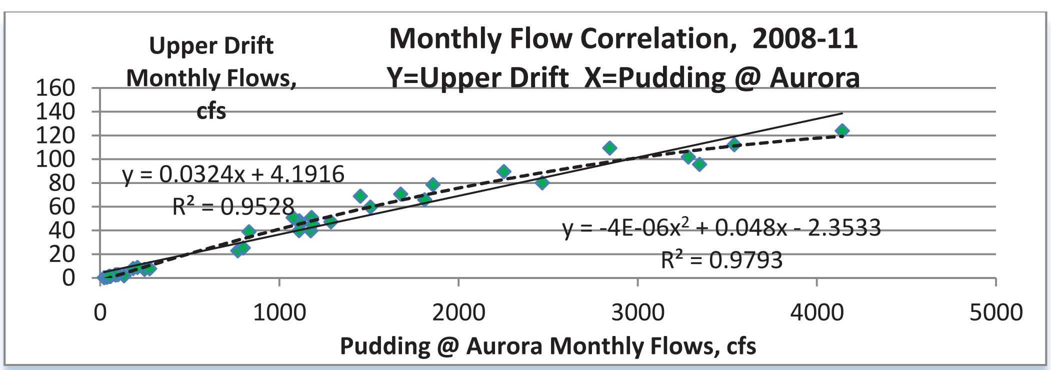

Y=Monthly Upper Drift, X= Monthly Zollner, 2008-14
y = 1.2515x + 14.904
R² = 0.8665
y = -0.0097x² + 2.1808x + 7.1683
R² = 0.9205
200
150
100
50
0
0
20
40
60
80
100
120
140

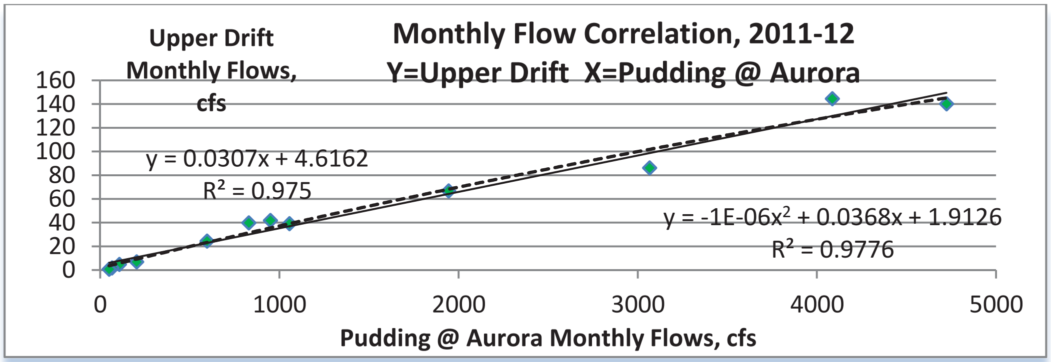
Figures 5.21 **Monthly** Flow Scatter Plots
(X=Pudding @ Aurora, Y=Upper Drift)

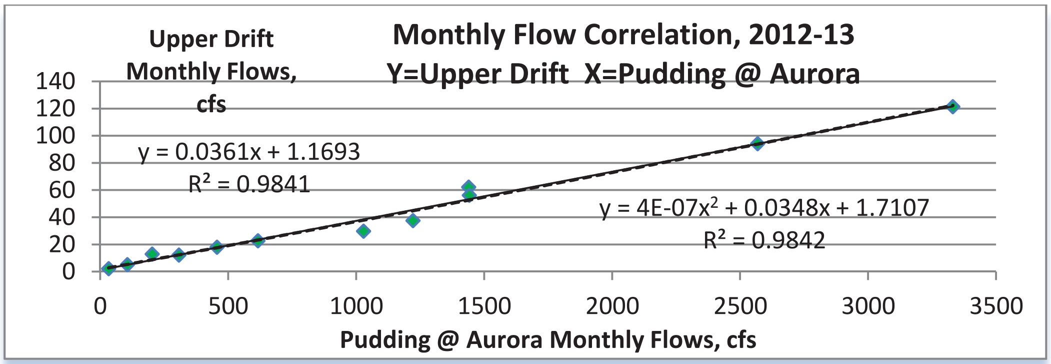


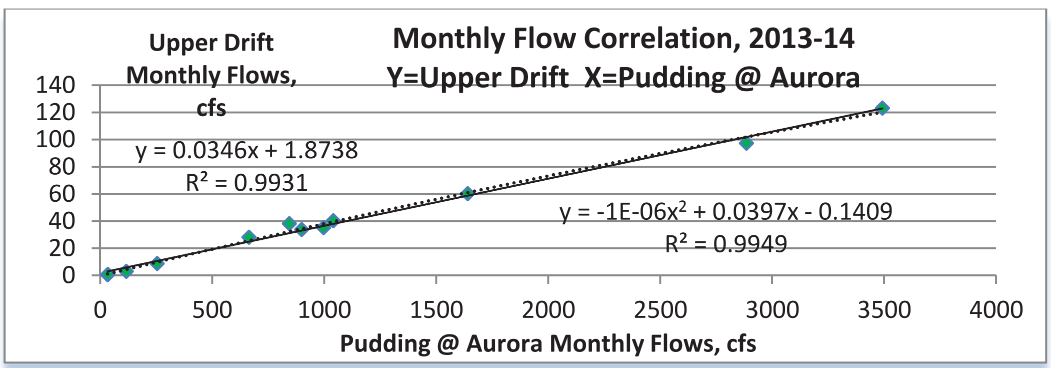


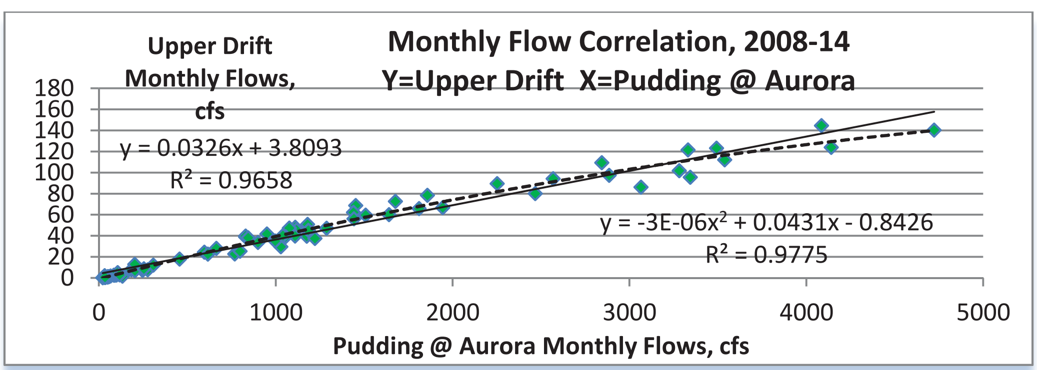




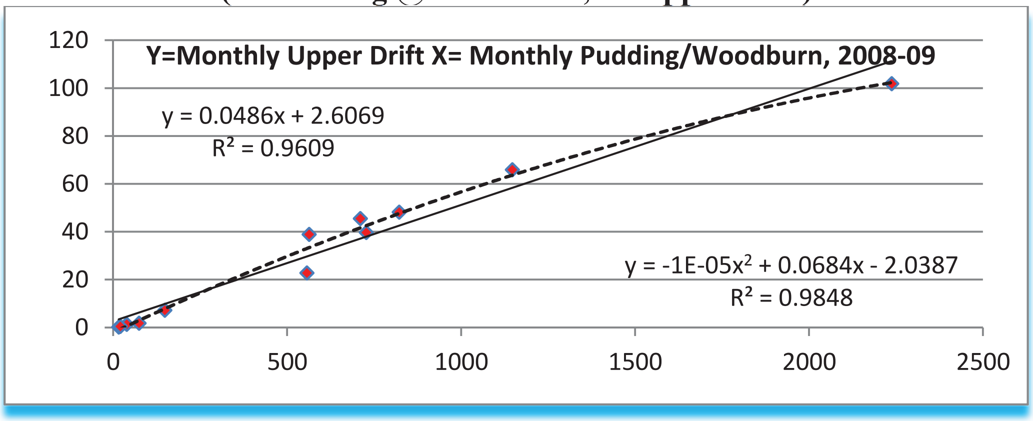

Monthly Flow Correlation, 2011-12
Y=Upper Drift X=Pudding @ Aurora
Upper Drift Monthly Flows, cfs
y = 0.0307x + 4.6162
R² = 0.975
y = -1E-06x² + 0.0368x + 1.9126
R² = 0.9776
Pudding @ Aurora Monthly Flows, cfs

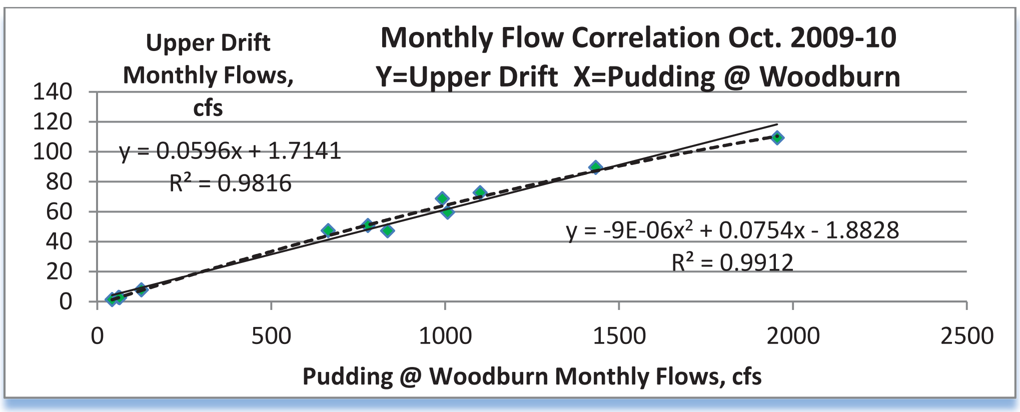

Monthly Flow Correlation, 2012-13
Y=Upper Drift X=Pudding @ Aurora
Upper Drift Monthly Flows, cfs
y = 0.0361x + 1.1693
R² = 0.9841
y = 4E-07x² + 0.0348x + 1.7107
R² = 0.9842
Pudding @ Aurora Monthly Flows, cfs

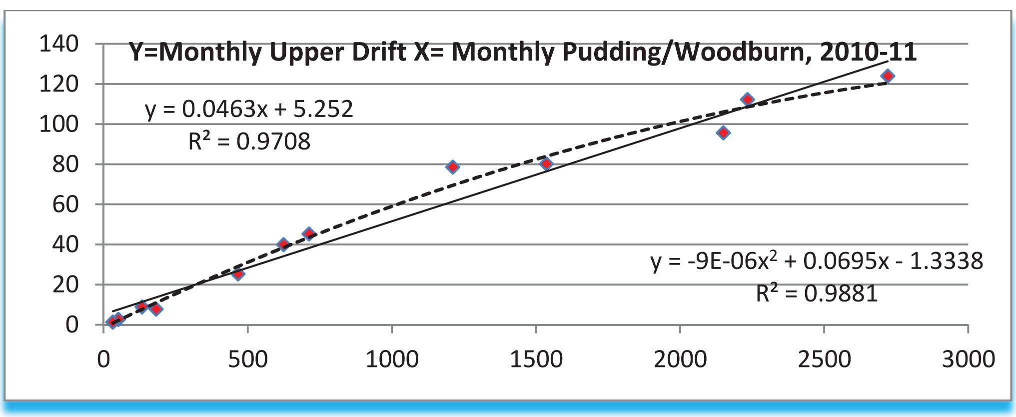

Monthly Flow Correlation, 2013-14
Y=Upper Drift X=Pudding @ Aurora
Upper Drift Monthly Flows, cfs
y = 0.0346x + 1.8738
R² = 0.9931
y = -1E-06x² + 0.0397x - 0.1409
R² = 0.9949
Pudding @ Aurora Monthly Flows, cfs

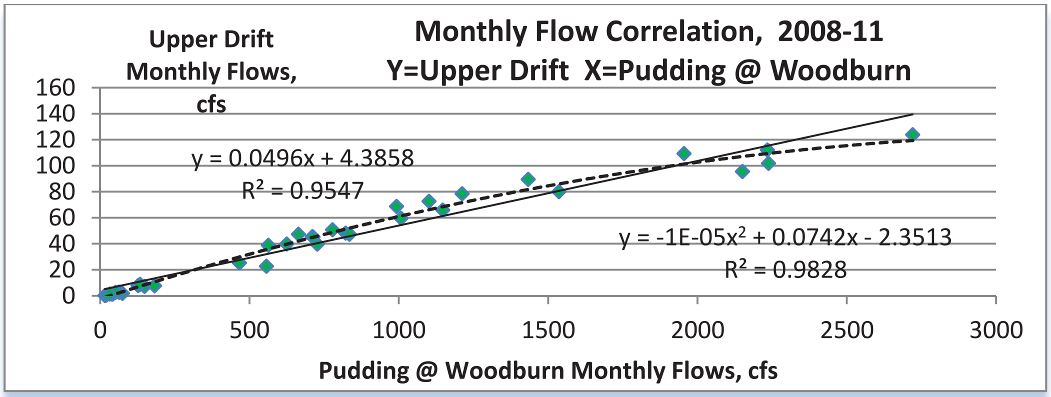

Monthly Flow Correlation, 2008-14
Y=Upper Drift X=Pudding @ Aurora
Upper Drift Monthly Flows, cfs
y = 0.0326x + 3.8093
R² = 0.9658
y = -3E-06x² + 0.0431x - 0.8426
R² = 0.9775
Pudding @ Aurora Monthly Flows, cfs

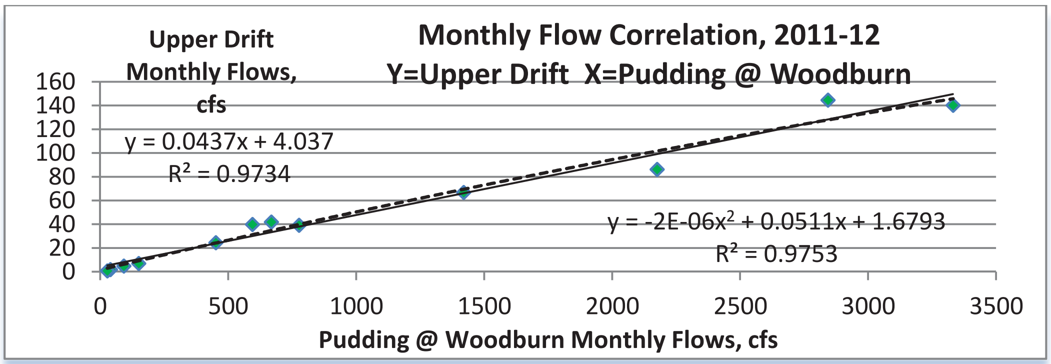
Figures 5.22 **Monthly** Flow Scatter Plots
(X=Pudding @ Woodburn, Y=Upper Drift)

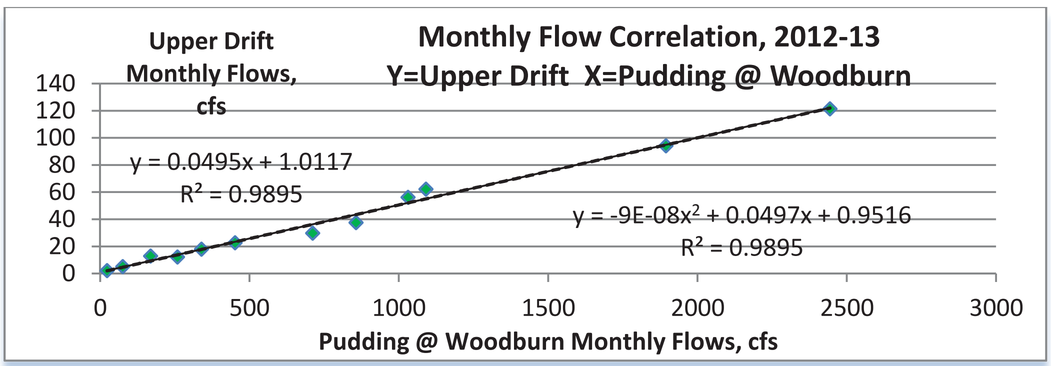


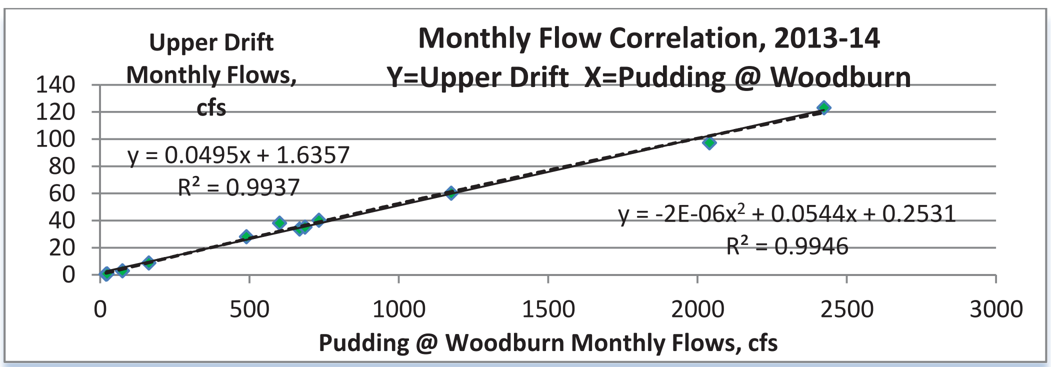


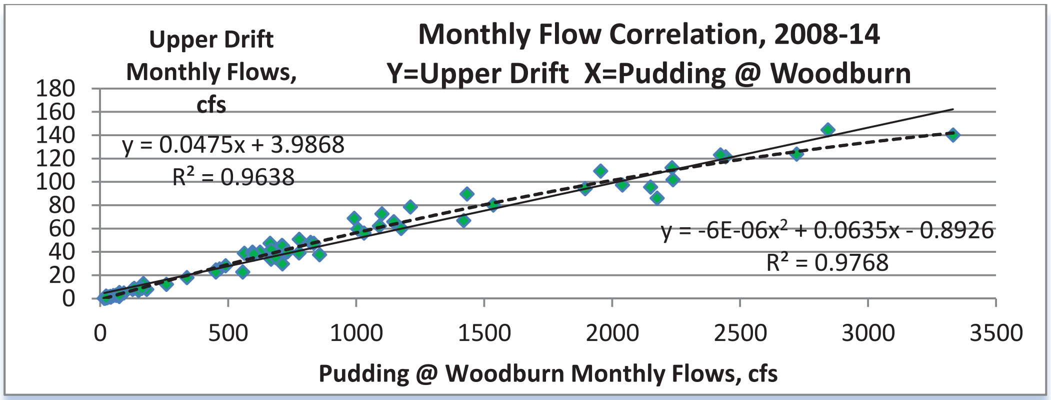



Monthly Flow Correlation, 2008-11
Y=Upper Drift X=Pudding @ Woodburn
Upper Drift Monthly Flows, cfs
y = 0.0496x + 4.3858
R² = 0.9547
y = -1E-05x² + 0.0742x - 2.3513
R² = 0.9828
Pudding @ Woodburn Monthly Flows, cfs

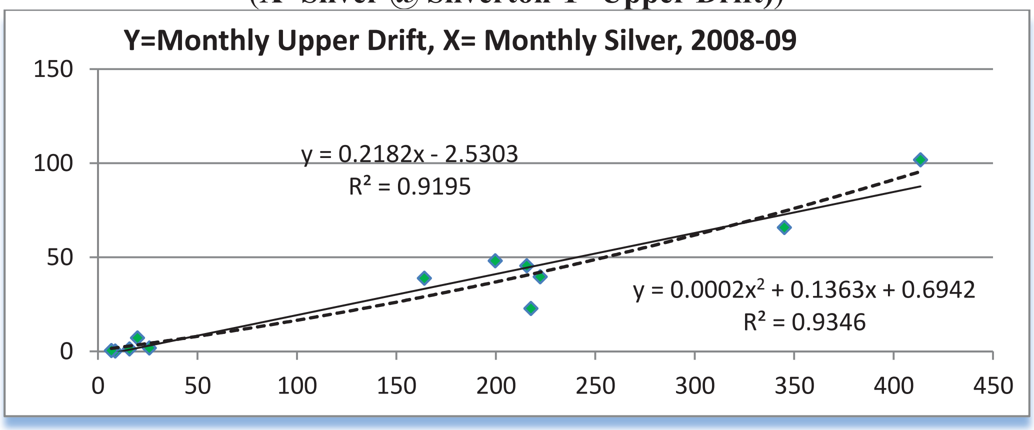

Monthly Flow Correlation, 2011-12
Y=Upper Drift X=Pudding @ Woodburn
Upper Drift Monthly Flows, cfs
y = 0.0437x + 4.037
R² = 0.9734
y = -2E-06x² + 0.0511x + 1.6793
R² = 0.9753
Pudding @ Woodburn Monthly Flows, cfs

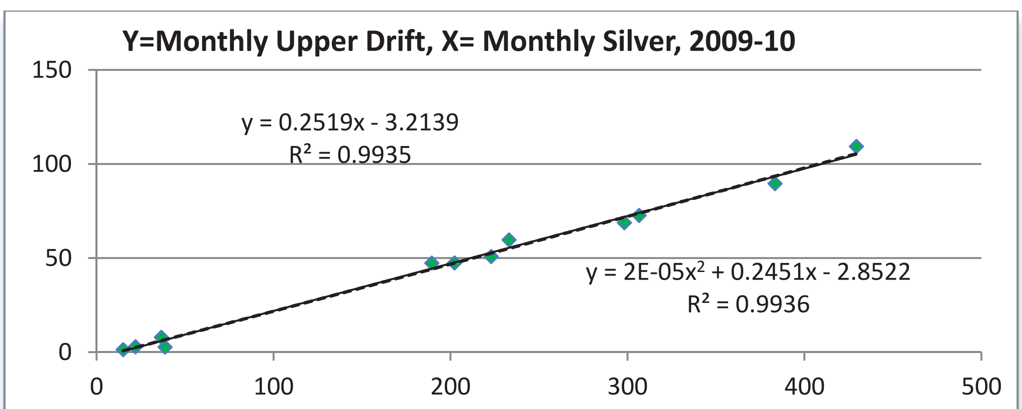

Monthly Flow Correlation, 2012-13
Y=Upper Drift X=Pudding @ Woodburn
Upper Drift Monthly Flows, cfs
y = 0.0495x + 1.0117
R² = 0.9895
y = -9E-08x² + 0.0497x + 0.9516
R² = 0.9895
Pudding @ Woodburn Monthly Flows, cfs

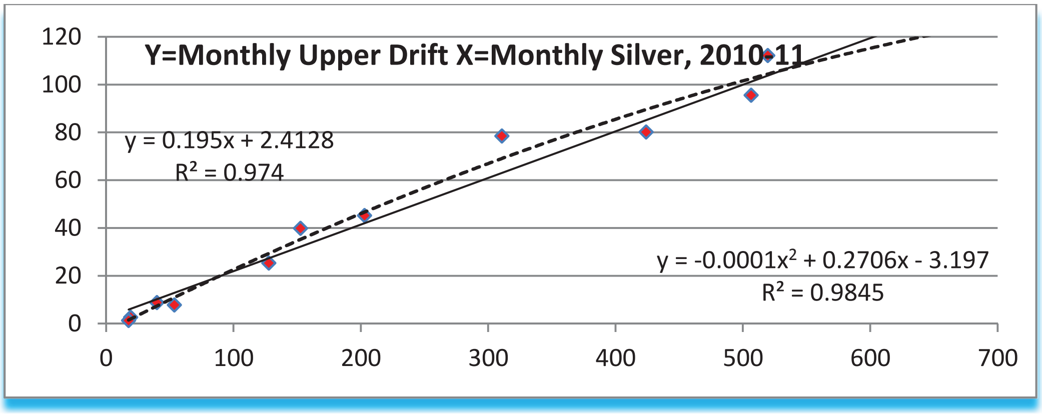

Monthly Flow Correlation, 2013-14
Y=Upper Drift X=Pudding @ Woodburn
Upper Drift Monthly Flows, cfs
y = 0.0495x + 1.6357
R² = 0.9937
y = -2E-06x² + 0.0544x + 0.2531
R² = 0.9946
Pudding @ Woodburn Monthly Flows, cfs

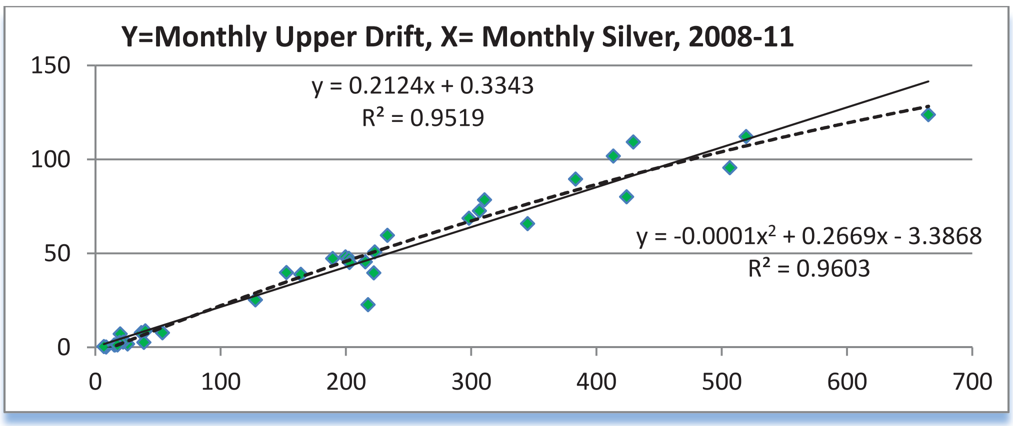


Figures 5.23 **Monthly** Flow Scatter Plots
(X=Silver @ Silverton Y=Upper Drift))

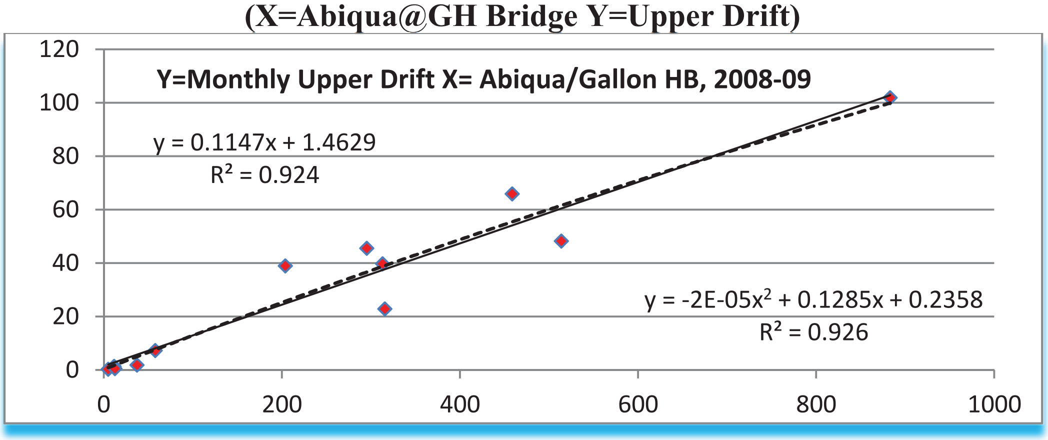


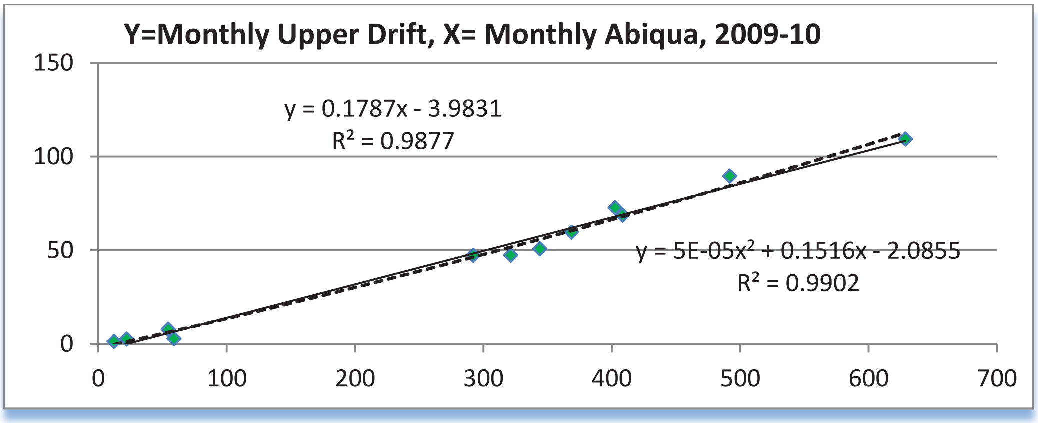


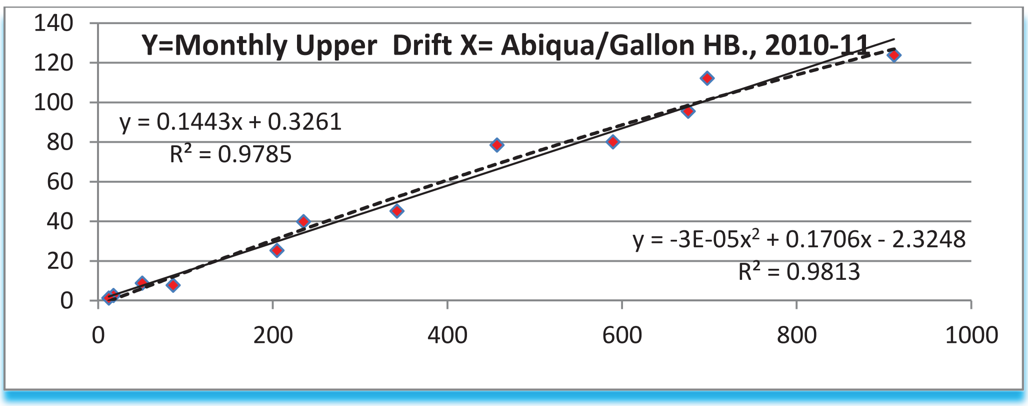


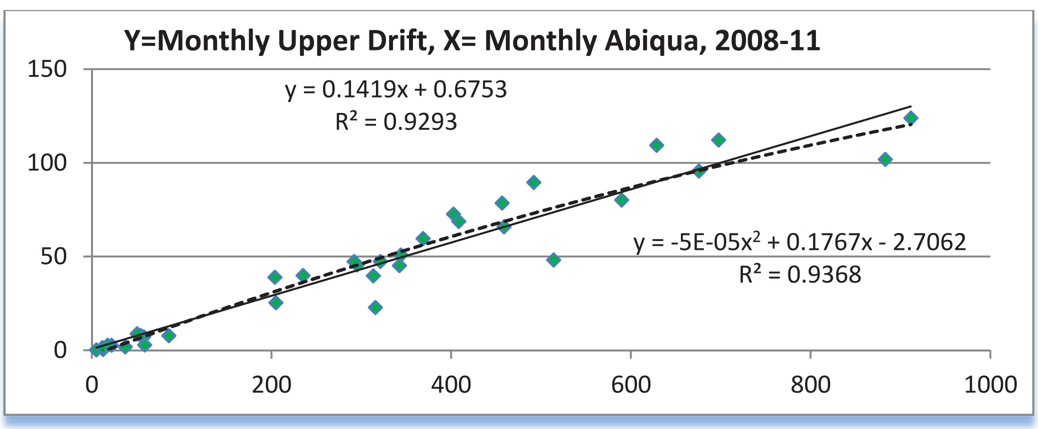


Figures 5.24 **Monthly** Flow Scatter Plots
(X=Abiqua@GH Bridge Y=Upper Drift)



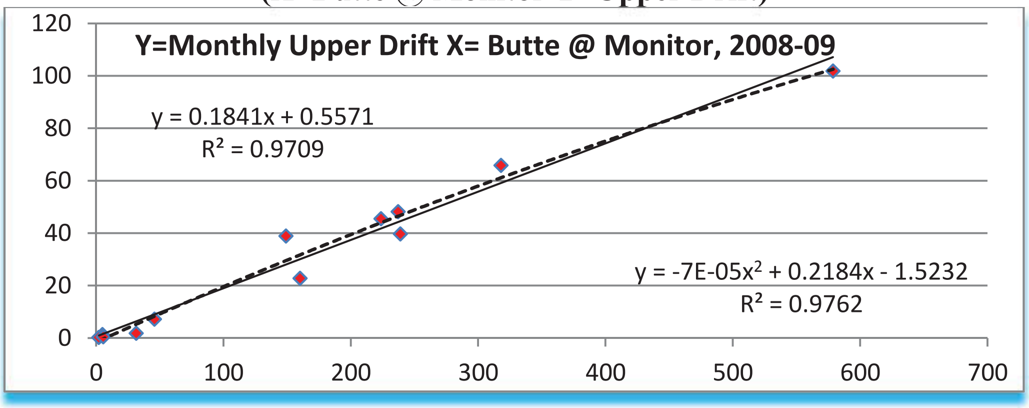

Y=Monthly Upper Drift, X= Monthly Abiqua, 2009-10
y = 0.1787x - 3.9831
R² = 0.9877
y = 5E-05x² + 0.1516x - 2.0855
R² = 0.9902
150
100
50
0
0
100
200
300
400
500
600
700

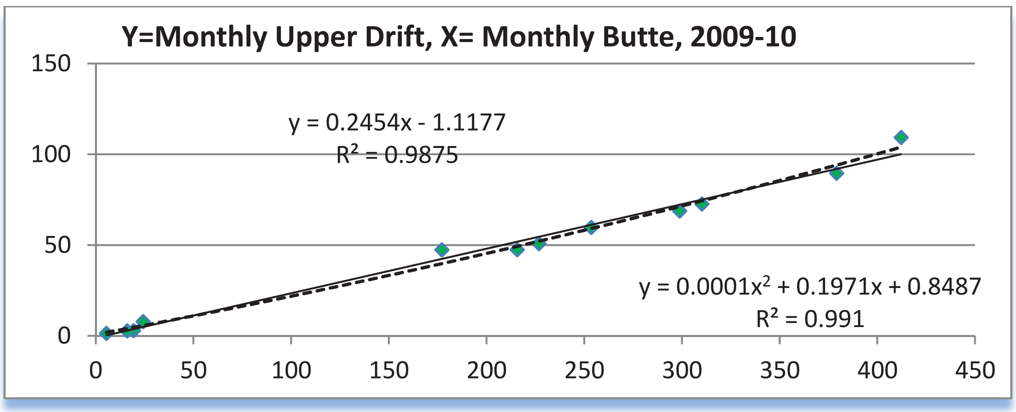

Y=Monthly Upper Drift X= Abiqua/Gallon HB., 2010-11
y = 0.1443x + 0.3261
R² = 0.9785
y = -3E-05x² + 0.1706x - 2.3248
R² = 0.9813
140
120
100
80
60
40
20
0
0
200
400
600
800
1000

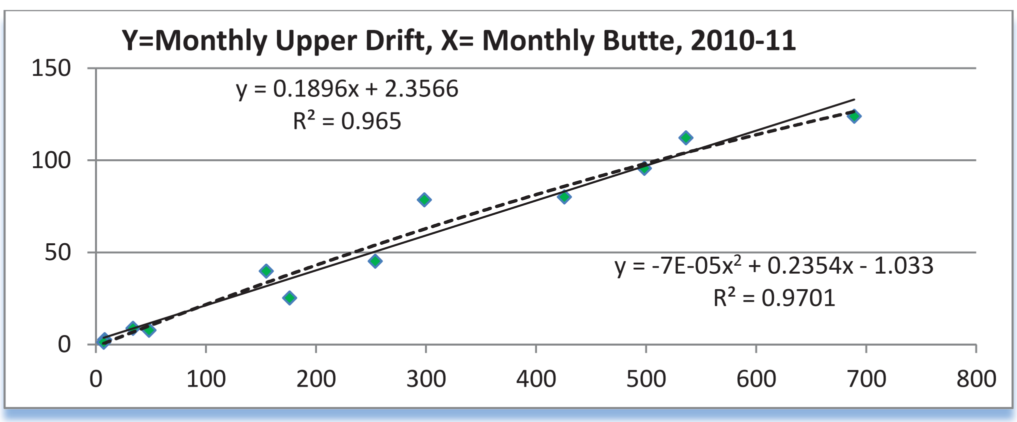

Y=Monthly Upper Drift, X= Monthly Abiqua, 2008-11
y = 0.1419x + 0.6753
R² = 0.9293
y = -5E-05x² + 0.1767x - 2.7062
R² = 0.9368
150
100
50
0
0
200
400
600
800
1000

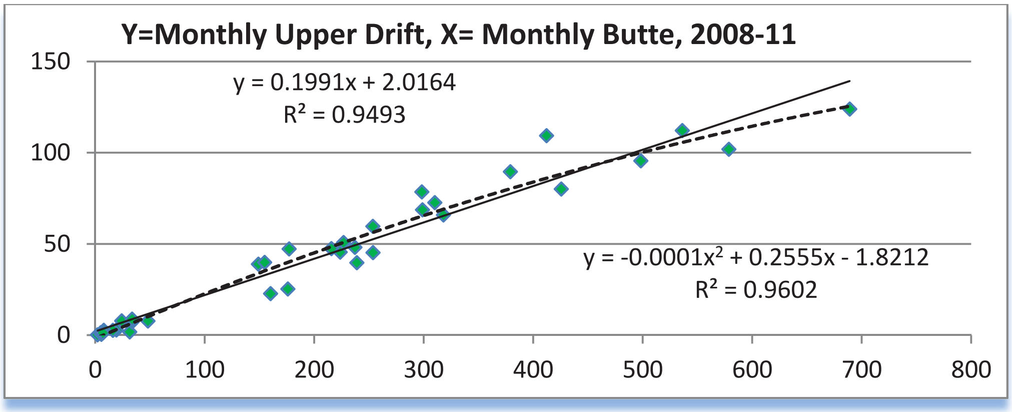
Figures 5.25 Monthly Flow Scatter Plots

(X=Butte @ Monitor Y=Upper Drift)

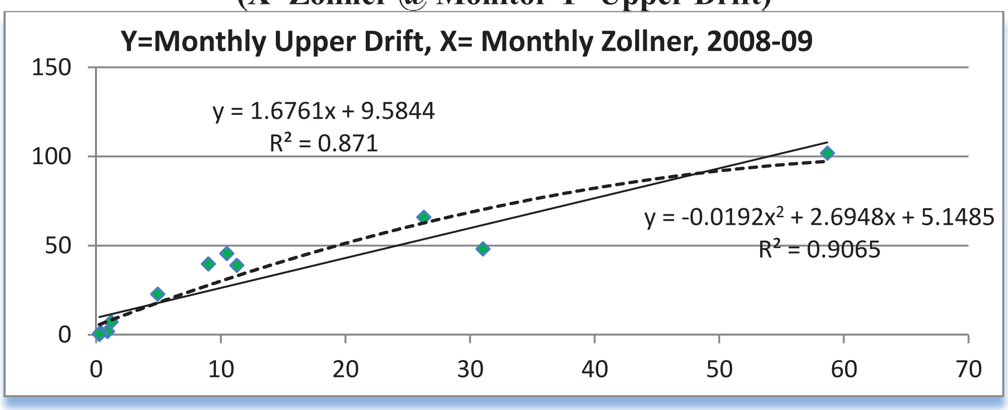


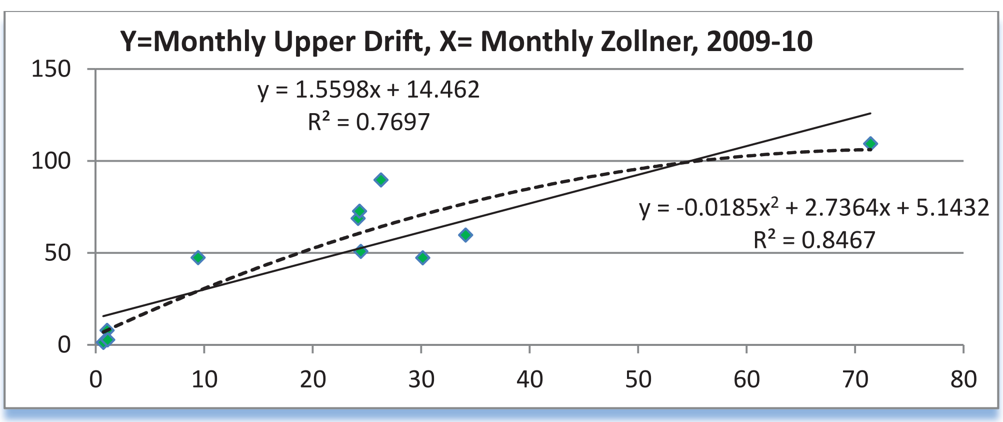


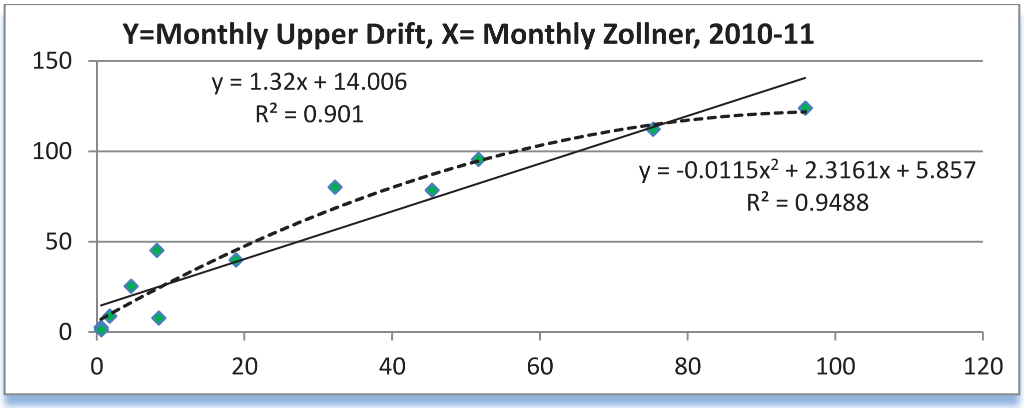


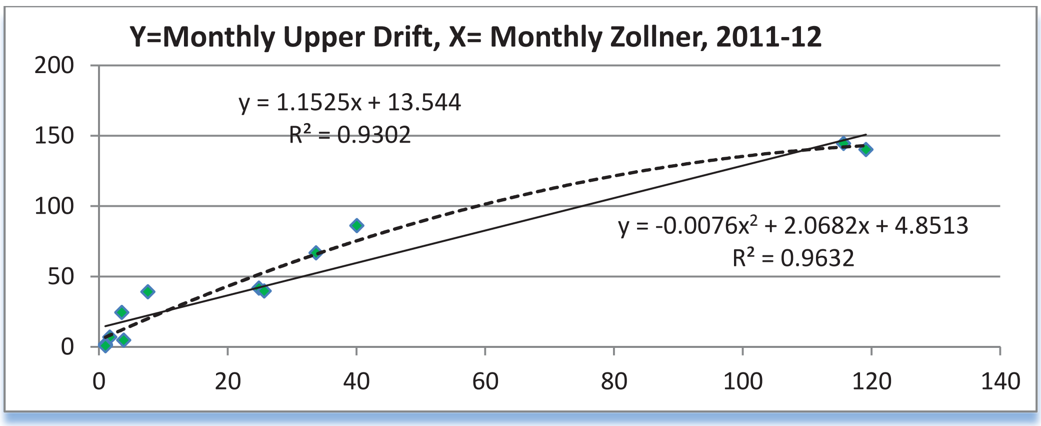


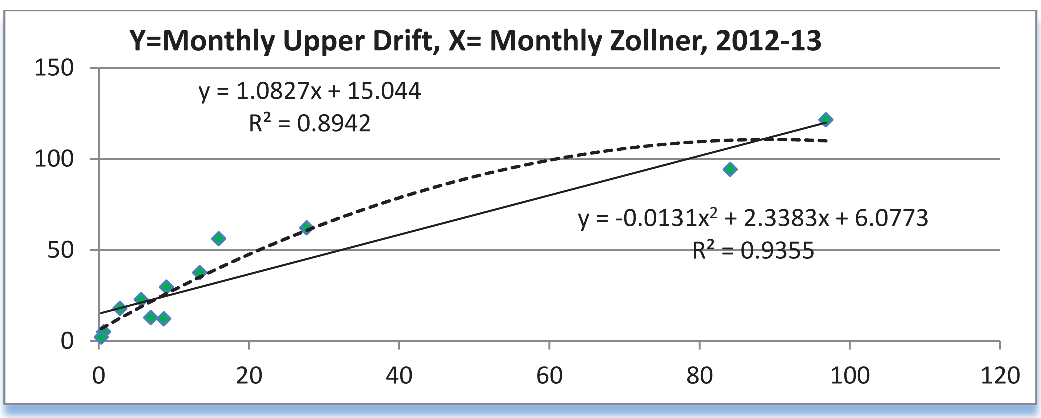
Figures 5.26 **Monthly** Flow Scatter Plots
(X=Zollner @ Monitor Y=Upper Drift)

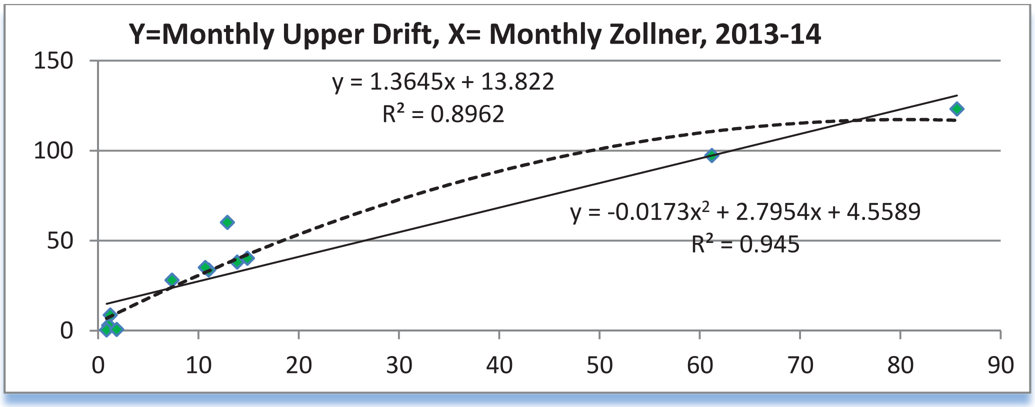





Y=Monthly Upper Drift, X= Monthly Zollner, 2010-11
y = 1.32x + 14.006
R² = 0.901
y = -0.0115x² + 2.3161x + 5.857
R² = 0.9488
150
100
50
0
0
20
40
60
80
100
120


Y=Monthly Upper Drift, X= Monthly Zollner, 2011-12
y = 1.1525x + 13.544
R² = 0.9302
y = -0.0076x² + 2.0682x + 4.8513
R² = 0.9632
200
150
100
50
0
0
20
40
60
80
100
120
140


Y=Monthly Upper Drift, X= Monthly Zollner, 2012-13
y = 1.0827x + 15.044
R² = 0.8942
y = -0.0131x² + 2.3383x + 6.0773
R² = 0.9355
150
100
50
0
0
20
40
60
80
100
120



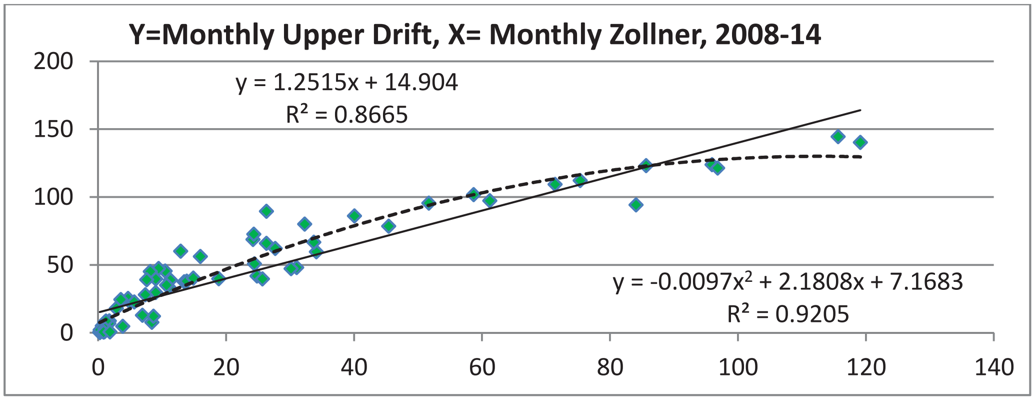


Table 5.2 summarizes the values of the correlation indicator R^2 obtained through the polynomial order 2 scatter plots, linking Upper Drift Creek data to equivalent data at other nearby streams. For each water year, the highest values are shown in bold and the lowest, in italics. As expected, the flows recorded at the lower Hibbard Road gauge yield the highest R^2 values. The lowest values of R^2 apply to the flows of Zollner Creek @ Monitor.

Table 5.2 Monthly Correlation Factor R^2 (order 2 polynomial trend line)
(Upper Drift vs. Other Nearby Streams)

HY	Abiqua @Silverton	Butte @Monitor	Lower Drift	Pudding @Aurora	Pudding @Woodburn	Silver @Silverton	Zollner @Mt. Angel
DAILY FLOWS							
2008-09	0.8714	**0.9563**	0.9560	*0.8064*	0.8112	0.8902	0.8765
2009-10	0.9295	0.9499	**0.9871**	0.8794	0.8991	0.9657	*0.7614*
2010-11	0.9161	0.9029	**0.9816**	0.8659	0.8803	0.9495	*0.8038*
2011-12				*0.7198*	0.7342		**0.778**
2012-13				0.8398	**0.8562**		*0.7699*
2013-14				0.8958	**0.9107**		*0.868*
2008-11	0.8729	0.9143	**0.9558**	0.8402	0.8579	0.9176	*0.7649*
2008-14				0.8111	**0.8249**		*0.7585*

MONTHLY FLOWS							
2008-09	0.926	0.9762	**0.9973**	0.9849	0.9848	0.9346	*0.9065*
2009-10	0.9902	0.991	**0.9936**	0.9905	0.9912	**0.9936**	*0.8467*
2010-11	0.9813	0.9701	**0.9919**	0.9857	0.9881	0.9845	*0.9488*
2011-12				**0.9776**	0.9753		*0.9632*
2012-13				0.9842	**0.9895**		*0.9355*
2013-14				**0.9949**	0.9946		*0.945*
2008-11	0.9368	0.9602	**0.9861**	0.9775	0.9828	0.9603	*0.909*
2008-14				**0.9793**	0.9768		*0.9205*

The best correlation indicators R^2 based on the three years of records (Oct. 2008 – Sep. 2011) are listed in Table 5.3. The ranking of these indicators help define the best gauging sites that could be used to generate more flow data for Upper Drift Creek, if the gauging stations involved continue to be operated without any problems.

Table 5.3 Station Ranking Based on Best Correlation Indicators
(Oct. 2008 – Sep. 2011 Stream Flows)

Ranking for **Daily** Flows	Daily Flows Correlation Indicator R^2	Ranking for **Monthly** Flows	Monthly Flows Correlation Indicator R^2
1. Drift Creek @ Hibbard Rd.	0.9558	1. Drift Creek @ Hibbard Rd	0.9862
2. Silver @ Silverton	0.9176	2. Pudding @ Woodburn	0.9823
3. Butte @ Monitor.	0.9143	3. Pudding @ Aurora	0.9793
4. Abiqua@ G.H. Bridge	0.8729	4. Butte @ Monitor	0.9604
5. Pudding @ Woodburn	0.8579	5. Silver@ Silverton	0.9566
6. Pudding @ Aurora	0.8402	6. Abiqua @ G.H. Bridge	0.9376
7. Zollner @ Mt. Angel	0.7649	7. Zollner @ Mt. Angel	0.8804

The above station ranking is based only on Oct. 2008 – Sep. 2011 stream flow data. Since the main practical purposes of the hydrologic runoff yield study is to develop more historical runoff data for Drift Creek, the selection of the ultimate station to be used as data generation index should also account for the length of the records collected (preferably in the most recent past) at that station. As of mid-November 2014, data availability is listed in Table 5.4 (which is an update of Table 3.1).

Table 5.4 Stream Gages, Drainage Areas, Period of Records and Number of Years (as of mid-November 2014)

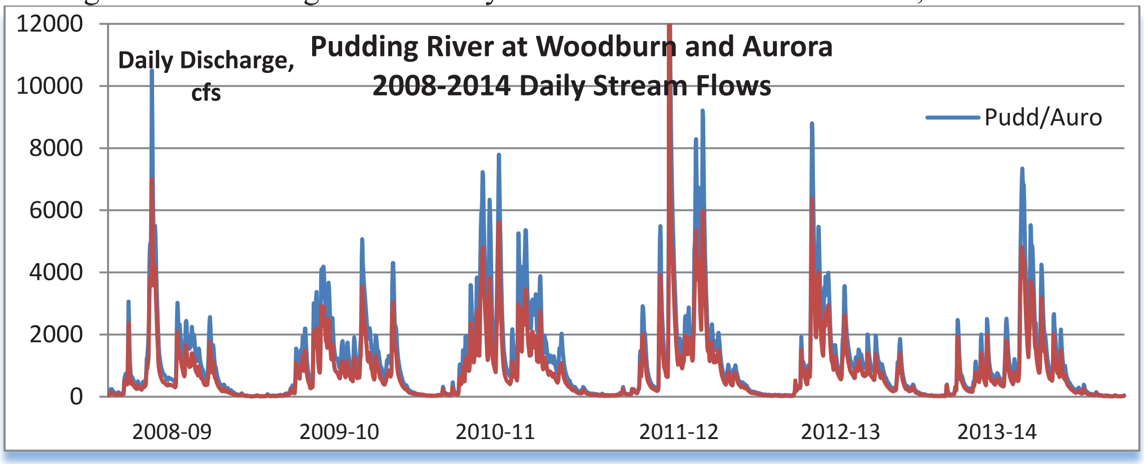
USGS Site Number	Site Name and Location	Drainage Area, sq. mi. (Multiple of Drift Cr. Site A)	Record Period	Number of years
14200300	Silver Creek At Silverton	47.9 (3.03)	1963-1969 and 1970-1979, 2008-2011, 2014 (Jun-Oct)	20
14200400	Little Abiqua Creek Near Scotts Mills	9.81 (0.62)	1993-2004, 2014 (Jun-Oct)	13
(*)	Lower Abiqua at Gallon House Bridge	75.7 (4.92)	2008-2011	3
14201000	Pudding River Near Mt. Angel	203 (12.85)	1939-1966	28
14201300	Zollner Creek Near Mt. Angel	15.0 (0.95)	1993-2008- to date	21
14201340	Pudding River Near Woodburn	314 (19.87)	1997-2008, 2009- to date	17
14202000	Pudding River Near Aurora	479 (30.32)	1928-1963, 1994-1997, and 2002 to date	54
14201500	Butte Creek at Monitor	58.70 (3.72)	1936-1985, 2008-11, 2014(Jan-Oct)	55
(**)	Drift Cr. @ Victor Point Rd	15.8 (1.00)	2008- to date	6
(*)	Drift Cr. @ Hibbard Rd. Bridge	24.8 (1.57)	2008-2011, May 2014 to date	4

(*) Stations operated by Marion Co. Soil & Conservation District (**) Station operated by EVWD's Contractor

Current focus is on number of years of records, relative drainage sizes, and status of the recording gauge (active vs. discontinued). In that context, the Pudding River is the stream with the longest records. Of the two Pudding River recording sites that are still active (Aurora and Woodburn), the Aurora gauge has by far the longer period of record of the two sites: 54 years of actual flows (as of mid-October 2014 and potentially 28 years of additional reconstituted flows between 1963 and 1993). Considering that their R^2 values are not that much different, the data from the Aurora site are more advantageous to use because they cover a longer period of records and, hence, a wider range of run-off conditions.

Daily stream flow hydrographs for the Pudding River at Woodburn and Aurora for the 2008 through 2014 hydrologic years are plotted in Figure 5.27, followed by a scatter plot showing the correlation between daily stream flows at those two sites. The high correlation R^2 values (0.9846 for linear regression and 0.9886 for the polynomial order 2 regression) strongly support the use of stream flow data recorded at Woodburn to fill in any previous data gaps of Pudding River at Aurora, if and when needed.

Figure 5.27 Pudding River's Daily Flows at Woodburn and Aurora, 2008-2014



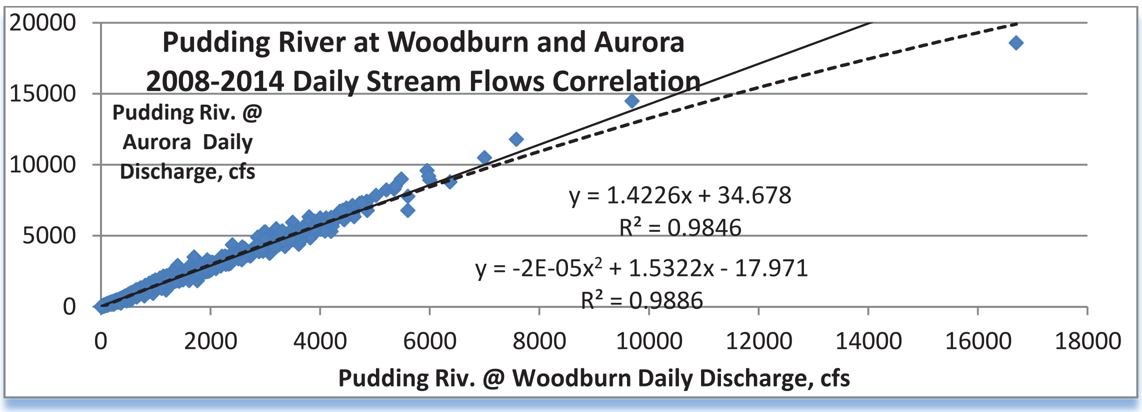


Table 5.5 contains the 2008-14 mean monthly discharges of the Pudding River near Aurora. The median annual runoff volume at that site, based on 52 years of stream flow measurements between 1928 and 2014, (excluding 1965-65 and 1997-98, which contain data gaps), is about 894,000 AF.

Table 5.5 Pudding River at Aurora Mean Monthly Discharges (cfs)

Hydro Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Au g	Sep	*Annual Ave.*
2008-09	132.6	767.8	1110.1	3281.8	830.1	1810.3	1174.8	1117.8	247.3	57.8	21.6	36.9	882.41
2009-10	99.8	1179.6	1508.2	2843.5	1287.6	1452.1	2252.3	1069.2	1644.8	183.7	49.3	90.1	1138.36
2010-11	275.9	1857.3	4141.0	3344.2	1109.6	3538.7	2467.0	1184.6	798.2	207.9	83.9	50.6	1588.25
2011-12	107.3	950.1	829.6	4723.2	1944.5	4085.5	3065.7	1056.1	596.0	203.7	66.7	49.9	1473.18
2012-13	307.2	2577.6	3382.9	1502.1	1442.6	1219.0	1025.7	615.7	455.9	106.3	32.7	203.0	1072.57
2013-14	664.2	844.3	898.9	1040.7	3492.2	2885.2	1640.5	997.3	253.9	116.5	32.7	34.1	1075.06

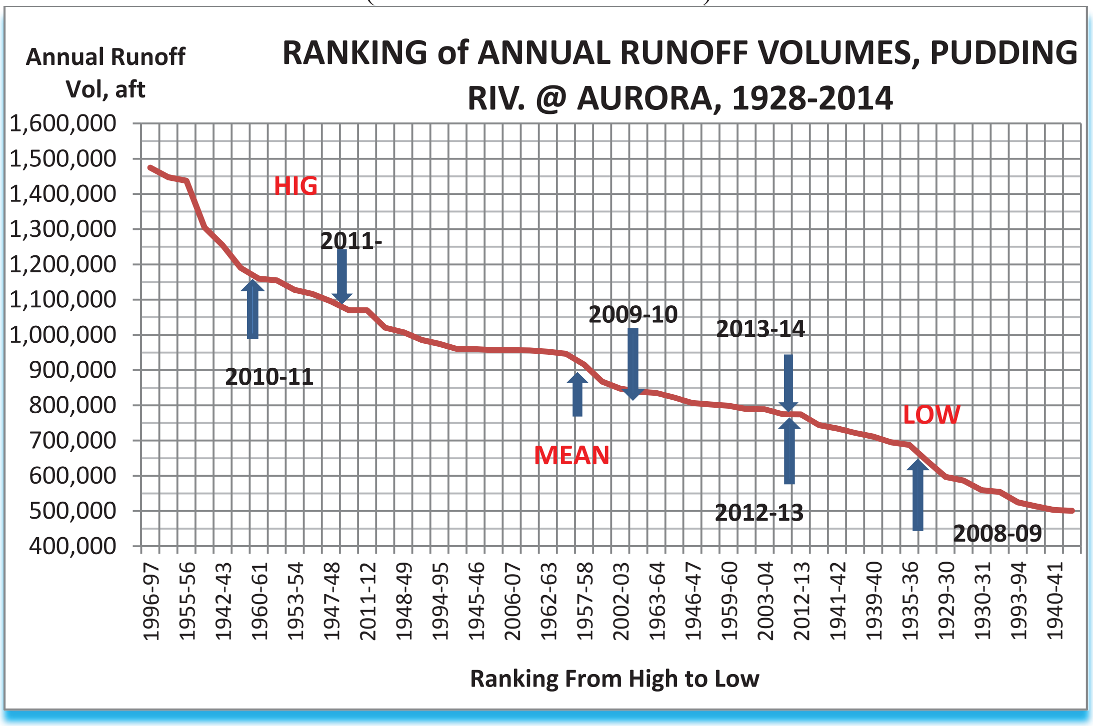
A relevant question is, how does the runoff of the last six hydrologic years (2008-2014) compare with other runoff years, based on the historical records of Pudding River @ Aurora going as far back as 1928? The answer to this question is provided in Table 5.6, based on the ranking of the annual runoff years. With an annual runoff volume of 641,582 AF at that site, the October 2008-September 2009 hydrologic year would rank 44rd in the existing 52 year record period. By the same token, the 821,837 AF volume for 2009-10 would rank 30th, and the 1,154,752 AF volume for 2010-11 would rank 8th. For the last three water years, the 2011-12 annual runoff volume of 1,069,775 AF would rank 13th, the 2012-13 annual runoff volume of 774,173 AF would rank 37th, and the 2013-14 annual runoff volume of 766,771 AF would rank 36th. See Table 5.6 and Figure 5.28.

Table 5.6 Pudding River at Aurora: Annual Runoff Volume Ranking
(as of mid-October 2014)

Ranking	Annual Runoff Volume (AF)	Hydrologic Year (Oct-Sep)	Runoff Size		Ranking	Annual Runoff Volume (AF)	Hydrolo-gic Year (Oct-Sep)	Runoff Size
1	1,474,450	1996-97			27	847,532	2002-03	
2	1,447,386	1995-96			28	839,022	1934-35	
3	1,437,398	1955-56			29	835,282	1963-64	
4	1,304,908	1950-51			30	821,837	2009-10	
5	1,254,722	1942-43			31	806,562	1946-47	
6	1,190,121	1937-38			32	802,527	1954-55	
7	1,159,557	1960-61			33	799,099	1959-60	
8	1,154,752	2010-11			34	789,243	1961-62	
9	1,127,442	1953-54	High		35	788,919	2003-04	
10	1,115,792	1949-50			36	774,173	2012-13	
11	1,095,130	1947-48			37	766,771	2013-14	
12	1,069,919	2005-06			38	743,883	1936-37	
13	1,069,775	2011-12			39	734,391	1941-42	
14	1,020,183	1932-33			40	721,816	1956-57	
15	1,007,579	1948-49			41	711,335	1939-40	
16	985,724	1931-32			42	695,169	1944-45	Low
17	974,484	1994-95			43	687,904	1935-36	
18	959,376	1952-53			44	641,582	2008-09	
19	959,325	1945-46			45	596,992	1929-30	
20	956,901	1951-52			46	586,594	1938-39	
21	956,679	2006-07			47	559,244	1930-31	
22	955,863	2007-08			48	554,344	1928-29	
23	952,064	1962-63			49	525,012	1993-94	
24	946,422	1958-59			50	513,563	1943-44	
25	916,004	1957-58			51	502,791	1940-41	
26	867,553	1933-34	Ave		52	500,823	2004-05	

Ave.=1 to 52 894,056 AF

Figure 5.28 Ranking of Annual Stream Flow Volumes of the Pudding River @ Aurora (based on 1928-2014 Data)



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Because of the close relationship between the runoff of the Pudding River near Aurora and Upper Drift Creek, the above information shed some light on the long-term runoff conditions at the proposed project site. Of the last six water years, two of them (2010-11 and 2011-12) witness fairly high runoff amounts, three (2009-10, 2012-13, and 2013-14) experienced slightly below average runoff, and one (2008-09) was considerably below the average.

Another important consideration is the October-April runoff volume. Table 5.7 contains a list of data related to Pudding River near Aurora and Drift Creek at the project site. This information provides some indications on the range of runoff volume expected at the project on a long-term perspective.

Table 5.7 October-April Runoff Volume, Pudding River and Upper Drift

Water Year	Oct-Apr Runoff Vol., Upper Drift Creek (1)	Oct-Apr Runoff Vol., Pudding @Aurora (2)	Upper Drift Vol./ Pudding@Aurora Vol.
2008-09	19,159	551,075	0.0347
2009-10	25,601	638,574	0.0401
2010-11	32,049	1,013,493	0.0316
2011-12	31,419	949,805	0.0331
2012-13	24,102	688,577	0.0350
2013-14	23,235	679,148	0.0342
2008-14	25,928	753,445	0.0348
1928-14	*(28,000)**	805,999	

Using the average volume ratio of 0.0348 and the 52-year (within the 1928-2014 period) average October-April for Pudding River @ Aurora of 805,999 AF, the expected long-term October-April runoff volume average at Upper Drift site would be about 28,000 AF. This average ratio of 0.0348 is close to the drainage area ratio for the two basins involved: [15.4 sq. mi. /479 sq. mi.]= 0.03215. The relatively minor difference between 0.0348 and 0.03215 is to be expected given the fact that, according to the normal annual precipitation map for the Pudding watershed, more rainfall is expected to fall each year over Drift Creek's watershed than over Pudding River's watershed. On the other hand, because of its much larger drainage area, Pudding River probably has a larger baseflow than Drift Creek.

As stated earlier**,** review of the 2008-2014 stream flow data at Upper Drift Creek and other nearby streams clearly suggested that, in order to extend the runoff records of Upper Drift Creek, the most promising gauging station to concentrate on is the Pudding River near Aurora station, followed by the Pudding River near Woodburn. Therefore, future study efforts will be focused on examining how closely predicted data for Upper Drift Creek based on data collected at those two Pudding River stations match actually observed stream flows.

6. Development of Regression Equations Based on 2008-2014 Data

Regression equations have been developed using the statistical correlation between the flows measured at Pudding River flows at Aurora and Upper Drift Creek flows at Victor Point. This section examines how the generated data for Upper Drift Creek, using order 2 polynomial regression trend based on 2008-2014 data, compare with observed data for the corresponding water year. The regression equations developed so far as plotted in the previous section and using the order 2 polynomial regression trend are listed in Table 6.1, with daily and monthly flow data reconstitution results presented separately.

Table 6.1 Regression Equations Used for Upper Drift Cr.
(based on Pudding Riv. @ Aurora)

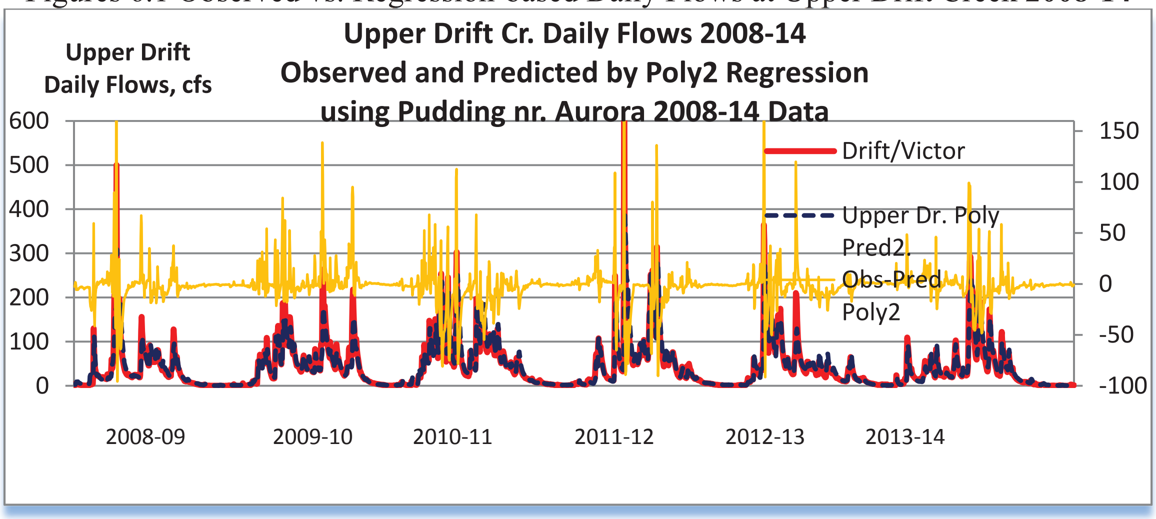
Time Step	Data Base	Regression Equations	R^2
Daily	2008-09	Y=-1E-06X^2+0.0418X-2.1791	0.8064
Daily	2009-10	Y=-6E-07X^2+0.0428X-0.3903	0.8794
Daily	2010-11	Y=-2E-06X^2+0.0379X+0.2981	0.8659
Daily	*2008-11*	*Y=-2E-06X^2+0.0416X-0.8081*	0.8402
Daily	2011-12	Y=-1E-06X^2+0.0389X+1.1204	0.7198
Daily	2012-13	Y=-2E-06X^2+0.0438X-1.8271	0.8398
Daily	2013-14	Y=-6E-07X^2+0.037X+1.0148	0.8958
Daily	*2008-14*	*Y=-1E-06X*2+0.0399X+0.0937*	*0.8111*
Monthly	2008-09	Y=-4E-06X^2+0.0453X-2.1196	0.9849
Monthly	2009-10	Y=-3E-06X^2+0.0475X-1.3567	0.9905
Monthly	2010-11	Y=-3E-06X^2+0.0423X-1.467	0.9857
Monthly	*2008-11*	*Y=-4E-06X^2+0.048X-2.3533*	*0.9793*
Monthly	2011-12	Y=-1E-06X^2+0.0368X+1.9126	0.9776
Monthly	2012-13	Y=4E-07X^2+0.0348X+1.7107	0.9842

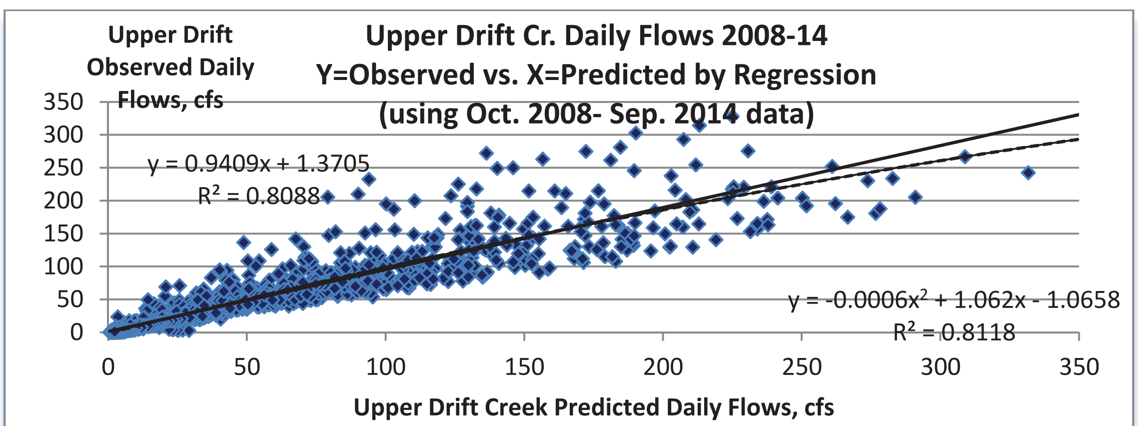
Monthly	2013-14	Y=-1E06X^2+0.0397X -0.1409	0.9949
Monthly	*2008-14*	*Y=-3E-06X^2+0.0431X-0.8109*	*0.9775*

6.1 Daily Flows

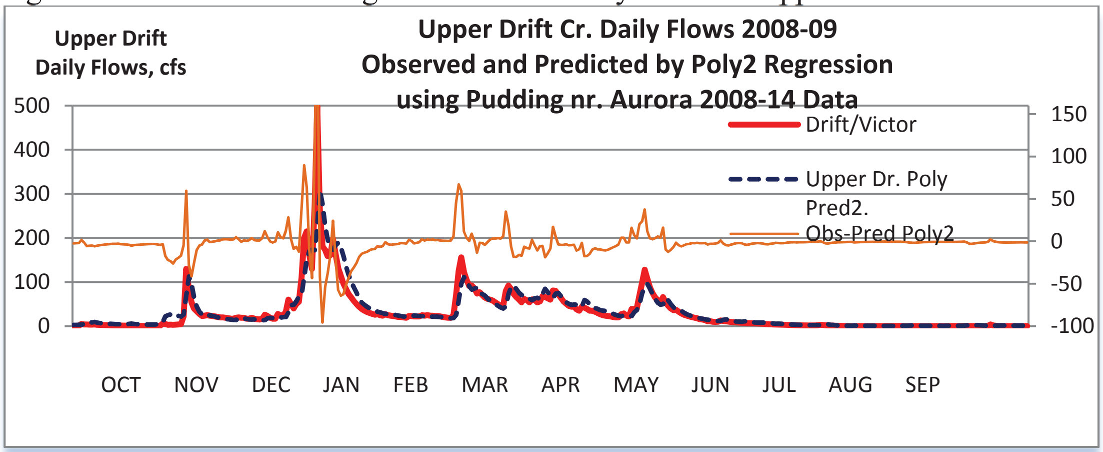
The hydrographs of the Daily Observed vs. Synthesized flows at Upper Drift Creek are plotted on Figure 6.1 for all 2008-14 water years, and on Figure 6.2 through 6.6 for each year of that period. The synthesized daily flows were developed using polynomial order 2 regression equation based on 2008-2014 daily flows of Upper Creek and Pudding River near Aurora (Y= -1E-06X^2 + 0.0399X + 0.0937; see Figure 5.15). The Observed minus Predicted error differences are graphed for each day. In addition, scatter plots of predicted vs. observed stream flows are also shown for each water year, along with the values of the correlation indices R^2.

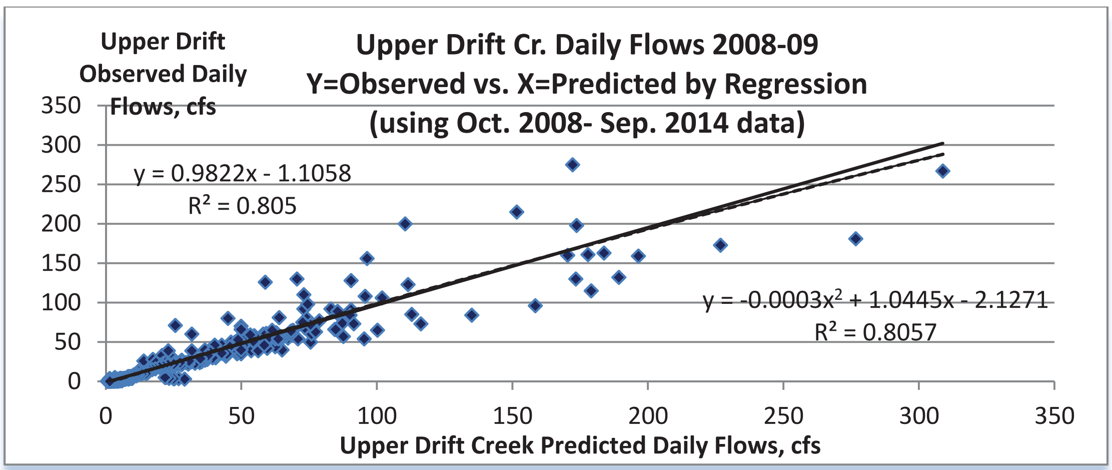
Figures 6.1 Observed vs. Regression-based Daily Flows at Upper Drift Creek **2008-14**



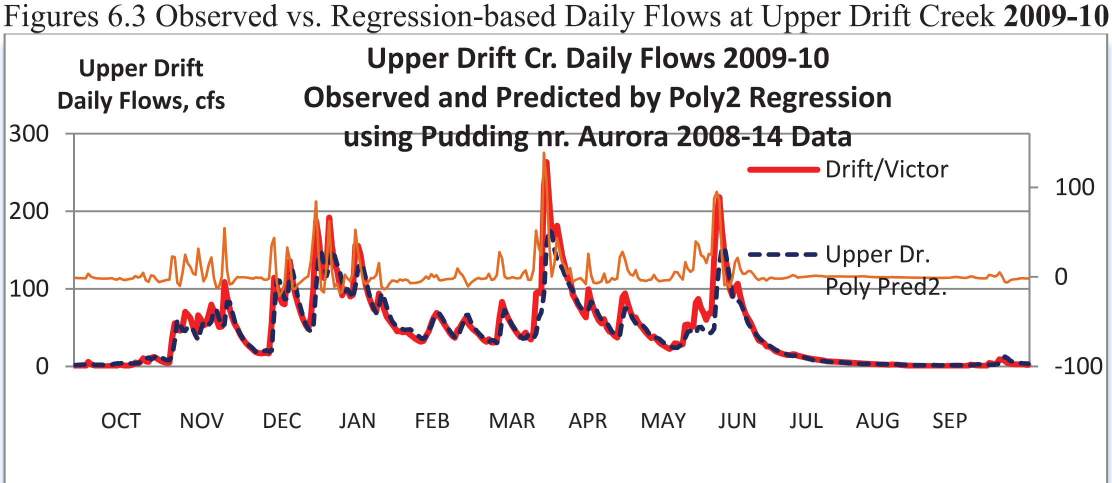


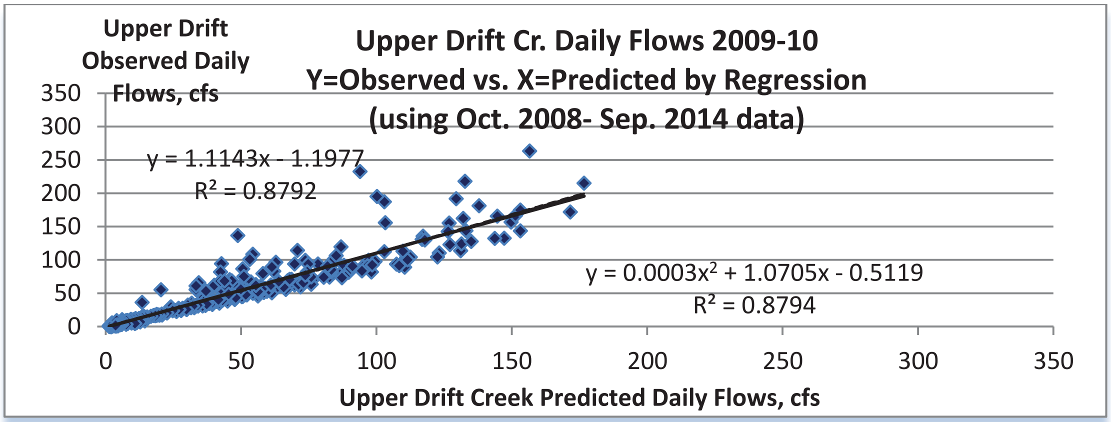
Figures 6.2 Observed vs. Regression-based Daily Flows at Upper Drift Creek **2008-09**



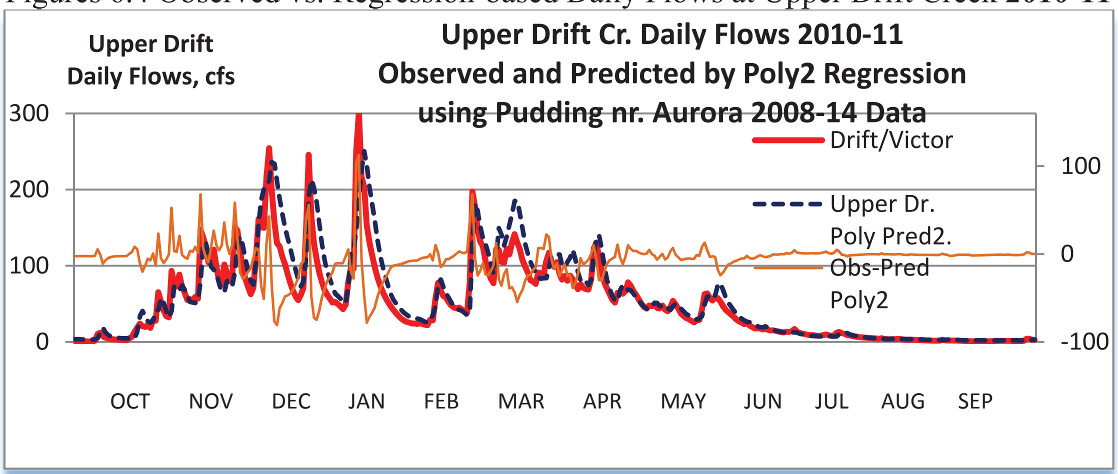


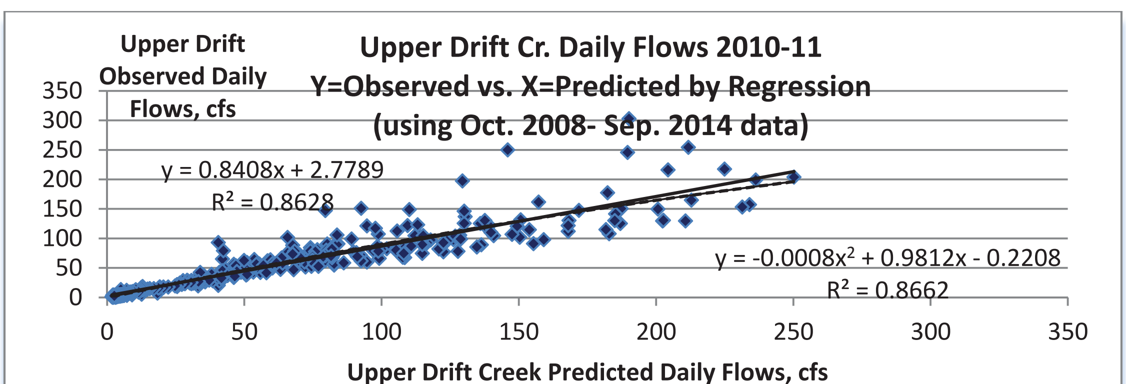
Figures 6.3 Observed vs. Regression-based Daily Flows at Upper Drift Creek **2009-10**



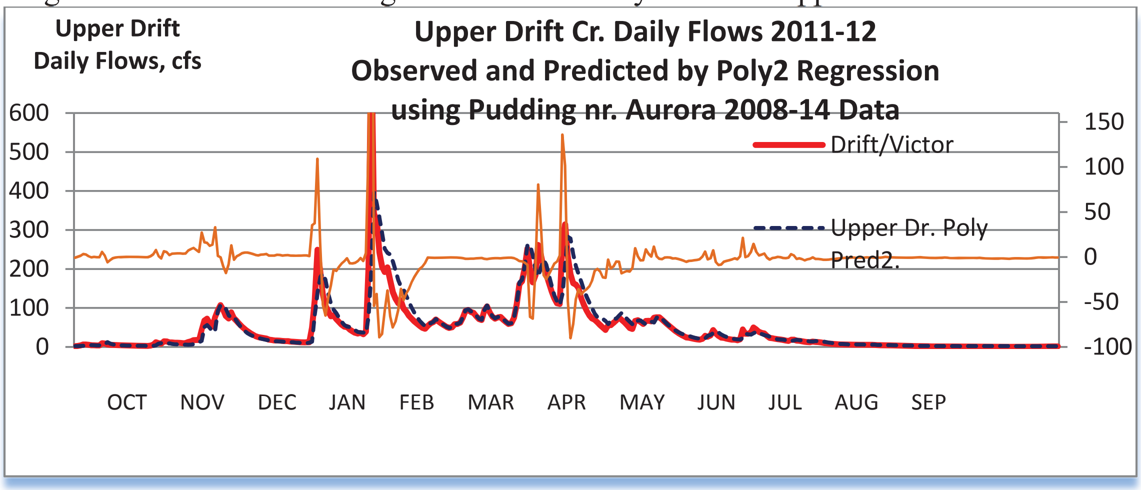


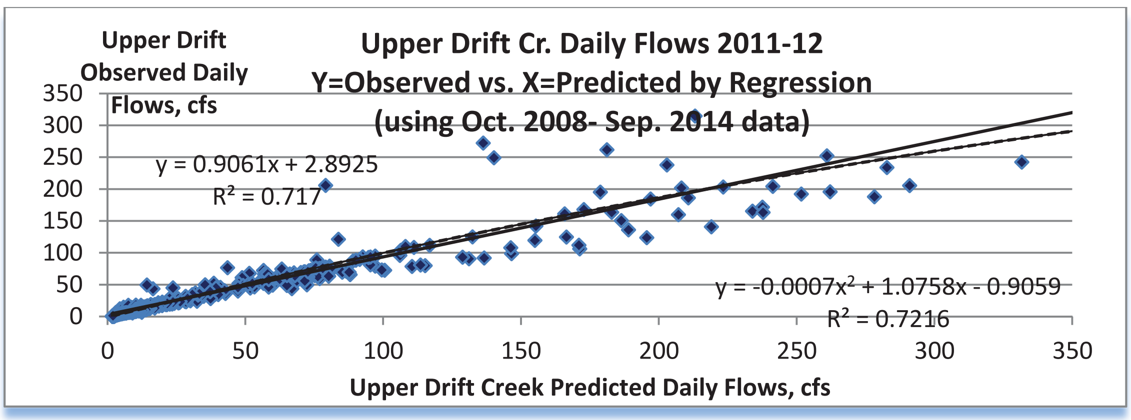
Figures 6.4 Observed vs. Regression-based Daily Flows at Upper Drift Creek **2010-11**



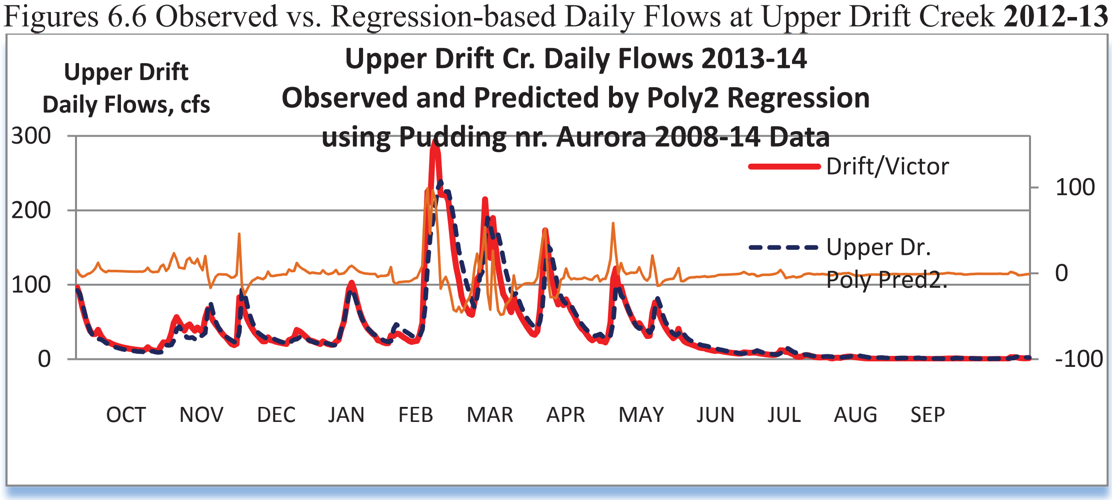


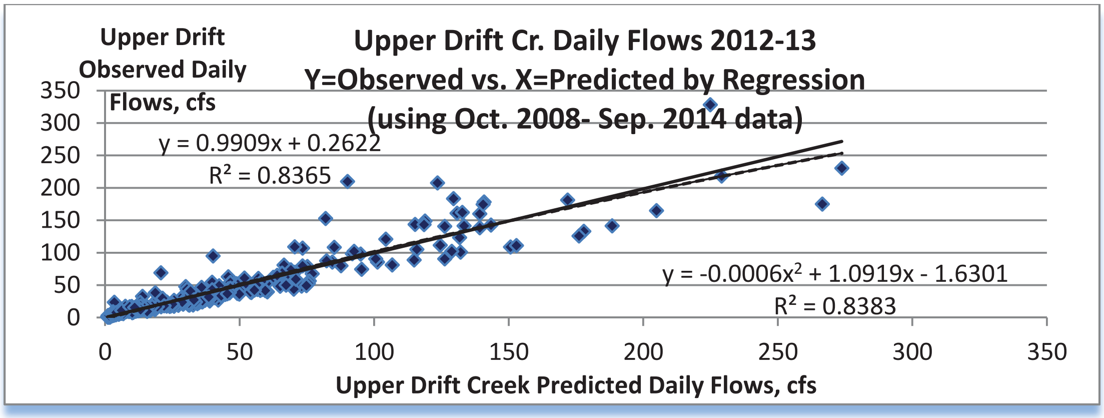
Figures 6.5 Observed vs. Regression-based Daily Flows at Upper Drift Creek **2011-12**



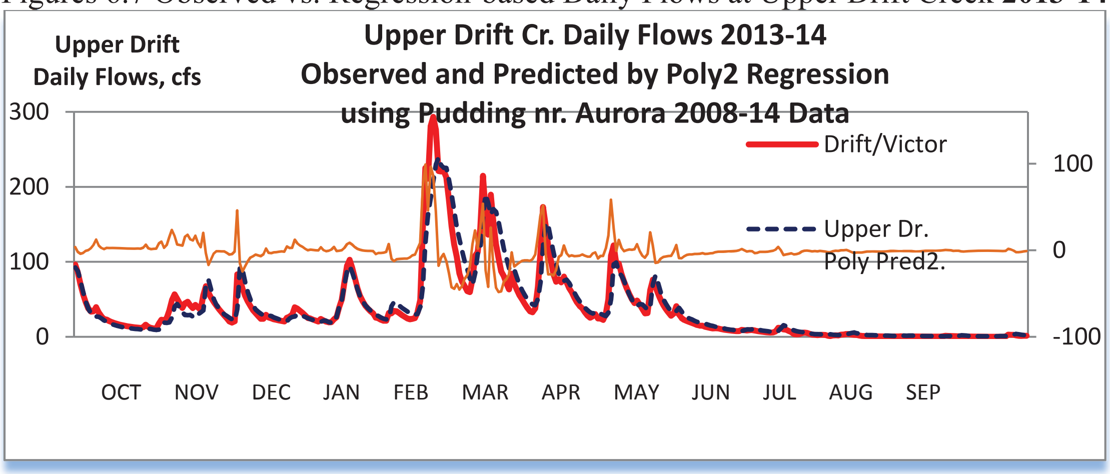


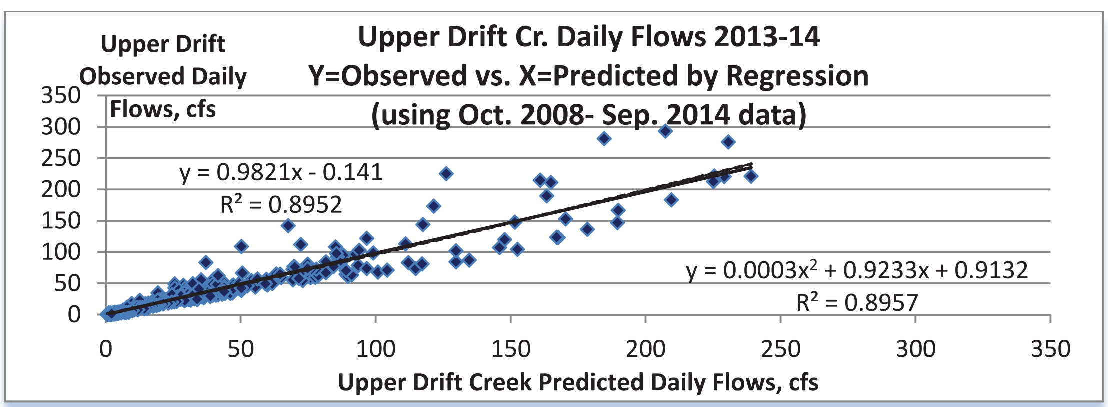
Figures 6.6 Observed vs. Regression-based Daily Flows at Upper Drift Creek **2012-13**





Figures 6.7 Observed vs. Regression-based Daily Flows at Upper Drift Creek **2013-14**





The results of the flows at Upper Drift Creek generated by regression equations involving daily Oct. 2008-2014 data of the Pudding River at Aurora are summarized in Table 6.2 in the condensed form of monthly values, and plotted in Figures 6.8, 6.9, 6.10, 6.11, 6.12 and 6.13. Differences between monthly observed and calculated values are also shown.

Table 6.2. Results of Daily Synthesized Flows (Expressed in Monthly Values)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2008-09Ob	1.83	22.82	48.19	101.87	38.93	65.90	39.73	45.55	7.24	1.35	0.24	0.49
2008-09Pr	5.36	29.70	41.43	113.24	32.03	68.89	45.42	43.07	9.89	2.40	0.96	1.57
Obs-Pr	*-3.54*	*-6.88*	*6.77*	*-11.37*	*6.90*	*-2.99*	*-5.69*	*2.48*	*-2.65*	*-1.04*	*-0.72*	*-1.07*
2009-10Ob	2.84	50.84	59.66	109.37	47.32	68.76	89.62	47.43	72.70	7.90	1.38	2.71
2009-10Pr	4.06	45.43	57.12	104.85	49.74	55.02	83.94	41.81	62.74	7.38	2.06	3.67
Obs-Pr	*-1.22*	*5.41*	*2.55*	*4.52*	*-2.42*	*13.74*	*5.68*	*5.62*	*9.96*	*0.52*	*-0.68*	*-0.96*
2010-11Ob	7.79	78.55	123.90	95.62	39.89	112.20	80.17	45.24	25.35	8.86	2.69	1.33
2010-11Pr	10.95	70.27	145.41	118.95	42.98	127.80	91.98	45.90	31.04	8.34	3.44	2.11
Obs-Pr	*-3.16*	*8.27*	*-21.50*	*-23.33*	*-3.09*	*-15.60*	*-11.81*	*-0.66*	*-5.68*	*0.51*	*-0.75*	*-0.78*
2011-12Ob	4.83	41.86	39.81	140.27	66.83	144.60	86.17	39.21	24.52	6.98	1.87	0.80
2011-12Pr	4.36	36.21	31.37	148.63	73.58	142.20	108.32	40.89	23.48	8.17	2.75	2.08
Obs-Pr	*0.47*	*5.65*	*8.44*	*-8.36*	*-6.75*	*2.40*	*-22.15*	*-1.68*	*1.04*	*-1.19*	*-0.88*	*-1.28*
2012-13Ob	12.25	94.24	121.47	62.22	56.23	37.61	29.75	22.76	18.07	5.17	2.22	12.94
2012-13Pr	12.06	89.60	121.08	55.00	55.19	47.27	39.98	24.07	17.99	4.32	1.40	8.05
Obs-Pr	*0.18*	*4.63*	*0.39*	*7.22*	*1.04*	*-9.66*	*-10.23*	*-1.31*	*0.07*	*0.85*	*0.82*	*4.90*
2013-14Ob	28.09	38.15	33.78	40.31	123.21	97.41	60.21	35.19	8.76	3.01	0.53	0.75
2013-14Pr	25.79	32.90	34.90	40.19	121.59	105.10	62.27	38.71	10.16	4.73	1.40	1.45
Obs-Pr	*2.30*	*5.25*	*-1.12*	*0.12*	*1.62*	*-7.69*	*-2.07*	*-3.51*	*-1.40*	*-1.72*	*-0.87*	*-0.70*

Figure 6.8 Plots of Observed vs. Regression-synthesized Daily Flows, **2008-09** (shown on monthly basis)

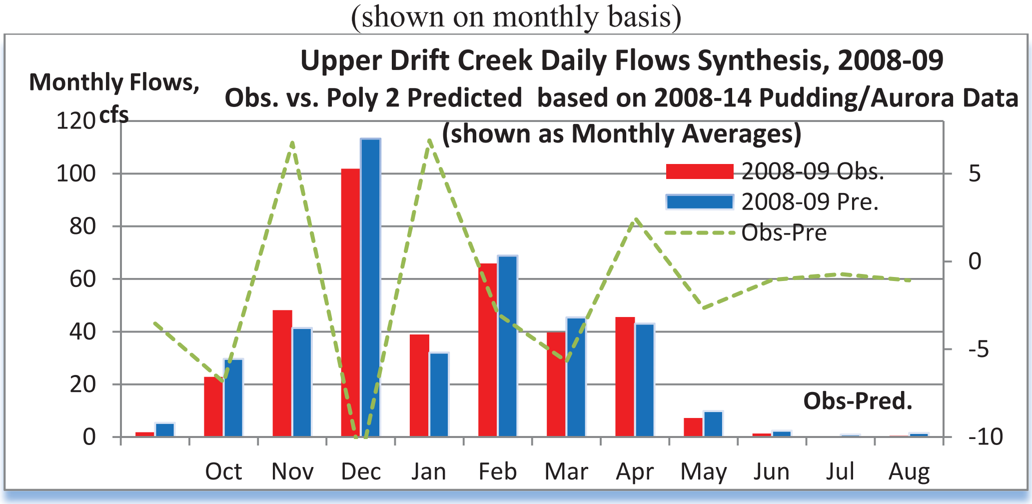


Figure 6.9 Plots of Observed vs. Regression-synthesized Daily Flows, **2009-10** (shown on monthly basis)

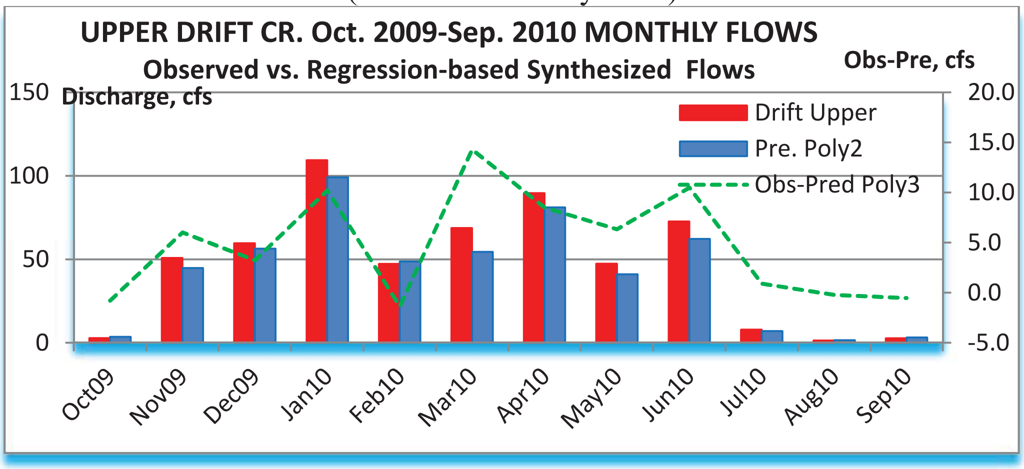


Figure 6.10 Plots of Observed vs. Regression-synthesized Daily Flows, **2010-11** (shown on monthly basis)

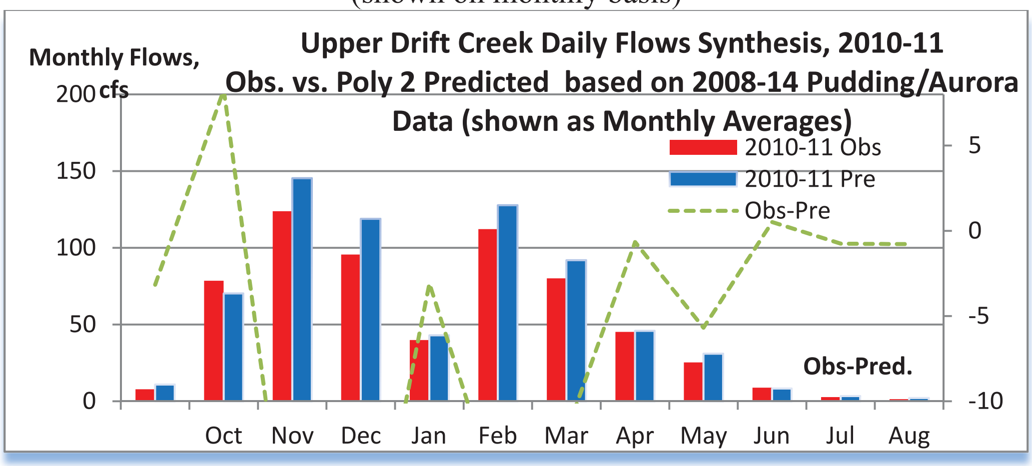


Figure 6.11 Plots of Observed vs. Regression-synthesized Daily Flows, **2011-12** (shown on monthly basis)

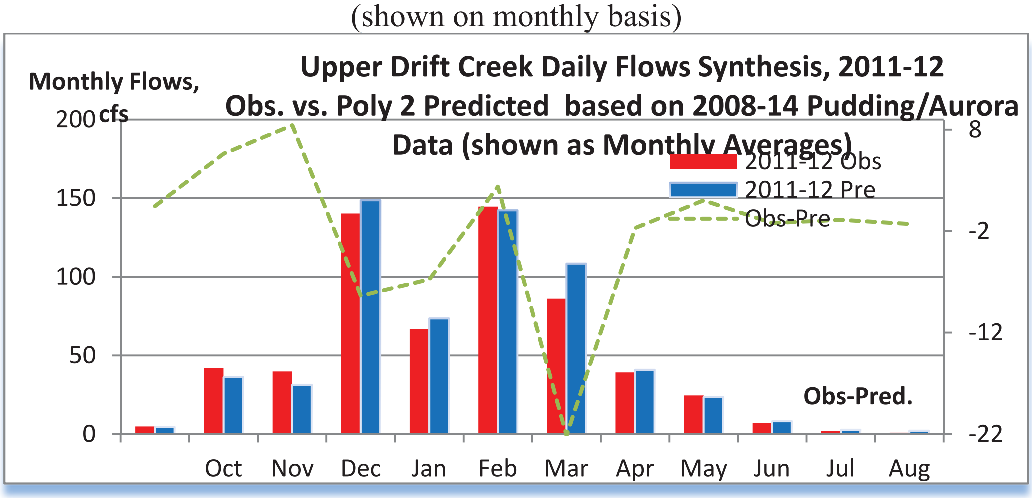


Figure 6.12 Plots of Observed vs. Regression-synthesized Daily Flows, 2012-13 (shown on monthly basis)

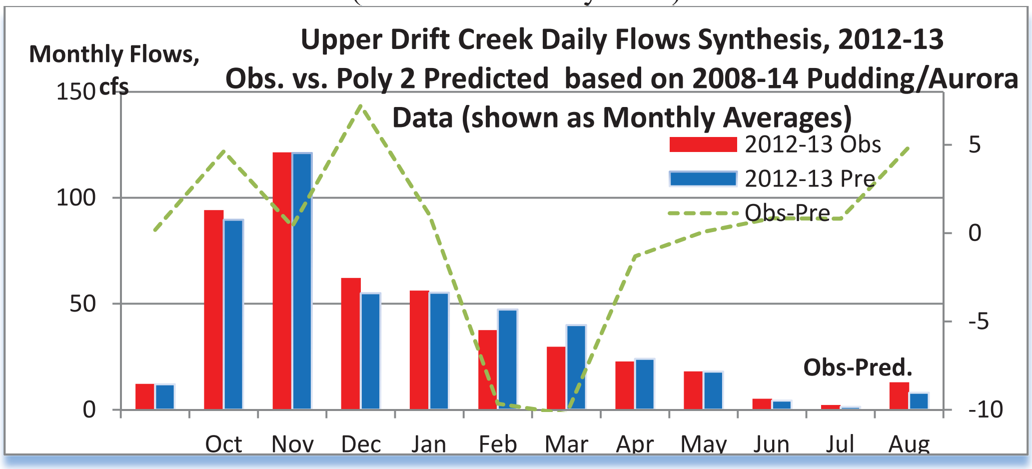
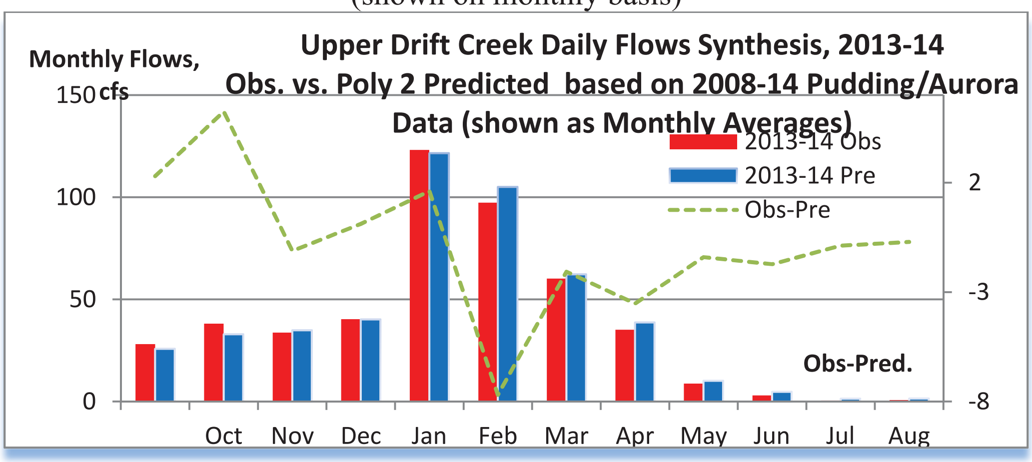
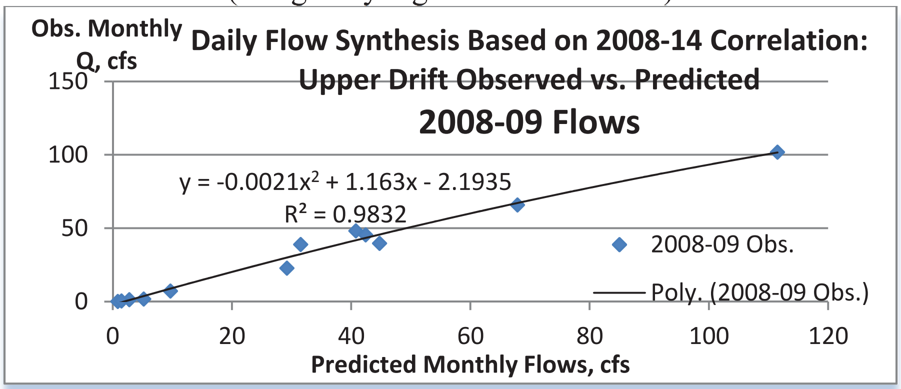


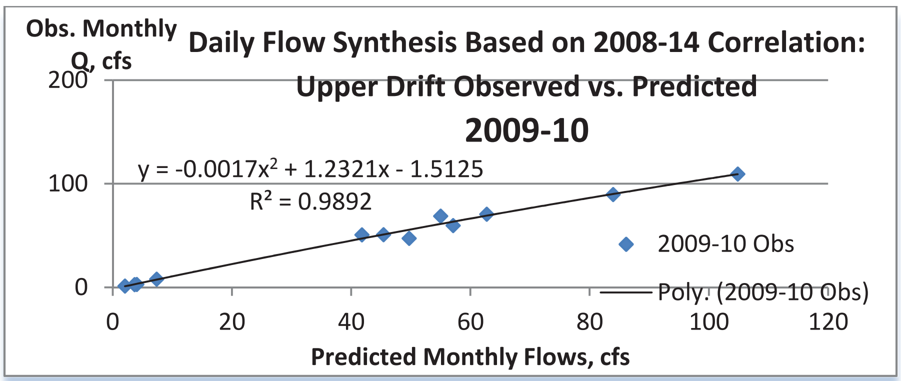
Figure 6.13 Plots of Observed vs. Regression-synthesized Daily Flows, 2013-14 (shown on monthly basis)

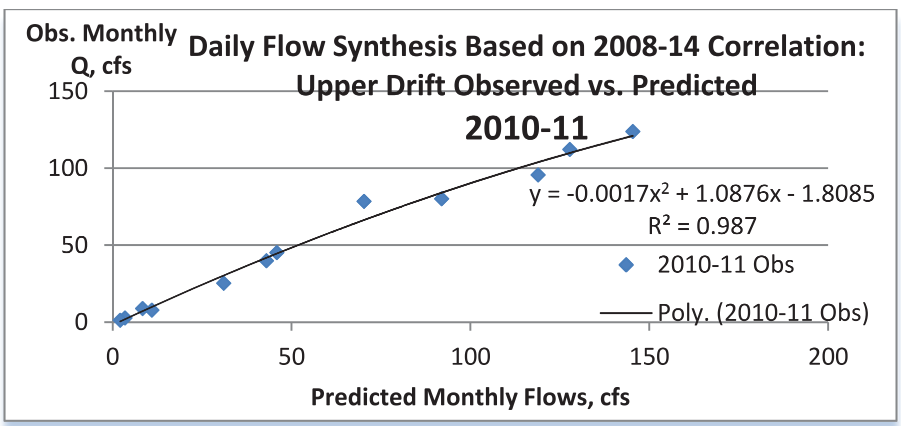


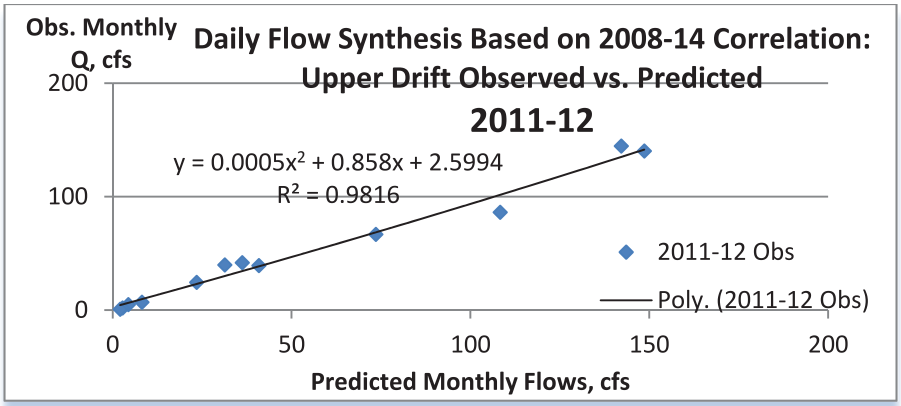
The group of scatter plots for the monthly average flows that were calculated based on daily values reconstituted through regression formulas are shown below in Figure 6.14 for each of the water years of the 2008- 2014 period, and for the entire 6 water years. This information illustrates the (greater) level of prediction accuracy achieved when monthly (instead of daily) values are used.

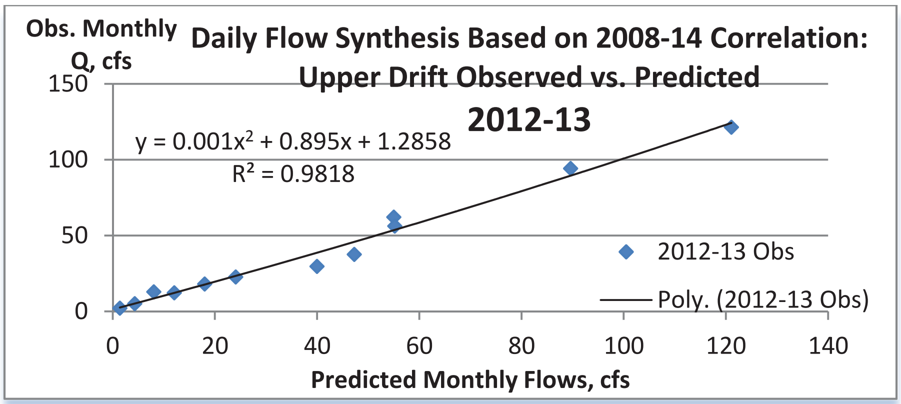
Figures 6.14 Scatter Plots of Observed vs. Calculated Monthly Flows
(using daily regression-based data)

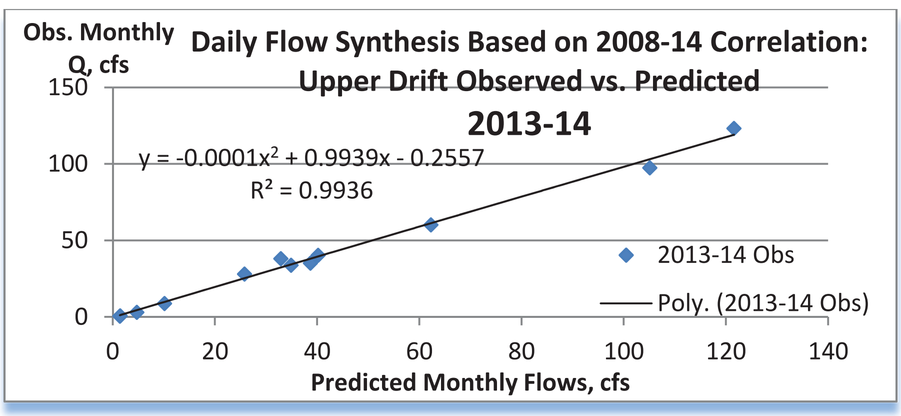


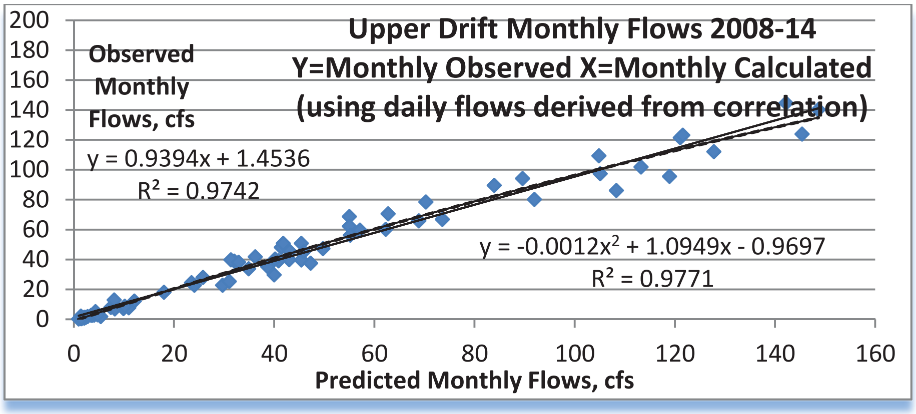





Daily Flow Synthesis Based on 2008-14 Correlation:
Upper Drift Observed vs. Predicted
2011-12
Obs. Monthly Q, cfs
200
100
0
y = 0.0005x² + 0.858x + 2.5994
R² = 0.9816
2011-12 Obs
Poly. (2011-12 Obs)
0
50
100
150
200
Predicted Monthly Flows, cfs


Daily Flow Synthesis Based on 2008-14 Correlation:
Upper Drift Observed vs. Predicted
2012-13
Obs. Monthly Q, cfs
150
100
50
0
y = 0.001x² + 0.895x + 1.2858
R² = 0.9818
2012-13 Obs
Poly. (2012-13 Obs)
0
20
40
60
80
100
120
140
Predicted Monthly Flows, cfs


Daily Flow Synthesis Based on 2008-14 Correlation:
Upper Drift Observed vs. Predicted
2013-14
Obs. Monthly Q, cfs
150
100
50
0
y = -0.0001x² + 0.9939x - 0.2557
R² = 0.9936
2013-14 Obs
Poly. (2013-14 Obs)
0
20
40
60
80
100
120
140
Predicted Monthly Flows, cfs



6.2 Regression-based Monthly Flows

The hydrographs of the **Monthly** Observed vs. Synthesized flows at Upper Drift Creek are plotted on Figures 6.15 through 6.20 for each of the water year during the 2008-14 period. The synthesized monthly flows were developed using polynomial order 2 regression equation based on 2008-2014 monthly flows of Upper Creek and Pudding River near Aurora (Y=-3E06X^2+0.0431X-0.8109; see Figure 5.21). The Observed minus Predicted error differences are also shown for each month.

Figure 6.15 Observed vs. Regression-based Monthly Flows at Upper Drift Creek **2008-09**

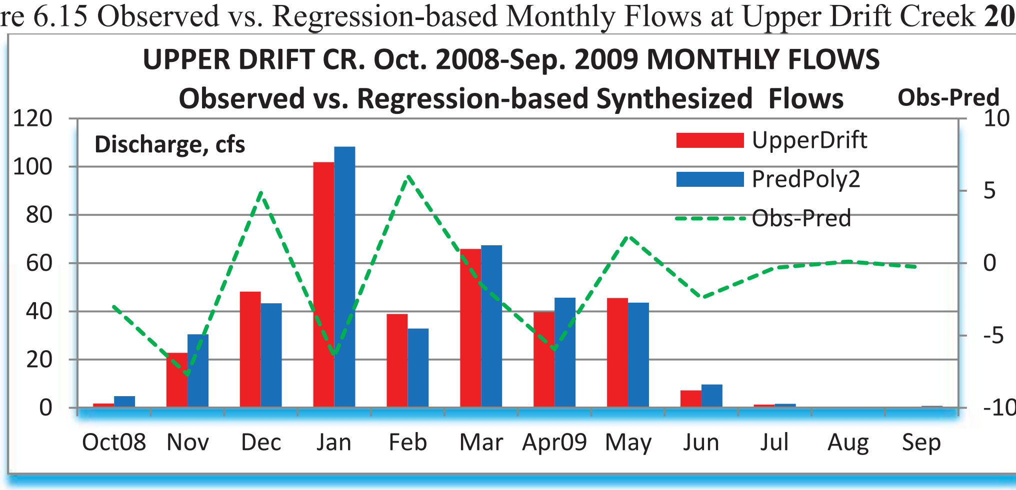


Figure 6.16 Observed vs. Regression-based Monthly Flows at Upper Drift Creek **2009-10**

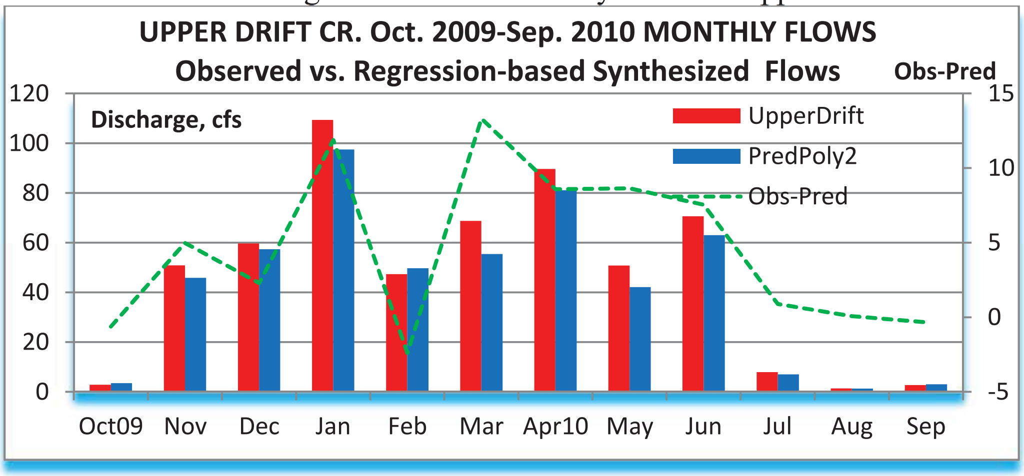


Figure 6.17 Observed vs. Regression-based Monthly Flows at Upper Drift Creek **2010-11**

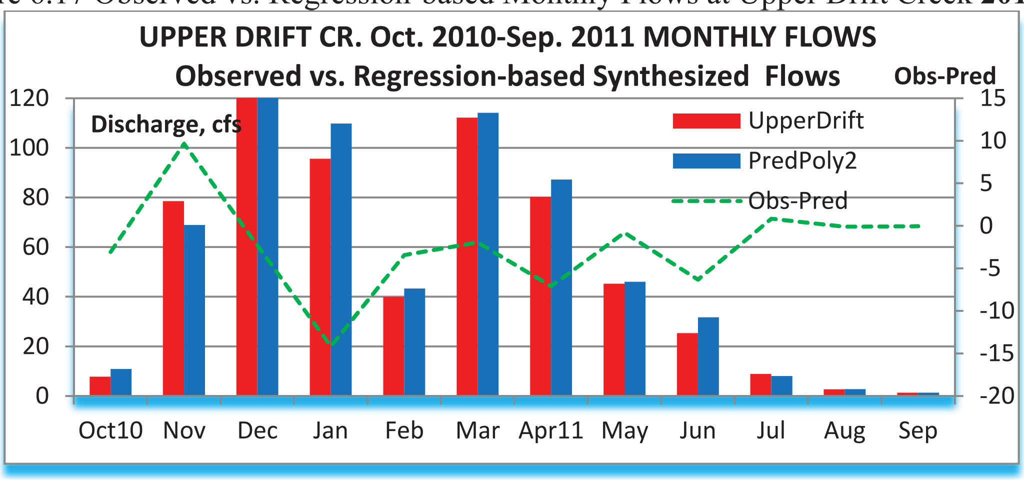


Figure 6.18 Observed vs. Regression-based Monthly Flows at Upper Drift Creek **2011-12**

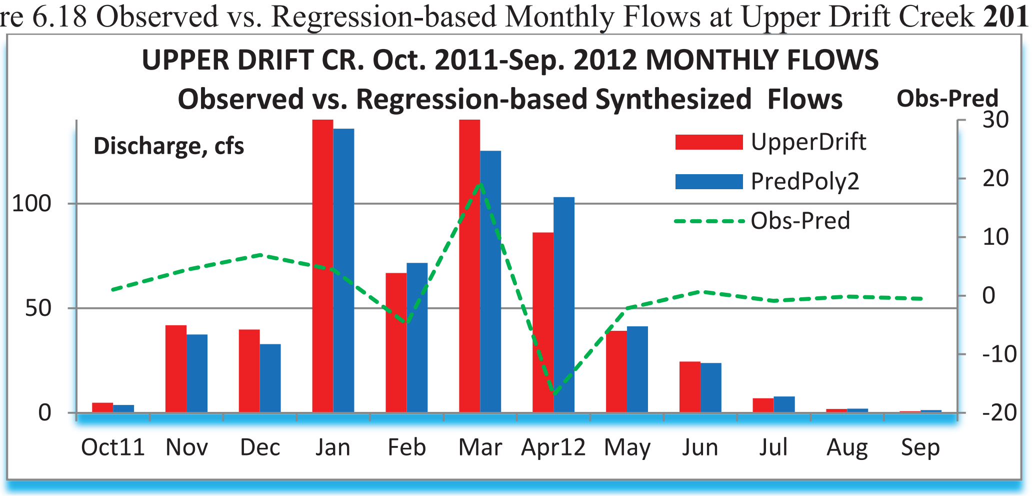


Figure 6.19 Observed vs. Regression-based Monthly Flows at Upper Drift Creek **2012-13**

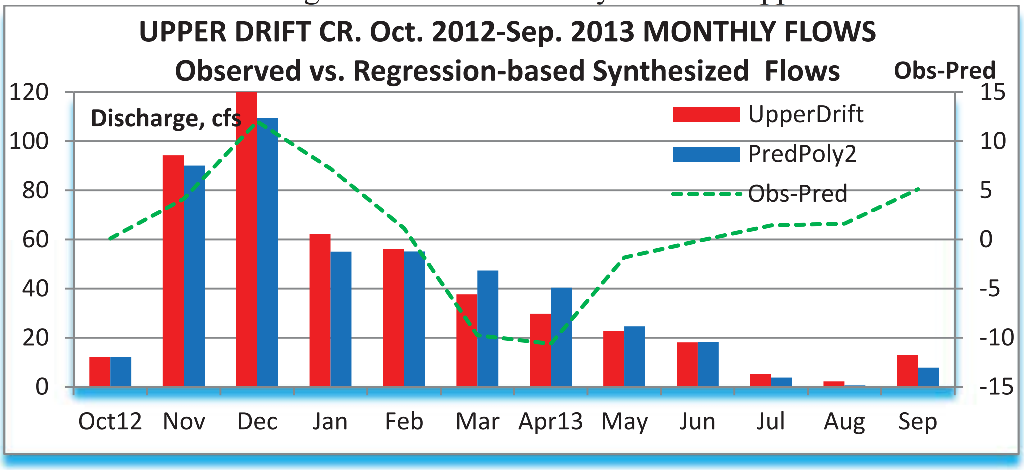
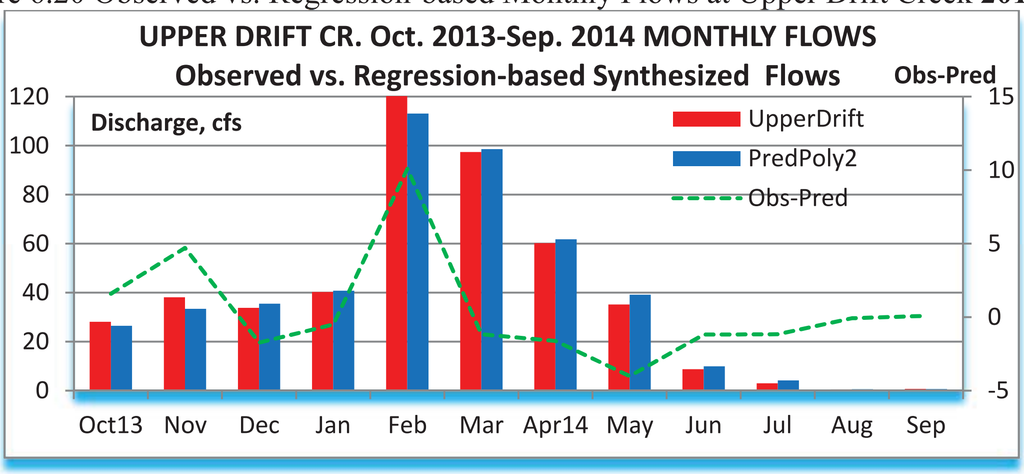


Figure 6.20 Observed vs. Regression-based Monthly Flows at Upper Drift Creek **2013-14**



Figures 6.21 and 6.22 show the same monthly information as above on a multi-year basis and provide an overall view of the prediction errors that result from applying a polynomial order 2 regression equation based on 2008-2014 monthly data.

Figure 6.21 Observed vs. Regression-based Monthly Flows at Upper Drift Creek (2008-14; Observed – Predicted in cfs)

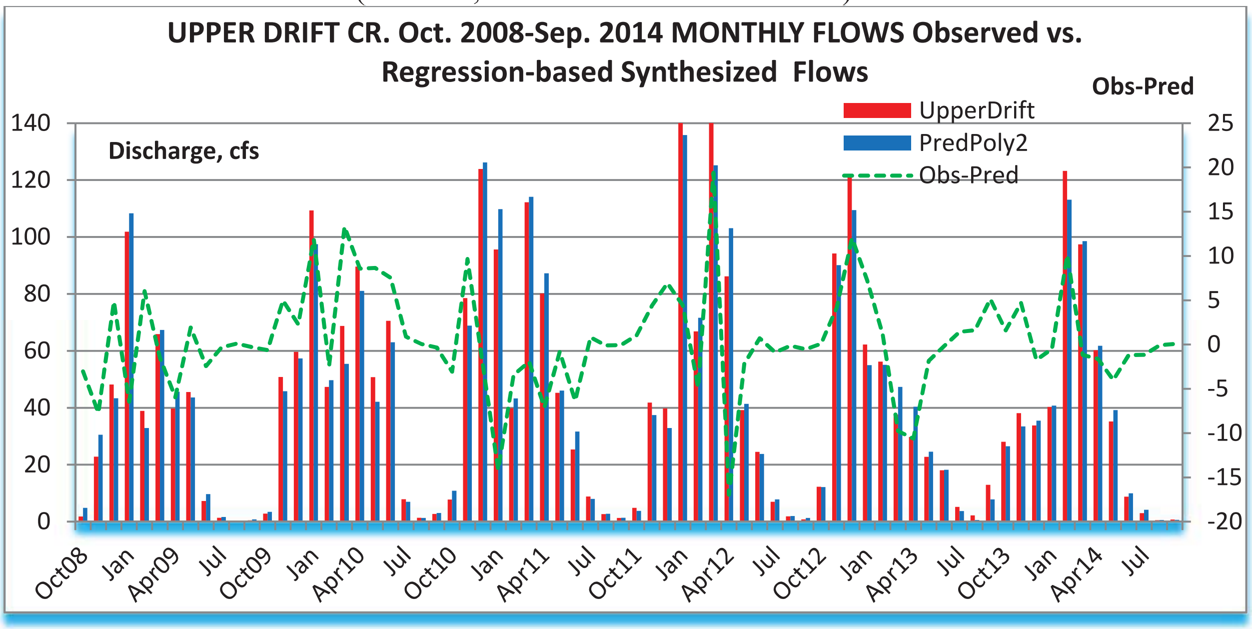
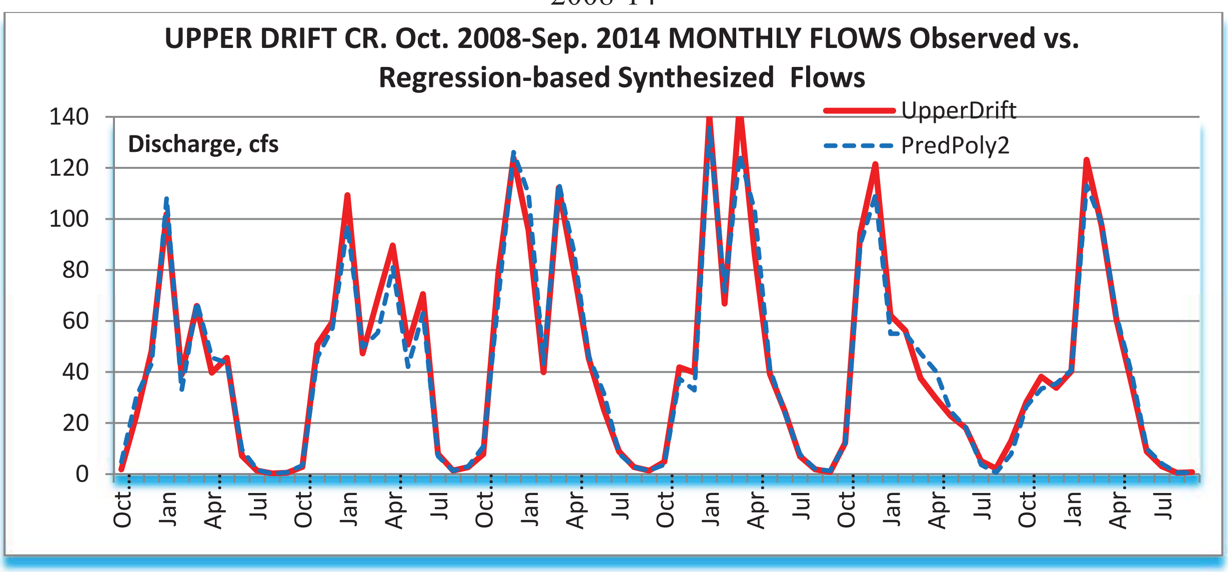
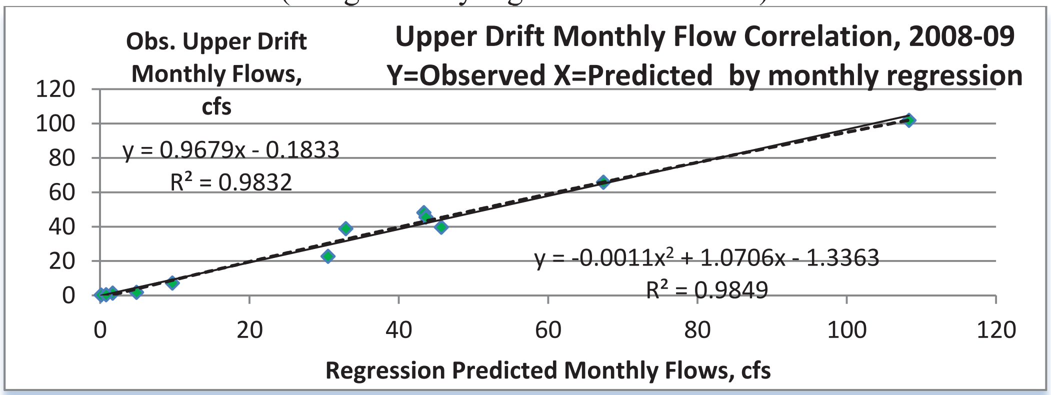


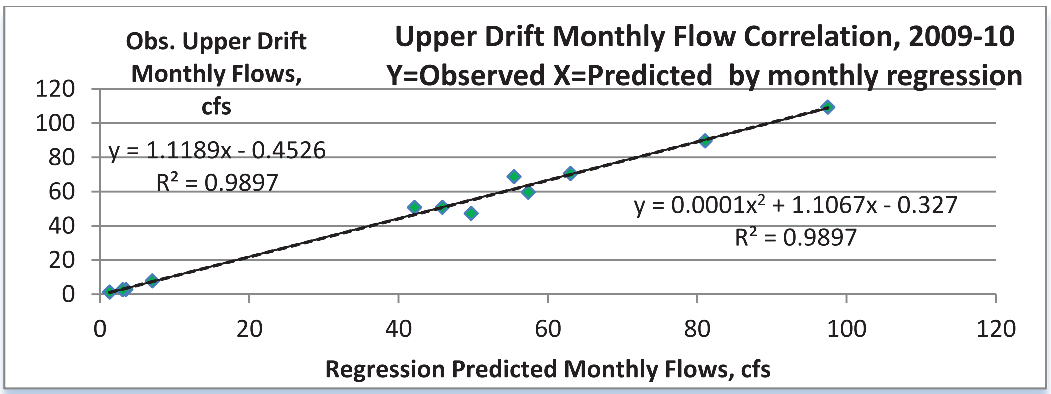
Figure 6.22 Observed vs. Regression-based Monthly Flows at Upper Drift Creek 2008-14

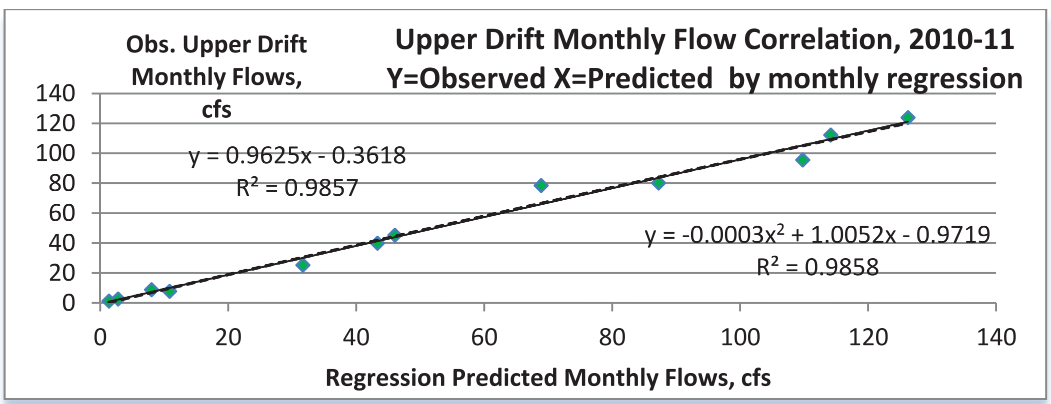


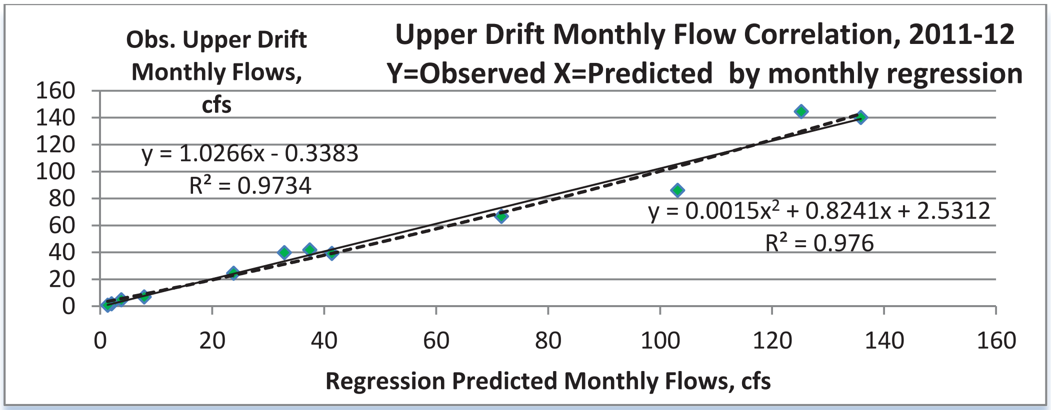
The group of scatter plots for the monthly average flows that were calculated based on monthly values reconstituted through regression formulas are shown below in Figures 6.23 for each of the water years of the 2008 - 2014 period, and for the entire 6 water years. As mentioned earlier, this information shows the greater level of prediction accuracy achieved when monthly results are used instead of daily results.

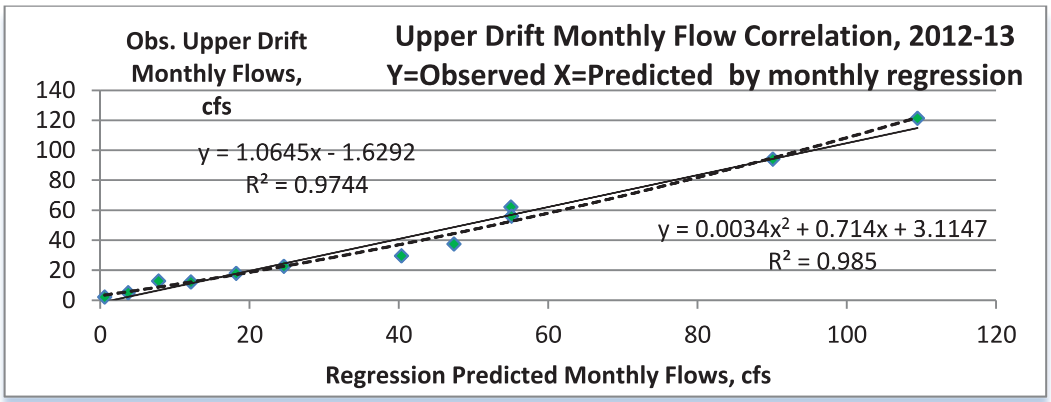
Figures 23. Scatter Plots of Observed vs. Calculated Monthly Flows
(using monthly regression-based data)

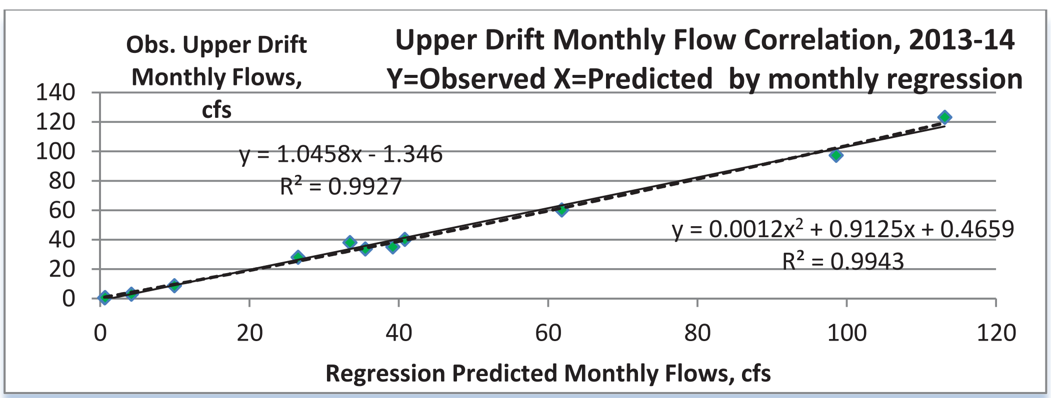


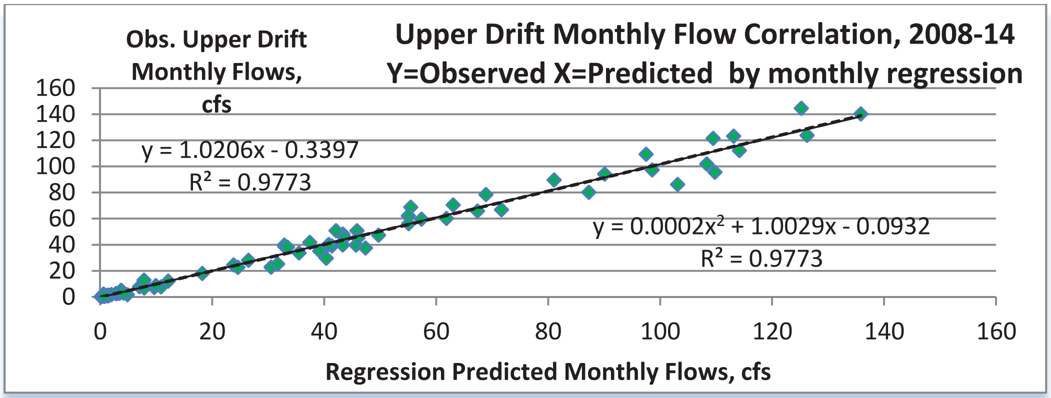





Upper Drift Monthly Flow Correlation, 2011-12
Y=Observed X=Predicted by monthly regression
Obs. Upper Drift Monthly Flows, cfs
y = 1.0266x - 0.3383
R² = 0.9734
y = 0.0015x² + 0.8241x + 2.5312
R² = 0.976
Regression Predicted Monthly Flows, cfs


Upper Drift Monthly Flow Correlation, 2012-13
Y=Observed X=Predicted by monthly regression
Obs. Upper Drift Monthly Flows, cfs
y = 1.0645x - 1.6292
R² = 0.9744
y = 0.0034x² + 0.714x + 3.1147
R² = 0.985
Regression Predicted Monthly Flows, cfs


Upper Drift Monthly Flow Correlation, 2013-14
Y=Observed X=Predicted by monthly regression
Obs. Upper Drift Monthly Flows, cfs
y = 1.0458x - 1.346
R² = 0.9927
y = 0.0012x² + 0.9125x + 0.4659
R² = 0.9943
Regression Predicted Monthly Flows, cfs



6.3 Comparison of Statistically Synthesized Daily and Monthly Flows

The results of the monthly flow synthesis are listed in Table 6.3. Predicted monthly numbers for Upper Drift Creek were derived from application of a polynomial 2 regression equation based on correlation between 2008-14 monthly flow data at Upper Drift and Pudding at Aurora. The table contains an additional line in italics showing the monthly equivalent "Observed minus Synthesized" numbers previously listed in Table 6.2.

Table 6.3. Results of Monthly Synthesized Flows

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2008-09Ob	1.83	22.82	48.19	101.87	38.93	65.90	39.73	45.55	7.24	1.35	0.24	0.49
2008-09Pr	4.85	30.51	43.34	108.32	32.90	67.38	45.68	43.62	9.66	1.67	0.12	0.78
Obs-Pre	-3.02	-7.69	4.86	-6.45	6.03	-1.48	-5.95	1.93	-2.42	-0.32	-0.12	-0.29
2009-10Ob	2.84	50.84	59.66	109.37	47.32	68.76	89.62	50.77	70.57	7.90	1.38	2.71
2009-10Pr	3.46	45.86	57.37	97.49	49.71	55.45	81.05	42.12	63.03	7.01	1.31	3.05
Obs-Pre	-0.62	4.98	2.30	11.88	-2.39	13.31	8.58	8.65	7.55	0.89	0.07	-0.34
2010-11Ob	7.79	78.55	123.90	95.62	39.89	112.20	80.17	45.24	25.35	8.86	2.69	1.33
2010-11Pr	10.85	68.89	126.22	109.77	43.32	114.14	87.26	46.04	31.68	8.02	2.79	1.36
Obs-Pre	-3.06	9.66	-2.32	-14.15	-3.43	-1.94	-7.09	0.80	-6.33	0.83	-0.10	-0.03
2011-12Ob	4.83	41.86	39.81	140.27	66.83	144.60	86.17	39.21	24.52	6.98	1.87	0.80
2011-12Pr	3.78	37.43	32.88	135.83	71.65	125.20	103.12	41.36	23.81	7.84	2.01	1.33
Obs-Pre	1.05	4.43	6.93	4.44	-4.82	19.40	-16.95	-2.15	0.71	-0.86	-0.14	-0.52
2012-13Ob	12.25	94.24	121.47	62.22	56.23	37.61	29.75	22.76	18.07	5.17	2.22	12.94
2012-13Pr	12.15	90.09	109.47	55.02	55.09	47.37	40.36	24.59	18.22	3.74	0.60	7.82
Obs-Pre	0.10	4.14	12.01	7.20	1.14	-9.76	-10.61	-1.84	-0.15	1.43	1.62	5.13
2013-14Ob	28.09	38.15	33.78	40.31	123.21	97.41	60.21	35.19	8.76	3.01	0.53	0.75
2013-14Pr	26.49	33.44	35.51	40.80	113.12	98.57	61.82	39.19	9.94	4.17	0.60	0.66
Obs-Pre	1.60	4.71	-1.72	-0.49	10.09	-1.16	-1.61	-4.00	-1.18	-1.16	-0.07	0.09

The results for both the daily and monthly flow syntheses indicate that the stream flow data generated for Drift Creek at the project site using regression equations linked to the Pudding River flows at Aurora are within acceptable ranges.

In most cases, stream flow data are developed on a daily basis. However, depending on the intended application and if a monthly stream flow synthesis is easier to perform and/or yields better results, stream flow data could be developed on a monthly basis –especially when daily flow fluctuations are not critical to the project operation. In this particular case, exploration of the two possible approaches was performed mainly to see which one would work better than the other. Drift Creek, flowing in a smaller watershed, could be more reflective to daily local storm effects than the Pudding River and, thus, could lead to more fluctuating hydrographs. Such an impact would normally be less critical when working on a longer time frame.

It is also possible that using data recorded at a site geographically closer to Victor Point and controlling a smaller catchment area (such as Woodburn for the Pudding River and Silverton for Silver Creek) might yield comparable or even better results. As noted earlier, however, the other important consideration to keep in mind is the record length at those sites compared to Aurora's 52+ year records.

In addition to graphical plots of observed and predicted hydrographs, Table 6.4 provides some numerical indices of the accuracy of the stream flow synthesis using daily and monthly data. Accuracy indices include the correlation R^2 and the annual October-September runoff volume for each of the six water years. The best predictions are highlighted in bold.

Table 6.4 Correlation R^2 and Annual Runoff Volume
of Daily and Monthly Stream Flow Synthesis

Water Year	R^2 (Daily)	R^2 (Monthly)	Obs. Annual Runoff V, AF	Pred.Ann. Volume, AF (Daily)	Pred.Annual Volume AF (Monthly)	(OBS-PRE)/OBS (Daily) In %	(OBS-PRE)/OBS (Monthly) In %
2008-09	0.9832	**0.9849**	22,629	23,855	**23,536**	-5.42	**-4.01**
2009-10	0.9892	**0.9898**	33,749	**31,148**	30,482	**7.92**	9.89
2010-11	**0.9870**	0.9857	37,606	**37,610**	39,346	**-0.01**	-4.63
2011-12	**0.9816**	0.9776	36,178	**37,016**	35,284	**-2.32**	2.47
2012-13	0.9818	**0.9842**	28,553	**28,625**	28,026	**-0.25**	1.85
2013-14	**0.9936**	0.9848	27,908	28,522	**27,659**	-2.20	**0.89**

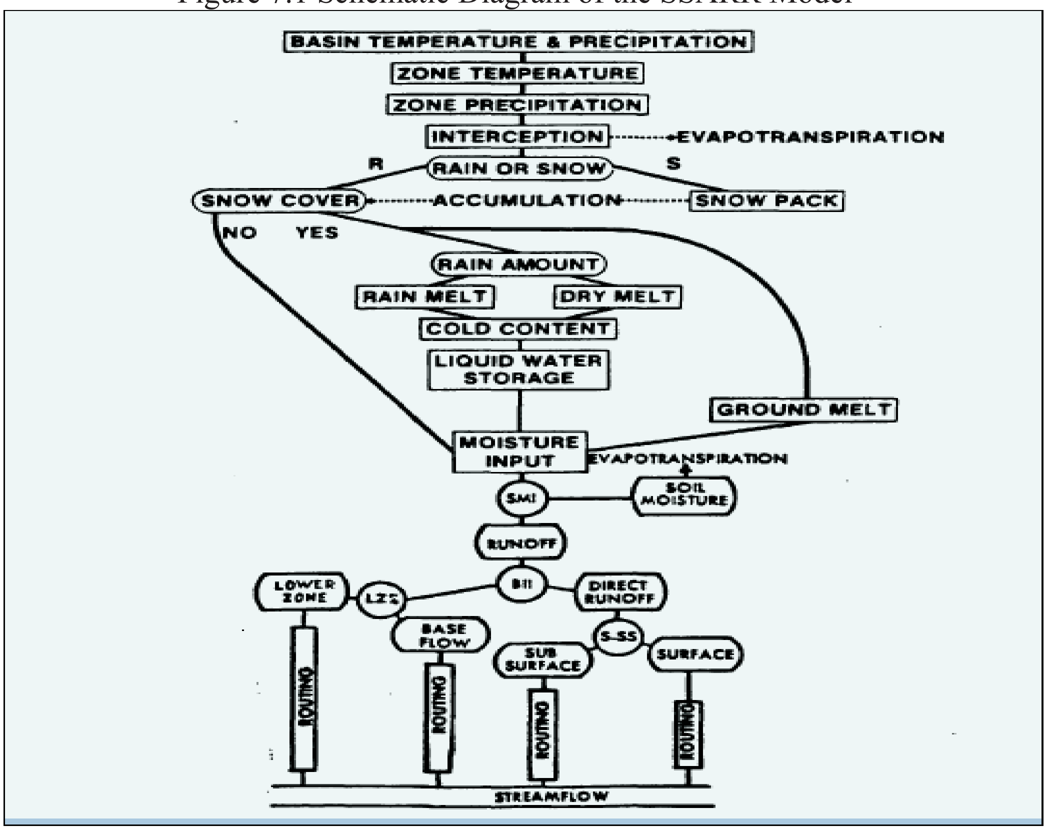
Based on the information shown in Table 6.4, the monthly stream flow predictions for Upper Drift Creek are within 1 and 10 percent, and fairly close to one another regardless of the daily or monthly procedure used. Neither approach seems to be consistently better than the other. Both need slight adjustments to exactly match the actually observed annual runoff volume.

7. Stream Flow Reconstitution Using Rainfall-Runoff Model

In addition to the statistical correlation approach that allows for development of regression equations needed to predict daily (and monthly) stream flow, another possible approach frequently used for the same purpose is to develop a deterministic rainfall-runoff model. This section documents the steps taken under this approach and provides some ideas about the accuracy of the model predictions.

Daily flows for Drift Creek at the project site were generated by a deterministic rainfall-runoff model based on the same procedures as the ones used in the U.S. Army Corps of Engineers' "Streamflow Synthesis and Reservoir Regulation" (SSARR) model. See Figure 7.1. For easy reference purposes, the rainfall-runoff model developed for Drift Creek is coded-named FLO4DRIFT. Its main inputs are the watershed runoff characteristics such as drainage area, soil-moisture indices that control excess runoff and infiltration, basin routing coefficients of each runoff components, and rainfall and/or snow data.

Figure 7.1 Schematic Diagram of the SSARR Model



As stated in the 1987 SSARR User Manual, "*the successful application of the SSARR Model is dependent upon derivations of the various parameters and relationships specific to a particular watershed or river system. Some of the relationships are general and, therefore, are applicable to many sub-basins within a major drainage. Others can be specifically derived for a particular watershed. Some are relationships which can be observed or derived, while others must be considered to be 'model parameters' which only have qualitative physical significance. Watershed runoff characteristics are primarily determined by trial-and-error solutions with the* *computer program to obtain the best fit of historical stream flow data. This procedure is repeated until adequate verification of observed flows is obtained*".

Simulation of Upper Drift Creek's daily flows is performed on an annual basis, starting on October 1 and ending on September 30. Initial soil moisture conditions, which determine the runoff coefficient at the start of the water year, can be either specified by the user, or automatically calculated by the model using the previous year results. This allows FLO4DRIFT to perform a smooth and continuous multi-year simulation throughout the 2008-2014 hydrologic years.

The rainfall coefficient RC is one of the most critical modeling elements since it determines how much rainfall amounts recorded at the index station actually falls over the drainage area. While the modeling starts with a given RC value, slight changes may be required from year to year to actually match the actual rainfall distribution and the resulting runoff volume. For example, in order to match the 2008-09 observed annual runoff volume, rainfall at Salem Airport had to be multiplier by a factor of 1.9 to account for infiltration, evaporation losses, and lack of snow information. For a slightly below average year like 2009-10, the rainfall multiplier is 1.5. For an above average year like 2010-11, the rainfall multiplier is 1.7. Table 7.1 provides a sample output for the FLO4DRIFT model.

Table 7.1 Sample FLO4DRIFT Model Output

TS= 2.0 TSS= 8.0 TSBF= 24.0 TSBII= 32.0 W(1)= 1.70

RUNOFF VOL (AF) = 37,673 CAL(Before Routing)= 38,795 OBS/CAL Ratio= 1.030

Title:DRIFT CREEK 2010-11

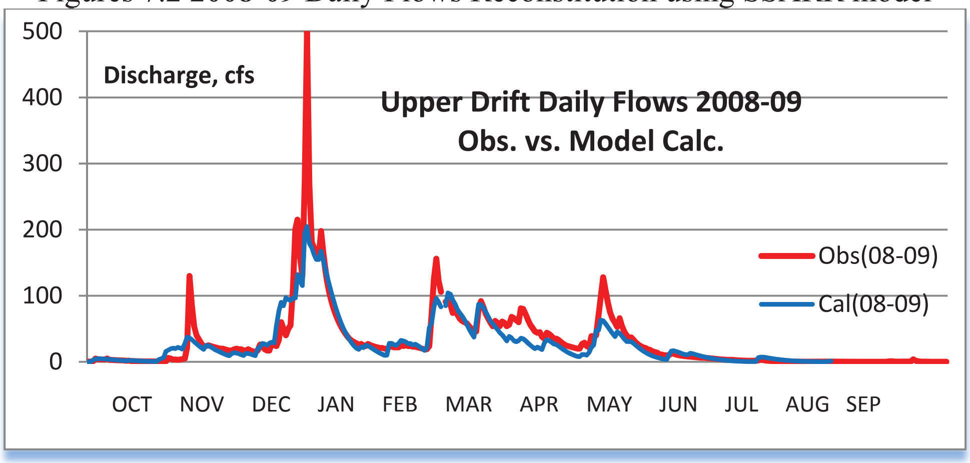
RUN DATE:05-20-2012 21:04:02

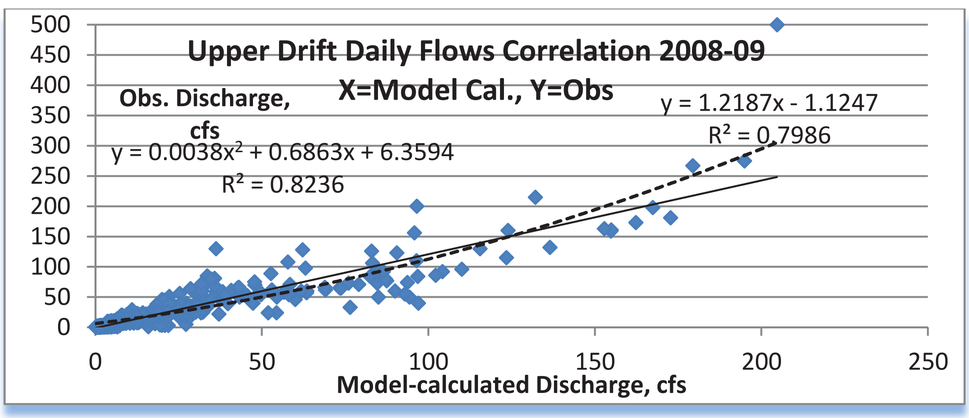
							<.......	D I S C H A R G E S			.........>	
DD/MM/YR	RAIN in.	ETI in.	SMI in.	ROP	BII	BFP	SUR cfs	SUB cfs	BFL cfs	BASE cfs	QCAL cfs	QOBS cfs
1/10/10	0.00	0.07	0.10	.15	1.00	.20	0.0	0.0	0.0	0.1	0.1	0.9
2/10/10	0.00	0.07	0.03	.15	0.45	.30	0.0	0.0	0.0	0.1	0.1	0.9
3/10/10	0.00	0.07	0.00	.15	0.21	.44	0.0	0.0	0.0	0.1	0.1	0.9
4/10/10	0.00	0.07	0.00	.15	0.09	.58	0.0	0.0	0.0	0.1	0.1	0.9
5/10/10	0.00	0.07	0.00	.15	0.04	.70	0.0	0.0	0.0	0.1	0.1	0.7
6/10/10	0.00	0.07	0.00	.15	0.02	.76	0.0	0.0	0.0	0.1	0.1	0.6
7/10/10	0.00	0.07	0.00	.15	0.01	.78	0.0	0.0	0.0	0.1	0.1	0.5
8/10/10	0.00	0.07	0.00	.15	0.00	.79	0.0	0.0	0.0	0.1	0.1	0.5
9/10/10	1.41	0.07	0.00	.15	0.00	.80	2.0	2.7	2.9	0.1	7.7	1.3
10/10/10	0.00	0.07	1.19	.19	0.00	.80	1.0	3.1	4.6	0.1	8.8	10.0
11/10/10	0.00	0.07	1.12	.19	0.00	.80	0.4	2.7	5.5	0.1	8.6	12.0
12/10/10	0.00	0.07	1.05	.18	0.00	.80	0.1	2.0	5.9	0.1	8.1	7.4
13/10/10	0.00	0.07	0.98	.18	0.00	.80	0.0	1.4	5.9	0.1	7.4	5.4
14/10/10	0.00	0.07	0.91	.18	0.00	.80	0.0	1.0	5.6	0.1	6.7	4.3
15/10/10	0.00	0.07	0.84	.18	0.00	.80	0.0	0.7	5.3	0.1	6.0	3.7
16/10/10	0.00	0.07	0.77	.17	0.00	.80	0.0	0.4	4.8	0.1	5.3	3.0
17/10/10	0.00	0.07	0.70	.17	0.00	.80	0.0	0.3	4.3	0.1	4.7	2.9
18/10/10	0.00	0.07	0.63	.17	0.00	.80	0.0	0.2	3.8	0.1	4.1	2.7
19/10/10	0.12	0.07	0.56	.17	0.00	.80	0.1	0.4	3.7	0.1	4.2	2.4
20/10/10	0.00	0.07	0.60	.17	0.00	.80	0.1	0.4	3.4	0.1	3.9	2.0
21/10/10	0.00	0.07	0.53	.17	0.00	.80	0.0	0.3	3.1	0.1	3.5	2.0
22/10/10	0.00	0.07	0.46	.16	0.00	.80	0.0	0.2	2.8	0.1	3.1	4.7
23/10/10	0.00	0.07	0.39	.16	0.00	.80	0.0	0.2	2.4	0.1	2.7	6.5
24/10/10	1.46	0.07	0.32	.16	0.00	.80	2.3	3.0	5.3	0.1	10.7	13.0
25/10/10	1.17	0.07	1.54	.20	0.00	.80	3.4	6.3	10.1	0.1	20.0	19.0

RAIN= rainfall amount; ET=evapo-transpiration index; SMI=soil moisture index
ROP = rainfall runoff percent; BII= base flow infiltration index; BFP=base flow percent
SUR =surface runoff; SUB= sub-surface runoff; BASE= base flow; QCAL=calculated discharge
QOBS= observed s=discharge

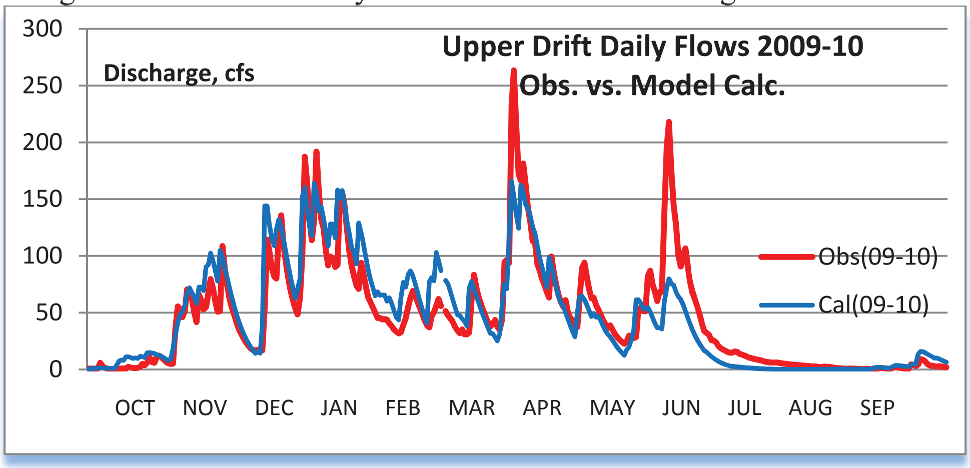
The results of the deterministic modeling work using rainfall data at the Salem airport are documented below in the form of daily hydrograph plots and numerical and graphic tabulations of observed and calculated data. Figures 7.2 through 7.7 show the hydrographs of observed versus model-predicted daily flows for the six water years involved (2008-14). Scatter plots are also provided to show the accuracy of the modeling results for each water year and the values of the correlation indicator R^2 for both a "linear" regression line and an "order 2 polynomial" curve.

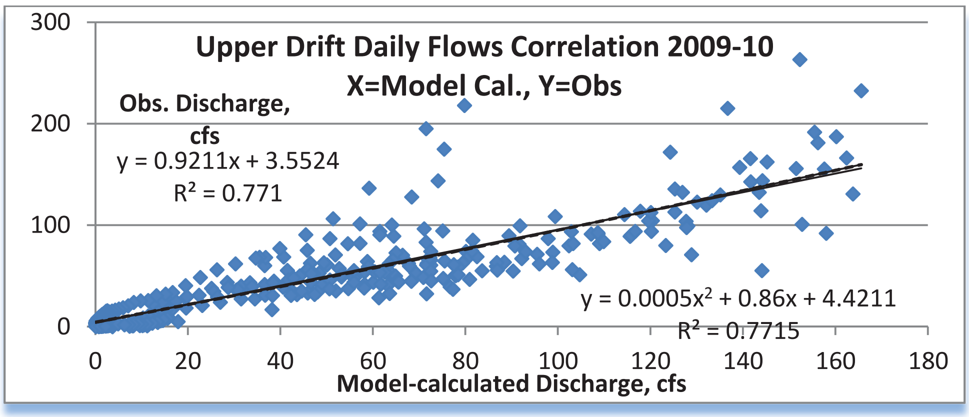
Figures 7.2 **2008-09** Daily Flows Reconstitution using SSARR model



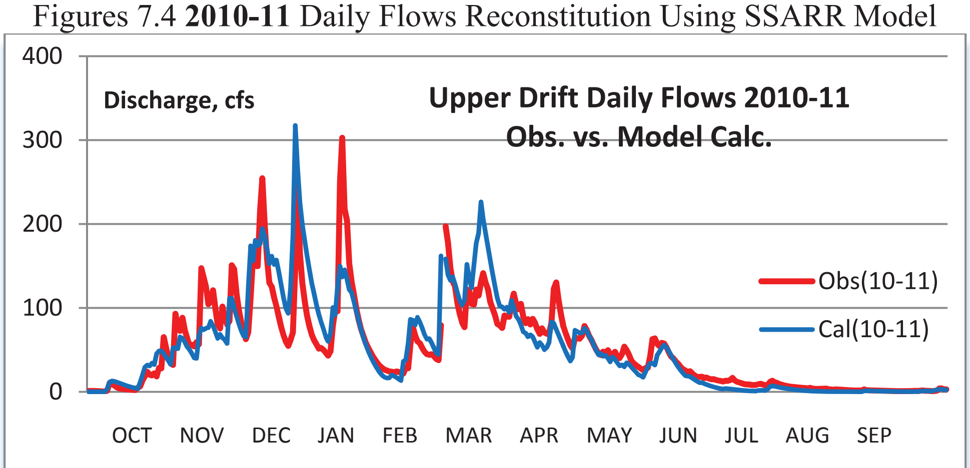


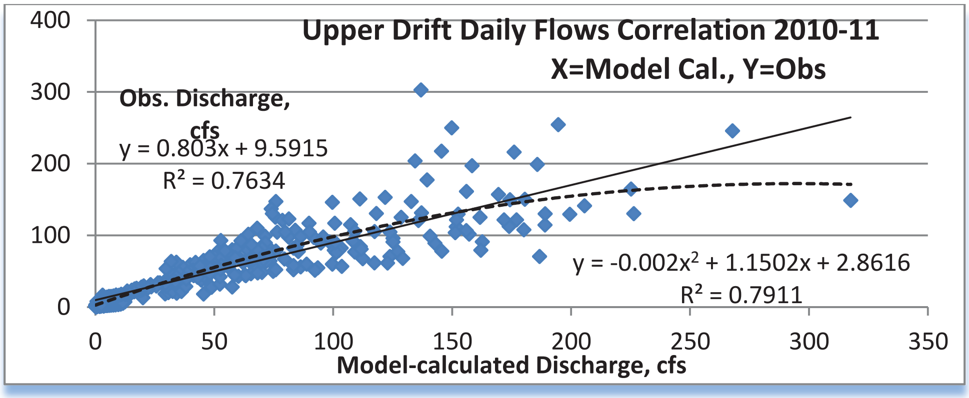
Figures 7.3 **2009-10** Daily Flows Reconstitution Using SSARR Model



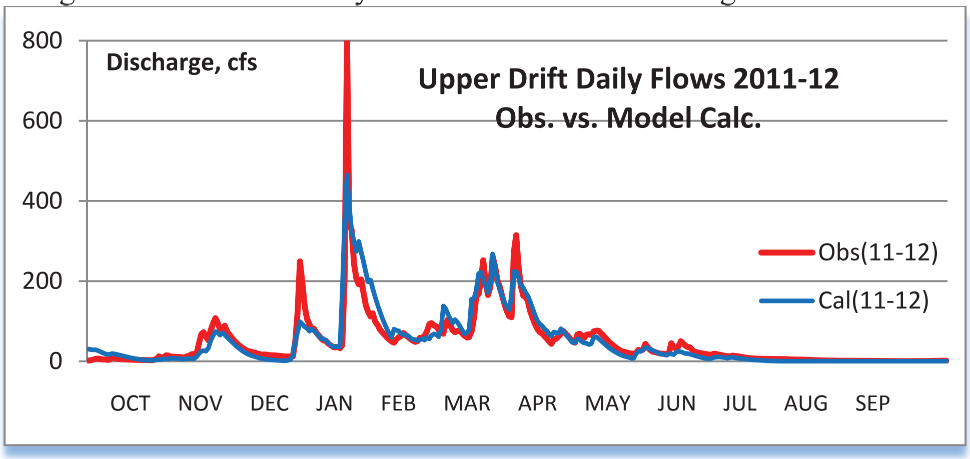


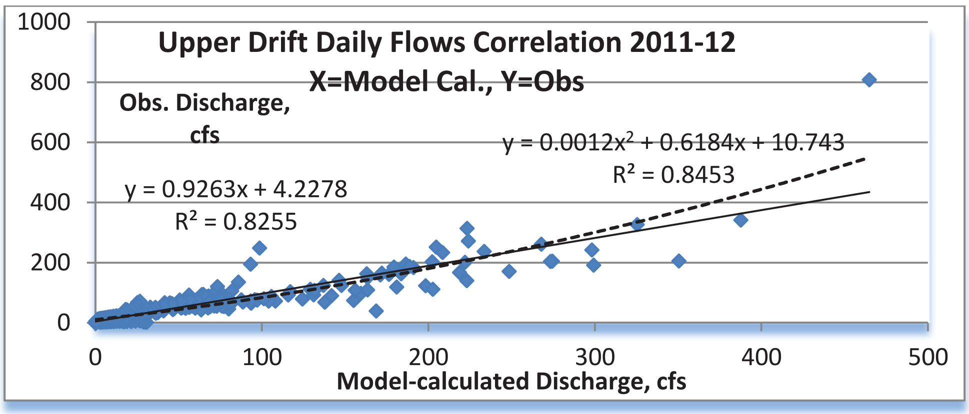
Figures 7.4 **2010-11** Daily Flows Reconstitution Using SSARR Model



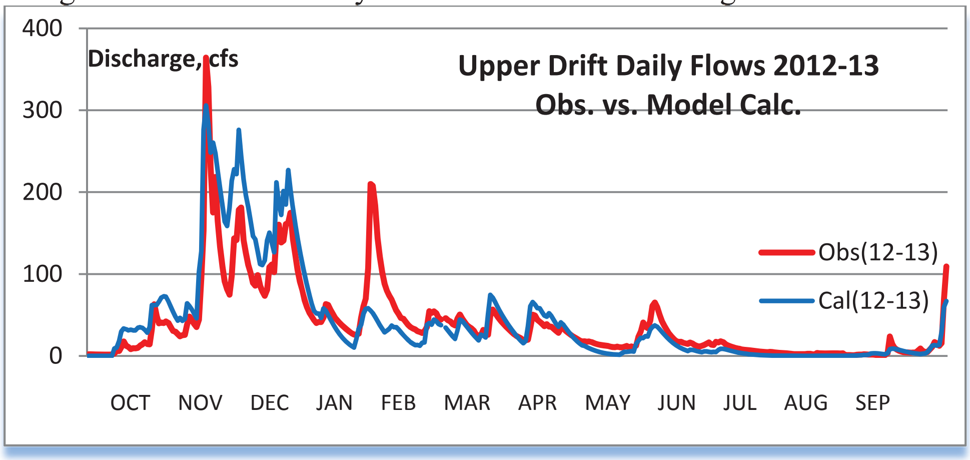


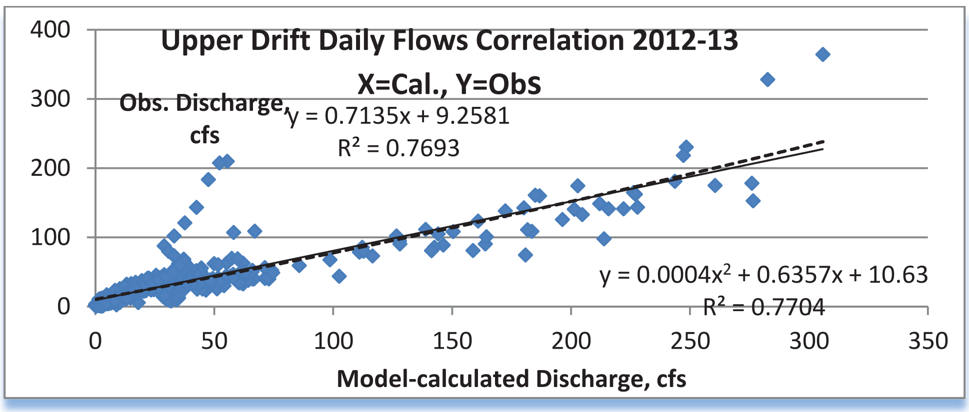
Figures 7.5 **2011-12** Daily Flows Reconstitution Using SSARR Model



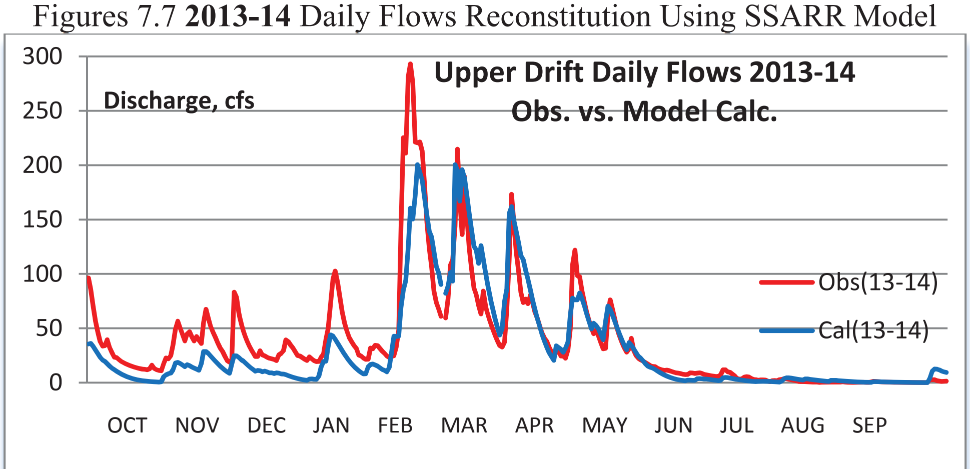


Figures 7.6 **2012-13** Daily Flows Reconstitution Using SSARR Model





Figures 7.7 **2013-14** Daily Flows Reconstitution Using SSARR Model



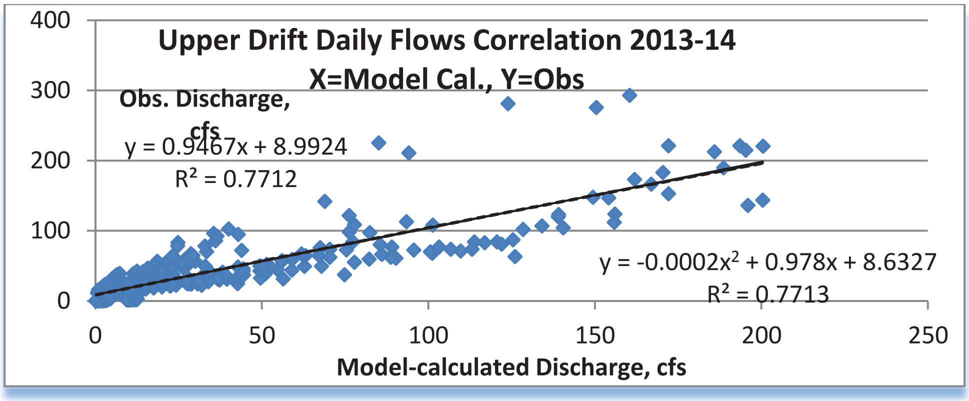


Table 7.2 summarizes the numerical values of the correlation indicator R^2 for the polynomial regression curves in each of the water year, for both model-calculated and regression-based daily stream flow predictions for Upper Drift Creek. The highest R^2 value for each year is shown in bold.

Table 7.2 R^2 Values of Daily Flow Reconstitution by Model and Regression

	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2008-14
Linear Trend							
Model-Calculated	0.7986	0.7710	0.7634	0.8255	0.7693	0.7712	0.7761
Regression-based	0.8050	0.8792	0.8628	0.7170	0.8366	0.8952	0.8088
Polynomial 2 Trend							
Model-Calculated	**0.8236**	0.7715	0.7911	**0.8453**	0.7704	0.7713	0.7767
Regression-based	0.8057	**0.8794**	**0.8662**	0.7216	**0.8383**	**0.8957**	**0.8118**

The results generated appear to be reasonably acceptable. The shape of the hydrograph and the total runoff volume in particular look very good. The R^2 values would be higher if the timing of the observed and calculated stream flows were more tightly fit. Obviously, more years of data are needed to cover a wider range of other runoff conditions. A higher runoff year for Drift Creek can be expected to have heavier rainfall, more sluggish soil conditions and some snowfall in the upper part of the basin, conditions that were practically non-existent in 2008-14. Also, the use of additional rainfall stations other than Salem Airport will be necessary to improve the results by more accurately representing the areal rainfall distribution over the Drift Creek's catchment area.

The main challenge with the rainfall-runoff modeling approach is to find a consistently representative rainfall multiplier (RFM) to generate the discharges for each water year. While the Salem Airport daily precipitation amounts closely reflect the daily fluctuations of Upper Drift Creek daily discharges, different RFM values had to be used to closely match the creek's observed and model-calculated annual runoff volume. For the six water years spanning from October 2008 to September 2014, the following slightly variable RFM values were used: 1.7, 1.5, 1.5, 1.5, 1.5, and 1.7 (1.60 average). Selected modeling details are shown in Table 7.3.

Table 7.3 Selected Rainfall-Runoff Model Simulation Details

HY	Salem Ann. Rainfall (")	Rainfall Multiplier	Adjusted Rain-fall (")	Rainfall Vol (AF)	Calculated Runoff (AF)	Observed Runoff (AF)	Difference OBS-CAL (AF)	Error Diff /OBS	Model Runoff Coeff.
2008-09	27.9	1.7	47.43	39,968	19,382	22,704	3,322	0.146	0.485
2009-10	44.6	1.5	66.90	56,374	33,849	33,748	-101	-0.003	0.600
2010-11	46.1	1.5	69.15	58,220	38,188	37,678	-510	-0.014	0.656
2011-12	43.5	1.5	65.25	54,933	35,748	36,250	502	0.014	0.651
2012-13	39.5	1.7	67.15	56,628	30,626	28,625	-2,001	-0.070	0.541
Average	38.4	1.6	60.72	51,166	30,066	31,164	1,098	0.044	0.588

From the above results, daily discharges calculated by the polynomial 2 regression equation based on the 2008-14 daily Pudding River flows at Aurora (X) and daily Drift Creek flows at the project site (Y) led to a higher R^2 value than for the model-calculated, Salem rainfall-based flows, in 2 out of 6 cases. To date, regression-based discharge predictions, using Pudding River discharges, are more accurate than those obtained via rainfall-runoff modeling. However, both procedures are promising and still deserve further evaluation because of their complementary application potential in reconstituting historical records and generating future runoff forecasts. For one, the modeling approach is irreplaceable when stream flows in response to fixed precipitation amounts have to be generated, as is the case when dealing with Probable Maximum Precipitation (PMP) and Probable Maximum Flood (PMF), and real-time inflow or flood forecasting.

8. Comparison of Predicted vs. Observed 2011-14 Stream Flows

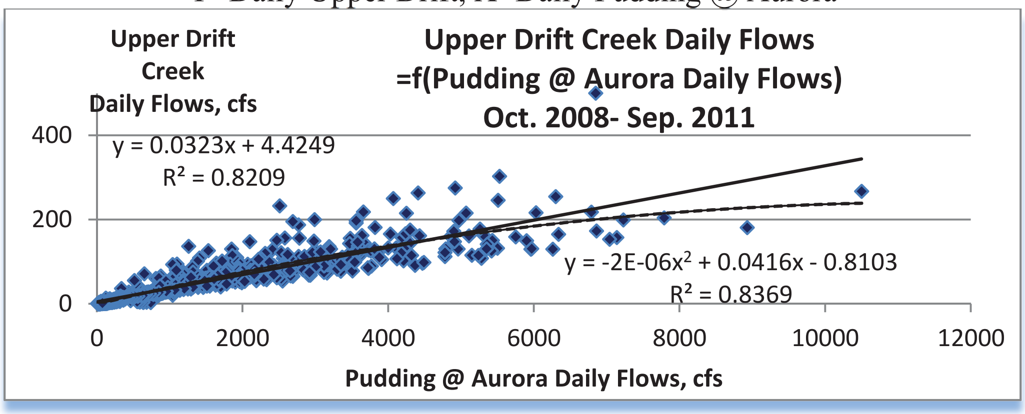
This section provides some ideas on the accuracy the daily flows predicted for Upper Drift Creek using (1) regression-based equations and (2) rainfall-runoff modeling. Only the polynomial order 2 trend is used in this section, since it yields better correlation than the linear trend in most cases. The corresponding regression equation is based on October 2008 – September 2011 Upper Drift Creek (Y) and Pudding at Aurora (X) daily flows. The rainfall-runoff model is calibrated based on 2008-11 Upper Drift Creek daily flows and daily precipitations at the Salem Airport for the specific year of interest.

The test data are the more recent data collected during October 2011 – September 2014 period. They were not part of the data used to develop the prediction tools. The observed and predicted hydrographs are shown on the primary axis, along with the Observed – Predicted differences on the secondary axis. They are followed by a scatter plot with the R^2 correlation value that reflects the level of prediction accuracy in each case.

8.1 Comparison Using Regression-based Stream Flows

The R^2 values and the Observed – Predicted differences are greatly influenced by time shifts in daily flows. For that reason, in addition to the daily flow predictions, results related to the equivalent monthly flows are also presented in each case. The scatter plot showing how the regression equation used in this section is derived is illustrated in Figure 8.1.

Figure 8.1 Scatter Plot Based on 2008-11 Daily Flows
Y=Daily Upper Drift, X=Daily Pudding @ Aurora

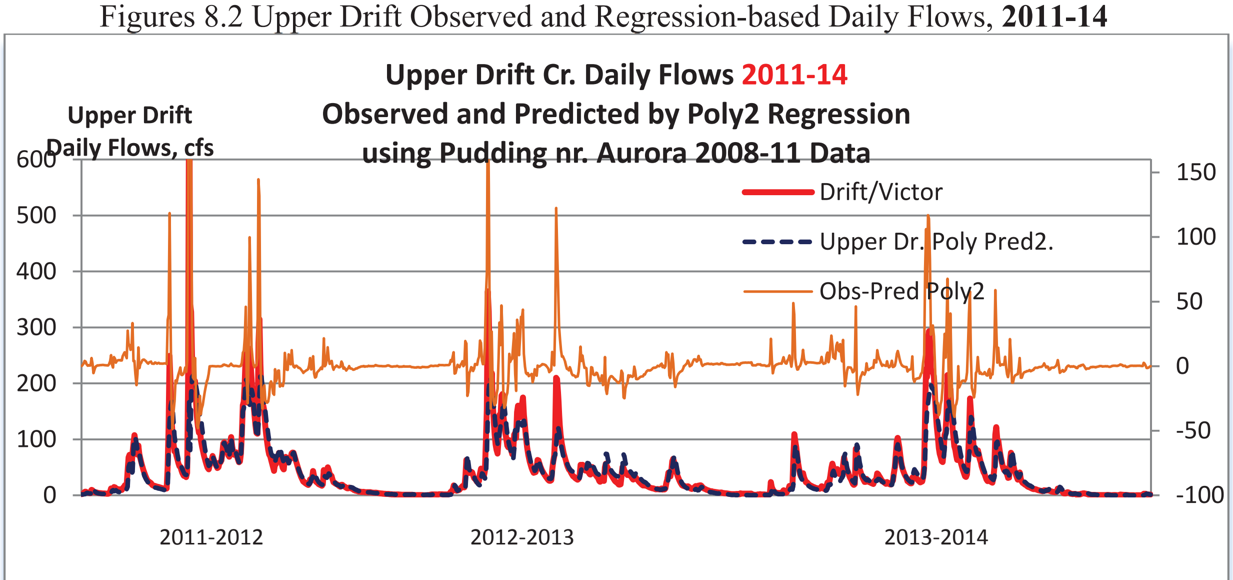


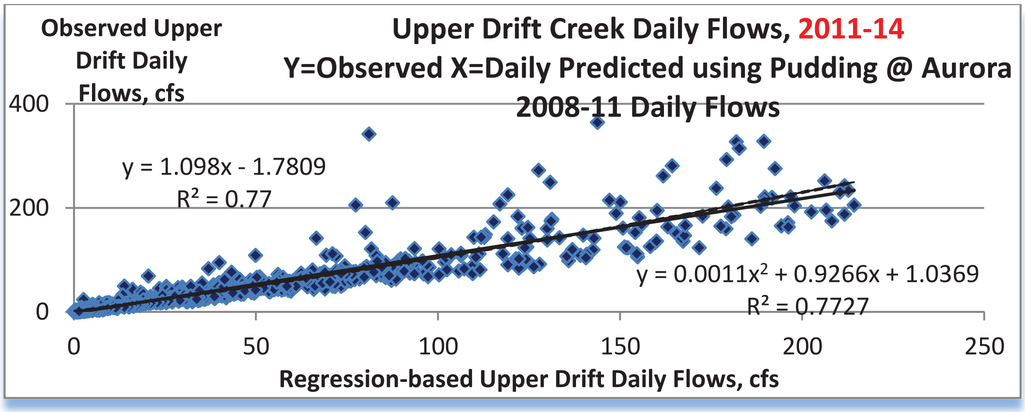
The regression equation used is listed below, with Y=Calculated Upper Drift daily flow, and X=Observed Pudding River at Aurora daily flows:

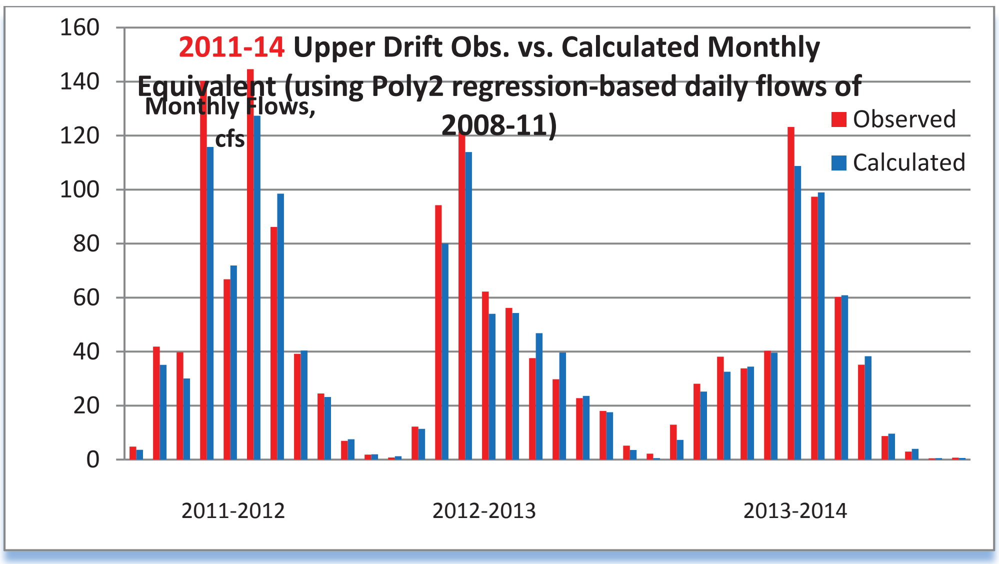
Y= -2E-06X^2 + 0.0416 X – 0.8103 (R^2= 0.8369)

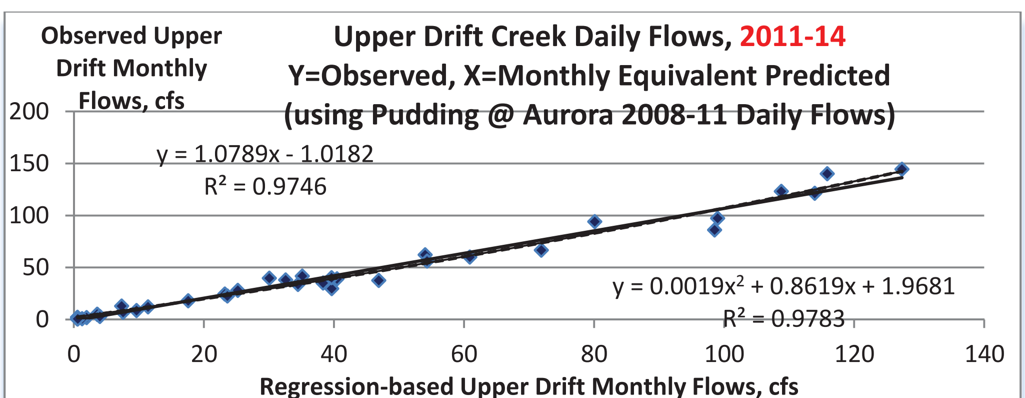
Using that regression equation, the hydrographs of the calculated Upper Drift daily flows are shown in Figures 8.2, 8.3, 8.4 and 8.5 for 2011-12, 2012-13, 2013-14 and 2011-14 water years respectively. Scatter plots are also provided for each water year, directly below the hydrographs.

Figures 8.2 Upper Drift Observed and Regression-based Daily Flows, **2011-14**

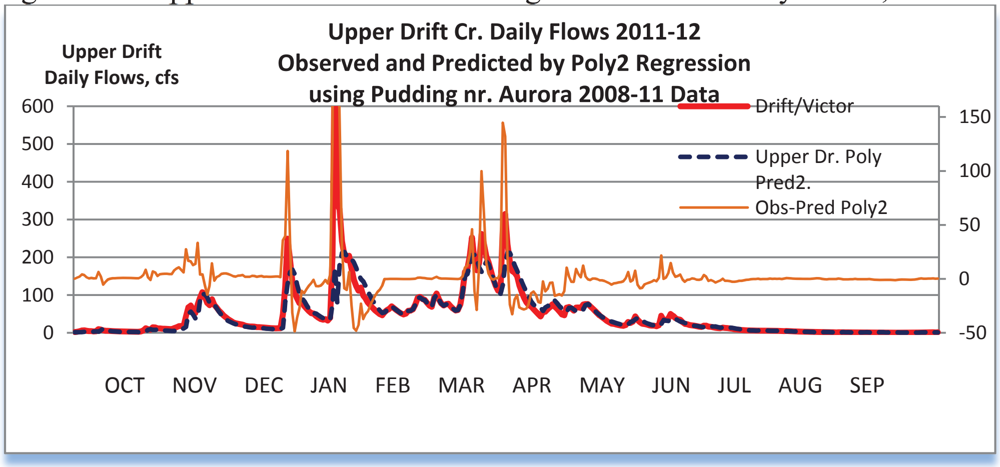


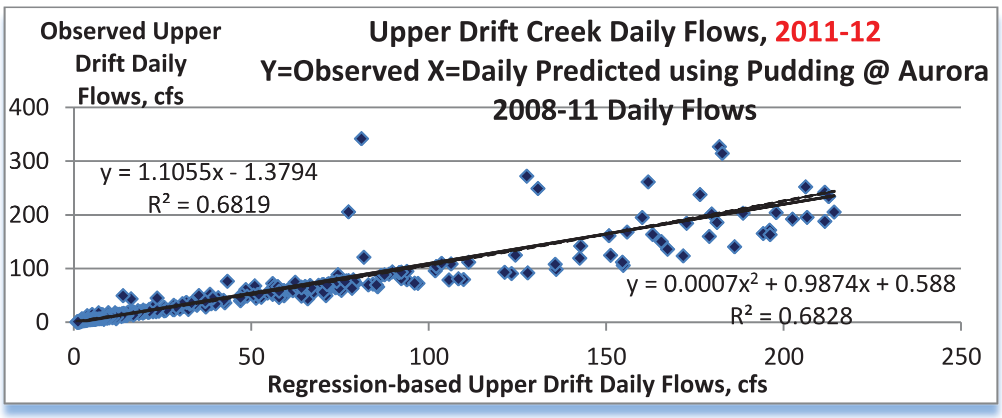

Upper Drift Creek Daily Flows, 2011-14
Y=Observed X=Daily Predicted using Pudding @ Aurora 2008-11 Daily Flows
Observed Upper Drift Daily Flows, cfs
y = 1.098x - 1.7809
R² = 0.77
y = 0.0011x² + 0.9266x + 1.0369
R² = 0.7727
400
200
0
0
50
100
150
200
250
Regression-based Upper Drift Daily Flows, cfs

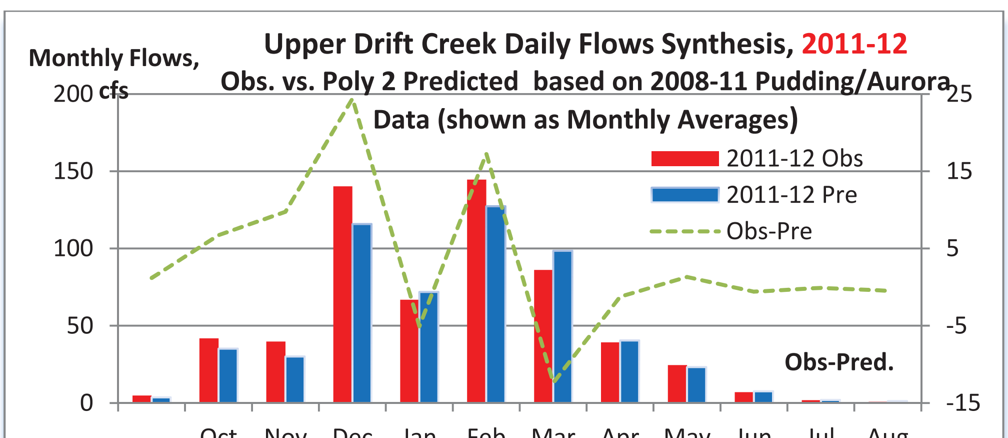

2011-14 Upper Drift Obs. vs. Calculated Monthly Equivalent (using Poly2 regression-based daily flows of 2008-11)
Monthly Flows, cfs
Observed
Calculated
160
140
120
100
80
60
40
20
0
2011-2012
2012-2013
2013-2014

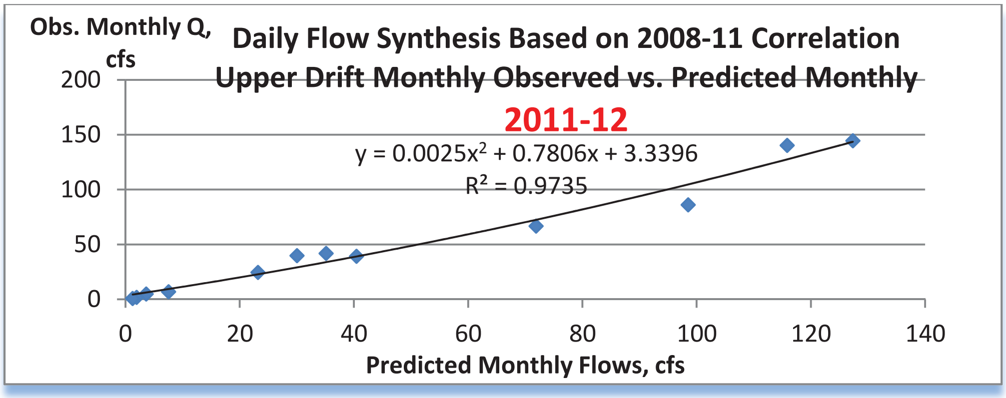

Upper Drift Creek Daily Flows, 2011-14
Y=Observed, X=Monthly Equivalent Predicted (using Pudding @ Aurora 2008-11 Daily Flows)
Observed Upper Drift Monthly Flows, cfs
y = 1.0789x - 1.0182
R² = 0.9746
y = 0.0019x² + 0.8619x + 1.9681
R² = 0.9783
200
150
100
50
0
0
20
40
60
80
100
120
140
Regression-based Upper Drift Monthly Flows, cfs

Figures 8.3 Upper Drift Observed and Regression-based Daily Flows, **2011-12**

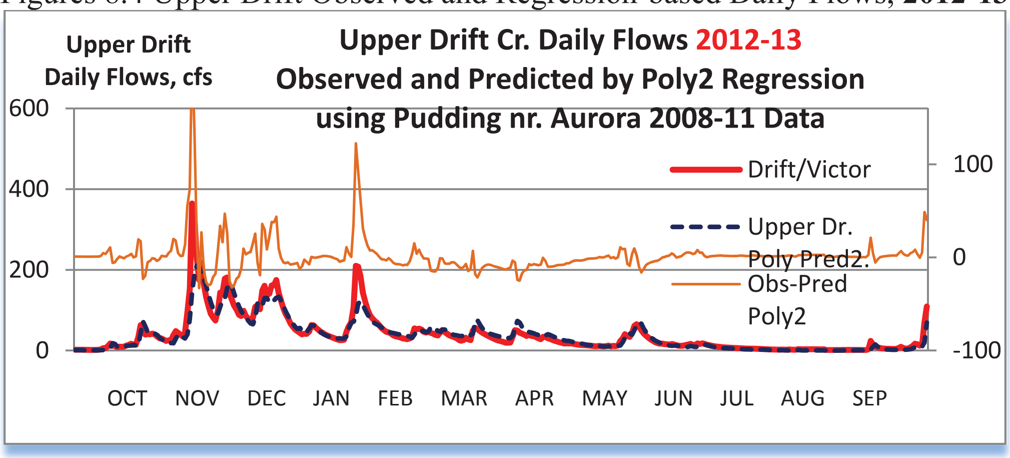


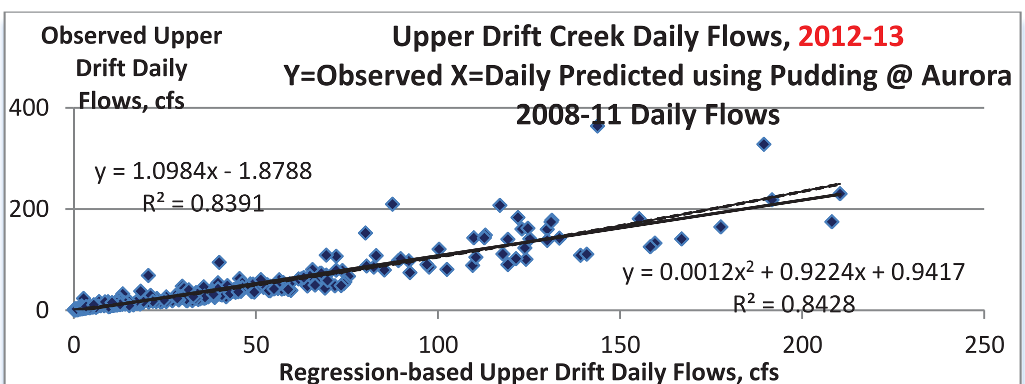


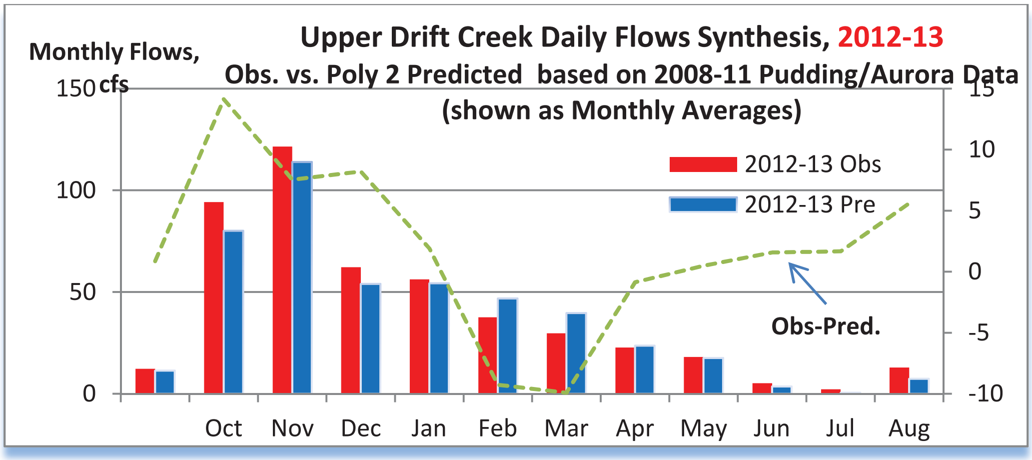


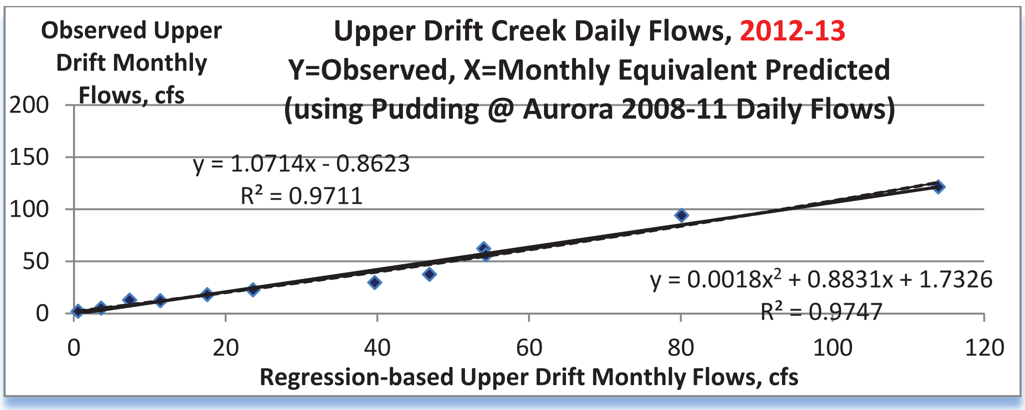


Figures 8.4 Upper Drift Observed and Regression-based Daily Flows, **2012-13**

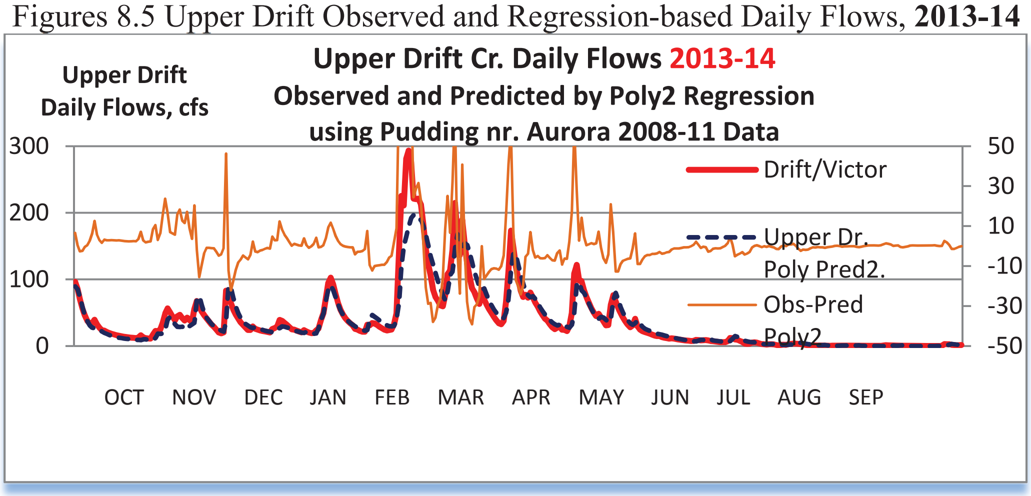


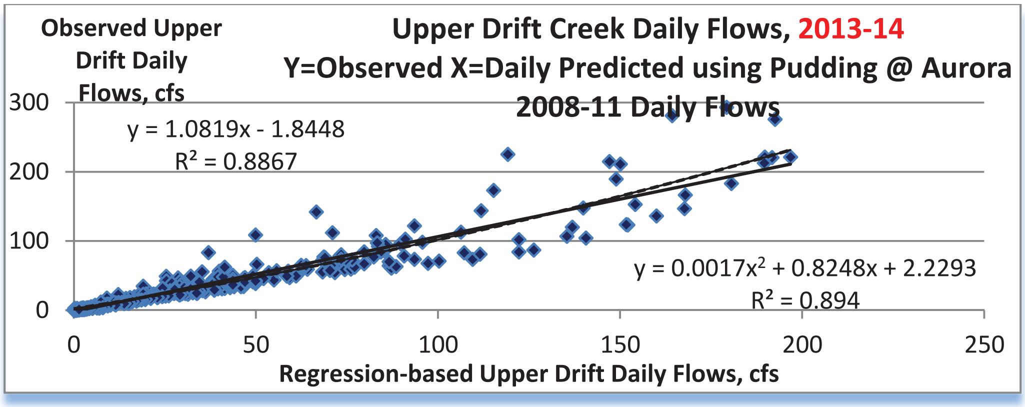


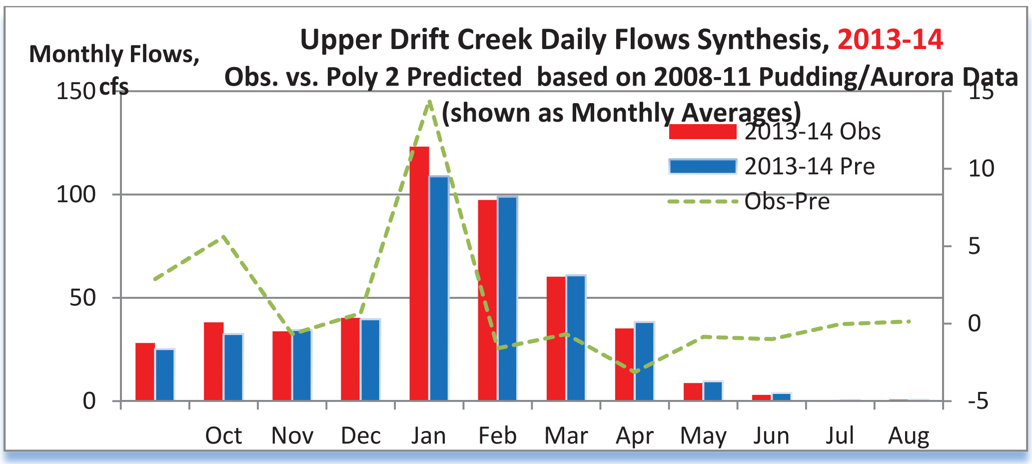


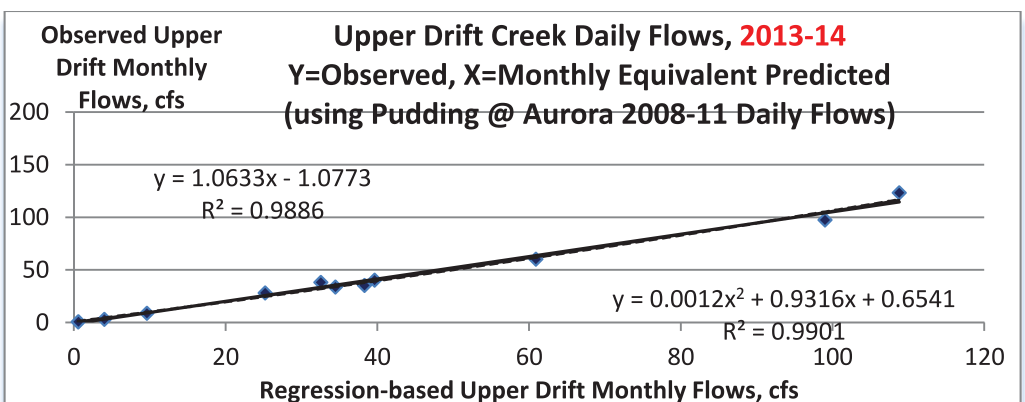


Figures 8.5 Upper Drift Observed and Regression-based Daily Flows, **2013-14**









Observed and predicted monthly runoff volumes for each of water year tested are summarized in Table 8.1, including prediction differences.

Table 8.1 Summary of Observed and Regression-Predicted Runoff Volumes

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2011-12 Obs	4.83	41.86	39.81	140.27	66.83	144.60	86.17	39.21	24.52	6.98	1.87	0.80
2011-12 Pre	3.62	35.13	30.05	115.84	71.89	127.34	98.53	40.45	23.20	7.57	1.96	1.26
Obs-Pre	*1.21*	*6.74*	*9.76*	*24.43*	*-5.06*	*17.26*	*-12.36*	*-1.23*	*1.32*	*-0.59*	*-0.08*	*-0.46*
2012-13 Obs	12.25	94.24	121.47	62.22	56.23	37.61	29.75	22.76	18.07	5.17	2.22	12.94
2012-13 Pre	11.39	80.10	113.92	54.01	54.32	46.87	39.65	23.61	17.57	3.58	0.55	7.34
Obs-Pre	*0.86*	*14.14*	*7.55*	*8.21*	*1.91*	*-9.26*	*-9.91*	*-0.85*	*0.50*	*1.59*	*1.67*	*5.61*
2013-14 Obs	28.09	38.15	33.78	40.31	123.21	97.41	60.21	35.19	8.76	3.01	0.53	0.75
2013-14 Pre	25.21	32.55	34.46	39.62	108.78	98.99	60.88	38.31	9.62	4.00	0.55	0.61
Obs-Pre	*2.88*	*5.60*	*-0.68*	*0.68*	*14.43*	*-1.58*	*-0.68*	*-3.12*	*-0.85*	*-0.99*	*-0.02*	*0.14*

Figure 8.6 shows the plot of cumulative "observed" versus "regression-based" monthly runoff volumes for each of the three water years tested. The observed and calculated annual runoff volumes are summarized in Table 8.2.

Figure 8.6 Plot of Cumulative Observed and Regression-based Runoff Volumes

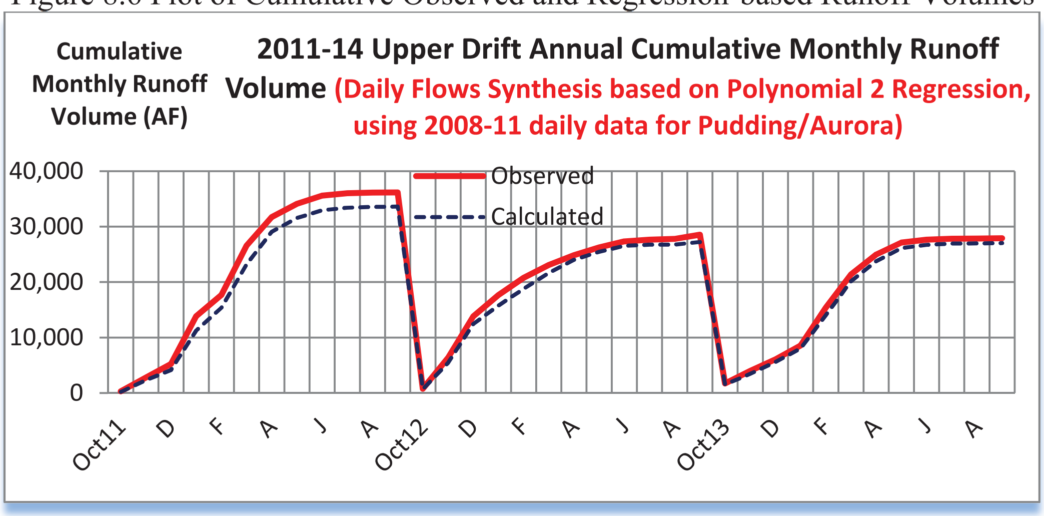


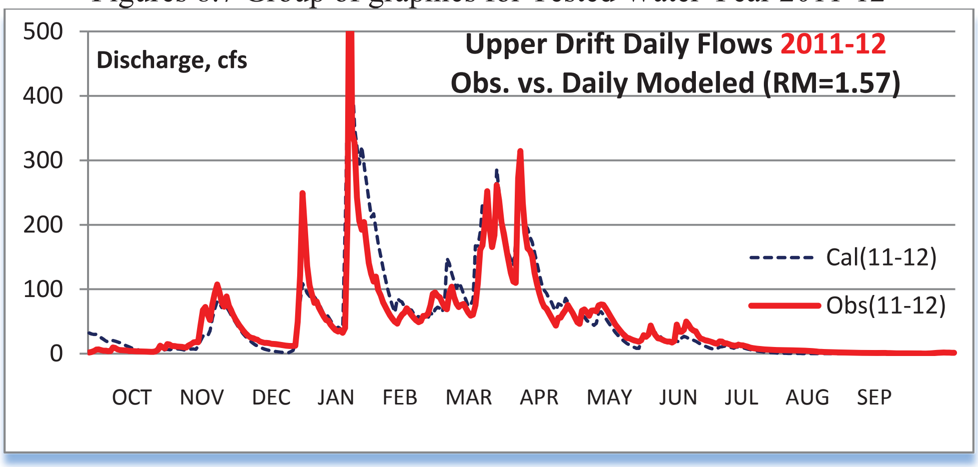
Table 8.2 Summary of Observed and Regression-Predicted Annual Runoff Volumes, and R^2

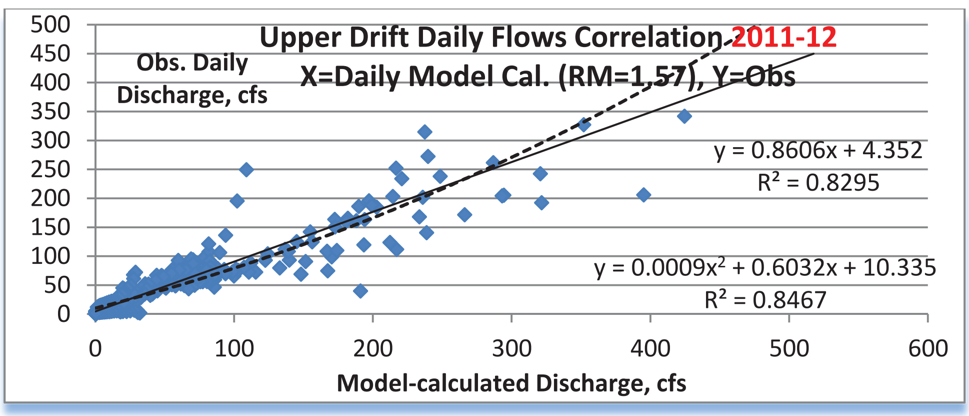
Water Years	Observed, Obs	Predicted, Pre	(Obs-Pred)/Obs %	R^2 (daily)	R^2 (monthly)
2011-12	36,178	33,631	-7.04%	0.6828	0.9735
2012-13	28,553	27,232	-4.63%	0.8428	0.9747
2013-14	27,908	27,031	-3.14%	0.8940	0.9901

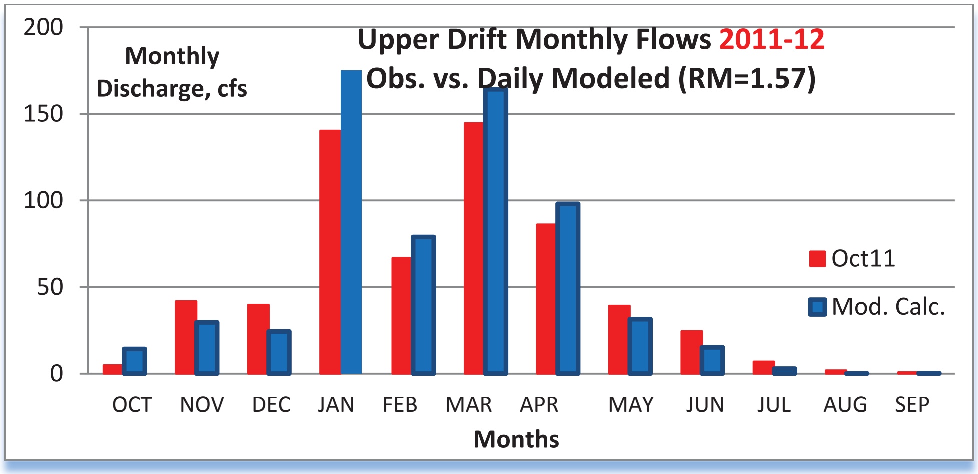
8.2 Comparison Based on Model-Reconstructed Stream Flows

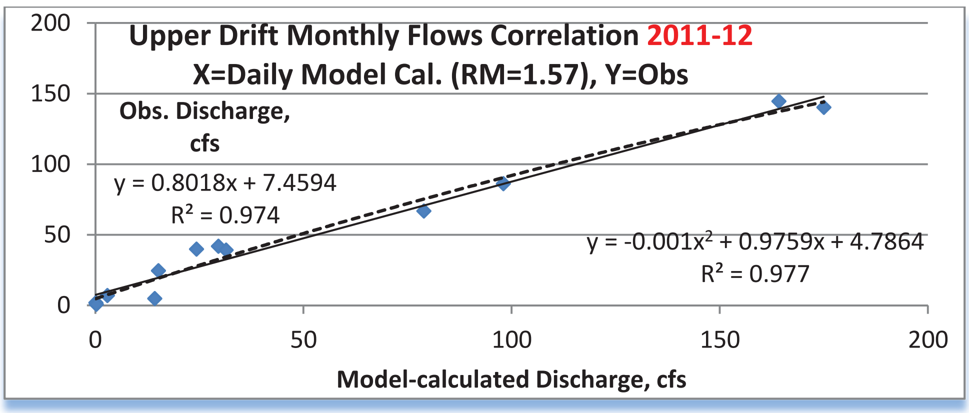
The average rainfall multiplier used for each of the 2008-11 model calibration years is equal to (1.7 +1.5 +1.5)/3= 1.57. Model predictions for 2011-14 are based on that 1.57 rainfall multiplier (RM) and the daily precipitations at Salem Airport for each of year tested. Observed and calculated hydrographs are shown for each tested water year in the group of figures starting from Figure 8.7 and ending at Figure 8.9. Each group consists of plots of (1) Daily hydrographs, (2) Scatter plot for daily flows, (3) Monthly bar charts, and (4) Scatter plots for monthly flows.

Figures 8.7 Group of graphics for Tested Water Year 2011-12

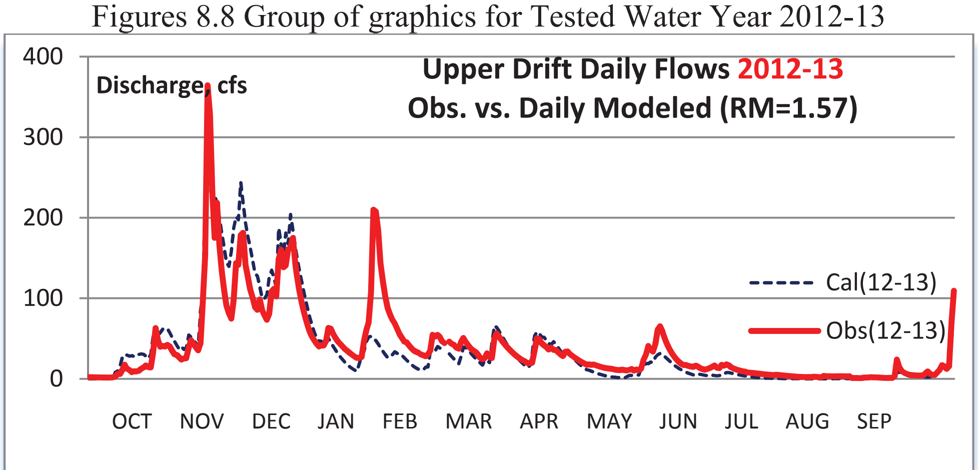


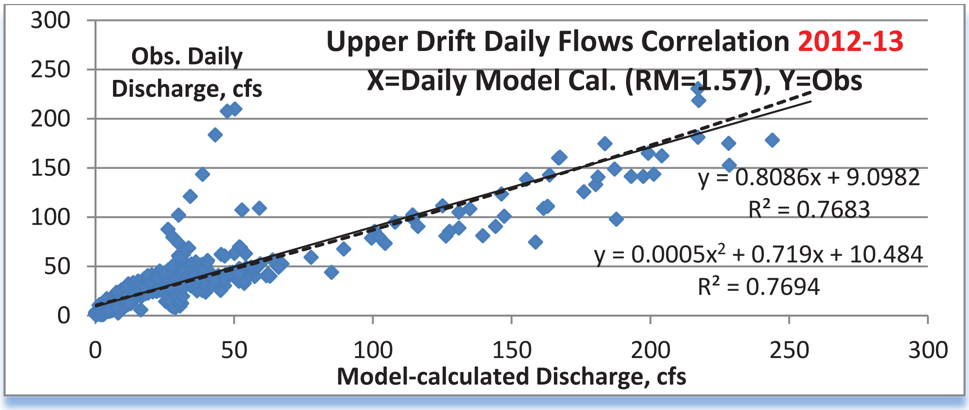


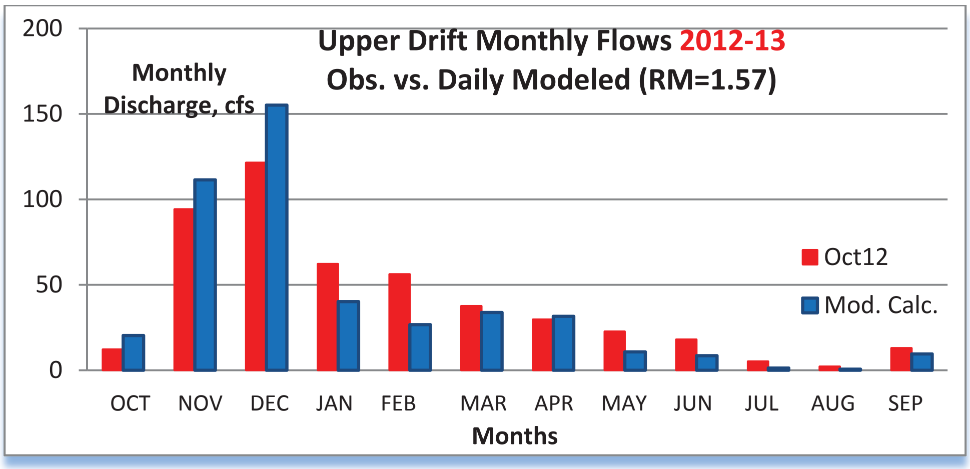


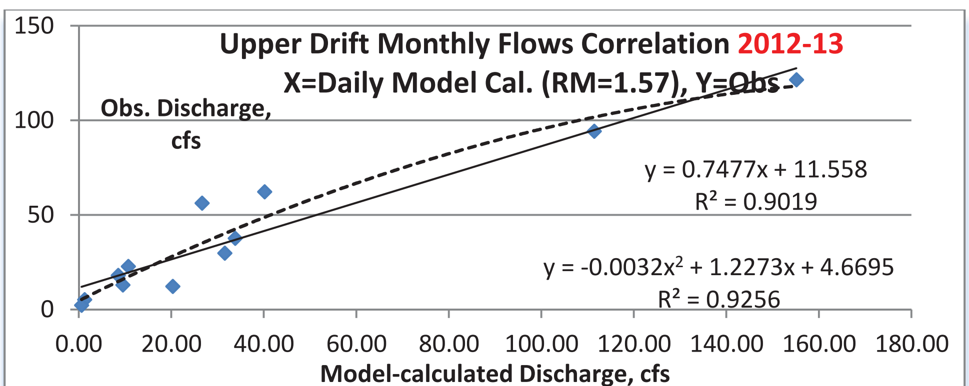


Figures 8.8 Group of graphics for Tested Water Year 2012-13

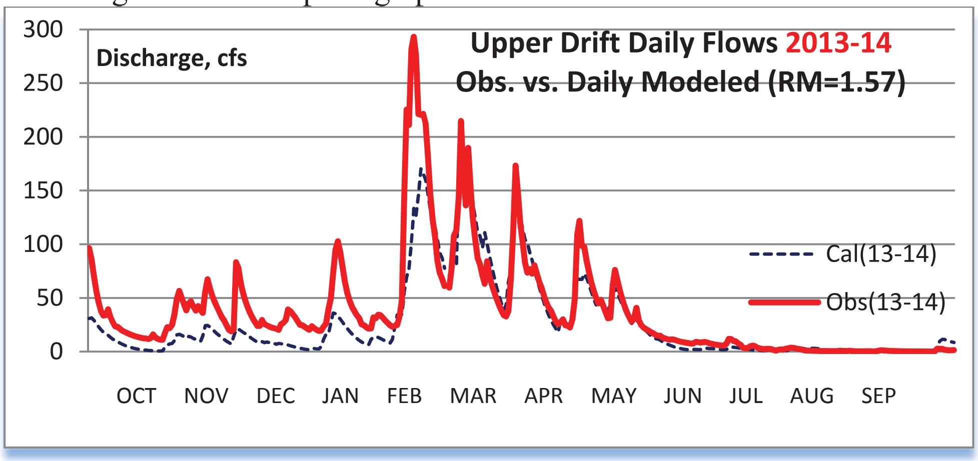


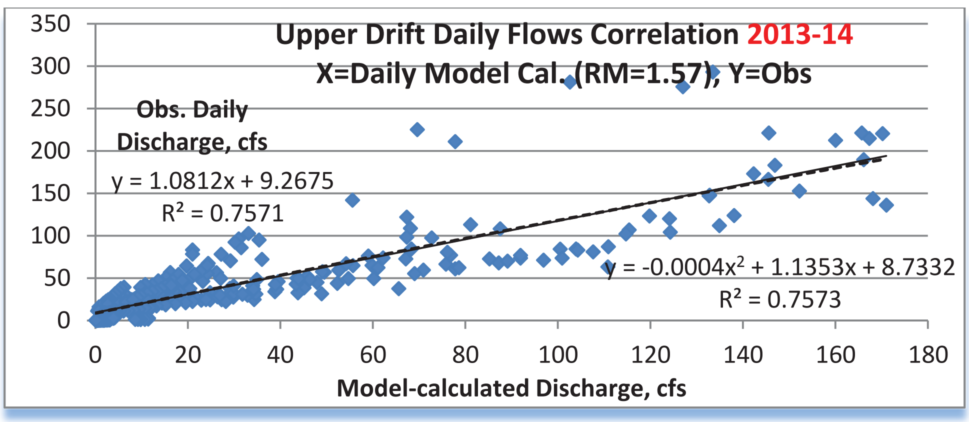

Upper Drift Daily Flows Correlation 2012-13
X=Daily Model Cal. (RM=1.57), Y=Obs
Obs. Daily Discharge, cfs
y = 0.8086x + 9.0982
R² = 0.7683
y = 0.0005x² + 0.719x + 10.484
R² = 0.7694
Model-calculated Discharge, cfs
0
50
100
150
200
250
300

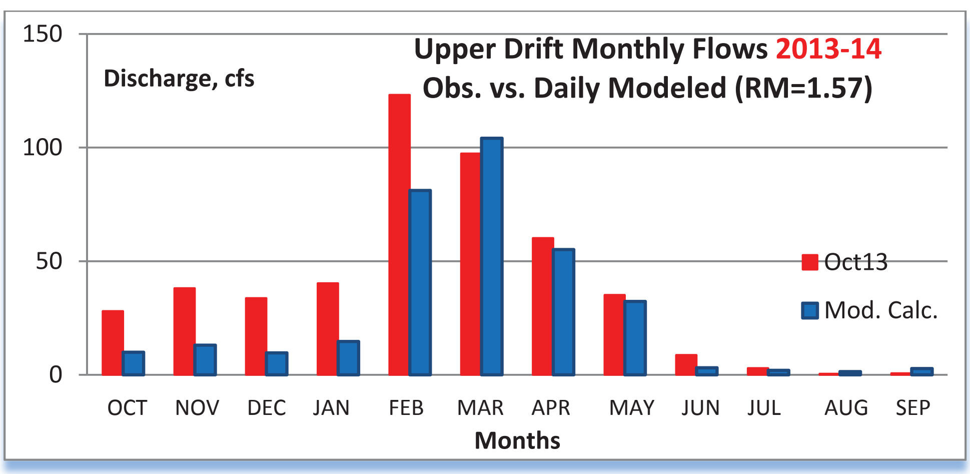

Upper Drift Monthly Flows 2012-13
Obs. vs. Daily Modeled (RM=1.57)
Monthly Discharge, cfs
Oct12
Mod. Calc.
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
Months
0
50
100
150
200

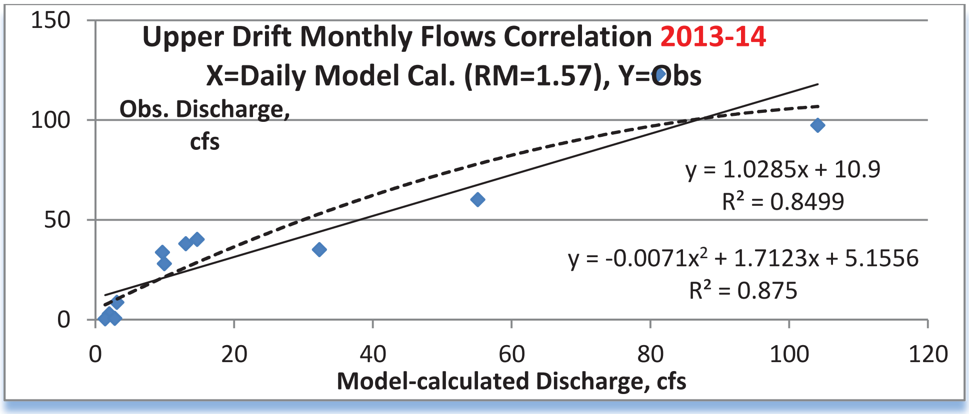

Upper Drift Monthly Flows Correlation 2012-13
X=Daily Model Cal. (RM=1.57), Y=Obs
Obs. Discharge, cfs
y = 0.7477x + 11.558
R² = 0.9019
y = -0.0032x² + 1.2273x + 4.6695
R² = 0.9256
Model-calculated Discharge, cfs
0.00
20.00
40.00
60.00
80.00
100.00
120.00
140.00
160.00
180.00
0
50
100
150

Figures 8.9 Groups of graphics for Tested Water Year 2013-14









Like for regression-based predictions, observed and model-predicted monthly runoff volumes for each of water year tested are summarized in Table 8.3, including prediction differences.

Table 8.3 Summary of Observed and Model-Predicted Runoff Volumes

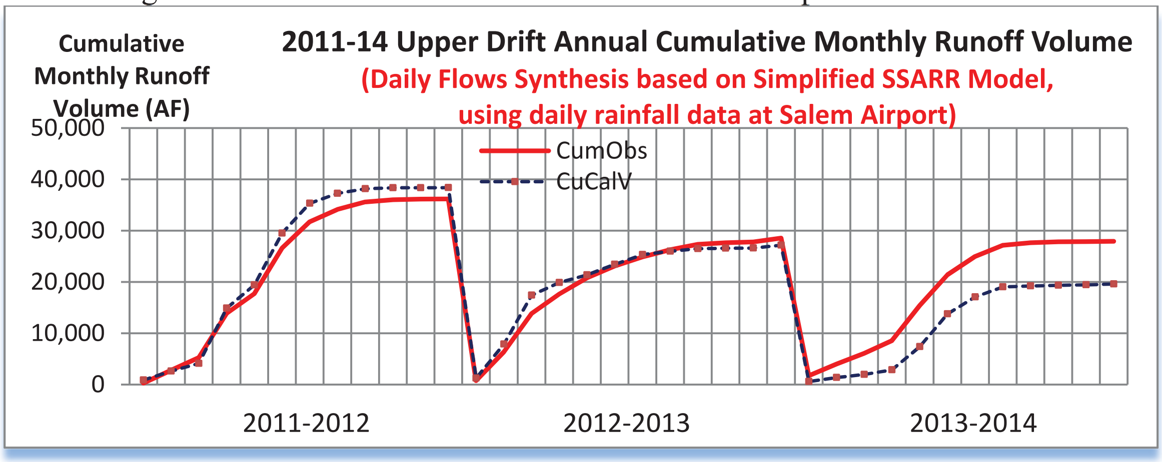
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2011-12 Obs	4.83	41.86	39.81	140.27	66.83	144.60	86.17	39.21	24.52	6.98	1.87	0.80
2011-12 Pre	14.26	29.55	24.27	174.98	78.90	164.18	98.00	31.40	15.16	2.89	0.11	0.21
Obs-Pre	*-9.43*	*12.32*	*15.54*	*-34.71*	*-12.08*	*-19.58*	*-11.83*	*7.81*	*9.72*	*4.09*	*1.77*	*0.59*
2012-13 Obs	12.25	94.24	121.47	62.22	56.23	37.61	29.75	22.76	18.07	5.17	2.22	12.94
2012-13 Pre	20.32	111.43	155.15	40.17	26.66	33.80	31.56	10.71	8.52	1.25	0.59	9.53
Obs-Pre	*-8.07*	*-17.19*	*-33.67*	*22.05*	*29.57*	*3.81*	*-1.82*	*12.05*	*9.55*	*3.92*	*1.63*	*3.42*
2013-14 Obs	28.09	38.15	33.78	40.31	123.21	97.41	60.21	35.19	8.76	3.01	0.53	0.75
2013-14 Pre	9.94	13.03	9.65	14.65	81.13	104.13	55.11	32.29	3.09	2.00	1.42	2.78
Obs-Pre	*18.16*	*25.12*	*24.13*	*25.65*	*42.08*	*-6.72*	*5.09*	*2.90*	*5.67*	*1.01*	*-0.89*	*-2.03*

The observed and calculated annual runoff volumes are summarized in Table 8.4 and Figure 8.10 shows the plot of cumulative "observed" versus "model-predicted" monthly runoff volumes for each of the three water years tested.

Table 8.4 Summary of Observed and Model-Predicted Annual Runoff Volumes, and R^2

Water Years	Observed, Obs	Predicted, Pre	(Obs-Pred)/Obs %	R^2 (daily)	R^2 (monthly)
2011-12	36,178	38,372	-6.07%	0.8467	0.9770
2012-13	28,553	27,166	4.86%	0.7694	0.9256
2013-14	27,908	19,607	29.74%	0.7573	0.8750

Figure 8.10 Plot of Cumulative Observed and Model-predicted Runoff Volumes



8.3 Conclusions on Prediction Accuracy

The results of the test based on 2011-14 daily stream flows and using statistical and modeling tools calibrated with 2008-11 data are generally within acceptable ranges, based on the values of the correlation R^2, the general shape of the hydrographs, and the runoff volume. The strong correlation between the Pudding River and Drift Creek stream flows is a steady foundation to build on in any attempt to extend the hydrologic data base, especially when using a longer time step that minimizes the impact of time shift between discharges at stations that are 30+ miles apart. Hence, correlation between monthly average flows is always higher than correlation between daily flows.

The other possible option involving the use of a rainfall-runoff model also produces reasonably acceptable results, in terms of hydrograph shapes and timing of high discharges -- although not as good as the equivalent, regression-based predictions. This is due mostly to the use of a unique rainfall station (Salem Airport) as precipitation index to the entire Drift Creek basin and the challenging need to specify the right rainfall multiplier every year to match the runoff volume of that year.

Based on the foregoing, regression-based predictions for Upper Drift Creek appear to be more accurate than model-based predictions. However, both regression and modeling deserve to be further investigated to complement each other and to respond to other study needs, such as real-time inflow forecasting and probable maximum flood events determination.

9. Updated Ranking of Low, Average and High Runoff Water Years

Representative low, average and high flow years are needed to define the range of runoff conditions that can be expected at the project site based on historical flow data. Data for the Pudding River near Aurora site were used because they cover the longest stream flow gauging records of all streams in the same general physical area as Drift Creek, and produce a high statistical correlation indicator R^2 with the Drift Creek Upper site data.

Figure 5.28 and Table 5.6, which are shown earlier in this report, contain the observed annual (October-September) runoff volumes of the Pudding River at Aurora ranked from highest to lowest for the 52 fully monitored years between 1928 and 2014. The ranking is used to help identify the typical average, low and high runoff water years as described further below.

The mean annual (October-September) runoff volume for those 52 years is about 894,000 AF. This 50% exceedance level volume is between the 916,004 AF recorded in 1957-58 (ranked 25th out of 52) and the 867,553 aft recorded in 1933-34 (ranked 26th out of 52). Therefore, using this criteria, the 26th ranked 1933-34 water year qualifies as the representative average water year (RAY).

The annual (October-September) runoff volume that is exceeded 80% of the 52 years (52 x0.80=41.6 years) corresponds to the 42+1=43th ranked. The 43th ranked 1935-36 water year, with an annual runoff volume of 687,904 AF, thus qualifies as a representative low flow year (RLY). Note that in the previous (2012) analysis, the 1944-45 water year with an annual runoff volume of 695,169 AF was the selected RLY).

By the same token, the annual runoff volume that is exceeded 20% of the 52 years corresponds to the 10+1=11th ranked runoff. Based on that criteria, the 11th ranked 1947-48 water year, with an annual runoff volume of 1,095,130 AF, is selected as representative high flow water year (RHY). Note that in 2012, the 1949-50 water year with an annual runoff volume of 1,127,442 AF was the selected RHY, which superseded the 1947- 48 water year with an annual runoff volume of 1,095,130 aft selected as RHY in Report Update #2. This was the result of the 2010-11 water year (with an annual runoff volume of 1,154,752 AF) being ranked 8th, ahead to 1949-50 and 1947-48. See Table 9.1.

Because of the strong correlation between the stream flows of the Pudding River at Aurora and those at the project site, as confirmed by the data collected during 2008-14, those same representative years for Pudding River at Aurora will be treated as typical average, low, and high water years respectively for Drift Creek at the project site as well.

It should be noted that the changes in average, low, and high water years due to the addition of the latest flow data are procedural in nature and may be driven only by a relatively small (less than 0.2%) change in runoff volume and/or water year ranking, and not by the runoff hydrograph shape. Because the selection of representative years was only based on annual runoff volume ranking, candidate water years may have comparable volume amounts but the shape of their runoff hydrograph may be different.

Table 9.1 Summary of Representative Years Selection

Flow Years	Representative Hydrologic Years	Observed Oct-Apr. Runoff Vol. (AF) Pudding @ Aurora	Multiplier (if applied)
High	1947-48 (1949-50) (1947-48) (1949-50)	961,931 (1,008,572) (961,931) (1,008,572)	 (0.037) (0.038) (0.0362)
Average	1933-34 (1933-34) (1933-34) (1957-58)	798,321 (798,321) (798,321) (851,445)	 (0.037) (0.038) (0.0362)
Low	1935-36 (1944-45) (1944-45) (1935-36)	585,279 (550,657) (550,657) (585,279)	 (0.037) (0.038) (0.0362)

Once the high, average and low water years are selected, the estimated Upper Drift Creek stream flows for those years are generated using the order 2 polynomial regression equation linking 2008-14 stream flow data at Pudding River at Aurora with those at Upper Drift Creek to define the shape of the hydrographs. Furthermore, those regression-based stream flows need to be adjusted to ensure that the annual runoff volume matches the equivalent volume for the Pudding River at Aurora, i.e. using an adjustment factor equal to the average volume ratio for the 2008-14 period.

Calculation details for the 6-year average volume ratio are shown in Table 9.2.

Table 9.2 Calculation of Runoff Volume Adjustment Factor

Water Year	Upper Drift Annual Runoff Volume V1	Pudding@Aurora Annual Runoff Volume V2	Ratio V1/V2
2008-09	22,629	641,582	0.03527
2009-10	33,827	821,837	0.04116
2010-11	37,606	1,154,752	0.03257
2011-12	36,178	1,069,775	0.03382
2012-13	28,553	774,173	0.03688
2013-14	27,908	766,771	0.03640
Average 2008-14			0.036016

To complete the hydrographs of the representative flow years, the following steps were performed as listed below and summarized in Table 9.3:

- Step I: determine the expected annual runoff volume for Pudding River at Aurora during the selected three years --1935-36, 1933-34 and 1947-48.
- Step II: estimate Upper Drift Creek's annual runoff volume for those same three years using the 0.036016 multiplier.

- Step III: calculate the Upper Drift Creek regression-based flows (using the polynomial 2 formula: Y=-0.000002*X^2+0.0566*X+0.7543), and
- Step IV: calculate Upper Drift Creek's corresponding annual runoff volumes and the adjustment factor needed to maintain the proper ratio with Pudding River runoff volume. Apply that correction faction to the regression-based daily stream flows.

Table 9.3 Estimation of Upper Drift Creek's Runoff Volumes

Step I) Pudding River at Aurora Monthly Flows, cfs

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Lo 35-36	135.9	318.7	668.3	4351.6	1773.4	1428.1	1001.7	858.9	489.3	191.2	68.5	79.9
Av 33-34	295.4	699.7	5170.3	3633.2	864.4	1324.8	1141.8	695.5	207.2	101.8	68.2	62.2
Hi 47-48	1774.2	*12.3*	1518.2	3663.5	2311.4	2454.2	1730.0	1416.3	395.6	146.1	109.2	116.4

Step II) Annual Runoff volume

	Pudding/AuroraAnnual Runoff Volume, AF (1)	Multiplier (2)	Estimated Upper Drift Ann. Runoff Vol: (1)*(2)
Lo 35-36	684,370	0.036016	24,648
Av 33-4	869,277	0.036016	31,308
Hi 47-48	1,095,201	0.036016	39,444

Step III) Upper Drift's Regression-based, Unadjusted Monthly Flows, cfs

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Lo 35-36	8.40	18.52	37.36	199.04	91.43	76.66	55.22	47.77	27.94	11.49	4.62	5.26
Av 33-4	16.97	38.84	218.91	177.59	48.02	70.84	61.39	38.92	12.39	6.50	4.60	4.27
Hi 47-48	88.65	127.50	81.24	160.81	115.00	126.03	92.62	76.09	22.79	8.98	6.91	7.31

Step IV) Adjustment of Annual Runoff Volume

	Upper Drift Unadjusted Regression-based Annual Runoff Volume, AF (1)	Target Upper Drift Creek Annual Runoff Volume, AF (from Step II) (2)	Multiplier to use to Adjust Estimated Regression-based Stream Flows of Upper Drift Creek (3)=(2)/(1)
Lo 35-36	35,308	24,648	0.6981
Av 33-4	42,467	31,308	0.7372
Hi 47-48	55,230	39,444	0.7142

Figure 9.1 shows the hydrographs of the estimated daily flows at Upper Drift Creek for the representative low, average and high flow years. Figure 9.2 shows the plots of the equivalent monthly flows. The most visible factor that appears to best characterize those years is the runoff volume during the October-December period. Figure 9.3 shows the cumulative runoff volume for each year.

Figure 9.1 Estimated Drift Creek's daily flows during representative low, average and high flow years.

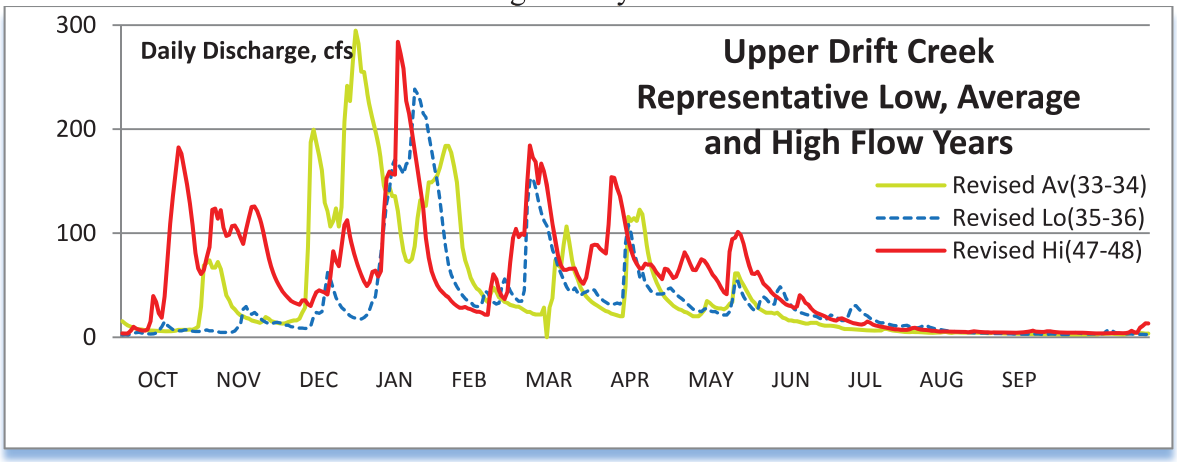


Figure 9.2 Plots of Estimated Drift Creek's Monthly flows during representative low, average and high flow years.

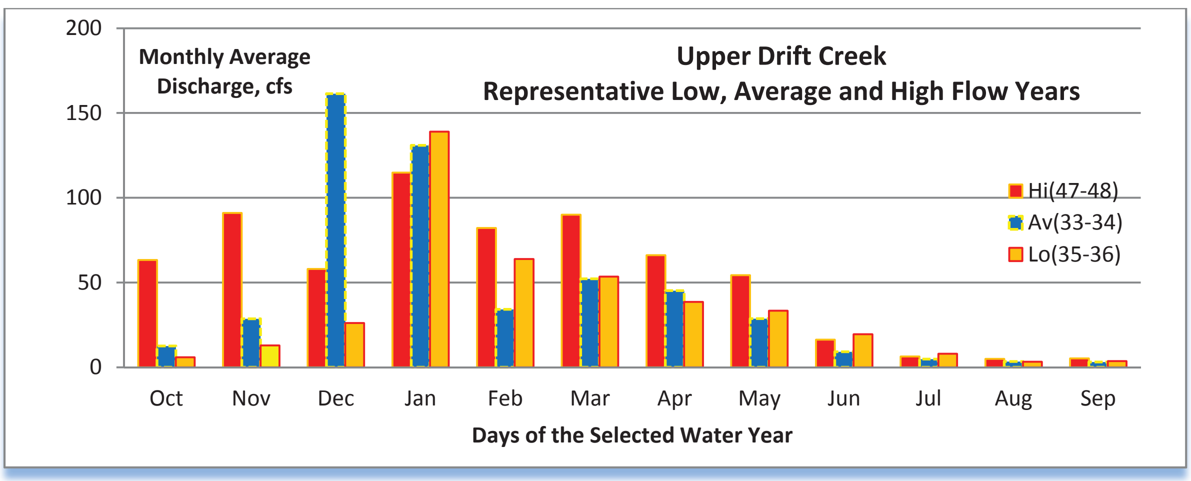
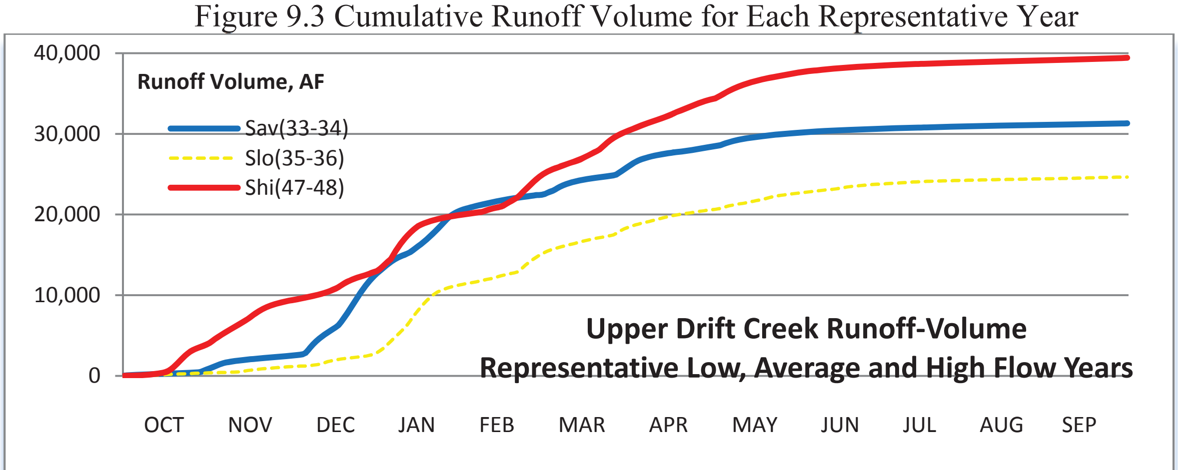


Figure 9.3 Cumulative Runoff Volume for Each Representative Year



It should be noted that another potential procedure to generate daily flows for representative flow years is through rainfall and/or snow-based modeling tools. Daily discharge reconstitution for the three representative years using the rainfall-runoff FLO4DRIFT model is feasible pending selection of appropriate sets of annual rainfall data that would qualify as “high”, “average” and “low” precipitation years. This alternative has not been fully explored, due to the lack of rainfall data and lower study priority.

Another impediment in the modeling option is the lack of data on snow-fed runoff on Drift Creek, as a sizeable portion of the runoff during high flow years in this basin is most probably derived from snow-melt. Snow daily data that are available now through the Portland National Weather Service page: http://www.weather.gov/climate/index.php?wfo=pqr only go back roughly 5 years. If in the future such a reconstitution is deemed necessary, data going back to 1892 from Salem, including daily max/min/average temperature, heating and cooling degree days, precipitation, snowfall and snow depth could be ordered from the Western Regional Climate Center, 2215 Raggio Parkway, Reno, NV 89512 Phone: 775-674-7010 Fax: 775-674-7001 http://www.wrcc.dri.edu

The estimated (and adjusted) daily stream flows data for the three representative flow years are listed in the Appendix for potential use in other study applications.

10. Updating of Previous October-April Runoff Volume Frequency Curve

The runoff volume estimates for Drift Creek described in the February 2007 report were only based on drainage area and basin mean annual precipitation-- not on actual runoff data which were then not available. The first update of the original estimates was made based on the relationships established between actual monthly discharges of the Pudding River near Aurora and those of Drift Creek at the project site using the 2008-2009 stream flow measurements. Those estimates have been gradually updated to reflect the significance of the more recent stream flow measurements.

The procedure includes the steps listed below and is further illustrated by numbers shown in Table 10.1:

- Compiling existing historical October-April runoff volumes for Pudding River near Aurora over the entire 1928-2014 period of record,
- Multiplying the Pudding River data by a factor of 0.0348 (see Table 5.7) (except for 2008-14 for which actual Upper Drift October-April runoff volumes are used) to produce the corresponding October-April runoff volumes for Drift Creek at the project site. The previous multiplier used in Report Update #1 was 0.0362. It was changed to 0.038 in the Report Update #2.
- Performing the statistical frequency analysis to produce an updated frequency curve for the October-April runoff volume. Calculations were made according to the procedure outlined in the U.S. Army Corps of Engineers manual, “Statistical Methods in Hydrology” by L. Beard (1962).

The accuracy of the frequency curve relies heavily on the single multiplier used to convert the October-April runoff volumes from the Pudding River near Aurora to Drift Creek at the project site. That multiplier is only based on six years of observed data, and will need to be updated as more data are collected. Multipliers that vary with the runoff and precipitation conditions and thus change from year to year would be more appropriate. In that sense, data permitting, the use of a precipitation-runoff model would an improvement.

Table 10.1 Details of Statistical Volume Frequency Calculation

N	Hydro Yr Oct-Apr	Pudding Oct-Apr Vol (AF)	Drift Oct-Apr Vol (AF)	Log(Vol) X	X^2	Dev X-M x	x^2
		Multiplier=	0.0348				
1	1928-29	470,330	16,367	4.213982	17.757644	-0.203660	0.041477
2	1029-30	506,791	17,636	4.246408	18.031982	-0.171234	0.029321
3	1930-31	498,485	17,347	4.239231	17.971082	-0.178411	0.031830
4	1931-32	904,509	31,477	4.497992	20.231933	0.080350	0.006456
5	1932-33	840,124	29,236	4.465923	19.944465	0.048281	0.002331
6	1933-34	798,321	27,782	4.443757	19.746974	0.026115	0.000682
7	1934-35	778,303	27,085	4.432728	19.649077	0.015086	0.000228
8	1935-36	585,279	20,368	4.308942	18.566983	-0.108700	0.011816
9	1936-37	616,209	21,444	4.331307	18.760223	-0.086335	0.007454
10	1937-38	1,122,245	39,054	4.591667	21.083405	0.174025	0.030285
11	1938-39	539,529	18,776	4.273594	18.263606	-0.144048	0.020750
12	1939-40	648,682	22,574	4.353611	18.953930	-0.064031	0.004100
13	1940-41	419,148	14,586	4.163947	17.338452	-0.253695	0.064361
14	1941-42	613,602	21,353	4.329466	18.744276	-0.088176	0.007775
15	1942-43	1,147,435	39,931	4.601307	21.172029	0.183665	0.033733
16	1943-44	454,753	15,825	4.199355	17.634581	-0.218287	0.047649
17	1944-45	550,657	19,163	4.282460	18.339467	-0.135182	0.018274
18	1945-46	894,637	31,133	4.493226	20.189081	0.075584	0.005713
19	1946-47	734,364	25,556	4.407491	19.425974	-0.010151	0.000103
20	1947-48	961,931	33,475	4.524723	20.473120	0.107081	0.011466
21	1948-49	909,843	31,663	4.500546	20.254912	0.082904	0.006873
22	1949-50	1,008,572	35,098	4.545286	20.659626	0.127644	0.016293
23	1950-51	1,237,781	43,075	4.634223	21.476023	0.216581	0.046907
24	1951-52	868,953	30,240	4.480576	20.075557	0.062934	0.003961
25	1952-53	811,270	28,232	4.450745	19.809128	0.033103	0.001096
26	1953-54	1,025,958	35,703	4.552709	20.727158	0.135067	0.018243
27	1954-55	674,511	23,473	4.370568	19.101867	-0.047074	0.002216
28	1955-56	1,357,641	47,246	4.674364	21.849681	0.256722	0.065906
29	1956-57	648,236	22,559	4.353312	18.951329	-0.064330	0.004138

30	1957-58	851,445	29,630	4.471736	19.996421	0.054094	0.002926
31	1958-59	834,219	29,031	4.462859	19.917113	0.045217	0.002045
32	1959-60	642,653	22,364	4.349556	18.918636	-0.068086	0.004636
33	1960-61	1,056,599	36,770	4.565489	20.843694	0.147847	0.021859
34	1961-62	660,499	22,985	4.361451	19.022258	-0.056191	0.003157
35	1962-63	780,119	27,148	4.433740	19.658051	0.016098	0.000259
36	1963-64	746,995	25,995	4.414897	19.491315	-0.002745	0.000008
37	1993-94	473,466	16,477	4.216868	17.781976	-0.200774	0.040310
38	1994-95	890,685	30,996	4.491303	20.171806	0.073661	0.005426
39	1995-96	1,302,397	45,323	4.656323	21.681340	0.238681	0.056968
40	1996-97	1,373,397	47,794	4.679375	21.896554	0.261733	0.068504
41	2002-03	759,339	26,425	4.422015	19.554216	0.004373	0.000019
42	2003-04	691,029	24,048	4.381076	19.193823	-0.036567	0.001337
43	2004-05	381,407	13,273	4.122968	16.998864	-0.294674	0.086833
44	2005-06	1,000,928	34,832	4.541982	20.629601	0.124340	0.015460
45	2006-07	908,008	31,599	4.499669	20.247020	0.082027	0.006728
46	2007-08	831,396	28,933	4.461387	19.903976	0.043745	0.001914
47	2008-09	551,076	19,159	4.282374	18.338727	-0.135268	0.018297
48	2009-10	638,574	25,601	4.408259	19.432746	-0.009383	0.000088
49	2010-11	1,013,493	32,049	4.505816	20.302380	0.088174	0.007775
50	2011-12	949,805	31,419	4.497193	20.224743	0.079551	0.006328
51	2012-13	688,577	24,102	4.382054	19.202400	-0.035588	0.001266
52	2013-14	679,148	23,235	4.366143	19.063204	-0.051499	0.002652
				X	X^2	x	x^2
			N=	52			
			S(X)=	229.93798		0	0.896235
			M=	4.42188423			
			S(X^2)=		1017.65443	S^2=	0.01757323
			[S(X)^2]/N		1016.75913	S=	0.13256407
			S(x^2)=		0.896235		

Pn	0.25	1	10	50	90	99	99.75
k (N=52)	2.979	2.432	1.316	0.000	-1.316	-2.432	-2.979
Log(V)=	4.816726	4.744280	4.596272	4.421884	4.247496	4.099488	4.027042
Vol, AF	65,573	55,498	39,470	26,417	17,681	12,574	10,642

	LogQ=M+kS						
N-1=40	3.01	2.45	1.32	0	-1.32	-2.45	-3.01
N-1=60	2.94	2.41	1.31	0	-1.31	-2.41	-2.94
N-1=51	2.979	2.432	1.316	0.000	-1.316	-2.432	-2.979

All previously made statistical October-April runoff volume estimates are listed in Table 11.2 for the same frequencies of occurrence. Those estimates include:

1) Estimates made in 2007, based on **78** years of observed and **synthesized** Pudding River runoff between 1928 and **2005**),
2) Estimates made in 2010 (based on **47** years of observed Pudding River runoff between 1928 and **2009,** and using a 0.0362 flow conversion multiplier),
3) Estimates made in **2011** (based on **48** years of Pudding River data between 1928 and 2010, and using a 0.038 flow conversion multiplier),
4) Estimates made in 2012 (based on **49** years of Pudding River data between 1928 and 2011, and using a 0.037 flow conversion multiplier), and
5) Estimates made in 2014 (based on **52** years of Pudding River data between 1928 and 2014, and using a 0.0348 flow conversion multiplier.

There are some slight volume changes between the various October-April runoff volume estimates made over the past six years. They all look reasonably favorable with respect to the 12,000 acre-foot storage volume target used for the project. They also match OWRD water surface availability data covered in Section 12.

Table 10.2. Statistical October-April Runoff Volume Estimates for Drift Cr. @ Victor Point, using 52 years of Pudding River Observed Flows

Pn	0.25	1	10	50	90	99	99.75
Recurrence Interval (Years)	400	100	10	2	1.11	1.01	1.0025
Vol (date:2014)	65,573	55,498	39,470	26,417	17,681	12,574	10,642
Vol (date:2012)	70,532	59,571	42,164	27,858	18,407	13,028	11,003
Vol (date:2011)	73,617	61,887	43,377	28,628	18,894	13,243	11,133
Vol (date:2010)	70,468	59,521	41,661	27,360	17,968	12,576	10,622
Vol (date:2007)	98,736	82,429	58,384	38,522	25,417	18,002	15,029

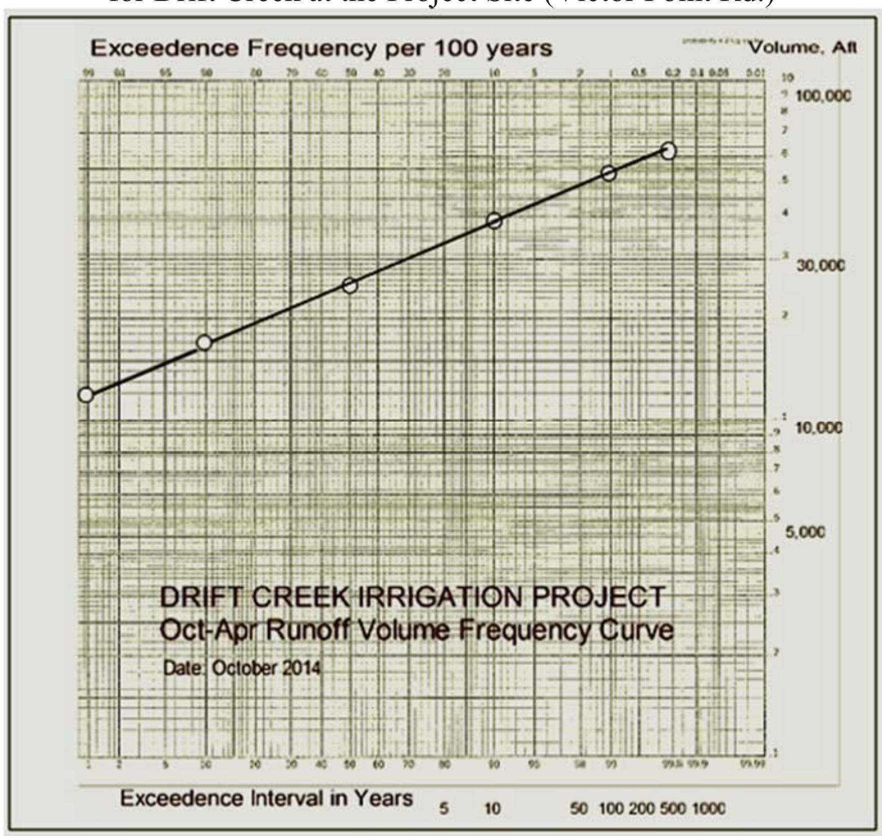
The updated October-April runoff volume frequency curves for Drift Creek at the project site based on the 2008-14 stream flow gauging records are shown in Figure 10.1.

For the record and to be fully consistent with the 2007 results, a statistical frequency analysis was also performed using flows for Pudding River near Aurora flows covering the entire 86 years between 1928 and 2014, including 52 years of observed flows and 34 more years of synthesized flows using rainfall and snow data at Salem. A 0.037 multiplier (instead of 0.0362 used in 2010 and 0.038 used in 2011) was used to convert Pudding River flows into Drift Creek flows. The results are summarized in Table 10.3, along with (1) previously estimated runoff volumes using 82 years of combined observed and synthesized data, and (2) estimated runoff volume using 49 years of actually observed data. Details of the calculation under this procedure are provided in the Appendix.

Table 10.3 Statistical October-April Runoff Volume Estimates for Drift Cr. @ Victor Point, using 86Years of Pudding River Observed and Synthesized Data (1928-2014)

Pn	0.25	1	10	50	90	99	99.75
k (N=86)	2.899	2.387	1.298	0.000	-1.298	-2.387	-2.899
Log(V)=	4.805492	4.734185	4.582760	4.402116	4.221472	4.070046	3.998739
Vol, AF	63,899	54,223	38,261	25,242	16,652	11,750	9,971

Figure 10.1 October-April Runoff Volume Frequency Curve
for Drift Creek at the Project Site (Victor Point Rd.)



11. Water Availability and Draft Water Use Permit

Two OWRD issues that directly affect this hydrologic update --water availability and water use permit provisions-- are discussed in this section. The procedure used to estimate the 90% and 95% exceedance frequencies, which are not covered by OWRD, and its results are also documented.

11.1 Water Availability

OWRD defines water availability as *"the amount of water that can be appropriated from a given point on a given stream for new out-of-stream consumptive uses. It is obtained from the natural stream flow by subtracting existing in-stream water rights and out-of-stream* *consumptive uses*". . Current standards for new appropriation of water are: *(1) consumptive use from allocations for out-of-stream uses can total no more than the 80-percent exceedance natural stream flow, and (2) allocations for in-stream flows can be no more than the 50-percent exceedance natural stream flow".*

OWRD provides up-to-date water availability data for Drift Creek at its confluence with the Pudding River for the 50% and 80% exceedance levels at the following address: http://apps.wrd.state.or.us/apps/wars/wars_display_wa_tables/display_wa_details.aspx?ws_id=70781&exlevel=80&scenario_id=1

Originally, the drainage area used for that site was shown as being 17.91 sq. mi., which is different from the 25.1 sq. mi. area calculated by Harvest Geographics, Inc. for the same location and lower than the 24.8 sq. mi. area used by Marion Water and Conservation Service District for a Drift Creek stream gauging site near Silverton and upstream from the mouth of Drift Creek. Following contacts by members of the project team, OWRD recognized that Drift Creek watershed was incorrectly delineated and subsequently changed the drainage area to 25.25 sq. mi. in early April 2010. The revised OWRD also reports a mean annual precipitation over Drift Creek watershed of 61.61 inches.

The water availability data as of 5/5/2015 shown on OWRD's website are listed in Table 11.1 for the 50% and 80% exceedance levels. Compared to the previous data postings, in-stream flow requirements remain the same but updates were made by OWRD for Consumptive Uses and Storages, as confirmed during a conference call on June 9, 2015. As a result, data shown for the Expected Stream Flows (third column from the right hand side) and Net Water Available (last column to the right) have been changed. The new numbers include the older flows and the additional flows requested by EVWD in its water use permit application, which was submitted in February 2013 and recommended for approval with conditions by OWRD in July 2014.

Table 11.1 Revised Water Availability Data for Drift Creek at Its Mouth, in cfs
(as of 5/5/2015)

a) <u>50% Exceedance</u> DRIFT CR > PUDDING R - AT MOUTH

Water Availability as of 5/5/2105

Col. 1	Col. 2	Col.3	Col. 4	Col. 5	Col. 6	Col. 7
Month	**Natural Stream Flow**	**Consumptive Uses and Storages**	**Expected Stream Flow**	**Reserved Stream Flow**	**Instream Flow Requirement**	**Net Water Available**
JAN	149.00	54.40	94.60	0.00	40.00	54.60
FEB	133.00	46.40	86.60	0.00	40.00	46.60
MAR	108.00	33.20	74.80	0.00	40.00	34.80
APR	68.10	13.70	54.40	0.00	40.00	14.40
MAY	32.70	0.22	32.50	0.00	30.10	2.38
JUN	41.90	0.44	41.50	0.00	13.60	27.90
JUL	18.30	0.77	17.50	0.00	3.00	14.50
AUG	8.40	0.61	7.79	0.00	2.00	5.79
SEP	4.65	0.30	4.35	0.00	2.00	2.35

OCT	7.56	0.02	7.54	0.00	5.26	2.28
NOV	61.10	10.80	50.30	0.00	40.00	10.30
DEC	138.00	48.80	89.20	0.00	40.00	49.20
ANN	46,300.00	12,600.00	33,700.00	0.00	17,800.00	15,900.00

Average annual stream flow discharge at 50% Exceedance level = 63.88 cfs

b) 80% Exceedance DRIFT CR > PUDDING R - AT MOUTH

Water Availability as of 5/22/2012

Month	Natural Stream Flow	Consumptive Uses and Storages	Expected Stream Flow	Reserved Stream Flow	Instream Flow Requirement	Net Water Available
JAN	67.30	54.40	12.90	0.00	40.00	-27.10
FEB	74.90	46.40	28.50	0.00	40.00	-11.50
MAR	66.80	33.20	33.60	0.00	40.00	-6.36
APR	48.80	13.70	35.10	0.00	40.00	-4.93
MAY	24.20	0.22	24.00	0.00	30.10	-6.12
JUN	11.50	0.44	11.10	0.00	13.60	-2.54
JUL	5.51	0.77	4.74	0.00	3.00	1.74
AUG	3.34	0.61	2.73	0.00	2.00	0.73
SEP	3.09	0.30	2.79	0.00	2.00	0.79
OCT	4.27	0.02	4.25	0.00	5.26	-1.01
NOV	23.70	10.80	12.90	0.00	40.00	-27.10
DEC	65.80	48.80	17.00	0.00	40.00	-23.00
ANN	46,300.00	12,600.00	33,700.00	0.00	17,800.00	15,900.00

Average annual stream flow discharge at 80% Exceedance level = 33.05 cfs

OWRD exceedance stream flows *"are determined directly from gage records, or for ungaged streams, by estimation through modeling"*. Since the natural stream flow numbers listed above were listed long before October 2008, when actual stream flow monitoring started at the Upper Drift Creek station, those numbers must have been based on modeling results. The following paragraphs document the extent to which the listed 50% and 80% annual runoff volume compare with actually monitored stream flow volumes.

For the 50% exceedance, the OWRD-calculated natural stream flow volume is 39,817 AF for the October-April runoff volume of Drift Creek at its mouth -- a 25.25 sq. mi. drainage area. The actually observed runoff volume for Drift Creek at the lower gauging station (24.8 sq. mi. drainage area) for October 2009-April 2011 (a slightly below average water year) was 35,699 AF. After drainage area adjustment, the observed runoff volume for Drift Creek at its mouth would be 35,699*(25.25/24.8) = 36,347 AF. As calculated, the two numbers are off by less than 9%, part of which could be attributed to higher rainfall distribution over the lower part of the watershed.

For the 80% exceedance flows, the OWRD-calculated natural stream flow volume for Drift Creek at its mouth is only 18,100 AF. This is considerably lower than the 27,847 AF runoff volume observed at Hibbard Road during the October 2008- April 2009 period, a water year that can classified as a low flow year at the 80% or even a lower exceedance level. This could either indicate that the OWRD data for the 80% exceedance level is underestimated or that the 2008-09 flow year should have been ranked higher compared to other historical years. Obviously, this cannot be reliably determined yet with just six years of actual stream flow data.

As briefly discussed with OWRD staff at the June 9, 2015 conference call, updating of the natural stream flows currently shown in Column 2 of the OWRD water availability 50% and 80% exceedance tables is not being contemplated by the Department any time in the near future. Therefore, absent changes in numbers shown in columns 3, 5 and 6, numbers in columns 4 and 7 will not change.

11.2 Draft Water Use Provisions

As listed in the Proposed Final Order to Water Rights Application Number R-87871 issued by OWRD-Water Rights Service Division on July 22, 2014, recommendations include the following:

- Source of water: unnamed streams, tributaries of Drift Creek, and Drift Creek, tributary of Pudding River
- Storage facility: Drift Creek Reservoir
- Purpose or use of the stored water: storage for irrigation and flow augmentation
- Maximum volume: 12,000 acre-feet each year
- Water may be appropriated for storage during the period: November 1 through April 30
- The permittee shall pass all live flow during May 1 through October
- Date of priority: February 21, 2013

All of the above provisions have been complied with in hydrologic model studies completed to date. The only partial exceptions are (1) the new October - April refill season, and (2) the provision to pass all live flows during May 1 through October. As modeled so far, both refilling the reservoir and passing live flows are not date specific, but inflow and minimum in-stream flow requirement specific. A result, the impacts of those two new provisions turned out to be relatively minimal. Future model runs will more strictly apply the two provisions.

Also, as stated in the draft permit, "*the use of water allowed herein may be made only at times when sufficient water is available to satisfy all prior rights, including prior rights for maintaining in-stream flows"*. Therefore, identifying those prior rights and including them in the model study as part of the reservoir release requirements will be necessary in future study updates.

The project team should continue to work closely with OWRD staff to stay informed, watch for any changes in the draft water use permit, address those changes in the model study, and document their impacts on previous study results.

11.3 Estimating 90% and 95% Exceedance Monthly Flows

Two additional exceedance frequencies, 90% and 95%, are needed for Drift Creek natural monthly flows to support further discussions on reservoir release operations. To perform this task, a procedure was developed based on observed stream flow data collected during the 2008-2014 hydrologic years to reflect actual runoff conditions, and using the OWRD 80% exceedance frequencies to ensure maximum consistency with OWRD data.

The steps involved are as follows:

1. Develop flow duration curves for each month, using the October 2008-September 2014 observed daily flows recorded at the Upper Drift Station; read out the monthly flow values for 50%, 80%, 90% and 95% exceedance frequencies;
2. Adjust the above values to calculate equivalent numbers applicable to Drift Creek at the mouth. The multiplier used is equal to the drainage area at the mouth divided by the drainage area at Upper Drift Creek, 25.25/14.50=1.6961;
3. Calculate the multipliers needed to match the results of Step 2 estimates with OWRD's 50% and 80% values; and
4. Use linear interpolation from the 50% and 80% multipliers to calculate the multipliers needed for the 90% and 95% exceedance values.

The above procedure is summarized in Table 11.2, and the results are illustrated in Figure 12.1 covering the 50%, 80%, 90% and 95% exceedance values.

Figure 11.1 50%, 80%, 90% and 95 % Exceedance Natural Stream Flows for Drift Creek

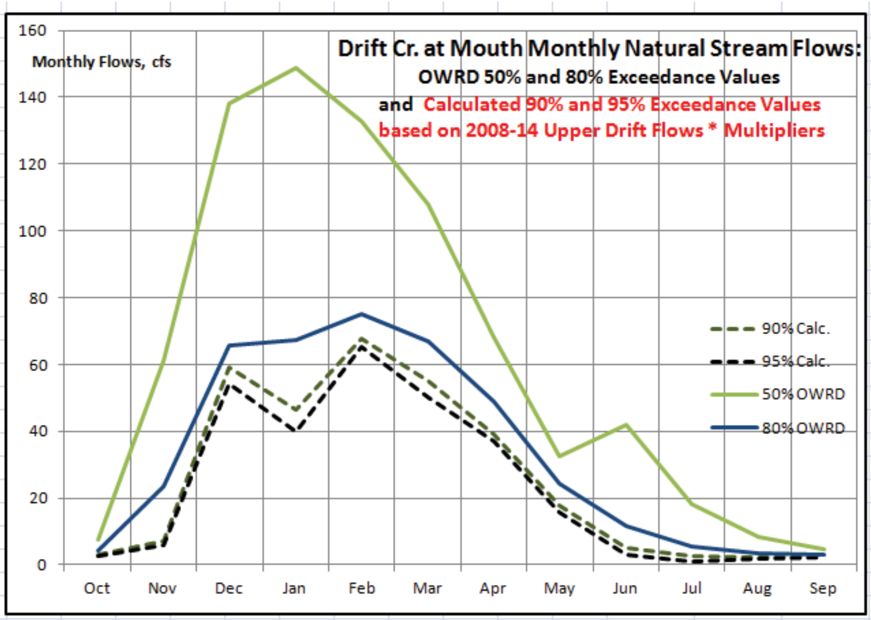


Table 11.1 Procedure to Estimate the 90% and 95% Exceedance Stream Flows for Drift Creek

Row	DATE	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
R2	% Exceed.	cfs	cfs	cfs	cfs	cfs	cfs	cfs	cfs	cfs	cfs	cfs	cfs
R3													
R4	Values based on Duration Curves of 2008-2014 Upper Drift Flows												
R5	50%	3.98	43.93	53.74	63.60	47.81	71.15	60.96	36.20	15.51	5.03	1.25	1.01
R6	80%	1.06	18.02	20.05	34.40	25.00	42.01	30.28	19.78	8.79	2.20	0.35	0.27
R7	90%	0.61	5.39	16.80	25.41	22.12	34.06	21.90	13.31	5.88	1.15	0.23	0.19
R8	95%	0.51	4.78	14.90	22.70	21.00	30.70	20.00	11.32	5.10	0.57	0.15	0.16
R9													
R10	Drainage area, sq.mi.		mouth=	25.25		Upper D	15.40		Mult.=	1.64			
R11													
R12	Values based on Duration Curves of 2008-2014 Upper Drift Flows * Drainage Area adjustment 1.63961												
R13	50%	6.53	72.03	88.11	104.28	78.39	116.66	99.95	59.35	25.43	8.25	2.05	1.66
R14	80%	1.74	29.55	32.87	56.40	40.99	68.88	49.65	32.43	14.41	3.61	0.57	0.44
R15	90%	1.00	8.84	27.55	41.66	36.27	55.85	35.91	21.82	9.64	1.89	0.38	0.31
R16	95%	0.84	7.84	24.43	37.22	34.43	50.34	32.79	18.56	8.36	0.93	0.25	0.26
R17													
R18	OWRD Water Availability (from website)												
R19	50% OWRD	7.56	61.10	138.00	149.00	133.00	108.00	68.10	32.70	41.90	18.30	8.40	4.65
R20	80% OWRD	4.27	23.70	65.80	67.30	74.90	66.80	48.80	24.20	11.50	5.51	3.34	3.09
R21													
R22	Multiplier R19/R13, R20/R14 and Proportional Linear Adjustments from 50% and 80% Data												
R23	50% (Obs-based)	1.16	0.85	1.57	1.43	1.70	0.93	0.68	0.55	1.65	2.22	4.10	2.81
R24	80%(Obs-based)	2.46	0.80	2.00	1.19	1.83	0.97	0.98	0.75	0.80	1.53	5.82	6.98
R25	90%(Obs-based)	2.89	0.79	2.15	1.11	1.87	0.98	1.08	0.81	0.51	1.30	6.39	8.37
R26	95%(Obs-based)	3.11	0.78	2.22	1.08	1.89	0.99	1.13	0.84	0.37	1.18	6.68	9.07
R27													
R28	Calculated Water Availability R15*R25 and R16*R26												
R29	90% Calc.	2.89	6.95	59.13	46.44	67.85	54.98	38.90	17.70	4.96	2.45	2.41	2.61
R30	95% Calc.	2.60	6.11	54.22	40.02	65.16	49.92	37.18	15.66	3.12	1.10	1.64	2.38

12. Ecological and Channel Maintenance Flows

A report was completed in March 2010 by Ellis Ecological Services, Inc. to "address the need for the proposed dam to provide trigger flows for upstream fish migration and flushing flows to move coarse bed streams and enhance habitat conditions below the dam".

Ecological Flows

The Ellis report concluded that "Oregon Department of Fish and Wildlife's in-stream flow water right, which increases incrementally from about 3 cfs in September to 40 cfs by mid-November, should be adequate to trigger upstream migration and provide sufficient water depths for migration through the reach. No other trigger flow requirements were identified in the analyses." Even if some habitat enhancement downstream of the dam site is undertaken, and assuming that spawning and rearing habitat was improved in this reach, more than sufficient flow should be available through ODFW's in-stream flow water to allow access to such habitat improvements.

Flushing Flow Analysis

The Ellis report also indicated that "flushing flows needed to move coarse bed streams are usually provided by a 2-3 year flood event", and estimated that the 2-year flood event would be approximately 630 cfs. Therefore, the project will be required to "bypass all flows greater than 630 cfs".

Based on the above, the dam would have to pass all flows up to ODFW's in-stream flow water right and all flows above the 2-year flood peak of 630 cfs.

13. Reservoir Modeling

There is a need to test how the proposed reservoir would best operate under various inflow conditions to meet all the flow requirements mentioned above and still be able to store enough water for irrigation purposes. Because the project would basically operate alone, for a single purpose, and in a relatively small size watershed, a simple reservoir regulation model, coded name RES4DRIFT, was developed using the Quick-Basic programming language.

RES4DRIFT uses the reservoir storage information prepared by Stuntzner Engineering, including storage elevation, volume, and surface area. See Table 13.1 and Figures 13.1 through 13.4. Release capability numbers were provided by Murray-Smith & Associates for the outlets and by PSU for the 50-foot long broad-crest spillway weir (with crest located at Elevation 667 feet msl). Model parameters related to the upper portion of the reservoir are extracted based on the trend line equations.

The reservoir upper bound is set that same elevation 667' used in the Murray-Smith & Associates report, and the reservoir lower bound is at elevation 620' --compared to an upper bound elevation of 680' used in previous model runs. The Probable Maximum Flood will raise the reservoir over the spillway by 7-Feet to 684'. The top of dam is a safe 3-feet (freeboard) over this elevation at 687'. Therefore, any additional inflow that would drive the elevation higher than 677' would be passed through by the outlet tower or over the spillway.

Table 13.1 Drift Creek Reservoir Characteristics

Elevation (ft msl)	Dam Height, (ft)	Reservoir Area (acre)	Reservoir Storage (AF)	Conduits Cap. (cfs)	Spillway Capacity (cfs)	Total Release (cfs)
616	0	0.40	0	0.0	0	0
620	4	3.66	8	15.0	0	0
621	5		49	92.1	0	92
622	6		89	106.4	0	106
623	7		129	118.9	0	119
624	8		170	130.3	0	130

625	9	4.45	210	140.7	0	141
626	10		251	150.4	0	150
627	11		291	159.6	0	160
628	12		332	168.2	0	168
629	13		372	176.4	0	176
630	14	77.24	413	184.2	0	184
631	15		512	191.8	0	192
632	16		611	199.0	0	199
633	17		710	206.0	0	206
634	18		810	212.7	0	213
635	19	121.27	962	219.3	0	219
636	20		1,115	225.7	0	226
637	21		1,268	231.8	0	232
638	22		1,420	237.9	0	238
639	23		1,573	243.7	0	244
640	24	184.04	1,726	386.0	0	386
641	25		1,946	394.6	0	395
642	26		2,167	403.1	0	403
643	27		2,388	411.4	0	411
644	28		2,608	419.6	0	420
645	29	220.71	2,829	427.6	0	428
646	30		3,050	435.4	0	435
647	31		3,271	443.1	0	443
648	32		3,491	450.7	0	451
649	33		3,712	458.1	0	458
650	34	257.39	3,933	465.5	0	465
651	35		4,212	472.7	0	473
652	36		4,490	479.8	0	480
653	37		4,769	486.8	0	487
654	38		5,048	493.7	0	494
655	39	288.88	5,327	500.5	0	501
656	40		5,606	507.2	0	507
657	41		5,885	513.9	0	514
658	42		6,164	520.4	0	520
659	43		6,443	526.9	0	527
660	44	300.37	6,722	533.3	0	533
661	45		7,035	539.6	0	540
662	46		7,349	545.8	0	546
663	47		7,662	552.0	0	552
664	48		7,976	558.1	0	558
665	49	313.54	8,289	564.1	0	564
666	50		8,603	570.1	0	570

667	51	318.84	8,917	576.0	0	576
668	52		9,230	581.9	901	1,482
669	53		9,544	587.6	2,547	3,135
670	54	326.81	9,857	593.4	4,679	5,273
671	55		10,198	599.1	7,204	7,803
672	56		10,538	604.7	10,068	10,673
673	57		10,878	610.2	13,235	13,845
674	58		11,218	615.8	16,678	17,294
675	59	340.15	11,558	621.2	20,377	20,998
676	60		11,898	626.7	24,314	24,941
677	**61**		**12,238**	**632.1**	**28,477**	**29,109**
678	62		12,579	637.4	32,854	33,491
679	63		12,919	642.7	37,434	38,077
680	64	353.49	13,259	647.9	42,210	42,857
685	69	366.83	14,960	674.6	64,000	64,675
686	70	367.91	15,364	676.2	68,065	68,741
687	71	368.87	15,772	677.6	71,916	72,593
688	72	369.68	16,186	678.8	75,512	76,191
689	73	370.37	16,605	679.7	78,815	79,494

NOTES: 1. Sources: (*)= MSA (**)= PSU Q=25.5 x H^1.5 (metric)
2. Some cells not critical to the analysis are left unfilled.
3. New values related to the top 9 feet of the reservoir are shown in yellow.
4. The 15 cfs outlet capacity added for El. 620 is to meet minimum in-stream flow.

Figure 13.1. Satellite Contour Map of the Proposed Project Site

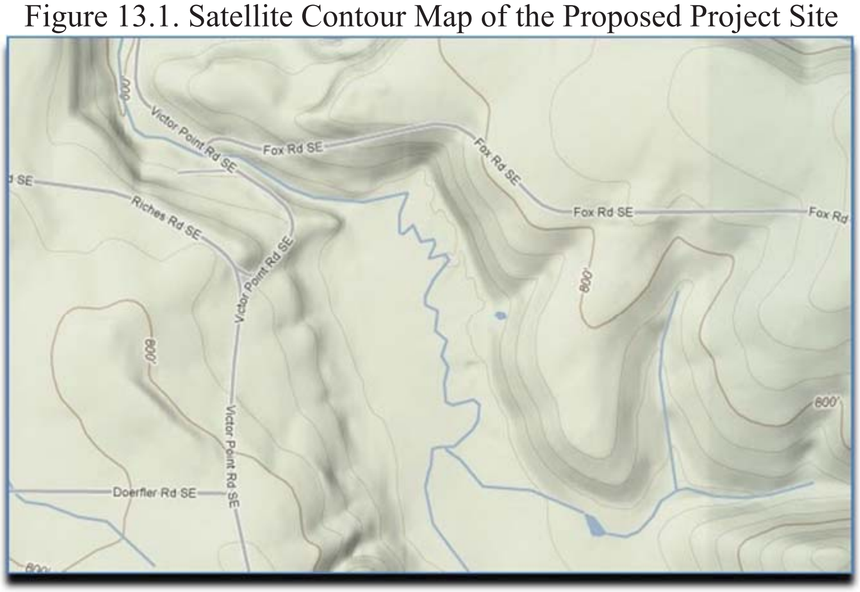


Figure 13.2 Project Dam Height vs. Storage

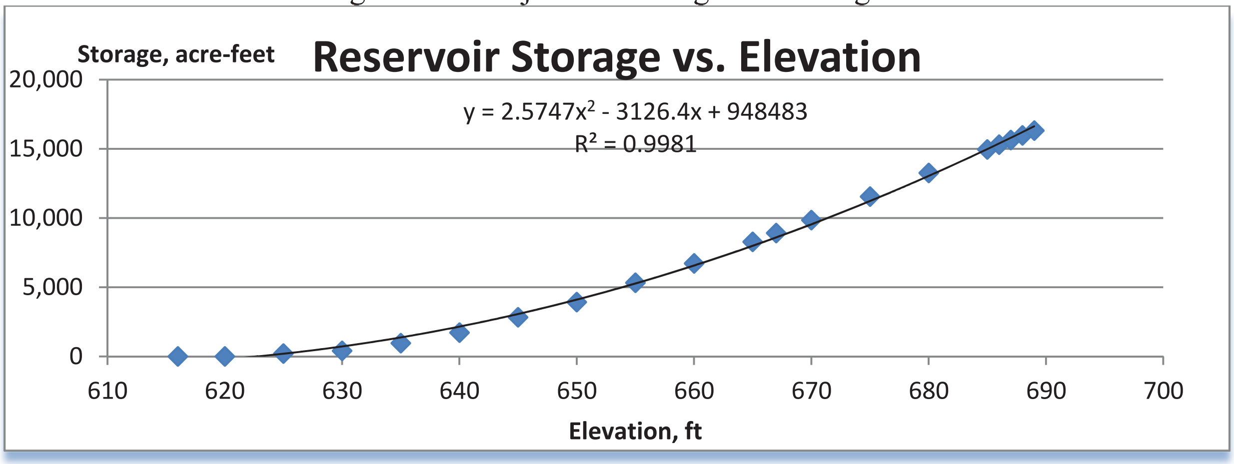


Figure 13.3 Project Area vs. Elevation

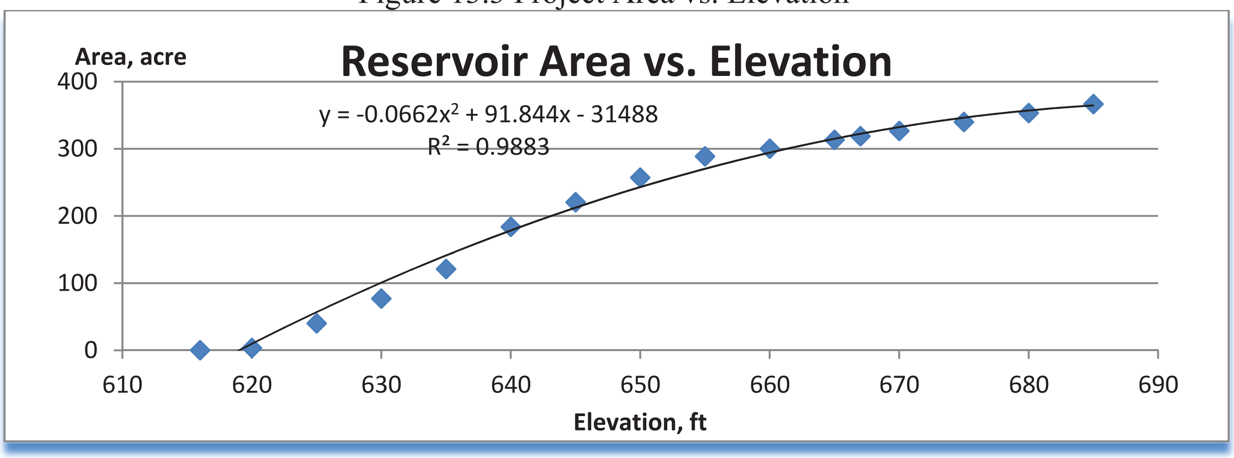


Figure 13.4
Project Outlets Release Capacity (Original source: MSA)

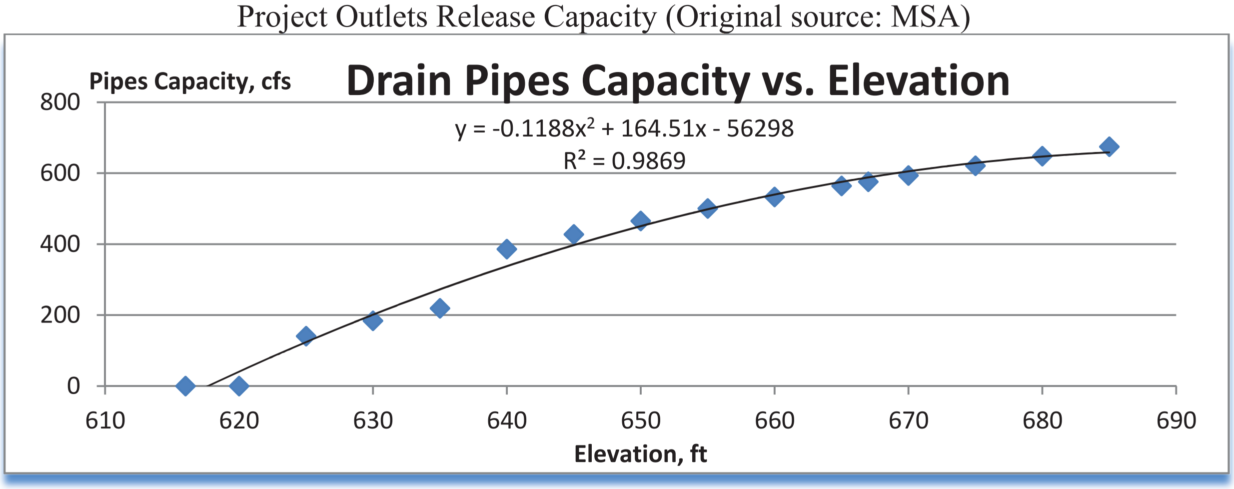
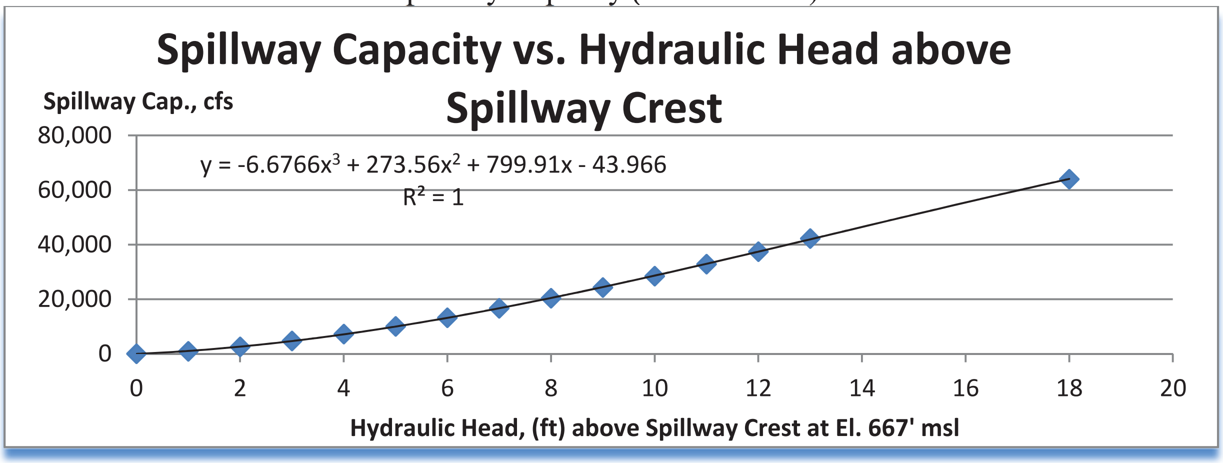
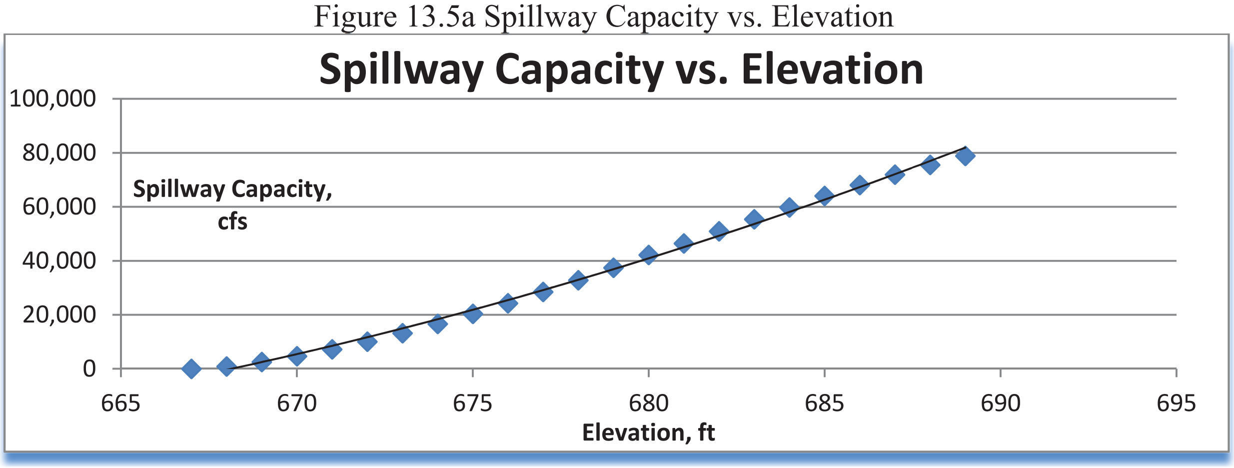


Figure 13.5
Spillway Capacity *(Source: PSU)*



As quoted in the report, "Drift Creek Reservoir model", prepared by PSU Water Quality Research Group in June 2011, "the spillway was … a broad-crested weir. Using the equation for a weir with a well-rounded upstream edge (Streeter and Wylie, 1985): Q=1.67 LH^1.5 where Q was the flow rate (cms), L was the weir width (m) and H was the head". The equation was further reduced to Q(cms)= 22.5 H^1.5, to reflect the 50 foot long spillway width. Note that the polynomial equation and the R^2 value shown in Figure 13.5 above were automatically provided by Excel based on the Outlet Capacity vs. Pool Elevation data. The polynomial equation should yield comparable outlet capacity values as the Q=1.67 LH^1.5 equation. Figure 13.5a is a replicate of Figure 13.5, showing elevation on the X axis.

Figure 13.5a Spillway Capacity vs. Elevation



RES4DRIFT also uses any set of daily inflow data provided by the user. For model testing purpose, flows patterned after the 1957-58 average runoff year were used to simulate the operation. Project releases are subject to flows needed to meet (1) the "Consumptive Uses and Storages", and "In-stream Flow Requirement" numbers listed in OWRD Water Availability Calculation table for Drift Creek at the mouth (see Table 13.2), and (2) the ecological and flushing flow requirements mentioned in the previous section. Project release requirements are summarized in Table 13.2.

Table 13.2 Project Release Requirements, in cfs

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Consumptive Use and Storage	2.28	2.03	0.03	0.04	0.22	0.44	0.77	0.61	0.3	0.02	0.93	2.11
Water Req.	40	40	40	40	30.1	13.6	3	2	2	5.26	40	40
Total	42.28	42.03	40.03	40.04	30.33	14.04	3.77	2.61	2.30	5.28	40.93	42.11
Flushing*	630	630	630	630	630	630	630	630	630	630	630	630

(*) The project is required to "bypass all flows greater than 630 cfs" (no water storing)

Originally, it was conservatively assumed that the flow requirements at the project site are the same as those specified for Drift Creek at its mouth. Hydrologically, applicable water rights and irrigation flows, among others, would be less at the project site than at the mouth of the creek. This is especially true for this case when the drainage area controlled by the project (at Victor Point) is only about 60 percent of the total drainage area of the creek. A detailed inventory of the sites involved, a detailed estimate of the local inflow and, above all, a final call by OWRD will determine the appropriate releases to be made in real-time.

Table 13.3 shows one way to calculate the monthly local inflow between the project site and the mouth of the creek for hydrologic years 2008-09 and 2009-10 respectively. Basically, the local inflow is calculated as the difference between the flow at the mouth (Qmouth) and the flow at the project (Qproj). Qmouth is derived from the flow at the lower (Hibbard Road) station in direct proportion of the drainage area at the mouth (25.25 sq. mi.) and the drainage area at Hibbard Road station (24.8 sq. mi.). Qproj is the flow recorded at the project site, at the Victor Road Junction (15.4 sq. mi.).

Through e-mail exchange back in May 2010 with OWRD Water Rights Section, it was understood that, under some conditions, the project could rely on local inflow to meet part of the relevant in-stream water rights (ISWR) downstream from it. The project may also not be required to release more than the natural inflow at the project site to meet those water rights. As a result, the water right portions that the project has to meet could be lower than the full water rights listed for the creek at its mouth. Therefore, for planning purposes, both options are still kept open in the modeling work.

The other OWRD general guidance was that "*water stored legally needs not be released later unless a call is made by a senior downstream storage right that has not been able to fill despite attempting to make full use of its right to store. This was rare, and may never have happened west of the Cascades. In other words, there is a profound distinction in this regard between stored water and live flow, and any in-stream water right (ISWR) refers to live flow*".

Furthermore, OWRD staff cautioned about the distinction between allocation and regulation. "*Allocation can occur only if water is available; ODFW may also request minimum bypass flows as a permit condition if no ISWR exists. With regard to meeting an ISWR, the flows simply need to be met upon measurement (regardless of whether the right is for a point or reach).*

If they are not met, regulation in favor of them occurs. All live flow must be passed outside the storage season".

The above directions are followed in the reservoir modeling whenever possible, especially when downstream senior water rights can be predicted. Because the modeling work conducted to date is investigative in nature, many reservoir release options that are hydrologically feasible have been considered and evaluated for study purposes.

Table 13.3 Monthly Water Right Requirements at Project Site, cfs

a) October 2008-2009 Water Year

		Mean Monthly Discharges, 2008-09												AFT
Station	DA	OCT 08	NOV 08	DEC 08	JAN 09	FEB 09	MAR 09	APR 09	MAY 09	JUN 09	JUL 09	AUG 09	SEP 09	annual
Drift/Victor	15.4	1.83	22.82	48.19	101.87	38.93	65.90	39.73	45.55	7.25	1.35	0.24	0.49	22629.8
Drift/Lower	24.8	4.20	28.50	117.20	151.50	51.10	100.50	50.30	55.10	9.00	1.80	0.60	0.90	34602.8
Victor/Lower	0.621	0.435	0.801	0.411	0.672	0.762	0.656	0.790	0.827	0.806	0.753	0.393	0.546	0.654
Drift/mouth	25.25	4.3	29.0	119.3	154.2	52.0	102.3	51.2	56.1	9.2	1.8	0.6	0.9	35230.6
ISWR mouth		5.28	40.92	42.09	42.25	42.01	40.02	40.04	30.23	14.04	3.76	2.61	2.30	18,340
Local Flow	9.9	2.5	6.2	71.1	52.4	13.1	36.4	11.5	10.6	1.9	0.5	0.4	0.4	12,601
ISWR Required		2.8	34.7	-29.0	-10.1	28.9	3.6	28.6	19.7	12.1	3.3	2.2	1.9	8,147
Actual ISWR Release		1.83	22.82	0.00	0.00	28.91	3.60	28.56	19.68	7.25	1.35	0.24	0.49	6,764
Check		4.28	29.02	71.13	52.38	42.01	40.02	40.04	30.23	9.16	1.83	0.61	0.92	19,365
Storageable flows		0.00	0.00	48.19	101.87	10.02	62.30	11.17	25.87	0.00	0.00	0.00	0.5	15,895
Salem Rainfall		0.96	3.59	6.02	3.56	2.90	3.03	1.35	3.03	1.39	0.68	0.18	1.20	27.89
Qmouth/Qproj.	1.640	2.34	1.27	2.48	1.51	1.34	1.55	1.29	1.23	1.26	1.35	2.59	1.87	1.67
Qlocal/Qproj	0.640	1.34	0.27	1.48	0.51	0.34	0.55	0.29	0.23	0.26	0.35	1.59	0.87	0.67

b) October 2009-2010 Water Year

		Mean Monthly Discharges, 2009-10												AFT
Station	DA	OCT09	NOV09	DEC09	JAN10	FEB10	MAR10	APR10	MAY10	JUN10	JUL10	AUG10	SEP10	annual
Drift/Victor	15.4	3.2	50.8	59.7	109.4	47.3	68.8	89.6	47.4	72.7	7.9	1.4	2.7	33,777
Drift/Lower	24.8	5.32	73.87	83.32	149.00	69.93	95.16	116.90	57.00	92.53	7.87	1.59	2.87	45,462
Victor/Lower	0.621	0.594	0.688	0.716	0.734	0.677	0.723	0.767	0.832	0.786	1.003	0.868	0.946	0.743
Drift/mouth	25.25	5.4	75.2	84.8	151.7	71.2	96.9	119.0	58.0	94.2	8.0	1.6	2.9	46,287
ISWR mouth		5.28	40.92	42.09	42.25	42.01	40.02	40.04	30.23	14.04	3.76	2.61	2.30	18,345
Local Flow	9.9	2.3	24.4	25.2	42.3	23.9	28.1	29.4	10.6	21.5	0.1	0.2	0.2	12,508
ISWR Required		3.0	16.6	16.9	-0.1	18.1	11.9	10.6	19.6	-7.5	3.6	2.4	2.1	4,798
Actual ISWR Release		3.02	16.55	16.92	0.00	18.13	11.89	10.64	19.63	0.00	3.64	1.38	2.09	6,221
Check		5.28	40.92	42.09	42.34	42.01	40.02	40.04	30.23	21.51	3.76	1.62	2.30	18,729
Storageable flows		0.14	34.29	42.74	109.37	29.19	56.87	78.98	27.80	72.70	4.26	0.00	2.7	27,671
Salem Rainfall		0.96	3.59	6.02	3.56	2.90	3.03	1.35	3.03	1.39	0.68	0.18	1.20	27.89
Qmouth/Qproj.	1.640	1.71	1.48	1.42	1.39	1.50	1.41	1.33	1.22	1.30	1.01	1.17	1.08	1.34
Qlocal/Qproj	0.640	0.71	0.48	0.42	0.39	0.50	0.41	0.33	0.22	0.30	0.01	0.17	0.08	0.34

Starting from a specified pool elevation, the model currently accepts three modes of operation including (1) releasing daily outflows at pre-defined discharge rates for each month of the year, (2) following a rule curve to reach designated end-of-the month elevations, and (3) releasing water above specified inflow rates. The model automatically controls the project release to prevent the reservoir from going below the project's lower bound or above its upper bound. It also keeps track of the release violations when the project cannot release the required outflow either for lack of available storage or reservoir overflow. See Table 13.4.

Table 13.4 Sample RES4DRIFT Model Output

Initial Begin-period: ELE= 653.0 S(aft)=4776.8
Reservoir Upper Bound ELE= 677.00 S(aft)= 12,238
Reservoir Lower Bound ELE= 620.00 S(aft)= 8
SUMMARY RESULTS OF RESERVOIR SIMULATION
Run Date:03-13-2015 00:32:12

I	DA	MO	YR	QIN	ELE1	ISWR	CONSU	QLOC	REQ	QREQ	IRR	QIRR	QREL	V	ELE2	STORAGE
1	1	10	2009	0.70	653.03	5.26	0.02	0.50	4.78	0.70	0.00	0.00	0.70	1	653.03	4,777
2	2	10	2009	0.70	653.03	5.26	0.02	0.50	4.78	0.70	0.00	0.00	0.70	1	653.03	4,777
3	3	10	2009	0.70	653.03	5.26	0.02	0.50	4.78	0.70	0.00	0.00	0.70	1	653.03	4,777
4	4	10	2009	0.70	653.03	5.26	0.02	0.50	4.78	0.70	0.00	0.00	0.70	1	653.03	4,777
5	5	10	2009	0.80	653.03	5.26	0.02	0.57	4.71	0.80	0.00	0.00	0.80	1	653.03	4,777
6	6	10	2009	5.80	653.03	5.26	0.02	4.12	1.16	1.16	0.00	0.00	1.16	0	653.06	4,786
7	7	10	2009	2.90	653.06	5.26	0.02	2.06	3.22	2.90	0.00	0.00	2.90	1	653.06	4,786
8	8	10	2009	1.40	653.06	5.26	0.02	0.99	4.29	1.40	0.00	0.00	1.40	1	653.06	4,786
9	9	10	2009	0.70	653.06	5.26	0.02	0.50	4.78	0.70	0.00	0.00	0.70	1	653.06	4,786
10	10	10	2009	0.30	653.06	5.26	0.02	0.21	5.07	0.30	0.00	0.00	0.30	1	653.06	4,786
11	11	10	2009	0.10	653.06	5.26	0.02	0.07	5.21	0.10	0.00	0.00	0.10	1	653.06	4,786
12	12	10	2009	0.10	653.06	5.26	0.02	0.07	5.21	0.10	0.00	0.00	0.10	1	653.06	4,786

QIN=natural inflow; ELE(1) =beginning-of-day storage elevation; ISWR= sum of in-stream water rights, and storage and irrigation withdrawals; ISWR (in-stream flow at the creek mouth); CONSU (consumptive use and storage); QLOC= local inflow between project site and the mouth of the creek; REQ=required minimum project release to meet in-stream flow requirements); QREQ (actual release to meet in-stream flow requirements); IRR= required irrigation needs); QIRR (actual release for irrigation); QREL= actual project release; VIOL= violation (0=normal, 1=too small inflow, 2=exceed upper bound, 3=exceed lower bound, 4=pass flow greater than 630 cfs for flushing purposes), 5=exceed outlet capacity; ELE(2(=end-of-day storage elevation, in AF).

As for irrigation releases, there are two possibilities to test the ground. The first option is to use a given percentage of the actual volume of the water stored in the reservoir on April 30, VSW, to define the required daily irrigation releases. Assuming a VSW of 8,000 AF, the proposed agricultural release schedule (through the proposed conduit) could be as follows:

10% in May (25.8 AF per day or approximately 13 CFS)
10% in June (26.7 AF per day or approximately 13.5 CFS)
20% in July (51.6 AF per day or approximately 26.0 CFS)
30% in August (77.41 AF per day or approximately 39.0 CFS)
30% in September (80 AF per day or approximately 40.33 CFS)

In a dry year, when the V volume of the water stored in the reservoir on April 30 is less than 8,000 AF, the project release could conceivably be proportionately reduced by keeping the same percentage and lowering the base volume amount from 8,000 AF to V aft. By the same token, under very wet conditions, the reservoir could have a storage volume greater than 8,000 AF on April 30, which would lead to proportionally increased irrigation withdrawals --same volume percentages but greater VSW.

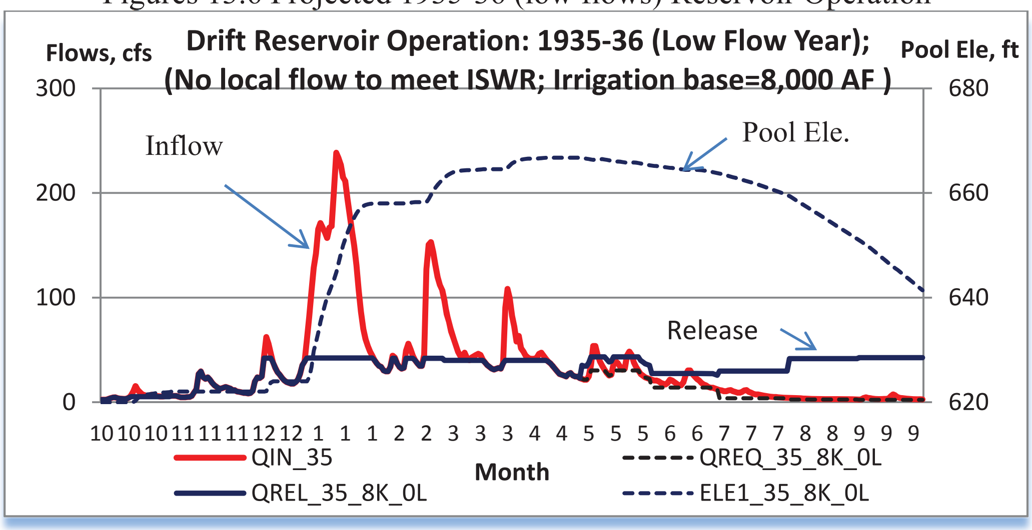
In this case, since VSW is expected to vary from year-to-year depending on the runoff, irrigation release discharges for the year would not be known until after April 30. Whatever irrigation releases are determined then, there will always be enough stored water to feed those the releases throughout the irrigation season.

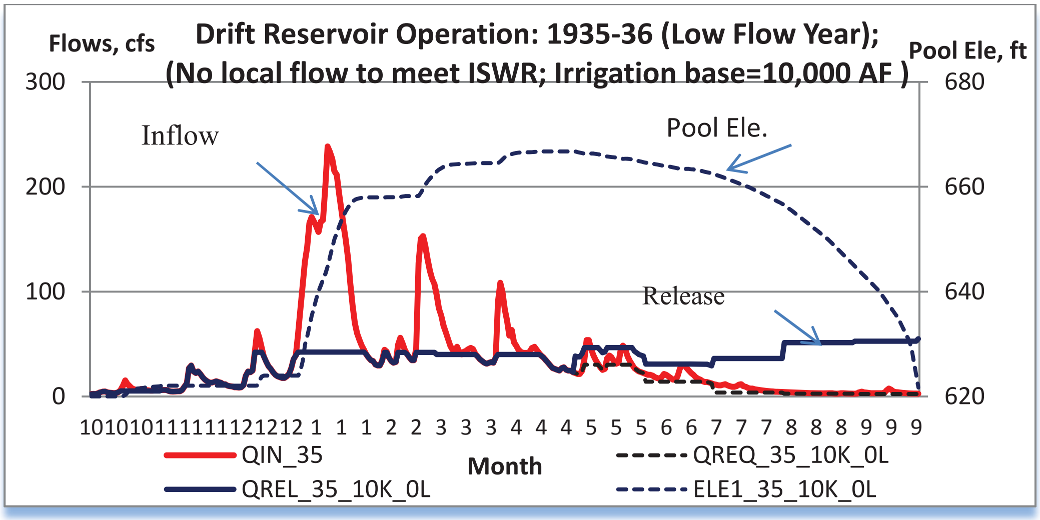
The second option is to set a firm VSW, regardless of the runoff forecasts for the year, and plan the irrigation releases based on that VSW volume alone, irrespective of the actual VSW as of April 30. While this option provides a bigger picture of the operating scenario, the irrigation releases could fall short if the actual VSW cannot sustain the required releases. As mentioned earlier, irrigation requirements under this option based on stored volumes of 10,000 and 12,000 AF were also modeled. These are extensions to the original 8,000 AF base volume scenario explored earlier, assuming the same irrigation releases every year regardless of stored water at the start of the irrigation season for that year.

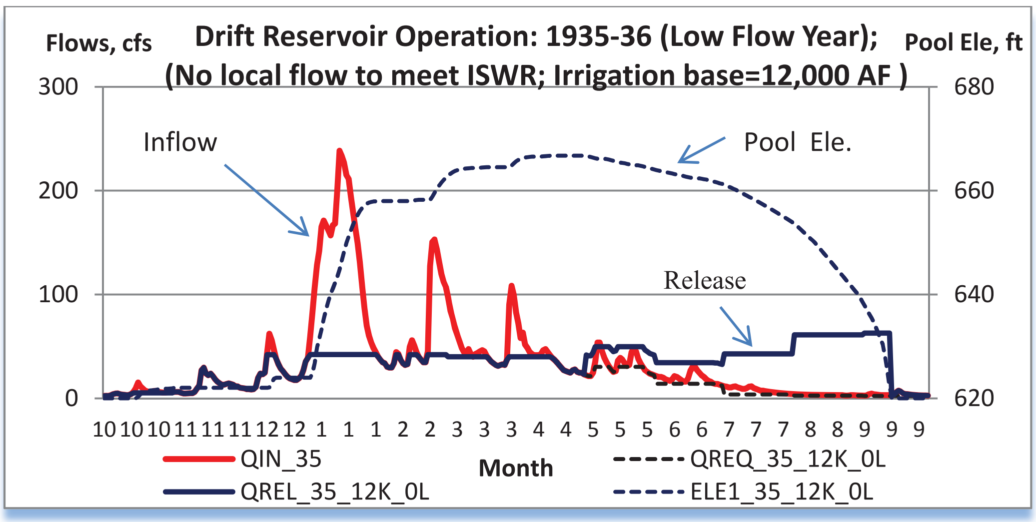
This chapter focuses on the modeling results for the representative (low, average and high) flow years. Modeling results for the more recent 2002-2014 stream flows will be covered later in the report.

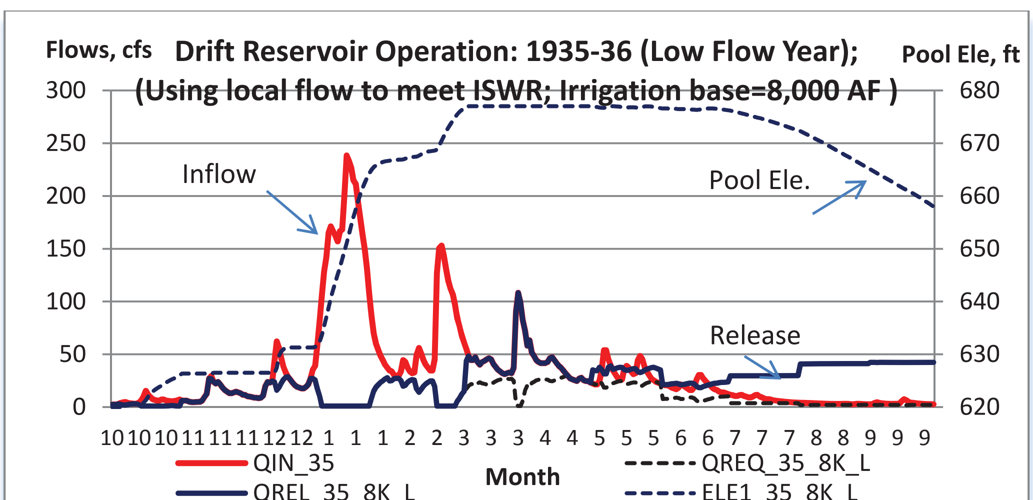
Figures 13.6, 13.7 and 13.8 (with and without ISWR adjustments) based on the 1935-36 (low), 1934-35 (average) and 1947-58 (high) water years respectively illustrate how the project would operate if it starts from empty (Elevation 620') on October 1. Irrigation requirements are those based in each case on assumed available storage volume of 8000, 10000 and 12000 AF.

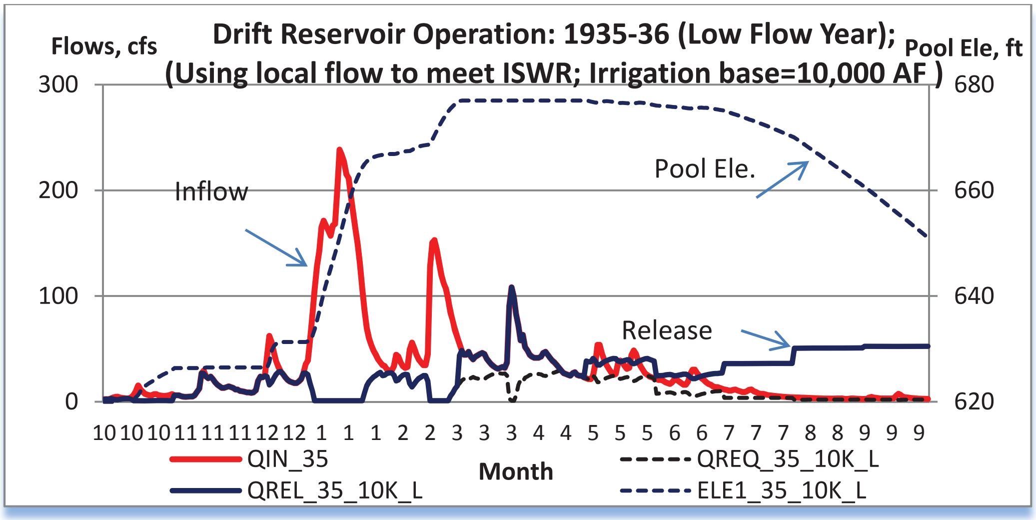
Figures 13.6 Projected 1935-36 (low flows) Reservoir Operation

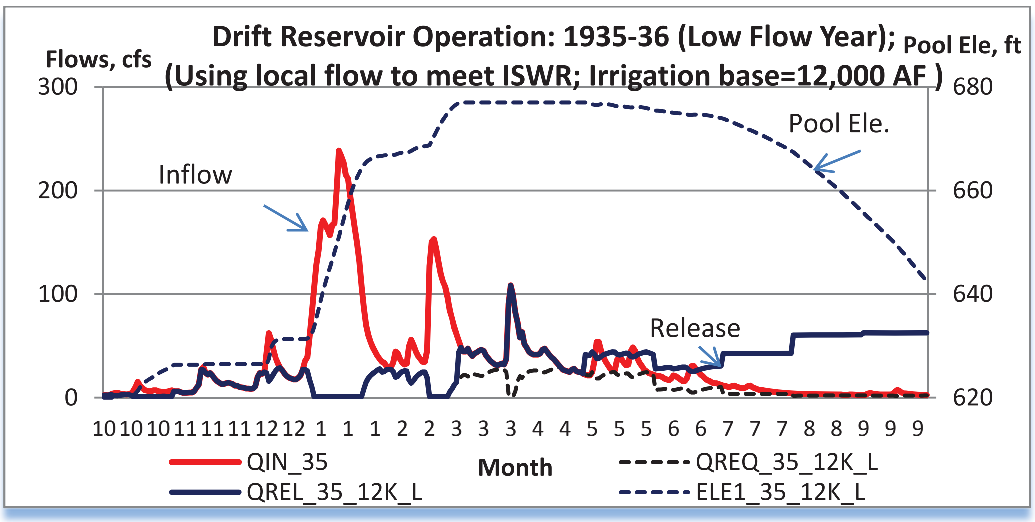



Flows, cfs
Drift Reservoir Operation: 1935-36 (Low Flow Year);
(No local flow to meet ISWR; Irrigation base=10,000 AF)
Pool Ele, ft
300
200
100
0
680
660
640
620
Inflow
Pool Ele.
Release
10 10 10 11 11 11 12 12 12 1 1 1 2 2 3 3 3 4 4 4 5 5 5 6 6 7 7 7 8 8 8 9 9 9
Month
QIN_35
QREL_35_10K_0L
QREQ_35_10K_0L
ELE1_35_10K_0L

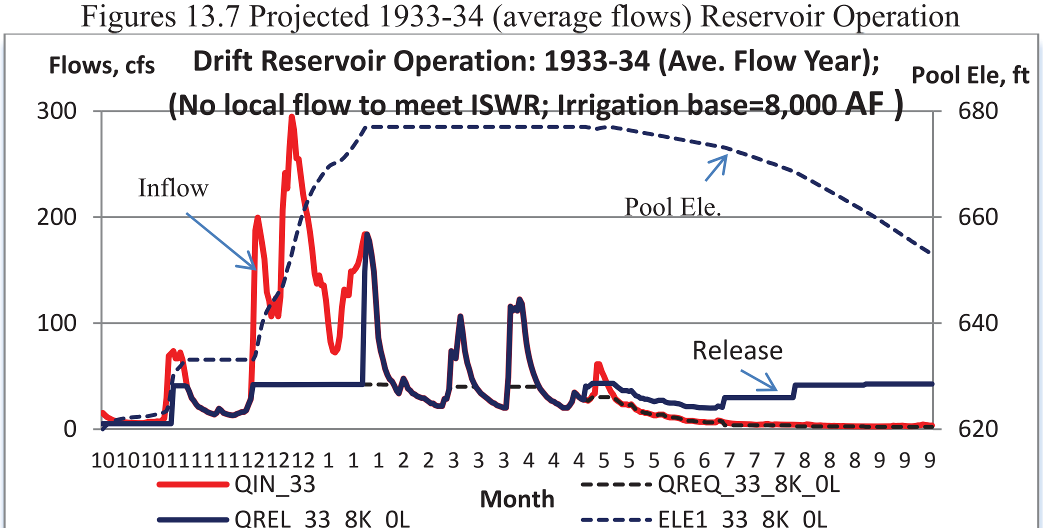

Flows, cfs
Drift Reservoir Operation: 1935-36 (Low Flow Year);
(No local flow to meet ISWR; Irrigation base=12,000 AF)
Pool Ele, ft
300
200
100
0
680
660
640
620
Inflow
Pool Ele.
Release
10 10 10 11 11 11 12 12 1 1 1 2 2 3 3 3 4 4 5 5 5 6 6 7 7 7 8 8 9 9 9
Month
QIN_35
QREL_35_12K_0L
QREQ_35_12K_0L
ELE1_35_12K_0L

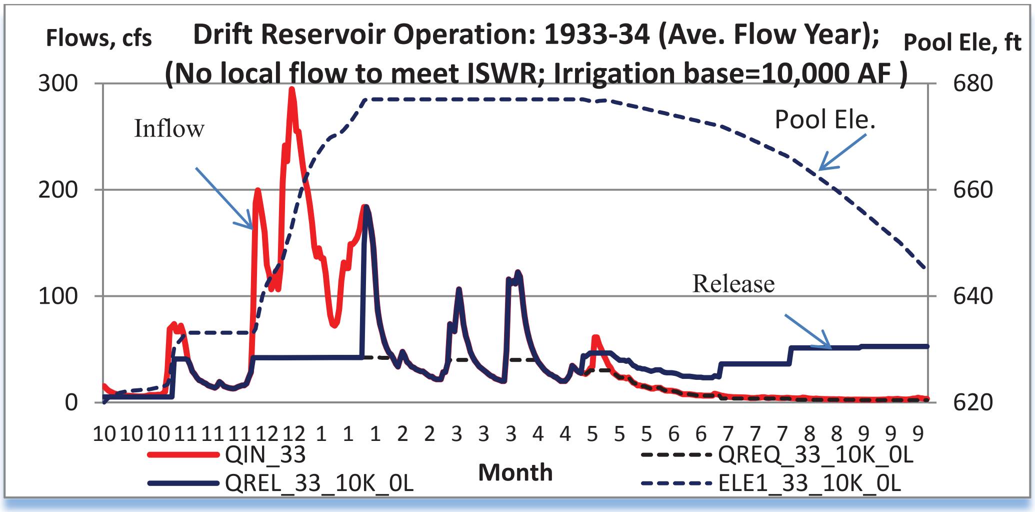

Flows, cfs
Drift Reservoir Operation: 1935-36 (Low Flow Year);
(Using local flow to meet ISWR; Irrigation base=8,000 AF)
Pool Ele, ft
300
250
200
150
100
50
0
680
670
660
650
640
630
620
Inflow
Pool Ele.
Release
10 10 10 11 11 11 12 12 1 1 1 2 2 3 3 3 4 4 5 5 5 6 6 7 7 7 8 8 9 9 9
Month
QIN_35
QREL_35_8K_L
QREQ_35_8K_L
ELE1_35_8K_L

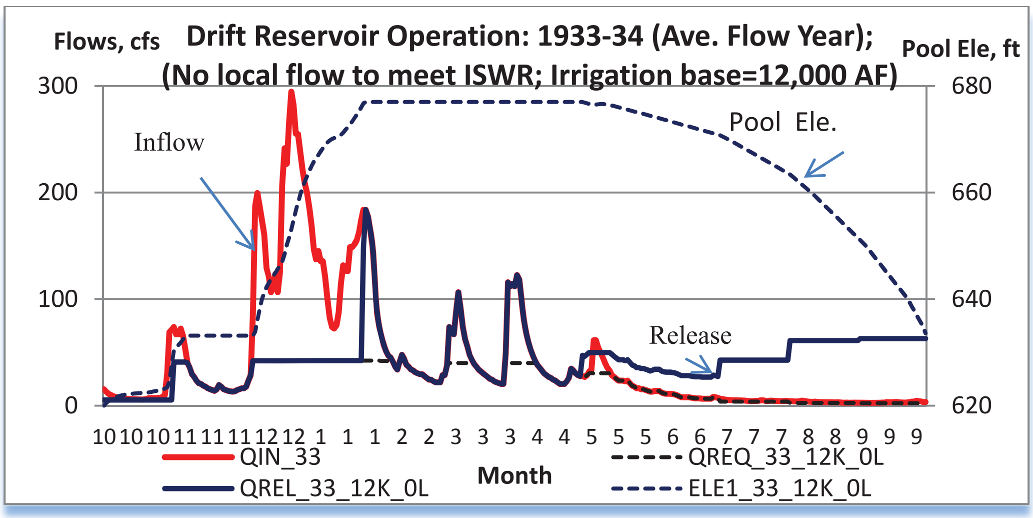


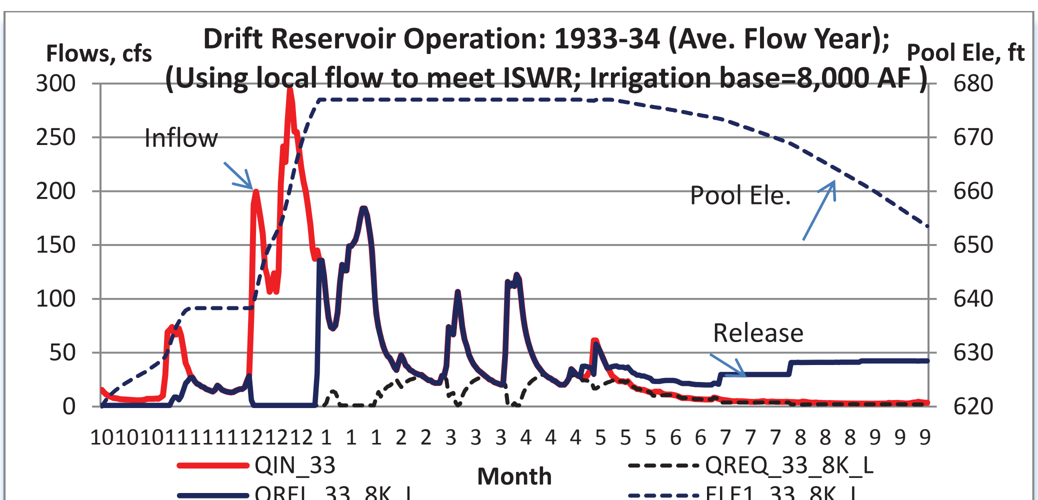


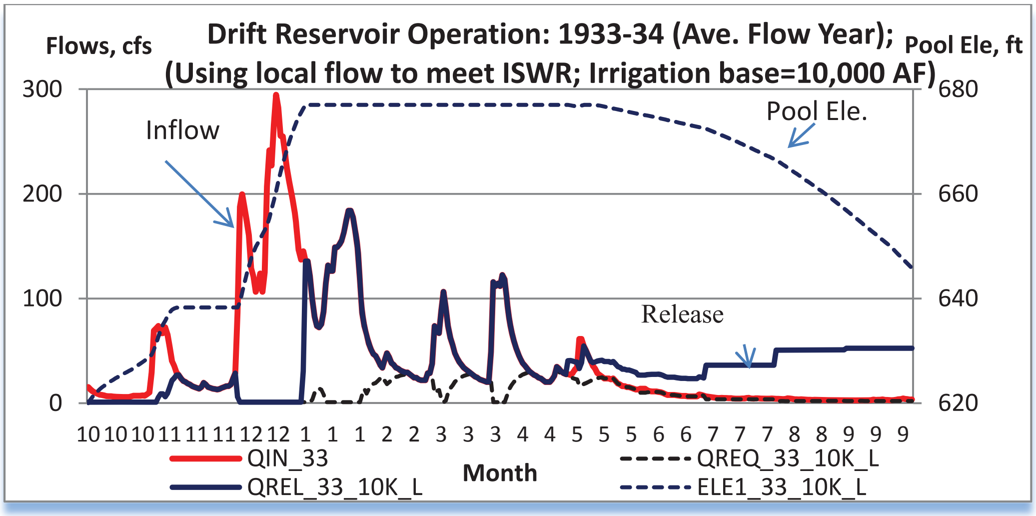
Figures 13.7 Projected 1933-34 (average flows) Reservoir Operation

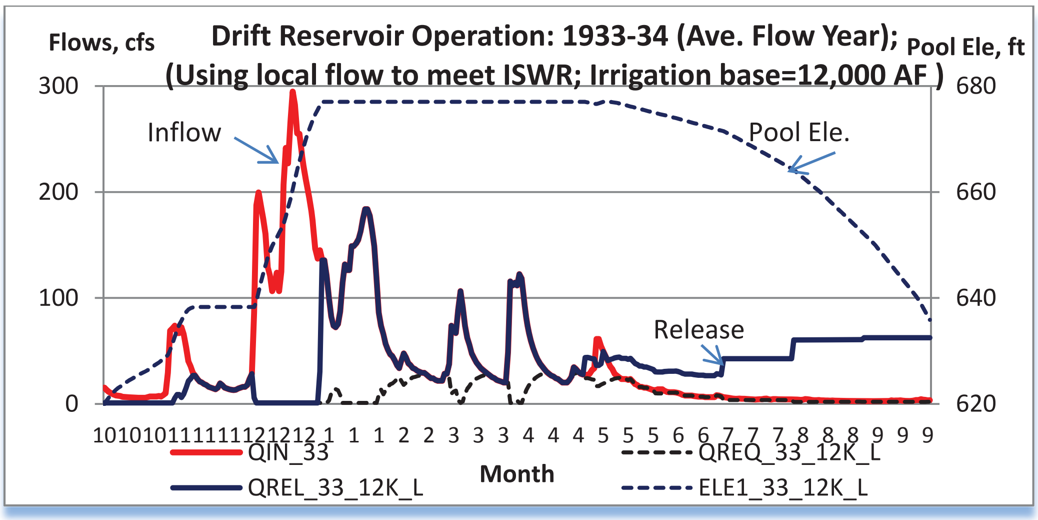



Flows, cfs
Drift Reservoir Operation: 1933-34 (Ave. Flow Year);
(No local flow to meet ISWR; Irrigation base=10,000 AF)
Pool Ele, ft
Inflow
Pool Ele.
Release
Month
QIN_33
QREL_33_10K_0L
QREQ_33_10K_0L
ELE1_33_10K_0L

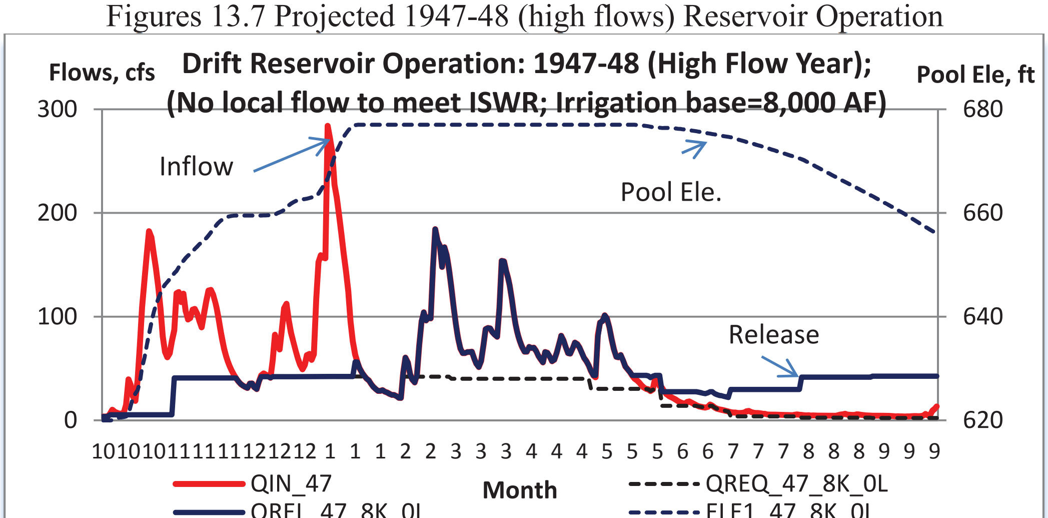

Flows, cfs
Drift Reservoir Operation: 1933-34 (Ave. Flow Year);
(No local flow to meet ISWR; Irrigation base=12,000 AF)
Pool Ele, ft
Inflow
Pool Ele.
Release
Month
QIN_33
QREL_33_12K_0L
QREQ_33_12K_0L
ELE1_33_12K_0L

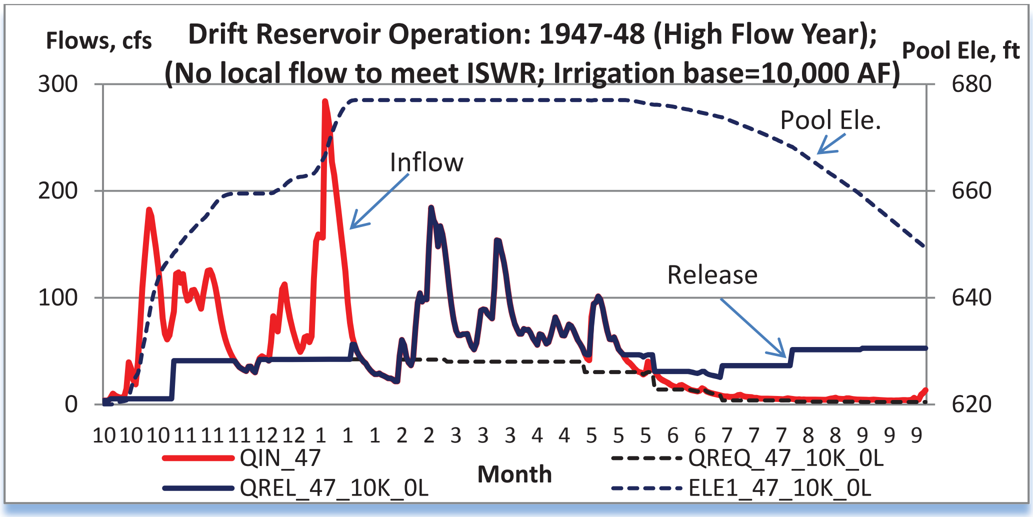

Flows, cfs
Drift Reservoir Operation: 1933-34 (Ave. Flow Year);
(Using local flow to meet ISWR; Irrigation base=8,000 AF)
Pool Ele, ft
Inflow
Pool Ele.
Release
Month
QIN_33
QREL_33_8K_L
QREQ_33_8K_L
ELE1_33_8K_L

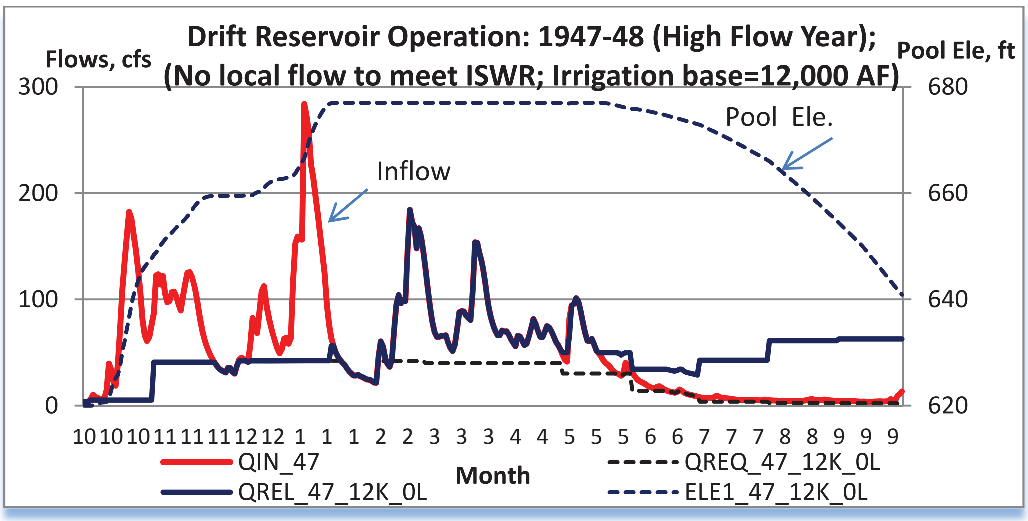


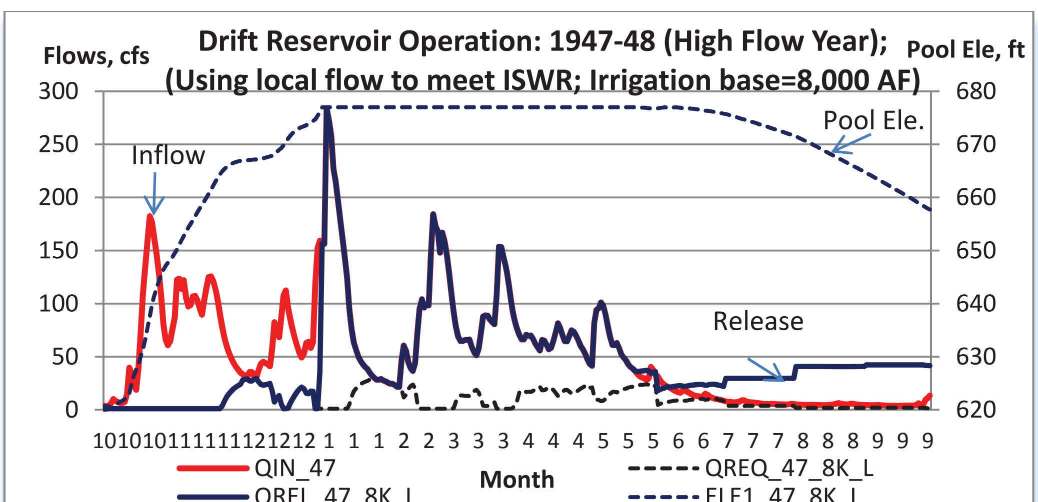


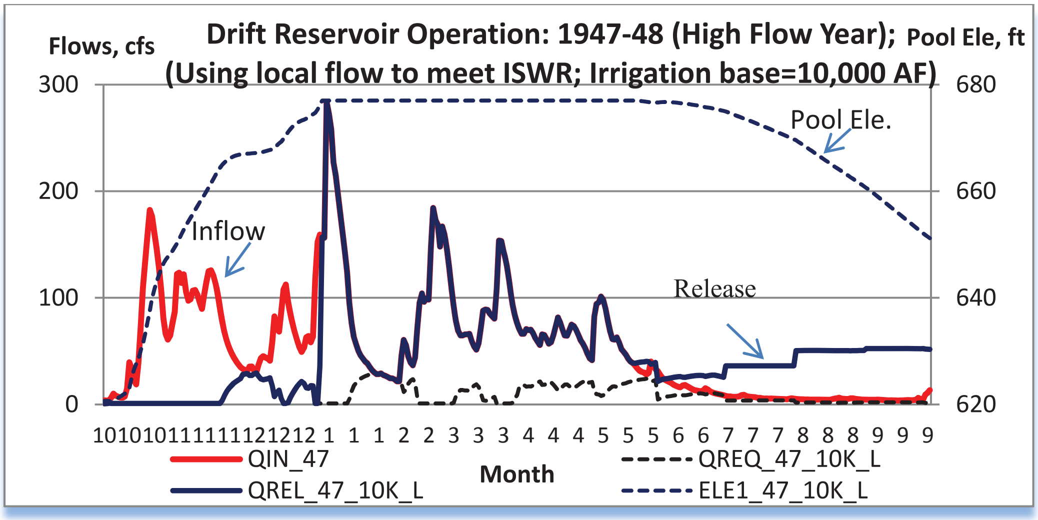
Figures 13.7 Projected 1947-48 (high flows) Reservoir Operation

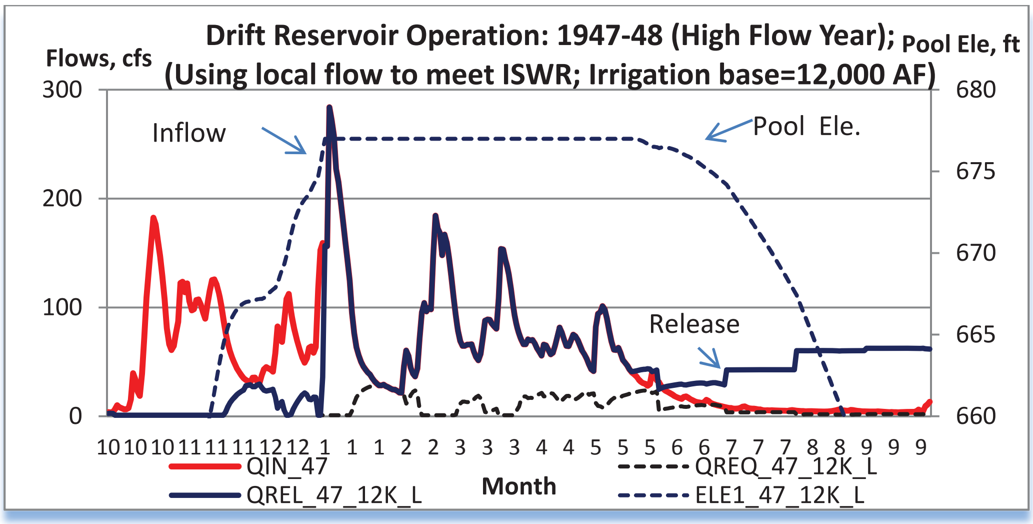



Drift Reservoir Operation: 1947-48 (High Flow Year);
(No local flow to meet ISWR; Irrigation base=10,000 AF)
Flows, cfs
Pool Ele, ft
Pool Ele.
Inflow
Release
Month
QIN_47
QREL_47_10K_0L
QREQ_47_10K_0L
ELE1_47_10K_0L


Drift Reservoir Operation: 1947-48 (High Flow Year);
(No local flow to meet ISWR; Irrigation base=12,000 AF)
Flows, cfs
Pool Ele, ft
Pool Ele.
Inflow
Month
QIN_47
QREL_47_12K_0L
QREQ_47_12K_0L
ELE1_47_12K_0L


Drift Reservoir Operation: 1947-48 (High Flow Year);
(Using local flow to meet ISWR; Irrigation base=8,000 AF)
Flows, cfs
Pool Ele, ft
Pool Ele.
Inflow
Release
Month
QIN_47
QREL_47_8K_L
QREQ_47_8K_L
ELE1_47_8K_L





Results of reservoir operations for other hydrologic years and using less drastic pool elevations at the start of the annual refill season are provided in the next section. RES4DRIFT model is ready to accept more reliable flow data when it becomes available, along with up-to-date information on proposed irrigation withdrawals after the storage season. It is flexible enough to accommodate any changes in reservoir characteristics and test the feasibility of meeting additional use of the stored water on a daily basis. A sample printout for part of the model output is provided in Appendix.

14. Modeling of Daily Reservoir Operation Using 2002-2014 Data

In May 2012, RES4DRIFT was modified to allow for multi-year continuous daily simulation of reservoir operation using the same release criteria as stated above. These criteria include the following:

1. Release the lesser of the inflow and the in-stream requirements to meet in-stream flow requirement; store the flow difference in the reservoir whenever feasible. [This particular criteria was applied to all model runs performed prior to 2014. Date-related criteria had to be added once it was found out that the OWRD draft permit issued in July 2014 specified that storage is only allowed between November 1 and April 30, and that "*permittee shall pass all live flows during May 1 and October 30*". Furthermore, earlier model runs only used the in-stream flow requirements shown in OWRD water availability table as the minimum downstream release requirements. In later model runs, after issuance of the draft water use permit, prior water rights were added to those minimum requirements to account for the EVWD's junior water rights status].
2. Provide the option of (1) relying or (2) not relying on the local inflow to help meet part of the in-stream flow requirement (ISR) at the mouth. Option (1) means that the project has to meet 100% of the ISR, while Option (2) means that the reservoir has to meet only the difference between ISR and the local inflow,
3. Pass inflows greater than 630 cfs for "peak flow" flushing purposes,
4. Limit all reservoir releases to the outlet pipe capacity as allowed by the hydraulic head (difference between the pool elevation reached at the time of the release and the hydro-turbine generator),
5. Meet the specified monthly irrigation release whenever possible,
6. Keep the reservoir at or below its assumed upper bound elevation of 677 feet msl, and
7. Keep the reservoir at or above its assumed lower bound elevation of 620 feet msl.

As an example, the modeling procedure applied to an incoming daily flow QIN that reaches the impoundment on Day D, when the reservoir pool is at Elevation EL1, can be described as follows. The total release requirements QTR on Day D include minimum downstream in-stream flows and consumptive uses QMIN, existing water rights QWR, and irrigation needs QIR. QTR may or may not be reduced depending on whether the local inflow between the project site and the mouth of the river is allowed to be accounted for in this operation or not. Furthermore, QMIN and QWR are mandatory requirements; any inflow up to QMIN + QWR has to be released; only inflow greater than QMIN+QWR can be stored. On the other hand, meeting QIR is optional and primarily relies on stored water and release than exceeds QMIN + QWR.

Once QTR is set, QIN is discharged in totality if it is equal to or greater than the flushing flow of 630 cfs. If it is less than 630 cfs, then QIN will be released in full if it is less than or equal to QTR, and only partially released up to the QTR amount if it is greater than QTR. In the later case, the difference QIN - QTR is stored in the reservoir to increase the water level in the reservoir from Elevation EL1 to Elevation EL2. EL2 may not exceed the reservoir upper bound. If it does, the remaining QIN-QTR amount is released to keep the reservoir within the set upper bound limit.

More detailed programming instructions for the above procedure are listed in the Appendix. As noted later in the report, more date-specific reservoir refill and release criteria as listed in the draft water use permit issued by OWRD on July 22, 2014 will have to included in future study updates.

Daily flow data are also shown in the Appendix. They were entered manually for each day of the 12-year period, from October 1, 2002 through the end of September 2014. The model simulation relies on regression-based daily flows derived from observed daily flow data of Pudding River at Aurora for the October 2002 – September 2008 period, and on actually observed data for Upper Drift Creek for the October 2008 – September 2014 period. October 1, 2002 was the day when stream gauging resumed for the Pudding River at Aurora, after a 5-year inactivity period. On this October 1, 2002 start date, the model assumes the reservoir was empty.

14. 1 Modeling Using Irrigation Releases for 8,000 AF of Stored Water

This simulation was mainly designed to test how the project would operate on a continuous basis for a sufficient period of records, using the listed criteria (or within slight variations thereof). The developed model can be used to test the sensitivity of the various criteria on pool variations, reservoir releases, reservoir refill period, etc.

In principle, operational flexibility is a plus. Therefore, not having to meet the full protected rights at the mouth would be advantageous. In practicality, however, that edge really depends on actual runoff situations and can vary from year to year, because (1) regardless of the water rights, we only have to release no more water than what is coming in, and (2) when we reach the top of the reservoir, we have no choice but to release the incoming inflow. To some extent, this is somewhat similar to adopting 1 October as the "official" date for the reservoir refill, while in fact the actual refill is flow and water rights-based --not a calendar date-based.

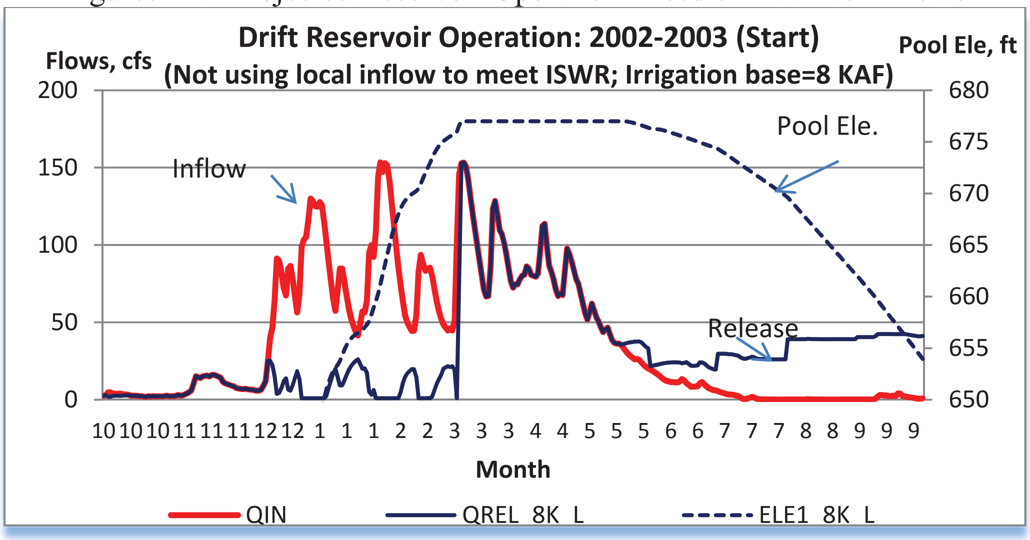
In the model simulation, the reservoir was assumed to start empty on October 1, 2002 and to operate on a continuous basis throughout the 12 year period. Pool elevation on October 1 of Hydrologic Year Y2 is controlled by the elevation reached on September 30 of the previous Hydrologic Year Y1.

Figures 14.1 through 14.12 illustrate the variations of the reservoir pool elevation during the October 1, 2002 – September 30, 2008 and October 1, 2008 – September 2014 continuous simulation periods respectively. They provide a general idea on the potential storage volume impacts when meeting protected water rights at the mouth with and without accounting for local inflow's contribution. In general, the impacts of relying on local inflows to meet the in-stream flow requirements at the mouth of the creek appear to be relatively minor in terms of storage volume reached on 30 April, as the reservoir would fill in all 2002 through 2014 water years except one.

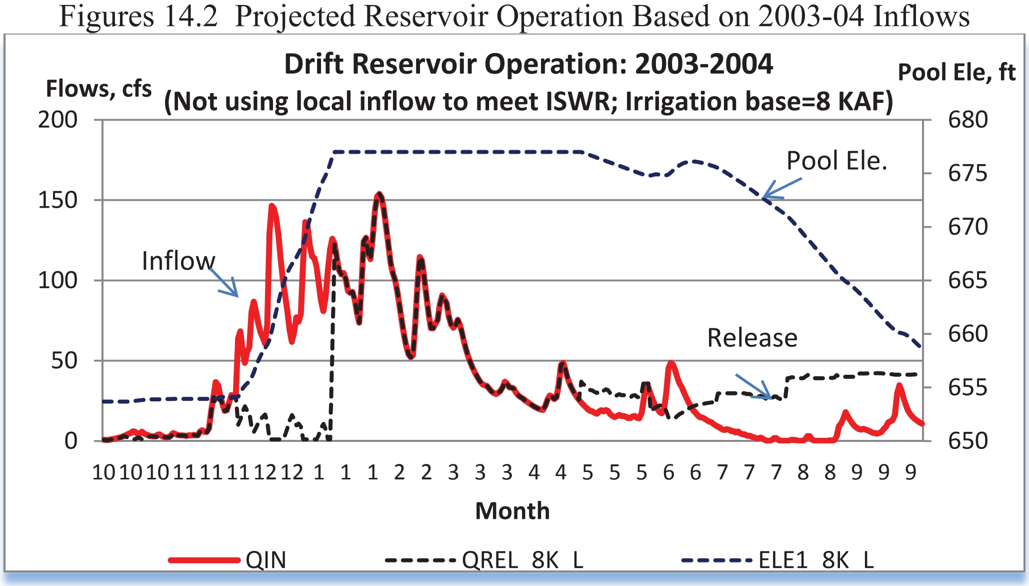
The plots attempt to show the daily variation of the various parameters that dictate the pool variation over those 12 years. Parameters include the inflow QIN, starting pool elevation ELE1, ins-stream water rights at the creek's mouth ISWR, consumptive use CONSU, theoretical release requirement REQ, actual release requirement QREQ, theoretical irrigation requirement IRR, permissible irrigation requirement QIRR, actual reservoir release QREL, violation code VIOL, end-of-day pool elevation ELE2, and end-of-day reservoir storage STORAGE.

For easier visual interpretation, only the main parameters are actually graphically shown --inflow, outflow, and pool elevation. The volume of the irrigation base are noted under the title, along with the assumed role assigned to the local inflow in meeting the in-stream flow requirements at the mouth. Pool elevation is graphed as a dashed curve to show how it changes during the water year, between the full pool elevation of 677' and the minimum pool elevation of 620'. More details covering the results for the entire 12 years are provided in the next section.

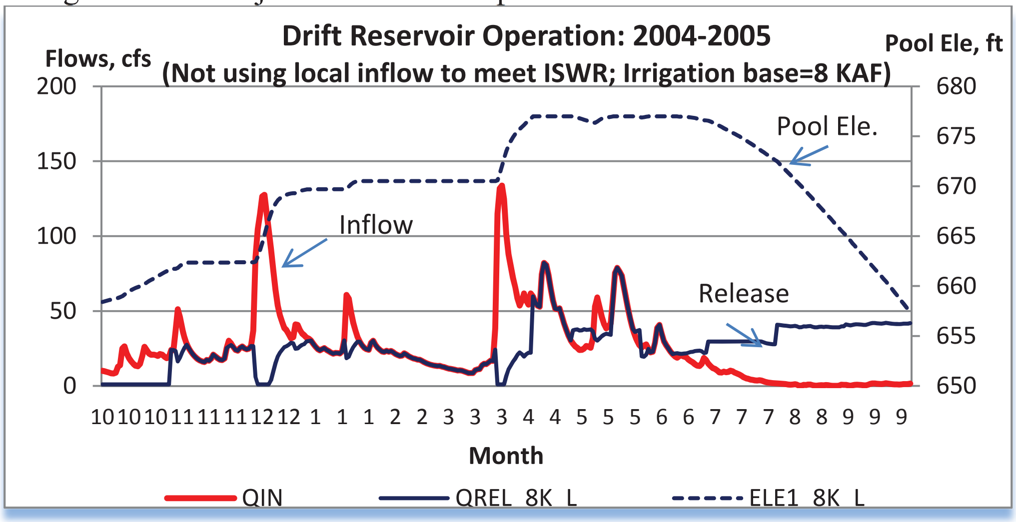
Figures 14.1 Projected Reservoir Operation Based on 2002-03 Inflows



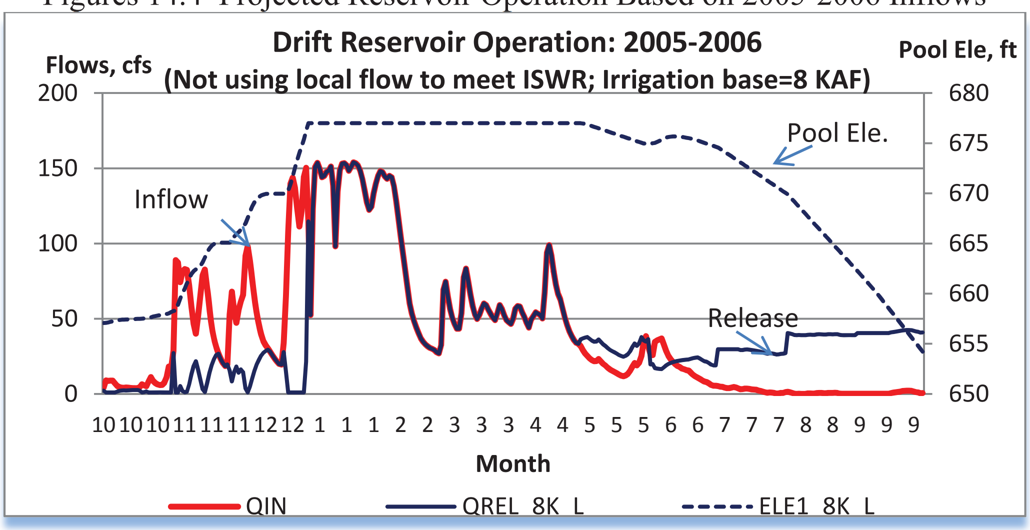
Figures 14.2 Projected Reservoir Operation Based on 2003-04 Inflows



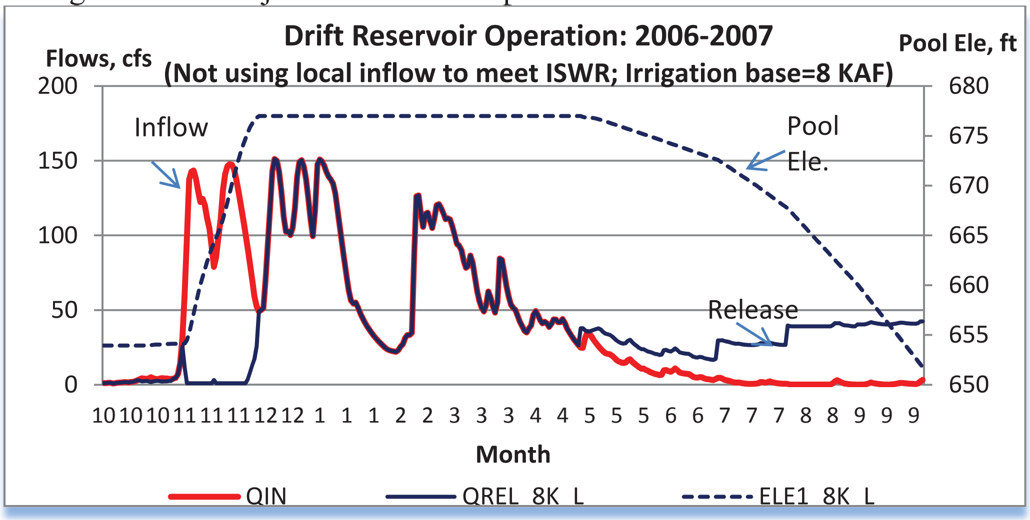
Figures 14.3 Projected Reservoir Operation Based on 2004-2005 Inflows



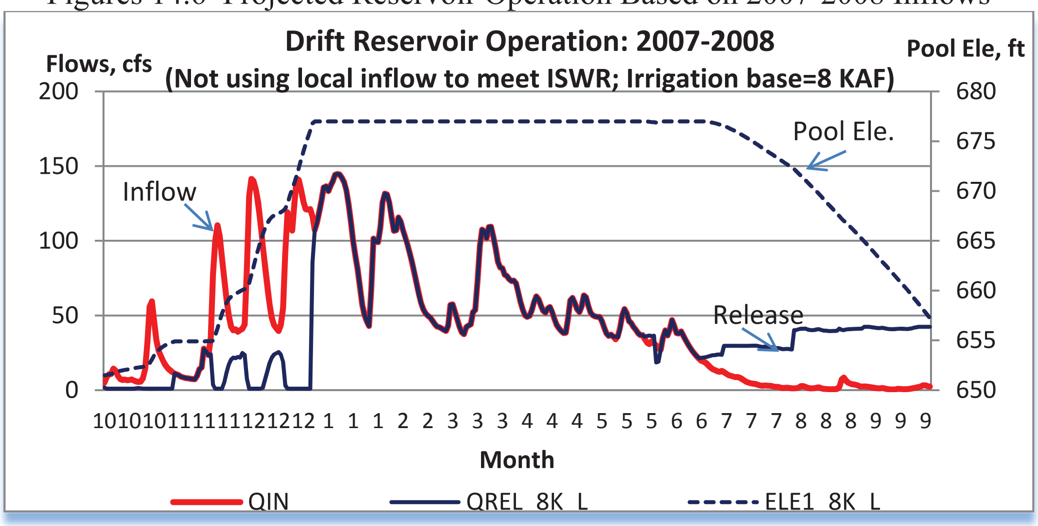
Figures 14.4 Projected Reservoir Operation Based on 2005-2006 Inflows



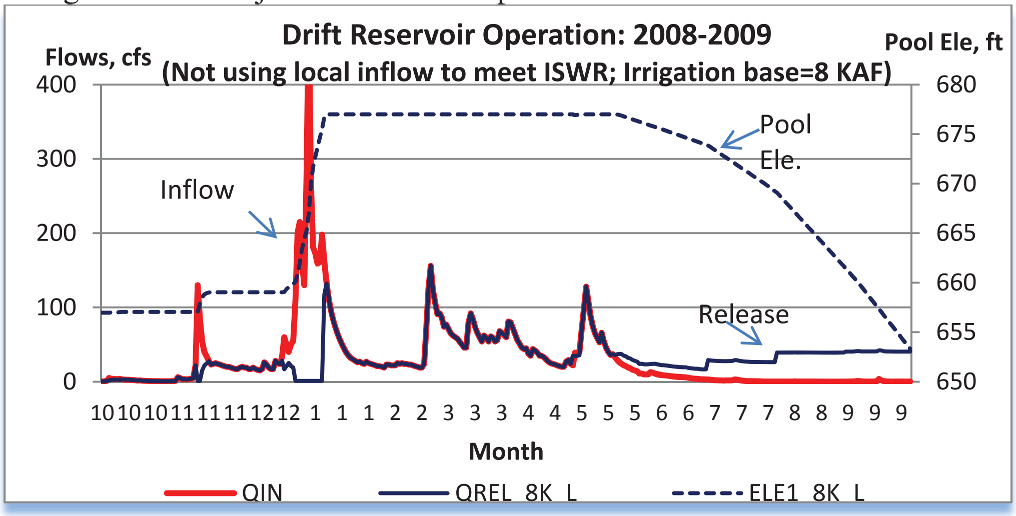
Figures 14.5 Projected Reservoir Operation Based on 2006-2007 Inflows



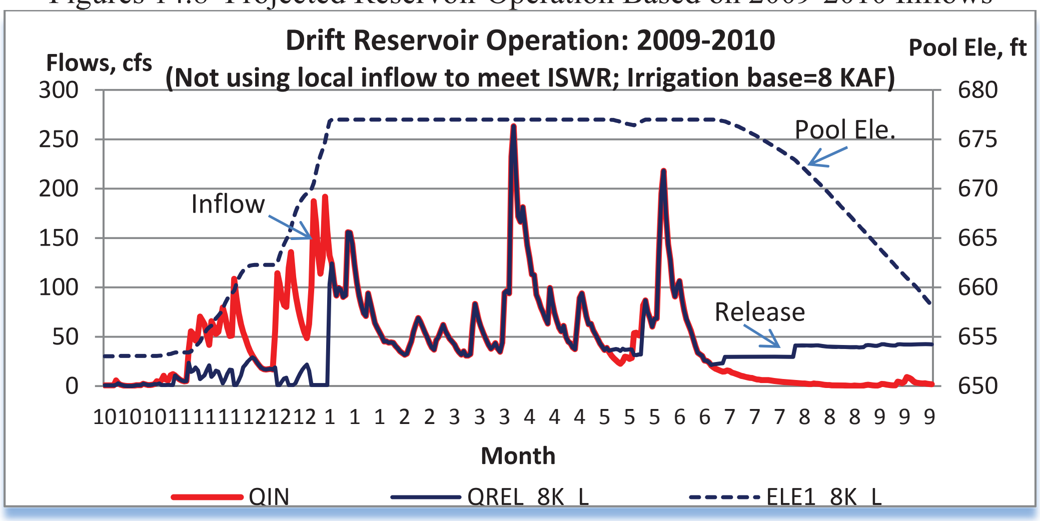
Figures 14.6 Projected Reservoir Operation Based on 2007-2008 Inflows



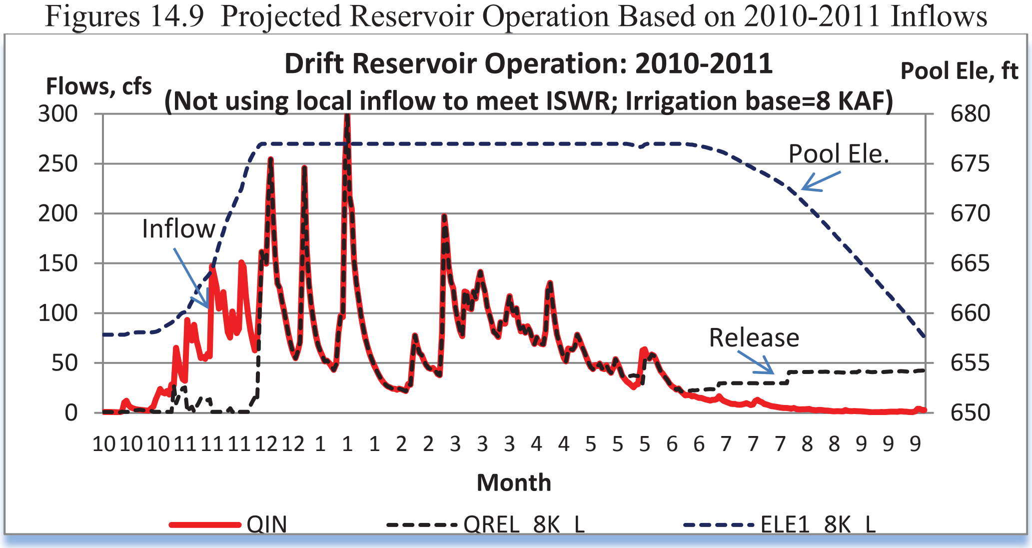
Figures 14.7 Projected Reservoir Operation Based on 2008-2009 Inflows



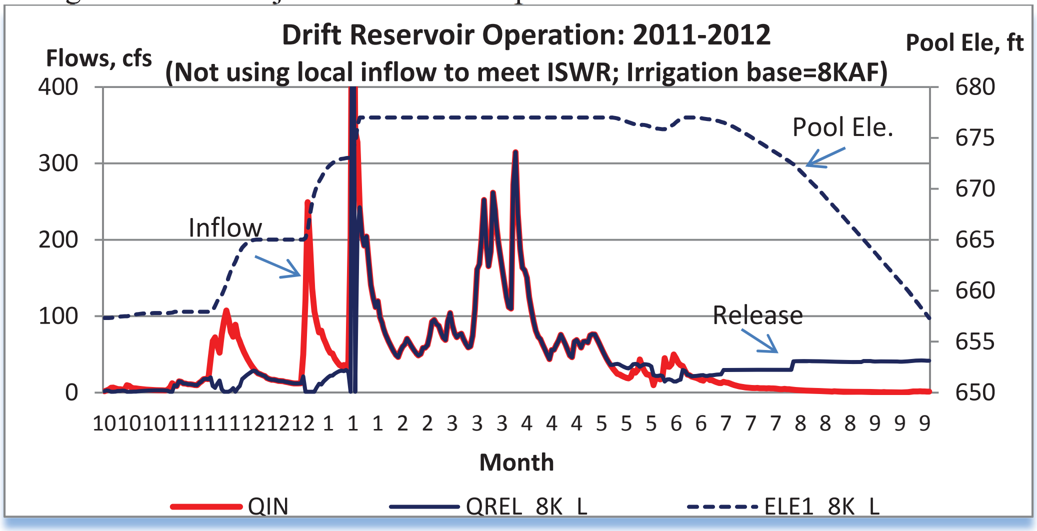
Figures 14.8 Projected Reservoir Operation Based on 2009-2010 Inflows



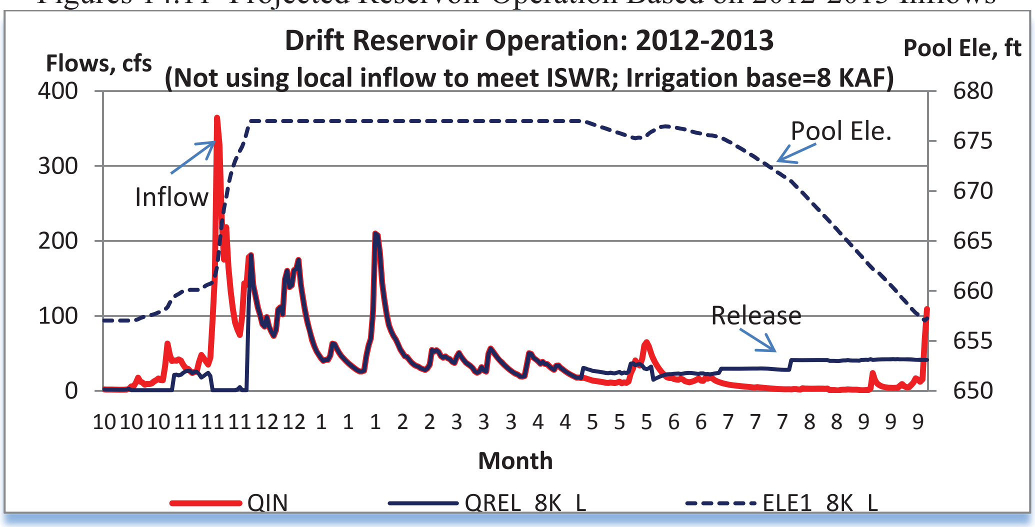
Figures 14.9 Projected Reservoir Operation Based on 2010-2011 Inflows



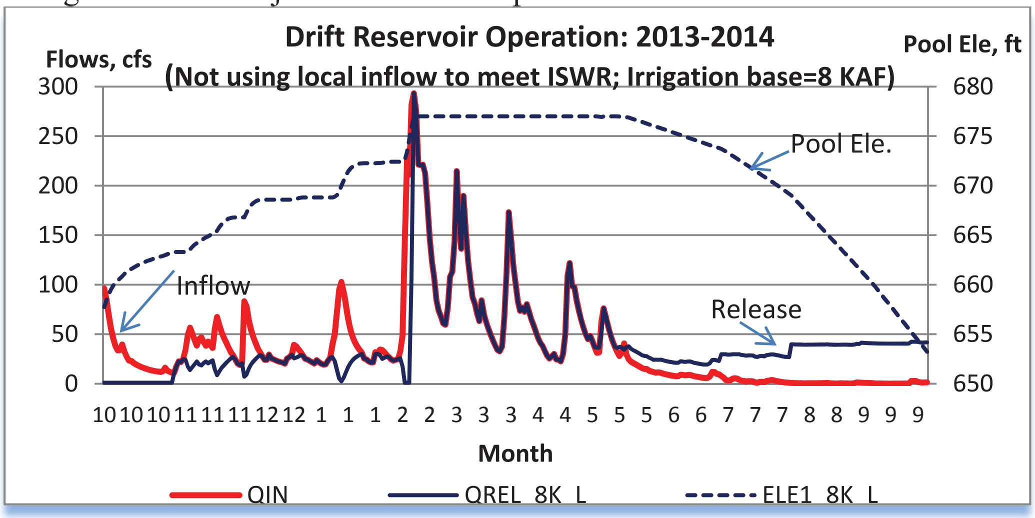
Figures 14.10 Projected Reservoir Operation Based on 2011-2012 Inflows



Figures 14.11 Projected Reservoir Operation Based on 2012-2013 Inflows



Figures 14.12 Projected Reservoir Operation Based on 2013-2014 Inflows



More detailed numerical model outputs for the two operating modes –with and without reliance on local inflows to meet in-stream water rights at the mouth—are provided in the Appendix. To save space, only outputs related to 2008-2014 are provided.

Reservoir release violation codes include the following:
0=normal (release unrestricted)
1=too small inflow (release limited by the inflow)
2=exceed upper bound (release made when the reservoir cannot store water)
3=exceed lower bound (release made when the reservoir is empty)
4=pass flow greater than 630 cfs for flushing purposes
5=release limited by outlet capacity

14. 2 Projected Operation Using Higher Irrigation Release Discharges

Two additional multi-year reservoir modeling runs were made in February 2015, using irrigation releases applicable to a reservoir refill volume of 10,000 AF and 12,000 AF (in addition to the 8,000 AF scenario used in previous model simulations. As done before, separated model runs performed in each case assuming (1) zero credit and (2) full credit for local inflow in meeting existing water rights at the mouth of Drift Creek. Results are illustrated in Figures 14.13 through 14.15 for reservoir pool elevations.

Figure 14.13 Reservoir Pool Variations, 2002-2014, 8 KAF Irrigation Volume

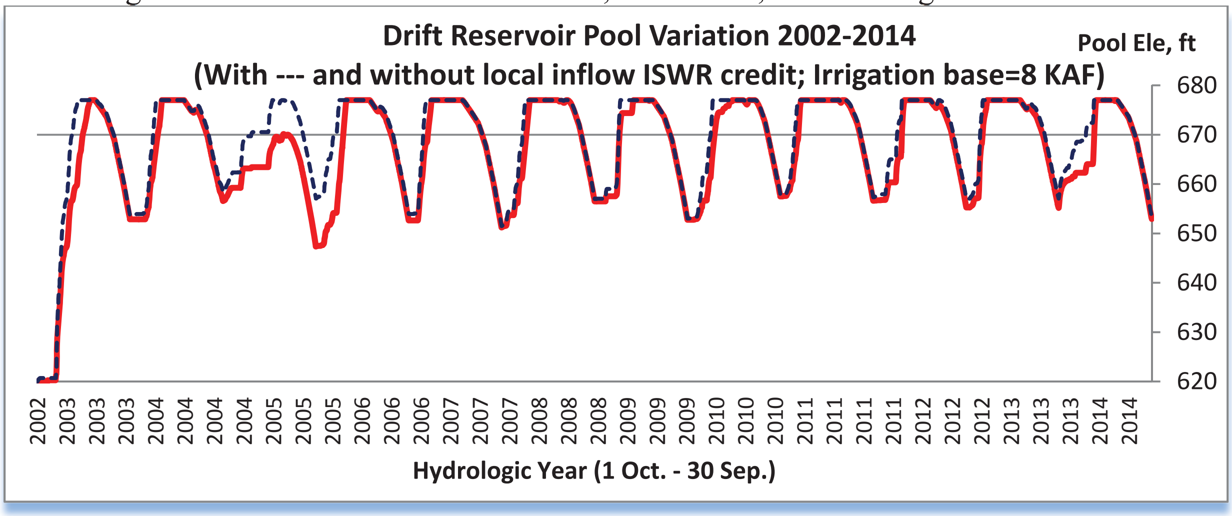


Figure 14.14 Reservoir Pool Variations, 2002-2014, 10 KAF Irrigation Volume

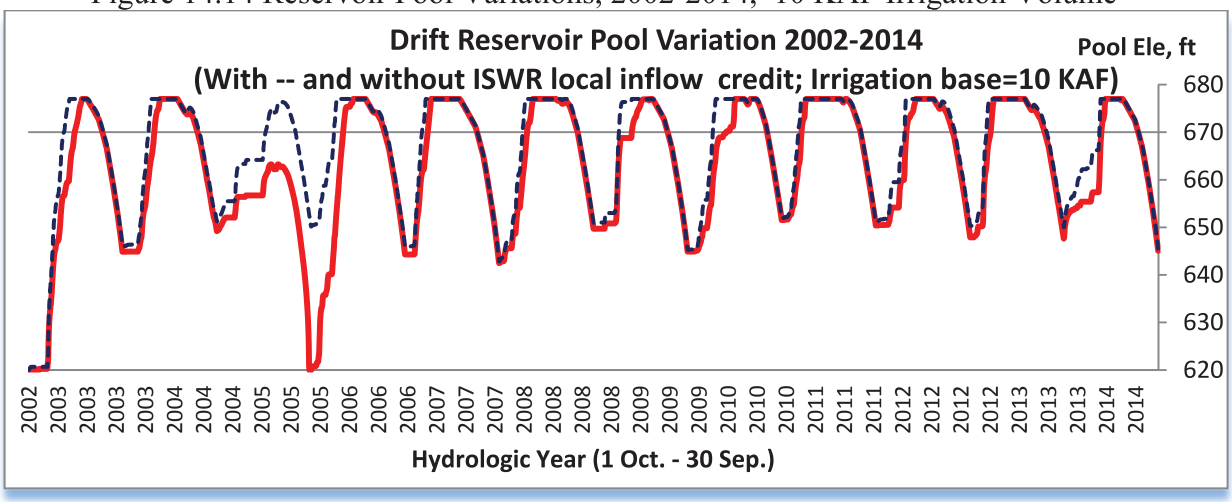
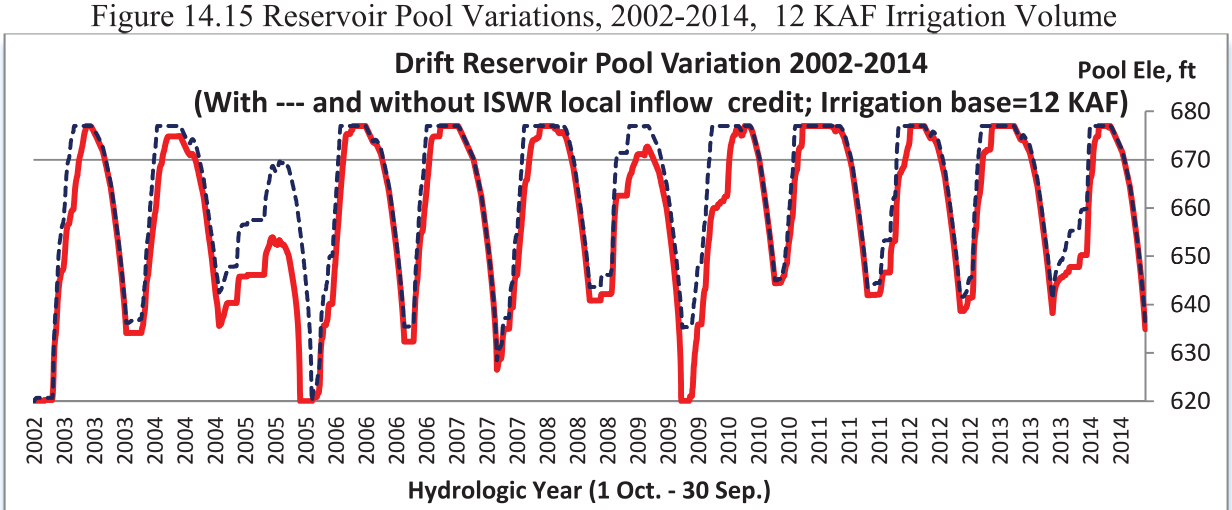


Figure 14.15 Reservoir Pool Variations, 2002-2014, 12 KAF Irrigation Volume



Based on the above plots, the role of the local inflow in meeting water rights and the size of the irrigation releases are the two major factors in the reservoir refill during the 12 year period tested. With an irrigation base volume of 8 KAF, the reservoir would fill every year if local inflow credit is allowed; if not, the reservoir would not fill for one year. The same situation would occur with an irrigation volume of 10 KAF, except that in this case, the reservoir would be empty in one year. Finally, with an irrigation volume of 12 KAF, the refill would be even worse --with no refill in one year and going empty in two years.

Results for the reservoir releases are illustrated below, in Figures 14.16 through 14.18. A monthly time step is selected for better visual clarity.

Figure 14.16 Average Monthly Release, 2002-2014, 8 KAF Irrigation Volume

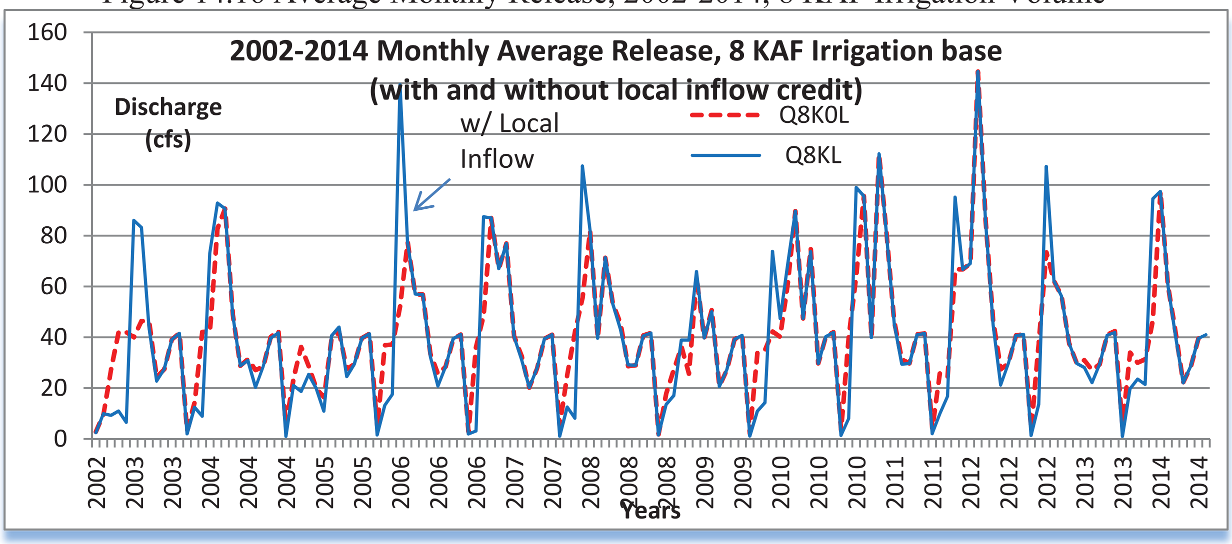


Figure 14.17 Daily Release, 2002-2014, 10 KAF Irrigation Volume

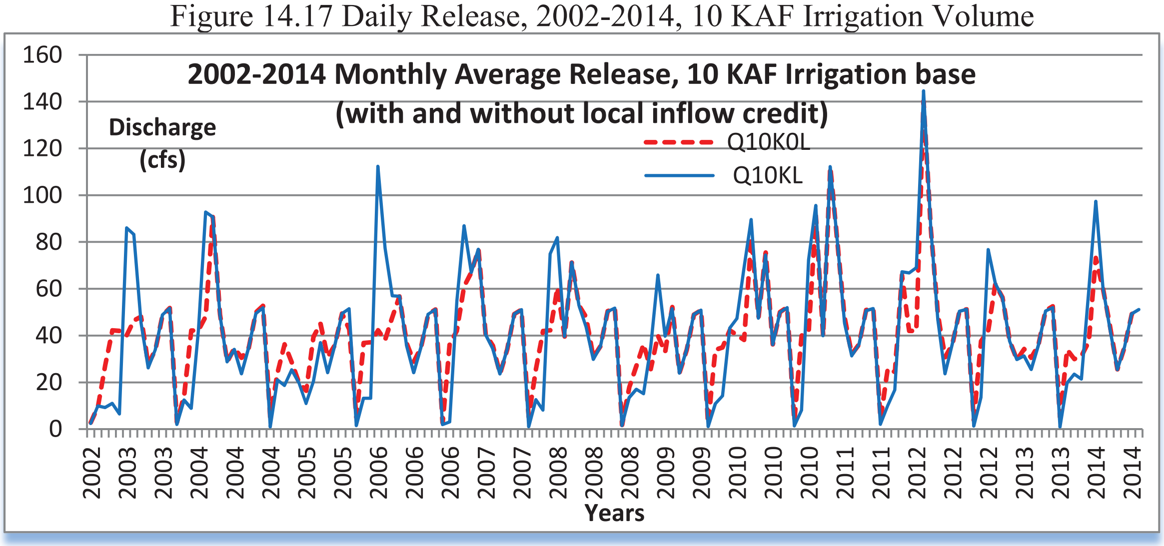
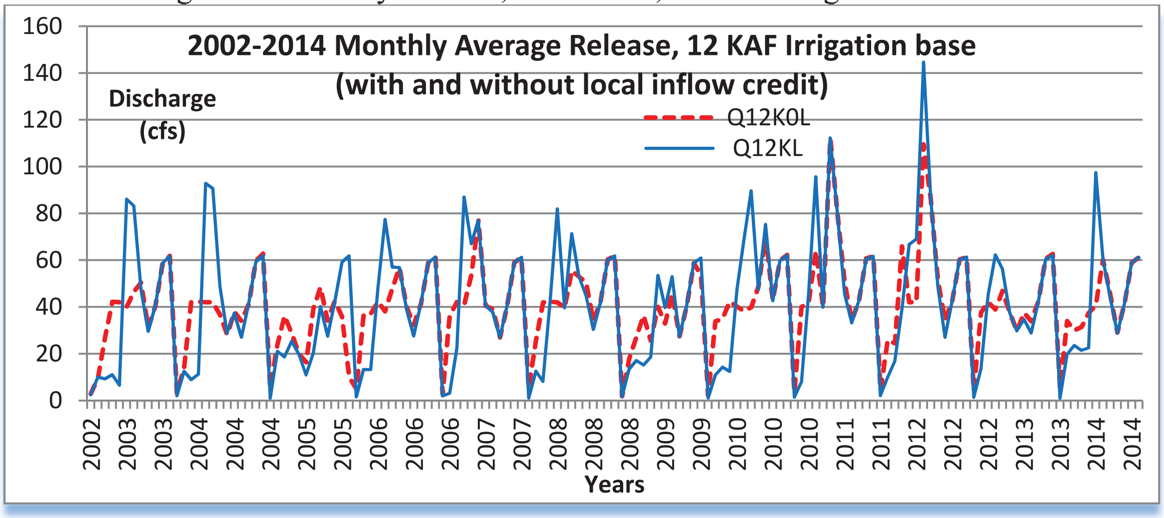


Figure 14.18 Daily Release, 2002-2014, 12 KAF Irrigation Volume



Release differences are hardly visible when they are plotted as above on a 12-year time span. They will be a little more obvious when shorter time spans are used and focused on the release season. See next section.

15 Pre- and Post-Project Flow Duration Curves

Stream flows released from the reservoir represent the erosive energy of the river and, as such, directly affect bank erosion and mud flats conditions in the river reach downstream from the dam. Higher flows generally mean stronger currents, higher flow velocities, and greater wetted perimeter areas under water and, therefore, more severe bank erosion. Low flows, on the other hand, mean slower currents, less downstream bank areas under water and, as a result, less severe bank erosion.

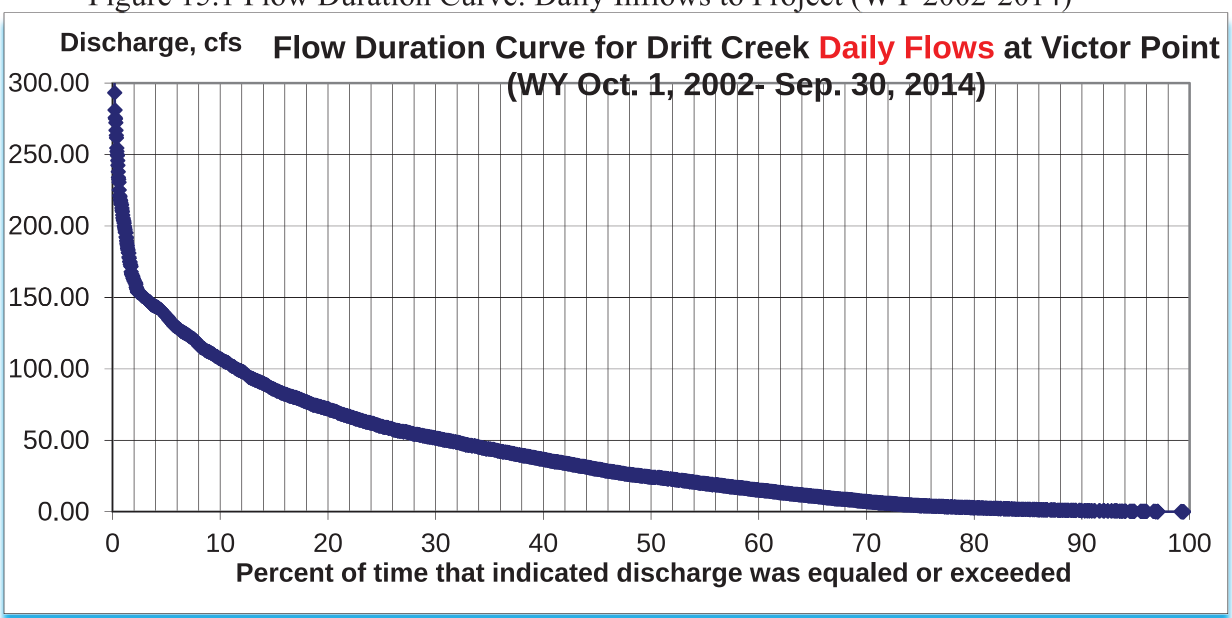
Based on the above, the operation of Drift Creek Reservoir, which is bound to change the natural flow regime of Drift Creek below the dam site, is expected to cause either less downstream bank erosion or more of the same, depending on the time of the year. Less downstream bank erosion is expected to occur during the October-April reservoir refill season, when all flows not needed to meet in-stream flow requirements --except for those greater than 630 cfs-- will be stored in the reservoir. More downstream bank erosion downstream, on the other hand, is to occur during the May- September period, when storage water will be released for irrigation purposes, at discharge rates that will be several folds higher than natural stream flows observed during that same period of the year.

Flow duration curves were prepared to show the percent of time during which specified flow rates immediately below the reservoir are exceeded during the pre- and post-project flow regimes. The analysis is explained in detail at OSU website *http://streamflow.engr.oregonstate.edu/analysis/flow/tutorial.htm* and involves several steps listed below:

1) List the daily stream flows in chronological order from October 1, 2002 to September 30, 2014;
2) Count the total number of time step intervals in the period of records;
3) Rank those daily stream flows by magnitude, from largest to smallest (using Excel "rank" command";
4) Calculate the percent of time that each discharge is equaled or exceeded. The exceedance probability is calculated as follows:
   P = 100 * [M / (n + 1)]
   P = the probability that a given flow will be equaled or exceeded (% of time)
   M = the ranked position on the listing (dimensionless)
   n = the number of events for period of record (dimensionless)
5) Create a formula to calculate this value for each record using the information from Step 2: (=(E2/('Step 2'!D4020+1))*100).
6) Graph the "exceedance probability" versus the discharge. The graph can have either linear or logarithmic axes. Linear axes are selected for the flow duration curve shown below.

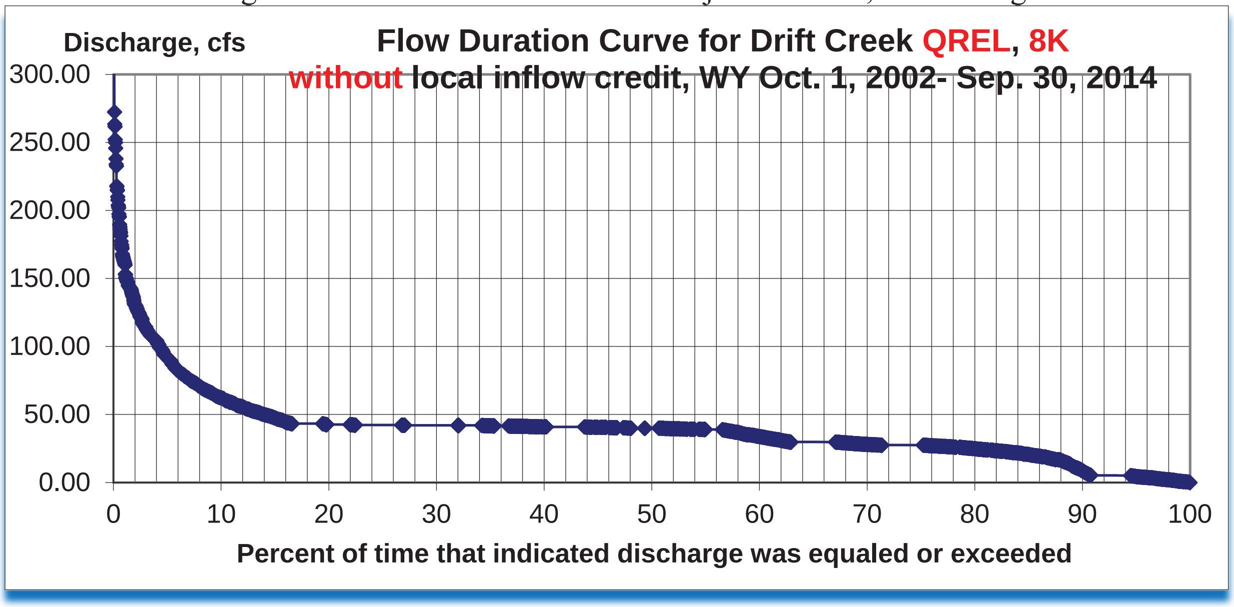
Figure 15.1 represents the flow duration curve of the inflows to the project for the 2002-2014 period -- a picture of the pre-project flow regime.

Figure 15.1 Flow Duration Curve: Daily Inflows to Project (WY 2002-2014)



Figures 15.2 through 15.4 represent the flow duration curves for the **outflows** for the three irrigation base volumes of 8000, 10000 and 12000 AF, with and without local inflow credit in meeting the in-stream water rights at the mouth of the creek.

Figure 15.2 Flow Duration Curve: Project Outflow, 8KAF Irrigation



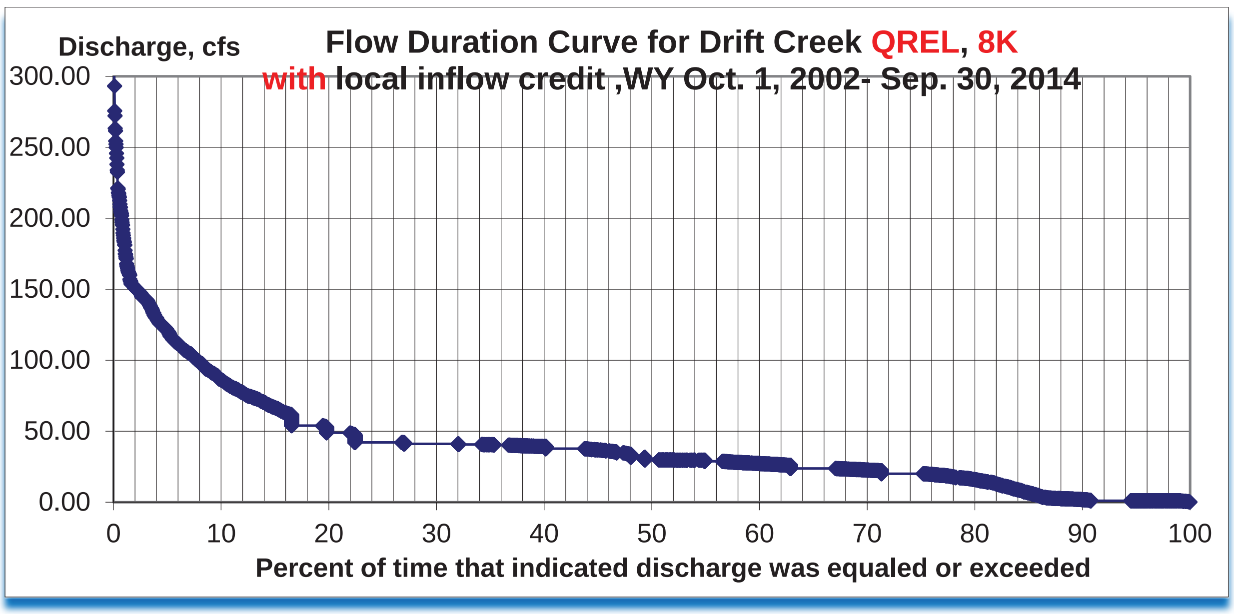
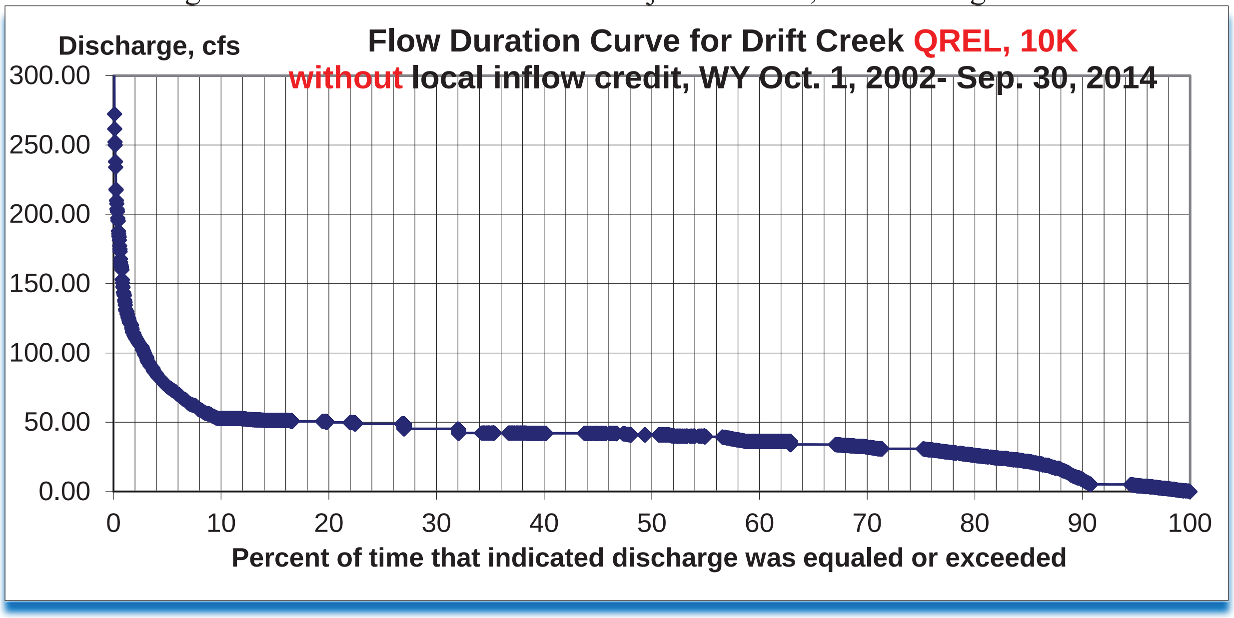


Figure 15.3 Flow Duration Curve: Project Outflow, 10KAF Irrigation



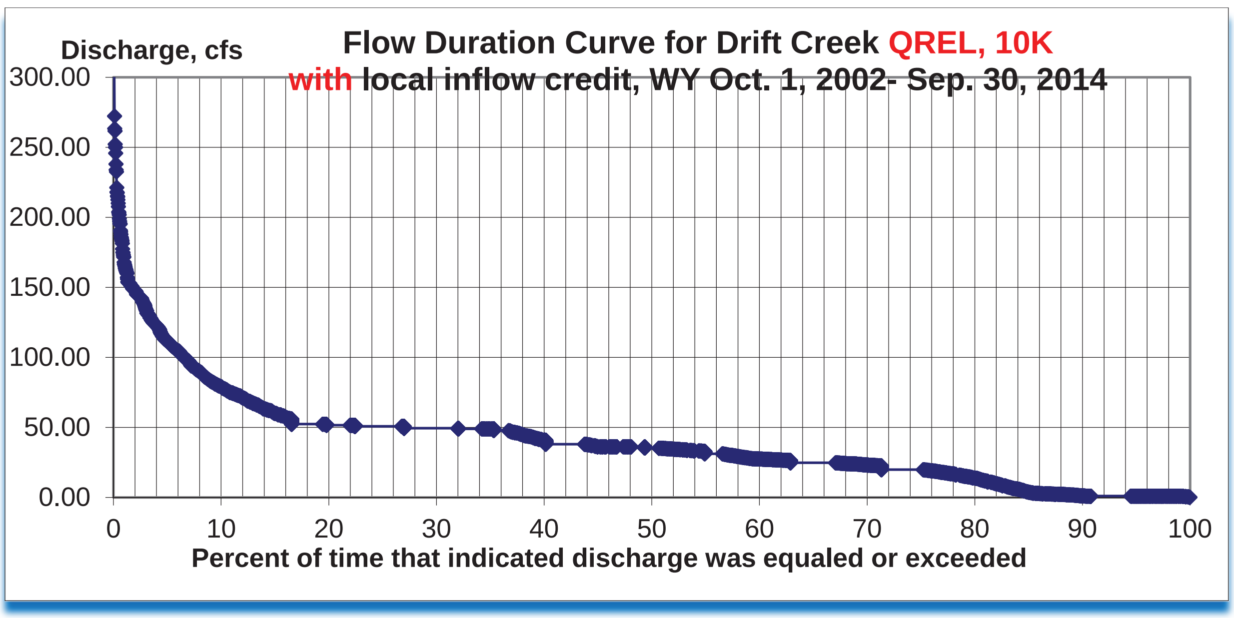
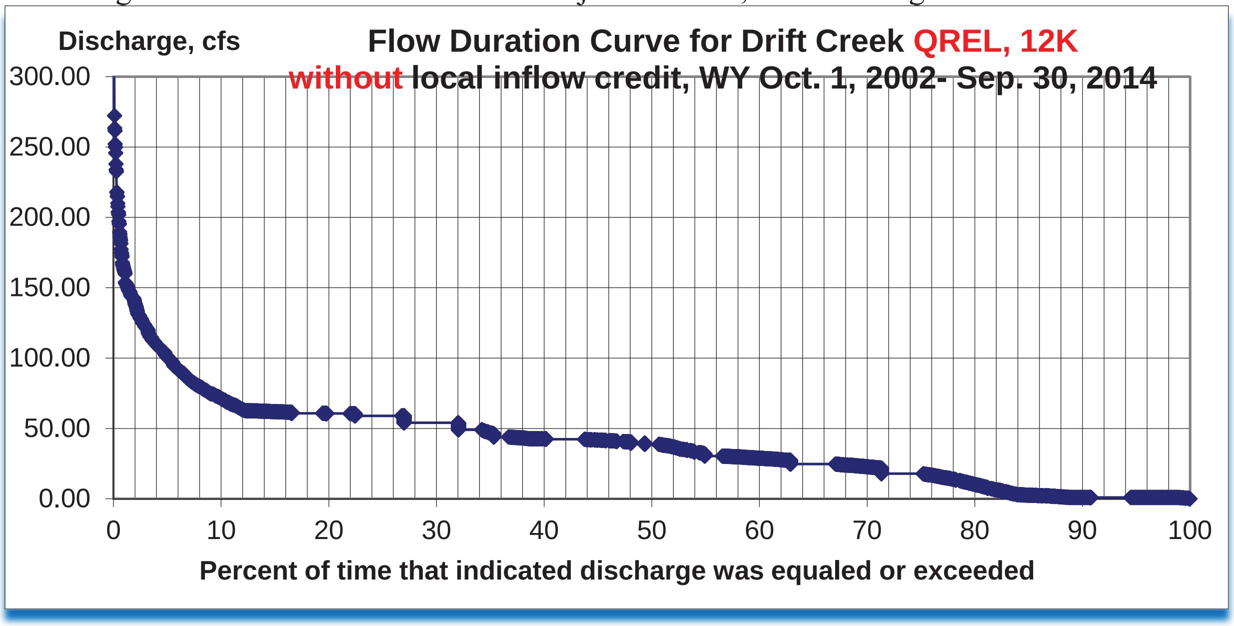
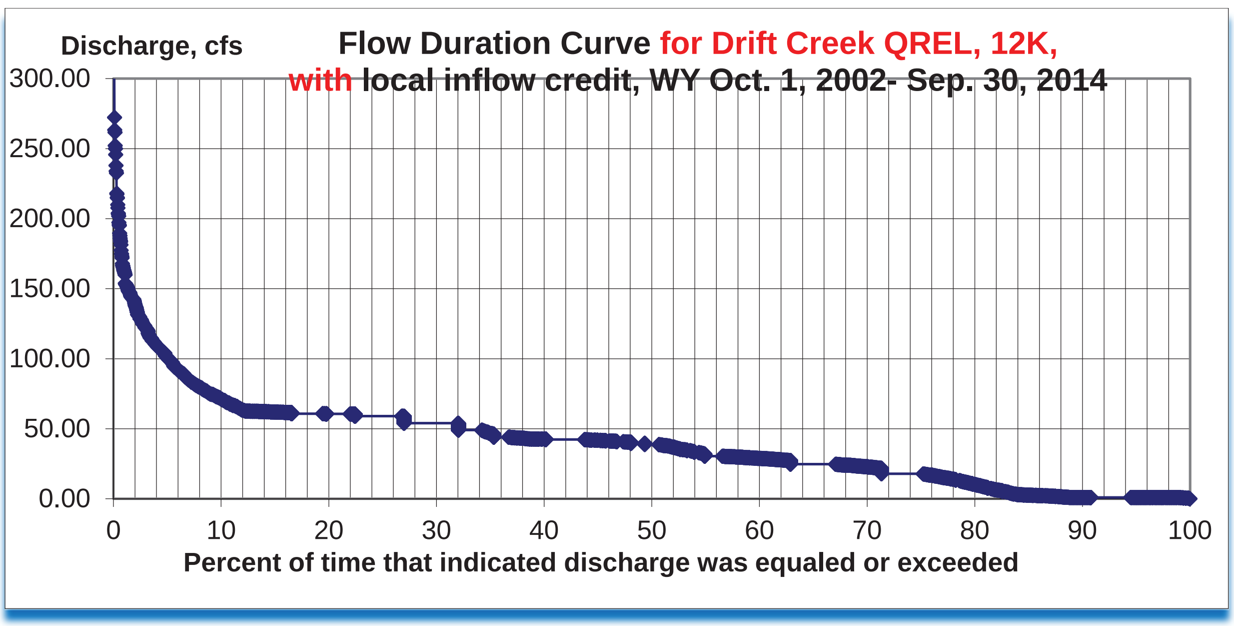


Figure 15.4 Flow Duration Curve: Project Outflow, 12K AF Irrigation





The differences in the discharges may be hard to detect from the graphics shown above. Table 15.1, which contains the discharges close to the 50 percent exceedance for each operating scenario, provides some ideas on the level of the changes in stream flow compared to the natural conditions at that 50% exceedance level.

Table 15.1 Discharges Near the 50% Exceedance Level (**Full Year Time Span)**

Operating Scenarios	% Exceedance PE1	Flows at PE1, cfs	% Exceedance PE2	Flow at PE2, cfs
QREL_8K0L (*)	49.34	40.03	50.66	40.00
QREL_10K0L	49.34	40.93	50.66	40.93
QREL_12K0L	49.34	38.81	50.66	38.80
QREL_8KL	49.34	40.03	50.66	40.00
QREL_10KL	49.34	40.93	50.66	40.93
QREL_12KL	49.34	38.81	50.66	38.80
Natural Inflows	49.98	24.24	50.00	24.21

(*) 8K0L= 8KAF Irrigation, no local inflow credit; 8KL= 8 KAF irrigation, with local inflow credit

Figures 15.5 through 15.8 represent flow duration curves covering the months that are going to experience greater increases in stream flows because of the reservoir releases and, therefore, the most impacts on bank erosion. These months spread from May through September.

Figure 15.5 Flow Duration Curve: May-September **Inflows**, WY 2002-2014

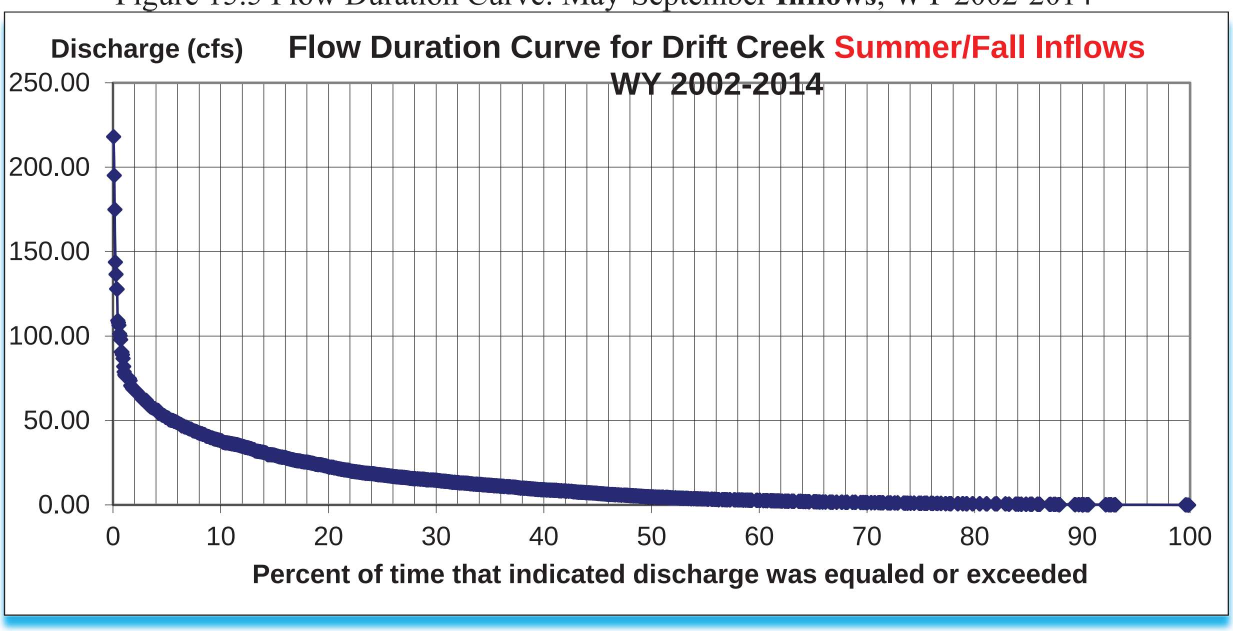
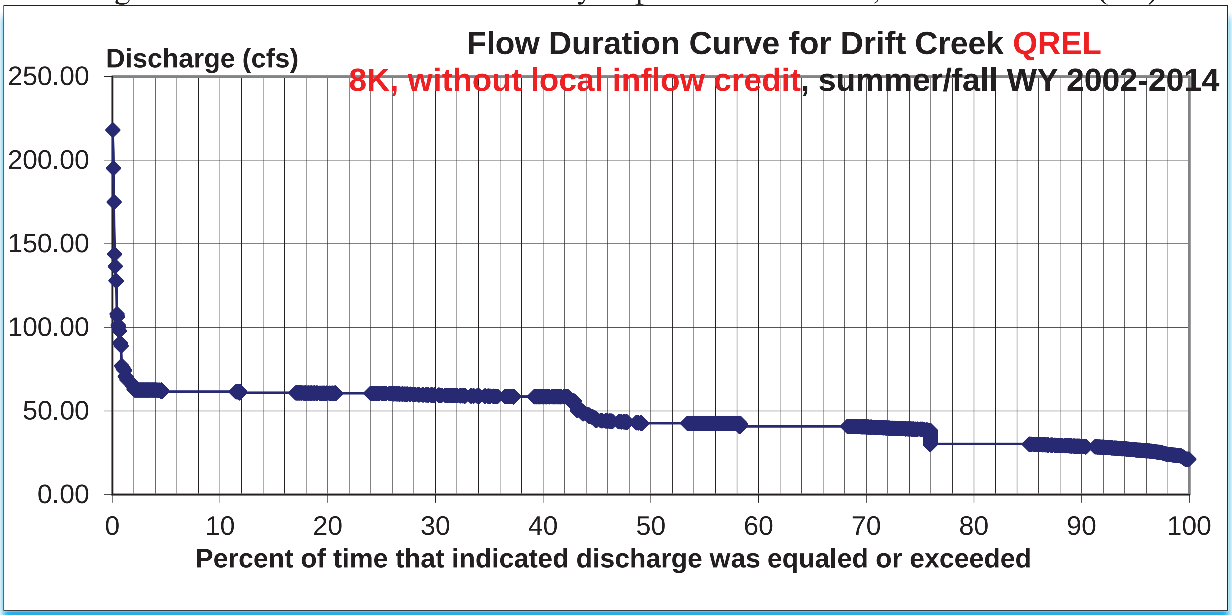


Figure 15.6 Flow Duration Curve: May-September **Outflows**, WY 2002-2014 **(8K)**



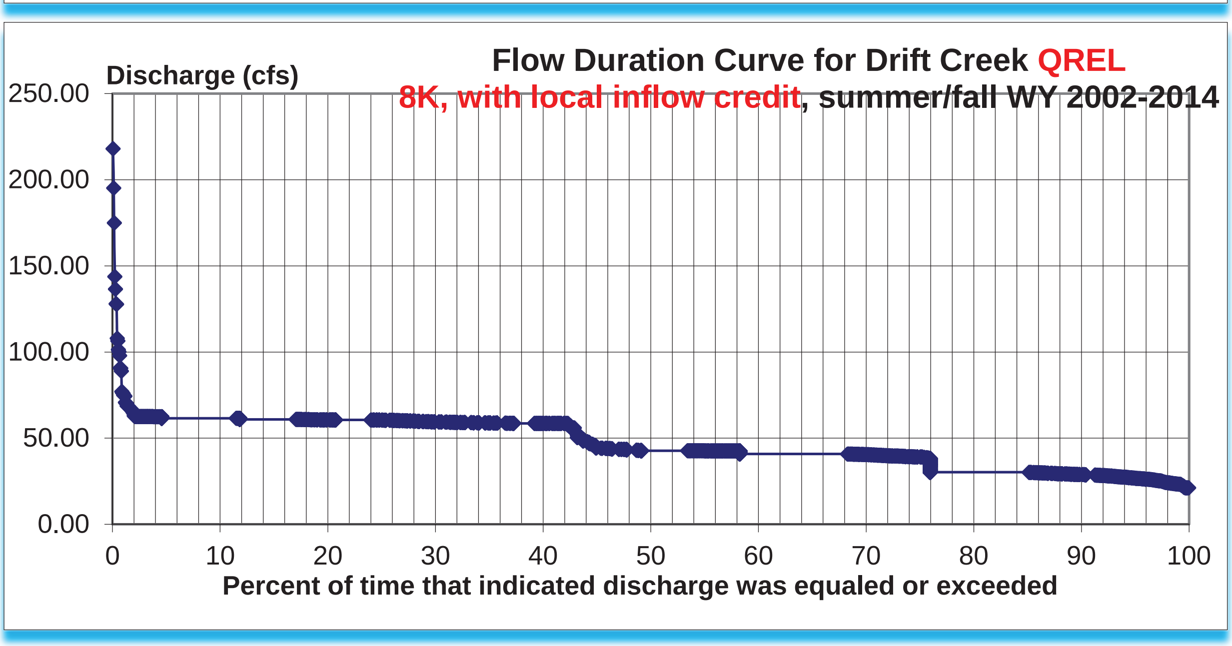
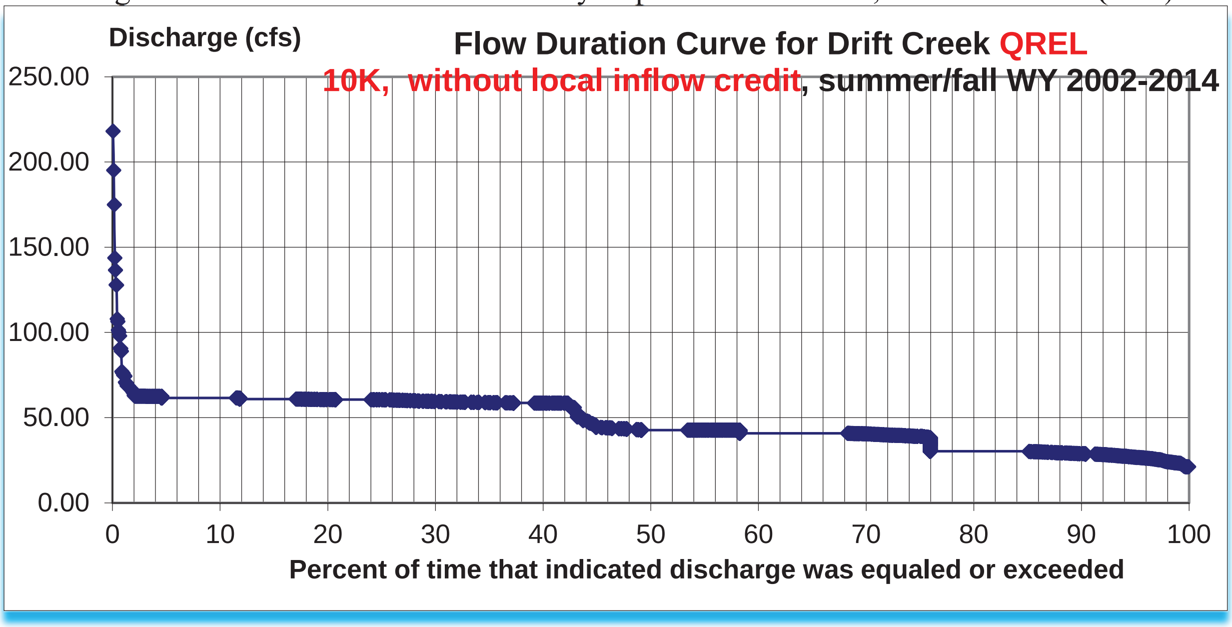


Figure 15.7 Flow Duration Curve: May-September **Outflows**, WY 2002-2014 **(10K)**



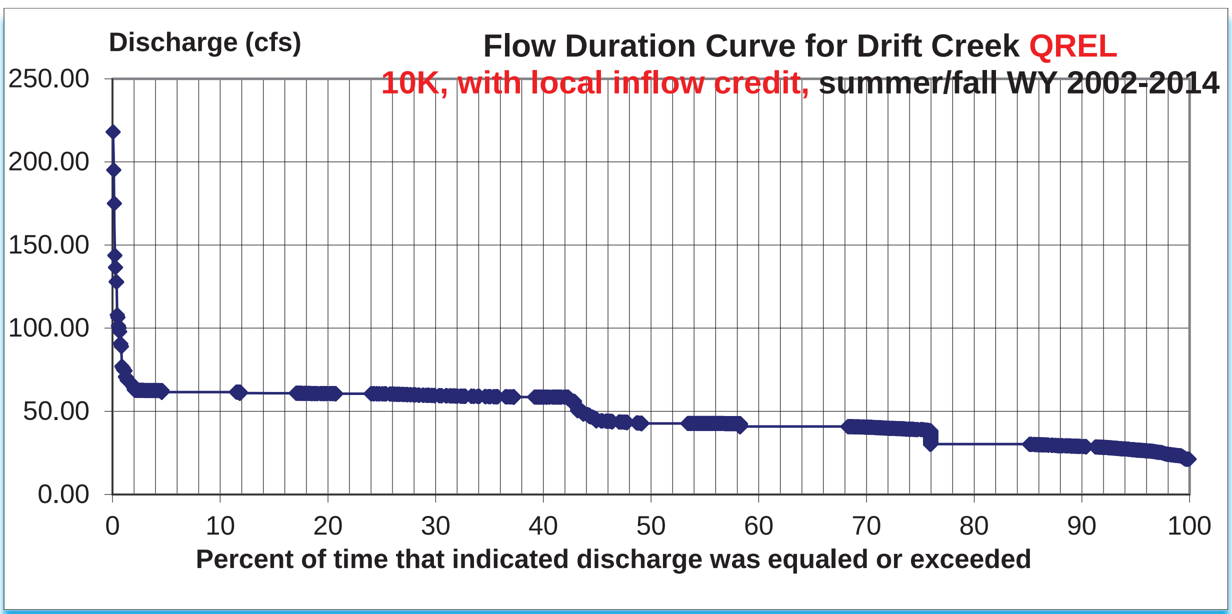
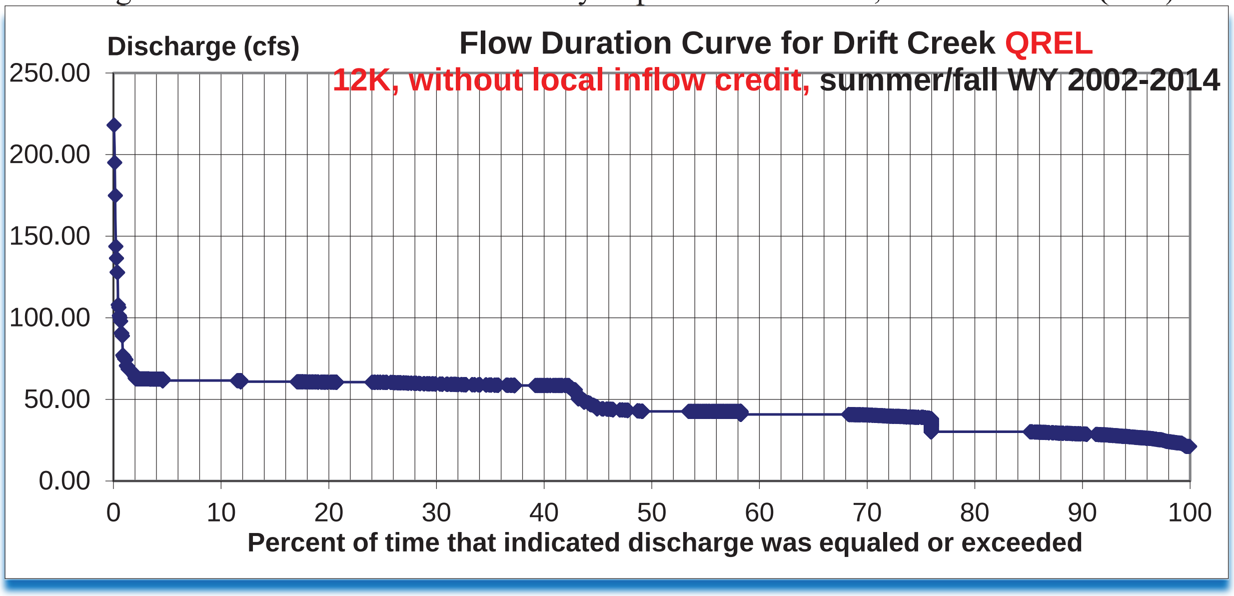


Figure 15.8 Flow Duration Curve: May-September **Outflows**, WY 2002-**2014 (12K**)



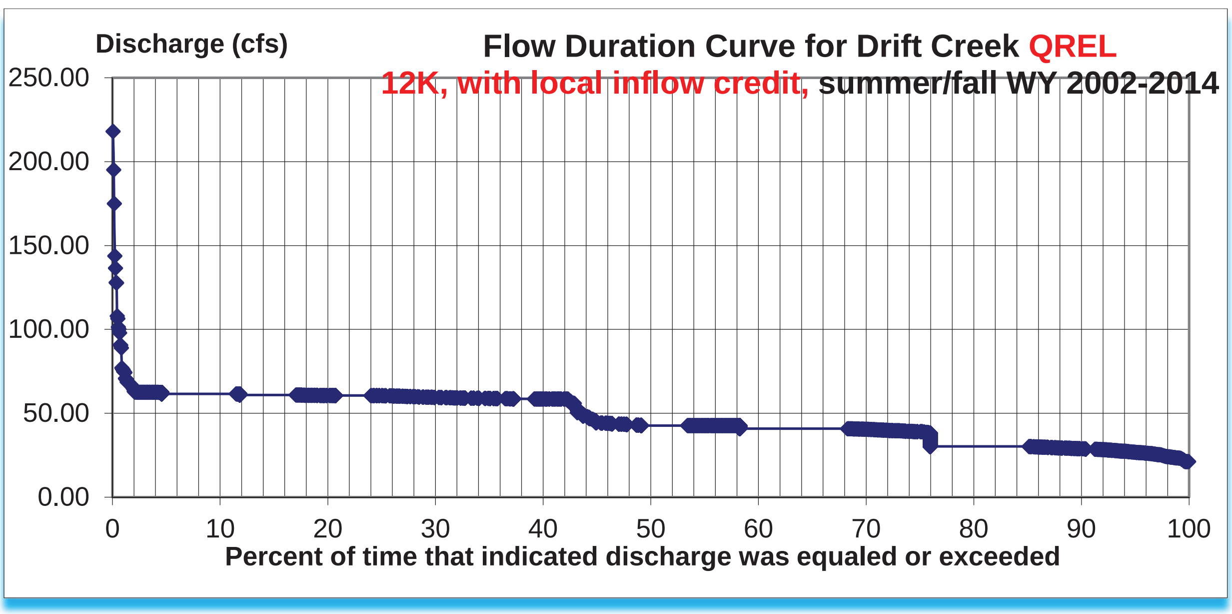


Table 15.2 provides numbers that reflect the minute changes in discharges expected to occur under various operating scenarios.

Based on the results graphically and numerically shown above, the differences in inflow and post-project outflows at the 50% exceedance level are more visible than differences in irrigation releases. Overall, 50 percent of the stream flows during spring through fall are expected to increase from the current 24 cfs average to around 39 cfs or more.

Table 15.2 Discharges Near the 50% Exceedance Level (**May-September** Time Span)

Operating Scenarios	% Exceedance PE1	Flows at PE1, cfs	% Exceedance PE2	Flow at PE2, cfs
QREL_8K0L (*)	49.34	40.03	50.66	40.00
QREL_10K0L	49.34	40.93	50.66	40.93
QREL_12K0L	49.34	38.81	50.66	38.80
QREL_8KL	49.34	40.03	50.66	40.00
QREL_10KL	49.34	40.93	50.66	40.93
QREL_12KL	49.34	38.81	50.66	38.80
Natural Inflows	49.978	24.24	50.00	24.21

(*) 8K0L= 8KAF Irrigation, no local inflow credit; 8KL= 8 KAF irrigation, with local inflow credit

To complement the flow duration curves, Figures 15.9 and 15.10 show the projected daily flows for the May-September season under the three irrigation volume bases and with and without local inflow credit. While the local inflow credit can impact reservoir releases during the October-through-March refill season, its effect on the summer-through-fall stream flows period is very limited.

Figure 15.9 Projected Daily Flows for the May-September Season, without local inflow credit

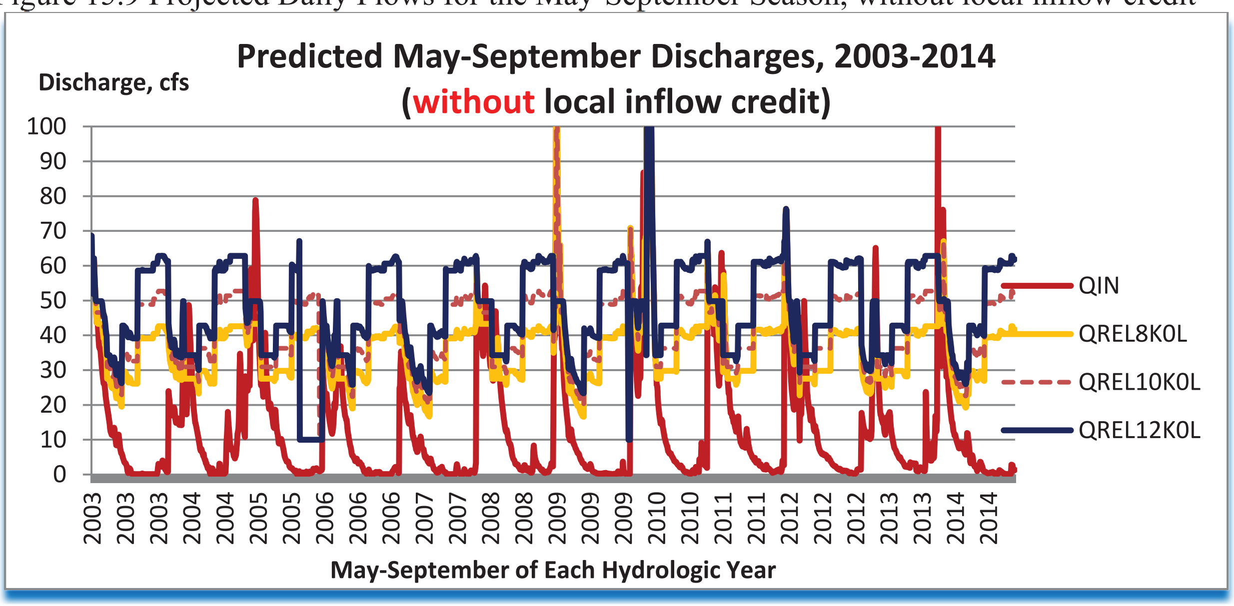
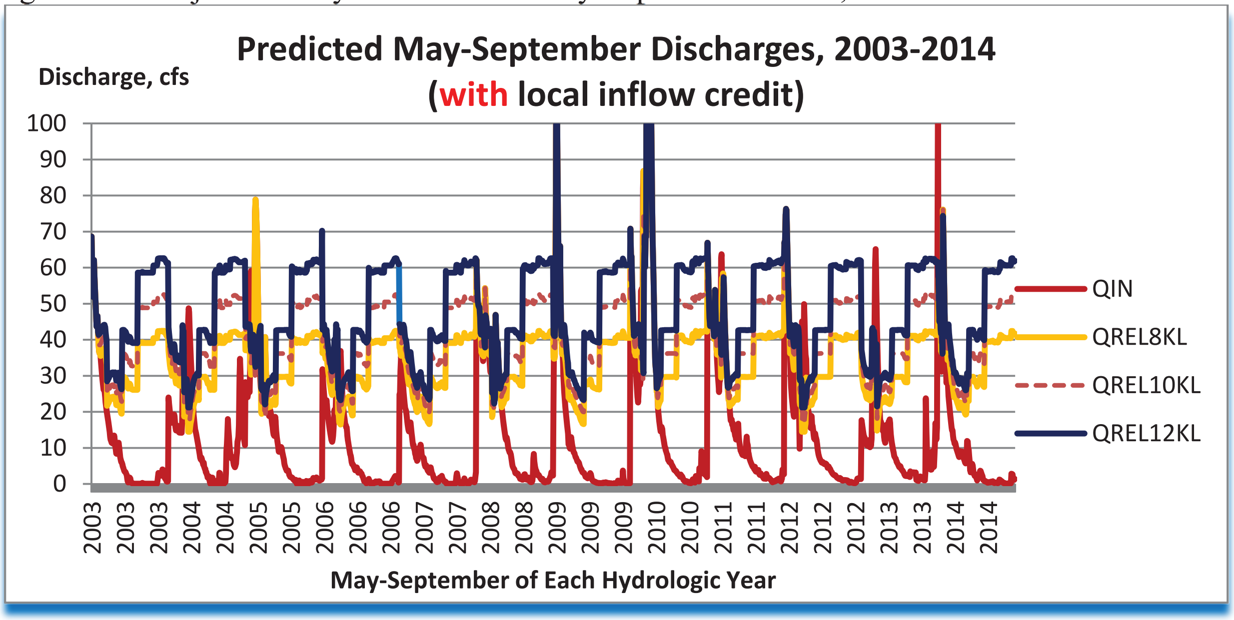


Figure 15.9 Projected Daily Flows for the May-September Season, with local inflow credit



Significant increases in summer/fall stream flows are likely to have an impact on stream bank erosion and sediment deposition. Other bank erosion-related parameters that need to be examined in the future would include flow velocity and wetted perimeters in the river reaches below the proposed dam site.

16. Evaporation Losses

A subject that had not been addressed in previous reports was evaporation, because its impact on the total runoff inflow to the project was assumed to be relatively low. Now that more relevant data are available, it is deemed appropriate to take a closer look and come up with a more detailed estimate of evaporation losses that could affect water availability at the project. The subject is approached from two different angles, long-term and short-term perspectives, using rainfall, pan evaporation, duration, and storage surface area data. The calculation procedure is as outlined in the US Army Corps of Engineers' Hydrologic Engineering Center Training Course on Hydropower, 28 February -11 March 1977 in Davis, California.

In the rainfall-runoff watershed model that was based only on the Salem Airport rainfall data (see Section 7), the rainfall multiplier needed to match Salem rainfall with Lower Drift Creek runoff ranged from 1.5 to 1.9, depending on the overall runoff conditions. This is mostly due to the fact that rainfall distribution is normally more intense over the Drift Creek Basin than over the Salem area. See the isohyet map shown earlier in Figure 3.2. For this assessment, an average rainfall multiplier of 1.6 is used.

Based on the results of the same rainfall-runoff modeling effort, the average runoff which contributes to the stream flow is 58.8 percent of the rainfall over the watershed. This means that, while runoff on the exposed surface of the reservoir is 100 percent, it is only 58.8 percent over this same area prior to the construction of the reservoir. Consequently, runoff to the project is increased by 100-58.8=41.2 percent of the precipitation over the reservoir surface.

Also, the rate of evaporation is taken as 70 percent of pan evaporation and based on the area of the reservoir at the average pool. Monthly average pan evaporation data posted on the Western Regional Climate Center's website at: http://www.wrcc.dri.edu/htmlfiles/westevap.final.html for several Oregon stations relatively close to Drift Creek are shown in Table 16.1. The average annual pan evaporation at those stations is 37.3 inches.

Table 16.1 Monthly Pan Evaporation Rates for Selected Oregon Sites

	PERIOD OF RECORD	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
ASTOR EXPERIMENT STN	1948-1973	0.56	0.96	1.47	2.21	3.75	3.95	4.65	4.10	2.95	1.65	0.87	0.70	27.82
BEND 7 NE	1991-2005	0.00	0.00	0.00	4.25	6.14	6.69	8.66	7.91	5.42	0.00	0.00	0.00	39.07
CORVALLIS STATE UNIV	1889-2005	0.00	0.00	1.79	2.96	4.59	5.86	7.70	7.07	5.06	2.33	0.96	0.00	38.32
COTTAGE GROVE DAM	1943-2005	0.00	1.27	2.16	3.07	4.56	5.60	7.75	6.70	4.47	2.06	0.82	0.00	38.46
DETROIT DAM	1954-2005	0.19	1.16	1.69	2.51	4.38	5.90	7.68	6.64	4.24	2.05	0.88	0.46	37.78
DORENA DAM	1948-2005	0.00	1.01	1.94	2.95	4.98	6.11	8.19	7.15	4.66	2.01	0.00	0.00	39.00
FERN RIDGE DAM	1943-2005	0.39	0.79	1.92	3.17	5.03	6.21	8.12	7.09	4.76	2.21	0.67	0.34	40.70

Rainfall data recorded at Salem Airport between October through September 2014 were listed in Table 3.12. Salem Airport rainfall data were multiplied by an average multiplier of 1.6 to derive the estimated rainfall over Drift Creek Basin during the period of interest. The last parameter, average reservoir surface elevation, ware extracted from selected reservoir model outputs.

Table 16.2 shows the details of the estimation of average net evaporation loss for the 6 year period starting from October 2008 through September 2014 (72 months). With a total of 230.0 inches of precipitation recorded at Salem Airport, the adjusted 6-year total rainfall estimate over Drift Creek watershed is 230.1x1.6=368 inches. The average annual pan evaporation extracted from Table 5.1 is 37.3 inches, which leads to a 6-year evaporation amount of 37.3 x 6=223.8 inches.

For the long-term period, given the fact that (1) rainfall over the basin is considerably higher than evaporation and (2) the relatively small size of the catchment area, the evaporation loss would only be equivalent to 0.03 cfs, which is negligible.

Table 16.2 Estimation of Long-term Net Evaporation Loss for Drift Creek (2008-2014)

Items	Comments	Calculation	Results
Total Rainfall (")	Salem Rain: 230" Mult.= 1.6	230*1.6	368.00
Pre-project runoff (")	Ave. Runoff C=0 .588	0.588*368	216.38
Additional runoff over reservoir (")	(1-.588)	(1.000-0.588)*368	151.62
Pan evaporation (")	37.3"	37.3x6	223.80
Reservoir evaporation (")	70% of pan evap.	223.8*.70	156.66
Net evaporation (")	Res. Eva. - Add. RO	156.66-151.62	5.04
Number of months	Oct 2008 to Sep 2014	72	72
Ave. monthly evap. Loss (")	Net Evap./Nb. Months	5.04/72	0.07
Ave. pool elevation (' msl)	From Continuous Modeling	670.5	670.5
Area of ave. pool el. (acre)	From Ele. vs. Area Curve	332	332
Net evaporation Loss (cfs)	Using Conversion Formula (*)	(0.07/12)*(332/60.33)	0.03

(*) Formula to convert 1 cfs during any month to month-second-feet
=(1 cfs x 3600 sec x 24 hours x 30 days)/53,4560 cubic feet)=60.33 AF

The long-term calculation works with average numbers and provides a constant evaporation loss rate over each month of the years of interest. A more accurate approach is to compute, each month, the net evaporation based on the net evaporation rate applied to the average reservoir area during that month. To respond to that need, calculation of evaporation loss for a shorter, monthly time period was performed, focusing on 2008-2009, which was driest of the last six hydrologic years and also recorded the lowest monthly average stream flow in August 2009. The results of the 2008-2009 evaporation loss calculation are summarized in Table 16.3.

Table 16.3 Estimation of Monthly Evaporation Losses for Drift Creek (2008-2009)

Items	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.
Salem Rainfall (")	0.95	3.62	6.02	3.56	2.90	3.03	1.40	3.04	1.39	0.68	0.17	1.20
Total Rainfall (")	1.62	6.15	10.23	6.05	4.93	5.15	2.38	5.17	2.36	1.16	0.29	2.04
Pre-project runoff (")	0.78	2.98	4.96	2.94	2.39	2.50	1.15	2.51	1.15	0.56	0.14	0.99
Additional runoff over reservoir (")	0.83	3.17	5.27	3.12	2.54	2.65	1.23	2.66	1.22	0.60	0.15	1.05
Pan evaporation (")	1.76	0.60	0.21	0.16	0.74	1.57	3.02	4.78	5.76	7.54	6.67	4.51
Reservoir evaporation (")	1.23	0.42	0.15	0.11	0.52	1.10	2.11	3.34	4.03	5.28	4.67	3.16
Net evaporation (")	0.40	-2.75	-5.12	-3.00	-2.02	-1.56	0.89	0.68	2.82	4.68	4.52	2.11
Number of months	1	1	1	1	1	1	1	1	1	1	1	1
Ave. monthly evap. Loss (")	0.40	-2.75	-5.12	-3.00	-2.02	-1.56	0.89	0.68	2.82	4.68	4.52	2.11
Ave. pool elevation (' msl) (*)	649.8	650.7	652.0	669.3	671.9	674.8	676.0	676.0	673.7	669.2	661.2	649.6
Area of ave. pool el. (acre)	240	245	252	328	336	344	347	347	341	328	297	239

Net evaporation Loss (cfs)	0.13	-0.93	-1.78	-1.36	-0.94	-0.74	0.42	0.33	1.33	2.12	1.86	0.69
Natural Av. Inflows, cfs	1.83	22.82	48.19	101.87	38.93	65.90	39.73	45.55	7.24	1.35	0.24	0.49
Post-project Av. Inflows, cfs	1.69	23.75	49.98	103.23	39.87	66.64	39.31	45.22	5.92	-0.76	-1.62	-0.20

(*) Average pool elevations based on the all 6 operating scenarios (with and without local inflow credit and using 8 Kaf, 10Kaf and 12 Kaf irrigation volumes).

Based on the foregoing, net evaporation losses over the proposed Drift Creek Reservoir are expected to be negligible. This is mainly due to the relatively small (less than 350 acres) size of the reservoir surface.

17. Climate Change Impacts on Drift Creek Flow Regime

Climate changes, which seem to be slowly taking place under various shapes and forms around the world, are likely to be more visible in the Pacific Northwest in the not-too-distant future. If parts of this region are to become warmer and/or experience new seasonal precipitation distributions, changes in hydrologic conditions would be unavoidable. Therefore, when dealing with a long-term project like Drift Creek that depends on stream flows and is designed to operate for several decades into the future, a succinct assessment of this global issue is needed to answer the basic question, "How would climate change affect the flow regime of Drift Creek in the next 40 years?"

The assessment is based on currently available information provided by researchers and analysis of historic observations trend lines. It focuses on the three main drivers of the flow regime of Drift Creek: precipitation (P), temperature (T) and runoff (Q). No snow impacts are considered since Drift Creek flows in a relatively low elevation, rain dominant watershed of the west Cascades region with little snow-melt and peak flows in the winter months. Other factors that normally control hydrologic responses to climate changes are not directly addressed in this report. Those factors include geographical location (e.g., east or west side of the Cascade Range), shorter-term climate patterns (e.g., Pacific Decadal Oscillation, El Niño, etc.), elevation, geology, soil infiltration, vegetation, and land use. The assessment also includes projections on the shapes of future stream flow hydrographs, based on the results of recent regional modeling efforts.

17.1 Assessments/Projections by Regional Researchers

Climate change assessments and projections by selected research projects are quoted below to provide a general idea on the type and magnitude of the actual and projected changes for the Pacific Northwest regions.

U.S. Natural Climate Data Center (2001): "*Global temperature changed by over 1 degree Fahrenheit between 1880 and 2000*".

University of Washington Climate Impacts Group (UW-CIG): *Both Pacific Northwest temperature and precipitation have increased over the 20th century. On average, the region* *warmed about 1.5°F; warming was largest west of the Cascades during winter and spring.[...]. Winter precipitation in the Willamette Valley will likely increase and spring/summer precipitation will decrease. Within the Cascades, average annual temperature is expected to increase along with changes in precipitation patterns (more rain in winter). Warming is expected continue, with a likely warming rate of about 0.5°F decade. [....] While future changes in precipitation are less certain, overall, precipitation is projected to increase. Most likely scenario: wetter, more intense runoff in the winter/spring and less base stream flow during the summer months*.

Cayan et al. (2001): "*All areas of the Pacific Northwest region became warmer and some areas received more winter precipitation over the course of the 20th century. [....] Western United States spring temperatures increased from 1.8 to 5.4 degrees Fahrenheit [ºF]) between 1970 and 1998.*

Regonda et al. (2005): "*Increased winter precipitation trends during 1950–1999 at many western United States sites, including several in the Pacific Northwest, although a consistent region-wide trend is not apparent over this period. [....] Based on 1950–1999 data from 89 stream gauges in the western United State system, significant trends toward earlier runoff were found in the Pacific Northwest.*

Luce and Holden (2009): "*Stream flow reductions are observed during 1948–2006 and significant trends in annual stream flow reductions during dry years"*.

Mote and Salathé 2010): "*Projected increases in average annual Pacific Northwest temperature of 2.0°F by the 2020s, 3.2°F by the 2040s, and 5.3°F by the 2080s (compared to 1970–1999). [...] Projected changes in average annual precipitation, averaged over all models, are small (+1 to +2 percent), but some models project an enhanced seasonal precipitation cycle with changes toward wetter autumns and winters and drier summers".*

US Bureau of Reclamation, US Army Corps of Engineers and Bonneville Power Administration Joint Operating Committee (2011): "[Based on model projections], *Columbia River Basin annual air temperatures are expected to rise from 1 to 3 degrees Fahrenheit above the historical reference period by the 2020 period, and 2 to 5 degrees Fahrenheit by the 2040 period. This change would affect Columbia River Basin precipitation and snowpack patterns (more rain, less snow) [...] and seasonal river flows. [....] Overall, yearly precipitation changes in the study were minimal -- an average annual precipitation over all models increase 1 to 2 percent. [....] All of the climate change scenarios exhibited a seasonal shift of higher flows in the winter and lower flows in the summer... due in part to more winter precipitation in the form of rain instead of snow, and increased snowmelt earlier in the year due to warmer temperatures".*

Dalton, M.M., P.W. Mote, and A.K. Snover (2013): "*During 1895–2011, the Northwest warmed by about 0.7 °C, while precipitation fluctuated with no consistent trend. [....] The Northwest is expected to experience an increase in temperature year-round with more warming in summer and little change in annual precipitation. [....] Annual average precipitation is projected to change by about +3%, with individual models ranging from –4.7% to +13.5%. [...] For every season, some models project decreases and others increases, although for summer more models project decreases than increases, with the largest projected change of about –30%*

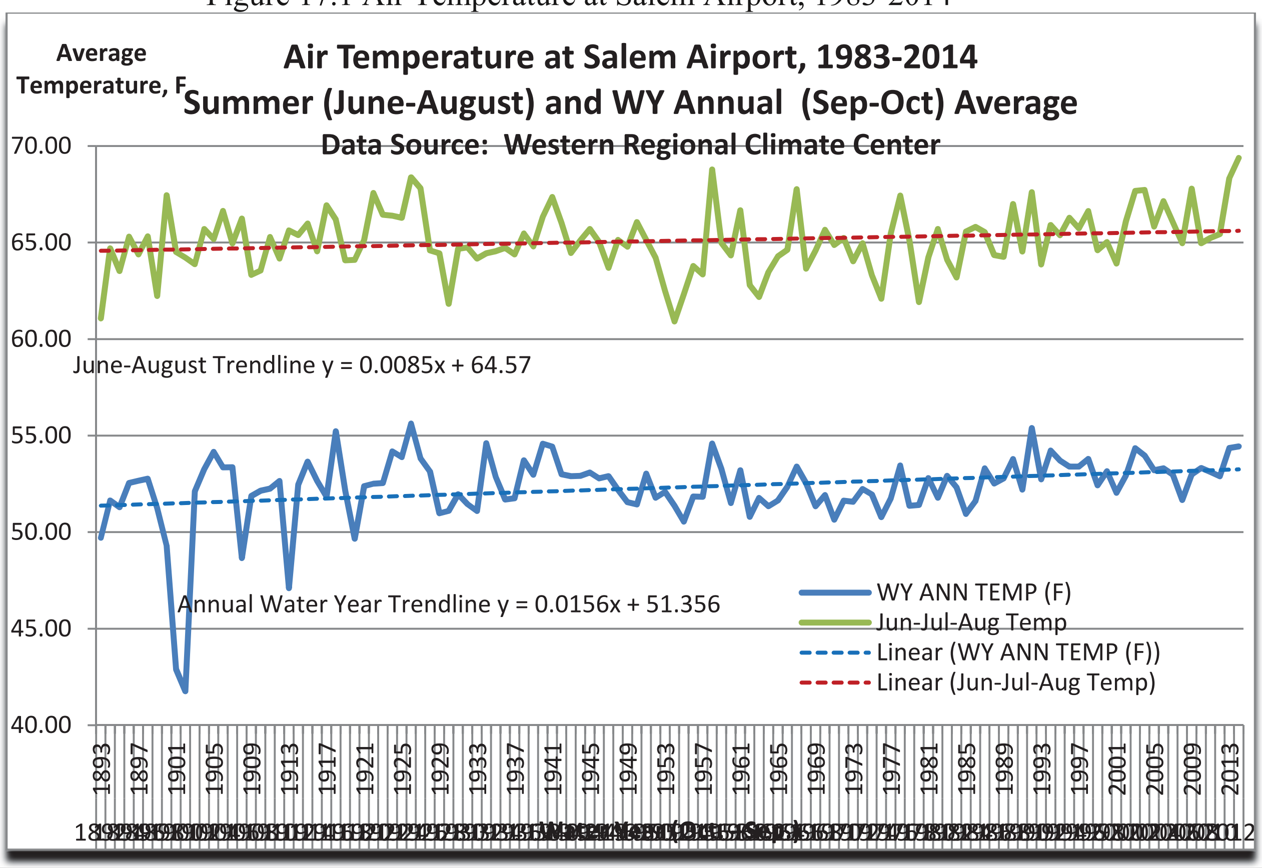
by 2041–2070. [....] Models that project the largest warming in summer also tend to project the largest precipitation decreases".

17.2 Trend Line Assessments Using Historical Records

To support and/or verify the accuracy of the T, P and Q numbers listed above, a trend line assessment is performed using historic data recorded at locations closest to the Drift Creek Basin. The trend will be classified as not significant if the slope of the trend line is not significantly different from zero.

(1) **Air temperature** at Salem Airport, going back as far as 1893 (121 years up to 2014). This information can be used as heat index for the region that includes Drift Creek drainage basin. Temperature data recorded during 5 years between 1893 and 1920 contains some monthly gaps that have to be filled assuming the same mean averages of similar months in the years immediately before and after the gap. The trend lines of the average air temperature over (1) the October - September water year, and (2) June-August summer period are shown in Figure 17.1. [Note that long-term water temperature data would be another interesting parameter to examine in the future, if the needed data are available].

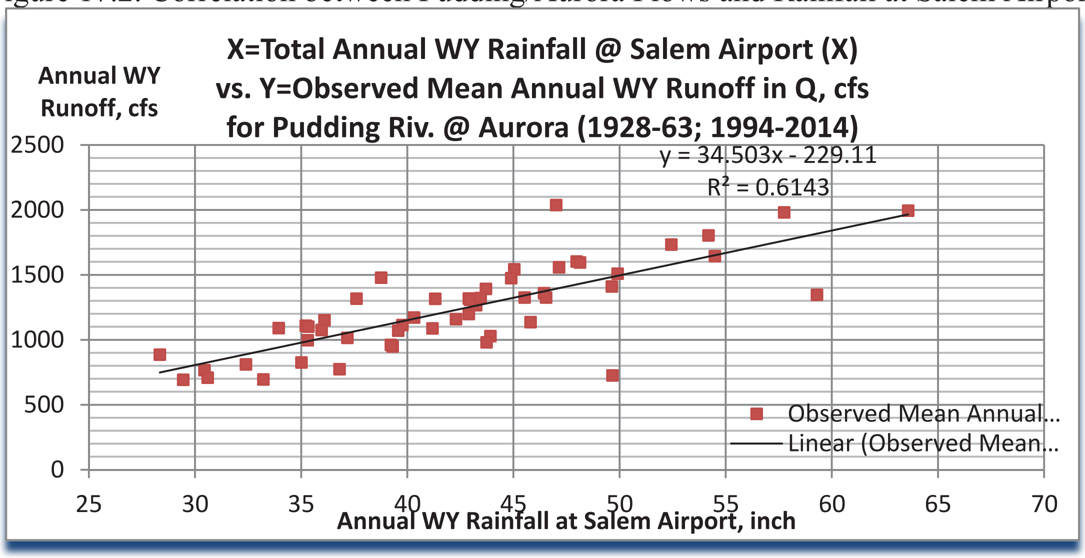
Figure 17.1 Air Temperature at Salem Airport, 1983-2014



(2) **Precipitation** (rainfall) at Salem Airport, going as far back as 1893 (121 years up to 2014). Rainfall can be used to represent runoff conditions since Drift Creek is in a rain-dominant

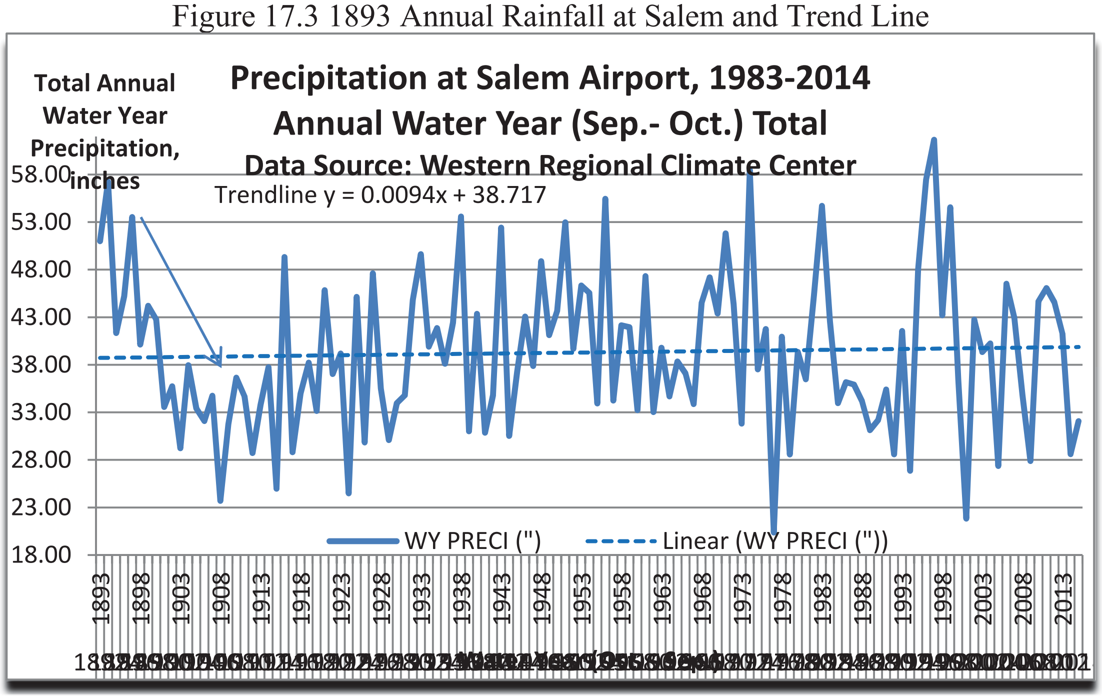
watershed. The annual correlation between Pudding River near Aurora flows and Salem Airport rainfall has an R^2 correlation value of 0.6143, which is within acceptable reach. See Figure 17.2.

Figure 17.2. Correlation between Pudding/Aurora Flows and Rainfall at Salem Airport



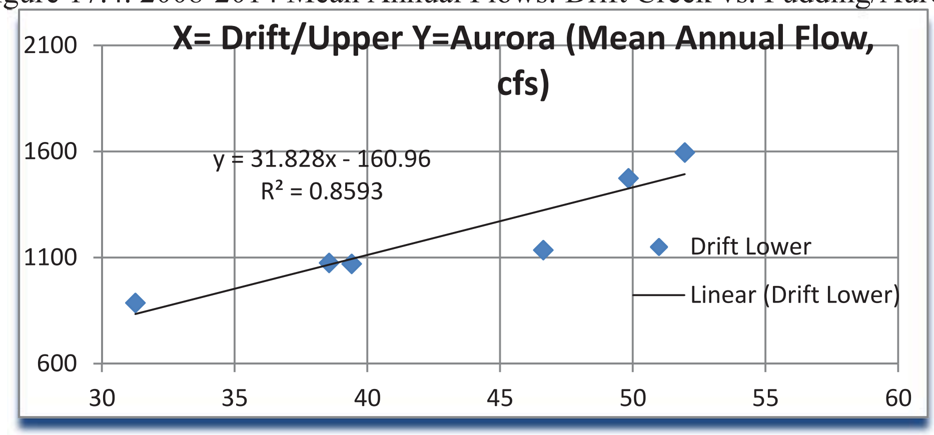
Rainfall data recorded at Salem Airport during 6 years between 1893 and 1901 contains some monthly gaps that have to be filled assuming the same mean average rainfall amounts for similar months in the years immediately before and after the gap. The 1893-2014 rainfall annual amounts and the trend line for that period is shown in Figure 17.3.

Figure 17.3 1893 Annual Rainfall at Salem and Trend Line



(3) **Stream flows** of the Pudding River near Aurora, stretching from 1928 through 2014 with two gaps (1964-1993 and 1998-2001). This is a 86 year long period with 52 years of continuous observed records. The 34-year gaps can be either left unfilled, or filled with statistically synthesized data. The Pudding River near Aurora station is selected because of (a) its long-period of record and (b) its reasonably good regression correlation with Drift Creek data, with an R^2 of 0.8593, based on Sep. 2008- Oct. 2014 observed stream flow data. See Figure 17.4.

Figure 17.4. 2008-2014 Mean Annual Flows: Drift Creek vs. Pudding/Aurora



Annual stream flows variations of Pudding River near Aurora between 1928 and 2014 and their trend lines are shown in Figures 17.5 (data gap unfilled) and 17.6 (data gap filled).

Figure 17.5 1928-2014 Pudding Riv./Aurora Mean Annual Flows (with gap)

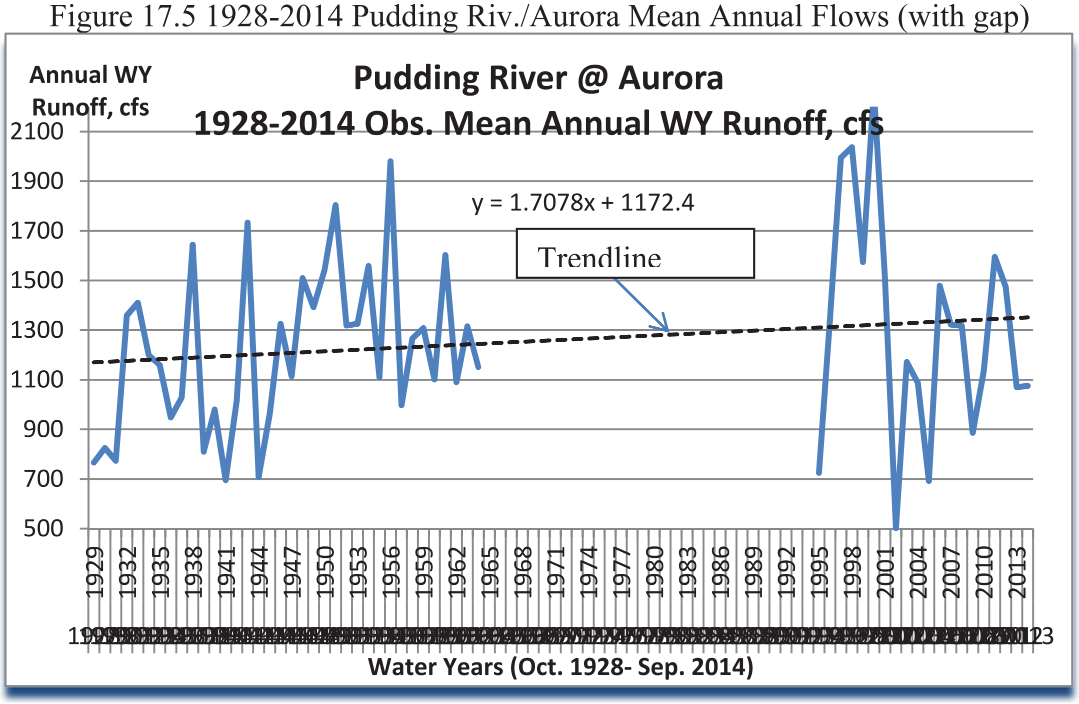
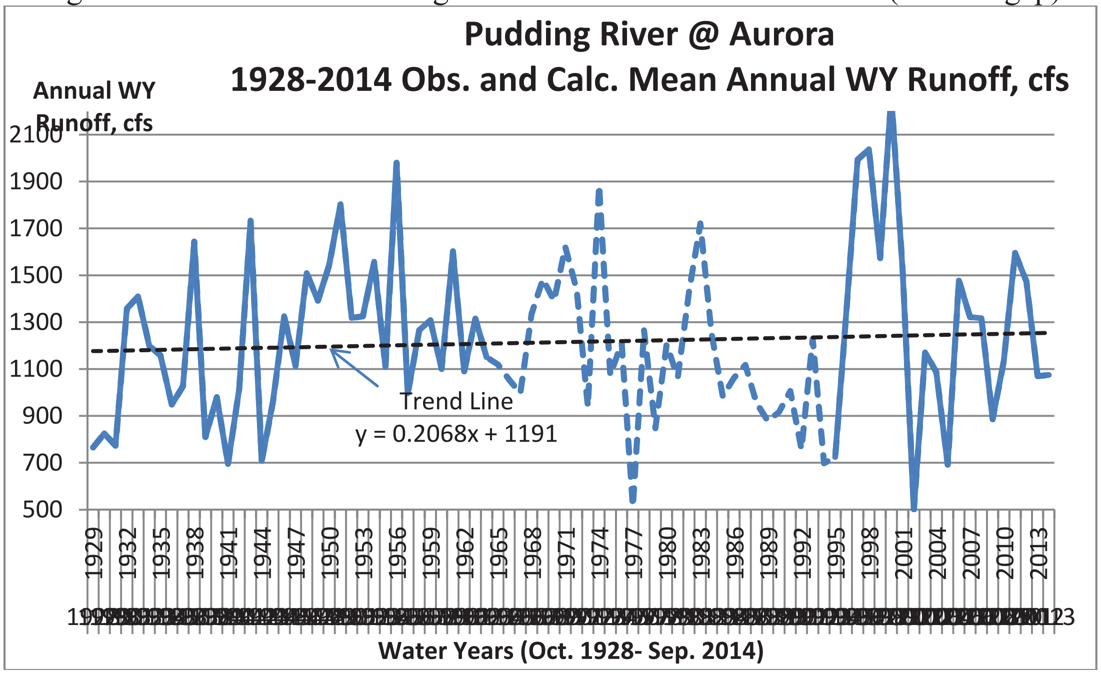


Figure 17.6 1928-2014 Pudding Riv./Aurora Mean Annual Flows (without gap)

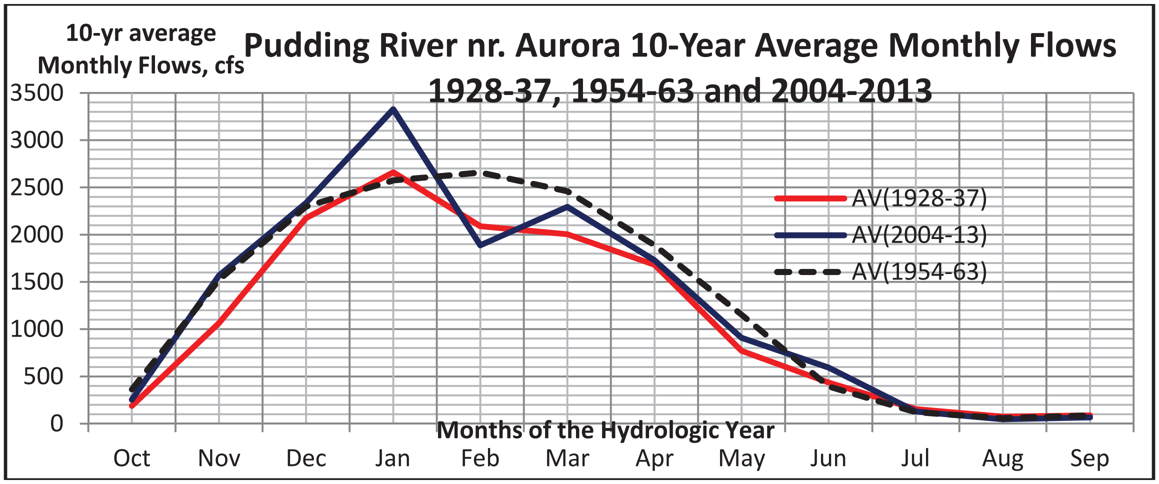


In addition to average annual stream flows, average monthly flows for the Pudding River near Aurora are also plotted for three different 10-year periods (1928-37, 1954-63 and 2004-2013) to detect temporal and quantitative flow changes between those periods. See Table 17.1 and 17.7.

Table 17.1 10-year average monthly flows, Pudding River near Aurora

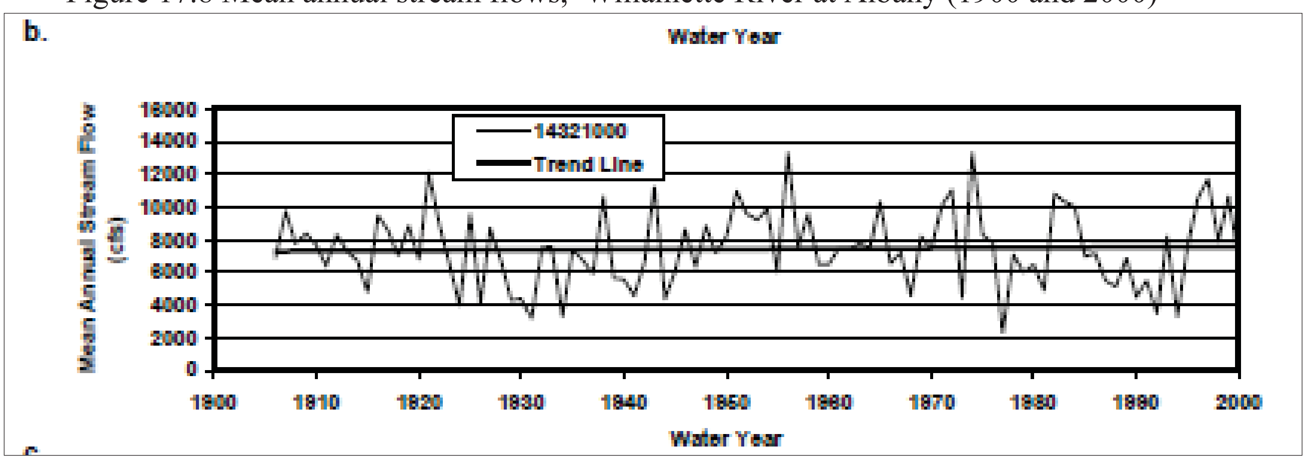
Av. Q	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1928-1937	187.8	1065.2	2176.1	2659.3	2088.9	2004.1	1680.5	770.7	435.8	154.6	73.7	85.7
1954-1963	364.1	1524.4	2300.0	2575.8	2658.4	2460.1	1888.1	1153.0	395.0	121.7	58.5	87.3
2004-2013	253.6	1568.0	2337.2	3327.4	1887.3	2295.0	1729.3	906.8	592.8	127.9	46.4	65.1

Figure 17.7 10-year average monthly flows, Pudding River near Aurora



The last piece of information examined is the plot of the mean annual stream flows of the Willamette River at Albany between 1900 and 2000, excerpted from the OWRD Report, "Determining Surface Water Availability in Oregon, Open File Report SW 02-002, June 2002". See Figure 17.8. Some slight increases were depicted for that 100 year time span based on the slowly climbing trend line.

Figure 17.8 Mean annual stream flows, Willamette River at Albany (1900 and 2000)



The results of the analysis described above for the Pudding River near Aurora are summarized below. For lack of better data, the conclusions reached for the Pudding River are assumed to be generally applicable as well to Drift Creek (one of its own tributaries).

- Average annual stream flows, based on Pudding River near Aurora data, shows a trend line increase from 1180 cfs in 1928 to 1350 cfs in 2014 (about 14%) over the past 86 years.
- Average annual precipitation, based on Salem rainfall data, shows a trend line increase of 2.8% (from about 38.9" to 41.1") over the past 121 years.
- Average annual air temperature, based on Salem temperature data, shows a trend line increase of 4.1% (from about 51.2 inches to about 53.3 inches) over the past 121 years.
- Average June through August air temperature, based on Salem temperature data, shows a trend line increase of 1.9% (from about 64.4 degree F to about 65.6 degree F) over the past 121 years.

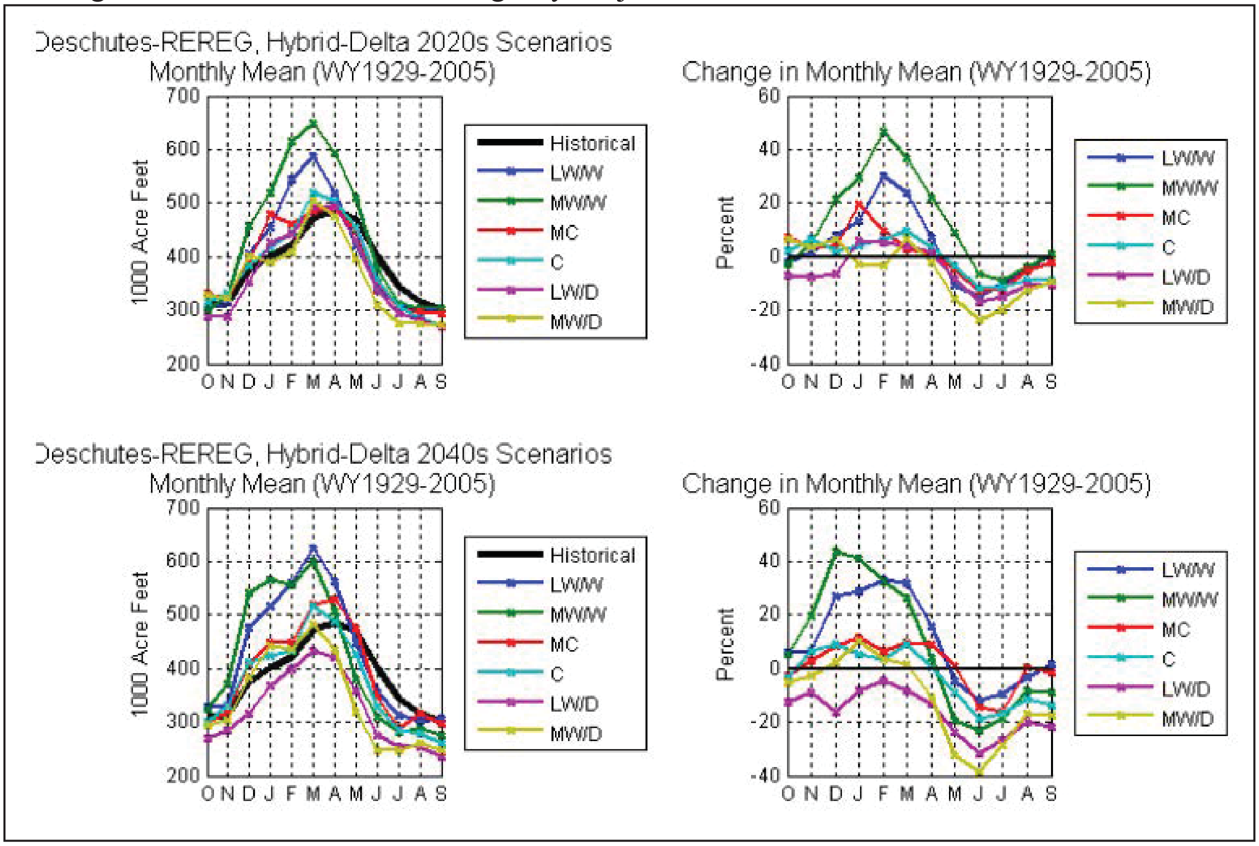
- Based on 10-year monthly average flows plots, there does not seem to be a clear, easily explainable pattern of changes in the steam flow hydrographs between 1928 and 2014. In general, the more recent average monthly flows appear to be slightly higher than those occurring in the 1930's. More recent January average flows also seem to be now higher than before.

17.3 Climate Change Projections for Drift Creek Flows

Climate change projections for Drift Creek were based on the modeling results of the Tri-Agency (Reclamation, Corps of Engineers and BPA) 2011 Study. The Study included a water supply forecast that reflects future hydrologic and climate conditions in the Columbia River Basin and associated sub-basins -- Yakima, Deschutes, and Snake River sub-basins. Of those three basins, the Deschutes River Basin was selected for the Drift Creek projection, because of its nearest vicinity to the Drift Creek watershed (despite its west side of the Cascades location, a limitation far less critical than the one associated with farther drainage basins).

Two time frame targets (2020 and 2040) were selected from the Tri-Agency's Climate Change Study, which also assumed six qualitative scenarios: central (C), more warming and wetter (MW/W), less warming and wetter (LW/W), more warming and drier (MW/D), less warming and drier (LW/D), minimal change (MC), roughly targeting less warming and central precipitation change. The results of the changes projected by the Tri-Agency Study for the Deschutes River Basin are illustrated in Figure 17.9. Those results were applied to Drift Creek with some adjustments.

Figure 17.9 2020 and 2040 Tri-Agency Projections for Deschutes River Basin Runoff



The procedure used to adjust the above results and make them applicable to Drift Creek Basin includes the following steps:

1. Calculate Pudding/Aurora monthly averages (in cfs) for the period 1929-2014 (Only observed data; no g
See Table 17.2 below.

Table 17.2 Pudding River near Aurora 1929-2014 Average Monthly Flows

Month	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	A
Q, cfs	335.3	1403.8	2470.2	2843.1	2736.3	2095.0	1543.4	874.3	427.1	148.2	68

2. Calculate regression equations and R^2 Correlation values for 2008-2014 monthly flows for Drift Creek vs. for Pudding/Aurora. See Figure 17.10 and Table 17.3.

Figures 17.10 Monthly Average Flows Regression Drift Cr. vs. Pudding/Aurora

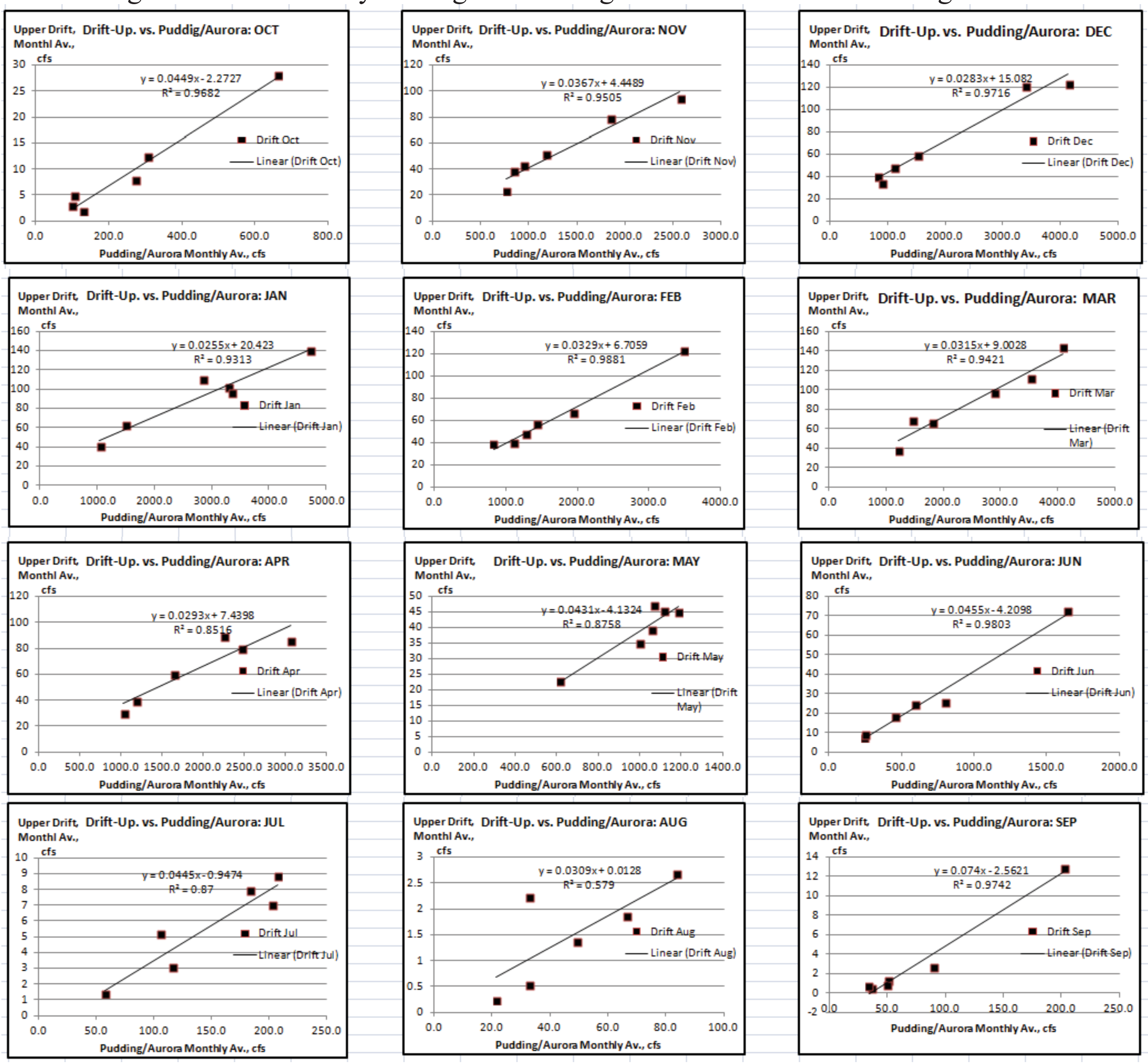


Table 17.3 Linear Regression Equations Y (Drift)= a * X (Pudding) + b

Month	a	b	R^2
Oct	0.0449	-2.2727	0.9682
Nov	0.0367	4.4489	0.9505
Dec	0.0283	15.082	0.9716
Jan	0.0255	20.423	0.9313
Feb	0.0329	6.7059	0.9481
Mar	0.0315	9.0028	0.9421
Apr	0.0293	7.4398	0.8516
May	0.0431	-4.1324	0.8753
Jun	0.0455	-4.2098	0.9803
Jul	0.0445	-0.9474	0.8700
Aug	0.0309	0.0128	0.5790
Sep	0.0740	-2.5621	0.9742

18. Conclusions

1. This hydrologic analysis report Update #4 complements the earlier reports prepared in February 2007 (Update #1), June 2010 (Update #2), and October 2012 (Update #3) in the light of more recent stream flow data collected for Drift Creek (during October 2011-September 2014). 2008-11 discharge measurements at the proposed project site on Victor Road and a station further downstream, closer to Drift Creek confluence with the Pudding River, seem to produce fairly consistent results.

2. As expected, the challenge continues to be the still relatively limited number of real-time discharge data. So far, only six years of actually observed data stretching from April 2008 to September 2014 are available. The 2008-09 period was dry; 2009-10 and 2012-14 slightly below average, and 2010-12 high years in the top ten. Those six years did cover the lower side and the high side of the expected runoff at the project, but they still leave open questions on the higher side of the runoff with more significant snow-melt contribution.

3. How to extend the stream flow records was one of the key issues. To address that need, attempts were made to identify reliable statistical correlations between Drift Creek discharges and discharges at other nearby streams. Of the six streams under consideration, Pudding River near Aurora has by far the longest period of records – 52+ years of observed flows and an additional 34 year period of synthesized flows using rainfall and snow data at Salem. One could either use the Drift Creek versus Pudding River regression equations to generate up over 80+ years of flow data for Drift Creek, or develop a rainfall-runoff model to link Drift Creek flows with rainfall and snow data at Salem. So far, the regression-based predictions appear to be more reliable than model predictions because of data limitation.

4. Other data discussed in this report include water availability, in-stream water rights, and ecological and channel maintenance flows. Based on the June 9, 2015 conference call with

OWRD staff, there are no immediate plans for OWRD to update natural stream flows listed for the 50% and 80% exceedance frequencies. Those flows were based on modeling results related to ungaged watersheds, and do not reflect any of the observed stream flow monitoring data recorded for Drift Creek.

5. Additional data for the 90% and 95% exceedance frequencies were developed using a simplified procedure based on 2008-2014 observed stream flows at Upper Drift Creek to reflect actual runoff conditions, with adjustment to both represent data at the mouth of the creek and ensure maximum consistency with OWRD data.

6. The latest information received from OWRD staff in early June 2015 covers OWRD Proposed Final Order on the draft permit that was issued to EVWD on July 22, 2014. Some of the provisions listed in the draft permit, including the definition of the authorized refill period (November 1 through April 30), the requirement to pass all live flows during May 1 through October 31, and the specification that the "*use of allowed water may only be made at times when sufficient water is available to satisfy all prior rights*" are slightly more restrictive than originally assumed and used as reservoir refill criteria in the model runs performed up to now. Based on previous exploratory model runs, those generally more date-specific criteria did not have any significant impacts on the timing and quantity of water that can be stored in the reservoir. They will, however, be more closely modeled in future study updates.

7. Based on the updated water availability information provided on the Internet by OWRD, the likelihood to see an October-April runoff volume of 12,000 AF available for storage at the project site looks reasonably good. That volume is estimated at 17,700 AF for the 90% exceedance frequency (EF); 26,400 cfs for the 50% EF (a 2 year exceedance interval); and 39,500 cfs for the 10% EF (10 year exceedance interval).

8. The October-April runoff volumes listed above can be stored in the reservoir when the project has to meet 100% of the required in-stream flows listed for Drift Creek at its confluence with the Pudding River. Since the drainage area below the project contributes about 40% of the creek's runoff at the mouth, the actual runoff volume that can be stored would be greater than indicated if that local inflow may be used to meet part of the in-stream requirements. A sequential mass curve was prepared using the 2008-2014 observed stream flow data at Upper Drift Creek as an additional tool to help determine the storage required to provide a given set of in-stream and irrigation release requirements.

9. Under both the 2008-09 and 2009-10 runoff conditions and assuming that the project starts empty, the project would not have filled under full release requirements. However, the project would have filled when relying on the local inflow to meet part of those release requirements. By the same token, under the wetter 2010-11 runoff conditions, the project would have filled even if it starts empty on October 1 and has to release 100 percent of the in-stream flow requirements (when allowed by the actual inflow).

10. In preparation for more detailed analyses covering a wider range of runoff conditions, both statistical regression and deterministic computer modeling tools had to be set up. The statistical procedure was based on 2008-14 data and led to the definition of representative low, average and high flow years.

11. Two computer models were developed for Drift Creek. The rainfall-runoff deterministic model is code-named FLO4DRIFT. Once fully calibrated, this runoff model can generate daily flows for any site along Drift Creek based on rainfall (and snow) input. The RES4DRIFT reservoir model, on the other hand, can simulate reservoir operation under various inflow and outflow scenarios on a daily time step. Daily reservoir release criteria closely follow the release requirements currently in effect with regard to meeting consumptive and in-stream water rights, and pre-planned irrigation releases.

12. A 12-year continuous time series reservoir simulation was performed for the October 1, 2002 – September 30, 2014 with the reservoir starting empty on October 1, 2002. The October 1, 2002 start date was the day the Pudding River gauge at Aurora resumed its operation after a long period of inactivity. The inflows to the project for October 1, 2002 through September 30, 2008 were derived through the use of regression equations based on daily flows of the Pudding River at Aurora, while daily inflows for the October 1, 2008 – September 30, 2014 were actually recorded flows at the project site.

13. This simulation indicates that meeting in-stream water rights with or without relying on local inflows may not be that critical to being able to fill the reservoir by April 30 in most years. Three irrigation release levels were also modeled using base storage volumes of 8000, 10000 and 12000 AF to predict the outflows that could affect the water surface level and annual bank exposure. Model results, including predicted reservoir pool and release discharge, are available for further evaluation for each day of the October 1, 2002 - September 30, 2014 simulation.

14. Over the last six years, the annual runoff volume ranged from 22,629 AF to 37,606 AF, with largest volume occurring during the October 1, 2010 – September 30, 2011 water year. It appears that 2009-10, 2010-11, and 2011-12 were high flow years; 2012-13 and 2013-14 were close to average runoff years; and 2008-09, a low flow year. The six year average annual runoff was 31,117 AF. Hydrologic data that would be most useful in the near future are data that relate to high runoff conditions that possibly also include some snow-melt effects.

15. Flow duration curves were developed for the reservoir release season, from April through September, when the post-project stream flows are expected to be greater than the pre-project conditions. During that period, 50 percent of the stream flows are predicted to increase from the current 25 cfs to about 50 cfs and, thus, could have an impact on bank erosion in the reach below the dam.

16. Evaporation losses for both the entire October 2008-September 2014 period and each of the 12 months of the October 2008-September hydrologic years were predicted to be negligible, mainly because of the small size (about 310 acres) of the reservoir storage surface.

17. Evaluation of climate changes impacts on the Drift Creek flow regime of Drift Creek was also evaluated based on trend line analysis of long-term precipitation and air temperature data recorded at Salem, and on Pudding River stream flows at Aurora. Slightly warmer air temperature and slightly greater runoff trends were identified, but there are not enough data to more accurately explain current and/or predict future hydrographs shifts for Drift Creek. However, a wetter and warmer summer is predicted in most studies for the next 20 to 40 years. An attempt to define the range of possible future changes in Drift Creek's hydrograph in 2020 and 2040 was made based on assumptions used by a tri-agency climate change work group.

18. There will be a continuing need to work closely with OWRD to keep tract of its water availability data and ensure that the latest requirements for reservoir refill and release are modeled as accurately as possible in future Drift Creek hydrologic updates. There will soon be a need to spend significant efforts in other hydrology-related adjacent areas as well, including dam-break analysis and daily operational simulation to support the project's physical and economic feasibility studies. The scope of future studies needs to be expanded beyond the reservoir area into the downstream reaches, addressing fish passage, in-stream water quality conditions, etc. The project's readiness and capability to release flushing flows of 630 cfs also deserves closer attention.

19. Bank erosion and mud flats movement have also raised some concerns, due to significant increases predicted for stream flows during summer and fall. Therefore, higher study priority should be soon assigned to this subject, including taking a look at stream velocities, wetted perimeters, and soil composition of the river bank downstream from the proposed dam site.

20. The validity of the conclusions reached so far in large part dependent on the length of the available stream flow data. As more of those data are available, more information will be gained to adequately cover all the most likely possible runoff conditions, and inspire more confidence on the study results.

19. Acknowledgments

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- GSI Water Solutions, Corvallis, OR
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- Marion Soil and Water Conservation District, Salem, OR
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- Oregon Water Resources Department (Hydrographics/Measurement & Reporting)
- Oregon Water Resources Department (Water Rights Program)
- Oregon Water Resources Department (Water Availability)
- Portland State University Water Quality Research Group
- Water & Energy Resource Services, Clackamas, OR

APPENDIX

1. Summary Drainage Areas
2. 2008-2011 Drift Creek Daily Stream Flow at Hibbard Rd by Marion SWCD
3. 2008-11 Daily Flows at Nearby Streams (Pudding River at Aurora and at Woodburn, Zollner Creek, Abiqua, Silver Creek)
4. Monthly Flows of Pudding River at Aurora, 1928-2011
5. Observed Monthly October-April Flows, Pudding River at Aurora
6. Monthly Flows of Other Nearby Streams (Zollner, Pudding/Woodburn)
7. October-April Runoff Volume Statistical Frequency Analysis
8. Computer Modeling (Reservoir and Runoff Model Outputs)
9. Flow Duration Curve -- Sample Output
10. Monthly Snowfalls at Salem McNary Field, OR
11. Monthly Temperature at Salem McNary Field, OR
12. Monthly Precipitation at Salem McNary Field, OR
13. Estimated Upper Drift Creek Daily Stream Flows for Representative Years (1935-36, 1933-34 and 1947-48)

Appendix 1. Summary of Drainage Areas

(Source: Marion SWCD)

Lower Abiqua Creek abv. Gallon House Bridge….. 75.7 sq. mi.

Butte Creek @ Monitor (14201500) ……………… 58.9 sq. mi.

Lower Drift Creek @ Hibbard Rd. ………………… 24.8 sq. mi.

Upper Drift Creek @ Victor Point Bridge………… 15.4 sq. mi.

Upper Pudding River @ Selah Springs Rd. ……… 34.5 sq. mi.

Silver Creek @ Silverton, OR (14200300) ………… 48.3 sq. mi.

Appendix 2. Lower Drift Cr. Daily Flow Data

Appendix 2.1 2008-09 Daily Flow Data (Finalized 5/4/10)

MARION SOIL AND WATER CONSERVATION DISTRICT

Lower Drift Creek @ Hibbard Rd. Bridge, Silverton, OR

LAT:44 58 36 LONG: 122 49 47 DA 24.8 SQ.MI. CO MARION

DAILY DISCHARGE IN CFS WATER YEAR **OCT 2008 TO SEP 2009**

Day	Oct08	Nov08	Dec08	Jan09	Feb09	Mar09	Apr09	May09	Jun09	Jul09	Aug09	Sep09
1	0.96	.68	16	400	33	117	80	25	14	3.7	.67	.23
2	.95	.85	21	800	32	122	101	45	13	3.1	.61	.25
3	1.5	2	21	400	31	123	98	50	12	2.7	.46	.21
4	8	7.8	19	340	30	107	89	48	13	2.4	.43	.18

5	7.2	6	18	300	29	112	79	87	18	2.4	.43	.73
6	7.2	4.6	18	270	33	108	71	113	15	2.3	.49	1.6
7	6.5	4.7	17	400	35	97	65	151	14	1.9	.73	1.7
8	6.5	3.8	18	490	33	97	60	131	13	1.7	.79	1.3
9	7.2	4.7	17	325	31	95	56	109	12	1.9	.87	.86
10	6.3	5	15	185	32	92	58	92	11	2	.88	.79
11	5.8	6.2	15	157	37	86	49	80	11	2	.64	.79
12	5.5	31	17	133	35	78	46	71	11	2.6	.82	.71
13	5	150	26	116	34	72	55	65	10	3.9	.86	.47
14	4.2	98	24	101	35	71	54	77	10	3.4	.82	.52
15	3.8	70	20	90	35	115	49	62	9	2.8	.86	.51
16	3.5	54	18	81	34	140	46	52	7.9	2.3	.87	2.2
17	2.4	43	17	72	33	131	44	46	7.8	1.9	.77	2.6
18	2	33	30	65	31	116	42	41	7.6	1.5	.76	1.7
19	1.5	28	27	58	30	104	38	43	7.6	1.4	.54	1.2
20	1.2	28	25	50	28	95	35	40	7.3	1.3	.47	1
21	1.1	29	40	48	28	87	34	35	6.6	1.3	.4	.79
22	1.2	31	70	47	25	94	31	31	6	1.2	.44	.72
23	.86	29	60	42	29	91	30	28	5.4	1.3	.25	.52
24	.68	26	55	40	73	83	27	25	5	1.1	.41	.44
25	.62	24	70	41	137	88	25	23	4.4	.98	.56	.39
26	.58	23	60	38	183	91	24	23	4.4	1	.56	.4
27	.61	21	160	36	153	85	23	23	3.9	.76	.43	.41
28	.62	21	250	39	132	84	30	21	4.1	.52	.27	.54
29	.61	18	300	37		104	34	19	3.6	.17	.44	1.4
30	.64	18	230	35		90	29	17	3.8	.61	.34	1.2
31	.63		190	34		84		15		.65	.49	
Mean	3.1	27.4	60.8	170.0	50.4	98.7	50.1	54.5	9.0	1.8	0.6	0.9
Vol (AF)	191	1,630	3,738	10,450	2,798	6,067	2,980	3,350	535	111	37	54

2008-09 Annual Volume (AF)= 31,942

Appendix 2.2 2009-10 Lower Drift Cr. Daily Flow Data

Day	Oct09	Nov09	Dec09	Jan10	Feb10	Mar10	Apr10	May10	Jun10	Jul10	Aug10	Sep10
1	1.20	20.0	75.	271.0	71.0	74.0	225.0	84.0	224.0	18.0	2.8	1.3
2	1.20	16.0	64.	225.0	71.0	67.0	217.0	75.0	273.0	19.0	2.7	1.5
3	1.20	13.0	54.	167.0	68.0	65.0	231.0	75.0	221.0	18.0	2.7	1.4
4	1.20	11.0	47.	136.0	67.0	61.0	215.0	67.0	183.0	17.0	2.8	1.3
5	1.30	14.0	42.	150.0	67.0	56.0	192.0	61.0	165.0	16.0	2.6	0.9
6	4.10	24.0	37.	265.0	62.0	51.0	175.0	56.0	134.0	14.0	2.5	0.9
7	3.30	48.0	34.	199.0	59.0	48.0	156.0	50.0	121.0	12.0	2.1	1.1
8	2.40	75.0	31.	164.0	54.0	53.0	156.0	46.0	133.0	11.0	2.3	1.7
9	1.70	71.0	25.	157.0	52.0	46.0	136.0	43.0	137.0	9.9	2.3	2.1
10	1.50	61.0	23.	135.0	49.0	45.0	123.0	47.0	116.0	8.9	2.6	1.7
11	1.30	69.0	23.	120.0	52.0	49.0	113.0	42.0	99.0	8.3	2.2	1.7
12	1.30	103.0	22.	134.0	60.0	85.0	106.0	38.0	86.0	8.3	2.1	1.5
13	1.40	95.0	21.	134.0	68.0	124.0	92.0	35.0	79.0	7.9	1.9	1.3
14	2.80	87.0	20.	125.0	80.0	109.0	84.0	33.0	73.0	7.5	1.5	1.6
15	2.70	68.0	73.	125.0	92.0	95.0	126.0	30.0	65.0	6.6	1.4	2.3
16	2.90	55.0	175.	217.0	99.0	85.0	110.0	29.0	59.0	5.1	1.3	3.4
17	5.40	72.0	167.	218.0	91.0	78.0	97.0	30.0	48.0	4.9	1.3	3.0
18	7.30	90.0	128.	203.0	85.0	68.0	85.0	35.0	45.0	4.8	1.2	3.5
19	6.60	76.0	112.	170.0	78.0	61.0	75.0	35.0	43.0	5.0	1.1	9.9
20	5.10	75.0	111.	147.0	70.0	57.0	70.0	36.0	37.0	4.8	0.9	8.6
21	3.70	103.0	192.	128.0	64.0	55.0	78.0	37.0	34.0	4.6	0.9	7.3
22	2.50	121.0	212.	114.0	59.0	62.0	63.0	65.0	32.0	4.3	1.2	4.7
23	3.60	109.0	156.	102.0	56.0	53.0	55.0	67.0	28.0	3.7	1.0	3.6
24	6.00	89.0	129.	100.0	68.0	49.0	52.0	64.0	25.0	3.7	0.4	3.2

25	6.30	73.0	107.	137.0	69.0	59.0	47.0	62.0	23.0	3.7	0.3	3.1
26	10.00	71.0	90.	125.0	78.0	117.0	45.0	94.0	20.0	3.2	0.4	3.0
27	19.00	168.0	77.	109.0	89.0	130.0	76.0	103.0	20.0	2.9	0.9	2.9
28	13.00	140.0	65.	97.0	80.0	124.0	103.0	90.0	19.0	2.8	1.0	2.6
29	10.00	109.0	58.	87.0		303.0	108.0	83.0	224.0	2.7	1.0	2.5
30	16.00	90.0	75.	82.0		333.0	96.0	74.0	273.0	2.8	1.0	2.4
31	19.00		138.	76.0		288.0		81.0		2.7	1.0	
Mean	5.3	73.87	83.32	149.00	69.93	95.16	116.90	57.00	101.30	7.87	1.59	2.87
Vol (AF)	327	4,395	5,122	9,159	3,883	5,850	6,954	3,504	6,026	484	98	171

2009-10 Annual Volume (AF)= 45,973

Appendix 2.3 2010-11 Lower Drift Cr. Daily Flow Data

Day	Oct10	Nov10	Dec10	Jan11	Feb11	Mar11	Apr11	May11	Jun11	Jul11	Aug11	Sep11
1	2.1	30.0	287.0	213.0	59.0	142.0	139.0	89.0	77.0	19.0	2.5	1.5
2	1.9	88.0	284.0	176.0	54.0	356.0	151.0	82.0	77.0	15.0	2.1	1.6
3	2.2	75.0	219.0	150.0	51.0	307.0	124.0	74.0	73.0	13.0	2.2	1.5
4	2.4	57.0	178.0	129.0	47.0	247.0	112.0	66.0	65.0	12.0	2.3	1.5
5	2.1	45.0	146.0	112.0	44.0	217.0	121.0	60.0	59.0	10.0	1.9	1.2
6	2.1	47.0	122.0	101.0	42.0	205.0	114.0	57.0	55.0	8.7	1.8	1.1
7	2.1	155.0	105.0	89.0	41.0	170.0	136.0	61.0	50.0	8.5	2.0	1.2
8	2.3	125.0	134.0	88.0	39.0	146.0	123.0	59.0	46.0	8.3	1.9	0.9
9	5.6	121.0	245.0	82.0	36.0	126.0	109.0	61.0	41.0	7.9	2.0	1.2
10	21.0	154.0	346.0	74.0	34.0	117.0	99.0	55.0	37.0	7.9	2.0	1.2
11	18.0	122.0	319.0	67.0	33.0	212.0	108.0	54.0	36.0	7.0	2.1	1.1
12	5.3	105.0	309.0	77.0	33.0	198.0	98.0	60.0	33.0	9.4	1.8	1.2
13	1.4	89.0	410.0	139.0	42.0	168.0	94.0	53.0	34.0	9.3	1.7	1.1
14	1.1	91.0	459.0	179.0	42.0	169.0	101.0	50.0	30.0	7.5	1.6	0.9
15	1.2	87.0	391.0	177.0	85.0	200.0	123.0	54.0	27.0	6.9	1.8	1.0
16	1.2	95.0	314.0	477.0	116.0	186.0	194.0	64.0	25.0	8.1	1.7	1.0
17	1.2	97.0	253.0	525.0	99.0	233.0	201.0	59.0	22.0	13.0	1.4	1.2
18	1.2	309.0	241.0	401.0	89.0	256.0	167.0	55.0	22.0	16.0	1.6	1.2
19	1.1	254.0	212.0	380.0	86.0	223.0	137.0	49.0	24.0	13.0	1.6	1.4
20	1.1	229.0	198.0	291.0	76.0	203.0	114.0	45.0	21.0	12.0	1.5	1.3
21	1.1	184.0	177.0	253.0	69.0	175.0	101.0	41.0	19.0	9.2	1.5	1.0
22	1.3	189.0	151.0	218.0	65.0	157.0	89.0	39.0	18.0	8.1	1.4	1.3
23	2.3	217.0	122.0	182.0	63.0	141.0	79.0	36.0	17.0	7.1	1.4	1.2
24	14.0	166.0	107.0	155.0	65.0	123.0	73.0	34.0	16.0	6.1	1.4	0.8
25	23.0	138.0	97.0	132.0	61.0	120.0	93.0	37.0	15.0	5.4	1.4	0.8
26	32.0	132.0	113.0	115.0	57.0	113.0	91.0	38.0	15.0	5.1	1.6	1.3
27	24.0	183.0	139.0	102.0	56.0	132.0	87.0	61.0	14.0	4.3	1.6	1.7
28	20.0	159.0	324.0	91.0	59.0	132.0	89.0	84.0	15.0	3.6	1.5	2.2
29	24.0	135.0	484.0	81.0		131.0	105.0	86.0	15.0	3.4	1.4	1.8
30	18.0	151.0	338.0	73.0		159.0	98.0	77.0	15.0	2.7	1.4	1.6
31	37.0		255.0	65.0		179.0		73.0		3.0	1.4	
Mean	8.82	134.30	241.26	174.00	58.68	182.03	115.67	58.48	33.77	8.73	1.73	1.27
Vol (AF)	542	7,990	14,831	10,696	3,258	11,190	6,881	3,595	2,009	537	106	76

2010-11 Annual Volume (AF)= 61,711

Appendix 3 Daily Flows at Nearby Streams

Table A3.1 Pudding River at Aurora Daily Discharge (2008-09)

Days	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	70	93	366	4920	644	2410	1790	590	349	105	21	19
2	66	109	354	6850	613	2200	1670	583	323	93	19	20
3	73	128	441	10500	584	2270	1950	808	309	87	17	21
4	81	235	492	8930	559	2320	1990	936	298	79	15	20
5	130	563	447	6860	545	2080	1790	1290	300	73	14	21
6	236	641	414	5750	538	1920	1570	1960	368	67	13	29
7	217	682	391	5110	570	1810	1410	2410	389	68	13	48
8	211	740	381	4970	620	1640	1310	2560	371	61	13	79
9	243	632	390	5310	602	1510	1250	2270	329	59	13	78
10	205	591	377	5500	581	1420	1270	1910	294	59	15	65
11	181	553	351	5150	572	1310	1260	1600	271	55	21	55
12	170	681	334	4470	585	1190	1140	1380	259	59	25	45
13	155	1850	351	3730	580	1100	1180	1260	254	70	21	39
14	141	3060	451	3160	567	1030	1550	1290	277	92	19	34
15	128	2550	480	2690	552	1160	1460	1660	285	110	26	33
16	120	1700	466	2330	546	1920	1290	1520	259	100	42	33
17	113	1140	429	1990	540	2400	1150	1290	231	77	44	31
18	112	842	438	1630	531	2440	1060	1100	215	63	46	29
19	114	681	505	1390	512	2240	1010	989	206	49	39	33
20	112	585	520	1250	487	2000	937	965	203	42	28	38
21	116	583	526	1140	468	1860	903	892	208	40	22	40
22	128	629	809	1040	459	1790	884	782	211	39	21	38
23	147	593	1230	959	466	1750	839	695	203	29	19	35
24	129	555	1260	892	651	1630	775	635	182	26	19	34
25	114	509	1470	838	1530	1540	710	580	163	26	18	32
26	112	476	1760	805	2580	1660	648	536	142	36	20	31
27	105	445	1920	752	3020	1690	602	499	136	35	21	31
28	100	415	2990	711	2740	1610	578	460	132	28	17	31
29	96	395	4250	719		1930	627	431	131	23	15	31
30	94	378	4860	714		2250	642	401	120	20	17	35
31	91		4960	676		2040		369		23	18	
Ave	132.6	767.8	1110.1	3281.8	830.1	1810.3	1174.8	1117.8	247.3	57.8	21.6	36.9
Vol (AF)	8150	45676	68241	201742	46089	111286	69891	68713	14710	3556	1331	2197

Table A3.2 Pudding River at Aurora Daily Discharge (2009-10)

Pudding @ Aurora

2009-2010

Days	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	41	343	1500	2770	1310	1520	4900	1780	1130	359	76	33
2	49	364	1250	4030	1250	1350	4240	1590	1260	344	79	32
3	48	291	1070	4110	1240	1220	3820	1440	2690	354	79	31
4	54	239	921	3610	1220	1110	3640	1500	3660	366	72	34
5	55	203	808	3180	1230	1020	3470	1460	4300	336	66	37
6	56	200	722	3560	1230	928	3210	1340	4300	308	66	38
7	61	338	653	4190	1160	850	2970	1240	3730	280	64	39
8	56	852	578	4000	1080	810	2770	1110	3020	255	62	37
9	51	1550	475	3620	1010	873	2640	1010	2430	227	67	45
10	48	1460	460	3350	943	853	2410	936	2240	201	67	59
11	49	1200	445	2930	908	774	2170	953	2260	188	60	64
12	47	1180	503	2600	998	852	2000	916	2170	186	55	62
13	48	1330	527	2670	1220	1620	1910	835	1940	177	52	58
14	53	1330	475	2540	1350	1910	1870	765	1670	170	48	53
15	57	1210	516	2340	1650	1730	1940	709	1440	160	44	50
16	87	1010	1860	2780	1760	1530	2210	664	1290	150	39	52
17	95	878	3010	3480	1790	1360	2130	629	1170	142	38	58
18	91	1240	2990	3670	1660	1230	1920	609	1070	138	36	69
19	111	1500	2630	3490	1490	1110	1720	613	956	140	34	100
20	111	1410	2310	3050	1330	1000	1570	684	868	137	34	190
21	96	1390	2310	2590	1180	919	1490	804	820	127	35	319
22	90	1510	3190	2210	1060	930	1470	949	760	122	36	270
23	94	1920	3370	1980	959	1050	1300	1160	689	116	40	187
24	97	1890	2900	1800	956	979	1150	1180	627	109	42	147
25	108	1600	2390	2070	1180	926	1090	1110	572	102	39	131
26	141	1330	2010	2530	1420	1100	1000	1090	524	97	33	120
27	150	1410	1680	2320	1730	1640	1030	1310	489	91	32	106
28	260	2190	1420	2000	1740	1830	1600	1320	462	80	34	98
29	283	2190	1240	1740		2510	1970	1200	421	75	32	94
30	232	1830	1160	1530		4410	1960	1150	386	80	32	89
31	276		1380	1410		5070		1090		79	36	
Ave	99.8	1179.6	1508.2	2843.5	1287.6	1452.1	2252.3	1069.2	1644.8	183.7	49.3	90.1
Vol (AF)	6137	70174	92711	174801	71495	89263	133991	65729	97849	11295	3032	5358

Table A3.3 Pudding River at Aurora Daily Discharge (2010-11)

Pudding @ Aurora

2010-2011

Days	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	84	1050	2470	5280	1190	3560	3120	1660	1610	313	118	59
2	82	1080	3580	4370	1080	5260	3130	1520	1990	303	112	53
3	80	1500	3840	3510	988	4910	3120	1410	2030	267	103	50
4	78	1330	3460	2910	914	4220	2680	1290	1780	252	99	46
5	77	1030	2920	2470	854	3760	2640	1190	1510	234	94	44
6	75	828	2460	2190	820	3530	2840	1120	1320	216	93	53
7	72	1040	2100	1900	800	3170	3000	1110	1200	201	98	55
8	71	1930	1980	1660	783	2740	3300	1210	1070	196	100	50
9	77	1840	2850	1570	767	2390	2920	1330	952	191	98	53
10	119	1770	4430	1480	715	2960	2430	1320	850	183	97	51
11	319	1950	5430	1380	671	4180	2120	1210	779	180	93	48
12	463	1790	5900	1320	647	3910	2180	1230	722	172	89	47
13	315	1570	6030	1950	741	3480	2080	1260	674	173	86	49
14	226	1360	6300	3210	906	3860	1970	1140	664	190	84	49
15	180	1340	7230	3390	1190	4320	2170	1080	629	186	85	44
16	153	1320	7140	4070	2000	4790	3070	1210	564	173	87	42
17	140	1440	6260	5530	2170	5360	3810	1300	519	177	80	44
18	129	2100	5420	6790	1890	5350	3880	1220	484	261	75	47
19	120	3590	4780	7790	1670	4780	3350	1130	484	307	72	51
20	116	3580	4210	7040	1510	4120	2650	1030	518	296	67	52
21	112	3090	3770	5970	1340	3540	2160	942	472	288	67	53
22	111	2650	3350	5240	1210	3130	1830	886	428	248	65	52
23	106	2530	2930	4490	1120	2830	1580	844	392	220	65	50
24	123	2370	2530	3720	1080	2600	1420	793	371	199	63	47
25	325	2020	2190	3120	1050	2420	1390	749	350	181	61	47
26	871	1720	1920	2660	975	2230	1790	783	327	166	59	45
27	1040	1720	2100	2290	899	2200	1970	867	316	157	59	50
28	846	2120	2980	1960	1090	2220	1850	1290	307	145	67	59
29	691	2110	5510	1650		2220	1790	1550	315	130	99	65
30	648	1950	6340	1450		2620	1770	1570	318	123	92	63
31	704		5960	1310		3040		1480		118	75	
Ave	275.9	1857.3	4141.0	3344.2	1109.6	3538.7	2467.0	1184.6	798.2	207.9	83.9	50.6
Vol (AF)	16961	110489	254558	205578	61612	217535	146762	72824	47483	12782	5160	3010

Table A3.4 Pudding River at Aurora Daily Discharge (2011-12)

Pudding @ Aurora

2011-2012

Days	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	60	223	1460	5490	3610	2550	9210	1660	545	360	106	50
2	58	249	1230	4890	3130	2870	9000	1700	510	348	101	53
3	65	208	1050	3780	2700	2400	7290	1650	499	313	97	60
4	73	217	914	2990	2340	2090	6130	1990	480	285	91	60
5	91	244	806	2550	2030	1940	5400	2060	601	261	87	57
6	119	203	721	2300	1760	2030	4730	1910	878	247	85	54
7	119	176	651	1980	1560	2070	4080	1700	839	224	82	53
8	107	170	593	1690	1380	1870	3540	1520	813	206	75	52
9	102	158	544	1470	1430	1690	3080	1360	906	192	68	51
10	104	152	501	1360	1590	1560	2670	1220	1010	176	63	54
11	102	144	464	1340	1680	1600	2260	1090	953	167	65	58
12	182	136	435	1220	1880	2000	2010	982	851	164	69	60
13	311	144	407	1100	1730	3010	1900	892	784	166	71	51
14	225	188	383	998	1590	4710	1900	822	739	168	70	41
15	167	256	363	956	1460	4940	1750	766	669	161	64	41
16	138	303	354	949	1350	6170	1530	715	601	158	60	41
17	121	415	348	915	1270	8240	1800	662	547	156	57	43
18	108	1330	332	2090	1320	8290	1910	613	498	150	55	45
19	98	1470	319	5670	1540	7140	1920	571	485	152	54	46
20	92	1260	313	18600	1550	5770	2140	535	476	151	58	44
21	86	988	300	14500	1650	5220	2330	518	445	146	65	42
22	82	1120	289	11800	2010	5980	2120	570	409	133	60	42
23	79	2470	276	9600	2530	6730	1880	733	394	130	55	46
24	78	2910	263	7850	2600	6260	1700	791	429	121	52	52
25	77	2860	255	7430	2440	5280	1520	922	470	117	49	55
26	76	2600	257	7280	2370	4370	1480	1030	440	116	48	53
27	76	2150	280	6570	2130	3650	1770	957	433	115	52	50
28	71	2000	359	5720	1920	3180	1780	828	431	112	52	48
29	71	2030	2220	4880	1840	2920	1630	725	386	360	52	47
30	77	1730	3890	4360		3770	1510	652	360	348	53	47
31	110		5140	4090		6350		594		313	53	
Ave	107.3	950.1	829.6	4723.2	1944.5	4085.5	3065.7	1056.1	596.0	200.5	66.7	49.9
Vol (AF)	6593	56523	50997	290347	111821	251147	182377	64919	35458	12326	4103	2967

Table A3.5 Pudding River at Aurora Daily Discharge (2012-13)

Pudding @ Aurora

2012-2013

Days	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	45	1190	2540	2030	3230	1240	891	579	1440	242	35	44
2	47	1140	3130	1770	2810	1520	877	526	1170	220	31	42
3	45	1110	3680	1560	2470	1500	835	486	988	198	32	40
4	43	1080	3910	1410	2180	1410	798	463	842	181	41	38
5	41	998	4910	1470	1930	1270	791	446	728	168	44	37
6	41	839	5470	1290	1810	1200	976	424	634	161	50	83
7	39	715	5050	1140	1720	1350	1460	393	555	152	40	258
8	38	650	4290	1200	1630	1360	1970	364	491	151	31	393
9	39	583	3640	1420	1510	1260	1840	345	440	145	27	252
10	40	520	3120	1660	1390	1150	1550	329	398	132	27	167
11	42	476	2720	1650	1290	1050	1400	311	359	122	26	125
12	45	471	2450	1480	1200	1000	1290	295	330	111	31	100
13	55	763	2240	1320	1150	979	1190	287	312	102	33	86
14	78	1010	1980	1180	1130	935	1150	281	323	99	29	73
15	114	968	1800	1070	1090	924	1110	274	343	98	27	70
16	187	861	1740	988	1050	932	1050	262	302	91	26	70
17	467	775	2260	921	1030	1000	996	270	269	83	25	70
18	421	1030	3410	865	998	1080	924	288	243	77	29	71
19	261	2170	3540	821	956	997	872	292	223	76	32	71
20	222	4410	3240	787	926	1090	966	308	253	78	31	69
21	247	6790	3860	758	888	2000	1050	321	299	74	28	76
22	282	8800	3860	783	801	1990	994	327	268	76	22	90
23	303	8480	3460	759	1020	1700	926	540	241	75	21	101
24	316	6950	3600	776	1260	1450	858	810	248	65	24	152
25	332	6050	3660	917	1200	1300	792	1110	299	60	28	227
26	373	5110	3900	1480	1280	1190	738	1110	331	51	36	307
27	342	4220	3990	1850	1240	1100	692	1020	393	43	44	330
28	348	3460	3630	1930	1180	1040	650	1340	369	39	42	275
29	1180	2880	3150	2400		996	621	1670	315	42	44	524
30	1920	2550	2700	3380		949	608	1860	272	43	41	1850
31	1570		2330	3560		913		1760		40	38	
Ave	307.2	2568.3	3331.0	1439.5	1441.8	1221.8	1028.8	615.8	455.9	106.3	32.7	203.0
Vol (AF)	18884	152788	204765	88491	80052	75106	61205	37857	27123	6534	2013	12078

Table A3.6 Pudding River at Aurora Daily Discharge (2013-14)

Pudding @ Aurora

2013-2014

Days	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	2470	230	556	546	1140	2050	3570	1460	384	300	55	24
2	2330	240	951	519	1070	1830	3040	1280	365	246	51	37
3	1960	317	2500	509	993	2260	2590	1130	342	213	50	34
4	1550	482	2370	546	929	3010	2240	1060	319	189	50	30
5	1210	470	1920	539	870	3200	2060	1130	303	173	54	46
6	963	489	1560	498	804	4550	1970	1110	285	159	45	44
7	796	650	1280	475	762	5520	2010	1020	266	152	38	37
8	708	1030	1090	489	758	5130	1890	919	246	134	35	28
9	691	1130	935	686	777	4630	1700	1070	237	114	29	20
10	681	984	854	1030	1020	4860	1530	1840	224	102	27	17
11	625	841	787	1280	1770	4750	1360	2160	204	87	31	17
12	560	740	729	1820	3460	4280	1220	1880	189	83	37	15
13	508	733	696	2340	4680	3720	1100	1540	188	82	38	15
14	468	748	725	2510	5340	3190	999	1300	219	91	36	14
15	428	686	707	2280	6140	2810	909	1130	249	94	34	14
16	397	651	657	1960	7010	2430	838	989	240	87	37	16
17	370	768	624	1650	7340	2300	796	879	251	79	39	16
18	349	831	593	1400	6950	2370	829	822	294	69	40	16
19	328	905	569	1220	6810	2080	866	885	264	61	42	16
20	312	1850	553	1080	6800	1820	783	995	226	59	34	19
21	299	2000	533	980	6220	1610	740	866	211	68	26	21
22	287	1620	618	891	5510	1440	709	746	200	74	22	22
23	276	1300	675	819	4770	1300	823	668	189	81	21	25
24	264	1100	689	757	4070	1190	1300	621	170	105	19	41
25	257	967	756	701	3570	1110	2590	587	159	126	20	72
26	248	855	744	651	3120	1090	2660	541	160	143	21	97
27	243	771	712	613	2710	1310	2270	503	199	119	18	87
28	239	705	676	590	2390	1900	2160	476	289	105	15	70
29	269	645	636	624		3320	1970	457	388	89	15	60
30	265	591	599	1050		4250	1690	442	358	71	17	54
31	240		571	1210		4130		412		57	19	
Ave	664.2	844.3	898.9	1,040.7	3.492.2	2,885.2	1,640.4	997.3	253.9	116.50	32.7	34.1
Vol (AF)	40832	50227	55258	63975	193904	177362	97587	61307	15105	7163	2012.7	2030

Appendix 4. Monthly Flows, Pudding River @ Aurora (1928-2014)

USGS 14202000 PUDDING RIVER AT AURORA, OR **00060**
Discharge, cfs

YEAR	Monthly mean in cfs (Calculation Period: 1928-10-01 -> 2014-09-30)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1928										162.0	605.2	1,273
1929	1,875	1,066	1,097	1,752	757.1	374.1	125.0	67.1	57.3	68.5	81.5	1,907
1930	962.2	3,868	1,073	682.9	828.4	374.9	128.1	71.0	79.6	123.4	460.5	573.4
1931	1,464	956.7	1,652	3,086	327.2	349.1	181.2	74.4	70.0	204.6	1,780	2,593
1932	3,304	2,010	3,312	1,754	743.7	332.4	123.1	74.6	60.0	161.3	1,613	2,168
1933	3,574	2,263	2,937	1,262	1,361	1,101	206.9	97.0	205.3	295.5	699.7	5,170
1934	3,633	864.4	1,325	1,142	695.5	207.2	101.8	68.2	62.2	355.4	1,975	2,842
1935	2,992	1,535	1,996	1,217	551.1	183.6	124.3	64.6	72.4	135.9	318.7	668.3
1936	4,352	1,773	1,428	1,002	858.9	489.3	191.2	68.5	79.9	66.1	78.9	662.4
1937	766.5	3,563	2,100	3,239	901.5	730.1	265.7	97.1	109.6	305.1	3,039	3,904
1938	3,670	2,990	3,121	1,668	682.1	216.5	99.0	54.8	60.7	120.3	888.6	1,204
1939	1,853	2,679	1,702	638.3	241.9	294.2	124.3	51.9	64.9	149.7	151.0	1,679
1940	1,353	3,532	2,491	1,477	671.6	158.0	66.7	49.6	81.0	205.1	1,110	1,863
1941	1,885	831.5	598.5	456.3	638.3	337.2	116.8	73.2	212.9	298.2	1,138	3,408
1942	1,719	2,277	916.2	498.4	929.1	661.7	242.7	94.1	60.6	78.1	3,098	4,624
1943	3,768	3,916	1,035	2,713	720.4	616.8	217.2	119.8	94.0	543.8	783.8	1,130
1944	1,463	1,466	1,047	1,120	474.4	283.3	97.3	54.2	58.5	70.9	373.2	435.9
1945	1,517	2,466	2,527	1,879	1,623	414.6	116.4	72.3	142.5	108.2	1,801	2,955
1946	3,488	2,507	3,000	1,028	466.5	263.8	179.1	71.0	83.1	353.0	2,006	3,452
1947	1,572	1,999	1,421	1,448	322.5	475.2	196.6	102.3	96.3	1,774	2,482	1,518
1948	3,664	2,311	2,454	1,730	1,416	395.6	146.1	109.2	116.4	295.3	1,508	3,661
1949	1,209	5,600	2,067	1,086	1,081	250.3	112.5	66.7	90.4	245.0	699.7	2,004
1950	4,735	4,263	3,310	1,638	990.8	471.5	143.4	78.7	77.5	1,170	4,643	3,239
1951	4,853	3,208	2,624	887.2	703.1	203.3	79.5	50.6	64.1	914.4	1,497	3,283
1952	2,241	3,474	1,905	1,130	618.3	327.5	364.0	69.4	64.1	63.8	104.3	792.7
1953	5,576	3,743	2,142	1,179	1,171	897.6	183.2	97.5	91.9	326.7	1,770	4,772
1954	3,721	3,375	1,506	1,656	418.0	707.9	282.5	112.5	157.9	390.6	1,028	1,808
1955	1,895	1,255	1,795	3,054	1,193	500.5	224.4	76.7	107.5	1,036	3,039	5,704
1956	5,722	2,127	3,115	1,630	682.1	365.3	116.4	71.0	76.9	331.8	755.7	1,421
1957	1,108	1,872	3,945	1,361	658.7	360.2	91.2	58.5	41.3	153.1	404.8	2,959
1958	2,982	4,384	1,459	2,011	567.4	305.5	95.2	33.9	60.0	103.3	1,846	1,874
1959	4,017	3,067	1,716	1,347	1,061	441.8	123.1	39.4	180.0	578.6	515.3	879.6
1960	1,374	2,789	2,543	2,037	1,820	532.5	84.2	54.3	73.5	142.4	2,775	1,883
1961	2,006	5,550	4,235	1,264	1,214	271.8	78.9	35.4	86.3	258.6	776.9	2,880
1962	1,322	1,242	2,589	1,882	1,454	417.9	85.7	75.1	77.6	461.1	2,163	2,302

1963	819.2	2,458	1,548	3,355	2,192	287.1	187.3	57.5	85.2	185.3	1,940	1,289
1964	4,513	1,840	1,656	939.9	687.7	467.2	131.0	83.5	84.6			
1993							290.4	116.5	73.6	79.5	99.1	1,114
1994	2,050	1,590	1,741	1,225	375.3	373.1	59.1	11.3	32.8	346.5	2,557	2,957
1995	3,017	3,335	1,595	1,123	812.2	329.4	111.8	54.8	67.8	520.0	2,233	4,323
1996	3,888	6,948	1,988	1,867	1,552	523.5	158.5	38.7	106.2	606.6	3,387	6,090
1997	4,643	2,875	3,728	1,446	727.9	498.3	178.6	63.9	197.6			
2002										86.6	255.4	1,383
2003	2,565	2,973	3,116	2,345	1,034	291.8	53.2	13.1	53.7	93.3	393.6	2,705
2004	3,364	2,884	1,296	727.5	469.7	618.8	98.9	106.2	329.4	428.9	617.0	1,579
2005	758.5	496.7	824.6	1,620	1,132	570.2	180.7	35.0	44.5	185.4	1,476	2,559
2006	6,873	2,506	1,507	1,515	527.8	469.2	81.5	27.0	33.0	85.3	3,454	3,554
2007	2,814	2,001	2,166	1,035	500.0	178.2	58.7	27.0	34.7	424.7	1,005	3,051
2008	3,524	2,371	1,992	1,387	1,092	691.7	134.7	76.5	53.9	132.6	767.8	1,110
2009	3282.0	830.1	1810.0	1175.0	1118.0	247.3	57.8	21.6	36.9	99.8	1180.0	1508.0
2010	2844.0	1288.0	1452.0	2252.0	1069.0	1645.0	183.7	49.3	90.1	275.9	1857.0	4141
2011	3344.0	1110.0	3539.0	2467.0	1185.0	798.2	207.9	83.9	50.6	107.3	950.1	829.6
2012	4723.0	1944.0	4085.0	3066.0	1056.0	596.0	203.7	66.7	49.9	307.2	2578.0	3383.0
2013	1502.0	1443.0	1219.0	1026.0	615.7	455.9	106.3	32.7	203.0	664.2	844.3	898.9
2014	1040.7	3492.2	2885.2	1640.4	997.3	253.9	116.5	32.7	34.1			
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

** No Incomplete data have been used for statistical calculation. Bold numbers=more recent data

Appendix 5. Observed Monthly Oct. –Apr. Flows (cfs), Pudding River nr. Aurora

(1928-2014)

Hydro Year=	Oct	Nov	Dec	Jan	Feb	Mar	Apr	Oct-Apr Vol (AF)
1928-29	162.0	605.2	1273.0	1875.0	1066.0	1097.0	1752.0	470,330
1929-30	68.5	81.5	1907.0	962.2	3868.0	1073.0	682.9	506,791
1930-31	123.4	460.5	573.4	1464.0	956.7	1652.0	3086.0	498,485
1931-32	204.6	1780.0	2593.0	3304.0	2010.0	3312.0	1754.0	904,509
1932-33	161.3	1613.0	2168.0	3574.0	2263.0	2937.0	1262.0	840,124
1933-34	295.5	699.7	5170.0	3633.0	864.4	1325.0	1142.0	798,321
1934-35	355.4	1975.0	2842.0	2992.0	1535.0	1996.0	1217.0	778,303
1935-36	135.9	318.7	668.3	4352.0	1773.0	1428.0	1002.0	585,279
1936-37	66.1	78.9	662.4	766.5	3563.0	2100.0	3239.0	616,209
1937-38	305.1	3039.0	3904.0	3670.0	2990.0	3121.0	1668.0	1,122,245
1938-39	120.3	888.6	1204.0	1853.0	2679.0	1702.0	638.3	539,529
1939-40	149.7	151.0	1679.0	1353.0	3532.0	2491.0	1477.0	648,682

1940-41	205.1	1110.0	1863.0	1885.0	831.5	598.5	456.3	419,148
1941-42	298.2	1138.0	3408.0	1719.0	2277.0	916.2	498.4	613,602
1942-43	78.1	3098.0	4624.0	3768.0	3916.0	1035.0	2713.0	1,147,435
1943-44	543.8	783.8	1130.0	1463.0	1466.0	1047.0	1120.0	454,753
1944-45	70.9	373.2	435.9	1517.0	2466.0	2527.0	1879.0	550,657
1945-46	108.2	1801.0	2955.0	3488.0	2507.0	3000.0	1028.0	894,637
1946-47	353.0	2006.0	3452.0	1572.0	1999.0	1421.0	1448.0	734,364
1947-48	1774.0	2482.0	1518.0	3664.0	2311.0	2454.0	1730.0	961,931
1948-49	295.3	1508.0	3661.0	1209.0	5600.0	2067.0	1086.0	909,843
1949-50	245.0	699.7	2004.0	4735.0	4263.0	3310.0	1638.0	1,008,572
1950-51	1170.0	4643.0	3239.0	4853.0	3208.0	2624.0	887.2	1,237,781
1951-52	914.4	1497.0	3283.0	2241.0	3474.0	1905.0	1130.0	869,953
1952-53	63.8	104.3	792.7	5576.0	3743.0	2142.0	1179.0	811,270
1953-54	326.7	1770.0	4772.0	3721.0	3375.0	1506.0	1656.0	1,025,958
1954-55	390.6	1028.0	1808.0	1895.0	1255.0	1795.0	3054.0	674,511
1955-56	1036.0	3039.0	5704.0	5722.0	2127.0	3115.0	1630.0	1,357,641
1956-57	331.8	755.7	1421.0	1108.0	1872.0	3945.0	1361.0	648,236
1957-58	153.1	404.8	2959.0	2982.0	4384.0	1459.0	2011.0	851,445
1958-59	103.3	1846.0	1874.0	4017.0	3067.0	1716.0	1347.0	834,219
1959-60	578.6	515.3	879.6	1374.0	2789.0	2543.0	2037.0	642,653
1960-61	142.4	2775.0	1883.0	2006.0	5550.0	4235.0	1264.0	1,056,599
1961-62	258.6	776.9	2880.0	1322.0	1242.0	2589.0	1882.0	660,499
1962-63	461.1	2163.0	2302.0	819.2	2458.0	1548.0	3355.0	780,119
1963-64	185.3	1940.0	1289.0	4513.0	1840.0	1656.0	939.9	746,995
1993-94	79.5	99.1	1114.0	2050.0	1590.0	1741.0	1225.0	473,466
1994-95	346.5	2557.0	2957.0	3017.0	3335.0	1595.0	1123.0	890,685
1995-96	520.0	2233.0	4323.0	3888.0	6948.0	1988.0	1867.0	1,302,397
1996-97	606.6	3387.0	6090.0	4643.0	2875.0	3728.0	1446.0	1,373,397
2002-03	86.6	255.4	1383.0	2565.0	2973.0	3116.0	2345.0	759,339
2003-04	93.3	393.6	2705.0	3364.0	2884.0	1296.0	727.5	691,029
2004-05	428.9	617.0	1579.0	758.5	496.7	824.6	1620.0	381,407
2005-06	185.4	1476.0	2559.0	6873.0	2506.0	1507.0	1515.0	1,000,928
2006-07	85.3	3454.0	3554.0	2814.0	2001.0	2166.0	1035.0	908,008
2007-08	424.7	1005.0	3051.0	3524.0	2371.0	1992.0	1387.0	831,396
2008-09	132.58	767.80	1110.10	3281.81	830.07	1810.32	1174.83	551,076
2009-10	99.84	1179.60	1508.16	2843.55	1287.64	1452.06	2252.33	638,574
2010-11	275.90	1857.27	4140.97	3344.19	1109.64	3538.71	2467.00	1,013,493
2011-12	107.26	950.13	829.58	4723.16	1944.48	4085.48	3065.67	949,805
2012-13	307.19	2577.63	3382.90	1502.10	1442.64	1219.00	1025.67	688,577
2013-14	664.23	844.30	898.87	1040.74	3492.25	2885.16	1640.47	679,148

Note: monthly flows are in cfs; last column numbers represent runoff volume in AF

Appendix 6. Monthly Flows of Other Nearby Streams

A6.1 Zollner Creek

USGS 14201300 ZOLLNER CREEK NEAR MT ANGEL, OR 00060, Discharge, cfs												
YEAR	Monthly mean in cfs (Calculation Period: 1993-10-01 -> 2008-09-30)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1993										1.67	1.89	35.6
1994	51.4	55.5	16.0	11.2	2.05	4.75	0.237	0.275	0.294	16.8	70.7	61.6
1995	62.8	48.2	30.7	9.05	4.86	2.60	1.12	0.795	1.00	9.65	86.6	82.0
1996	103.4	113.8	24.5	25.9	21.8	3.65	1.12	0.598	1.70	23.1	121.3	186.9
1997	78.2	45.0	91.5	20.0	6.35	6.60	1.66	0.932	2.54	12.4	24.4	26.1
1998	40.6	33.1	38.6	8.14	10.0	4.91	1.59	0.522	1.22	3.67	55.2	91.8
1999	77.2	102.6	43.4	10.0	4.40	1.53	0.631	0.404	0.239	0.934	27.8	42.1
2000	49.6	57.9	29.2	5.80	5.26	2.05	0.771	0.264	0.698	1.78	3.09	10.9
2001	7.47	9.27	10.4	9.32	3.58	1.67	0.381	0.142	0.185	0.976	33.6	97.6
2002	66.5	37.2	35.9	6.15	2.88	0.950	0.712	0.278	0.434	0.798	1.51	35.0
2003	58.7	37.1	49.9	38.5	7.87	1.63	0.548	0.590	0.686	1.39	5.48	46.6
2004	51.4	40.1	13.7	2.75	2.11	2.41	0.376	0.156	0.278	3.05	5.13	20.8
2005	8.83	6.99	17.5	21.0	14.5	2.67	0.342	0.307	0.450	4.94	42.3	81.8
2006	128.1	32.7	25.2	23.0	5.02	2.98	0.314	0.474	0.281	0.700	78.1	68.6
2007	44.3	39.8	29.1	12.6	4.20	0.932	0.606	0.301	0.481	8.76	19.4	63.0
2008	70.3	32.2	27.1	14.7	2.53	1.17	0.269	0.434	0.331	**0.9**	**16.7**	**123**
2009	**264.1**	**19.0**	**28.0**	**8.6**	**9.8**	**1.1**	**0.3**	**0.3**	**0.3**			
Mean of monthly Discharge	**72.7**	**44.4**	**31.9**	**14**	**6.7**	**2.6**	**0.69**	**0.40**	**0.69**	**5.72**	**37.1**	**67.1**

A6.2 Pudding Riv. @ Woodburn

USGS 14201340 PUDDING RIVER NEAR WOODBURN, OR 00060, Discharge, cfs												
YEAR	Monthly mean in cfs (Calculation Period: 1997-10-01 -> 2008-09-30)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1997										599.7	936.3	1,024
1998	2,318	1,564	1,613	718.8	846.2	459.5	112.0	39.6	43.5	174.4	1,394	2,845
1999	2,842	2,835	2,082	924.8	812.4	293.5	98.0	52.9	33.4	61.3	1,025	2,023
2000	1,881	1,920	1,346	504.5	677.5	350.5	72.9	25.0	36.9	101.7	202.0	716.9

2001	477.8	460.2	581.5	774.1	429.5	171.2	54.1	25.5	19.9	64.3	787.2	2,507
2002	2,062	1,850	1,639	947.5	353.5	188.7	94.1	22.1	24.3	28.5	173.4	1,059
2003	1,792	2,050	2,117	1,670	694.7	145.1	34.5	13.5	23.4	58.2	314.5	1,964
2004	2,445	2,062	966.3	503.8	278.1	424.4	65.4	56.8	182.7	288.5	505.1	1,195
2005	603.2	386.6	561.0	1,123	819.3	450.2	115.5	28.1	23.3	132.6	1,095	1,720
2006	4,612	1,698	1,113	1,094	347.4	332.2	54.2	21.6	16.3	42.8	2,405	2,359
2007	1,897	1,373	1,469	694.7	299.6	102.9	41.8	18.5	25.6	283.1	713.5	2,069
2008	2,371	1,646	1,437	1,004	723.9	417.8	62.5	47.9	33.7	74.2	556.7	821.8
2009	2,237	562.9	1,147	727.0	710.0	148.2	39.0	15.6	20.2	61.2	777.7	1007.0
2010	1954.7	834.5	992.1	1432.8	685.5	1076.7	126.6	42.4	64.7	181.81	1211.5	2720.6
2011	2150.1	624.4	2233.9	1535.7	712.5	465.9	133.2	51.2	31.7	92.2	668.9	594.6
2012	3331.7	1419.7	2843.2	2175.7	777.0	451.4	150.3	39.5	27.8	258.5	1894.4	2443.2
2013	1090.5	1030.8	856.6	711.5	451.5	338.7	75.1	22.7	168.8	489.7	600.4	657.9
2014	732.1	2423.4	2040.2	1175.3	685.3	162.7	74.5	19.8	17.1			

Appendix 7. Oct-Apr Runoff Volume Statistical Frequency

FOR DRIFT CREEK AT PROJECT SITE –BASED ON 86 YEARS OF FLOWS OF PUDDING RIVER NEAR AURORA (52 YEARS OF OBSERVED FLOWS BETWEEN 1928-2014 + 34 YEARS OF SYNTHESIZED FLOWS)

N	Hydro Yr Oct-Apr	Pudding Oct-Apr Vol (AF)	Drift Oct-Apr Vol (AF)	Log(Vol) X	X^2	Dev X-M x	x^2
		Multiplier=	0.0348				
1	1928-29	470,330	16,367	4.213982	17.757644	-0.188134	0.035394
2	1929-30	506,791	17,636	4.246408	18.031982	-0.155708	0.024245
3	1930-31	498,485	17,347	4.239231	17.971082	-0.162884	0.026531
4	1931-32	904,509	31,477	4.497992	20.231933	0.095876	0.009192
5	1932-33	840,124	29,236	4.465923	19.944465	0.063807	0.004071
6	1933-34	798,321	27,782	4.443757	19.746974	0.041641	0.001734
7	1934-35	778,303	27,085	4.432728	19.649077	0.030612	0.000937
8	1935-36	585,279	20,368	4.308942	18.566983	-0.093174	0.008681
9	1936-37	616,209	21,444	4.331307	18.760223	-0.070809	0.005014
10	1937-38	1,122,245	39,054	4.591667	21.083405	0.189551	0.035930
11	1938-39	539,529	18,776	4.273594	18.263606	-0.128522	0.016518
12	1939-40	648,682	22,574	4.353611	18.953930	-0.048505	0.002353
13	1940-41	419,148	14,586	4.163947	17.338452	-0.238169	0.056725
14	1941-42	613,602	21,353	4.329466	18.744276	-0.072650	0.005278
15	1942-43	1,147,435	39,931	4.601307	21.172029	0.199192	0.039677

16	1943-44	451,846	15,724	4.196570	17.611197	-0.205546	0.042249
17	1944-45	550,657	19,163	4.282460	18.339467	-0.119655	0.014317
18	1945-46	894,637	31,133	4.493226	20.189081	0.091110	0.008301
19	1946-47	734,364	25,556	4.407491	19.425974	0.005375	0.000029
20	1947-48	957,349	33,316	4.522650	20.454359	0.120534	0.014528
21	1948-49	909,843	31,663	4.500546	20.254912	0.098430	0.009688
22	1949-50	1,008,572	35,098	4.545286	20.659626	0.143170	0.020498
23	1950-51	1,237,781	43,075	4.634223	21.476023	0.232107	0.053874
24	1951-52	862,064	30,000	4.477119	20.044592	0.075003	0.005625
25	1952-53	811,270	28,232	4.450745	19.809128	0.048629	0.002365
26	1953-54	1,025,958	35,703	4.552709	20.727158	0.150593	0.022678
27	1954-55	674,511	23,473	4.370568	19.101867	-0.031548	0.000995
28	1955-56	1,353,423	47,099	4.673013	21.837049	0.270897	0.073385
29	1956-57	648,236	22,559	4.353312	18.951329	-0.048803	0.002382
30	1957-58	851,445	29,630	4.471736	19.996421	0.069620	0.004847
31	1958-59	834,219	29,031	4.462859	19.917113	0.060743	0.003690
32	1959-60	637,122	22,172	4.345802	18.885994	-0.056314	0.003171
33	1960-61	1,056,599	36,770	4.565489	20.843694	0.163374	0.026691
34	1961-62	660,499	22,985	4.361451	19.022258	-0.040664	0.001654
35	1962-63	780,119	27,148	4.433740	19.658051	0.031624	0.001000
36	1963-64	743,346	25,868	4.412770	19.472541	0.010654	0.000114
37	1964-65	766,851	26,686	4.426290	19.592045	0.024174	0.000584
38	1965-66	721,428	25,106	4.399772	19.357996	-0.002344	0.000005
39	1966-67	657,317	22,875	4.359354	19.003968	-0.042762	0.001829
40	1967-68	708,640	24,661	4.392005	19.289707	-0.010111	0.000102
41	1968-69	1,012,349	35,230	4.546910	20.674386	0.144794	0.020965
42	1969-70	874,116	30,419	4.483148	20.098619	0.081032	0.006566
43	1970-71	1,047,283	36,445	4.561643	20.808590	0.159527	0.025449
44	1971-72	873,458	30,396	4.482821	20.095687	0.080705	0.006513
45	1972-73	470,469	16,372	4.214110	17.758725	-0.188006	0.035346
46	1973-74	1,259,453	43,829	4.641761	21.545947	0.239645	0.057430
47	1974-75	707,696	24,628	4.391426	19.284622	-0.010690	0.000114
48	1975-76	786,755	27,379	4.437419	19.690685	0.035303	0.001246
49	1976-77	197,929	6,888	3.838089	14.730925	-0.564027	0.318127
50	1977-78	668,444	23,262	4.366644	19.067582	-0.035472	0.001258
51	1978-79	418,772	14,573	4.163557	17.335206	-0.238559	0.056910
52	1979-80	757,077	26,346	4.420719	19.542759	0.018603	0.000346
53	1980-81	597,766	20,802	4.318110	18.646078	-0.084005	0.007057
54	1981-82	926,194	32,232	4.508281	20.324599	0.106165	0.011271
55	1982-83	1,012,188	35,224	4.546840	20.673758	0.144725	0.020945
56	1983-84	740,659	25,775	4.411198	19.458664	0.009082	0.000082
57	1984-85	612,787	21,325	4.328889	18.739278	-0.073227	0.005362
58	1985-86	597,101	20,779	4.317627	18.641903	-0.084489	0.007138

59	1986-87	678,463	23,611	4.373105	19.124051	-0.029010	0.000842
60	1987-88	599,374	20,858	4.319277	18.656155	-0.082839	0.006862
61	1988-89	529,715	18,434	4.265622	18.195527	-0.136494	0.018631
62	1989-90	550,087	19,143	4.282011	18.335615	-0.120105	0.014425
63	1990-91	606,560	21,108	4.324453	18.700894	-0.077663	0.006032
64	1991-92	544,536	18,950	4.277606	18.297912	-0.124510	0.015503
65	1992-93	727,869	25,330	4.403632	19.391979	0.001517	0.000002
66	1993-94	473,466	16,477	4.216868	17.781976	-0.185248	0.034317
67	1994-95	890,685	30,996	4.491303	20.171806	0.089188	0.007954
68	1995-96	1,288,619	44,844	4.651704	21.638348	0.249588	0.062294
69	1996-97	1,373,397	47,794	4.679375	21.896554	0.277260	0.076873
70	1997-98	787,841	27,417	4.438018	19.696002	0.035902	0.001289
71	1998-99	758,191	26,385	4.421358	19.548405	0.019242	0.000370
72	1999-00	726,590	25,285	4.402869	19.385252	0.000753	0.000001
73	2000-01	381,814	13,287	4.123431	17.002684	-0.278685	0.077665
74	2001-02	867,323	30,183	4.479760	20.068251	0.077644	0.006029
75	2002-03	759,339	26,425	4.422015	19.554216	0.019899	0.000396
76	2003-04	685,310	23,849	4.377466	19.162211	-0.024650	0.000608
77	2004-05	381,407	13,273	4.122968	16.998864	-0.279148	0.077924
78	2005-06	1,000,928	34,832	4.541982	20.629601	0.139866	0.019563
79	2006-07	908,008	31,599	4.499669	20.247020	0.097553	0.009517
80	2007-08	831,396	28,933	4.461387	19.903976	0.059271	0.003513
81	2008-09	551,076	19,159	4.282374	18.338727	-0.119742	0.014338
82	2009-10	638,574	25,601	4.408259	19.432746	0.006143	0.000038
83	2010-11	1,013,493	32,049	4.505816	20.302380	0.103700	0.010754
84	2011-12	949,805	31,419	4.497193	20.224743	0.095077	0.009040
85	2012-13	688,577	24,102	4.382054	19.202400	-0.020062	0.000402
86	2013-14	679,148	23,235	4.366143	19.063204	-0.035973	0.001294
				X	X^2	x	x^2
			N=	86			
			S(X)=	378.581961		0	1.645484
			M=	4.40211582			
			S(X^2)=		1668.20712	S^2=	0.01935864
			[S(X)^2]/N		1666.56164	S=	0.13913531
			S(x^2)=		1.645484		

Pn	0.25	1	10	50	90	99	99.75
k (N=86)	2.899	2.387	1.298	0.000	-1.298	-2.387	-2.899
Log(V)=	4.805492	4.734185	4.582760	4.402116	4.221472	4.070046	3.998739
Vol, AF	63,899	54,223	38,261	25,242	16,652	11,750	9,971

Appendix 8. Time Step Computer Modeling

A8.1 Sample FLO4DRIFT Runoff Model Input

```
DRIFT CREEK 2008-14  (11Oct14)
NQIN, 1,CKE,0.001, smi(ndf),0.1, bii(ndf), 1,qbase,0.1
CETI, 0.05,.07,.10,.15,.20,.22,.22,.20,.13,.07,.03,.03
area, 15.8, NSTA, 1,ts,2.0, tss,8, tsbf,24, tsbii,32
w(i),1.5
nsmi, 5
smi/rop, 0,0.15,  2.5,0.23,  5,0.36,  12,1.00,  100,1.00
nbii, 10
bii/bfp, 0,.8, 0.1,.57, .2,.45, .3,.37, .4,.32, .5,.29, .6,.27, 1.,.2, 2.,.1, 100,.1
nke, 4
RN/KE, 0,1, .5,.3, 2,0., 99, 0.
kss,0.09
nks, 9
RG/RS, 0,0, .016,.0026, .033,.008, .05,.015, .067,.024, .083,.036, .1,.05, .5,.41, 1.0,0.99
0,2008,2009,Discharge
oct, 0.5,0.5,1.0,5.0,4.0,3.8,3.5,3.5,5.0,3.0,2.8,2.6,2.5,2.3,2.1, 2,1.6,1.8,1.3,  1,  1,1.2, .8,0.7, .6, .6, .6, .6, .6, .6, .6
nov, 0.7,  .7, 1,  6,  5,3.3,3.5,  3,3.5,  4,  5, 22,130, 85, 54, 40, 34, 28, 23, 24, 25, 24, 23, 22, 21, 20, 20, 19, 18, 17
dec,  17, 19, 20, 19, 19, 17, 17, 19, 17, 16, 15, 17, 26, 23, 19,17, 17, 28, 25, 24, 33, 60, 50, 40, 50, 5,110,200,215,160, 130
jan, 275,500,267,181,173,159,161,198,163,132,115, 96, 84, 73, 65,57, 50, 44, 39, 35, 32, 30, 28, 26, 27, 25, 24, 27, 25, 24, 23
feb,  22, 21, 21, 20, 19, 23, 23, 22, 22, 22, 25, 24, 25, 24, 24, 23, 23, 22, 21, 20, 19, 19, 24, 71,126,156,123,106
mar,  91, 92, 86, 74, 77, 71, 65, 62, 60, 58, 54, 50, 46, 46, 80, 92, 84, 73, 66, 60, 54, 62, 59, 54, 61, 59, 54, 56, 68, 66, 63
apr,  60, 81, 80, 72, 64, 56, 51, 46, 44, 45, 38, 35, 44, 42, 39,35, 35, 33, 30, 27, 25, 24, 23, 22, 21, 20, 20, 27, 29, 24
may,  22, 39, 39, 40, 70, 98,128,108, 89, 75, 65, 59, 53, 66, 54, 46, 40, 36, 37, 33, 29, 26, 24, 22, 21, 19, 18, 16, 15, 14, 11
jun,  11, 10,9.8, 10, 13, 12, 11, 10,9.3,8.8,8.7,8.4,7.9,7.5,7.2, 6.8,6.5,6.2,6.2,  6,5.8,5.1,4.7,4.4,  4,  4,3.5,3.2,3.2,3.1
jul,   3,2.7,2.3,  2,  2,1.8,1.7,1.6,1.7,1.8,1.8,  2,  3,2.8,2.1,1.6,1.2,.92,.78,.73,.66,.63,.57,.51,.40,.35,.31,.29,.26,.25,.24
aug, .23,.23,.23,.22,.23,.25,.28,.35,.42,.34,.30,.39,.50,.35,.30,29,.26,.20,.18,.17,.15,.15,.15,.14,.13,.13,.13,.13,.15,.16,.17
sep, .16,.17,.19,.19,.49,.90,.85,.40,.29,.30,.29,.27,.25,.25,.73,3.7,1.7,.83,.43,.32,.27,.23,.21,.20,.19,.18,.17,.17,.18,.22
1.7, 2008-09 PRECIPITATION
oct,0,0,.31,.10,.03,.01,.02,0,.03,0,0,0,0,0,0,.01,0,.07,0,0,0,0,0,0,0,0,0,0,0,0,0.37
nov,.05,.20,.84,.10,.18,.14,.02,.26,.01,.02,.64,.59,0,0,0,0,0,0,0,.45,.04,0,0,0,.04,0,.01,0,0,.03
dec,.23,.08,0,0,0,0,.22,0,0,0,0,.52,.12,.25,0,0,.22,.12,.03,.88,.68,.47,0,.47,.09,.16,.27,.18,.84,.09,.10
jan,1.32,.64,0,.26,.09,.14,.27,.46,0,0,.05,.01,0,0,0,0,0,0,0,0,0,0,0,.04,.14,0,.13,.01,0,0,0
feb,0,0,0,0,.04,.40,0,0,.03,.13,.13,.02,.02,0,.08,0,.10,0,0,0,0,.17,.65,.21,.56,.36,0,0
mar,.21,.50,.12,0,.07,0,.08,.07,.04,0,0,0,0,.58,.62,.14,.07,0,0,0,.08,.02,.06,0,.05,0,0,.27,0,0,.05
apr,.13,.16,.03,0,0,0,0,.02,.14,0,0,.37,.17,.01,0,0,.07,0,0,0,0,0,.01,0,0,0,.04,.19,0,0
may,.24,.35,.15,.80,.06,.59,.06,0,0,.01,0,.02,.45,.02,0,0,0,.17,.12,0,0,0,0,0,0,0,0,0,0,0,0
jun,0,0,.02,.56,.35,0,0,0,0,0,.05,.05,.27,.01,0,0,0,.03,0,.01,.04,0,0,0,0,0,0,0,0,0
jul,0,0,0,0,0,0,0,0,0,0,0,0,.68,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0
aug,0,0,0,0,0,0,0,0,0,0,0,.09,0,0,0,0,0,0,0,0,0,0,0,0,0,0,.03,0,0,.05,0,0,0
sep,0,0,0,0,.53,.22,.09,0,0,0,0,0,0,0,0,.13,0,0,.06,0,0,0,0,0,0,0,0,0,0,.15,.02
-1,2009,2010,DISCHARGE
oct09,.70,.70,.70,.70,.79,5.78,2.87,1.42,.67,.30,.14,.05,.01,.41,.95,.85,.91,2.26,1.72,1.07,1.06,1.35,2.09,4.89
   3.68,6.11,10.53,6.52,5.80,10.91,12.15
nov,10.79,8.59,6.66,5.42,4.78,5.08,36.28,55.48,52.93,46.11,51.62,70.48,66.70,62.52,50.95,41.70,65.84,60.65,52.80
    54.80,67.07,79.67,71.38,59.61,50.82,51.31,108.69,89.71,74.28,62.44
dec,54.39,48.26,41.19,35.61,31.07,27.47,24.13,21.00,18.39,17.07,16.81,17.13,17.46,16.84,55.29,114.32,103.93
    89.10,82.03,80.05,119.79,135.69,110.51,93.72,81.40,70.00,60.92,53.72,48.54,62.75,100.94
jan,187.27,165.74,132.53,113.88,130.90,191.81,157.00,132.48,124.22,104.58,91.60,99.40,97.79,90.21,91.97,155.85
    155.43,143.91,122.95,104.39,91.33,81.97,73.89,70.91,93.90,83.75,73.38,63.59,59.02,54.70,50.00
feb,45.19,45.43,44.04,44.32,43.94,40.61,38.22,35.25,33.35,31.71,32.79,39.27,45.29,55.18,63.16,68.98,64.85,59.67
    54.35,49.01,43.59,38.99,36.92,46.62,50.28,56.25,61.95,55.78
mar,51.35,47.56,44.84,42.01,37.53,34.17,31.81,35.16,30.86,30.79,32.37,61.17,83.26,72.85,64.35,57.41,52.17,46.22
    41.64,37.87,40.14,43.58,37.75,34.79,43.75,94.43,96.52,93.94,232.61,263.37,215.25
apr,171.98,166.41,181.37,162.35,142.77,129.91,113.09,112.58,92.67,86.88,79.64,74.54,68.17,63.26,99.46,85.35,74.17
    65.93,59.30,55.28,60.96,50.16,45.01,43.31,39.20,37.25,62.12,89.32,94.04,82.19
```

may,70.85,62.56,63.13,56.63,52.36,47.98,43.37,39.85,36.46,38.71,34.80,31.07,28.35,26.15,24.13,22.61,25.01,29.70
29.28,27.45,28.51,53.49,54.12,51.45,51.19,81.95,86.80,75.31,68.72,60.16,68.22
jun,68.46,136.61,195.20,218.07,174.99,143.78,127.85,100.15,90.73,101.39,106.54,90.62,77.12,67.57,61.91,56.13,48.52,40.54
,33.76
32.08,30.63,25.78,25.48,23.87,20.65,18.78,17.54,16.39,15.39,14.59
jul,14.77,15.78,15.30,13.73,13.06,12.24,11.35,10.54,9.99,9.27,8.93,8.43,8.15,7.40,6.73,6.46,6.12,6.04,6.00,6.06
5.70,5.42,5.12,4.83,4.56,4.26,3.89,3.81,3.83,3.64,3.51
aug,3.19,3.03,2.80,2.71,2.65,2.40,2.11,2.05,2.60,2.31,2.23,1.96,1.60,1.25,1.05,0.99,0.81,0.61,0.72,0.78,0.69,0.65
0.56,0.44,0.33,0.31,0.51,0.40,0.24,0.30,0.54
sep,1.00,1.32,1.12,0.77,0.51,0.43,1.13,2.24,1.98,1.51,1.20,0.93,0.76,0.65,4.38,3.89,2.88,4.27,9.06,8.42,7.00,4.66
3.51,3.15,2.76,2.60,2.80,2.42,2.10,1.86
1.5, 2009-10 PRECIPITATION
Oct-09,0,0.06,0,0.08,0,0,0,0,0,0,0,0,0.4,0.38,0.03,0,0.41,0,0,0,0.17,0,0.3,0,0.01,0.52,0.03,0.05,0.08,0,0.09
Nov-09,0,0,0,0,0.21,0.78,0.85,0.64,0.41,0.21,0.42,0.54,0.35,0,0.08,0.01,0.71,0.18,0.1,0.79,0.26,0.49,0,0,0,0.86,0.12,0,0,0.01
Dec-09,0,0,0,0,0,0,0,0,0,0,0,0.11,0,0.65,1.78,0.55,0.09,0,0.07,0.49,0.38,0.07,0,0,0,0,0.02,0,0.37,0.33,1.23
Jan-10,0.54,0,0,0.07,0.93,0.2,0,0.37,0.04,0,0.03,0.58,0.25,0,0.88,0.23,0.42,0,0,0.07,0,0.18,0,0.78,0.12,0.07,0,0,0,0.08,0.01
Feb-10,0.24,0.07,0.15,0.13,0,0.21,0,0,0,0.08,0.49,0.36,0.02,0.36,0.19,0.04,0,0,0,0,0,0,0.78,0.25,0.1,0.6,0,0
Mar-10,0,0.12,0,0.02,0,0,0.14,0.05,0.06,0.01,0.76,0.28,0,0,0,0,0.01,0,0,0,0.11,0,0,0.25,0.62,0.51,0,1,1.06,0.14,0
Apr-10,0,0.91,0.22,0.1,0.23,0.13,0.06,0.18,0,0.04,0.11,0.02,0.02,0.76,0.07,0,0,0,0.07,0.1,0,0,0,0,0,0.69,0.44,0.14,0.04,0.02
May-10,0,0,0.26,0.01,0.18,0,0,0,0.04,0.06,0,0,0,0,0,0,0.33,0.14,0.34,0.37,0.96,0.1,0.04,0,0.18,0.22,0,0,0,0.03,0.21
Jun-10,0.09,1.03,0.55,0.42,0,0.18,0,0.09,0.14,0.06,0,0,0,0,0.01,0.01,0,0,0,0.06,0,0,0,0,0,0,0,0,0,0
Jul-10,0.02,0.02,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0
Aug-10,0,0,0,0,0,0,0,0.02,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0.18,0
Sep-10,0,0,0,0,0,0,0.18,0.12,0,0,0,0,0,0,0.27,0.07,0.04,1.05,0.15,0.01,0,0,0.03,0,0,0.15,0,0,0,0
-1,2010,2011,DISCHARGE
oct10,0.93,0.89,0.87,0.85,0.70,0.58,0.48,0.49,1.34,10.27,12.07,7.36,5.38,4.34,3.66,3.31,2.95,2.68,2.45,2.29,2.19
4.66,6.54,13.30,18.51,23.92,20.36,19.53,21.88,18.34,28.39
nov,27.76,65.17,52.99,41.19,33.72,32.08,93.07,76.55,72.60,88.34,73.01,64.54,54.87,56.06,54.18,59.11,56.68,147.34
137.00,125.47,104.50,107.28,121.10,99.00,80.73,75.48,101.56,90.63,79.97,84.46
dec,150.98,146.27,117.08,97.92,82.74,72.05,62.73,70.85,112.46,161.50,150.43,149.68,216.24,254.46,199.07,157.15
129.72,125.35,112.07,102.02,89.26,77.25,67.60,59.93,54.81,61.51,70.77,148.98,245.75,164.79,129.61
jan,107.95,91.19,78.10,68.02,61.75,56.90,51.46,52.29,49.88,46.57,42.96,48.52,79.27,97.22,95.98,250.04,302.76
217.56,203.90,153.15,130.74,114.96,97.94,85.55,74.58,66.05,58.64,52.69,47.35,42.39,37.93
feb,33.98,30.72,28.21,26.29,25.39,24.27,24.09,23.23,24.34,23.58,22.57,21.81,28.92,28.09,56.26,77.59,67.17,60.02
58.04,52.18,47.81,44.88,44.00,44.94,42.47,39.01,37.81,79.31
mar,197.32,177.45,147.41,131.63,125.27,105.42,92.36,82.51,76.97,121.70,120.77,104.77,103.92,121.83,114.71,130.45
141.44,130.18,121.67,106.88,98.89,90.87,80.86,79.09,76.00,90.95,89.78,89.38,105.84,117.06,104.72
apr,98.27,104.75,89.55,81.81,86.61,80.34,86.91,82.17,74.60,69.10,75.56,70.82,69.17,68.74,82.27,123.00,130.35
110.06,92.64,78.28,70.35,62.51,55.49,51.56,64.36,63.94,63.28,66.73,78.25,73.58
may,66.94,62.00,56.02,50.39,46.05,43.75,47.76,46.90,49.48,44.48,43.92,47.69,42.48,40.20,44.97,53.75,49.46,43.82
37.15,34.01,31.41,29.68,27.57,25.55,28.32,28.72,42.19,62.67,63.70,57.14,54.31
jun,58.42,57.30,52.73,46.85,41.84,39.17,35.83,32.91,29.38,26.93,25.32,23.32,24.53,21.52,19.45,17.62,17.76,17.88
16.48,16.94,15.67,14.86,15.04,14.21,13.39,12.86,12.31,13.15,13.04,13.88
jul,16.74,13.55,11.88,10.96,10.09,9.23,8.84,8.78,8.23,8.03,8.17,8.93,9.65,8.70,7.71,8.31,11.94,13.12,11.37,10.55
8.91,8.36,7.47,6.84,6.37,6.13,5.70,5.40,5.01,4.78,4.75
aug,4.51,4.09,4.76,3.76,3.51,3.43,3.55,3.64,3.69,3.89,3.14,2.69,2.55,2.90,2.88,2.60,2.34,2.19,2.04,1.72,1.55,1.67
1.65,1.50,1.45,2.79,2.02,1.67,1.69,1.78,1.62
sep,1.56,1.45,1.34,1.13,1.01,0.66,0.55,0.56,0.69,0.70,0.66,0.72,0.80,0.99,1.10,1.18,1.14,0.98,1.39,1.52,1.20,1.07
0.89,0.73,0.90,1.41,4.04,3.95,2.78,2.75
1.5, 2010-11 PRECIPITATION
Oct-10,0,0,0,0,0,0,0,0,0.02,0.4,0.83,0,0,0,0,0,0,0,0,0,0,0, 0,0.01,0.86,0.69,0.67,0.17,0,0.39,0,0.91,0.27
Nov-10,0.16,0,0,0,0,1.05,0.15,0.11,0.66,0.07,0.02,0,0.08,0.01,0,0.16,0.92,0.41,0.1,0.23,0.18,0.37,0,0,0,0.34,0.04,0.12,0.04,1.22
Dec-10,0.33,0,0,0,0,0.05,0.15,1.18,1.12,0.14,0.77,0.22,0.34,0.59,0.15,0,0,0.49,0.12,0.41,0,0,0,0.02,0.14,0.69,1.1,1.7,0.24,0,0
Jan-11,0,0,0,0,0.08,0,0.04,0.06,0.04,0,0.08,0.34,0.63,0,0.72,0.62,0.02,0.41,0,0,0.18,0,0,0,0,0,0,0,0.01,0.02,0,0
Feb-11,0,0,0,0.02,0.04,0.05,0.11,0,0,0,0,0.51,0.07,0.46,0.6,0.09,0.01,0.34,0,0, 0,0.05,0.17,0.02,0,0,0.1,1.67
Mar,0.55,0.14,0.18,0.3,0.01,0,0.06,0.14,0.34,0.89,0,0.1,0.72,0.7,0.54,0.87,0.05,0.11,0.01,0.03,0.03,0,0.04,0.1,0.24,0.17,0.27,0.
07,0.48,0.02,0
Apr-11,0.15,0.05,0,0.17,0.06,0.22,0.09,0,0,0.3,0.04,0,0.22,0.26,0.63,0.09,0,0.02,0,0,0,0,0,0.27,0.84,0.11,0.13,0.17,0.28,0.05
May-11,0,0.07,0,0,0.02,0.23,0.02,0.19,0,0,0.34,0,0,0,0.19,0.01,0.31,0,0,0,0,0,0.08,0,0.41,0.33,0.23,0.06,0.01,0.64,0.26
Jun-11,0.29,0.23,0,0,0,0,0,0,0,0,0,0.15,0.07,0,0,0,0,0.11,0,0,0,0,0,0,0,0,0,0.02,0.11,0,0
Jul-11,0,0,0,0,0,0,0,0,0,0,0,0,0.13,0,0,0,0.21,0.4,0,0,0,0,0,0,0,0,0,0,0,0,0
Aug-11,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0.11,0,0,0,0,0

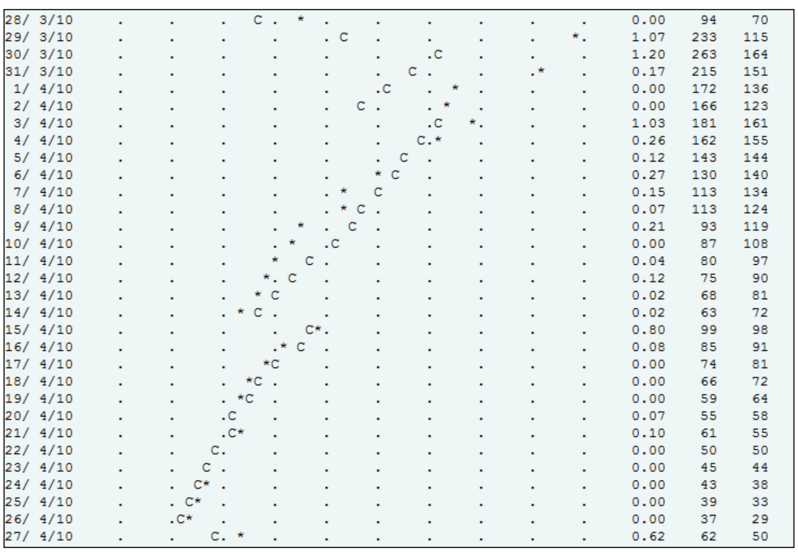
Sep-11,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0.02,0.06,0,0,0,0,0,0,0.16,0.05,0.06,0,0,0
-1,2011,2012,DISCHARGE
oct11,1.80,2.72,4.03,6.33,6.55,5.58,4.50,4.46,3.86,4.07,9.72,8.88,6.57,5.60,5.45,
5.05,4.83,4.22,3.96,3.83,3.65,3.49,3.41,3.27,3.13,3.07,2.91,2.76,3.71,6.14,12.25
nov, 9.75,8.39,14.76,14.10,11.94,11.80,11.04,10.94,10.46,9.87,9.63,12.68,14.69,17.64
18.07,17.74,43.59,67.75,72.31,61.11,52.26,76.57,93.71,107.40,95.88,79.18,73.03,88.82,73.83,66.94
dec, 58.40,51.91,45.76,40.58,35.89,31.68,27.96,25.17,24.17,22.68,21.67,18.89,17.73,16.72
16.83,16.27,15.32,15.13,14.87,14.01,13.56,12.98,12.50,12.02,11.89,12.00,12.27,49.60,121.21,249.25,195.25
jan,136.07,106.17,91.88,78.75,81.18,71.08,64.24,57.43,52.03,51.10,44.71,40.12,36.28,34.51
36.15,32.55,39.79,205.75,808.62,342.00,327.25,242.50,205.46,192.30,204.22,171.59,140.72
123.71,111.88,119.60,98.69
feb, 90.72,79.80,72.60,65.93,59.62,54.12,49.25,46.63,54.49,60.20,63.39,70.41,65.15,60.20
55.56,51.61,48.73,50.53,58.42,58.77,62.32,74.94,92.70,95.05,89.67,87.29,79.09,71.81,69.01
mar, 93.37,104.02,88.31,77.71,72.51,75.63,77.02,70.06,63.74,59.13,60.55,74.59,108.62,161.28,167.97,201.90
252.18,195.68,165.53,184.46,261.65,237.99,203.23,186.13,163.62,141.99,124.99,111.85,110.03, 272.33,314.63
apr,233.97,187.98,163.40,159.95,150.60,124.75,108.06,93.09,80.95,73.02,69.68,62.97,56.29,49.73
43.72,55.83,55.95,62.38,68.03,75.65,69.53,63.38,56.07,48.75,46.37,66.68,68.69,64.17,58.80,66.61
may, 67.05,65.56,74.76,76.32,76.01,70.28,64.37,58.10,51.84,45.70,40.89,36.20,31.74,28.03,24.60
23.71,22.00,20.63,19.38,18.65,20.79,28.56,26.09,29.60,43.48,34.50,28.35,23.96,23.27,21.35,19.78
jun, 18.78,18.76,17.21,19.65,45.07,34.13,33.80,37.08,49.87,45.11,38.90,35.86,34.61,28.30,23.40
22.61,20.80,19.90,19.01,17.79,16.38,15.51,18.87,18.74,16.43,16.07,14.74,13.40,12.59,12.38
jul, 14.01,13.15,12.78,11.81,10.70,9.37,8.58,8.14,7.58,7.08,6.74,6.43,6.18,5.93,5.87,6.12,5.76
5.65,5.61,5.47,5.73,5.47,5.52,5.22,4.78,4.49,4.52,4.83,4.53,4.35,4.01
aug, 3.69,3.47,3.27,2.99,2.82,2.67,2.54,2.43,2.45,2.41,2.26,2.05,1.89,1.69,1.63,1.58,1.43,1.36
1.69,1.58,1.40,1.25,1.09,0.98,0.94,1.12,1.12,1.12,1.09,1.06,1.06
sep, 1.06,0.98,0.95,0.87,0.65,0.40,0.36,0.34,0.57,0.63,0.54,0.49,0.40,0.31,0.26,0.25,0.23,0.23
0.29,0.42,0.62,1.09,1.48,1.56,1.56,1.63,1.61,1.57,1.35,1.38
1.5, 2011-12 PRECIPITATION
Oct-11,0.32,0.13,0.24,0.31,0.01,0,0.03,0,0.07,0.25,0.36,0.04,0.03,0.06,0,0,0,0,0,0,0,0,0,0,0,0,0,0.08,0.05,0.12,0.05
Nov-11,0,0.26,0,0,0.21,0.02,0.04,0.02,0,0,0.14,0.1,0,0.09,0,0.52,0.66,0.44,0.11,0,0.63,1.01,0.69,0.53,0,0,0.45,0,0.01,0.03
Dec-11,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0.01,0,0,0,0,0,0,0.08,0.07,0.38,1.19,0.71,0.77,0
Jan-12,0,0.1,0,0.35,0.04,0.05,0,0,0.21,0.03,0,0,0,0.2,0.04,0.13,2.18,2.47,2.13,0.65,0.15,0.19,0,0.77,0.04,0.08,0,0,0.5,0,0.01
Feb-12,0.05,0,0,0,0,0,0.03,0.54,0.11,0.14,0,0.12,0.1,0.11,0,0.06,0.13,0.06,0.15,0.17,0.01,0.28,0,0.31,0.17,0.08,0,0.47,1.05
Mar-12,0.21,0,0,0,0.38,0.03,0,0,0,0.26,0.31,1.26,0.45,0.69,0.93,0.48,0.07,0,0.07,0.63,1.27,0.07,0,0,0.07,0.01,0.16,0.15,0.81,1.13,0.54
Apr-12,0.24,0,0.27,0.08,0.19,0,0,0,0,0.13,0.15,0.06,0.1,0,0.11,0.38,0.11,0.13,0.4,0,0,0,0,0,0.17,0.35,0.03,0,0.07,0.11
May-12,0.02,0.21,0.5,0.13,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0.07,0.57,0.27,0.01,0.27,0.26,0,0,0,0,0,0
Jun-12,0.09,0,0.08,0.3,0,0,0.47,0.17,0,0,0,0.14,0,0,0,0,0,0,0.01,0,0,0.22,0.22,0.06,0.14,0.02,0,0,0,0.28
Jul-12,0.04,0.02,0.01,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0
Aug-12,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0
Sep-12,0,0,0,0,0,0,0,0,0,0,0.02,0,0,0,0,0,0,0,0,0,0,0,0.01,0,0.01,0,0,0,0,0,0
-1,2012,2013,DISCHARGE
oct12,2.03,1.95,1.92,1.85,1.78,1.61,1.58,1.59,1.70,1.72,1.80,2.67,6.13,5.98,10.89,17.61,12.42,11.02,8.21,9.43,9.19
9.94,12.60,14.21,16.63,14.46,14.24,32.91,63.04,48.69,39.84
nov,40.72,40.21,42.08,40.44,35.02,30.52,29.64,26.63,23.90,25.33,25.61,38.17,47.86,43.91,39.18,35.25,44.06,95.11
152.95,364.40,328.25,230.55,175.09,218.49,164.96,133.15,108.97,90.71,81.26,74.71
dec,97.97,143.66,141.51,178.28,181.20,141.43,125.95,111.14,101.09,89.00,85.72,98.58,85.66,78.82,73.43,80.94,108.52
111.59,102.25,148.92,160.18,138.54,140.80,161.01,162.39,174.77,142.90,123.61,105.14,90.73,79.96
jan,67.67,59.44,52.59,47.87,43.58,40.17,41.62,41.41,46.90,63.22,62.21,56.13,50.93,46.37,43.06,39.86,37.05,34.55
32.05,29.75,27.65,25.95,25.88,27.13,46.67,60.62,69.87,107.25,210.04,207.69,183.62
feb,143.61,121.15,102.24,87.76,79.73,73.63,68.67,62.23,55.45,50.94,46.32,45.40,41.50,37.89,35.16,33.54,32.40,30.19
29.20,27.98,30.04,35.05,54.63,52.45,54.46,51.95,46.46,44.39
mar,46.07,43.50,42.11,38.73,37.26,45.40,50.61,45.69,41.54,37.72,35.50,33.49,30.70,26.13,24.24,25.73,31.71,27.18
25.77,49.17,56.51,52.63,48.36,44.18,40.81,37.97,34.82,31.88,29.22,26.66,24.64
apr,23.02,21.61,19.43,19.24,19.78,34.42,50.35,49.34,44.09,41.76,39.41,36.26,38.72,35.92,35.70,32.89,30.28,28.18
33.53,33.81,30.69,28.55,26.19,24.21,22.40,20.71,19.05,17.60,17.92,17.33
may,17.69,16.76,15.73,14.82,13.91,13.33,12.90,12.55,12.20,11.43,10.89,10.67,11.32,10.74,10.44,11.20,12.24,10.18
11.54,10.53,12.47,23.38,29.80,40.66,35.88,33.83,42.88,61.00,65.12,59.32,50.08
jun,42.50,36.81,31.86,27.49,23.87,20.76,18.19,17.15,17.17,16.00,15.29,14.78,16.30,15.24,13.06,12.04,11.43,12.38
13.41,14.94,16.52,13.76,13.42,17.32,16.44,17.92,16.83,14.45,12.92,11.71
jul,10.78,9.98,9.28,8.66,7.84,7.47,7.25,6.98,6.56,6.21,5.89,5.63,5.40,5.03,4.67,4.58,4.97,4.67,4.18,3.96,3.79
3.63,3.37,3.12,2.81,2.48,2.24,2.19,2.22,2.22,2.20
aug,2.15,2.61,2.53,2.07,1.93,3.51,3.22,3.08,3.03,2.98,3.08,3.22,3.22,3.17,3.03,2.93,3.17,1.09,1.13,1.14,0.90

0.83,1.35,1.69,1.74,2.09,1.77,1.60,1.58,1.58,1.30
sep,1.08,1.05,1.17,1.03,3.14,23.75,14.50,9.74,7.58,6.22,5.22,4.61,4.28,4.18,4.02,4.14,3.99,6.57,9.08,5.88,4.67
4.83,7.88,11.15,16.86,15.29,12.33,15.62,69.21,109.21
1.7, 2012-13 PRECIPITATION
Oct-12,0,0,0,0,0,0,0,0,0,0,0,0.96,0.02,0.67,0.8,0.22,0,0.06,0.2,0.08,0.15,0.31,0.15,0.09,0.01,0,0.48,1.16,0.12,0.18,0.28
Nov-12,0.3,0.19,0.14,0,0,0.02,0.01,0.02,0.27,0,0.21,0.59,0,0.05,0,0,1.22,0.75,1.92,1.12,0.51,0,0.57,0.15,0,0,0,0.02,0.26,0.6
Dec-12,0.74,0.58,0.32,0.93,0,0.03,0.07,0.1,0.02,0,0.24,0,0,0.23,0.29,0.53,0.36,0.04,0.03,1.09,0.12,0.2,0.63,0.05,0.77,0.01
0.01,0,0.01,0,0
Jan-13,0,0,0,0,0.01,0.09,0.11,0,0.29,0.03,0,0,0,0,0,0,0,0,0,0,0,0,0.23,0.23,0.11,0.27,0.14,0.07,0.02,0.03,0
Feb-13,0,0,0,0,0.12,0.1,0.13,0,0.07,0,0,0,0,0,0,0,0.01,0,0.05,0,0.12,0.02,0.45,0.07,0.01,0.2,0,0,0.06
Mar-13,0,0,0,0,0,0.3,0.32,0,0,0,0,0,0,0,0,0.24,0,0,0.68,0.56,0.03,0.01,0,0,0,0.04,0.02,0.01,0,0,0
Apr-13,0,0,0,0.16,0.49,0.62,0.2,0.02,0,0.14,0,0.03,0.11,0.24,0,0,0,0.05,0.28,0,0,0,0,0,0,0,0,0,0.05,0
May-13,0,0,0,0,0,0,0,0,0,0,0,0.02,0,0,0.14,0.1,0,0.05,0.04,0,0.73,0.19,0.25,0.01,0.24,0.04,0.59,0.24,0.19,0.02,0
Jun-13,0,0,0,0,0,0,0,0,0,0,0,0,0.22,0,0,0,0,0.02,0.16,0.01,0,0,0.11,0.02,0.33,0.15,0,0,0,0
Jul-13,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0
Aug-13,0,0,0,0,0,0,0,0,0,0,0.02,0,0,0,0,0,0,0,0,0,0,0,0,0.02,0,0,0.07,0.03,0,0.04,0.17,0,0
Sep-13,0,0,0,0,0.18,0.52,0,0,0,0,0,0,0,0,0,0,0,0,0,0.1,0.05,0.22,0.36,0.4,0.01,0,0.18,1.33,1.64,0.42
-1,2013,2014,DISCHARGE
oct13,96.34,85.87,70.45,56.48,46.18,37.79,33.64,33.95,39.54,32.29,27.39,23.46,22.99,21.09,19.53,18.35
17.23,16.27,15.48,14.72,14.02,13.42,12.87,12.41,12.26,11.81,12.69,16.12,13.09,11.91,11.22
nov,11.01,17.57,22.71,21.82,24.75,34.67,49.06,56.60,50.60,44.53,38.42,44.75,46.86,41.96,38.30,42.53
38.95,36.02,55.54,67.42,58.88,51.71,46.38,41.63,36.70,32.24,28.93,24.72,20.42,18.92
dec,20.55,83.23,78.44,64.42,54.43,47.22,41.01,35.47,31.61,27.59,24.04,24.05,29.41,25.62
24.59,23.42,22.49,21.80,21.29,20.29,25.51,27.03,29.34,39.27,37.66,34.72,31.82,28.40,25.01,24.49,23.00
jan,21.60,20.42,23.71,21.79,20.19,19.25,19.53,23.27,26.12,39.55,49.60,72.18,95.01,102.72,92.32,78.22,64.94
54.52,47.17,41.54,37.57,34.07,31.26,25.40,24.52,22.61,21.44,21.51,31.92,31.14,34.39
feb,34.02,31.64,28.94,26.76,24.53,23.23,24.01,24.73,32.58,48.43,141.99,225.28,211.02,281.20,293.23,275.75
221.22,220.53,221.26,212.60,183.14,146.96,123.21,106.95,84.26,73.63,67.86,60.97
mar,59.52,76.97,108.07,112.98,143.84,214.80,166.53,136.19,189.68,152.83,123.79,104.29,87.10,81.03,71.15,63.24
84.22,70.13,62.33,55.32,49.49,43.82,38.62,34.04,32.73,37.46,66.47,112.03,173.18,147.83,119.96
apr,102.06,83.02,73.56,76.95,72.56,80.38,72.73,64.90,59.21,52.06,45.91,40.99,37.97,32.77,28.21,25.37,27.47,30.07
24.54,24.27,22.48,29.88,49.38,108.76,121.93,98.39,97.50,84.35,73.82,64.70
may,57.08,50.13,44.99,48.28,42.89,36.86,31.14,31.61,62.31,76.09,67.03,57.63,49.41,42.52,36.78,32.01,28.04,30.96
40.80,29.69,24.75,22.39,20.98,19.80,18.46,17.18,15.68,14.90,14.83,13.32,12.38
jun,11.77,11.18,11.49,11.09,10.40,9.66,9.15,8.71,8.30,7.85,7.49,7.64,9.14,8.85,8.45,8.79,8.97,8.42,7.58,7.17,6.74
6.26,5.89,5.72,5.85,7.22,11.93,11.76,9.89,9.51
jul, 7.73,6.31,3.72,3.23,3.39,5.05,5.58,5.17,3.92,2.86,2.70,2.22,2.58,2.60,2.41,1.38,0.98,1.80,1.95,1.69,2.79,3.05
3.66,3.60,3.17,2.67,2.34,1.67,1.15,1.00,0.90
aug, 0.75,0.81,0.66,0.62,0.55,0.47,0.35,0.45,0.45,0.47,0.46,0.44,0.62,0.55,0.55,0.63,0.76,0.50,0.38,0.26,0.25,0.31
0.42,0.36,0.37,0.34,0.22,0.26,0.68,1.25,1.12
sep, 1.04,0.84,0.84,0.75,0.62,0.42,0.30,0.20,0.26,0.26,0.18,0.12,0.07,0.06,0.05,0.16,0.16,0.21,0.25,0.18,0.11,0.22
2.81,2.71,2.70,1.78,1.40,1.12,1.31,1.37
1.7, 2013-14 PRECIPITATION
Oct-13,0.19,0.22,0,0,0,0,0.03,0.09,0,0,0,0.04,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0
Nov-13,0.03,0.39,0.07,0.08,0.05,0.27,0.43,0.02,0,0,0,0.23,0,0,0.04,0.03,0.01,0.44,0.59,0,0,0,0,0,0,0,0,0,0,0
Dec-13,0.49,0.35,0,0,0,0.03,0,0,0,0,0,0.11,0.02,0,0.09,0,0,0.05,0,0.08,0.01,0,0.04,0,0,0,0,0,0,0,0
Jan-14,0,0,0.08,0,0,0.01,0.16,0.37,0.2,0,0.57,0.4,0,0,0,0,0,0,0,0,0,0,0,0,0,0.06,0.28,0.08,0.04,0.01
Feb-14,0.01,0,0,0.02,0,0.22,0.54,0.45,0.01,0.11,0.79,0.52,0.36,0.76,0.86,0.1,0.67,0.74,0.23,0.2,0,0,0.03,0.22,0,0,0.17,0
Mar-14,0.07,0.34,0.4,0.01,1.46,0.51,0,0.74,0.22,0.01,0,0,0,0.22,0,0.51,0,0,0,0, 0,0,0,0,0.26,0.55,0.33,1.08,0.45,0.1,0.06
Apr-14,0.02,0,0.17,0.01,0.08,0,0,0.03,0.01,0,0,0,0,0,0.01,0,0.41,0,0.04,0,0.19,0.2,0.63,0.42,0.07,0.14,0.28,0,0,0
May-14,0,0,0.31,0.07,0.05,0,0,0.59,0.46,0.04,0,0,0,0,0,0,0.02,0.36,0,0,0,0,0.06,0,0,0,0.05,0.05,0.01,0,0
Jun-14,0,0,0,0,0,0,0,0,0,0,0,0.08,0,0,0.03,0.15,0,0,0,0.04,0,0,0,0,0,0.07,0.27,0,0,0
Jul-14,0,0,0,0,0,0,0,0,0,0,0,0,0.06,0,0,0,0,0,0,0,0,0,0.11,0.26,0.03,0,0,0,0,0,0,0
Aug-14,0.15,0,0,0,0,0,0,0,0,0,0,0,0.13,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0.07,0
Sep-14,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0.47,.57,.08,0,0,0,.04,.03
-1,9999,9999,END

A8.2 Sample FLO4DRIFT Runoff Model Output

							<.........	D I S C H A R G E S			.........>
DD/MM/YR	RAIN in.	ETI in.	SMI in.	ROP	BII	BFP	SUR cfs	SUB cfs	BFL cfs	BASE cfs	QCAL cfs	QOBS cfs
1/ 4/10	0.00	0.15	9.65	.78	0.00	.80	9.4	18.6	107.5	0.1	135.6	172.0
2/ 4/10	0.00	0.15	9.50	.77	0.00	.80	3.1	13.8	106.3	0.1	123.3	166.4
3/ 4/10	1.37	0.15	9.35	.76	0.00	.80	28.6	16.7	115.4	0.1	160.7	181.4
4/ 4/10	0.33	0.15	9.66	.79	0.00	.80	16.8	17.7	120.1	0.1	154.7	162.4
5/ 4/10	0.15	0.15	9.65	.78	0.00	.80	7.5	16.4	119.9	0.1	143.8	142.8
6/ 4/10	0.34	0.15	9.56	.78	0.00	.80	5.5	16.2	118.6	0.1	140.4	129.9
7/ 4/10	0.19	0.15	9.56	.78	0.00	.80	3.5	15.1	115.1	0.1	133.8	113.1
8/ 4/10	0.09	0.15	9.50	.77	0.00	.80	1.8	12.9	109.2	0.1	124.1	112.6
9/ 4/10	0.27	0.15	9.38	.76	0.00	.80	2.6	12.4	103.9	0.1	119.0	92.7
10/ 4/10	0.00	0.15	9.36	.76	0.00	.80	1.2	10.0	96.3	0.1	107.6	86.9
11/ 4/10	0.06	0.15	9.21	.74	0.00	.80	0.7	8.0	88.2	0.1	96.9	79.6
12/ 4/10	0.16	0.15	9.08	.73	0.00	.80	1.2	7.4	81.1	0.1	89.8	74.5
13/ 4/10	0.03	0.15	9.01	.73	0.00	.80	0.7	6.2	73.7	0.1	80.6	68.2
14/ 4/10	0.03	0.15	8.88	.71	0.00	.80	0.4	5.0	66.2	0.1	71.7	63.3
15/ 4/10	1.14	0.15	8.74	.70	0.00	.80	17.6	10.4	69.7	0.1	97.8	99.5
16/ 4/10	0.11	0.15	9.06	.73	0.00	.80	9.3	11.4	70.2	0.1	90.9	85.3
17/ 4/10	0.00	0.15	8.96	.72	0.00	.80	3.5	9.6	67.7	0.1	80.9	74.2
18/ 4/10	0.00	0.15	8.81	.71	0.00	.80	1.2	7.2	63.4	0.1	71.9	65.9
19/ 4/10	0.00	0.15	8.66	.69	0.00	.80	0.4	5.1	58.1	0.1	63.7	59.3
20/ 4/10	0.11	0.15	8.51	.68	0.00	.80	0.6	4.5	53.3	0.1	58.5	55.3
21/ 4/10	0.15	0.15	8.41	.67	0.00	.80	1.0	4.8	49.5	0.1	55.4	61.0
22/ 4/10	0.00	0.15	8.34	.67	0.00	.80	0.4	4.0	45.1	0.1	49.7	50.2
23/ 4/10	0.00	0.15	8.19	.65	0.00	.80	0.2	3.0	40.5	0.1	43.8	45.0
24/ 4/10	0.00	0.15	8.04	.64	0.00	.80	0.1	2.1	35.9	0.1	38.2	43.3
25/ 4/10	0.00	0.15	7.89	.62	0.00	.80	0.0	1.5	31.6	0.1	33.1	39.2
26/ 4/10	0.00	0.15	7.74	.61	0.00	.80	0.0	1.0	27.5	0.1	28.6	37.3
27/ 4/10	1.03	0.15	7.59	.60	0.00	.80	11.1	6.7	32.2	0.1	50.0	62.1
28/ 4/10	0.66	0.15	7.98	.63	0.00	.80	11.2	12.0	39.6	0.1	62.9	89.3
29/ 4/10	0.21	0.15	8.18	.65	0.00	.80	6.0	13.3	44.6	0.1	64.0	94.0
30/ 4/10	0.06	0.15	8.15	.65	0.00	.80	2.5	11.8	46.6	0.1	61.0	82.2

A8.3 Sample FLO4DRIFT Runoff Model Hydrograph Plot



A8.4 Release Criteria Used for the Reservoir Model RES4DRIFT

1. Start the pool at a given elevation ELE --normally at Elevation reached at the end of the last calculation time step
2. Input the Inflow to the reservoir for that day, QIN
3. Calculate the storage XSTOR at Elevation ELE --based on Elevation vs. Storage Curve
4. Calculate the capacity of the outlet at Elevation ELE --using the Elevation vs. Capacity Curve
5. Initialize for Time Step IN

```
viol(in) = 0   'violation code)
qloc(in) = qin(in) * aqloc(i): IF qloc(in) < 0 THEN qloc(in) = 0  'local inflow between Reservoir and
River mouth
quse(in) = mquse(i)    ' required consumptive use
qinstr(in) = mqinstr(i)  ' required instream flows
qirrig(in) = mirrig(i)   ' required irrigation flows
qreq(in) = qinstr(in) + quse(in) - qloc(in)  ' required release flows from the reservoir
IF qreq(in) < qminmin THEN qreq(in) = qminmin  'release from Reservoir should be at least = a pre-
specified Minimum Q
req = qreq(in)   'final reservoir release target for time step IN
```

6. Sort out release restrictions
6.1 If inflow is >630 cfs, release the full inflow amount. Assign Violation code=4. Go to Step 7

```
If qin(in) > 630 THEN qrel(in) = qin(in): viol(in) = 4
```

6.2 If inflow is < the required release, then:
Assign Violation Code=1
- if there is no irrigation requirement, then just release the inflow and go to Step 7
- if there is an irrigation requirement, then release the inflow + the irrigation requirement

```
IF qin(in) <= qreq(in) THEN
viol(in) = 1
IF mirrig(i) = 0 THEN qrel(in) = qin(in): qreq(in) = qin(in):  GOTO 3006
IF mirrig(i) > 0 THEN qrel(in) = qin(in) + qirrig(in): qreq(in) = qin(in): GOTO 3006
END IF
```

6.3 If inflow is > required release, then:
- if there is no irrigation requirement, then release the required amount (instream flow at the mouth minus the local inflow), and go to Step 7
- if there is an irrigation requirement, then release the required amount (instream flow at the mouth minus the local inflow and plus the irrigation amount), and go to Step 7

```
IF qin(in) > qreq(in) THEN
IF mirrig(i) = 0 THEN qrel(in) = qreq(in): GOTO 3006
IF mirrig(i) > 0 THEN qrel(in) = qreq(in) + qirrig(in): GOTO 3006
END IF
```

7. Check for release restrictions
If the proposed release is > release capacity at the given elevation, then:

Assign a violation code 4 and limit the release to the outlet capacity

```
IF qrel(in) > qqcap(in) THEN qrel(in) = qqcap(in): viol(in) = 4
```

8. Calculate the new storage at the end of the time step IN and check for upper/lower bound violation

```
stor(in + 1) = stor(in) + (qin(in) - qrel(in)) * 1.983
```

8.1 If the pool is within the lower and upper bounds, continue to Step 9

```
IF stor(in + 1) < vlupper AND stor(in + 1) > vlower THEN GOTO 3113
```

8.2 If the pool is higher than Upper Bound, set the pool to Upper bound and increase the release as needed

```
IF stor(in + 1) > vupper THEN
delv = stor(in + 1) - vupper: qadj = delv / 1.983
qrel(in) = qrel(in) + qadj: viol(in) = 2: stor(in + 1) = vupper: GOTO 3113
END IF
```

8.3 If the pool is lower than Lower bound, set the pool to Lower Bound and decrease the release as needed

```
IF stor(in + 1) < vlower THEN
delv = stor(in + 1) - vlower: qadj = delv / 1.983
qrel(in) = qrel(in) - qadj: viol(in) = 3: stor(in + 1) = vlower
END IF
```

9. Double-check for release capacity: Assign violation code to 5 if the release has to be again limited to outlet capacity

```
IF qrel(in) > qcapmax THEN viol(in) = 5: qrel(in) = qcapmax
```

10. If needed, recalculate end-of-time step storage and pool elevation.

```
FOR j = 1 TO npoint: xx(j) = STO(j): yy(j) = E(j): NEXT j:
np = npoint: try = stor(in + 1): ele(in + 1) = out1
```

11. Print results

```
PRINT "  I DA MO   YR     QIN    ELE1  ISWR CONSU   QLOC   REQ  QREQ   IRR  QIRR   QREL V
ELE2   STORAGE"
```

12. Go the next time step IN=1

VIOL= violation code
0=normal
1=too small inflow
2=exceed upper bound

3=exceed lower bound
4=pass flow greater than 630 cfs for flushing purposes
5=release limited by outlet capacity

As noted in the main report, more date-specific criteria will be added in future updates as called for in the draft water permit issued by OWRD on July 22, 2014.

A8.5 Input Data Used in Multi-Year Reservoir Simulation

```
MULTI-YEAR CONTINOUS RESERVOIR SMILATION Starting Oct 2002 Ending Sep 2014
2002-03, Pudding River at Aurora
Regression equation used to convert Pudding 2 Drift flows,-2E-06,0.0416,-0.8081
OCT, 79.0, 90.0,132.0,132.0,115.0,109.0,108.0,112.0,110.0, 99.0, 99.0, 95.0, 82.0, 81.0, 80.0
     78.0, 75.0, 73.0, 65.0, 65.0, 73.0, 70.0, 73.0, 71.0, 71.0, 72.0, 70.0, 75.0, 80.0, 75.0, 75.0
NOV, 75.0, 78.0, 90.0, 84.0, 83.0, 99.0,114.0,134.0,162.0,269.0,381.0,365.0,352.0,378.0,387.0
    393.0,379.0,400.0,405.0,391.0,377.0,357.0,296.0,271.0,255.0,245.0,231.0,222.0,197.0,191.0
DEC,183.0,181.0,187.0,178.0,173.0,171.0,164.0,157.0,157.0,171.0,231.0,306.0,629.0, 1020, 1200
     1710, 2610, 2560, 2290, 1960, 1810, 2380, 2440, 2150, 1800, 1480, 1830, 2900, 3080, 3150, 3630
JAN, 4360, 4270, 4080, 4060, 4230, 4110, 3570, 3020, 2530, 2110, 1740, 1510, 1910, 2380, 2380
     2100, 1810, 1560, 1370, 1230, 1130, 1060, 1270, 1500, 1480, 1710, 2760, 2940, 2650, 3290, 5390
FEB, 7620, 8680, 7780, 6330, 5170, 4230, 3440, 2880, 2430, 2030, 1660, 1420, 1290, 1210, 1140
     1150, 1430, 2320, 2700, 2500, 2330, 2370, 2400, 2220, 1950, 1700, 1510, 1360
MAR, 1260, 1200, 1150, 1190, 1150, 1320, 3010, 5510, 6590, 6710, 6140, 5230, 4450, 3850, 3320
     2960, 2610, 2240, 1930, 1790, 1800, 2410, 4000, 4270, 3790, 3340, 3220, 2990, 2700, 2380, 2100
APR, 1970, 2040, 2040, 2150, 2220, 2240, 2430, 2380, 2240, 2220, 2200, 2270, 2790, 3460, 3520
     2920, 2450, 2310, 2140, 1930, 1800, 1850, 1820, 2320, 2850, 2710, 2540, 2340, 2150, 2050
MAY, 1850, 1650, 1470, 1350, 1480, 1650, 1520, 1390, 1310, 1210, 1120, 1170, 1200, 1080,981.0
    930.0,919.0,923.0,898.0,846.0,797.0,750.0,713.0,685.0,656.0,659.0,647.0,602.0,563.0,531.0,506.0
JUN,489.0,468.0,441.0,417.0,390.0,359.0,331.0,311.0,303.0,291.0,291.0,286.0,285.0,297.0,339.0
    315.0,273.0,249.0,219.0,217.0,220.0,225.0,271.0,291.0,254.0,224.0,194.0,179.0,164.0,161.0
JUL,150.0,134.0,125.0,115.0,104.0, 99.0, 99.0, 93.0, 84.0, 77.0, 53.0, 36.0, 30.0, 36.0, 48.0
     61.0, 56.0, 36.0, 27.0, 26.0, 26.0, 21.0, 20.0, 18.0, 14.0, 10.0, 10.0,  9.0, 10.0, 12.0, 11.0
AUG, 10.0,  9.0,  9.0,  9.0, 12.0, 14.0, 15.0, 15.0, 19.0, 27.0, 25.0, 20.0, 13.0, 11.0, 11.0
     14.0, 16.0, 16.0, 13.0, 13.0, 10.0, 12.0,  9.0,  8.0, 11.0, 13.0, 13.0, 13.0, 10.0,  8.0,  8.0
SEP,  9.0, 14.0, 14.0, 13.0, 17.0, 16.0, 13.0, 20.0, 35.0, 67.0, 91.0, 91.0, 83.0, 85.0, 74.0
     74.0, 80.0, 73.0,114.0,112.0, 76.0, 72.0, 65.0, 56.0, 52.0, 48.0, 39.0, 35.0, 35.0, 39.0
2003-04, Pudding River at Aurora
Regression equation used to convert Pudding 2 Drift flows,-2E-06,0.0416,-0.8081
OCT, 38.0, 34.0, 35.0, 41.0, 47.0, 54.0, 60.0, 66.0, 78.0, 92.0,108.0,122.0,136.0,161.0,155.0
    126.0,129.0,156.0,127.0,113.0,103.0, 93.0, 88.0, 86.0,112.0,116.0, 89.0, 78.0, 74.0, 74.0,102.0
NOV,136.0,121.0,106.0,101.0,102.0, 99.0, 92.0,104.0, 99.0,109.0,102.0,101.0,158.0,177.0,153.0
    151.0,203.0,474.0,687.0,931.0,884.0,721.0,576.0,471.0,480.0,601.0,719.0,691.0,749.0, 1710
DEC, 1840, 1480, 1260, 1450, 1540, 2230, 2450, 2230, 2000, 1820, 1720, 1610, 1970, 4320, 5610
     5430, 4970, 4270, 3500, 2950, 2590, 2240, 1870, 1640, 1820, 2120, 2030, 2180, 3390, 4760, 4580
JAN, 3920, 3580, 3530, 3300, 2870, 2480, 2250, 2560, 3190, 3790, 4130, 3960, 3540, 3200, 3090
     3130, 2970, 2690, 2650, 2670, 2490, 2210, 2010, 2820, 4040, 4160, 3640, 3500, 4150, 5330, 6440
FEB, 7000, 6280, 5350, 4560, 3940, 3400, 3120, 2950, 2680, 2360, 2040, 1770, 1560, 1410, 1360
     1400, 1980, 2850, 3560, 3450, 3010, 2570, 2180, 1900, 1900, 1990, 2070, 2400, 2590
MAR, 2510, 2420, 2140, 1970, 1910, 1960, 2070, 1970, 1790, 1610, 1460, 1330, 1230, 1140, 1070
    998.0,939.0,894.0,876.0,869.0,824.0,779.0,754.0,737.0,756.0,784.0,845.0,938.0,905.0,844.0,840.0
APR,824.0,761.0,714.0,686.0,663.0,634.0,610.0,585.0,562.0,538.0,520.0,502.0,490.0,485.0,551.0
    650.0,712.0,691.0,656.0,687.0,890.0, 1220, 1260, 1140, 1000,892.0,813.0,748.0,694.0,646.0
```

```
MAY,601.0,562.0,530.0,496.0,471.0,464.0,441.0,426.0,460.0,480.0,463.0,483.0,468.0,418.0,392.0
    374.0,390.0,408.0,392.0,393.0,379.0,361.0,359.0,386.0,393.0,363.0,357.0,437.0,664.0,898.0,851.0
JUN,741.0,641.0,559.0,500.0,452.0,434.0,497.0,751.0, 1170, 1260, 1230, 1130,998.0,904.0,842.0
    752.0,673.0,601.0,538.0,481.0,447.0,404.0,374.0,367.0,353.0,330.0,310.0,299.0,274.0,251.0
JUL,233.0,214.0,190.0,180.0,193.0,184.0,166.0,163.0,145.0,158.0,131.0,118.0,118.0, 96.0, 97.0
     83.0, 74.0, 61.0, 58.0, 69.0, 55.0, 34.0, 12.0, 11.0, 31.0, 61.0, 61.0, 35.0, 16.0, 10.0, 10.0
AUG, 20.0, 30.0, 39.0, 33.0, 31.0, 14.0, 13.0, 18.0, 45.0, 92.0, 90.0, 42.0, 24.0, 17.0,  9.0
      8.0,  7.0,  7.0, 19.0, 29.0, 28.0, 33.0, 88.0,237.0,281.0,355.0,451.0,384.0,331.0,279.0,238.0
SEP,213.0,193.0,187.0,198.0,187.0,176.0,158.0,141.0,135.0,128.0,137.0,151.0,197.0,227.0,295.0
    311.0,331.0,408.0,750.0,879.0,788.0,655.0,549.0,468.0,413.0,374.0,343.0,319.0,295.0,275.0
2004-05, Pudding River at Aurora
Regression equation used to convert Pudding 2 Drift flows,-2E-06,0.0416,-0.8081
OCT,260.0,251.0,240.0,230.0,219.0,215.0,228.0,326.0,347.0,626.0,664.0,542.0,466.0,413.0,370.0
    340.0,331.0,369.0,500.0,655.0,598.0,542.0,520.0,524.0,515.0,503.0,534.0,523.0,488.0,465.0,492.0
NOV,604.0,600.0,928.0, 1330, 1180,973.0,812.0,704.0,628.0,568.0,521.0,482.0,450.0,425.0,409.0
    402.0,437.0,424.0,455.0,524.0,495.0,461.0,439.0,433.0,458.0,636.0,761.0,716.0,652.0,604.0
DEC,591.0,637.0,661.0,629.0,612.0,622.0,668.0,940.0, 2430, 3130, 3560, 4160, 4220, 3620, 3090
     2610, 2130, 1710, 1400, 1220, 1090,985.0,944.0,877.0,802.0,822.0, 1050, 1040,948.0,889.0,854.0
JAN,813.0,795.0,762.0,707.0,659.0,617.0,597.0,614.0,634.0,604.0,582.0,559.0,540.0,553.0,551.0
    543.0,577.0,771.0, 1610, 1540, 1280, 1080,936.0,823.0,743.0,683.0,640.0,616.0,603.0,721.0,761.0
FEB,693.0,642.0,606.0,577.0,568.0,587.0,571.0,584.0,564.0,537.0,517.0,502.0,507.0,545.0,524.0
    496.0,477.0,461.0,454.0,441.0,438.0,421.0,400.0,382.0,368.0,356.0,348.0,342.0
MAR,337.0,340.0,327.0,319.0,306.0,296.0,289.0,283.0,274.0,264.0,267.0,261.0,250.0,236.0,223.0
    222.0,224.0,269.0,282.0,287.0,346.0,372.0,368.0,396.0,425.0,420.0,981.0, 3580, 4470, 4590, 4060
APR, 3000, 2490, 2220, 1960, 1770, 1540, 1400, 1490, 1640, 1500, 1420, 1640, 1580, 1470, 1400
     1380, 2040, 2290, 2240, 2020, 1740, 1500, 1340, 1330, 1350, 1210, 1070,953.0,850.0,765.0
MAY,710.0,664.0,639.0,602.0,603.0,626.0,669.0,662.0,639.0,804.0, 1390, 1560, 1380, 1190, 1060
    980.0, 1010, 1070, 1530, 2070, 2180, 2100, 2010, 1760, 1510, 1310, 1130,970.0,837.0,752.0,683.0
JUN,641.0,676.0,696.0,620.0,560.0,571.0,728.0,988.0, 1040,886.0,751.0,683.0,631.0,573.0,529.0
    493.0,472.0,502.0,512.0,492.0,482.0,445.0,418.0,397.0,364.0,342.0,337.0,372.0,467.0,437.0
JUL,376.0,336.0,303.0,290.0,263.0,233.0,230.0,246.0,235.0,242.0,262.0,252.0,229.0,214.0,198.0
    179.0,154.0,139.0,131.0,119.0,114.0,106.0,105.0,108.0,104.0, 92.0, 79.0, 72.0, 66.0, 63.0, 62.0
AUG, 62.0, 60.0, 54.0, 50.0, 47.0, 42.0, 39.0, 41.0, 46.0, 38.0, 19.0, 25.0, 37.0, 34.0, 41.0
     42.0, 31.0, 23.0, 24.0, 30.0, 32.0, 28.0, 33.0, 31.0, 25.0, 19.0, 15.0, 18.0, 24.0, 39.0, 37.0
SEP, 36.0, 29.0, 22.0, 29.0, 36.0, 39.0, 37.0, 35.0, 29.0, 30.0, 39.0, 51.0, 59.0, 58.0, 55.0
     52.0, 48.0, 55.0, 62.0, 57.0, 52.0, 47.0, 45.0, 43.0, 41.0, 44.0, 50.0, 50.0, 48.0, 57.0
2005-06, Pudding River at Aurora
Regression equation used to convert Pudding 2 Drift flows,-2E-06,0.0416,-0.8081
OCT,121.0,232.0,224.0,230.0,230.0,185.0,144.0,125.0,118.0,115.0,119.0,117.0,112.0,109.0,110.0
    108.0,123.0,170.0,154.0,140.0,219.0,284.0,225.0,189.0,168.0,158.0,160.0,197.0,280.0,458.0,424.0
NOV,719.0, 2530, 2470, 2030, 2260, 2320, 2300, 1960, 1530, 1200, 1020, 1350, 1750, 2180, 2310
     1910, 1470, 1170,945.0,790.0,672.0,583.0,515.0,464.0,491.0, 1380, 1830, 1450, 1220, 1470
DEC, 1630, 1760, 2620, 2870, 2510, 2090, 1710, 1400, 1190, 1010,888.0,818.0,762.0,706.0,646.0
    589.0,541.0,499.0,489.0,859.0, 1740, 3260, 5000, 5340, 4810, 3990, 3410, 3900, 5400, 6090, %10800
JAN, %13000, %10400, 8220, 6870, 5980, 5370, 5450, 5720, 5830, 6220, 9450, %11500, 9740, 8510, 7720
     6740, 6390, 8550, 8200, 7170, 6730, 6340, 5830, 5250, 4680, 4200, 3940, 4040, 4560, 5000, 5460
FEB, 5790, 5700, 5420, 5270, 5460, 5370, 4880, 4260, 3660, 3140, 2700, 2300, 1930, 1590, 1390
```

```
     1250, 1130, 1030,938.0,878.0,830.0,797.0,771.0,754.0,735.0,697.0,676.0,820.0
MAR, 1870, 2040, 1730, 1480, 1310, 1200, 1110, 1110, 1400, 2140, 2330, 2050, 1770, 1540, 1380
     1290, 1370, 1490, 1590, 1560, 1470, 1390, 1320, 1270, 1410, 1560, 1480, 1360, 1270, 1230, 1200
APR, 1300, 1490, 1540, 1530, 1420, 1330, 1220, 1130, 1280, 1350, 1420, 1390, 1370, 1300, 1810
     2710, 2900, 2640, 2270, 1980, 1780, 1670, 1490, 1320, 1180, 1060,978.0,907.0,858.0,842.0
MAY,803.0,731.0,673.0,632.0,592.0,563.0,544.0,546.0,582.0,541.0,501.0,472.0,438.0,410.0,387.0
    369.0,350.0,327.0,309.0,297.0,312.0,338.0,386.0,455.0,515.0,475.0,518.0,633.0,888.0,979.0,797.0
JUN,661.0,646.0,877.0,902.0,919.0,936.0,828.0,719.0,636.0,579.0,536.0,499.0,466.0,450.0,422.0
    412.0,396.0,392.0,356.0,322.0,296.0,274.0,256.0,233.0,214.0,205.0,186.0,161.0,149.0,149.0
JUL,143.0,133.0,130.0,118.0,109.0,109.0,117.0,127.0,119.0,106.0, 93.0, 94.0,102.0,103.0, 98.0
     91.0, 88.0, 85.0, 73.0, 66.0, 56.0, 44.0, 37.0, 43.0, 41.0, 34.0, 24.0, 27.0, 35.0, 36.0, 47.0
AUG, 53.0, 45.0, 36.0, 23.0, 21.0, 23.0, 20.0, 20.0, 20.0, 27.0, 29.0, 26.0, 26.0, 33.0, 36.0
     34.0, 30.0, 30.0, 36.0, 35.0, 34.0, 37.0, 36.0, 26.0, 17.0, 16.0, 13.0, 13.0, 12.0, 14.0, 15.0
SEP, 14.0, 13.0, 13.0, 13.0, 19.0, 16.0, 13.0, 14.0, 13.0, 10.0, 10.0, 12.0, 16.0, 20.0, 23.0
     32.0, 40.0, 44.0, 49.0, 56.0, 64.0, 68.0, 71.0, 70.0, 68.0, 58.0, 48.0, 42.0, 29.0, 32.0
2006-07, Pudding River at Aurora
Regression equation used to convert Pudding 2 Drift flows,-2E-06,0.0416,-0.8081
OCT, 44.0, 46.0, 51.0, 50.0, 39.0, 42.0, 50.0, 53.0, 55.0, 61.0, 60.0, 55.0, 62.0, 66.0, 75.0
     89.0,104.0,120.0,116.0,110.0,120.0,136.0,121.0,111.0,108.0,117.0,122.0,119.0,119.0,113.0,109.0
NOV,116.0,129.0,183.0,363.0,801.0, 1620, 2890, 4850, 5250, 5310, 4890, 4350, 3940, 4050, 3830
     3430, 3130, 2650, 2180, 2400, 2900, 3390, 4360, 5110, 5590, 5750, 5690, 5380, 4830, 4260
DEC, 3810, 3440, 3020, 2630, 2250, 1870, 1560, 1370, 1270, 1300, 1330, 1920, 2750, 3740, 5280
     6210, 6040, 5260, 4300, 3460, 3040, 3050, 2950, 3150, 3730, 4980, 5930, 6100, 5560, 4830, 4050
JAN, 3380, 2920, 3660, 5730, 6160, 5970, 5640, 5230, 4970, 4820, 4640, 4250, 3690, 3150, 2700
     2330, 1990, 1670, 1480, 1420, 1440, 1350, 1240, 1160, 1070,999.0,943.0,888.0,828.0,779.0,741.0
FEB,705.0,664.0,627.0,595.0,578.0,567.0,559.0,554.0,583.0,642.0,683.0,788.0,841.0,841.0,880.0
     2390, 4140, 4170, 3570, 3170, 3550, 3590, 3350, 3140, 3430, 3830, 3860, 3730
MAR, 3570, 3390, 3420, 3380, 3190, 2960, 2730, 2680, 2570, 2320, 2160, 2200, 2440, 2280, 1960
     1670, 1470, 1340, 1270, 1390, 1660, 1540, 1370, 1250, 1440, 2370, 2340, 2060, 1770, 1560, 1400
APR, 1340, 1300, 1190, 1080, 1000,920.0,888.0,957.0, 1010, 1210, 1280, 1200, 1110, 1050, 1080
     1050,983.0, 1040, 1120, 1120, 1070, 1070, 1130, 1060,956.0,884.0,822.0,764.0,715.0,663.0
MAY,623.0,621.0,789.0,896.0,862.0,805.0,744.0,692.0,646.0,601.0,561.0,529.0,519.0,510.0,485.0
    451.0,415.0,392.0,375.0,367.0,375.0,412.0,428.0,386.0,353.0,326.0,296.0,274.0,276.0,254.0,237.0
JUN,218.0,205.0,188.0,183.0,171.0,175.0,247.0,254.0,235.0,224.0,245.0,278.0,247.0,212.0,201.0
    196.0,192.0,189.0,168.0,143.0,134.0,131.0,141.0,136.0,119.0,109.0,105.0, 98.0, 93.0,109.0
JUL,127.0,127.0,112.0, 95.0, 87.0, 81.0, 69.0, 58.0, 53.0, 56.0, 50.0, 43.0, 37.0, 35.0, 32.0
     33.0, 34.0, 38.0, 42.0, 62.0, 59.0, 50.0, 59.0, 72.0, 61.0, 53.0, 46.0, 41.0, 38.0, 35.0, 35.0
AUG, 33.0, 23.0, 18.0, 14.0, 14.0, 17.0, 18.0, 19.0, 15.0, 15.0, 16.0, 15.0, 17.0, 19.0, 19.0
     14.0, 12.0, 11.0, 13.0, 21.0, 39.0, 72.0, 89.0, 72.0, 54.0, 40.0, 36.0, 33.0, 26.0, 19.0, 14.0
SEP, 12.0, 10.0, 12.0, 19.0, 29.0, 41.0, 56.0, 46.0, 37.0, 36.0, 28.0, 24.0, 19.0, 19.0, 18.0
     21.0, 27.0, 34.0, 40.0, 47.0, 47.0, 42.0, 39.0, 35.0, 34.0, 33.0, 31.0, 40.0, 69.0, 96.0
2007-08, Pudding River at Aurora
Regression equation used to convert Pudding 2 Drift flows,-2E-06,0.0416,-0.8081
OCT,136.0,229.0,271.0,275.0,362.0,325.0,243.0,195.0,178.0,186.0,177.0,179.0,190.0,171.0,156.0
    149.0,154.0,206.0,355.0,803.0, 1470, 1570, 1190,847.0,657.0,569.0,487.0,420.0,370.0,338.0,308.0
NOV,284.0,269.0,252.0,230.0,219.0,210.0,206.0,198.0,194.0,192.0,249.0,354.0,380.0,699.0,651.0
    587.0,891.0, 2130, 2940, 3370, 3060, 2520, 2020, 1600, 1290, 1090, 1020, 1040,996.0, 1020
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DEC, 1050, 1130, 2300, 4360, 5140, 5020, 4630, 4080, 3420, 2810, 2340, 1920, 1520, 1260, 1120
     1060, 1010, 1120, 1440, 2670, 3770, 3500, 3220, 4090, 5150, 5080, 4610, 4150, 3880, 3860, 3880
JAN, 3640, 3240, 3450, 3790, 4180, 4720, 4770, 4560, 4800, 5020, 5380, 5430, 5400, 5210, 4960
     4580, 4030, 3470, 2930, 2560, 2250, 1850, 1500, 1310, 1190, 1100, 1800, 3000, 2920, 2910, 3300
FEB, 4130, 4450, 4420, 4110, 3630, 3210, 3230, 3610, 3490, 3240, 3030, 2850, 2630, 2430, 2190
     1940, 1710, 1540, 1420, 1340, 1290, 1260, 1200, 1140, 1090, 1080, 1060, 1030, 1010
MAR, 1110, 1500, 1510, 1370, 1230, 1090,988.0,952.0, 1080, 1110, 1130, 1360, 1400, 2020, 2810
     3250, 3200, 3010, 3320, 3330, 3060, 2740, 2420, 2290, 2270, 2130, 2100, 2030, 1990, 2000, 1940
APR, 1750, 1560, 1410, 1300, 1270, 1290, 1400, 1560, 1670, 1610, 1490, 1390, 1350, 1430, 1460
     1360, 1230, 1120, 1060, 1010,971.0,979.0, 1240, 1590, 1640, 1540, 1420, 1360, 1470, 1690
MAY, 1650, 1480, 1350, 1300, 1280, 1270, 1270, 1190, 1070,967.0,921.0,944.0,907.0,862.0,913.0
     1070, 1300, 1420, 1340, 1190, 1150, 1080, 1030,970.0,935.0,935.0,866.0,799.0,778.0,827.0,790.0
JUN,753.0,706.0,677.0,887.0, 1020,929.0, 1040, 1210, 1100,972.0,964.0, 1000,925.0,845.0,779.0
    716.0,657.0,610.0,563.0,522.0,492.0,477.0,456.0,420.0,384.0,354.0,339.0,319.0,310.0,326.0
JUL,305.0,282.0,259.0,244.0,234.0,226.0,228.0,214.0,193.0,170.0,149.0,135.0,126.0,120.0,115.0
    103.0, 92.0, 88.0, 92.0, 89.0, 87.0, 86.0, 74.0, 71.0, 70.0, 60.0, 52.0, 55.0, 58.0, 53.0, 47.0
AUG, 47.0, 49.0, 61.0, 82.0, 83.0, 71.0, 56.0, 48.0, 47.0, 49.0, 59.0, 62.0, 48.0, 40.0, 38.0
     34.0, 32.0, 34.0, 33.0, 40.0, 71.0,186.0,216.0,167.0,135.0,119.0,110.0,104.0, 94.0, 81.0, 75.0
SEP, 78.0, 75.0, 69.0, 64.0, 58.0, 53.0, 47.0, 47.0, 52.0, 45.0, 38.0, 33.0, 31.0, 30.0, 33.0
     39.0, 38.0, 35.0, 35.0, 34.0, 37.0, 44.0, 52.0, 60.0, 68.0, 77.0, 95.0, 95.0, 82.0, 74.0
2008-09, Upper Drift Creek
Regression equation used to convert Pudding 2 Drift flows,0,1,0
OCT,  0.5,  0.5,  1.0,  5.0,  4.0,  3.8,  3.5,  3.5,  4.0,  3.0,  2.8,  2.6,  2.5,  2.3,  2.1
      2.0,  1.6,  1.8,  1.3,  1.0,  1.0,  1.2,  0.8,  0.7,  0.6,  0.6,  0.6,  0.6,  0.6,  0.6,  0.6
NOV,  0.6,  0.7,  1.0,  6.0,  5.0,  3.3,  3.5,  3.0,  3.5,  4.0,  5.0, 22.0,130.0, 85.0, 54.0
     40.0, 34.0, 28.0, 23.0, 24.0, 25.0, 24.0, 23.0, 22.0, 21.0, 20.0, 20.0, 19.0, 18.0, 17.0
DEC, 17.0, 19.0, 20.0, 19.0, 19.0, 17.0, 17.0, 19.0, 17.0, 16.0, 15.0, 17.0, 26.0, 23.0, 19.0
     17.0, 17.0, 28.0, 25.0, 24.0, 33.0, 60.0, 50.0, 40.0, 50.0, 55.0,110.0,200.0,215.0,160.0,130.0
JAN,275.0,500.0,267.0,181.0,173.0,159.0,161.0,198.0,163.0,132.0,115.0, 96.0, 84.0, 73.0, 65.0
     57.0, 50.0, 44.0, 39.0, 35.0, 32.0, 30.0, 28.0, 26.0, 27.0, 25.0, 24.0, 27.0, 25.0, 24.0, 23.0
FEB, 22.0, 21.0, 21.0, 20.0, 19.0, 23.0, 23.0, 22.0, 22.0, 22.0, 25.0, 24.0, 25.0, 24.0, 24.0
     23.0, 23.0, 22.0, 21.0, 20.0, 19.0, 19.0, 24.0, 71.0,126.0,156.0,123.0,106.0
MAR, 91.0, 92.0, 86.0, 74.0, 77.0, 71.0, 65.0, 62.0, 60.0, 58.0, 54.0, 50.0, 46.0, 46.0, 80.0
     92.0, 84.0, 73.0, 66.0, 60.0, 54.0, 62.0, 59.0, 54.0, 61.0, 59.0, 54.0, 56.0, 68.0, 66.0, 63.0
APR, 60.0, 81.0, 80.0, 72.0, 64.0, 56.0, 51.0, 46.0, 44.0, 45.0, 38.0, 35.0, 44.0, 42.0, 39.0
     35.0, 35.0, 33.0, 30.0, 27.0, 25.0, 24.0, 23.0, 22.0, 21.0, 20.0, 20.0, 27.0, 29.0, 24.0
MAY, 22.0, 39.0, 39.0, 40.0, 70.0, 98.0,128.0,108.0, 89.0, 75.0, 65.0, 59.0, 53.0, 66.0, 54.0
     46.0, 40.0, 36.0, 37.0, 33.0, 29.0, 26.0, 24.0, 22.0, 21.0, 19.0, 18.0, 16.0, 15.0, 14.0, 11.0
JUN, 11.0, 10.0,  9.8, 10.0, 13.0, 12.0, 11.0, 10.0,  9.3,  8.8,  8.7,  8.4,  7.9,  7.5,  7.2
      6.8,  6.5,  6.2,  6.2,  6.0,  5.8,  5.1,  4.7,  4.4,  4.0,  4.0,  3.5,  3.2,  3.2,  3.1
JUL,  3.0,  2.7,  2.3,  2.0,  2.0,  1.8,  1.7,  1.6,  1.7,  1.8,  1.8,  2.0,  3.0,  2.8,  2.1
      1.6,  1.2,  0.9,  0.8,  0.7,  0.7,  0.6,  0.6,  0.5,  0.4,  0.3,  0.3,  0.3,  0.3,  0.3,  0.2
AUG,  0.2,  0.2,  0.2,  0.2,  0.2,  0.3,  0.3,  0.3,  0.4,  0.3,  0.3,  0.4,  0.5,  0.3,  0.3
      0.3,  0.3,  0.2,  0.2,  0.2,  0.2,  0.2,  0.2,  0.1,  0.1,  0.1,  0.1,  0.1,  0.2,  0.2,  0.2
SEP,  0.2,  0.2,  0.2,  0.2,  0.5,  0.9,  0.9,  0.4,  0.3,  0.3,  0.3,  0.3,  0.3,  0.3,  0.7
      3.7,  1.7,  0.8,  0.4,  0.3,  0.3,  0.2,  0.2,  0.2,  0.2,  0.2,  0.2,  0.2,  0.2,  0.2
2009-10, UPPER DRIFT CR
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Regression equation used to convert Pudding 2 Drift flows,0,1,0
OCT,  0.7,  0.7,  0.7,  0.7,  0.8,  5.8,  2.9,  1.4,  0.7,  0.3,  0.1,  0.1,  0.0,  0.4,  0.9
      0.9,  0.9,  2.3,  1.7,  1.1,  1.1,  1.3,  2.1,  4.9,  3.7,  6.1, 10.5,  6.5,  5.8, 10.9, 12.1
NOV, 10.8,  8.6,  6.7,  5.4,  4.8,  5.1, 36.3, 55.5, 52.9, 46.1, 51.6, 70.5, 66.7, 62.5, 51.0
     41.7, 65.8, 60.7, 52.8, 54.8, 67.1, 79.7, 71.4, 59.6, 50.8, 51.3,108.7, 89.7, 74.3, 62.4
DEC, 54.4, 48.3, 41.2, 35.6, 31.1, 27.5, 24.1, 21.0, 18.4, 17.1, 16.8, 17.1, 17.5, 16.8, 55.3
    114.3,103.9, 89.1, 82.0, 80.1,119.8,135.7,110.5, 93.7, 81.4, 70.0, 60.9, 53.7, 48.5, 62.8,100.9
JAN,187.3,165.7,132.5,113.9,130.9,191.8,157.0,132.5,124.2,104.6, 91.6, 99.4, 97.8, 90.2, 92.0
    155.8,155.4,143.9,123.0,104.4, 91.3, 82.0, 73.9, 70.9, 93.9, 83.8, 73.4, 63.6, 59.0, 54.7, 50.0
FEB, 45.2, 45.4, 44.0, 44.3, 43.9, 40.6, 38.2, 35.2, 33.4, 31.7, 32.8, 39.3, 45.3, 55.2, 63.2
     69.0, 64.9, 59.7, 54.4, 49.0, 43.6, 39.0, 36.9, 46.6, 50.3, 56.3, 62.0, 55.8
MAR, 51.4, 47.6, 44.8, 42.0, 37.5, 34.2, 31.8, 35.2, 30.9, 30.8, 32.4, 61.2, 83.3, 72.9, 64.3
     57.4, 52.2, 46.2, 41.6, 37.9, 40.1, 43.6, 37.8, 34.8, 43.8, 94.4, 96.5, 93.9,232.6,263.4,215.2
APR,172.0,166.4,181.4,162.4,142.8,129.9,113.1,112.6, 92.7, 86.9, 79.6, 74.5, 68.2, 63.3, 99.5
     85.4, 74.2, 65.9, 59.3, 55.3, 61.0, 50.2, 45.0, 43.3, 39.2, 37.3, 62.1, 89.3, 94.0, 82.2
MAY, 70.8, 62.6, 63.1, 56.6, 52.4, 48.0, 43.4, 39.8, 36.5, 38.7, 34.8, 31.1, 28.3, 26.2, 24.1
     22.6, 25.0, 29.7, 29.3, 27.5, 28.5, 53.5, 54.1, 51.5, 51.2, 82.0, 86.8, 75.3, 68.7, 60.2, 68.2
JUN, 68.5,136.6,195.2,218.1,175.0,143.8,127.8,100.2, 90.7,101.4,106.5, 90.6, 77.1, 67.6, 61.9
     56.1, 48.5, 40.5, 33.8, 32.1, 30.6, 25.8, 25.5, 23.9, 20.6, 18.8, 17.5, 16.4, 15.4, 14.6
JUL, 14.8, 15.8, 15.3, 13.7, 13.1, 12.2, 11.4, 10.5, 10.0,  9.3,  8.9,  8.4,  8.2,  7.4,  6.7
      6.5,  6.1,  6.0,  6.0,  6.1,  5.7,  5.4,  5.1,  4.8,  4.6,  4.3,  3.9,  3.8,  3.8,  3.6,  3.5
AUG,  3.2,  3.0,  2.8,  2.7,  2.6,  2.4,  2.1,  2.0,  2.6,  2.3,  2.2,  2.0,  1.6,  1.2,  1.0
      1.0,  0.8,  0.6,  0.7,  0.8,  0.7,  0.6,  0.6,  0.4,  0.3,  0.3,  0.5,  0.4,  0.2,  0.3,  0.5
SEP,  1.0,  1.3,  1.1,  0.8,  0.5,  0.4,  1.1,  2.2,  2.0,  1.5,  1.2,  0.9,  0.8,  0.7,  4.4
      3.9,  2.9,  4.3,  9.1,  8.4,  7.0,  4.7,  3.5,  3.1,  2.8,  2.6,  2.8,  2.4,  2.1,  1.9
2010-11, UPPER DRIFT CR.
Regression equation used to convert Pudding 2 Drift flows,0,1,0
OCT,  0.9,  0.9,  0.9,  0.9,  0.7,  0.6,  0.5,  0.5,  1.3, 10.3, 12.1,  7.4,  5.4,  4.3,  3.7
      3.3,  3.0,  2.7,  2.5,  2.3,  2.2,  4.7,  6.5, 13.3, 18.5, 23.9, 20.4, 19.5, 21.9, 18.3, 28.4
NOV, 27.8, 65.2, 53.0, 41.2, 33.7, 32.1, 93.1, 76.6, 72.6, 88.3, 73.0, 64.5, 54.9, 56.1, 54.2
     59.1, 56.7,147.3,137.0,125.5,104.5,107.3,121.1, 99.0, 80.7, 75.5,101.6, 90.6, 80.0, 84.5
DEC,151.0,146.3,117.1, 97.9, 82.7, 72.1, 62.7, 70.8,112.5,161.5,150.4,149.7,216.2,254.5,199.1
    157.1,129.7,125.3,112.1,102.0, 89.3, 77.3, 67.6, 59.9, 54.8, 61.5, 70.8,149.0,245.8,164.8,129.6
JAN,107.9, 91.2, 78.1, 68.0, 61.8, 56.9, 51.5, 52.3, 49.9, 46.6, 43.0, 48.5, 79.3, 97.2, 96.0
    250.0,302.8,217.6,203.9,153.1,130.7,115.0, 97.9, 85.6, 74.6, 66.1, 58.6, 52.7, 47.3, 42.4, 37.9
FEB, 34.0, 30.7, 28.2, 26.3, 25.4, 24.3, 24.1, 23.2, 24.3, 23.6, 22.6, 21.8, 28.9, 28.1, 56.3
     77.6, 67.2, 60.0, 58.0, 52.2, 47.8, 44.9, 44.0, 44.9, 42.5, 39.0, 37.8, 79.3
MAR,197.3,177.4,147.4,131.6,125.3,105.4, 92.4, 82.5, 77.0,121.7,120.8,104.8,103.9,121.8,114.7
    130.4,141.4,130.2,121.7,106.9, 98.9, 90.9, 80.9, 79.1, 76.0, 90.9, 89.8, 89.4,105.8,117.1,104.7
APR, 98.3,104.8, 89.6, 81.8, 86.6, 80.3, 86.9, 82.2, 74.6, 69.1, 75.6, 70.8, 69.2, 68.7, 82.3
    123.0,130.4,110.1, 92.6, 78.3, 70.3, 62.5, 55.5, 51.6, 64.4, 63.9, 63.3, 66.7, 78.3, 73.6
MAY, 66.9, 62.0, 56.0, 50.4, 46.0, 43.8, 47.8, 46.9, 49.5, 44.5, 43.9, 47.7, 42.5, 40.2, 45.0
     53.8, 49.5, 43.8, 37.2, 34.0, 31.4, 29.7, 27.6, 25.5, 28.3, 28.7, 42.2, 62.7, 63.7, 57.1, 54.3
JUN, 58.4, 57.3, 52.7, 46.8, 41.8, 39.2, 35.8, 32.9, 29.4, 26.9, 25.3, 23.3, 24.5, 21.5, 19.5
     17.6, 17.8, 17.9, 16.5, 16.9, 15.7, 14.9, 15.0, 14.2, 13.4, 12.9, 12.3, 13.1, 13.0, 13.9
JUL, 16.7, 13.6, 11.9, 11.0, 10.1,  9.2,  8.8,  8.8,  8.2,  8.0,  8.2,  8.9,  9.6,  8.7,  7.7
      8.3, 11.9, 13.1, 11.4, 10.6,  8.9,  8.4,  7.5,  6.8,  6.4,  6.1,  5.7,  5.4,  5.0,  4.8,  4.8
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AUG,  4.5,  4.1,  4.8,  3.8,  3.5,  3.4,  3.5,  3.6,  3.7,  3.9,  3.1,  2.7,  2.5,  2.9,  2.9
      2.6,  2.3,  2.2,  2.0,  1.7,  1.5,  1.7,  1.6,  1.5,  1.4,  2.8,  2.0,  1.7,  1.7,  1.8,  1.6
SEP,  1.6,  1.4,  1.3,  1.1,  1.0,  0.7,  0.5,  0.6,  0.7,  0.7,  0.8,  0.7,  0.8,  1.0,  1.1
      1.2,  1.1,  1.0,  1.4,  1.5,  1.2,  1.1,  0.9,  0.7,  0.9,  1.4,  4.0,  3.9,  2.8,  2.7
2011-12, UPPER DRIFT CR.
Regression equation used to convert Pudding 2 Drift flows,0,1,0
OCT, 1.80,2.72,4.03,6.33,6.55,5.58,4.50,4.46,3.86,4.07,9.72,8.88,6.57,5.60,5.45
     5.05,4.83,4.22,3.96,3.83,3.65,3.49,3.41,3.27,3.13,3.07,2.91,2.76,3.71,6.14,12.25
NOV, 9.75,8.39,14.76,14.10,11.94,11.80,11.04,10.94,10.46,9.87,9.63,12.68,14.69,17.64,18.07
    17.74,43.59,67.75,72.31,61.11,52.26,76.57,93.71,107.40,95.88,79.18,73.03,88.82,73.83,66.94
DEC,58.40,51.91,45.76,40.58,35.89,31.68,27.96,25.17,24.17,22.68,21.67,18.89,17.73,16.72,16.83
    16.27,15.32,15.13,14.87,14.01,13.56,12.98,12.50,12.02,11.89,12.00,12.27,49.60,121.21,249.25,195.25
JAN,136.07,106.17,91.88,78.75,81.18,71.08,64.24,57.43,52.03,51.10,44.71,40.12,36.28,34.51,36.15
     32.55,39.79,205.75,808.62,342.00,327.25,242.50,205.46,192.30,204.22,171.59,140.72,123.71,111.88,119.60,98.69
FEB,90.72,79.80,72.60,65.93,59.62,54.12,49.25,46.63,54.49,60.20,63.39,70.41,65.15,60.20,55.56
    51.61,48.73,50.53,58.42,58.77,62.32,74.94,92.70,95.05,89.67,87.29,79.09,71.81,69.01
MAR,93.37,104.02,88.31,77.71,72.51,75.63,77.02,70.06,63.74,59.13,60.55,74.59,108.62,161.28,167.97
   201.90,252.18,195.68,165.53,184.46,261.65,237.99,203.23,186.13,163.62,141.99,124.99,111.85,110.03,272.33,314.63
APR,233.97,187.98,163.40,159.95,150.60,124.75,108.06,93.09,80.95,73.02,69.68,62.97,56.29,49.73,43.72
    55.83,55.95,62.38,68.03,75.65,69.53,63.38,56.07,48.75,46.37,66.68,68.69,64.17,58.80,66.61
MAY,67.05,65.56,74.76,76.32,76.01,70.28,64.37,58.10,51.84,45.70,40.89,36.20,31.74,28.03,24.60
    23.71,22.00,20.63,19.38,18.65,20.79,28.56,26.09,29.60,43.48,34.50,28.35,23.96,23.27,21.35,9.78
JUN,18.78,18.76,17.21,19.65,45.07,34.13,33.80,37.08,49.87,45.11,38.90,35.86,34.61,28.30,23.40
    22.61,20.80,19.90,19.01,17.79,16.38,15.51,18.87,18.74,16.43,16.07,14.74,13.40,12.59,12.38
JUL,14.01,13.15,12.78,11.81,10.70,9.37,8.58,8.14,7.58,7.08,6.74,6.43,6.18,5.93,5.87
     6.12,5.76,5.65,5.61,5.47,5.73,5.47,5.52,5.22,4.78,4.49,4.52,4.83,4.53,4.35,4.01
AUG,3.69,3.47,3.27,2.99,2.82,2.67,2.54,2.43,2.45,2.41,2.26,2.05,1.89,1.69,1.63
    1.58,1.43,1.36,1.69,1.58,1.40,1.25,1.09,0.98,0.94,1.12,1.12,1.12,1.09,1.06,1.06
SEP,1.06,0.98,0.95,0.87,0.65,0.40,0.36,0.34,0.57,0.63,0.54,0.49,0.40,0.31,0.26
    0.25,0.23,0.23,0.29,0.42,0.62,1.09,1.48,1.56,1.56,1.63,1.61,1.57,1.35,1.38
2012-13, UPPER DRIFT CR.
Regression equation used to convert Pudding 2 Drift flows,0,1,0
OCT,2.03,1.95,1.92,1.85,1.78,1.61,1.58,1.59,1.70,1.72,1.80,2.67,6.13,5.98,10.89
   17.61,12.42,11.02,8.21,9.43,9.19,9.94,12.60,14.21,16.63,14.46,14.24,32.91,63.04,48.69,39.84
NOV,40.72,40.21,42.08,40.44,35.02,30.52,29.64,26.63,23.90,25.33,25.61,38.17,47.86,43.91,39.18
    35.25,44.06,95.11,152.95,364.40,328.25,230.55,175.09,218.49,164.96,133.15,108.97,90.71,81.26,74.71
DEC,97.97,143.66,141.51,178.28,181.20,141.43,125.95,111.14,101.09,89.00,85.72,98.58,85.66,78.82,73.43
    80.94,108.52,111.59,102.25,148.92,160.18,138.54,140.80,161.01,162.39,174.77,142.90,123.61,105.14,90.73,79.96
JAN,67.67,59.44,52.59,47.87,43.58,40.17,41.62,41.41,46.90,63.22,62.21,56.13,50.93,46.37,43.06
    39.86,37.05,34.55,32.05,29.75,27.65,25.95,25.88,27.13,46.67,60.62,69.87,107.25,210.04,207.69,183.62
FEB,143.61,121.15,102.24,87.76,79.73,73.63,68.67,62.23,55.45,50.94,46.32,45.40,41.50,37.89,35.16
    33.54,32.40,30.19,29.20,27.98,30.04,35.05,54.63,52.45,54.46,51.95,46.46,44.39
MAR,46.07,43.50,42.11,38.73,37.26,45.40,50.61,45.69,41.54,37.72,35.50,33.49,30.70,26.13,24.24
    25.73,31.71,27.18,25.77,49.17,56.51,52.63,48.36,44.18,40.81,37.97,34.82,31.88,29.22,26.66,24.64
APR,23.02,21.61,19.43,19.24,19.78,34.42,50.35,49.34,44.09,41.76,39.41,36.26,38.72,35.92,35.70
    32.89,30.28,28.18,33.53,33.81,30.69,28.55,26.19,24.21,22.40,20.71,19.05,17.60,17.92,17.33
MAY,17.69,16.76,15.73,14.82,13.91,13.33,12.90,12.55,12.20,11.43,10.89,10.67,11.32,10.74,10.44
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    11.20,12.24,10.18,11.54,10.53,12.47,23.38,29.80,40.66,35.88,33.83,42.88,61.00,65.12,59.32,50.08
JUN,42.50,36.81,31.86,27.49,23.87,20.76,18.19,17.15,17.17,16.00,15.29,14.78,16.30,15.24,13.06
    12.04,11.43,12.38,13.41,14.94,16.52,13.76,13.42,17.32,16.44,17.92,16.83,14.45,12.92,11.71
JUL,10.78,9.98,9.28,8.66,7.84,7.47,7.25,6.98,6.56,6.21,5.89,5.63,5.40,5.03,4.67,4.58,4.97,4.67
    4.18,3.96,3.79,3.63,3.37,3.12,2.81,2.48,2.24,2.19,2.22,2.22,2.20
AUG,2.15,2.61,2.53,2.07,1.93,3.51,3.22,3.08,3.03,2.98,3.08,3.22,3.22,3.17,3.03
    2.93,3.17,1.09,1.13,1.14,0.90,0.83,1.35,1.69,1.74,2.09,1.77,1.60,1.58,1.58,1.30
SEP,1.08,1.05,1.17,1.03,3.14,23.75,14.50,9.74,7.58,6.22,5.22,4.61,4.28,4.18,4.02
    4.14,3.99,6.57,9.08,5.88,4.67,4.83,7.88,11.15,16.86,15.29,12.33,15.62,69.21,109.21
2013-14, UPPER DRIFT CR.
Regression equation used to convert Pudding 2 Drift flows,0,1,0
OCT,96.34,85.87,70.45,56.48,46.18,37.79,33.64,33.95,39.54,32.29,27.39,23.46,22.99,21.09,19.53
    18.35,17.23,16.27,15.48,14.72,14.02,13.42,12.87,12.41,12.26,11.81,12.69,16.12,13.09,11.91,11.22
NOV,11.01,17.57,22.71,21.82,24.75,34.67,49.06,56.60,50.60,44.53,38.42,44.75,46.86,41.96,38.30
    42.53,38.95,36.02,55.54,67.42,58.88,51.71,46.38,41.63,36.70,32.24,28.93,24.72,20.42,18.92
DEC,20.55,83.23,78.44,64.42,54.43,47.22,41.01,35.47,31.61,27.59,24.04,24.05,29.41,25.62,24.59
    23.42,22.49,21.80,21.29,20.29,25.51,27.03,29.34,39.27,37.66,34.72,31.82,28.40,25.01,24.49,23.00
JAN,21.60,20.42,23.71,21.79,20.19,19.25,19.53,23.27,26.12,39.55,49.60,72.18,95.01,102.72,92.32
    78.22,64.94,54.52,47.17,41.54,37.57,34.07,31.26,25.40,24.52,22.61,21.44,21.51,31.92,31.14,34.39
FEB,34.02,31.64,28.94,26.76,24.53,23.23,24.01,24.73,32.58,48.43,141.99,225.28,211.02,281.20,293.23
    275.75,221.22,220.53,221.26,212.60,183.14,146.96,123.21,106.95,84.26,73.63,67.86,60.97
MAR,59.52,76.97,108.07,112.98,143.84,214.80,166.53,136.19,189.68,152.83,123.79,104.29,87.10,81.03,71.15
    63.24,84.22,70.13,62.33,55.32,49.49,43.82,38.62,34.04,32.73,37.46,66.47,112.03,173.18,147.83,119.96
APR,102.06,83.02,73.56,76.95,72.56,80.38,72.73,64.90,59.21,52.06,45.91,40.99,37.97,32.77,28.21
    25.37,27.47,30.07,24.54,24.27,22.48,29.88,49.38,108.76,121.93,98.39,97.50,84.35,73.82,64.70
MAY,57.08,50.13,44.99,48.28,42.89,36.86,31.14,31.61,62.31,76.09,67.03,57.63,49.41,42.52,36.78
    32.01,28.04,30.96,40.80,29.69,24.75,22.39,20.98,19.80,18.46,17.18,15.68,14.90,14.83,13.32,12.38
JUN,11.77,11.18,11.49,11.09,10.40,9.66,9.15,8.71,8.30,7.85,7.49,7.64,9.14,8.85,8.45
    8.79,8.97,8.42,7.58,7.17,6.74,6.26,5.89,5.72,5.85,7.22,11.93,11.76,9.89,9.51
JUL,7.73,6.31,3.72,3.23,3.39,5.05,5.58,5.17,3.92,2.86,2.70,2.22,2.58,2.60,2.41
    1.38,0.98,1.80,1.95,1.69,2.79,3.05,3.66,3.60,3.17,2.67,2.34,1.67,1.15,1.00,0.90
AUG,0.75,0.81,0.66,0.62,0.55,0.47,0.35,0.45,0.45,0.47,0.46,0.44,0.62,0.55,0.55
    0.63,0.76,0.50,0.38,0.26,0.25,0.31,0.42,0.36,0.37,0.34,0.22,0.26,0.68,1.25,1.12
SEP,1.04,0.84,0.84,0.75,0.62,0.42,0.30,0.20,0.26,0.26,0.18,0.12,0.07,0.06,0.05
    0.16,0.16,0.21,0.25,0.18,0.11,0.22,2.81,2.71,2.70,1.78,1.40,1.12,1.31,1.37
END
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A8.6 Model Output for 2008-2009 Multi-Year Simulation
(Relying on local Inflow in Meeting Water Rights)

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* CONTINUOUS, MULTI-YEAR RESERVOIR REGULATION MODEL FOR DRIFT CREEK *
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RUN DATE: 03-13-2015 Time=00:32:12 LOCAL INFLOW CREDIT =1 (0=zero credit) IRRIGATION VOL=  8,000 AF


    ELEVATION vs STORAGE (Kaf) and OUTLET+SPILLWAY CAPACITY (cfs):
EL=  616 H=    0 AREA=    0.4 VOL=      0 QCAP1(OUTLET)=     0.0, QCAP2(SPILLWAY)=      0 QTOT=      0
EL=  620 H=    4 AREA=    3.7 VOL=      8 QCAP1(OUTLET)=    10.0, QCAP2(SPILLWAY)=      0 QTOT=     10
EL=  625 H=    9 AREA=   40.5 VOL=    210 QCAP1(OUTLET)=   140.7, QCAP2(SPILLWAY)=      0 QTOT=    141
EL=  630 H=   14 AREA=   77.2 VOL=    413 QCAP1(OUTLET)=   184.2, QCAP2(SPILLWAY)=      0 QTOT=    184
EL=  635 H=   19 AREA=  121.3 VOL=    962 QCAP1(OUTLET)=   219.3, QCAP2(SPILLWAY)=      0 QTOT=    219
EL=  640 H=   24 AREA=  184.0 VOL=   1726 QCAP1(OUTLET)=   386.0, QCAP2(SPILLWAY)=      0 QTOT=    386
EL=  645 H=   29 AREA=  220.7 VOL=   2829 QCAP1(OUTLET)=   427.6, QCAP2(SPILLWAY)=      0 QTOT=    428
EL=  650 H=   34 AREA=  257.4 VOL=   3933 QCAP1(OUTLET)=   465.5, QCAP2(SPILLWAY)=      0 QTOT=    466
EL=  655 H=   39 AREA=  288.9 VOL=   5327 QCAP1(OUTLET)=   500.5, QCAP2(SPILLWAY)=      0 QTOT=    501
EL=  660 H=   44 AREA=  300.4 VOL=   6722 QCAP1(OUTLET)=   533.3, QCAP2(SPILLWAY)=      0 QTOT=    533
EL=  665 H=   49 AREA=  313.5 VOL=   8289 QCAP1(OUTLET)=   564.1, QCAP2(SPILLWAY)=      0 QTOT=    564
EL=  667 H=   51 AREA=  318.8 VOL=   8916 QCAP1(OUTLET)=   576.0, QCAP2(SPILLWAY)=      0 QTOT=    576
EL=  670 H=   54 AREA=  326.8 VOL=   9857 QCAP1(OUTLET)=   593.4, QCAP2(SPILLWAY)=  4,679 QTOT=  4,679
EL=  675 H=   59 AREA=  340.1 VOL=  11558 QCAP1(OUTLET)=   621.2, QCAP2(SPILLWAY)= 20,377 QTOT= 20,998
EL=  680 H=   64 AREA=  353.5 VOL=  13259 QCAP1(OUTLET)=   635.7, QCAP2(SPILLWAY)= 42,210 QTOT= 42,857
EL=  685 H=   69 AREA=  366.8 VOL=  14960 QCAP1(OUTLET)=   674.6, QCAP2(SPILLWAY)= 64,000 QTOT= 64,675
EL=  686 H=   70 AREA=  367.9 VOL=  15364 QCAP1(OUTLET)=   676.2, QCAP2(SPILLWAY)= 68,065 QTOT= 68,741
EL=  687 H=   71 AREA=  368.9 VOL=  15772 QCAP1(OUTLET)=   677.6, QCAP2(SPILLWAY)= 71,916 QTOT= 72,593
EL=  688 H=   72 AREA=  369.7 VOL=  16186 QCAP1(OUTLET)=   678.8, QCAP2(SPILLWAY)= 75,512 QTOT= 76,191
EL=  689 H=   73 AREA=  370.4 VOL=  16605 QCAP1(OUTLET)=   679.7, QCAP2(SPILLWAY)= 78,815 QTOT= 79,494
EL= 9999 H= 9999 AREA= 9999.0 VOL=  99999 QCAP1(OUTLET)= 99999.0, QCAP2(SPILLWAY)= 99,999 QTOT= 99,999


Reservoir Upper Bound El.= 677.00 Lower Bound El.= 620.00

MONTHLY INSTEAM FLOW REQUIREMENTS
 I= 1 MONTH=10 (OCT)  QMIN=   5.26
 I= 2 MONTH=11 (NOV)  QMIN=  40.00
 I= 3 MONTH=12 (DEC)  QMIN=  40.00
 I= 4 MONTH= 1 (JAN)  QMIN=  40.00
 I= 5 MONTH= 2 (FEB)  QMIN=  40.00
 I= 6 MONTH= 3 (MAR)  QMIN=  40.00
 I= 7 MONTH= 4 (APR)  QMIN=  40.00
 I= 8 MONTH= 5 (MAY)  QMIN=  30.10
 I= 9 MONTH= 6 (JUN)  QMIN=  13.60
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 I=10 MONTH= 7 (JUL)  QMIN=   3.00
 I=11 MONTH= 8 (AUG)  QMIN=   2.00
 I=12 MONTH= 9 (SEP)  QMIN=   2.00


Absolute Minimum Release= 1.00


MONTHLY CONSUMPTIVE USES AND STORAGES
 I= 1 MONTH=10 (OCT)  QMIN=   0.02
 I= 2 MONTH=11 (NOV)  QMIN=   0.93
 I= 3 MONTH=12 (DEC)  QMIN=   2.11
 I= 4 MONTH= 1 (JAN)  QMIN=   2.28
 I= 5 MONTH= 2 (FEB)  QMIN=   2.03
 I= 6 MONTH= 3 (MAR)  QMIN=   0.03
 I= 7 MONTH= 4 (APR)  QMIN=   0.04
 I= 8 MONTH= 5 (MAY)  QMIN=   0.22
 I= 9 MONTH= 6 (JUN)  QMIN=   0.44
 I=10 MONTH= 7 (JUL)  QMIN=   0.77
 I=11 MONTH= 8 (AUG)  QMIN=   0.61
 I=12 MONTH= 9 (SEP)  QMIN=   0.30

Multiplier for MONTHLY LOCAL INFLOW BETWEEN SITE A AND CREEK MOUTH (AQLOC)
 I= 1 MONTH=10 (OCT)  AQLOC=   0.71
 I= 2 MONTH=11 (NOV)  AQLOC=   0.48
 I= 3 MONTH=12 (DEC)  AQLOC=   0.42
 I= 4 MONTH= 1 (JAN)  AQLOC=   0.39
 I= 5 MONTH= 2 (FEB)  AQLOC=   0.50
 I= 6 MONTH= 3 (MAR)  AQLOC=   0.41
 I= 7 MONTH= 4 (APR)  AQLOC=   0.33
 I= 8 MONTH= 5 (MAY)  AQLOC=   0.22
 I= 9 MONTH= 6 (JUN)  AQLOC=   0.30
 I=10 MONTH= 7 (JUL)  AQLOC=   0.01
 I=11 MONTH= 8 (AUG)  AQLOC=   0.17
 I=12 MONTH= 9 (SEP)  AQLOC=   0.08


YESLOC=1 (0=Local Inflow Not Accounted for in Meeting ISTR at the mouth)


Operating Mode: Project Must meet MinQ-Qloc
Title:Time Series Multi-year Continuous Reservoir Simulation Date:03-13-2015 Time:00:32:12

Irrigation Monthly Requirement starting in Oct (cfs) based on IRRVOL=  8,000 AF:
 OCT/  0.0
 NOV/  0.0
 DEC/  0.0
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 JAN/  0.0
 FEB/  0.0
 MAR/  0.0
 APR/  0.0
 MAY/ 13.0
 JUN/ 13.5
 JUL/ 26.0
 AUG/ 39.0
 SEP/ 40.3

TOTAL INFLOW VOLUME (AF)= 22,630
Initial Begin-period: ELE= 657.0  S(aft)=5877.5
Reservoir Upper Bound ELE= 677.00 S(aft)= 12,238
Reservoir Lower Bound ELE= 620.00 S(aft)=      8
SUMMARY RESULTS OF RESERVOIR SIMULATION
 Run Date:03-13-2015 00:32:12
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I	DA	MO	YR	QIN	ELE1	ISWR	CONSU	QLOC	REQ	QREQ	IRR	QIRR	QREL	V	ELE2	STORAGE
1	1	10	2008	0.50	656.97	5.26	0.02	0.35	4.93	0.50	0.00	0.00	0.50	1	656.97	5,877
2	2	10	2008	0.50	656.97	5.26	0.02	0.35	4.93	0.50	0.00	0.00	0.50	1	656.97	5,877
3	3	10	2008	1.00	656.97	5.26	0.02	0.71	4.57	1.00	0.00	0.00	1.00	1	656.97	5,877
4	4	10	2008	5.00	656.97	5.26	0.02	3.55	1.73	1.73	0.00	0.00	1.73	0	657.00	5,884
5	5	10	2008	4.00	657.00	5.26	0.02	2.84	2.44	2.44	0.00	0.00	2.44	0	657.01	5,887
6	6	10	2008	3.80	657.01	5.26	0.02	2.70	2.58	2.58	0.00	0.00	2.58	0	657.02	5,889
7	7	10	2008	3.50	657.02	5.26	0.02	2.48	2.80	2.80	0.00	0.00	2.80	0	657.02	5,891
8	8	10	2008	3.50	657.02	5.26	0.02	2.48	2.80	2.80	0.00	0.00	2.80	0	657.03	5,892
9	9	10	2008	4.00	657.03	5.26	0.02	2.84	2.44	2.44	0.00	0.00	2.44	0	657.04	5,895
10	10	10	2008	3.00	657.04	5.26	0.02	2.13	3.15	3.00	0.00	0.00	3.00	1	657.04	5,895
11	11	10	2008	2.80	657.04	5.26	0.02	1.99	3.29	2.80	0.00	0.00	2.80	1	657.04	5,895
12	12	10	2008	2.60	657.04	5.26	0.02	1.85	3.43	2.60	0.00	0.00	2.60	1	657.04	5,895
13	13	10	2008	2.50	657.04	5.26	0.02	1.77	3.51	2.50	0.00	0.00	2.50	1	657.04	5,895
14	14	10	2008	2.30	657.04	5.26	0.02	1.63	3.65	2.30	0.00	0.00	2.30	1	657.04	5,895
15	15	10	2008	2.10	657.04	5.26	0.02	1.49	3.79	2.10	0.00	0.00	2.10	1	657.04	5,895
16	16	10	2008	2.00	657.04	5.26	0.02	1.42	3.86	2.00	0.00	0.00	2.00	1	657.04	5,895
17	17	10	2008	1.60	657.04	5.26	0.02	1.14	4.14	1.60	0.00	0.00	1.60	1	657.04	5,895
18	18	10	2008	1.80	657.04	5.26	0.02	1.28	4.00	1.80	0.00	0.00	1.80	1	657.04	5,895
19	19	10	2008	1.30	657.04	5.26	0.02	0.92	4.36	1.30	0.00	0.00	1.30	1	657.04	5,895
20	20	10	2008	1.00	657.04	5.26	0.02	0.71	4.57	1.00	0.00	0.00	1.00	1	657.04	5,895
21	21	10	2008	1.00	657.04	5.26	0.02	0.71	4.57	1.00	0.00	0.00	1.00	1	657.04	5,895
22	22	10	2008	1.20	657.04	5.26	0.02	0.85	4.43	1.20	0.00	0.00	1.20	1	657.04	5,895
23	23	10	2008	0.80	657.04	5.26	0.02	0.57	4.71	0.80	0.00	0.00	0.80	1	657.04	5,895
24	24	10	2008	0.70	657.04	5.26	0.02	0.50	4.78	0.70	0.00	0.00	0.70	1	657.04	5,895
25	25	10	2008	0.60	657.04	5.26	0.02	0.43	4.85	0.60	0.00	0.00	0.60	1	657.04	5,895
26	26	10	2008	0.60	657.04	5.26	0.02	0.43	4.85	0.60	0.00	0.00	0.60	1	657.04	5,895
27	27	10	2008	0.60	657.04	5.26	0.02	0.43	4.85	0.60	0.00	0.00	0.60	1	657.04	5,895
28	28	10	2008	0.60	657.04	5.26	0.02	0.43	4.85	0.60	0.00	0.00	0.60	1	657.04	5,895
29	29	10	2008	0.60	657.04	5.26	0.02	0.43	4.85	0.60	0.00	0.00	0.60	1	657.04	5,895
30	30	10	2008	0.60	657.04	5.26	0.02	0.43	4.85	0.60	0.00	0.00	0.60	1	657.04	5,895

31	31	10	2008	0.60	657.04	5.26	0.02	0.43	4.85	0.60	0.00	0.00	0.60	1	657.04	5,895
32	1	11	2008	0.60	657.04	40.00	0.93	0.29	40.64	0.60	0.00	0.00	0.60	1	657.04	5,895
33	2	11	2008	0.70	657.04	40.00	0.93	0.34	40.59	0.70	0.00	0.00	0.70	1	657.04	5,895
34	3	11	2008	1.00	657.04	40.00	0.93	0.48	40.45	1.00	0.00	0.00	1.00	1	657.04	5,895
35	4	11	2008	6.00	657.04	40.00	0.93	2.88	38.05	6.00	0.00	0.00	6.00	1	657.04	5,895
36	5	11	2008	5.00	657.04	40.00	0.93	2.40	38.53	5.00	0.00	0.00	5.00	1	657.04	5,895
37	6	11	2008	3.30	657.04	40.00	0.93	1.58	39.35	3.30	0.00	0.00	3.30	1	657.04	5,895
38	7	11	2008	3.50	657.04	40.00	0.93	1.68	39.25	3.50	0.00	0.00	3.50	1	657.04	5,895
39	8	11	2008	3.00	657.04	40.00	0.93	1.44	39.49	3.00	0.00	0.00	3.00	1	657.04	5,895
40	9	11	2008	3.50	657.04	40.00	0.93	1.68	39.25	3.50	0.00	0.00	3.50	1	657.04	5,895
41	10	11	2008	4.00	657.04	40.00	0.93	1.92	39.01	4.00	0.00	0.00	4.00	1	657.04	5,895
42	11	11	2008	5.00	657.04	40.00	0.93	2.40	38.53	5.00	0.00	0.00	5.00	1	657.04	5,895
43	12	11	2008	22.00	657.04	40.00	0.93	10.56	30.37	22.00	0.00	0.00	22.00	1	657.04	5,895
44	13	11	2008	130.00	657.04	40.00	0.93	62.40	1.00	1.00	0.00	0.00	1.00	0	657.95	6,151
45	14	11	2008	85.00	657.95	40.00	0.93	40.80	1.00	1.00	0.00	0.00	1.00	0	658.55	6,318
46	15	11	2008	54.00	658.55	40.00	0.93	25.92	15.01	15.01	0.00	0.00	15.01	0	658.83	6,395
47	16	11	2008	40.00	658.83	40.00	0.93	19.20	21.73	21.73	0.00	0.00	21.73	0	658.96	6,431
48	17	11	2008	34.00	658.96	40.00	0.93	16.32	24.61	24.61	0.00	0.00	24.61	0	659.02	6,450
49	18	11	2008	28.00	659.02	40.00	0.93	13.44	27.49	27.49	0.00	0.00	27.49	0	659.03	6,451
50	19	11	2008	23.00	659.03	40.00	0.93	11.04	29.89	23.00	0.00	0.00	23.00	1	659.03	6,451
51	20	11	2008	24.00	659.03	40.00	0.93	11.52	29.41	24.00	0.00	0.00	24.00	1	659.03	6,451
52	21	11	2008	25.00	659.03	40.00	0.93	12.00	28.93	25.00	0.00	0.00	25.00	1	659.03	6,451
53	22	11	2008	24.00	659.03	40.00	0.93	11.52	29.41	24.00	0.00	0.00	24.00	1	659.03	6,451
54	23	11	2008	23.00	659.03	40.00	0.93	11.04	29.89	23.00	0.00	0.00	23.00	1	659.03	6,451
55	24	11	2008	22.00	659.03	40.00	0.93	10.56	30.37	22.00	0.00	0.00	22.00	1	659.03	6,451
56	25	11	2008	21.00	659.03	40.00	0.93	10.08	30.85	21.00	0.00	0.00	21.00	1	659.03	6,451
57	26	11	2008	20.00	659.03	40.00	0.93	9.60	31.33	20.00	0.00	0.00	20.00	1	659.03	6,451
58	27	11	2008	20.00	659.03	40.00	0.93	9.60	31.33	20.00	0.00	0.00	20.00	1	659.03	6,451
59	28	11	2008	19.00	659.03	40.00	0.93	9.12	31.81	19.00	0.00	0.00	19.00	1	659.03	6,451
60	29	11	2008	18.00	659.03	40.00	0.93	8.64	32.29	18.00	0.00	0.00	18.00	1	659.03	6,451
61	30	11	2008	17.00	659.03	40.00	0.93	8.16	32.77	17.00	0.00	0.00	17.00	1	659.03	6,451
62	1	12	2008	17.00	659.03	40.00	2.11	7.14	34.97	17.00	0.00	0.00	17.00	1	659.03	6,451
63	2	12	2008	19.00	659.03	40.00	2.11	7.98	34.13	19.00	0.00	0.00	19.00	1	659.03	6,451
64	3	12	2008	20.00	659.03	40.00	2.11	8.40	33.71	20.00	0.00	0.00	20.00	1	659.03	6,451
65	4	12	2008	19.00	659.03	40.00	2.11	7.98	34.13	19.00	0.00	0.00	19.00	1	659.03	6,451
66	5	12	2008	19.00	659.03	40.00	2.11	7.98	34.13	19.00	0.00	0.00	19.00	1	659.03	6,451
67	6	12	2008	17.00	659.03	40.00	2.11	7.14	34.97	17.00	0.00	0.00	17.00	1	659.03	6,451
68	7	12	2008	17.00	659.03	40.00	2.11	7.14	34.97	17.00	0.00	0.00	17.00	1	659.03	6,451
69	8	12	2008	19.00	659.03	40.00	2.11	7.98	34.13	19.00	0.00	0.00	19.00	1	659.03	6,451
70	9	12	2008	17.00	659.03	40.00	2.11	7.14	34.97	17.00	0.00	0.00	17.00	1	659.03	6,451
71	10	12	2008	16.00	659.03	40.00	2.11	6.72	35.39	16.00	0.00	0.00	16.00	1	659.03	6,451
72	11	12	2008	15.00	659.03	40.00	2.11	6.30	35.81	15.00	0.00	0.00	15.00	1	659.03	6,451
73	12	12	2008	17.00	659.03	40.00	2.11	7.14	34.97	17.00	0.00	0.00	17.00	1	659.03	6,451
74	13	12	2008	26.00	659.03	40.00	2.11	10.92	31.19	26.00	0.00	0.00	26.00	1	659.03	6,451
75	14	12	2008	23.00	659.03	40.00	2.11	9.66	32.45	23.00	0.00	0.00	23.00	1	659.03	6,451
76	15	12	2008	19.00	659.03	40.00	2.11	7.98	34.13	19.00	0.00	0.00	19.00	1	659.03	6,451
77	16	12	2008	17.00	659.03	40.00	2.11	7.14	34.97	17.00	0.00	0.00	17.00	1	659.03	6,451

78	17	12	2008	17.00	659.03	40.00	2.11	7.14	34.97	17.00	0.00	0.00	17.00	1	659.03	6,451
79	18	12	2008	28.00	659.03	40.00	2.11	11.76	30.35	28.00	0.00	0.00	28.00	1	659.03	6,451
80	19	12	2008	25.00	659.03	40.00	2.11	10.50	31.61	25.00	0.00	0.00	25.00	1	659.03	6,451
81	20	12	2008	24.00	659.03	40.00	2.11	10.08	32.03	24.00	0.00	0.00	24.00	1	659.03	6,451
82	21	12	2008	33.00	659.03	40.00	2.11	13.86	28.25	28.25	0.00	0.00	28.25	0	659.06	6,460
83	22	12	2008	60.00	659.06	40.00	2.11	25.20	16.91	16.91	0.00	0.00	16.91	0	659.37	6,546
84	23	12	2008	50.00	659.37	40.00	2.11	21.00	21.11	21.11	0.00	0.00	21.11	0	659.57	6,603
85	24	12	2008	40.00	659.57	40.00	2.11	16.80	25.31	25.31	0.00	0.00	25.31	0	659.68	6,632
86	25	12	2008	50.00	659.68	40.00	2.11	21.00	21.11	21.11	0.00	0.00	21.11	0	659.88	6,690
87	26	12	2008	55.00	659.88	40.00	2.11	23.10	19.01	19.01	0.00	0.00	19.01	0	660.12	6,761
88	27	12	2008	110.00	660.12	40.00	2.11	46.20	1.00	1.00	0.00	0.00	1.00	0	660.81	6,977
89	28	12	2008	200.00	660.81	40.00	2.11	84.00	1.00	1.00	0.00	0.00	1.00	0	662.07	7,372
90	29	12	2008	215.00	662.07	40.00	2.11	90.30	1.00	1.00	0.00	0.00	1.00	0	663.43	7,796
91	30	12	2008	160.00	663.43	40.00	2.11	67.20	1.00	1.00	0.00	0.00	1.00	0	664.43	8,111
92	31	12	2008	130.00	664.43	40.00	2.11	54.60	1.00	1.00	0.00	0.00	1.00	0	665.25	8,367
93	1	1	2009	275.00	665.25	40.00	2.28	107.25	1.00	1.00	0.00	0.00	1.00	0	666.98	8,910
94	2	1	2009	500.00	666.98	40.00	2.28	195.00	1.00	1.00	0.00	0.00	1.00	0	670.13	9,900
95	3	1	2009	267.00	670.13	40.00	2.28	104.13	1.00	1.00	0.00	0.00	1.00	0	671.68	10,427
96	4	1	2009	181.00	671.68	40.00	2.28	70.59	1.00	1.00	0.00	0.00	1.00	0	672.73	10,784
97	5	1	2009	173.00	672.73	40.00	2.28	67.47	1.00	1.00	0.00	0.00	1.00	0	673.73	11,125
98	6	1	2009	159.00	673.73	40.00	2.28	62.01	1.00	1.00	0.00	0.00	1.00	0	674.65	11,439
99	7	1	2009	161.00	674.65	40.00	2.28	62.79	1.00	1.00	0.00	0.00	1.00	0	675.58	11,756
100	8	1	2009	198.00	675.58	40.00	2.28	77.22	1.00	1.00	0.00	0.00	1.00	0	676.73	12,147
101	9	1	2009	163.00	676.73	40.00	2.28	63.57	1.00	1.00	0.00	0.00	116.75	2	677.00	12,238
102	10	1	2009	132.00	677.00	40.00	2.28	51.48	1.00	1.00	0.00	0.00	132.00	2	677.00	12,238
103	11	1	2009	115.00	677.00	40.00	2.28	44.85	1.00	1.00	0.00	0.00	115.00	2	677.00	12,238
104	12	1	2009	96.00	677.00	40.00	2.28	37.44	4.84	4.84	0.00	0.00	96.00	2	677.00	12,238
105	13	1	2009	84.00	677.00	40.00	2.28	32.76	9.52	9.52	0.00	0.00	84.00	2	677.00	12,238
106	14	1	2009	73.00	677.00	40.00	2.28	28.47	13.81	13.81	0.00	0.00	73.00	2	677.00	12,238
107	15	1	2009	65.00	677.00	40.00	2.28	25.35	16.93	16.93	0.00	0.00	65.00	2	677.00	12,238
108	16	1	2009	57.00	677.00	40.00	2.28	22.23	20.05	20.05	0.00	0.00	57.00	2	677.00	12,238
109	17	1	2009	50.00	677.00	40.00	2.28	19.50	22.78	22.78	0.00	0.00	50.00	2	677.00	12,238
110	18	1	2009	44.00	677.00	40.00	2.28	17.16	25.12	25.12	0.00	0.00	44.00	2	677.00	12,238
111	19	1	2009	39.00	677.00	40.00	2.28	15.21	27.07	27.07	0.00	0.00	39.00	2	677.00	12,238
112	20	1	2009	35.00	677.00	40.00	2.28	13.65	28.63	28.63	0.00	0.00	35.00	2	677.00	12,238
113	21	1	2009	32.00	677.00	40.00	2.28	12.48	29.80	29.80	0.00	0.00	32.00	2	677.00	12,238
114	22	1	2009	30.00	677.00	40.00	2.28	11.70	30.58	30.00	0.00	0.00	30.00	1	677.00	12,238
115	23	1	2009	28.00	677.00	40.00	2.28	10.92	31.36	28.00	0.00	0.00	28.00	1	677.00	12,238
116	24	1	2009	26.00	677.00	40.00	2.28	10.14	32.14	26.00	0.00	0.00	26.00	1	677.00	12,238
117	25	1	2009	27.00	677.00	40.00	2.28	10.53	31.75	27.00	0.00	0.00	27.00	1	677.00	12,238
118	26	1	2009	25.00	677.00	40.00	2.28	9.75	32.53	25.00	0.00	0.00	25.00	1	677.00	12,238
119	27	1	2009	24.00	677.00	40.00	2.28	9.36	32.92	24.00	0.00	0.00	24.00	1	677.00	12,238
120	28	1	2009	27.00	677.00	40.00	2.28	10.53	31.75	27.00	0.00	0.00	27.00	1	677.00	12,238
121	29	1	2009	25.00	677.00	40.00	2.28	9.75	32.53	25.00	0.00	0.00	25.00	1	677.00	12,238
122	30	1	2009	24.00	677.00	40.00	2.28	9.36	32.92	24.00	0.00	0.00	24.00	1	677.00	12,238
123	31	1	2009	23.00	677.00	40.00	2.28	8.97	33.31	23.00	0.00	0.00	23.00	1	677.00	12,238
124	1	2	2009	22.00	677.00	40.00	2.03	11.00	31.03	22.00	0.00	0.00	22.00	1	677.00	12,238

125	2	2	2009	21.00	677.00	40.00	2.03	10.50	31.53	21.00	0.00	0.00	21.00	1	677.00	12,238
126	3	2	2009	21.00	677.00	40.00	2.03	10.50	31.53	21.00	0.00	0.00	21.00	1	677.00	12,238
127	4	2	2009	20.00	677.00	40.00	2.03	10.00	32.03	20.00	0.00	0.00	20.00	1	677.00	12,238
128	5	2	2009	19.00	677.00	40.00	2.03	9.50	32.53	19.00	0.00	0.00	19.00	1	677.00	12,238
129	6	2	2009	23.00	677.00	40.00	2.03	11.50	30.53	23.00	0.00	0.00	23.00	1	677.00	12,238
130	7	2	2009	23.00	677.00	40.00	2.03	11.50	30.53	23.00	0.00	0.00	23.00	1	677.00	12,238
131	8	2	2009	22.00	677.00	40.00	2.03	11.00	31.03	22.00	0.00	0.00	22.00	1	677.00	12,238
132	9	2	2009	22.00	677.00	40.00	2.03	11.00	31.03	22.00	0.00	0.00	22.00	1	677.00	12,238
133	10	2	2009	22.00	677.00	40.00	2.03	11.00	31.03	22.00	0.00	0.00	22.00	1	677.00	12,238
134	11	2	2009	25.00	677.00	40.00	2.03	12.50	29.53	25.00	0.00	0.00	25.00	1	677.00	12,238
135	12	2	2009	24.00	677.00	40.00	2.03	12.00	30.03	24.00	0.00	0.00	24.00	1	677.00	12,238
136	13	2	2009	25.00	677.00	40.00	2.03	12.50	29.53	25.00	0.00	0.00	25.00	1	677.00	12,238
137	14	2	2009	24.00	677.00	40.00	2.03	12.00	30.03	24.00	0.00	0.00	24.00	1	677.00	12,238
138	15	2	2009	24.00	677.00	40.00	2.03	12.00	30.03	24.00	0.00	0.00	24.00	1	677.00	12,238
139	16	2	2009	23.00	677.00	40.00	2.03	11.50	30.53	23.00	0.00	0.00	23.00	1	677.00	12,238
140	17	2	2009	23.00	677.00	40.00	2.03	11.50	30.53	23.00	0.00	0.00	23.00	1	677.00	12,238
141	18	2	2009	22.00	677.00	40.00	2.03	11.00	31.03	22.00	0.00	0.00	22.00	1	677.00	12,238
142	19	2	2009	21.00	677.00	40.00	2.03	10.50	31.53	21.00	0.00	0.00	21.00	1	677.00	12,238
143	20	2	2009	20.00	677.00	40.00	2.03	10.00	32.03	20.00	0.00	0.00	20.00	1	677.00	12,238
144	21	2	2009	19.00	677.00	40.00	2.03	9.50	32.53	19.00	0.00	0.00	19.00	1	677.00	12,238
145	22	2	2009	19.00	677.00	40.00	2.03	9.50	32.53	19.00	0.00	0.00	19.00	1	677.00	12,238
146	23	2	2009	24.00	677.00	40.00	2.03	12.00	30.03	24.00	0.00	0.00	24.00	1	677.00	12,238
147	24	2	2009	71.00	677.00	40.00	2.03	35.50	6.53	6.53	0.00	0.00	71.00	2	677.00	12,238
148	25	2	2009	126.00	677.00	40.00	2.03	63.00	1.00	1.00	0.00	0.00	126.00	2	677.00	12,238
149	26	2	2009	156.00	677.00	40.00	2.03	78.00	1.00	1.00	0.00	0.00	156.00	2	677.00	12,238
150	27	2	2009	123.00	677.00	40.00	2.03	61.50	1.00	1.00	0.00	0.00	123.00	2	677.00	12,238
151	28	2	2009	106.00	677.00	40.00	2.03	53.00	1.00	1.00	0.00	0.00	106.00	2	677.00	12,238
152	1	3	2009	91.00	677.00	40.00	0.03	37.31	2.72	2.72	0.00	0.00	91.00	2	677.00	12,238
153	2	3	2009	92.00	677.00	40.00	0.03	37.72	2.31	2.31	0.00	0.00	92.00	2	677.00	12,238
154	3	3	2009	86.00	677.00	40.00	0.03	35.26	4.77	4.77	0.00	0.00	86.00	2	677.00	12,238
155	4	3	2009	74.00	677.00	40.00	0.03	30.34	9.69	9.69	0.00	0.00	74.00	2	677.00	12,238
156	5	3	2009	77.00	677.00	40.00	0.03	31.57	8.46	8.46	0.00	0.00	77.00	2	677.00	12,238
157	6	3	2009	71.00	677.00	40.00	0.03	29.11	10.92	10.92	0.00	0.00	71.00	2	677.00	12,238
158	7	3	2009	65.00	677.00	40.00	0.03	26.65	13.38	13.38	0.00	0.00	65.00	2	677.00	12,238
159	8	3	2009	62.00	677.00	40.00	0.03	25.42	14.61	14.61	0.00	0.00	62.00	2	677.00	12,238
160	9	3	2009	60.00	677.00	40.00	0.03	24.60	15.43	15.43	0.00	0.00	60.00	2	677.00	12,238
161	10	3	2009	58.00	677.00	40.00	0.03	23.78	16.25	16.25	0.00	0.00	58.00	2	677.00	12,238
162	11	3	2009	54.00	677.00	40.00	0.03	22.14	17.89	17.89	0.00	0.00	54.00	2	677.00	12,238
163	12	3	2009	50.00	677.00	40.00	0.03	20.50	19.53	19.53	0.00	0.00	50.00	2	677.00	12,238
164	13	3	2009	46.00	677.00	40.00	0.03	18.86	21.17	21.17	0.00	0.00	46.00	2	677.00	12,238
165	14	3	2009	46.00	677.00	40.00	0.03	18.86	21.17	21.17	0.00	0.00	46.00	2	677.00	12,238
166	15	3	2009	80.00	677.00	40.00	0.03	32.80	7.23	7.23	0.00	0.00	80.00	2	677.00	12,238
167	16	3	2009	92.00	677.00	40.00	0.03	37.72	2.31	2.31	0.00	0.00	92.00	2	677.00	12,238
168	17	3	2009	84.00	677.00	40.00	0.03	34.44	5.59	5.59	0.00	0.00	84.00	2	677.00	12,238
169	18	3	2009	73.00	677.00	40.00	0.03	29.93	10.10	10.10	0.00	0.00	73.00	2	677.00	12,238
170	19	3	2009	66.00	677.00	40.00	0.03	27.06	12.97	12.97	0.00	0.00	66.00	2	677.00	12,238
171	20	3	2009	60.00	677.00	40.00	0.03	24.60	15.43	15.43	0.00	0.00	60.00	2	677.00	12,238

172	21	3	2009	54.00	677.00	40.00	0.03	22.14	17.89	17.89	0.00	0.00	54.00	2	677.00	12,238
173	22	3	2009	62.00	677.00	40.00	0.03	25.42	14.61	14.61	0.00	0.00	62.00	2	677.00	12,238
174	23	3	2009	59.00	677.00	40.00	0.03	24.19	15.84	15.84	0.00	0.00	59.00	2	677.00	12,238
175	24	3	2009	54.00	677.00	40.00	0.03	22.14	17.89	17.89	0.00	0.00	54.00	2	677.00	12,238
176	25	3	2009	61.00	677.00	40.00	0.03	25.01	15.02	15.02	0.00	0.00	61.00	2	677.00	12,238
177	26	3	2009	59.00	677.00	40.00	0.03	24.19	15.84	15.84	0.00	0.00	59.00	2	677.00	12,238
178	27	3	2009	54.00	677.00	40.00	0.03	22.14	17.89	17.89	0.00	0.00	54.00	2	677.00	12,238
179	28	3	2009	56.00	677.00	40.00	0.03	22.96	17.07	17.07	0.00	0.00	56.00	2	677.00	12,238
180	29	3	2009	68.00	677.00	40.00	0.03	27.88	12.15	12.15	0.00	0.00	68.00	2	677.00	12,238
181	30	3	2009	66.00	677.00	40.00	0.03	27.06	12.97	12.97	0.00	0.00	66.00	2	677.00	12,238
182	31	3	2009	63.00	677.00	40.00	0.03	25.83	14.20	14.20	0.00	0.00	63.00	2	677.00	12,238
183	1	4	2009	60.00	677.00	40.00	0.04	19.80	20.24	20.24	0.00	0.00	60.00	2	677.00	12,238
184	2	4	2009	81.00	677.00	40.00	0.04	26.73	13.31	13.31	0.00	0.00	81.00	2	677.00	12,238
185	3	4	2009	80.00	677.00	40.00	0.04	26.40	13.64	13.64	0.00	0.00	80.00	2	677.00	12,238
186	4	4	2009	72.00	677.00	40.00	0.04	23.76	16.28	16.28	0.00	0.00	72.00	2	677.00	12,238
187	5	4	2009	64.00	677.00	40.00	0.04	21.12	18.92	18.92	0.00	0.00	64.00	2	677.00	12,238
188	6	4	2009	56.00	677.00	40.00	0.04	18.48	21.56	21.56	0.00	0.00	56.00	2	677.00	12,238
189	7	4	2009	51.00	677.00	40.00	0.04	16.83	23.21	23.21	0.00	0.00	51.00	2	677.00	12,238
190	8	4	2009	46.00	677.00	40.00	0.04	15.18	24.86	24.86	0.00	0.00	46.00	2	677.00	12,238
191	9	4	2009	44.00	677.00	40.00	0.04	14.52	25.52	25.52	0.00	0.00	44.00	2	677.00	12,238
192	10	4	2009	45.00	677.00	40.00	0.04	14.85	25.19	25.19	0.00	0.00	45.00	2	677.00	12,238
193	11	4	2009	38.00	677.00	40.00	0.04	12.54	27.50	27.50	0.00	0.00	38.00	2	677.00	12,238
194	12	4	2009	35.00	677.00	40.00	0.04	11.55	28.49	28.49	0.00	0.00	35.00	2	677.00	12,238
195	13	4	2009	44.00	677.00	40.00	0.04	14.52	25.52	25.52	0.00	0.00	44.00	2	677.00	12,238
196	14	4	2009	42.00	677.00	40.00	0.04	13.86	26.18	26.18	0.00	0.00	42.00	2	677.00	12,238
197	15	4	2009	39.00	677.00	40.00	0.04	12.87	27.17	27.17	0.00	0.00	39.00	2	677.00	12,238
198	16	4	2009	35.00	677.00	40.00	0.04	11.55	28.49	28.49	0.00	0.00	35.00	2	677.00	12,238
199	17	4	2009	35.00	677.00	40.00	0.04	11.55	28.49	28.49	0.00	0.00	35.00	2	677.00	12,238
200	18	4	2009	33.00	677.00	40.00	0.04	10.89	29.15	29.15	0.00	0.00	33.00	2	677.00	12,238
201	19	4	2009	30.00	677.00	40.00	0.04	9.90	30.14	30.00	0.00	0.00	30.00	1	677.00	12,238
202	20	4	2009	27.00	677.00	40.00	0.04	8.91	31.13	27.00	0.00	0.00	27.00	1	677.00	12,238
203	21	4	2009	25.00	677.00	40.00	0.04	8.25	31.79	25.00	0.00	0.00	25.00	1	677.00	12,238
204	22	4	2009	24.00	677.00	40.00	0.04	7.92	32.12	24.00	0.00	0.00	24.00	1	677.00	12,238
205	23	4	2009	23.00	677.00	40.00	0.04	7.59	32.45	23.00	0.00	0.00	23.00	1	677.00	12,238
206	24	4	2009	22.00	677.00	40.00	0.04	7.26	32.78	22.00	0.00	0.00	22.00	1	677.00	12,238
207	25	4	2009	21.00	677.00	40.00	0.04	6.93	33.11	21.00	0.00	0.00	21.00	1	677.00	12,238
208	26	4	2009	20.00	677.00	40.00	0.04	6.60	33.44	20.00	0.00	0.00	20.00	1	677.00	12,238
209	27	4	2009	20.00	677.00	40.00	0.04	6.60	33.44	20.00	0.00	0.00	20.00	1	677.00	12,238
210	28	4	2009	27.00	677.00	40.00	0.04	8.91	31.13	27.00	0.00	0.00	27.00	1	677.00	12,238
211	29	4	2009	29.00	677.00	40.00	0.04	9.57	30.47	29.00	0.00	0.00	29.00	1	677.00	12,238
212	30	4	2009	24.00	677.00	40.00	0.04	7.92	32.12	24.00	0.00	0.00	24.00	1	677.00	12,238
213	1	5	2009	22.00	677.00	30.10	0.22	4.84	25.48	22.00	13.00	13.00	35.00	1	676.92	12,213
214	2	5	2009	39.00	676.92	30.10	0.22	8.58	21.74	21.74	13.00	13.00	34.74	0	676.95	12,221
215	3	5	2009	39.00	676.95	30.10	0.22	8.58	21.74	21.74	13.00	13.00	34.74	0	676.97	12,230
216	4	5	2009	40.00	676.97	30.10	0.22	8.80	21.52	21.52	13.00	13.00	35.52	2	677.00	12,238
217	5	5	2009	70.00	677.00	30.10	0.22	15.40	14.92	14.92	13.00	13.00	70.00	2	677.00	12,238
218	6	5	2009	98.00	677.00	30.10	0.22	21.56	8.76	8.76	13.00	13.00	98.00	2	677.00	12,238

219	7	5	2009	128.00	677.00	30.10	0.22	28.16	2.16	2.16	13.00	13.00	128.00	2	677.00	12,238
220	8	5	2009	108.00	677.00	30.10	0.22	23.76	6.56	6.56	13.00	13.00	108.00	2	677.00	12,238
221	9	5	2009	89.00	677.00	30.10	0.22	19.58	10.74	10.74	13.00	13.00	89.00	2	677.00	12,238
222	10	5	2009	75.00	677.00	30.10	0.22	16.50	13.82	13.82	13.00	13.00	75.00	2	677.00	12,238
223	11	5	2009	65.00	677.00	30.10	0.22	14.30	16.02	16.02	13.00	13.00	65.00	2	677.00	12,238
224	12	5	2009	59.00	677.00	30.10	0.22	12.98	17.34	17.34	13.00	13.00	59.00	2	677.00	12,238
225	13	5	2009	53.00	677.00	30.10	0.22	11.66	18.66	18.66	13.00	13.00	53.00	2	677.00	12,238
226	14	5	2009	66.00	677.00	30.10	0.22	14.52	15.80	15.80	13.00	13.00	66.00	2	677.00	12,238
227	15	5	2009	54.00	677.00	30.10	0.22	11.88	18.44	18.44	13.00	13.00	54.00	2	677.00	12,238
228	16	5	2009	46.00	677.00	30.10	0.22	10.12	20.20	20.20	13.00	13.00	46.00	2	677.00	12,238
229	17	5	2009	40.00	677.00	30.10	0.22	8.80	21.52	21.52	13.00	13.00	40.00	2	677.00	12,238
230	18	5	2009	36.00	677.00	30.10	0.22	7.92	22.40	22.40	13.00	13.00	36.00	2	677.00	12,238
231	19	5	2009	37.00	677.00	30.10	0.22	8.14	22.18	22.18	13.00	13.00	37.00	2	677.00	12,238
232	20	5	2009	33.00	677.00	30.10	0.22	7.26	23.06	23.06	13.00	13.00	36.06	0	676.98	12,232
233	21	5	2009	29.00	676.98	30.10	0.22	6.38	23.94	23.94	13.00	13.00	36.94	0	676.94	12,217
234	22	5	2009	26.00	676.94	30.10	0.22	5.72	24.60	24.60	13.00	13.00	37.60	0	676.87	12,194
235	23	5	2009	24.00	676.87	30.10	0.22	5.28	25.04	24.00	13.00	13.00	37.00	1	676.79	12,168
236	24	5	2009	22.00	676.79	30.10	0.22	4.84	25.48	22.00	13.00	13.00	35.00	1	676.72	12,142
237	25	5	2009	21.00	676.72	30.10	0.22	4.62	25.70	21.00	13.00	13.00	34.00	1	676.64	12,116
238	26	5	2009	19.00	676.64	30.10	0.22	4.18	26.14	19.00	13.00	13.00	32.00	1	676.57	12,090
239	27	5	2009	18.00	676.57	30.10	0.22	3.96	26.36	18.00	13.00	13.00	31.00	1	676.49	12,065
240	28	5	2009	16.00	676.49	30.10	0.22	3.52	26.80	16.00	13.00	13.00	29.00	1	676.41	12,039
241	29	5	2009	15.00	676.41	30.10	0.22	3.30	27.02	15.00	13.00	13.00	28.00	1	676.34	12,013
242	30	5	2009	14.00	676.34	30.10	0.22	3.08	27.24	14.00	13.00	13.00	27.00	1	676.26	11,987
243	31	5	2009	11.00	676.26	30.10	0.22	2.42	27.90	11.00	13.00	13.00	24.00	1	676.19	11,961
244	1	6	2009	11.00	676.19	13.60	0.44	3.30	10.74	10.74	13.50	13.50	24.24	0	676.11	11,935
245	2	6	2009	10.00	676.11	13.60	0.44	3.00	11.04	10.00	13.50	13.50	23.50	1	676.03	11,908
246	3	6	2009	9.80	676.03	13.60	0.44	2.94	11.10	9.80	13.50	13.50	23.30	1	675.95	11,882
247	4	6	2009	10.00	675.95	13.60	0.44	3.00	11.04	10.00	13.50	13.50	23.50	1	675.87	11,855
248	5	6	2009	13.00	675.87	13.60	0.44	3.90	10.14	10.14	13.50	13.50	23.64	0	675.81	11,834
249	6	6	2009	12.00	675.81	13.60	0.44	3.60	10.44	10.44	13.50	13.50	23.94	0	675.74	11,810
250	7	6	2009	11.00	675.74	13.60	0.44	3.30	10.74	10.74	13.50	13.50	24.24	0	675.66	11,784
251	8	6	2009	10.00	675.66	13.60	0.44	3.00	11.04	10.00	13.50	13.50	23.50	1	675.59	11,757
252	9	6	2009	9.30	675.59	13.60	0.44	2.79	11.25	9.30	13.50	13.50	22.80	1	675.51	11,730
253	10	6	2009	8.80	675.51	13.60	0.44	2.64	11.40	8.80	13.50	13.50	22.30	1	675.43	11,704
254	11	6	2009	8.70	675.43	13.60	0.44	2.61	11.43	8.70	13.50	13.50	22.20	1	675.35	11,677
255	12	6	2009	8.40	675.35	13.60	0.44	2.52	11.52	8.40	13.50	13.50	21.90	1	675.27	11,650
256	13	6	2009	7.90	675.27	13.60	0.44	2.37	11.67	7.90	13.50	13.50	21.40	1	675.19	11,623
257	14	6	2009	7.50	675.19	13.60	0.44	2.25	11.79	7.50	13.50	13.50	21.00	1	675.11	11,597
258	15	6	2009	7.20	675.11	13.60	0.44	2.16	11.88	7.20	13.50	13.50	20.70	1	675.03	11,570
259	16	6	2009	6.80	675.03	13.60	0.44	2.04	12.00	6.80	13.50	13.50	20.30	1	674.96	11,543
260	17	6	2009	6.50	674.96	13.60	0.44	1.95	12.09	6.50	13.50	13.50	20.00	1	674.88	11,516
261	18	6	2009	6.20	674.88	13.60	0.44	1.86	12.18	6.20	13.50	13.50	19.70	1	674.80	11,490
262	19	6	2009	6.20	674.80	13.60	0.44	1.86	12.18	6.20	13.50	13.50	19.70	1	674.72	11,463
263	20	6	2009	6.00	674.72	13.60	0.44	1.80	12.24	6.00	13.50	13.50	19.50	1	674.64	11,436
264	21	6	2009	5.80	674.64	13.60	0.44	1.74	12.30	5.80	13.50	13.50	19.30	1	674.56	11,409
265	22	6	2009	5.10	674.56	13.60	0.44	1.53	12.51	5.10	13.50	13.50	18.60	1	674.48	11,382

266	23	6	2009	4.70	674.48	13.60	0.44	1.41	12.63	4.70	13.50	13.50	18.20	1	674.41	11,356
267	24	6	2009	4.40	674.41	13.60	0.44	1.32	12.72	4.40	13.50	13.50	17.90	1	674.33	11,329
268	25	6	2009	4.00	674.33	13.60	0.44	1.20	12.84	4.00	13.50	13.50	17.50	1	674.25	11,302
269	26	6	2009	4.00	674.25	13.60	0.44	1.20	12.84	4.00	13.50	13.50	17.50	1	674.17	11,275
270	27	6	2009	3.50	674.17	13.60	0.44	1.05	12.99	3.50	13.50	13.50	17.00	1	674.09	11,249
271	28	6	2009	3.20	674.09	13.60	0.44	0.96	13.08	3.20	13.50	13.50	16.70	1	674.01	11,222
272	29	6	2009	3.20	674.01	13.60	0.44	0.96	13.08	3.20	13.50	13.50	16.70	1	673.93	11,195
273	30	6	2009	3.10	673.93	13.60	0.44	0.93	13.11	3.10	13.50	13.50	16.60	1	673.85	11,168
274	1	7	2009	3.00	673.85	3.00	0.77	0.03	3.74	3.00	26.00	26.00	29.00	1	673.70	11,117
275	2	7	2009	2.70	673.70	3.00	0.77	0.03	3.74	2.70	26.00	26.00	28.70	1	673.55	11,065
276	3	7	2009	2.30	673.55	3.00	0.77	0.02	3.75	2.30	26.00	26.00	28.30	1	673.40	11,014
277	4	7	2009	2.00	673.40	3.00	0.77	0.02	3.75	2.00	26.00	26.00	28.00	1	673.25	10,962
278	5	7	2009	2.00	673.25	3.00	0.77	0.02	3.75	2.00	26.00	26.00	28.00	1	673.10	10,911
279	6	7	2009	1.80	673.10	3.00	0.77	0.02	3.75	1.80	26.00	26.00	27.80	1	672.95	10,859
280	7	7	2009	1.70	672.95	3.00	0.77	0.02	3.75	1.70	26.00	26.00	27.70	1	672.79	10,807
281	8	7	2009	1.60	672.79	3.00	0.77	0.02	3.75	1.60	26.00	26.00	27.60	1	672.64	10,756
282	9	7	2009	1.70	672.64	3.00	0.77	0.02	3.75	1.70	26.00	26.00	27.70	1	672.49	10,704
283	10	7	2009	1.80	672.49	3.00	0.77	0.02	3.75	1.80	26.00	26.00	27.80	1	672.34	10,653
284	11	7	2009	1.80	672.34	3.00	0.77	0.02	3.75	1.80	26.00	26.00	27.80	1	672.19	10,601
285	12	7	2009	2.00	672.19	3.00	0.77	0.02	3.75	2.00	26.00	26.00	28.00	1	672.04	10,550
286	13	7	2009	3.00	672.04	3.00	0.77	0.03	3.74	3.00	26.00	26.00	29.00	1	671.88	10,498
287	14	7	2009	2.80	671.88	3.00	0.77	0.03	3.74	2.80	26.00	26.00	28.80	1	671.73	10,447
288	15	7	2009	2.10	671.73	3.00	0.77	0.02	3.75	2.10	26.00	26.00	28.10	1	671.58	10,395
289	16	7	2009	1.60	671.58	3.00	0.77	0.02	3.75	1.60	26.00	26.00	27.60	1	671.43	10,343
290	17	7	2009	1.20	671.43	3.00	0.77	0.01	3.76	1.20	26.00	26.00	27.20	1	671.28	10,292
291	18	7	2009	0.90	671.28	3.00	0.77	0.01	3.76	0.90	26.00	26.00	26.90	1	671.13	10,240
292	19	7	2009	0.80	671.13	3.00	0.77	0.01	3.76	0.80	26.00	26.00	26.80	1	670.98	10,189
293	20	7	2009	0.70	670.98	3.00	0.77	0.01	3.76	0.70	26.00	26.00	26.70	1	670.82	10,137
294	21	7	2009	0.70	670.82	3.00	0.77	0.01	3.76	0.70	26.00	26.00	26.70	1	670.67	10,086
295	22	7	2009	0.60	670.67	3.00	0.77	0.01	3.76	0.60	26.00	26.00	26.60	1	670.52	10,034
296	23	7	2009	0.60	670.52	3.00	0.77	0.01	3.76	0.60	26.00	26.00	26.60	1	670.37	9,983
297	24	7	2009	0.50	670.37	3.00	0.77	0.00	3.76	0.50	26.00	26.00	26.50	1	670.22	9,931
298	25	7	2009	0.40	670.22	3.00	0.77	0.00	3.77	0.40	26.00	26.00	26.40	1	670.07	9,879
299	26	7	2009	0.30	670.07	3.00	0.77	0.00	3.77	0.30	26.00	26.00	26.30	1	669.91	9,828
300	27	7	2009	0.30	669.91	3.00	0.77	0.00	3.77	0.30	26.00	26.00	26.30	1	669.74	9,776
301	28	7	2009	0.30	669.74	3.00	0.77	0.00	3.77	0.30	26.00	26.00	26.30	1	669.58	9,725
302	29	7	2009	0.30	669.58	3.00	0.77	0.00	3.77	0.30	26.00	26.00	26.30	1	669.41	9,673
303	30	7	2009	0.30	669.41	3.00	0.77	0.00	3.77	0.30	26.00	26.00	26.30	1	669.25	9,622
304	31	7	2009	0.20	669.25	3.00	0.77	0.00	3.77	0.20	26.00	26.00	26.20	1	669.09	9,570
305	1	8	2009	0.20	669.09	2.00	0.61	0.03	2.58	0.20	39.00	39.00	39.20	1	668.84	9,493
306	2	8	2009	0.20	668.84	2.00	0.61	0.03	2.58	0.20	39.00	39.00	39.20	1	668.59	9,415
307	3	8	2009	0.20	668.59	2.00	0.61	0.03	2.58	0.20	39.00	39.00	39.20	1	668.35	9,338
308	4	8	2009	0.20	668.35	2.00	0.61	0.03	2.58	0.20	39.00	39.00	39.20	1	668.10	9,261
309	5	8	2009	0.20	668.10	2.00	0.61	0.03	2.58	0.20	39.00	39.00	39.20	1	667.85	9,183
310	6	8	2009	0.30	667.85	2.00	0.61	0.05	2.56	0.30	39.00	39.00	39.30	1	667.61	9,106
311	7	8	2009	0.30	667.61	2.00	0.61	0.05	2.56	0.30	39.00	39.00	39.30	1	667.36	9,029
312	8	8	2009	0.30	667.36	2.00	0.61	0.05	2.56	0.30	39.00	39.00	39.30	1	667.11	8,951

313	9	8	2009	0.40	667.11	2.00	0.61	0.07	2.54	0.40	39.00	39.00	39.40	1	666.87	8,874
314	10	8	2009	0.30	666.87	2.00	0.61	0.05	2.56	0.30	39.00	39.00	39.30	1	666.62	8,797
315	11	8	2009	0.30	666.62	2.00	0.61	0.05	2.56	0.30	39.00	39.00	39.30	1	666.37	8,719
316	12	8	2009	0.40	666.37	2.00	0.61	0.07	2.54	0.40	39.00	39.00	39.40	1	666.13	8,642
317	13	8	2009	0.50	666.13	2.00	0.61	0.09	2.53	0.50	39.00	39.00	39.50	1	665.88	8,565
318	14	8	2009	0.30	665.88	2.00	0.61	0.05	2.56	0.30	39.00	39.00	39.30	1	665.63	8,487
319	15	8	2009	0.30	665.63	2.00	0.61	0.05	2.56	0.30	39.00	39.00	39.30	1	665.39	8,410
320	16	8	2009	0.30	665.39	2.00	0.61	0.05	2.56	0.30	39.00	39.00	39.30	1	665.14	8,333
321	17	8	2009	0.30	665.14	2.00	0.61	0.05	2.56	0.30	39.00	39.00	39.30	1	664.89	8,255
322	18	8	2009	0.20	664.89	2.00	0.61	0.03	2.58	0.20	39.00	39.00	39.20	1	664.65	8,178
323	19	8	2009	0.20	664.65	2.00	0.61	0.03	2.58	0.20	39.00	39.00	39.20	1	664.40	8,101
324	20	8	2009	0.20	664.40	2.00	0.61	0.03	2.58	0.20	39.00	39.00	39.20	1	664.15	8,023
325	21	8	2009	0.20	664.15	2.00	0.61	0.03	2.58	0.20	39.00	39.00	39.20	1	663.91	7,946
326	22	8	2009	0.20	663.91	2.00	0.61	0.03	2.58	0.20	39.00	39.00	39.20	1	663.66	7,869
327	23	8	2009	0.20	663.66	2.00	0.61	0.03	2.58	0.20	39.00	39.00	39.20	1	663.41	7,791
328	24	8	2009	0.10	663.41	2.00	0.61	0.02	2.59	0.10	39.00	39.00	39.10	1	663.16	7,714
329	25	8	2009	0.10	663.16	2.00	0.61	0.02	2.59	0.10	39.00	39.00	39.10	1	662.92	7,637
330	26	8	2009	0.10	662.92	2.00	0.61	0.02	2.59	0.10	39.00	39.00	39.10	1	662.67	7,559
331	27	8	2009	0.10	662.67	2.00	0.61	0.02	2.59	0.10	39.00	39.00	39.10	1	662.42	7,482
332	28	8	2009	0.10	662.42	2.00	0.61	0.02	2.59	0.10	39.00	39.00	39.10	1	662.18	7,405
333	29	8	2009	0.20	662.18	2.00	0.61	0.03	2.58	0.20	39.00	39.00	39.20	1	661.93	7,327
334	30	8	2009	0.20	661.93	2.00	0.61	0.03	2.58	0.20	39.00	39.00	39.20	1	661.68	7,250
335	31	8	2009	0.20	661.68	2.00	0.61	0.03	2.58	0.20	39.00	39.00	39.20	1	661.44	7,173
336	1	9	2009	0.20	661.44	2.00	0.30	0.02	2.28	0.20	40.33	40.33	40.53	1	661.18	7,093
337	2	9	2009	0.20	661.18	2.00	0.30	0.02	2.28	0.20	40.33	40.33	40.53	1	660.93	7,013
338	3	9	2009	0.20	660.93	2.00	0.30	0.02	2.28	0.20	40.33	40.33	40.53	1	660.67	6,933
339	4	9	2009	0.20	660.67	2.00	0.30	0.02	2.28	0.20	40.33	40.33	40.53	1	660.42	6,853
340	5	9	2009	0.50	660.42	2.00	0.30	0.04	2.26	0.50	40.33	40.33	40.83	1	660.16	6,773
341	6	9	2009	0.90	660.16	2.00	0.30	0.07	2.23	0.90	40.33	40.33	41.23	1	659.89	6,693
342	7	9	2009	0.90	659.89	2.00	0.30	0.07	2.23	0.90	40.33	40.33	41.23	1	659.61	6,613
343	8	9	2009	0.40	659.61	2.00	0.30	0.03	2.27	0.40	40.33	40.33	40.73	1	659.32	6,533
344	9	9	2009	0.30	659.32	2.00	0.30	0.02	2.28	0.30	40.33	40.33	40.63	1	659.04	6,453
345	10	9	2009	0.30	659.04	2.00	0.30	0.02	2.28	0.30	40.33	40.33	40.63	1	658.75	6,373
346	11	9	2009	0.30	658.75	2.00	0.30	0.02	2.28	0.30	40.33	40.33	40.63	1	658.46	6,293
347	12	9	2009	0.30	658.46	2.00	0.30	0.02	2.28	0.30	40.33	40.33	40.63	1	658.18	6,213
348	13	9	2009	0.30	658.18	2.00	0.30	0.02	2.28	0.30	40.33	40.33	40.63	1	657.89	6,133
349	14	9	2009	0.30	657.89	2.00	0.30	0.02	2.28	0.30	40.33	40.33	40.63	1	657.60	6,053
350	15	9	2009	0.70	657.60	2.00	0.30	0.06	2.24	0.70	40.33	40.33	41.03	1	657.32	5,973
351	16	9	2009	3.70	657.32	2.00	0.30	0.30	2.00	2.00	40.33	40.33	42.33	0	657.04	5,896
352	17	9	2009	1.70	657.04	2.00	0.30	0.14	2.16	1.70	40.33	40.33	42.03	1	656.75	5,816
353	18	9	2009	0.80	656.75	2.00	0.30	0.06	2.24	0.80	40.33	40.33	41.13	1	656.47	5,736
354	19	9	2009	0.40	656.47	2.00	0.30	0.03	2.27	0.40	40.33	40.33	40.73	1	656.18	5,656
355	20	9	2009	0.30	656.18	2.00	0.30	0.02	2.28	0.30	40.33	40.33	40.63	1	655.89	5,576
356	21	9	2009	0.30	655.89	2.00	0.30	0.02	2.28	0.30	40.33	40.33	40.63	1	655.61	5,497
357	22	9	2009	0.20	655.61	2.00	0.30	0.02	2.28	0.20	40.33	40.33	40.53	1	655.32	5,417
358	23	9	2009	0.20	655.32	2.00	0.30	0.02	2.28	0.20	40.33	40.33	40.53	1	655.03	5,337
359	24	9	2009	0.20	655.03	2.00	0.30	0.02	2.28	0.20	40.33	40.33	40.53	1	654.75	5,257

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360 25  9 2009    0.20  654.75  2.00  0.30   0.02  2.28  0.20 40.33 40.33  40.53 1  654.46     5,177
361 26  9 2009    0.20  654.46  2.00  0.30   0.02  2.28  0.20 40.33 40.33  40.53 1  654.17     5,097
362 27  9 2009    0.20  654.17  2.00  0.30   0.02  2.28  0.20 40.33 40.33  40.53 1  653.89     5,017
363 28  9 2009    0.20  653.89  2.00  0.30   0.02  2.28  0.20 40.33 40.33  40.53 1  653.60     4,937
364 29  9 2009    0.20  653.60  2.00  0.30   0.02  2.28  0.20 40.33 40.33  40.53 1  653.31     4,857
365 30  9 2009    0.20  653.31  2.00  0.30   0.02  2.28  0.20 40.33 40.33  40.53 1  653.03     4,777
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A8.7 Output Data for 2008-2009 Multi-Year Simulation

(Without Relying on local Inflow in Meeting Water Rights)
Irrigation base volume: 8,000 AF

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* PROGRAM  RESERVOIR REGULATION MODEL FOR DRIFT CREEK *
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TOTAL INFLOW VOLUME (AF)= 22,630
Initial Begin-period: ELE= 656.5  S(AF)=5742.1
Reservoir Upper Bound ELE= 677.00 S(AF)= 12,238
Reservoir Lower Bound ELE= 620.00 S(AF)=      8
SUMMARY RESULTS OF RESERVOIR SIMULATION
 Run Date:03-13-2015 00:41:07
  I DA MO   YR     QIN    ELE1  ISWR CONSU   QLOC   REQ  QREQ   IRR  QIRR   QREL V    ELE2   STORAGE
  1  1 10 2008    0.50  656.49  5.26  0.02   0.00  5.28  0.50  0.00  0.00   0.50 1  656.49     5,742
  2  2 10 2008    0.50  656.49  5.26  0.02   0.00  5.28  0.50  0.00  0.00   0.50 1  656.49     5,742
  3  3 10 2008    1.00  656.49  5.26  0.02   0.00  5.28  1.00  0.00  0.00   1.00 1  656.49     5,742
  4  4 10 2008    5.00  656.49  5.26  0.02   0.00  5.28  5.00  0.00  0.00   5.00 1  656.49     5,742
  5  5 10 2008    4.00  656.49  5.26  0.02   0.00  5.28  4.00  0.00  0.00   4.00 1  656.49     5,742
  6  6 10 2008    3.80  656.49  5.26  0.02   0.00  5.28  3.80  0.00  0.00   3.80 1  656.49     5,742
  7  7 10 2008    3.50  656.49  5.26  0.02   0.00  5.28  3.50  0.00  0.00   3.50 1  656.49     5,742
  8  8 10 2008    3.50  656.49  5.26  0.02   0.00  5.28  3.50  0.00  0.00   3.50 1  656.49     5,742
  9  9 10 2008    4.00  656.49  5.26  0.02   0.00  5.28  4.00  0.00  0.00   4.00 1  656.49     5,742
 10 10 10 2008    3.00  656.49  5.26  0.02   0.00  5.28  3.00  0.00  0.00   3.00 1  656.49     5,742
 11 11 10 2008    2.80  656.49  5.26  0.02   0.00  5.28  2.80  0.00  0.00   2.80 1  656.49     5,742
 12 12 10 2008    2.60  656.49  5.26  0.02   0.00  5.28  2.60  0.00  0.00   2.60 1  656.49     5,742
 13 13 10 2008    2.50  656.49  5.26  0.02   0.00  5.28  2.50  0.00  0.00   2.50 1  656.49     5,742
 14 14 10 2008    2.30  656.49  5.26  0.02   0.00  5.28  2.30  0.00  0.00   2.30 1  656.49     5,742
 15 15 10 2008    2.10  656.49  5.26  0.02   0.00  5.28  2.10  0.00  0.00   2.10 1  656.49     5,742
 16 16 10 2008    2.00  656.49  5.26  0.02   0.00  5.28  2.00  0.00  0.00   2.00 1  656.49     5,742
 17 17 10 2008    1.60  656.49  5.26  0.02   0.00  5.28  1.60  0.00  0.00   1.60 1  656.49     5,742
 18 18 10 2008    1.80  656.49  5.26  0.02   0.00  5.28  1.80  0.00  0.00   1.80 1  656.49     5,742
 19 19 10 2008    1.30  656.49  5.26  0.02   0.00  5.28  1.30  0.00  0.00   1.30 1  656.49     5,742
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20	20	10	2008	1.00	656.49	5.26	0.02	0.00	5.28	1.00	0.00	0.00	1.00	1	656.49	5,742
21	21	10	2008	1.00	656.49	5.26	0.02	0.00	5.28	1.00	0.00	0.00	1.00	1	656.49	5,742
22	22	10	2008	1.20	656.49	5.26	0.02	0.00	5.28	1.20	0.00	0.00	1.20	1	656.49	5,742
23	23	10	2008	0.80	656.49	5.26	0.02	0.00	5.28	0.80	0.00	0.00	0.80	1	656.49	5,742
24	24	10	2008	0.70	656.49	5.26	0.02	0.00	5.28	0.70	0.00	0.00	0.70	1	656.49	5,742
25	25	10	2008	0.60	656.49	5.26	0.02	0.00	5.28	0.60	0.00	0.00	0.60	1	656.49	5,742
26	26	10	2008	0.60	656.49	5.26	0.02	0.00	5.28	0.60	0.00	0.00	0.60	1	656.49	5,742
27	27	10	2008	0.60	656.49	5.26	0.02	0.00	5.28	0.60	0.00	0.00	0.60	1	656.49	5,742
28	28	10	2008	0.60	656.49	5.26	0.02	0.00	5.28	0.60	0.00	0.00	0.60	1	656.49	5,742
29	29	10	2008	0.60	656.49	5.26	0.02	0.00	5.28	0.60	0.00	0.00	0.60	1	656.49	5,742
30	30	10	2008	0.60	656.49	5.26	0.02	0.00	5.28	0.60	0.00	0.00	0.60	1	656.49	5,742
31	31	10	2008	0.60	656.49	5.26	0.02	0.00	5.28	0.60	0.00	0.00	0.60	1	656.49	5,742
32	1	11	2008	0.60	656.49	40.00	0.93	0.00	40.93	0.60	0.00	0.00	0.60	1	656.49	5,742
33	2	11	2008	0.70	656.49	40.00	0.93	0.00	40.93	0.70	0.00	0.00	0.70	1	656.49	5,742
34	3	11	2008	1.00	656.49	40.00	0.93	0.00	40.93	1.00	0.00	0.00	1.00	1	656.49	5,742
35	4	11	2008	6.00	656.49	40.00	0.93	0.00	40.93	6.00	0.00	0.00	6.00	1	656.49	5,742
36	5	11	2008	5.00	656.49	40.00	0.93	0.00	40.93	5.00	0.00	0.00	5.00	1	656.49	5,742
37	6	11	2008	3.30	656.49	40.00	0.93	0.00	40.93	3.30	0.00	0.00	3.30	1	656.49	5,742
38	7	11	2008	3.50	656.49	40.00	0.93	0.00	40.93	3.50	0.00	0.00	3.50	1	656.49	5,742
39	8	11	2008	3.00	656.49	40.00	0.93	0.00	40.93	3.00	0.00	0.00	3.00	1	656.49	5,742
40	9	11	2008	3.50	656.49	40.00	0.93	0.00	40.93	3.50	0.00	0.00	3.50	1	656.49	5,742
41	10	11	2008	4.00	656.49	40.00	0.93	0.00	40.93	4.00	0.00	0.00	4.00	1	656.49	5,742
42	11	11	2008	5.00	656.49	40.00	0.93	0.00	40.93	5.00	0.00	0.00	5.00	1	656.49	5,742
43	12	11	2008	22.00	656.49	40.00	0.93	0.00	40.93	22.00	0.00	0.00	22.00	1	656.49	5,742
44	13	11	2008	130.00	656.49	40.00	0.93	0.00	40.93	40.93	0.00	0.00	40.93	0	657.12	5,919
45	14	11	2008	85.00	657.12	40.00	0.93	0.00	40.93	40.93	0.00	0.00	40.93	0	657.43	6,006
46	15	11	2008	54.00	657.43	40.00	0.93	0.00	40.93	40.93	0.00	0.00	40.93	0	657.53	6,032
47	16	11	2008	40.00	657.53	40.00	0.93	0.00	40.93	40.00	0.00	0.00	40.00	1	657.53	6,032
48	17	11	2008	34.00	657.53	40.00	0.93	0.00	40.93	34.00	0.00	0.00	34.00	1	657.53	6,032
49	18	11	2008	28.00	657.53	40.00	0.93	0.00	40.93	28.00	0.00	0.00	28.00	1	657.53	6,032
50	19	11	2008	23.00	657.53	40.00	0.93	0.00	40.93	23.00	0.00	0.00	23.00	1	657.53	6,032
51	20	11	2008	24.00	657.53	40.00	0.93	0.00	40.93	24.00	0.00	0.00	24.00	1	657.53	6,032
52	21	11	2008	25.00	657.53	40.00	0.93	0.00	40.93	25.00	0.00	0.00	25.00	1	657.53	6,032
53	22	11	2008	24.00	657.53	40.00	0.93	0.00	40.93	24.00	0.00	0.00	24.00	1	657.53	6,032
54	23	11	2008	23.00	657.53	40.00	0.93	0.00	40.93	23.00	0.00	0.00	23.00	1	657.53	6,032
55	24	11	2008	22.00	657.53	40.00	0.93	0.00	40.93	22.00	0.00	0.00	22.00	1	657.53	6,032
56	25	11	2008	21.00	657.53	40.00	0.93	0.00	40.93	21.00	0.00	0.00	21.00	1	657.53	6,032
57	26	11	2008	20.00	657.53	40.00	0.93	0.00	40.93	20.00	0.00	0.00	20.00	1	657.53	6,032
58	27	11	2008	20.00	657.53	40.00	0.93	0.00	40.93	20.00	0.00	0.00	20.00	1	657.53	6,032
59	28	11	2008	19.00	657.53	40.00	0.93	0.00	40.93	19.00	0.00	0.00	19.00	1	657.53	6,032
60	29	11	2008	18.00	657.53	40.00	0.93	0.00	40.93	18.00	0.00	0.00	18.00	1	657.53	6,032
61	30	11	2008	17.00	657.53	40.00	0.93	0.00	40.93	17.00	0.00	0.00	17.00	1	657.53	6,032
62	1	12	2008	17.00	657.53	40.00	2.11	0.00	42.11	17.00	0.00	0.00	17.00	1	657.53	6,032
63	2	12	2008	19.00	657.53	40.00	2.11	0.00	42.11	19.00	0.00	0.00	19.00	1	657.53	6,032
64	3	12	2008	20.00	657.53	40.00	2.11	0.00	42.11	20.00	0.00	0.00	20.00	1	657.53	6,032
65	4	12	2008	19.00	657.53	40.00	2.11	0.00	42.11	19.00	0.00	0.00	19.00	1	657.53	6,032
66	5	12	2008	19.00	657.53	40.00	2.11	0.00	42.11	19.00	0.00	0.00	19.00	1	657.53	6,032

67	6	12	2008	17.00	657.53	40.00	2.11	0.00	42.11	17.00	0.00	0.00	17.00	1	657.53	6,032
68	7	12	2008	17.00	657.53	40.00	2.11	0.00	42.11	17.00	0.00	0.00	17.00	1	657.53	6,032
69	8	12	2008	19.00	657.53	40.00	2.11	0.00	42.11	19.00	0.00	0.00	19.00	1	657.53	6,032
70	9	12	2008	17.00	657.53	40.00	2.11	0.00	42.11	17.00	0.00	0.00	17.00	1	657.53	6,032
71	10	12	2008	16.00	657.53	40.00	2.11	0.00	42.11	16.00	0.00	0.00	16.00	1	657.53	6,032
72	11	12	2008	15.00	657.53	40.00	2.11	0.00	42.11	15.00	0.00	0.00	15.00	1	657.53	6,032
73	12	12	2008	17.00	657.53	40.00	2.11	0.00	42.11	17.00	0.00	0.00	17.00	1	657.53	6,032
74	13	12	2008	26.00	657.53	40.00	2.11	0.00	42.11	26.00	0.00	0.00	26.00	1	657.53	6,032
75	14	12	2008	23.00	657.53	40.00	2.11	0.00	42.11	23.00	0.00	0.00	23.00	1	657.53	6,032
76	15	12	2008	19.00	657.53	40.00	2.11	0.00	42.11	19.00	0.00	0.00	19.00	1	657.53	6,032
77	16	12	2008	17.00	657.53	40.00	2.11	0.00	42.11	17.00	0.00	0.00	17.00	1	657.53	6,032
78	17	12	2008	17.00	657.53	40.00	2.11	0.00	42.11	17.00	0.00	0.00	17.00	1	657.53	6,032
79	18	12	2008	28.00	657.53	40.00	2.11	0.00	42.11	28.00	0.00	0.00	28.00	1	657.53	6,032
80	19	12	2008	25.00	657.53	40.00	2.11	0.00	42.11	25.00	0.00	0.00	25.00	1	657.53	6,032
81	20	12	2008	24.00	657.53	40.00	2.11	0.00	42.11	24.00	0.00	0.00	24.00	1	657.53	6,032
82	21	12	2008	33.00	657.53	40.00	2.11	0.00	42.11	33.00	0.00	0.00	33.00	1	657.53	6,032
83	22	12	2008	60.00	657.53	40.00	2.11	0.00	42.11	42.11	0.00	0.00	42.11	0	657.65	6,068
84	23	12	2008	50.00	657.65	40.00	2.11	0.00	42.11	42.11	0.00	0.00	42.11	0	657.71	6,083
85	24	12	2008	40.00	657.71	40.00	2.11	0.00	42.11	40.00	0.00	0.00	40.00	1	657.71	6,083
86	25	12	2008	50.00	657.71	40.00	2.11	0.00	42.11	42.11	0.00	0.00	42.11	0	657.77	6,099
87	26	12	2008	55.00	657.77	40.00	2.11	0.00	42.11	42.11	0.00	0.00	42.11	0	657.86	6,124
88	27	12	2008	110.00	657.86	40.00	2.11	0.00	42.11	42.11	0.00	0.00	42.11	0	658.34	6,259
89	28	12	2008	200.00	658.34	40.00	2.11	0.00	42.11	42.11	0.00	0.00	42.11	0	659.46	6,572
90	29	12	2008	215.00	659.46	40.00	2.11	0.00	42.11	42.11	0.00	0.00	42.11	0	660.62	6,915
91	30	12	2008	160.00	660.62	40.00	2.11	0.00	42.11	42.11	0.00	0.00	42.11	0	661.36	7,149
92	31	12	2008	130.00	661.36	40.00	2.11	0.00	42.11	42.11	0.00	0.00	42.11	0	661.92	7,323
93	1	1	2009	275.00	661.92	40.00	2.28	0.00	42.28	42.28	0.00	0.00	42.28	0	663.39	7,784
94	2	1	2009	500.00	663.39	40.00	2.28	0.00	42.28	42.28	0.00	0.00	42.28	0	666.29	8,692
95	3	1	2009	267.00	666.29	40.00	2.28	0.00	42.28	42.28	0.00	0.00	42.28	0	667.71	9,138
96	4	1	2009	181.00	667.71	40.00	2.28	0.00	42.28	42.28	0.00	0.00	42.28	0	668.58	9,413
97	5	1	2009	173.00	668.58	40.00	2.28	0.00	42.28	42.28	0.00	0.00	42.28	0	669.41	9,672
98	6	1	2009	159.00	669.41	40.00	2.28	0.00	42.28	42.28	0.00	0.00	42.28	0	670.14	9,904
99	7	1	2009	161.00	670.14	40.00	2.28	0.00	42.28	42.28	0.00	0.00	42.28	0	670.83	10,139
100	8	1	2009	198.00	670.83	40.00	2.28	0.00	42.28	42.28	0.00	0.00	42.28	0	671.74	10,448
101	9	1	2009	163.00	671.74	40.00	2.28	0.00	42.28	42.28	0.00	0.00	42.28	0	672.44	10,687
102	10	1	2009	132.00	672.44	40.00	2.28	0.00	42.28	42.28	0.00	0.00	42.28	0	672.96	10,865
103	11	1	2009	115.00	672.96	40.00	2.28	0.00	42.28	42.28	0.00	0.00	42.28	0	673.39	11,009
104	12	1	2009	96.00	673.39	40.00	2.28	0.00	42.28	42.28	0.00	0.00	42.28	0	673.70	11,116
105	13	1	2009	84.00	673.70	40.00	2.28	0.00	42.28	42.28	0.00	0.00	42.28	0	673.94	11,198
106	14	1	2009	73.00	673.94	40.00	2.28	0.00	42.28	42.28	0.00	0.00	42.28	0	674.12	11,259
107	15	1	2009	65.00	674.12	40.00	2.28	0.00	42.28	42.28	0.00	0.00	42.28	0	674.25	11,304
108	16	1	2009	57.00	674.25	40.00	2.28	0.00	42.28	42.28	0.00	0.00	42.28	0	674.34	11,334
109	17	1	2009	50.00	674.34	40.00	2.28	0.00	42.28	42.28	0.00	0.00	42.28	0	674.39	11,349
110	18	1	2009	44.00	674.39	40.00	2.28	0.00	42.28	42.28	0.00	0.00	42.28	0	674.40	11,352
111	19	1	2009	39.00	674.40	40.00	2.28	0.00	42.28	39.00	0.00	0.00	39.00	1	674.40	11,352
112	20	1	2009	35.00	674.40	40.00	2.28	0.00	42.28	35.00	0.00	0.00	35.00	1	674.40	11,352
113	21	1	2009	32.00	674.40	40.00	2.28	0.00	42.28	32.00	0.00	0.00	32.00	1	674.40	11,352

114	22	1	2009	30.00	674.40	40.00	2.28	0.00	42.28	30.00	0.00	0.00	30.00	1	674.40	11,352
115	23	1	2009	28.00	674.40	40.00	2.28	0.00	42.28	28.00	0.00	0.00	28.00	1	674.40	11,352
116	24	1	2009	26.00	674.40	40.00	2.28	0.00	42.28	26.00	0.00	0.00	26.00	1	674.40	11,352
117	25	1	2009	27.00	674.40	40.00	2.28	0.00	42.28	27.00	0.00	0.00	27.00	1	674.40	11,352
118	26	1	2009	25.00	674.40	40.00	2.28	0.00	42.28	25.00	0.00	0.00	25.00	1	674.40	11,352
119	27	1	2009	24.00	674.40	40.00	2.28	0.00	42.28	24.00	0.00	0.00	24.00	1	674.40	11,352
120	28	1	2009	27.00	674.40	40.00	2.28	0.00	42.28	27.00	0.00	0.00	27.00	1	674.40	11,352
121	29	1	2009	25.00	674.40	40.00	2.28	0.00	42.28	25.00	0.00	0.00	25.00	1	674.40	11,352
122	30	1	2009	24.00	674.40	40.00	2.28	0.00	42.28	24.00	0.00	0.00	24.00	1	674.40	11,352
123	31	1	2009	23.00	674.40	40.00	2.28	0.00	42.28	23.00	0.00	0.00	23.00	1	674.40	11,352
124	1	2	2009	22.00	674.40	40.00	2.03	0.00	42.03	22.00	0.00	0.00	22.00	1	674.40	11,352
125	2	2	2009	21.00	674.40	40.00	2.03	0.00	42.03	21.00	0.00	0.00	21.00	1	674.40	11,352
126	3	2	2009	21.00	674.40	40.00	2.03	0.00	42.03	21.00	0.00	0.00	21.00	1	674.40	11,352
127	4	2	2009	20.00	674.40	40.00	2.03	0.00	42.03	20.00	0.00	0.00	20.00	1	674.40	11,352
128	5	2	2009	19.00	674.40	40.00	2.03	0.00	42.03	19.00	0.00	0.00	19.00	1	674.40	11,352
129	6	2	2009	23.00	674.40	40.00	2.03	0.00	42.03	23.00	0.00	0.00	23.00	1	674.40	11,352
130	7	2	2009	23.00	674.40	40.00	2.03	0.00	42.03	23.00	0.00	0.00	23.00	1	674.40	11,352
131	8	2	2009	22.00	674.40	40.00	2.03	0.00	42.03	22.00	0.00	0.00	22.00	1	674.40	11,352
132	9	2	2009	22.00	674.40	40.00	2.03	0.00	42.03	22.00	0.00	0.00	22.00	1	674.40	11,352
133	10	2	2009	22.00	674.40	40.00	2.03	0.00	42.03	22.00	0.00	0.00	22.00	1	674.40	11,352
134	11	2	2009	25.00	674.40	40.00	2.03	0.00	42.03	25.00	0.00	0.00	25.00	1	674.40	11,352
135	12	2	2009	24.00	674.40	40.00	2.03	0.00	42.03	24.00	0.00	0.00	24.00	1	674.40	11,352
136	13	2	2009	25.00	674.40	40.00	2.03	0.00	42.03	25.00	0.00	0.00	25.00	1	674.40	11,352
137	14	2	2009	24.00	674.40	40.00	2.03	0.00	42.03	24.00	0.00	0.00	24.00	1	674.40	11,352
138	15	2	2009	24.00	674.40	40.00	2.03	0.00	42.03	24.00	0.00	0.00	24.00	1	674.40	11,352
139	16	2	2009	23.00	674.40	40.00	2.03	0.00	42.03	23.00	0.00	0.00	23.00	1	674.40	11,352
140	17	2	2009	23.00	674.40	40.00	2.03	0.00	42.03	23.00	0.00	0.00	23.00	1	674.40	11,352
141	18	2	2009	22.00	674.40	40.00	2.03	0.00	42.03	22.00	0.00	0.00	22.00	1	674.40	11,352
142	19	2	2009	21.00	674.40	40.00	2.03	0.00	42.03	21.00	0.00	0.00	21.00	1	674.40	11,352
143	20	2	2009	20.00	674.40	40.00	2.03	0.00	42.03	20.00	0.00	0.00	20.00	1	674.40	11,352
144	21	2	2009	19.00	674.40	40.00	2.03	0.00	42.03	19.00	0.00	0.00	19.00	1	674.40	11,352
145	22	2	2009	19.00	674.40	40.00	2.03	0.00	42.03	19.00	0.00	0.00	19.00	1	674.40	11,352
146	23	2	2009	24.00	674.40	40.00	2.03	0.00	42.03	24.00	0.00	0.00	24.00	1	674.40	11,352
147	24	2	2009	71.00	674.40	40.00	2.03	0.00	42.03	42.03	0.00	0.00	42.03	0	674.56	11,410
148	25	2	2009	126.00	674.56	40.00	2.03	0.00	42.03	42.03	0.00	0.00	42.03	0	675.05	11,576
149	26	2	2009	156.00	675.05	40.00	2.03	0.00	42.03	42.03	0.00	0.00	42.03	0	675.72	11,802
150	27	2	2009	123.00	675.72	40.00	2.03	0.00	42.03	42.03	0.00	0.00	42.03	0	676.19	11,963
151	28	2	2009	106.00	676.19	40.00	2.03	0.00	42.03	42.03	0.00	0.00	42.03	0	676.56	12,090
152	1	3	2009	91.00	676.56	40.00	0.03	0.00	40.03	40.03	0.00	0.00	40.03	0	676.86	12,191
153	2	3	2009	92.00	676.86	40.00	0.03	0.00	40.03	40.03	0.00	0.00	68.00	2	677.00	12,238
154	3	3	2009	86.00	677.00	40.00	0.03	0.00	40.03	40.03	0.00	0.00	86.00	2	677.00	12,238
155	4	3	2009	74.00	677.00	40.00	0.03	0.00	40.03	40.03	0.00	0.00	74.00	2	677.00	12,238
156	5	3	2009	77.00	677.00	40.00	0.03	0.00	40.03	40.03	0.00	0.00	77.00	2	677.00	12,238
157	6	3	2009	71.00	677.00	40.00	0.03	0.00	40.03	40.03	0.00	0.00	71.00	2	677.00	12,238
158	7	3	2009	65.00	677.00	40.00	0.03	0.00	40.03	40.03	0.00	0.00	65.00	2	677.00	12,238
159	8	3	2009	62.00	677.00	40.00	0.03	0.00	40.03	40.03	0.00	0.00	62.00	2	677.00	12,238
160	9	3	2009	60.00	677.00	40.00	0.03	0.00	40.03	40.03	0.00	0.00	60.00	2	677.00	12,238

161	10	3	2009	58.00	677.00	40.00	0.03	0.00	40.03	40.03	0.00	0.00	58.00	2	677.00	12,238
162	11	3	2009	54.00	677.00	40.00	0.03	0.00	40.03	40.03	0.00	0.00	54.00	2	677.00	12,238
163	12	3	2009	50.00	677.00	40.00	0.03	0.00	40.03	40.03	0.00	0.00	50.00	2	677.00	12,238
164	13	3	2009	46.00	677.00	40.00	0.03	0.00	40.03	40.03	0.00	0.00	46.00	2	677.00	12,238
165	14	3	2009	46.00	677.00	40.00	0.03	0.00	40.03	40.03	0.00	0.00	46.00	2	677.00	12,238
166	15	3	2009	80.00	677.00	40.00	0.03	0.00	40.03	40.03	0.00	0.00	80.00	2	677.00	12,238
167	16	3	2009	92.00	677.00	40.00	0.03	0.00	40.03	40.03	0.00	0.00	92.00	2	677.00	12,238
168	17	3	2009	84.00	677.00	40.00	0.03	0.00	40.03	40.03	0.00	0.00	84.00	2	677.00	12,238
169	18	3	2009	73.00	677.00	40.00	0.03	0.00	40.03	40.03	0.00	0.00	73.00	2	677.00	12,238
170	19	3	2009	66.00	677.00	40.00	0.03	0.00	40.03	40.03	0.00	0.00	66.00	2	677.00	12,238
171	20	3	2009	60.00	677.00	40.00	0.03	0.00	40.03	40.03	0.00	0.00	60.00	2	677.00	12,238
172	21	3	2009	54.00	677.00	40.00	0.03	0.00	40.03	40.03	0.00	0.00	54.00	2	677.00	12,238
173	22	3	2009	62.00	677.00	40.00	0.03	0.00	40.03	40.03	0.00	0.00	62.00	2	677.00	12,238
174	23	3	2009	59.00	677.00	40.00	0.03	0.00	40.03	40.03	0.00	0.00	59.00	2	677.00	12,238
175	24	3	2009	54.00	677.00	40.00	0.03	0.00	40.03	40.03	0.00	0.00	54.00	2	677.00	12,238
176	25	3	2009	61.00	677.00	40.00	0.03	0.00	40.03	40.03	0.00	0.00	61.00	2	677.00	12,238
177	26	3	2009	59.00	677.00	40.00	0.03	0.00	40.03	40.03	0.00	0.00	59.00	2	677.00	12,238
178	27	3	2009	54.00	677.00	40.00	0.03	0.00	40.03	40.03	0.00	0.00	54.00	2	677.00	12,238
179	28	3	2009	56.00	677.00	40.00	0.03	0.00	40.03	40.03	0.00	0.00	56.00	2	677.00	12,238
180	29	3	2009	68.00	677.00	40.00	0.03	0.00	40.03	40.03	0.00	0.00	68.00	2	677.00	12,238
181	30	3	2009	66.00	677.00	40.00	0.03	0.00	40.03	40.03	0.00	0.00	66.00	2	677.00	12,238
182	31	3	2009	63.00	677.00	40.00	0.03	0.00	40.03	40.03	0.00	0.00	63.00	2	677.00	12,238
183	1	4	2009	60.00	677.00	40.00	0.04	0.00	40.04	40.04	0.00	0.00	60.00	2	677.00	12,238
184	2	4	2009	81.00	677.00	40.00	0.04	0.00	40.04	40.04	0.00	0.00	81.00	2	677.00	12,238
185	3	4	2009	80.00	677.00	40.00	0.04	0.00	40.04	40.04	0.00	0.00	80.00	2	677.00	12,238
186	4	4	2009	72.00	677.00	40.00	0.04	0.00	40.04	40.04	0.00	0.00	72.00	2	677.00	12,238
187	5	4	2009	64.00	677.00	40.00	0.04	0.00	40.04	40.04	0.00	0.00	64.00	2	677.00	12,238
188	6	4	2009	56.00	677.00	40.00	0.04	0.00	40.04	40.04	0.00	0.00	56.00	2	677.00	12,238
189	7	4	2009	51.00	677.00	40.00	0.04	0.00	40.04	40.04	0.00	0.00	51.00	2	677.00	12,238
190	8	4	2009	46.00	677.00	40.00	0.04	0.00	40.04	40.04	0.00	0.00	46.00	2	677.00	12,238
191	9	4	2009	44.00	677.00	40.00	0.04	0.00	40.04	40.04	0.00	0.00	44.00	2	677.00	12,238
192	10	4	2009	45.00	677.00	40.00	0.04	0.00	40.04	40.04	0.00	0.00	45.00	2	677.00	12,238
193	11	4	2009	38.00	677.00	40.00	0.04	0.00	40.04	38.00	0.00	0.00	38.00	1	677.00	12,238
194	12	4	2009	35.00	677.00	40.00	0.04	0.00	40.04	35.00	0.00	0.00	35.00	1	677.00	12,238
195	13	4	2009	44.00	677.00	40.00	0.04	0.00	40.04	40.04	0.00	0.00	44.00	2	677.00	12,238
196	14	4	2009	42.00	677.00	40.00	0.04	0.00	40.04	40.04	0.00	0.00	42.00	2	677.00	12,238
197	15	4	2009	39.00	677.00	40.00	0.04	0.00	40.04	39.00	0.00	0.00	39.00	1	677.00	12,238
198	16	4	2009	35.00	677.00	40.00	0.04	0.00	40.04	35.00	0.00	0.00	35.00	1	677.00	12,238
199	17	4	2009	35.00	677.00	40.00	0.04	0.00	40.04	35.00	0.00	0.00	35.00	1	677.00	12,238
200	18	4	2009	33.00	677.00	40.00	0.04	0.00	40.04	33.00	0.00	0.00	33.00	1	677.00	12,238
201	19	4	2009	30.00	677.00	40.00	0.04	0.00	40.04	30.00	0.00	0.00	30.00	1	677.00	12,238
202	20	4	2009	27.00	677.00	40.00	0.04	0.00	40.04	27.00	0.00	0.00	27.00	1	677.00	12,238
203	21	4	2009	25.00	677.00	40.00	0.04	0.00	40.04	25.00	0.00	0.00	25.00	1	677.00	12,238
204	22	4	2009	24.00	677.00	40.00	0.04	0.00	40.04	24.00	0.00	0.00	24.00	1	677.00	12,238
205	23	4	2009	23.00	677.00	40.00	0.04	0.00	40.04	23.00	0.00	0.00	23.00	1	677.00	12,238
206	24	4	2009	22.00	677.00	40.00	0.04	0.00	40.04	22.00	0.00	0.00	22.00	1	677.00	12,238
207	25	4	2009	21.00	677.00	40.00	0.04	0.00	40.04	21.00	0.00	0.00	21.00	1	677.00	12,238

208	26	4	2009	20.00	677.00	40.00	0.04	0.00	40.04	20.00	0.00	0.00	20.00	1	677.00	12,238
209	27	4	2009	20.00	677.00	40.00	0.04	0.00	40.04	20.00	0.00	0.00	20.00	1	677.00	12,238
210	28	4	2009	27.00	677.00	40.00	0.04	0.00	40.04	27.00	0.00	0.00	27.00	1	677.00	12,238
211	29	4	2009	29.00	677.00	40.00	0.04	0.00	40.04	29.00	0.00	0.00	29.00	1	677.00	12,238
212	30	4	2009	24.00	677.00	40.00	0.04	0.00	40.04	24.00	0.00	0.00	24.00	1	677.00	12,238
213	1	5	2009	22.00	677.00	30.10	0.22	0.00	30.32	22.00	13.00	13.00	35.00	1	676.92	12,213
214	2	5	2009	39.00	676.92	30.10	0.22	0.00	30.32	30.32	13.00	13.00	43.32	0	676.90	12,204
215	3	5	2009	39.00	676.90	30.10	0.22	0.00	30.32	30.32	13.00	13.00	43.32	0	676.87	12,195
216	4	5	2009	40.00	676.87	30.10	0.22	0.00	30.32	30.32	13.00	13.00	43.32	0	676.85	12,189
217	5	5	2009	70.00	676.85	30.10	0.22	0.00	30.32	30.32	13.00	13.00	45.03	2	677.00	12,238
218	6	5	2009	98.00	677.00	30.10	0.22	0.00	30.32	30.32	13.00	13.00	98.00	2	677.00	12,238
219	7	5	2009	128.00	677.00	30.10	0.22	0.00	30.32	30.32	13.00	13.00	128.00	2	677.00	12,238
220	8	5	2009	108.00	677.00	30.10	0.22	0.00	30.32	30.32	13.00	13.00	108.00	2	677.00	12,238
221	9	5	2009	89.00	677.00	30.10	0.22	0.00	30.32	30.32	13.00	13.00	89.00	2	677.00	12,238
222	10	5	2009	75.00	677.00	30.10	0.22	0.00	30.32	30.32	13.00	13.00	75.00	2	677.00	12,238
223	11	5	2009	65.00	677.00	30.10	0.22	0.00	30.32	30.32	13.00	13.00	65.00	2	677.00	12,238
224	12	5	2009	59.00	677.00	30.10	0.22	0.00	30.32	30.32	13.00	13.00	59.00	2	677.00	12,238
225	13	5	2009	53.00	677.00	30.10	0.22	0.00	30.32	30.32	13.00	13.00	53.00	2	677.00	12,238
226	14	5	2009	66.00	677.00	30.10	0.22	0.00	30.32	30.32	13.00	13.00	66.00	2	677.00	12,238
227	15	5	2009	54.00	677.00	30.10	0.22	0.00	30.32	30.32	13.00	13.00	54.00	2	677.00	12,238
228	16	5	2009	46.00	677.00	30.10	0.22	0.00	30.32	30.32	13.00	13.00	46.00	2	677.00	12,238
229	17	5	2009	40.00	677.00	30.10	0.22	0.00	30.32	30.32	13.00	13.00	43.32	0	676.98	12,232
230	18	5	2009	36.00	676.98	30.10	0.22	0.00	30.32	30.32	13.00	13.00	43.32	0	676.94	12,217
231	19	5	2009	37.00	676.94	30.10	0.22	0.00	30.32	30.32	13.00	13.00	43.32	0	676.90	12,205
232	20	5	2009	33.00	676.90	30.10	0.22	0.00	30.32	30.32	13.00	13.00	43.32	0	676.84	12,184
233	21	5	2009	29.00	676.84	30.10	0.22	0.00	30.32	29.00	13.00	13.00	42.00	1	676.77	12,159
234	22	5	2009	26.00	676.77	30.10	0.22	0.00	30.32	26.00	13.00	13.00	39.00	1	676.69	12,133
235	23	5	2009	24.00	676.69	30.10	0.22	0.00	30.32	24.00	13.00	13.00	37.00	1	676.61	12,107
236	24	5	2009	22.00	676.61	30.10	0.22	0.00	30.32	22.00	13.00	13.00	35.00	1	676.54	12,081
237	25	5	2009	21.00	676.54	30.10	0.22	0.00	30.32	21.00	13.00	13.00	34.00	1	676.46	12,055
238	26	5	2009	19.00	676.46	30.10	0.22	0.00	30.32	19.00	13.00	13.00	32.00	1	676.39	12,030
239	27	5	2009	18.00	676.39	30.10	0.22	0.00	30.32	18.00	13.00	13.00	31.00	1	676.31	12,004
240	28	5	2009	16.00	676.31	30.10	0.22	0.00	30.32	16.00	13.00	13.00	29.00	1	676.23	11,978
241	29	5	2009	15.00	676.23	30.10	0.22	0.00	30.32	15.00	13.00	13.00	28.00	1	676.16	11,952
242	30	5	2009	14.00	676.16	30.10	0.22	0.00	30.32	14.00	13.00	13.00	27.00	1	676.08	11,926
243	31	5	2009	11.00	676.08	30.10	0.22	0.00	30.32	11.00	13.00	13.00	24.00	1	676.01	11,901
244	1	6	2009	11.00	676.01	13.60	0.44	0.00	14.04	11.00	13.50	13.50	24.50	1	675.93	11,874
245	2	6	2009	10.00	675.93	13.60	0.44	0.00	14.04	10.00	13.50	13.50	23.50	1	675.85	11,847
246	3	6	2009	9.80	675.85	13.60	0.44	0.00	14.04	9.80	13.50	13.50	23.30	1	675.77	11,820
247	4	6	2009	10.00	675.77	13.60	0.44	0.00	14.04	10.00	13.50	13.50	23.50	1	675.69	11,794
248	5	6	2009	13.00	675.69	13.60	0.44	0.00	14.04	13.00	13.50	13.50	26.50	1	675.61	11,767
249	6	6	2009	12.00	675.61	13.60	0.44	0.00	14.04	12.00	13.50	13.50	25.50	1	675.54	11,740
250	7	6	2009	11.00	675.54	13.60	0.44	0.00	14.04	11.00	13.50	13.50	24.50	1	675.46	11,713
251	8	6	2009	10.00	675.46	13.60	0.44	0.00	14.04	10.00	13.50	13.50	23.50	1	675.38	11,686
252	9	6	2009	9.30	675.38	13.60	0.44	0.00	14.04	9.30	13.50	13.50	22.80	1	675.30	11,660
253	10	6	2009	8.80	675.30	13.60	0.44	0.00	14.04	8.80	13.50	13.50	22.30	1	675.22	11,633
254	11	6	2009	8.70	675.22	13.60	0.44	0.00	14.04	8.70	13.50	13.50	22.20	1	675.14	11,606

255	12	6	2009	8.40	675.14	13.60	0.44	0.00	14.04	8.40	13.50	13.50	21.90	1	675.06	11,579
256	13	6	2009	7.90	675.06	13.60	0.44	0.00	14.04	7.90	13.50	13.50	21.40	1	674.98	11,553
257	14	6	2009	7.50	674.98	13.60	0.44	0.00	14.04	7.50	13.50	13.50	21.00	1	674.91	11,526
258	15	6	2009	7.20	674.91	13.60	0.44	0.00	14.04	7.20	13.50	13.50	20.70	1	674.83	11,499
259	16	6	2009	6.80	674.83	13.60	0.44	0.00	14.04	6.80	13.50	13.50	20.30	1	674.75	11,472
260	17	6	2009	6.50	674.75	13.60	0.44	0.00	14.04	6.50	13.50	13.50	20.00	1	674.67	11,446
261	18	6	2009	6.20	674.67	13.60	0.44	0.00	14.04	6.20	13.50	13.50	19.70	1	674.59	11,419
262	19	6	2009	6.20	674.59	13.60	0.44	0.00	14.04	6.20	13.50	13.50	19.70	1	674.51	11,392
263	20	6	2009	6.00	674.51	13.60	0.44	0.00	14.04	6.00	13.50	13.50	19.50	1	674.43	11,365
264	21	6	2009	5.80	674.43	13.60	0.44	0.00	14.04	5.80	13.50	13.50	19.30	1	674.35	11,339
265	22	6	2009	5.10	674.35	13.60	0.44	0.00	14.04	5.10	13.50	13.50	18.60	1	674.28	11,312
266	23	6	2009	4.70	674.28	13.60	0.44	0.00	14.04	4.70	13.50	13.50	18.20	1	674.20	11,285
267	24	6	2009	4.40	674.20	13.60	0.44	0.00	14.04	4.40	13.50	13.50	17.90	1	674.12	11,258
268	25	6	2009	4.00	674.12	13.60	0.44	0.00	14.04	4.00	13.50	13.50	17.50	1	674.04	11,231
269	26	6	2009	4.00	674.04	13.60	0.44	0.00	14.04	4.00	13.50	13.50	17.50	1	673.96	11,205
270	27	6	2009	3.50	673.96	13.60	0.44	0.00	14.04	3.50	13.50	13.50	17.00	1	673.88	11,178
271	28	6	2009	3.20	673.88	13.60	0.44	0.00	14.04	3.20	13.50	13.50	16.70	1	673.80	11,151
272	29	6	2009	3.20	673.80	13.60	0.44	0.00	14.04	3.20	13.50	13.50	16.70	1	673.73	11,124
273	30	6	2009	3.10	673.73	13.60	0.44	0.00	14.04	3.10	13.50	13.50	16.60	1	673.65	11,098
274	1	7	2009	3.00	673.65	3.00	0.77	0.00	3.77	3.00	26.00	26.00	29.00	1	673.50	11,046
275	2	7	2009	2.70	673.50	3.00	0.77	0.00	3.77	2.70	26.00	26.00	28.70	1	673.34	10,995
276	3	7	2009	2.30	673.34	3.00	0.77	0.00	3.77	2.30	26.00	26.00	28.30	1	673.19	10,943
277	4	7	2009	2.00	673.19	3.00	0.77	0.00	3.77	2.00	26.00	26.00	28.00	1	673.04	10,891
278	5	7	2009	2.00	673.04	3.00	0.77	0.00	3.77	2.00	26.00	26.00	28.00	1	672.89	10,840
279	6	7	2009	1.80	672.89	3.00	0.77	0.00	3.77	1.80	26.00	26.00	27.80	1	672.74	10,788
280	7	7	2009	1.70	672.74	3.00	0.77	0.00	3.77	1.70	26.00	26.00	27.70	1	672.59	10,737
281	8	7	2009	1.60	672.59	3.00	0.77	0.00	3.77	1.60	26.00	26.00	27.60	1	672.43	10,685
282	9	7	2009	1.70	672.43	3.00	0.77	0.00	3.77	1.70	26.00	26.00	27.70	1	672.28	10,634
283	10	7	2009	1.80	672.28	3.00	0.77	0.00	3.77	1.80	26.00	26.00	27.80	1	672.13	10,582
284	11	7	2009	1.80	672.13	3.00	0.77	0.00	3.77	1.80	26.00	26.00	27.80	1	671.98	10,531
285	12	7	2009	2.00	671.98	3.00	0.77	0.00	3.77	2.00	26.00	26.00	28.00	1	671.83	10,479
286	13	7	2009	3.00	671.83	3.00	0.77	0.00	3.77	3.00	26.00	26.00	29.00	1	671.68	10,427
287	14	7	2009	2.80	671.68	3.00	0.77	0.00	3.77	2.80	26.00	26.00	28.80	1	671.53	10,376
288	15	7	2009	2.10	671.53	3.00	0.77	0.00	3.77	2.10	26.00	26.00	28.10	1	671.37	10,324
289	16	7	2009	1.60	671.37	3.00	0.77	0.00	3.77	1.60	26.00	26.00	27.60	1	671.22	10,273
290	17	7	2009	1.20	671.22	3.00	0.77	0.00	3.77	1.20	26.00	26.00	27.20	1	671.07	10,221
291	18	7	2009	0.90	671.07	3.00	0.77	0.00	3.77	0.90	26.00	26.00	26.90	1	670.92	10,170
292	19	7	2009	0.80	670.92	3.00	0.77	0.00	3.77	0.80	26.00	26.00	26.80	1	670.77	10,118
293	20	7	2009	0.70	670.77	3.00	0.77	0.00	3.77	0.70	26.00	26.00	26.70	1	670.62	10,067
294	21	7	2009	0.70	670.62	3.00	0.77	0.00	3.77	0.70	26.00	26.00	26.70	1	670.46	10,015
295	22	7	2009	0.60	670.46	3.00	0.77	0.00	3.77	0.60	26.00	26.00	26.60	1	670.31	9,963
296	23	7	2009	0.60	670.31	3.00	0.77	0.00	3.77	0.60	26.00	26.00	26.60	1	670.16	9,912
297	24	7	2009	0.50	670.16	3.00	0.77	0.00	3.77	0.50	26.00	26.00	26.50	1	670.01	9,860
298	25	7	2009	0.40	670.01	3.00	0.77	0.00	3.77	0.40	26.00	26.00	26.40	1	669.85	9,809
299	26	7	2009	0.30	669.85	3.00	0.77	0.00	3.77	0.30	26.00	26.00	26.30	1	669.68	9,757
300	27	7	2009	0.30	669.68	3.00	0.77	0.00	3.77	0.30	26.00	26.00	26.30	1	669.52	9,706
301	28	7	2009	0.30	669.52	3.00	0.77	0.00	3.77	0.30	26.00	26.00	26.30	1	669.35	9,654

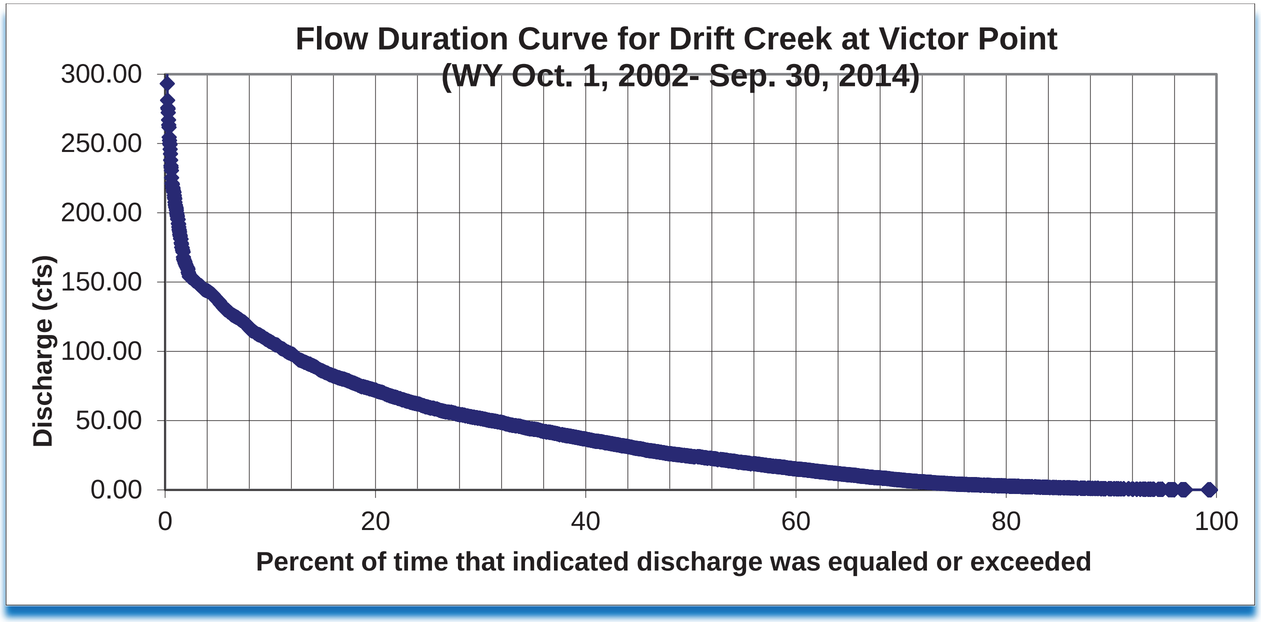
302	29	7	2009	0.30	669.35	3.00	0.77	0.00	3.77	0.30	26.00	26.00	26.30	1	669.19	9,602
303	30	7	2009	0.30	669.19	3.00	0.77	0.00	3.77	0.30	26.00	26.00	26.30	1	669.02	9,551
304	31	7	2009	0.20	669.02	3.00	0.77	0.00	3.77	0.20	26.00	26.00	26.20	1	668.86	9,499
305	1	8	2009	0.20	668.86	2.00	0.61	0.00	2.61	0.20	39.00	39.00	39.20	1	668.61	9,422
306	2	8	2009	0.20	668.61	2.00	0.61	0.00	2.61	0.20	39.00	39.00	39.20	1	668.37	9,345
307	3	8	2009	0.20	668.37	2.00	0.61	0.00	2.61	0.20	39.00	39.00	39.20	1	668.12	9,267
308	4	8	2009	0.20	668.12	2.00	0.61	0.00	2.61	0.20	39.00	39.00	39.20	1	667.87	9,190
309	5	8	2009	0.20	667.87	2.00	0.61	0.00	2.61	0.20	39.00	39.00	39.20	1	667.63	9,113
310	6	8	2009	0.30	667.63	2.00	0.61	0.00	2.61	0.30	39.00	39.00	39.30	1	667.38	9,035
311	7	8	2009	0.30	667.38	2.00	0.61	0.00	2.61	0.30	39.00	39.00	39.30	1	667.13	8,958
312	8	8	2009	0.30	667.13	2.00	0.61	0.00	2.61	0.30	39.00	39.00	39.30	1	666.89	8,881
313	9	8	2009	0.40	666.89	2.00	0.61	0.00	2.61	0.40	39.00	39.00	39.40	1	666.64	8,803
314	10	8	2009	0.30	666.64	2.00	0.61	0.00	2.61	0.30	39.00	39.00	39.30	1	666.39	8,726
315	11	8	2009	0.30	666.39	2.00	0.61	0.00	2.61	0.30	39.00	39.00	39.30	1	666.15	8,649
316	12	8	2009	0.40	666.15	2.00	0.61	0.00	2.61	0.40	39.00	39.00	39.40	1	665.90	8,571
317	13	8	2009	0.50	665.90	2.00	0.61	0.00	2.61	0.50	39.00	39.00	39.50	1	665.65	8,494
318	14	8	2009	0.30	665.65	2.00	0.61	0.00	2.61	0.30	39.00	39.00	39.30	1	665.41	8,417
319	15	8	2009	0.30	665.41	2.00	0.61	0.00	2.61	0.30	39.00	39.00	39.30	1	665.16	8,339
320	16	8	2009	0.30	665.16	2.00	0.61	0.00	2.61	0.30	39.00	39.00	39.30	1	664.91	8,262
321	17	8	2009	0.30	664.91	2.00	0.61	0.00	2.61	0.30	39.00	39.00	39.30	1	664.67	8,185
322	18	8	2009	0.20	664.67	2.00	0.61	0.00	2.61	0.20	39.00	39.00	39.20	1	664.42	8,107
323	19	8	2009	0.20	664.42	2.00	0.61	0.00	2.61	0.20	39.00	39.00	39.20	1	664.17	8,030
324	20	8	2009	0.20	664.17	2.00	0.61	0.00	2.61	0.20	39.00	39.00	39.20	1	663.93	7,953
325	21	8	2009	0.20	663.93	2.00	0.61	0.00	2.61	0.20	39.00	39.00	39.20	1	663.68	7,875
326	22	8	2009	0.20	663.68	2.00	0.61	0.00	2.61	0.20	39.00	39.00	39.20	1	663.43	7,798
327	23	8	2009	0.20	663.43	2.00	0.61	0.00	2.61	0.20	39.00	39.00	39.20	1	663.19	7,721
328	24	8	2009	0.10	663.19	2.00	0.61	0.00	2.61	0.10	39.00	39.00	39.10	1	662.94	7,643
329	25	8	2009	0.10	662.94	2.00	0.61	0.00	2.61	0.10	39.00	39.00	39.10	1	662.69	7,566
330	26	8	2009	0.10	662.69	2.00	0.61	0.00	2.61	0.10	39.00	39.00	39.10	1	662.45	7,489
331	27	8	2009	0.10	662.45	2.00	0.61	0.00	2.61	0.10	39.00	39.00	39.10	1	662.20	7,411
332	28	8	2009	0.10	662.20	2.00	0.61	0.00	2.61	0.10	39.00	39.00	39.10	1	661.95	7,334
333	29	8	2009	0.20	661.95	2.00	0.61	0.00	2.61	0.20	39.00	39.00	39.20	1	661.71	7,257
334	30	8	2009	0.20	661.71	2.00	0.61	0.00	2.61	0.20	39.00	39.00	39.20	1	661.46	7,179
335	31	8	2009	0.20	661.46	2.00	0.61	0.00	2.61	0.20	39.00	39.00	39.20	1	661.21	7,102
336	1	9	2009	0.20	661.21	2.00	0.30	0.00	2.30	0.20	40.33	40.33	40.53	1	660.96	7,022
337	2	9	2009	0.20	660.96	2.00	0.30	0.00	2.30	0.20	40.33	40.33	40.53	1	660.70	6,942
338	3	9	2009	0.20	660.70	2.00	0.30	0.00	2.30	0.20	40.33	40.33	40.53	1	660.45	6,862
339	4	9	2009	0.20	660.45	2.00	0.30	0.00	2.30	0.20	40.33	40.33	40.53	1	660.19	6,782
340	5	9	2009	0.50	660.19	2.00	0.30	0.00	2.30	0.50	40.33	40.33	40.83	1	659.93	6,702
341	6	9	2009	0.90	659.93	2.00	0.30	0.00	2.30	0.90	40.33	40.33	41.23	1	659.64	6,622
342	7	9	2009	0.90	659.64	2.00	0.30	0.00	2.30	0.90	40.33	40.33	41.23	1	659.35	6,542
343	8	9	2009	0.40	659.35	2.00	0.30	0.00	2.30	0.40	40.33	40.33	40.73	1	659.07	6,462
344	9	9	2009	0.30	659.07	2.00	0.30	0.00	2.30	0.30	40.33	40.33	40.63	1	658.78	6,382
345	10	9	2009	0.30	658.78	2.00	0.30	0.00	2.30	0.30	40.33	40.33	40.63	1	658.50	6,302
346	11	9	2009	0.30	658.50	2.00	0.30	0.00	2.30	0.30	40.33	40.33	40.63	1	658.21	6,222
347	12	9	2009	0.30	658.21	2.00	0.30	0.00	2.30	0.30	40.33	40.33	40.63	1	657.92	6,142
348	13	9	2009	0.30	657.92	2.00	0.30	0.00	2.30	0.30	40.33	40.33	40.63	1	657.64	6,062

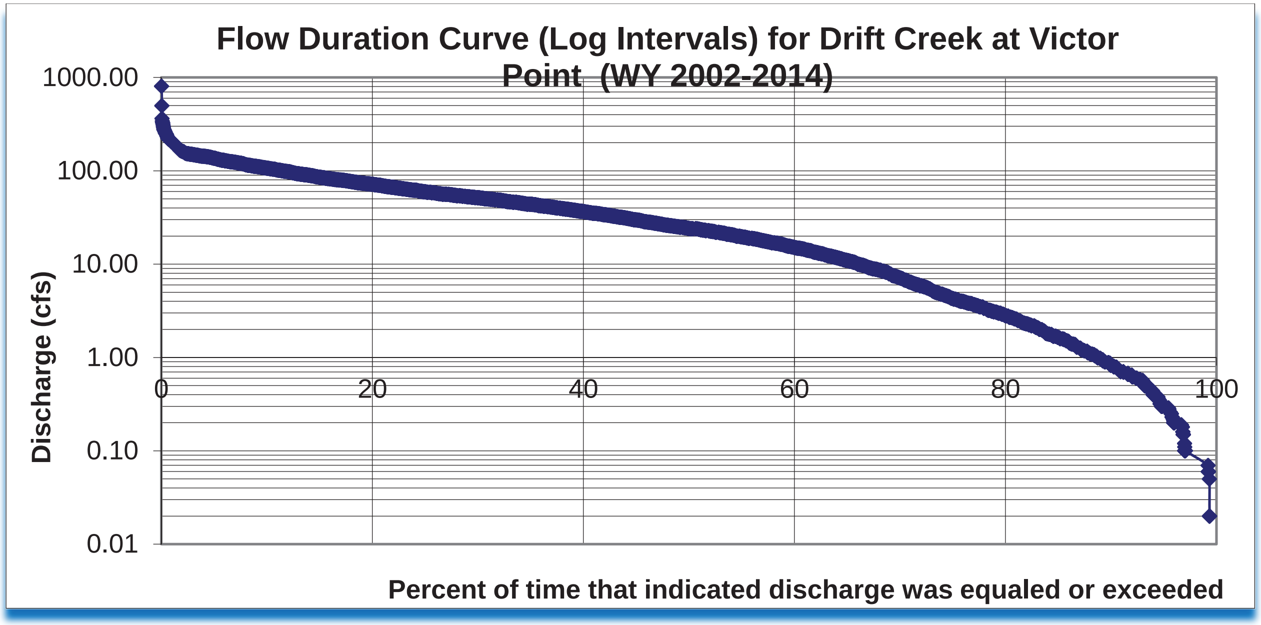
349	14	9	2009	0.30	657.64	2.00	0.30	0.00	2.30	0.30	40.33	40.33	40.63	1	657.35	5,982
350	15	9	2009	0.70	657.35	2.00	0.30	0.00	2.30	0.70	40.33	40.33	41.03	1	657.06	5,902
351	16	9	2009	3.70	657.06	2.00	0.30	0.00	2.30	2.30	40.33	40.33	42.63	0	656.79	5,825
352	17	9	2009	1.70	656.79	2.00	0.30	0.00	2.30	1.70	40.33	40.33	42.03	1	656.50	5,745
353	18	9	2009	0.80	656.50	2.00	0.30	0.00	2.30	0.80	40.33	40.33	41.13	1	656.21	5,665
354	19	9	2009	0.40	656.21	2.00	0.30	0.00	2.30	0.40	40.33	40.33	40.73	1	655.93	5,585
355	20	9	2009	0.30	655.93	2.00	0.30	0.00	2.30	0.30	40.33	40.33	40.63	1	655.64	5,505
356	21	9	2009	0.30	655.64	2.00	0.30	0.00	2.30	0.30	40.33	40.33	40.63	1	655.35	5,425
357	22	9	2009	0.20	655.35	2.00	0.30	0.00	2.30	0.20	40.33	40.33	40.53	1	655.07	5,345
358	23	9	2009	0.20	655.07	2.00	0.30	0.00	2.30	0.20	40.33	40.33	40.53	1	654.78	5,265
359	24	9	2009	0.20	654.78	2.00	0.30	0.00	2.30	0.20	40.33	40.33	40.53	1	654.49	5,185
360	25	9	2009	0.20	654.49	2.00	0.30	0.00	2.30	0.20	40.33	40.33	40.53	1	654.21	5,105
361	26	9	2009	0.20	654.21	2.00	0.30	0.00	2.30	0.20	40.33	40.33	40.53	1	653.92	5,025
362	27	9	2009	0.20	653.92	2.00	0.30	0.00	2.30	0.20	40.33	40.33	40.53	1	653.63	4,945
363	28	9	2009	0.20	653.63	2.00	0.30	0.00	2.30	0.20	40.33	40.33	40.53	1	653.34	4,865
364	29	9	2009	0.20	653.34	2.00	0.30	0.00	2.30	0.20	40.33	40.33	40.53	1	653.06	4,785
365	30	9	2009	0.20	653.06	2.00	0.30	0.00	2.30	0.20	40.33	40.33	40.53	1	652.77	4,705

Appendix 9. Flow Duration Curve: Sample Output

DATE (Month, Day, Year)	STREAMFLOW (CFS)	Rank	Percent Exceeded
1/19/2012	808.62	1	0.023
1/2/2009	500.00	2	0.046
11/20/2012	364.40	3	0.068
1/20/2012	342.00	4	0.091
11/21/2012	328.25	5	0.114
1/21/2012	327.25	6	0.137
3/31/2012	314.63	7	0.160
1/17/2011	302.80	8	0.182
2/15/2014	293.23	9	0.205
2/14/2014	281.20	10	0.228
2/16/2014	275.75	11	0.251
1/1/2009	275.00	12	0.274
3/30/2012	272.33	13	0.297
1/3/2009	267.00	14	0.319
3/30/2010	263.40	15	0.342

3/21/2012	261.65	16	0.365
12/14/2010	254.50	17	0.388
3/17/2012	252.18	18	0.411
1/16/2011	250.00	19	0.433
12/30/2011	249.25	20	0.456
12/29/2010	245.80	21	0.479
1/22/2012	242.50	22	0.502
3/22/2012	237.99	23	0.525
4/1/2012	233.97	24	0.547
3/29/2010	232.60	25	0.570
11/22/2012	230.55	26	0.593
2/12/2014	225.28	27	0.616
2/19/2014	221.26	28	0.639
2/17/2014	221.22	29	0.661
2/18/2014	220.53	30	0.684
11/24/2012	218.49	31	0.707
6/4/2010	218.10	32	0.730
1/18/2011	217.60	33	0.753
12/13/2010	216.20	34	0.776
3/31/2010	215.20	35	0.798
12/29/2008	215.00	36	0.821
3/6/2014	214.80	37	0.844
2/20/2014	212.60	38	0.867
2/13/2014	211.02	39	0.890
1/29/2013	210.04	40	0.912
1/30/2013	207.69	41	0.935
1/18/2012	205.75	42	0.958
1/23/2012	205.46	43	0.981
1/25/2012	204.22	44	1.004
1/19/2011	203.90	45	1.026
3/23/2012	203.23	46	1.049
3/16/2012	201.90	47	1.072


Flow Duration Curve for Drift Creek at Victor Point
(WY Oct. 1, 2002- Sep. 30, 2014)
Discharge (cfs)
300.00
250.00
200.00
150.00
100.00
50.00
0.00
0
20
40
60
80
100
Percent of time that indicated discharge was equaled or exceeded



Appendix 10. Monthly Sum of Snowfalls at Salem McNary Field, OR

Monthly Sum of Snowfall (Inches)

(357500)

File last updated on Jul 29, 2014

a = 1 day missing, b = 2 days missing, c = 3 days, ..etc..,
z = 26 or more days missing, A = Accumulations present
Long-term means based on columns; thus, the monthly row may not sum (or average) to the long-term annual value.

MAXIMUM ALLOWABLE NUMBER OF MISSING DAYS : 5

Individual Months not used for annual or monthly statistics if more than 5 days are missing.
Individual Years not used for annual statistics if any month in that year has more than 5 days missing.

YEAR(S)	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	ANN
1892-93	-----z	-----z	-----z	-----z	-----z	-----z	9.70	6.00	-----z	-----z	-----z	-----z	15.70j
1893-94	-----z	-----z	-----z	-----z	-----z	-----z	0.00	0.00	-----z	-----z	-----z	-----z	0.00j

1894-95	-----z	-----z	-----z	-----z	0.00	-----z	-----z	-----z	0.00	-----z	-----z	-----z	0.00j
1895-96	-----z	-----z	-----z	-----z	-----z	-----z	-----z	0.00	-----z	0.00	-----z	-----z	0.00j
1896-97	-----z	-----z	-----z	-----z	-----z	-----z	1.00	-----z	0.00	0.00	-----z	-----z	1.00i
1897-98	-----z	-----z	-----z	-----z	3.00	-----z	3.00	-----z	-----z	-----z	-----z	-----z	6.00j
1898-99	0.00	-----z	-----z	-----z	-----z	-----z	-----z	11.00	-----z	-----z	-----z	-----z	11.00j
1899-00	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	0.00l
1900-01	-----z	-----z	-----z	-----z	-----z	-----z	3.00	-----z	-----z	-----z	-----z	-----z	3.00k
1901-02	-----z	-----z	-----z	-----z	-----z	-----z	1.00	0.00	0.00	-----z	-----z	-----z	1.00i
1902-03	-----z	-----z	-----z	0.00	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	0.00k
1903-04	-----z	-----z	-----z	-----z	-----z	-----z	-----z	0.90	-----z	-----z	-----z	-----z	0.90k
1904-05	-----z	-----z	-----z	-----z	-----z	-----z	3.00	-----z	-----z	-----z	-----z	-----z	3.00k
1905-06	-----z	-----z	-----z	-----z	-----z	0.00	-----z	-----z	-----z	0.00	0.00	-----z	0.00i
1906-07	0.00	0.00	0.00	0.00	-----z	-----z	-----z	-----z	-----z	-----z	0.00	-----z	0.00g
1907-08	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	0.00l
1908-09	-----z	-----z	-----z	0.00	-----z	0.00	16.00y	-----z	-----z	-----z	-----z	-----z	0.00j
1909-10	0.00	-----z	-----z	-----z	0.00	-----z	2.00	3.00	0.00	-----z	-----z	-----z	5.00g
1910-11	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	0.00l
1911-12	-----z	-----z	-----z	-----z	1.00	-----z	-----z	-----z	-----z	-----z	-----z	-----z	1.00k
1912-13	-----z	-----z	-----z	-----z	-----z	-----z	6.00	-----z	-----z	-----z	-----z	-----z	6.00k
1913-14	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	0.00	-----z	-----z	0.00k
1914-15	-----z	0.00	0.00	0.00	0.00	-----z	0.00	0.00	-----z	0.00	0.00	0.00	0.00c
1915-16	0.00	0.00	0.00	-----z	-----z	-----z	15.00	3.00	0.00	-----z	0.00	0.00	18.00d
1916-17	0.00	0.00	0.00	0.00	-----z	1.00	-----z	0.00	-----z	0.00	-----z	-----z	1.00e
1917-18	-----z	0.00	0.00	0.00	0.00	0.00	0.00	2.50	-----z	0.00	0.00	0.00	2.50b
1918-19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-----z	0.00	0.00	0.00	0.00a
1919-20	0.00	0.00	-----z	0.00	-----z	23.00	0.00	0.00	1.50	-----z	-----z	-----z	24.50e
1920-21	-----z	0.00	0.00	0.00	0.00	0.00	0.00	0.60	0.00	0.00	0.00	0.00	0.60a
1921-22	0.00	0.00	0.00	-----z	0.00	6.70y	0.20	0.90	0.00	0.00	0.00	0.00	1.10b
1922-23	0.00	0.00	0.00	0.00	0.00	5.00	0.80	7.50	0.00	0.00	0.00	0.00	13.30
1923-24	0.00	0.00	0.00	0.00	0.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00	5.00
1924-25	0.00	0.00	0.00	0.00	0.00	6.00	0.00	0.00	0.00	0.00	0.00	0.00	6.00
1925-26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1926-27	0.00	0.00	0.00	0.00	0.00	-----z	4.30	0.00	0.00	0.00	0.00	0.00	4.30a
1927-28	0.00	0.00	0.00	0.00	0.00	2.50	2.00	0.00	0.00	0.00	0.00	0.00	4.50
1928-29	0.00	0.00	0.00	0.00	0.00	7.50	11.70	0.00	0.00	0.00	0.00	0.00	19.20
1929-30	0.00	0.00	0.00	0.00	0.00	0.00	18.70	0.00	0.00	0.00	0.00	0.00	18.70
1930-31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1931-32	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.00	0.00	0.00	0.00	0.00	0.50
1932-33	0.00	0.00	0.00	0.00	0.00	0.30	2.10	1.00	0.00	0.00	0.00	0.00	3.40
1933-34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1934-35	0.00	0.00	0.00	0.00	0.00	0.00	9.80	0.00	0.00	0.00	0.00	0.00	9.80
1935-36	0.00	0.00	0.00	5.00	0.00	0.00	0.00	1.20	2.00	0.00	0.00	0.00	8.20

1936-37	0.00	0.00	0.00	0.00	0.00	0.00	8.80	25.20	0.00	0.00	0.00	0.00	34.00
1937-38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.20	0.00	0.00	0.00	1.20
1938-39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	1.00
1939-40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1940-41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1941-42	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00
1942-43	0.00	0.00	0.00	0.00	0.00	1.50	22.10	0.00	0.00	0.00	0.00	0.00	23.60
1943-44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1944-45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1945-46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	1.00
1946-47	0.00	0.00	0.00	0.00	0.00	0.00	2.90	0.00	0.00	0.00	0.00	0.00	2.90
1947-48	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.00	0.50	0.00	0.00	0.00	1.00
1948-49	0.00	0.00	0.00	0.00	0.00	0.30	3.50	2.40	0.00	0.00	0.00	0.00	6.20
1949-50	0.00	0.00	0.00	0.00	0.00	0.00	32.80	0.30	0.40	0.00	0.00	0.00	33.50
1950-51	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.00	10.90	0.00	0.00	0.00	11.00
1951-52	0.00	0.00	0.00	0.00	0.00	0.20	2.50	5.80	0.00	0.00	0.00	0.00	8.50
1952-53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1953-54	0.00	0.00	0.00	0.00	0.00	0.00	7.60	0.00	0.70	0.00	0.00	0.00	8.30
1954-55	0.00	0.00	0.00	0.00	0.00	0.50	0.80	0.00	0.70	0.00	0.00	0.00	2.00
1955-56	0.00	0.00	0.00	0.00	5.80	0.00	5.50	2.10	1.80	0.00	0.00	0.00	15.20
1956-57	0.00	0.00	0.00	0.00	0.00	8.20	2.40	0.00	0.00	0.00	0.00	0.00	10.60
1957-58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1958-59	0.00	0.00	0.00	0.00	0.00	0.00	3.40	2.10	0.00	0.00	0.00	0.00	5.50
1959-60	0.00	0.00	0.00	0.00	0.00	0.00	6.90	0.00	8.50	0.00	0.00	0.00	15.40
1960-61	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1961-62	0.00	0.00	0.00	0.00	0.00	0.00	2.50	8.40	2.60	0.00	0.00	0.00	13.50
1962-63	0.00	0.00	0.00	0.00	0.00	0.00	6.60	0.00	0.00	0.00	0.00	0.00	6.60
1963-64	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1964-65	0.00	0.00	0.00	0.00	0.00	5.70	0.00	0.00	0.00	0.00	0.00	0.00	5.70
1965-66	0.00	0.00	0.00	0.00	0.00	7.40	1.70	0.20	0.60	0.00	0.00	0.00	9.90
1966-67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1967-68	0.00	0.00	0.00	0.00	0.00	1.00	9.30	0.00	0.00	0.00	0.00	0.00	10.30
1968-69	0.00	0.00	0.00	0.00	0.00	12.60	21.90	0.40	0.00	0.00	0.00	0.00	34.90
1969-70	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.00	0.00	0.00	0.00	0.00	0.20
1970-71	0.00	0.00	0.00	0.00	0.00	0.90	11.10	8.10	1.40	0.00	0.00	0.00	21.50
1971-72	0.00	0.00	0.00	0.00	0.00	2.20	0.40	0.00	0.30	0.10	0.00	0.00	3.00
1972-73	0.00	0.00	0.00	0.00	0.00	14.60	0.70	0.00	0.00	0.00	0.00	0.00	15.30
1973-74	0.00	0.00	0.00	0.00	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50
1974-75	0.00	0.00	0.00	0.00	0.00	0.00	1.60	0.00	0.00	0.00	0.00	0.00	1.60
1975-76	0.00	0.00	0.00	0.00	0.00	1.50	0.00	0.00	0.30	0.00	0.00	0.00	1.80
1976-77	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1977-78	0.00	0.00	0.00	0.00	6.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.10

1978-79	0.00	0.00	0.00	0.00	1.50	2.90	2.20	0.60	0.00	0.00	0.00	0.00	7.20
1979-80	0.00	0.00	0.00	0.00	0.00	0.00	1.80	0.00	0.00	0.00	0.00	0.00	1.80
1980-81	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1981-82	0.00	0.00	0.00	0.00	0.00	0.00	4.40	0.60	0.00	0.00	0.00	0.00	5.00
1982-83	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1983-84	0.00	0.00	0.00	0.00	0.00	4.30	0.00	0.00	0.00	0.00	0.00	0.00	4.30
1984-85	0.00	0.00	0.00	0.00	0.00	0.30	0.00	4.60	0.00	0.00	0.00	0.00	4.90
1985-86	0.00	0.00	0.00	0.00	2.00	6.50	0.00	3.60	0.00	0.00	0.00	0.00	12.10
1986-87	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1987-88	0.00	0.00	0.00	0.00	0.00	5.80	1.00	0.00	0.00	0.00	0.00	0.00	6.80
1988-89	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.90	0.70	0.00	0.00	0.00	9.60
1989-90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.60	0.00	0.00	0.00	0.00	9.60
1990-91	0.00	0.00	0.00	0.00	0.00	1.20	0.00	0.00	0.00	0.00	0.00	0.00	1.20
1991-92	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1992-93	0.00	0.00	0.00	0.00	0.00	7.90	10.00	14.10	0.00	0.00	0.00	0.00	32.00
1993-94	0.00	0.00	0.00	0.00	0.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.40
1994-95	0.00	0.00	0.00	0.00	0.00	1.90	0.10	3.10	0.00	0.00	0.00	0.00	5.10
1995-96	0.00	0.00	0.00	0.00	0.00	0.00a	0.00	-----z	-----z	-----z	-----z	-----z	0.00e
1996-97	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	0.00l
1997-98	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	0.00l
1998-99	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	0.00l
1999-00	-----z	-----z	-----z	-----z	-----z	-----z	0.00r	0.00n	0.00o	0.00	0.00	0.00c	0.00i
2000-01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00d	0.00	0.00	0.00	0.00
2001-02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00x	-----z	-----z	-----z	-----z	0.00e
2002-03	0.00q	-----z	0.00s	0.00y	0.00v	-----z	-----z	0.00t	-----z	0.00o	0.00t	0.00s	0.00l
2003-04	0.00s	0.00s	0.00q	0.00t	0.00u	0.00y	-----z	0.00v	0.00m	0.00k	0.00o	0.00a	0.00k
2004-05	0.00	0.00	0.00e	0.00q	0.00r	0.00u	0.00m	0.00j	0.00r	0.00w	0.00l	0.00o	0.00i
2005-06	0.00	0.00	0.00e	0.00o	0.00t	0.00r	-----z	0.00n	-----z	0.00t	0.00l	0.00	0.00h
2006-07	0.00	0.00a	0.00e	0.00h	0.00w	0.00r	0.00r	0.00y	0.00s	0.00q	0.00m	0.00c	0.00h
2007-08	0.00	0.00	0.00e	0.00s	0.00n	0.00x	0.00v	0.00v	-----z	0.00u	0.00h	0.00h	0.00i
2008-09	0.00	0.00b	0.00d	0.00k	0.00n	0.00v	0.00p	0.00s	0.00v	0.00p	0.00m	0.00	0.00h
2009-10	0.00	0.00a	0.00c	0.00l	0.00x	0.00r	0.00y	0.00r	0.00v	0.00x	0.00m	0.00e	0.00h
2010-11	0.00	0.00	0.00a	0.00l	0.00u	0.00w	0.00s	0.00r	-----z	0.00v	0.00v	0.00i	0.00i
2011-12	0.00a	0.00a	0.00d	0.00k	0.00y	0.00p	0.00s	0.00t	0.00w	0.00y	0.00i	0.00h	0.00i
2012-13	0.00b	0.00a	0.00	0.00j	0.00q	-----z	0.00s	0.00p	0.00o	0.00l	0.00o	0.00e	0.00h
2013-14	0.00	0.00	0.00h	0.00m	0.00w	0.00k	0.00o	0.00v	0.00s	0.00s	0.00g	0.00a	0.00i
2014-15	0.00e	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	0.00k
Period of Record Statistics													
MEAN	0.00	0.00	0.00	0.06	0.24	1.69	2.92	1.56	0.43	0.00	0.00	0.00	6.87
S.D.	0.00	0.00	0.00	0.54	0.99	3.77	5.65	3.79	1.57	0.01	0.00	0.00	8.70
SKEW	0.00	0.00	0.00	9.06	4.92	3.28	2.93	3.74	5.44	9.06	0.00	0.00	1.74
MAX	0.00	0.00	0.00	5.00	6.10	23.00	32.80	25.20	10.90	0.10	0.00	0.00	34.90

MIN	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
YRS	95.00	95.00	93.00	85.00	85.00	82.00	92.00	89.00	82.00	85.00	83.00	88.00	73.00

Appendix 11. Monthly Temperature at Salem McNary Field, OR

Monthly Average of Average Daily Temperature (Degree Fahrenheit)

(357500)
File last updated on Jul 29, 2014
a = 1 day missing, b = 2 days missing, c = 3 days, ..etc..,
z = 26 or more days missing, A = Accumulations present
Long-term means based on columns; thus, the monthly row may not
sum (or average) to the long-term annual value.
MAXIMUM ALLOWABLE NUMBER OF MISSING DAYS : 5
Individual Months not used for annual or monthly statistics if more than 5 days are missing.
Individual Years not used for annual statistics if any month in that year has more than 5 days missing.

YEAR(S)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
1892	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z
1893	33.82	40.48b	45.38a	47.45	53.76	57.83a	61.95	63.44	56.62	48.32	43.48	43.97	49.71
1894	41.32	38.86	44.92	50.17	54.90	59.28a	64.97	69.85	59.58	52.21	46.17	39.16	51.78
1895	38.90	42.50	44.27	51.67	53.06w	61.20	64.29	65.08	56.97	53.68	43.87	42.16	51.33a
1896	43.26	45.90	45.26	47.53	52.69	60.67	69.65	65.61	60.20	54.05	39.60	44.74	52.43
1897	39.87	-----z	43.28o	53.40	59.53	60.88	63.39	68.90	58.70	52.15	45.82	42.95	54.56b
1898	38.77t	45.25	43.13	51.62	56.13	62.55	65.37	68.05	61.42	51.52	44.32b	37.79	53.38a
1899	44.39	43.02c	44.08a	48.22	52.97	58.68b	65.97	62.05	61.87	50.10	50.62	43.29	52.10
1900	42.98b	42.80	50.26	50.65	58.47	65.85	69.23	67.27	-----z	55.45b	-----z	-----z	55.88c
1901	-----z	-----z	-----z	-----z	57.35e	58.98e	-----z	67.18l	59.62a	59.35a	-----z	40.60a	55.18g
1902	37.86c	46.14	44.98	49.47	56.00	60.93	-----z	-----z	59.62	53.58	44.05	41.72b	49.44b
1903	43.18	40.23	45.31	48.36b	55.65	62.72	63.65	65.27	61.52	53.82	45.78	41.44	52.24
1904	41.94	41.43	43.63	53.73	57.68	62.33	66.81	67.97	62.47	55.15	50.18	42.79	53.84
1905	40.52	42.50	50.98	54.38	55.65	60.75	68.82	65.98	62.23	50.58	43.10	40.45	53.00
1906	43.53	44.52	45.06	54.68	56.56	59.52	71.95	68.45	61.90	55.10	47.13	43.89	54.36
1907	35.85	46.98c	45.69	52.12	58.16	61.83	67.65	65.38w	60.56u	-----z	47.30y	43.04r	52.61e
1908	41.88n	44.08q	46.02b	51.31c	51.13h	60.27	70.41d	68.04q	60.42	53.98	47.97	38.98	53.67d
1909	34.60	43.88	47.32	49.77	53.47a	61.72	62.90	65.35	62.53	53.29	46.67	35.17b	51.39
1910	38.34b	39.55	51.26	52.55	59.18	59.92	67.21	63.52	59.07	54.85	45.50	43.24	52.85
1911	38.71	40.12	48.50	49.48b	53.56	59.64a	69.45	66.79	57.22	52.42	46.46b	41.13	51.96
1912	42.21	44.77a	45.44g	49.35	57.37	61.68	67.02e	63.82i	60.12a	50.35	46.32	40.48	51.97b
1913	38.58e	40.45	44.66	50.85	56.63	61.83	66.08	68.98	-----z	51.34	42.63	38.10f	52.20b
1914	43.04f	41.27	47.62b	51.00b	59.21	60.35	68.31	67.50	59.03	55.29	46.23b	36.56	53.85a
1915	39.48	44.50	51.89	54.83	55.85	61.13	66.52	70.31	61.23	56.53	46.15	42.44	54.24

1916	33.00	46.21	46.47	52.25	52.94	60.98	64.16	68.50a	62.25	52.63	41.93	38.47	51.65
1917	41.17a	41.05	41.66	47.88	54.15	61.27	69.05	70.47	62.27	54.97	50.52	47.90	53.53
1918	43.82a	41.71	47.61	55.67	55.65	66.17	65.96c	66.45	66.30	54.60a	44.45	40.68	54.09
1919	40.40b	41.39	45.39	50.45a	55.32a	58.95a	66.74	66.55	60.72	45.95a	-----z	32.02k	53.18b
1920	37.59c	39.46a	43.83a	47.22	53.06	60.40	64.68	67.23	59.93g	51.50a	44.62	42.48	50.19a
1921	39.50b	45.02	46.58	49.65	55.32	63.70	65.15	66.58	58.50	55.70a	47.76a	38.61d	52.67
1922	35.62b	39.07	42.69	47.59a	57.13	66.23	69.47	67.00	63.28	53.67b	40.85d	38.91i	52.96a
1923	42.56e	37.20c	45.48a	51.98a	56.90	61.82	67.58	69.92	63.67	54.42	48.00	41.41d	53.41
1924	39.31b	47.53	45.58	52.02	60.32	65.02	67.27	66.89	62.40	54.68	45.05a	35.90	53.50
1925	44.55b	45.98a	46.61	53.20	59.66	63.20	69.34	66.31	62.12	54.17a	44.88b	44.91b	54.58
1926	40.82	47.86	52.27	59.28	58.16	67.02	70.82	67.31	60.00a	56.00	48.58	41.79	55.83
1927	39.15h	44.32	46.15	51.05	54.21	64.68	69.63	69.12a	61.28	54.03a	49.28a	37.18a	54.63a
1928	39.53	42.53	50.10	50.28	61.02	60.40a	67.97	65.42	60.07h	53.65d	44.69a	38.00	52.14a
1929	34.06	36.00	46.89	47.42	55.92	61.19a	65.21	66.93c	61.78	56.10a	42.90	45.11	51.63
1930	27.44	45.86	47.29g	51.39c	51.16f	57.48b	62.23a	65.77g	60.50g	48.94m	42.45j	38.61h	48.88g
1931	42.79l	41.14f	45.76j	50.76i	58.62f	59.91h	67.26h	66.85g	60.47a	53.60f	41.75b	38.61	46.94i
1932	38.18a	39.59	45.92	49.22g	54.70c	63.80	63.69	66.77	61.58	55.69	46.89c	36.03a	52.08a
1933	38.76	38.15b	45.65	49.47	52.10	60.62	64.98	66.90	57.82	54.18a	43.75	46.21	51.55
1934	45.65	45.93	52.03	55.95	58.27	62.27	64.48	66.58	59.98	55.47	49.48b	42.26	54.86
1935	40.66c	43.09a	42.69e	49.28e	54.19b	61.95	65.85	65.85	63.55	51.57a	40.95	39.08	51.56
1936	42.69	35.41	44.05	53.50	58.27	62.60	65.55	66.02	60.58	55.32	41.71a	42.68	52.37
1937	30.06	41.55	48.56	50.00	57.16	62.67	65.69	64.81	60.90	56.00	48.82	42.37	52.38
1938	39.29	42.59	45.26	51.75	56.95	63.07	69.24	64.11	65.22	53.97	42.53	41.94	52.99
1939	41.87	39.77	47.53	52.93	57.53	59.65	67.79	66.95	63.23	54.32	47.12	44.76	53.62
1940	39.66	45.33	49.35	52.37	59.20a	64.02	66.50	68.48	63.85	56.56	43.45	42.71	54.29
1941	41.95	45.34	51.15	53.03	56.63	62.15	71.97	67.97	60.28	53.92	46.62	42.13	54.43
1942	35.63	43.04	45.69	51.85	55.87	60.18	68.56	69.32	63.17	55.31	45.77	43.94	53.19
1943	33.84	43.98	45.32	53.32	54.48	60.25	67.02	66.10	65.47	54.55	45.67	39.16	52.43
1944	39.24	42.79	45.79	50.80	56.37	61.37	67.73	66.24	65.30	57.37	45.23	38.42	53.05
1945	42.10	44.57	44.50	49.65	57.95	61.70	68.06	67.34	60.15	53.34	45.75	41.05	53.01
1946	40.26	42.61	46.13	50.27	58.45	60.38	67.32	67.37	60.45	50.18	43.52	41.63	52.38
1947	37.00	45.48	49.02	53.35	60.61	60.65	65.73	64.68	62.95	54.37	46.68	42.08	53.55
1948	39.50	40.62	43.98	47.55	55.21	64.97	65.48	64.97	60.97	51.71	43.15	37.48	51.30
1949	29.47	40.73	46.73	52.75	58.94	62.13	66.00	66.23	63.30	48.66	49.15	40.16	52.02
1950	29.61	41.29	44.79	48.40	55.19	62.17	67.29	68.71	61.72	51.89	46.77	47.40	52.10
1951	39.81	43.12	40.92	52.52	55.84	64.02	66.68	64.73	62.68	53.10	45.23	37.55	52.18
1952	38.45	40.57	44.15	50.40	55.42	59.32	67.32	66.00	63.82	57.40	38.60	41.02	51.87
1953	46.94	43.00	44.85	49.15	54.08	57.50	64.61	65.35	62.52	54.16	47.63	42.50	52.69
1954	40.16	42.86	42.90	48.83	55.58	57.00	62.68	63.06	59.03	51.31	49.00	40.08	51.04
1955	39.15	40.02	41.39	45.22	53.05	59.88	62.53	64.52	60.42	53.21	43.00	41.11	50.29
1956	41.08	36.95	43.89	51.28	58.55	58.45	67.77	65.16	61.73	51.63	42.37	40.03	51.57
1957	32.94	42.68	46.89	51.80	58.35	61.67	64.63	63.74	65.27	53.21	42.85	43.03	52.25

1958	42.85	48.27	44.97	50.22	60.95	64.95	71.16	70.24	62.38	55.37	46.88	45.52	55.31
1959	42.76	42.88	45.98	50.78	54.00	61.57	67.94	65.44	60.15	54.32	44.22	39.60	52.47
1960	36.60	41.57	44.34	49.55	52.45	60.68	67.56	64.76	62.42	54.79	46.85	40.08	51.80
1961	42.95	46.09	46.34	49.05	53.95	63.27	67.50	69.26	58.32	52.53	41.23	40.97	52.62
1962	37.06	40.73	43.89	50.83	51.37	59.28	64.31	64.79	62.52	52.61	46.72	41.74	51.32
1963	33.69	47.73	44.37	47.03	55.16	59.12	61.85	65.58	65.68	53.74	46.07	39.85	51.66
1964	41.63	40.28	43.61	48.03	53.63	60.27	66.39	63.77	58.80	53.19	41.93	39.53	50.92
1965	40.48	43.04	46.61	50.32	52.15	58.93	67.21	66.73	59.55	55.31	47.92	37.82	52.17
1966	39.58	40.54	44.55	50.53	54.85	61.80	65.18	66.89	63.23	52.60	47.12	44.18	52.59
1967	44.10	42.59	43.08	44.58	54.34	64.13	67.58	71.60	64.90	54.29	46.43	41.95	53.30
1968	39.63	48.10	47.29	46.85	54.50	59.60	66.13	65.21	60.45	51.42	45.33	37.00	51.79
1969	32.95	40.32	46.24	49.08	58.87	65.35	64.90	63.50	61.10	49.85	44.07	41.92	51.51
1970	41.63	44.93	45.45	45.77	54.16	64.37	67.18	65.44	58.30	50.63	43.58	39.00	51.70
1971	39.06	39.41	41.92	47.12	53.29	58.18	67.34	69.10	59.13	50.58	44.50	39.47	50.76
1972	38.26	43.19	47.85	45.93	56.50	59.97	67.55	68.19	57.55	50.10	46.35	36.15a	51.47
1973	38.84	43.84	44.61	49.10	55.73	61.08	67.44	63.56	62.10	51.90	43.95	43.37	52.13
1974	37.53	41.21	46.08	49.32	52.84	61.80	65.76	67.35	65.73	53.00	46.40	43.00	52.50
1975	42.58	41.88	43.55	45.32	54.23	59.83	67.05	63.05	63.53	51.58	43.90	41.92	51.53
1976	40.66	40.21	42.47	47.13	53.24	56.85	65.26	64.16	61.97	52.08	45.90	38.73	50.72
1977	37.63	44.45	44.45	50.58	51.77	61.78	64.55	70.08	58.93	52.05	44.57	43.16	52.00
1978	41.37	45.25	48.15	48.88	54.76	65.18	68.79	68.34	60.98	54.13	39.35	34.74	52.49
1979	31.21	42.64	49.00	50.43	56.76	61.73	67.89	65.65	62.88	54.63	41.72	44.76	52.44
1980	35.53	43.14	44.55	50.67	53.69	57.52	65.48	62.74	62.48	53.56	47.28	42.84	51.62
1981	40.60	43.11	46.52	50.55	54.53	59.00	65.05	68.66	61.90	50.37	44.53	42.90	52.31
1982	38.53	41.55	44.48	45.83	54.69	65.05	65.65	66.42	61.37	53.32	42.33	41.10	51.69
1983	43.23	46.04	48.92	50.10	57.29	60.27	64.32	67.74	60.30	52.66	49.30	38.39	53.21
1984	43.19	44.17	48.63	47.75	52.89	57.38	65.44	66.76	61.28	51.39	44.40	37.42	51.72
1985	34.27	39.59	42.74	51.37	55.13	61.20	70.13	65.39	58.33	51.18	37.28	33.23	49.99
1986	43.19	44.34	50.15	48.35	55.23	64.17	63.45	69.82	58.92	53.65	46.63	39.58	53.12
1987	39.48	43.82	47.26	51.90	58.03	63.97	64.84	67.81	62.70	56.08	46.90	38.85	53.47
1988	39.34	43.33	45.58	51.10	53.69	60.48	66.77	65.81	62.25	56.63	46.82	40.52	52.69
1989	41.61	34.73	46.37	54.57	56.23	63.28	64.58	64.92	63.10	52.95	47.35	39.56	52.44
1990	42.76	41.27	47.79	52.73	55.21	62.27	69.60	69.11	64.87	51.19	46.87	34.44	53.17
1991	39.50	48.62	44.61	49.18	53.08	57.88	67.95	67.77	65.38	54.21	47.28	41.60	53.09
1992	44.10	47.57	50.52	53.80	60.82	65.75	68.89	68.18	62.00	55.05	46.12	39.19	55.16
1993	36.32	39.38	49.11	52.27	60.48	61.23	63.16	67.19	63.30	56.50	40.48	41.05	52.54
1994	44.27	42.95	50.18	53.20	59.19	61.65	69.06	67.03	65.15	52.63	41.68	42.24	54.10
1995	44.44	46.48	47.42	49.93	58.98	62.58	68.50	65.06	64.63	52.34	51.07	42.23	54.47
1996	41.92	42.17	47.23	51.85	53.13	60.87	70.21	67.77	59.95	52.42	45.18	42.45	52.93
1997	40.92	42.30	46.39	49.43	60.37	60.53	66.92	69.77	64.10	51.98	48.00	39.50	53.35
1998	43.95	45.46	47.26	50.43	54.56	61.28	69.61	69.00	64.47	52.35	47.70	39.90	53.83
1999	41.74	43.07	44.65	49.33	53.34	59.87	66.06	67.87	63.22	53.90	49.35	42.53	52.91

2000	40.13	43.43b	44.23	51.28	55.74	63.57	65.95	65.56	62.17	53.21	41.27	40.52	52.25
2001	40.56	41.79	46.68	47.85	57.29	58.57	66.03	67.15	63.57	52.55	47.58	41.16	52.56
2002	41.06	43.21	43.74	50.40	54.00	61.98	68.81	67.52a	63.17	52.10	46.37	43.13	52.96
2003	44.92	43.59	49.00	49.50	55.77	64.05	70.23	68.76	64.80	56.92	43.70	41.69	54.41
2004	39.52	43.59	49.15	52.53	56.74	63.10	69.97	70.10	60.58	54.24	43.80	42.47	53.82
2005	41.82	41.36	48.63	50.20	57.89	59.70	68.85	68.94	60.58	54.19	42.47	39.81	52.87
2006	44.39	41.41	44.55	50.90	57.11	64.30	69.76	67.39	63.40	51.98	46.92	39.58	53.47
2007	38.06	44.30	48.98	49.82	56.66	61.07	69.85	67.27	61.30	51.50	43.63	40.11	52.71
2008	37.08	43.09	43.27	46.42	56.84b	59.27	68.03	67.61	63.08	51.76	47.80	37.06	51.78
2009	39.65	41.09	44.15	49.43	57.23	63.87	71.19	68.32	64.38	53.34	46.87	37.23	53.06
2010	46.24	46.29	47.23	49.70	54.37	60.00	67.50	67.40	63.65	54.53	45.40	43.87	53.85
2011	42.26	40.95	47.03	47.47	53.55	60.73	65.92	69.08	66.57	54.50	45.03	38.74	52.65
2012	42.13	42.67	43.92	51.57	55.73	59.83	66.85	69.63	64.13	55.08	47.62	42.23	53.45
2013	37.13	43.55	47.63	51.55	58.15	63.93	70.45	70.61	64.33	51.56	45.70	36.16	53.40
2014	41.29	42.32	49.08	52.93	59.81	63.17	72.12c	-----z	-----z	-----z	-----z	-----z	54.39e
Period of Record Statistics													
MEAN	39.66	42.73	46.15	50.40	55.99	61.46	66.94	66.89	61.82	53.36	45.30	40.77	52.65
S.D.	3.71	2.71	2.44	2.45	2.32	2.21	2.30	1.99	2.20	2.06	2.65	2.72	1.14
SKEW	-0.90	-0.24	0.43	0.25	0.28	0.23	0.03	-0.08	-0.11	-0.29	-0.38	-0.19	0.19
MAX	46.94	48.62	52.27	59.28	61.02	67.02	72.12	71.60	66.57	59.35	51.07	47.90	55.83
MIN	27.44	34.73	40.92	44.58	51.37	56.85	61.85	62.05	56.62	45.95	37.28	33.23	49.71
YRS	116.00	118.00	117.00	119.00	118.00	121.00	119.00	114.00	115.00	118.00	116.00	115.00	102.00

Appendix 12. 1892-2014 Monthly Precipitation at Salem McNary Field, OR

(Inches)

(357500)

File last updated on Jul 29, 2014

a = 1 day missing, b = 2 days missing, c = 3 days, ..etc..,
z = 26 or more days missing, A = Accumulations present
Long-term means based on columns; thus, the monthly row may not
sum (or average) to the long-term annual value.
MAXIMUM ALLOWABLE NUMBER OF MISSING DAYS : 5
Individual Months not used for annual or monthly statistics if more than 5 days are missing.
Individual Years not used for annual statistics if any month in that year has more than 5 days missing.

YEAR(S)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
1892	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	6.08	6.08k
1893	1.90	5.43	4.16	7.50	4.20	1.24	0.00	0.10	3.55	7.49	9.33	4.18	49.08

1894	9.92	4.32	10.13	3.68	2.24	3.50	0.19	0.00	2.27	4.39	2.19	4.62	47.45
1895	13.72	1.89	4.56	2.34	4.10k	0.50	0.61	0.23	2.18	0.00	3.71	11.16	40.90a
1896	6.35	3.31	2.69	6.12	5.54	0.99	0.00	1.00	0.66	2.97	16.99	8.31	54.93
1897	-----z	5.73	6.11	2.29b	1.78	1.77	0.64	0.28	1.77b	2.08	11.67	7.76	41.88a
1898	3.43a	5.64	2.15	2.44	1.75	1.61	0.40	0.06	1.13	4.65	6.82	4.31	34.39
1899	5.76a	6.35	4.13	3.72	3.90	0.25	0.00	2.91	1.40	3.95	9.22	6.58	48.17
1900	4.15	2.98	4.25	2.60	3.90	2.20	0.62	0.00	-----z	4.70	2.76	6.86	35.02a
1901	7.08a	5.13	-----z	0.72w	1.79	0.50e	-----z	0.30	3.25	1.25	4.39a	5.32	29.01c
1902	1.48	7.90b	6.00	3.71	3.59	0.90	-----z	-----z	0.42	1.07	7.98	7.49	40.54b
1903	4.56	0.88	2.73	1.20a	1.09	1.30	0.40	0.29	0.23	1.65	8.28	1.95	24.56
1904	3.78	9.47	9.04	1.68	0.43	0.32	0.80	0.14	0.42	2.82	6.53	6.65	42.08
1905	4.71	2.08	4.64	0.86	1.57	0.59	0.05	0.03	2.86	4.26	2.26	4.58	28.49
1906	5.42	5.78	1.94	1.58	1.85	2.50	0.00	0.00	1.92	2.38	5.99	4.65	34.01
1907	8.01	4.34	2.88	1.69	0.92	1.55a	0.67	1.07	0.60e	0.58a	1.37g	7.68f	22.31b
1908	3.54e	1.63d	2.63	1.99	2.38	1.06	0.02	0.52a	0.30	4.88	3.61	2.90	25.46
1909	8.28	5.98b	1.51	0.51	1.02	0.18	1.96	0.02	0.90	3.24	10.56	4.80	38.96
1910	5.63	4.92	1.24	2.20	1.58	1.19	0.00	0.02	1.26	1.80	8.03	4.02	31.89
1911	8.43	1.72	0.59	1.83	2.78	0.85	0.06	0.00	4.56	0.81	1.97	3.95	27.55
1912	5.52	3.94	1.79	2.03	2.40	2.70	0.32	1.81	1.49	3.22	5.78	4.72	35.72
1913	4.36	1.20	3.36	2.24	2.24	3.48	0.29	0.30	2.57	2.17b	5.54	3.39	31.14
1914	8.71	4.12	2.56	2.59	1.96	1.85	0.00	0.00	4.84	3.34	3.38	2.52	35.87
1915	4.08	3.64	1.88	1.40	2.38	0.94	0.99	0.00	0.42	1.54	8.06	7.22	32.55
1916	5.39	6.43	9.96	2.59	2.58	1.31	2.72	0.35	1.17	1.43	7.12	4.71	45.76
1917	1.30	2.83	3.73	3.62	1.60	1.13	0.02	0.00	1.32	0.00	3.24	14.03	32.82
1918	4.39	5.68	3.81	1.22	1.08	0.00	0.67	0.67	0.17	2.83	3.94	3.76	28.22
1919	8.43	8.10	4.54	3.18	0.81	0.16	0.05	0.00	2.42	1.42	5.85	6.05	41.01
1920	2.98	0.34	4.24	3.37	0.25	2.69	0.55	0.95	4.45	4.97c	6.76	8.29	39.84
1921	7.27	6.90	5.07	1.93	1.62	1.05g	0.00	0.13	1.86	3.69	10.37	2.81a	41.65a
1922	3.11	4.33	6.14	2.16	0.93	0.03	0.00	1.49	1.97	4.91	2.57	10.41	38.05
1923	10.17	2.62	1.99	1.70	1.89	0.97	1.21x	0.05	0.70	2.21	3.80	6.22	32.32a
1924	3.54	2.59b	1.29	1.10	0.61	0.22	0.00	0.53	2.37	8.31	7.98	4.61	33.15
1925	6.73	8.07	1.41	2.71a	1.86	0.96	0.00	0.77	1.73	0.03	5.65	3.40	33.32
1926	3.21	8.91	0.64	0.49	2.95	0.24	0.00	2.42	1.89	4.28	9.30	4.84	39.17
1927	8.90	9.05	2.65	1.46	1.75	1.54	0.01	0.12	3.71	3.91	7.02	3.11	43.23
1928	4.83	1.29	8.00	5.21	0.45	0.85	0.05	0.00	0.78	1.78	7.15	7.64	38.03
1929	2.50	1.28	2.51	4.09	1.10	1.71	0.00	0.05	0.27	1.17	0.63	11.09	26.40
1930	3.98	6.43	1.93	3.95	1.75	0.99	0.01	0.01	2.03	1.92	3.75	3.30	30.05
1931	6.77	3.46	6.49	3.38	0.78	3.35	0.00	0.00	1.59	4.48	7.38	10.98	48.66
1932	6.08	2.00	6.06	3.38	3.06	0.22	0.65	0.54	0.01	4.33	7.96	7.77	42.06
1933	9.26	4.38	5.89	0.48	4.61	1.58	0.00	0.37	2.99	3.83	1.63	17.54	52.56
1934	6.40	1.59	3.89	2.33	1.35	0.34	0.30	0.27	0.43	3.64	9.49	9.38	39.41
1935	4.39	4.00	6.20	1.87	0.41	0.36	0.39	0.53	1.20	3.30	2.26	5.99	30.90

1936	10.22	5.57	3.13	1.13	3.41	1.11	0.49	0.00	1.49	0.21	0.48	6.37	33.61
1937	6.17	10.36	3.19	7.68	1.60	4.61	0.13	0.71	0.91	3.41	11.13	13.60	63.50
1938	4.48	7.60	8.42	2.27	0.78	0.08	0.36	0.06	1.38	3.68	4.26	5.18	38.55
1939	6.00	5.08	2.65	0.39	0.90	0.98	0.47	1.04	0.38	2.63	0.84	10.32	31.68
1940	4.75	11.66	5.94	1.99	2.17	0.07	0.62	0.00	2.36	3.79	4.55	5.03	42.93
1941	4.25	1.43	1.95	1.80	3.83	0.49	0.03	1.33	2.37	2.87	5.36	8.43	34.14
1942	4.79	3.10	1.27	1.74	4.58	1.69	0.92	0.04	0.01	2.04	13.38	11.70	45.26
1943	4.35	4.50	6.71	2.75	1.09	3.38	0.32	2.14	0.06	6.31	2.36	5.17	39.14
1944	5.27	3.53	1.64	2.75	0.93	0.50	0.05	0.05	1.97	1.54	4.30	2.67	25.20
1945	5.34	5.92	6.67	2.89	4.44	0.32	0.51	0.20	2.46	1.75	10.73	6.25	47.48
1946	6.57	5.77	5.72	1.14	1.15	1.28	0.72	0.09	1.89	4.55	8.04	4.45	41.37
1947	3.23	3.43	5.29	2.24	0.18	3.60	1.41	0.44	1.01	11.17	3.42	4.11	39.53
1948	6.73	6.35	5.01	3.85	4.15	0.38	0.60	0.52	2.60	2.26	7.56	9.14	49.15
1949	0.57	12.31	3.06	1.00	2.23	0.97	0.26	0.38	1.37	2.31	5.86	5.45	35.77
1950	11.70	6.22	4.86	1.88	1.21	2.80	0.18	0.35	0.84	10.74	9.67	6.10	56.55
1951	9.49	5.43	4.02	0.98	2.49	0.01	0.17	0.65	3.22	7.29	6.99	6.73	47.47
1952	6.60	4.86	2.59	1.57	0.20	2.64	0.00	0.00	0.20	0.83	1.73	8.63	29.85
1953	15.40	4.87	4.95	1.58	3.76	1.34	0.00	1.65	1.59	3.06	6.99	7.80	52.99
1954	9.99	5.87	3.02	2.70	1.34	2.47	0.31	0.72	1.28	3.45	5.07	6.26	42.48
1955	2.63	2.25	3.66	5.18	1.18	1.09	0.86	0.00	2.30	7.78	6.75	12.22	45.90
1956	12.68	5.42	5.91	0.64	1.61	1.20	0.00	0.37	0.87	6.50	1.03	2.94	39.17
1957	2.38	4.93	8.16	2.02	2.77	2.10	0.18	0.27	0.96	2.98	3.31	8.87	38.93
1958	8.80	7.04	2.50	3.71	1.38	2.53	0.00	0.03	1.00	2.23	7.18	4.71	41.11
1959	11.15	4.98	4.45	1.12	2.09	1.41	0.50	0.02	2.10	1.53	2.06	3.97	35.38
1960	4.41	5.41	6.99	3.50	3.59	0.47	0.00	0.65	0.65	2.75	9.45	3.24	41.11
1961	4.79	10.82	8.19	3.19	2.44	0.30	0.96	0.28	0.91	3.18	4.42	6.64	46.12
1962	1.11	3.97	5.65	3.03	2.11	0.69	0.00	0.70	1.53	4.55	8.54	3.01	34.89
1963	2.80	3.34	6.51	4.07	3.70	0.85	0.91	0.09	1.41	3.59	6.52	3.85	37.64
1964	11.19	0.78	3.55	1.28	0.59	1.73	0.45	0.41	0.74	0.93	8.44	12.40	42.49
1965	8.15	1.57	0.87	2.41	1.16	1.11	0.19	0.99	0.13	2.20	7.00	7.95	33.73
1966	6.60	2.24	6.08	1.07	0.78	0.58	0.53	0.40	1.66	2.06	5.88	7.32	35.20
1967	7.29	2.06	3.84	2.02	1.87	0.69	0.00	0.00	0.84	5.08	3.30	5.45	32.44
1968	6.37	7.73	3.32	1.47	3.46	1.29	0.39	4.17	2.48	6.14	6.49	11.05	54.36
1969	8.61	3.24	1.63	2.51	0.89	2.94	0.05	0.05	3.58	4.44	3.21	9.23	40.38
1970	13.47	4.46	1.92	2.63	1.36	0.85	0.01	0.00	1.81	3.25	7.18	9.74	46.68
1971	6.49	4.34	6.93	4.05	1.89	2.47	0.01	1.49	3.98	3.09	6.27	8.18	49.19
1972	7.98	4.68	4.96	3.79	2.40	0.69	0.12	0.14	2.07	0.70	3.77	8.70	40.00
1973	5.64	1.62	3.50	1.69	1.11	1.48	0.00	0.80	2.80	2.79	15.23	11.08	47.74
1974	10.89	5.56	7.95	1.48	0.90	0.41	1.80	0.11	0.28	2.15	7.42	6.94	45.89
1975	4.96	4.68	4.22	2.20	1.66	0.81	0.51	1.96	0.00	5.51	6.06	6.07	38.64
1976	5.47	6.92	3.66	2.00	1.33	1.04	0.67	1.89	1.13	1.51	1.13	1.26	28.01
1977	0.88	2.83	3.33	0.62	3.76	0.73	0.26	1.70	2.36	2.37	6.19	8.73	33.76

1978	5.67	3.54	1.23	3.50	2.97	0.48	1.07	2.56	2.64	0.37	4.50	2.64	31.17
1979	2.84	7.19	2.17	2.82	2.20	0.65	0.30	0.70	2.19	6.06	3.83	6.95	37.90
1980	6.58	4.04	3.48	3.58	1.53	1.99	0.22	0.04	1.05	1.45	5.24	10.44	39.64
1981	2.09	3.29	3.45	2.06	2.19	3.33	0.15	0.00	2.78	4.63	7.54	9.73	41.24
1982	6.11	6.02	2.81	3.80	0.73	1.36	0.33	0.41	1.83	3.04	4.92	9.26	40.62
1983	6.00	10.57	8.56	2.72	2.12	2.48	2.63	2.09	0.32	1.31	10.06	6.49	55.35
1984	2.34	5.50	4.40	3.74	3.32	4.19	0.03	0.00	1.19	4.31	12.70	3.71	45.43
1985	0.24	3.44	3.80	0.93	0.65	2.42	0.32	0.20	1.25	3.17	4.81	2.51	23.74
1986	6.25	8.26	2.89	1.30	2.22	0.42	1.23	0.00	3.12	2.71	7.24	3.86	39.50
1987	7.67	3.52	3.98	2.36	1.52	0.26	2.51	0.15	0.14	0.47	3.00	10.92	36.50
1988	6.78	0.75	3.34	3.56	2.39	1.97	0.03	0.00	0.98	0.12	9.50	3.23	32.65
1989	3.57	2.79	6.47	1.06	1.08	1.03	0.77	0.48	1.03	2.50	3.09	3.95	27.82
1990	8.51	5.31	2.39	1.67	1.94	1.09	0.47	0.85	0.42	5.63	4.91	2.82	36.01
1991	2.42	3.72	5.18	3.84	4.51	1.55	0.11	0.67	0.04	1.70	5.94	3.73	33.41
1992	4.76	4.46	0.89	4.35	0.05	1.12	0.50	0.38	0.70	3.52	4.84	7.83	33.40
1993	4.77	1.61	5.12	5.64	3.59	3.17	1.05	0.40	0.01	1.11	1.26	6.84	34.57
1994	4.28	4.21	2.56	2.16	1.61	1.14	0.00	0.05	1.64	7.96	7.09	4.91	37.61
1995	8.63	4.35	4.44	4.41	1.29	1.48	0.36	1.29	1.81	4.07	9.07	7.28	48.48
1996	8.26	13.01	3.08	5.72	3.21	0.74	0.90	0.20	1.94	4.78	10.11	15.01	66.96
1997	9.07	2.08	7.32	3.41	2.71	1.86	0.36	1.13	3.81	6.45	4.40	3.16	45.76
1998	9.06	6.18	4.96	1.63	5.56	0.98	0.10	0.04	0.68	2.52	11.70	8.66	52.07
1999	9.61	11.40	5.06	1.35	1.90	1.43	0.15	0.68	0.09	2.44	7.26	5.38	46.75
2000	7.05	6.92	2.98	1.29	1.56	0.71	0.09	0.03	0.75	2.40	2.53	3.62	29.93
2001	1.81	1.22	2.82	2.49	1.45	1.89	0.24	0.78	0.57	3.35	9.02	8.03	33.67
2002	8.93	3.54	4.47	1.77	1.35	1.22	0.07	0.02	0.98	0.47	3.84	11.20	37.86
2003	7.38	2.78	4.79	5.54	1.74	0.62	0.00	0.03	0.94	2.47	4.99	10.42	41.70
2004	6.65	5.10	1.43	2.13	2.06	1.78	0.09	1.04	2.08	3.30	2.14	3.89	31.69
2005	1.43	0.49	4.15	2.82	4.65	1.90	0.21	0.05	2.33	2.70	6.04	11.52	38.29
2006	13.37	2.12	4.17	2.46a	2.88	0.65	0.07	0.00	0.54	0.65	15.15	7.35	49.41
2007	3.92	5.33	2.35	2.29	1.27	0.78	0.34	0.72	2.76	4.24	3.75	8.25	36.00
2008	8.34	1.89	3.54	1.97	0.43	0.74	0.00	1.28	0.41	0.96	3.59	6.02	29.17
2009	3.56	2.90	3.03	1.35	3.03	1.39	0.68	0.18	1.20	2.61	8.02	6.14	34.09
2010	5.85	4.07	5.20	4.35	3.47	2.64	0.04	0.20	2.07	5.22	6.44	9.95	49.50
2011	3.25	4.31	7.16	4.15	3.40	0.98	0.74	0.11	0.35	2.15	5.96	3.32	35.88
2012	11.29	4.14	9.98	3.08	2.31	2.20	0.07	0.00	0.04	5.94	8.92	7.40	55.37
2013	1.63	1.42	2.21	2.39	2.94	1.02	0.00	0.35	7.05	0.63	2.68	1.27	23.59
2014	2.26	7.01	7.32	2.71	2.07	0.64	0.46	0.35	1.19				
Period of Record Statistics													
MEAN	6.04	4.69	4.20	2.57	2.08	1.33	0.39	0.52	1.56	3.19	6.12	6.65	39.32
S.D.	3.08	2.63	2.16	1.38	1.20	0.97	0.52	0.71	1.20	2.09	3.22	3.13	8.47
SKEW	0.54	0.86	0.67	1.14	0.72	1.05	2.45	2.24	1.29	1.14	0.69	0.72	0.57
MAX	15.40	13.01	10.13	7.68	5.56	4.61	2.72	4.17	7.05	11.17	16.99	17.54	66.96

```
MIN     0.24    0.34    0.59    0.39    0.05    0.00    0.00    0.00    0.00    0.00    0.48    1.26   23.59
YRS   121.00  122.00  121.00  121.00  121.00  121.00  119.00  120.00  120.00  121.00  120.00  121.00  113.00
```

Appendix 13. Upper Drift Creek Daily Stream Flows for Representative Years

(1935-36, 1933-34 and 1947-48)

```
Estimated daily stream flows for representative flow years (33-34 av; 35-36 low; 47-48 high)
Oct33,15.39,13.06,11.22,10.16,9.09,8.10,7.77,7.44,6.78,6.66,6.53,6.37,6.20,6.04,5.96
      5.91,5.79,5.79,5.91,6.41,7.11,7.11,7.11,7.11,7.44,7.11,8.43,10.16,29.44,69.06,71.25
Nov33,73.79,66.86,66.86,72.34,65.76,53.44,40.23,35.62,29.44,26.86,23.50,21.05,20.25,18.63,17.82
      16.20,15.39,14.61,13.84,15.39,19.44,17.82,15.39,14.61,13.84,13.43,13.06,13.43,14.61,15.39
Dec33,16.20,16.20,17.82,23.50,28.57,86.27,187.23,199.51,187.23,174.48,160.45,129.16,121.24,106.50,111.81
      123.79,106.50,125.06,206.98,241.62,226.99,265.78,294.71,282.06,255.29,254.82,237.99,221.45,208.81,199.51,185.45
Jan34,168.52,146.26,137.22,145.07,135.68,135.68,121.24,99.76,82.39,73.79,72.34,75.24,87.33,114.43,131.66
      126.33,126.33,148.92,148.92,151.55,155.32,162.98,174.48,183.91,183.91,177.67,164.38,148.92,118.34,86.27,73.79
Feb34,65.76,56.83,51.17,46.97,45.06,41.20,36.52,33.82,41.20,47.74,43.90,38.32,36.52,33.82,32.91
      31.18,30.31,29.44,29.44,27.69,26.02,24.34,24.34,22.66,21.86,21.86,21.86,28.57
Mar34,28.57,37.42,73.79,69.06,66.86,88.73,106.50,91.51,73.79,62.43,55.71,47.74,43.13,39.25,36.52
      33.82,32.05,30.31,28.57,26.86,25.18,24.34,22.66,21.86,21.05,20.25,20.25,48.89,115.74,111.81,114.43
Apr34,111.81,122.52,118.34,99.76,81.32,69.06,60.20,53.44,46.97,42.36,38.32,35.62,32.91,30.31,28.57
      26.86,26.02,24.34,23.50,21.86,20.25,20.25,20.25,22.66,26.02,34.72,32.91,30.31,28.57,27.69
May34,27.69,26.86,28.57,32.05,33.82,61.32,61.32,54.58,50.03,45.06,40.23,35.62,32.91,28.57,26.86
      25.18,23.50,23.50,23.50,22.66,23.50,21.05,18.63,17.82,16.20,16.20,15.39,15.39,14.61,13.84,13.06
Jun34,13.06,13.84,13.84,13.84,12.29,11.51,11.14,11.14,11.14,10.77,10.40,9.66,8.60,7.90,7.90
      7.90,7.90,7.52,7.19,6.86,6.86,6.86,6.49,6.49,6.49,6.49,6.49,8.27,7.90,7.19
Jul34,6.49,6.16,5.83,5.58,5.17,4.96,4.96,5.05,4.92,4.92,4.84,4.71,4.47,4.30,4.26
      4.30,4.47,4.51,4.92,5.05,4.47,4.26,4.63,4.63,4.47,4.38,4.30,4.30,4.30,4.47,4.38
Aug34,4.13,4.13,3.97,3.88,4.01,4.63,4.47,4.13,3.76,3.64,3.55,3.72,3.47,3.39,3.26
      3.26,3.14,3.22,3.18,3.14,3.05,3.14,2.97,2.89,2.76,2.81,2.76,2.64,2.64,2.72,2.76
Sep34,2.89,2.89,2.81,2.81,2.76,2.64,2.51,2.51,2.64,2.72,2.81,2.89,3.39,3.14,3.22
      3.26,3.47,3.14,3.05,2.89,2.81,2.97,3.26,3.72,3.80,4.51,4.05,3.88,3.39,3.55

Oct35,2.38,2.46,2.38,3.13,3.99,4.58,4.78,3.99,3.52,3.36,3.13,3.32,4.23,6.50,10.20
      15.34,11.64,9.50,7.48,6.81,6.15,6.15,7.13,7.13,6.15,5.84,5.52,5.52,5.84,6.50,7.13
Nov35,6.15,6.15,6.15,5.29,4.70,4.66,4.78,4.97,4.97,6.15,9.50,12.37,27.05,29.52,23.84,22.25,23.84
      21.46,18.41,16.11,14.57,13.10,13.10,13.84,14.57,13.84,13.10,11.64,11.64,10.20
Dec35,9.85,9.50,8.80,8.80,8.45,8.80,10.90,19.93,23.84,23.05,24.64,43.76,62.27,55.95,46.29
      38.09,32.88,28.70,26.22,23.05,20.70,19.17,18.41,17.64,17.64,19.17,21.46,27.05,35.44,39.01,59.12
Jan36,81.70,105.87,128.48,142.13,165.22,171.21,166.73,162.16,156.97,166.73,168.24,201.12,238.45,233.59,227.09
      214.94,211.46,194.26,178.96,163.69,149.52,131.09,107.12,86.66,69.87,60.17,53.82,48.45,44.48,40.11,37.17
Feb36,34.59,33.73,30.35,29.52,29.52,33.73,44.48,42.66,37.17,33.73,32.02,32.88,49.53,55.95,50.61
      44.48,40.11,37.17,34.59,34.59,45.21,127.31,150.60,153.00,143.51,131.09,119.63,112.06,107.12
```

```
Mar36,97.03,84.02,77.01,67.47,61.22,54.88,48.45,44.48,44.48,47.37,42.66,40.11,42.66,43.76,45.21,46.29,45.21
      40.84,38.09,35.44,33.73,32.02,31.17,32.02,32.88,32.02,37.17,90.58,108.36,99.58,82.69
Apr36,72.27,58.06,63.31,51.68,48.45,44.48,42.66,41.57,41.57,41.57,42.66,46.29,47.37,44.48,41.57
      39.01,37.17,34.59,32.02,29.52,27.05,26.22,25.43,24.64,27.05,27.88,25.43,24.64,24.64,23.05
May36,22.25,21.46,21.46,24.64,35.44,53.82,53.82,45.21,39.01,34.59,31.17,27.88,25.43,26.22,36.29
      39.01,37.17,33.73,31.17,32.02,44.48,48.45,45.21,38.09,33.73,30.35,27.05,25.43,23.84,23.05,22.25
Jun36,21.46,20.70,20.70,19.93,18.41,17.64,16.88,18.41,21.46,20.70,19.17,17.64,16.11,16.11,19.17
      26.22,30.35,30.35,27.05,24.64,22.25,20.70,18.41,16.88,16.11,14.57,13.84,13.84,13.10,12.37
Jul36,11.64,11.25,10.55,10.55,11.25,11.64,10.55,9.85,9.15,9.15,9.85,11.25,11.64,9.85,9.15
      8.14,7.48,7.48,6.97,6.50,6.15,5.84,5.52,5.21,5.09,4.97,4.70,4.50,4.39,4.27,4.23
Aug36,4.15,4.07,3.99,3.91,3.91,3.76,3.52,3.56,3.52,3.36,3.32,3.21,3.09,3.05,2.97
      2.93,2.89,2.89,3.05,3.05,3.05,3.05,2.85,2.66,2.85,3.09,3.05,2.97,2.85,2.73,2.62
Sep36,2.62,2.73,4.07,4.66,4.07,3.76,3.36,3.13,3.05,3.05,3.09,3.13,3.13,3.44,5.84
      7.48,6.50,4.82,4.15,3.99,3.68,3.44,3.21,3.09,2.89,2.85,2.85,2.81,2.66,2.62

Oct47,3.72,3.64,3.76,6.41,10.08,8.13,7.25,6.49,6.41,7.57,15.26,39.53,33.94,22.92,18.79
      39.16,72.54,109.27,135.58,159.78,182.36,176.42,161.39,147.10,128.75,107.68,80.85,66.20,60.84,64.42,76.36
Nov47,86.97,122.39,123.61,114.01,122.08,105.43,97.30,98.61,106.72,107.36,102.85,95.65,89.66,103.17,114.95
      125.13,125.74,121.16,113.38,101.88,90.67,77.40,67.26,59.40,53.24,48.47,44.02,40.66,37.65,35.00
Dec47,33.41,32.27,31.20,35.46,35.57,31.77,30.05,37.46,43.28,45.14,44.02,42.90,41.03,57.96,82.56
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Feb48,27.56,26.79,25.63,24.47,24.55,23.39,21.68,21.60,45.88,60.48,55.79,44.76,39.23,36.59,43.65
      71.84,95.65,104.14,96.31,99.60,98.29,147.38,184.30,172.88,168.51,147.95,166.94,159.51,146.54
Mar48,127.55,108.95,93.67,78.44,69.02,64.77,64.77,65.84,65.84,66.20,59.40,54.33,51.41,57.24,71.84
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Apr48,70.43,66.20,66.20,70.78,69.73,70.08,66.90,62.28,59.04,55.79,65.84,65.13,61.20,56.87,58.32
      65.13,73.23,81.53,77.06,70.43,64.77,64.42,69.38,74.98,73.58,70.08,65.13,60.12,56.87,52.87
May48,47.73,43.28,41.41,82.21,94.33,95.65,101.23,98.29,89.66,78.44,68.67,61.20,60.84,62.99,57.96
      51.77,49.20,46.62,42.90,40.28,38.71,36.52,33.87,31.77,30.44,29.86,28.13,29.59,40.28,37.65,33.03
Jun48,31.39,27.94,25.09,23.39,22.30,21.21,19.96,18.48,17.46,16.52,16.05,17.70,18.24,16.99,15.73
      14.63,13.60,13.09,12.58,12.22,12.93,15.18,14.08,12.22,11.27,10.59,10.16,9.68,9.12,8.53
Jul48,8.01,7.57,7.57,7.05,7.09,7.17,7.57,8.81,9.08,8.01,7.37,7.09,6.97,6.73,6.25
      6.21,5.69,5.45,5.53,5.45,5.53,5.41,5.25,5.25,5.21,5.17,5.05,4.89,5.33,5.69,5.41
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      4.45,5.01,5.49,5.81,6.29,5.49,5.33,5.17,5.13,5.77,5.69,5.25,4.97,4.77,4.57,4.53
Sep48,4.53,4.41,4.41,4.33,4.41,4.53,4.41,4.21,4.08,3.96,3.80,3.88,3.80,3.80,3.68,3.76
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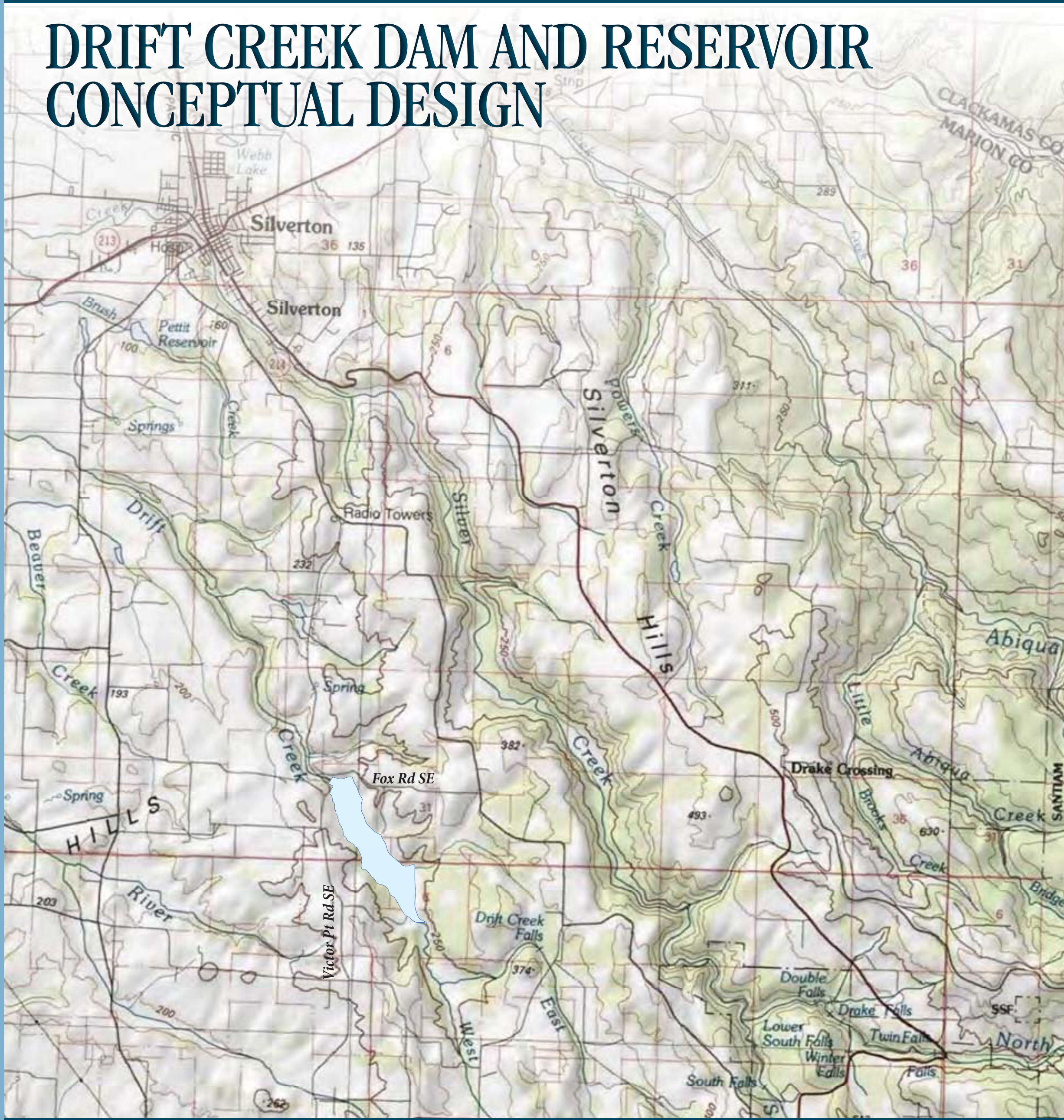
Basis of Design Document

DRIFT CREEK DAM AND RESERVOIR CONCEPTUAL DESIGN



East Valley Water District, Oregon

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

June 2011

DRIFT CREEK DAM AND RESERVOIR CONCEPTUAL DESIGN BASIS OF DESIGN DOCUMENT

FOR

EAST VALLEY WATER DISTRICT

June 2011

Prepared by:

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MSA

SECTION 1

SECTION 1
INTRODUCTION

Authorization and Purpose

In February 2011, the East Valley Water District (District) authorized Murray, Smith & Associates, Inc. (MSA) to complete conceptual designs for the Drift Creek Dam and Reservoir located near Silverton, Oregon. The key focus of this conceptual work was to further assess the technical feasibility of the project and to develop conceptual designs in support of environmental assessments and permitting activities (by others). This conceptual work builds on prior engineering and analysis work performed by the District and was funded in part by a grant from the Oregon Water Resources Department, Water Conservation, Reuse and Storage Grant Program. This Basis of Design Document summarizes conceptual design work, presents guidance for next step engineering and geotechnical work, and provides updated project cost estimates for further financial planning and project development by the District.

Background and Project Need

The East Valley Water District is an irrigation district established in 2002 for the benefit of member lands and associated agricultural operations in Marion County and Clackamas County, Oregon in the general vicinity of Mt. Angel. The District's general service area of approximately 15,000 acres extends northerly from just north of Silverton, to just south of Woodburn and Molalla, between the Pudding River on the west and the Cascade Mountain foothills on the east. The District's approximately 75 members are currently served by individual farm wells and direct withdrawals from local surface waters. Limited surface water supplies and lowering groundwater levels make the development of a new surface water source an imperative.

The District is considering the development of a new water reservoir impoundment on Drift Creek, a tributary to the Pudding River. The intended reservoir site is located approximately six miles southeast of Silverton in Marion County, and the facility would be the cornerstone of a new surface water supply system for the District. Stored winter water would be released during the summertime months and conveyed downstream to the District's service area via either a new raw water pipeline or by natural channel flow along Drift Creek and possibly the Pudding River. Supplied water would be used for irrigation purposes and would require the development of a new water distribution piping system for delivery of irrigation water to served members.

A conceptual overview and general layout of the prospective Drift Creek water supply facilities is illustrated on Figure 1.

Previous Project Alternatives Investigation

Various water source and storage site alternatives have been investigated by the District and others in the region. Prior studies included a Detroit-Molalla project in the 1950s, and various other sources were investigated by the Soil Conservation Services in the 1960s.

In 1993, the precursor organization to the District, the Pudding River Basin Water Resource Development Association was formed for the purpose of finding alternative sources of irrigation water. The Association, through donations and grants, raised funds to commission several studies pursuing the viability of potential sources of alternative water supplies including ground water recharge, importing water from Detroit Lake, use of municipal wastewater, and building a storage reservoir.

More recently, the District has investigated project opportunities including impoundments on nearby Butte Creek (Scotts Mills Dam) and Rock Creek.

Prior Related Studies and Feasibility Investigation

The potential for a dam and reservoir on Drift Creek has been acknowledged for many years. Prior studies by the U.S. Department of Agriculture Soil Conservation Service (now Natural Resource Conservation Service) and others have identified a Drift Creek reservoir as one of several potential projects that might benefit the Pudding River Basin. Although the District has considered other project alternatives as discussed above, engineering and environmental assessments have established a Drift Creek dam and reservoir to be a viable and preferable option.

The District's prior Drift Creek project studies investigated the apparent technical feasibility of the proposed dam and reservoir from a general civil and geotechnical engineering perspective and from the environmental perspective. These preliminary assessments include the following:

Preliminary Dam Feasibility Assessment

- Initial feasibility report by Stuntzner Engineering & Forestry, LLC (2005)
- Stage-storage evaluation by Stuntzner Engineering & Forestry, LLC (2007)

Preliminary Geologic Assessment

- "Engineering Geologic Information for Feasibility of Proposed Drift Creek Dam" by H. G. Schlicker & Associates (2005)
- "Drift Creek Reservoir and Dam - Geotechnical Reconnaissance" report by Siemens & Associates (2009)

Preliminary Environmental & Permitting Feasibility Assessment

- Various environmental investigations by the Northwest Environmental and Energy Professionals (NEEP) team (2006), including:
  - Cultural resources investigation by Dr. Robert Keeler
  - Wetland delineation by Schott and Associates
  - Wetland mapping by Ellis Ecological Services, Inc.
  - Plant survey by Schott and Associates
  - Bird survey by Northwest Wildlife Consultants, Inc.
  - Fish surveys, fish passage and mitigation by Ellis Ecological Services, Inc.
  - Water quality by Vigil-Agrimis, Inc.
  - Land use

- "Determination of Appropriate Ecological and Channel Maintenance Flows for Drift Creek Downstream of the Proposed Dam" by Ellis Ecological Services, Inc. (2010)

- Drift Creek temperature and flow data by Ellis Ecological Services, Inc. (2011)

Preliminary Runoff Yield Analysis
- "Runoff Yield Analysis for Drift Creek Site "A" Near Silverton, Oregon" by Dr. Bolyvong Tanovan (revised 2008)
- "Runoff Yield Analysis for Drift Creek Site "A" Near Silverton, Oregon (Update #1)" by Dr. Bolyvong Tanovan (2010)
- "Runoff Yield Analysis for Drift Creek Site "A" Near Silverton, Oregon (Update #2)" by Dr. Bolyvong Tanovan (2011)

Drift Creek Dam Site Topographic Survey
- Topographic data created by 3DI West (for Stuntzner 2007 report)

Preliminary Concept Analysis
- "Overall Project Planning Assessment/Water Conveyance System Alternatives Analysis" by MSA (2007)

Such studies of the Drift Creek site have established the apparent feasibility of developing an earthen embankment type of impoundment and reservoir just upstream of the intersection of Victor Point Road and Fox Road.

MSA's 2007 planning and analysis evaluated the feasibility and comparative costs of piped raw water transmission and creek conveyance options. In 2008, with an assistance grant from the Oregon Water Resources Department, preliminary routing studies were advanced for the project's prospective 10.5-mile water transmission piping system.

While it has been recognized that the overall project faces several key challenges, no apparent "fatal flaws" have been reported to-date that would make the project non-constructible.

Scope

The scope of work for this conceptual design includes the following major elements:

- ***Agency Approvals & Permitting Requirements Review –*** A review of permit requirements for the conceptual design phase was performed with input from the District's environmental consultant. Fish passage considerations were also discussed. In addition, MSA consulted with the OWRD Dam Safety group to confirm project requirements and review conceptual dam designs.

- ***Conceptual Level Hydraulic Evaluation –*** A conceptual level hydraulic evaluation of the reservoir was performed based on hydrological information and analyses provided by the District's hydrologist, Dr. Bolyvong Tanovan. A preliminary estimation of the Probable

Maximum Flood (PMF) was developed for the purpose of determining general sizing requirements for the emergency spillway. Additionally, a preliminary hydraulic evaluation was completed to determine the conceptual design of the reservoir outlet works for the anticipated maximum withdrawals and rapid drawdown scenarios.

- ***Conceptual Level Geotechnical Assessment & Geotechnical Work Plan –*** Conceptual level geotechnical work included a review of prior geologic reporting, site reconnaissance and test trench excavations, laboratory testing of soil samples, and engineering analysis and design recommendations. Geotechnical assessment included investigation and evaluation of previously reported and mapped landslides within the project area and ground faults at the dam embankment location.

- ***Conceptual Designs, Drawings & Technical Specifications List –*** Conceptual design work included a review of prior engineering studies, site reconnaissance, development of recommended design concepts, and preparation of conceptual design drawings. Conceptual designs expanded on prior project work completed by the District and incorporated conceptual hydraulic evaluation and conceptual geotechnical engineering work performed under this scope of work. Designs incorporated design review input by the District project team and OWRD Dam Safety.

- ***Material Quantities and Cost Estimates & Project Schedule –*** Conceptual level material quantity estimates and preliminary cost estimates for the Drift Creek dam and reservoir were developed. Cost estimates include preliminary and final engineering costs, probable construction costs, administration costs, and construction contingencies. A proposed schedule for the preliminary design, final design, and construction of the prospective dam and reservoir was also developed.

- ***Basis of Design Document –*** This Basis of Design Document presents the conceptual design work completed relative to the above project tasks.

Basic Criteria and Assumptions

Conceptual design work was based on previous project studies and information provided by the District. Such prior work established the following criteria.

- Prospective dam to consist of impervious earthen-fill embankment

- Location of dam to be approximately 1,100 feet upstream of existing Victor Point Road Bridge

- Target reservoir volume is 12,000 AF

- Normal maximum water surface elevation is 677 feet for 12,000 AF reservoir pool volume based on stage-storage data

Conceptual designs were based on the above criteria and the following additional primary assumptions and considerations.

- Basic Dam/Reservoir Concepts -- Embankment fill will consist of suitable borrow material from the upstream pool inundation area. Approximately 3 feet of freeboard and about 7 feet of flood storage to be provided between maximum water surface elevation and crest of dam to accommodate the Probable Maximum Flood.

- Geotechnical Assessments -- Future geotechnical engineering work during preliminary and final project design phases will address: (a) subsurface soil and rock conditions beneath the embankment, reservoir, and spillway; (b) suitability of available borrow sources and disposal areas for reservoir construction; (c) final location of emergency spillway; (d) shear strength and permeability of the in situ foundation material; (e) shear strength and permeability of the compacted embankment soils; (f) seepage losses through the embankment and reservoir area; and (g) static and seismic stability of the embankment and surrounding slopes.

- Emergency Spillway -- A preliminary estimated Probable Maximum Flood (PMF) was established based on existing information and simplified hydrologic calculations. Flood storage was accommodated based on engineering judgment and standard industry practice for dams of this magnitude. More rigorous hydrologic/hydraulic modeling will be conducted to determine the design PMF as part of future final design work. An "Ogee-Weir" style reinforced concrete structure is assumed.

- Outlet Works & Fish Screening -- Multiple outlet ports with drum-style fish screen systems to be provided upstream for proper flow control and anticipated water temperature management requirements. Piping and mechanical components to be sized for maximum 40 cfs in-stream water rights (fish flow) releases and for maximum 40 cfs District irrigation supply demand. A downstream diversion structure to be considered for alternative conveyance options for District supply.

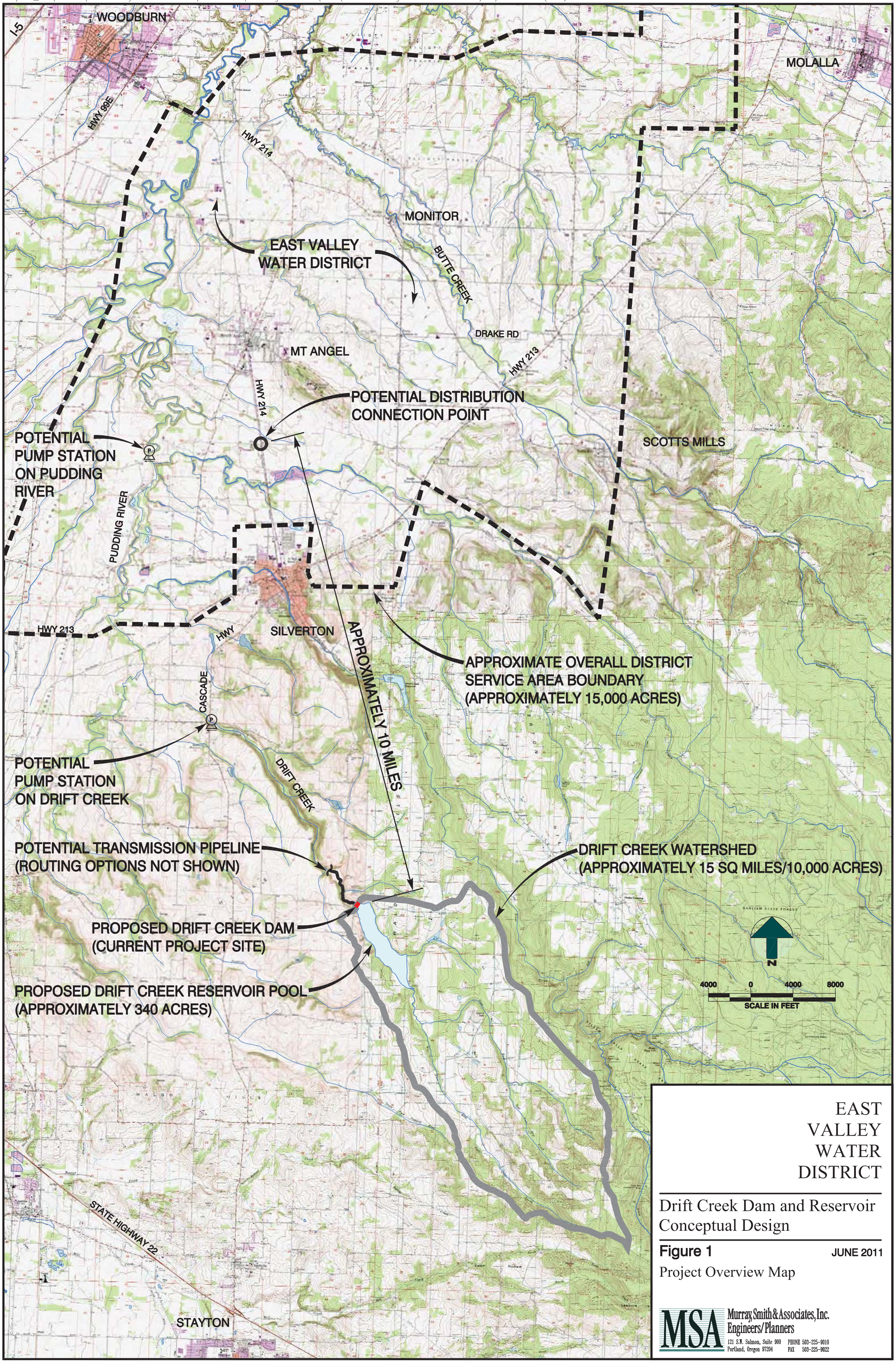
- Fish Passage -- Fish passage requirements are being established by others. Fish passage provisions and concept designs will be developed by others.

- Permitting Technical Support -- Environmental assessments and permitting evaluations are being performed by others. An Environmental Impact Statement (EIS) or Environmental Assessment (EA) process is anticipated. It is anticipated that conceptual drawings developed herein by MSA (related civil engineering elements) will be referenced by environmental reporting and permitting applications prepared by others.

- Base Mapping -- Electronic topographic mapping previously developed for the project was provided by the District. Mapping, developed from aerial photography, provides 2-ft contours at the dam site with 10-ft contour intervals elsewhere.

- Cost Estimates & Project Schedule -- Preliminary conceptual-level cost and schedule estimates for construction are based on general assumptions and MSA's recent construction experience on similar projects in the local Willamette Valley area. Estimates assume the use of private construction contractors and conventional public procurement/contracting procedures. As cost estimates are not based on detailed designs, appropriate contingencies and other provisions for engineering and administration have been incorporated to enable estimates to be suitable for general planning and budgeting purposes.

G:\PDX_BD\Clients\East Valley Water District\Dam Concept Design 12-10\CAD\FIGURE 1.dwg OVERVIEW MAP 5/12/11 10:41 (DAK)



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SECTION 2

SECTION 2
AGENCY APPROVALS & PERMITTING REQUIREMENTS

General

There are a variety of regulatory and permitting interests that must be considered relative to the prospective Drift Creek dam and reservoir. New dam construction involves a complicated process of environmental, water rights, land use and dam safety related consultations, reviews, approvals and permits. Dam construction must address impacts to existing properties, streamways and wetlands, as well as impacts to stream hydrological characteristics relative to fishery interests. Dam design, construction and operation must also address a broad range of safety issues. Successful implementation of this project relies significantly on the careful planning and successful permitting of the project.

Water Rights

Under Oregon law all natural occurring water is publicly owned, and in most cases special regulatory permission must be obtained from the Oregon Water Resources Department (OWRD) to use water from streams, lakes or underground aquifers. Water rights permits for diversion and storage purposes must be obtained prior to construction of such facilities and the actual use of the water. New water rights are “perfected” through a three step process which includes: (1) applying for and receiving a permit from the OWRD to use water from the source; (2) construction of necessary facilities to harness the water and the commencement of water use, and (3) certification of the permitted use by a Certified Water Right Examiner (CWRE) and issuance of a water right certificate. Specific time limits and milestones must be met once a permit has been issued and before it can be certified.

The water right applicant generally has a limited time to construct facilities and begin using the water as detailed in their permit. The definition of “beginning construction” varies depending on whether the source is surface water or groundwater. Generally, for a surface water right, the applicant must begin construction of a project to withdraw the water, which can be as minor as starting to install a transmission pipeline to the source, in order to satisfy the requirement. Once a water right is obtained and as long as water is available, the holder can divert water, without waste, up to the amount and for the beneficial use specified in the permit. The date an application is filed with the OWRD usually establishes the order of use, and is called the priority date of the right.

Water rights permits will need to be procured for the Drift Creek project. The District has begun the process and anticipates submitting applications by the end of the year.

Regulatory and Permitting Interests

The District has completed a number of environmental surveys and investigations, including threatened and endangered species surveys, cultural survey, wetlands delineation assessment, ecological/channel maintenance flows analysis, stream temperature and flow monitoring, water quality modeling, and fish passage assessment work. Based on these initial assessments, no listed fish/wildlife/plant species were observed and no significant cultural or historical resources were identified. Wetland delineation of a 240-acre reservoir footprint identified an estimated total wetland area impact of 23 acres.

Conceptual Design Permitting Requirements

Ellis Ecological Services, Inc. (EES), the District's environmental consultant, is providing on-going environmental assessment and permitting services for the project. Based on discussions with the District and EES, it is anticipated that a "NEPA" Environmental Impact Statement (EIS) process will be required for the project.

Although no project permit submittals are required at the conceptual design phase of the project, the primary purpose of this report is to support the environmental assessment work for the project and provide conceptual design drawings for accompanying future environmental document submittals.

OWRD Dam Safety Requirements

The State Dam Safety Engineer at OWRD reviews dam construction plans and monitors the development of dam projects through construction and into operation. A copy of this report has been sent to the State Dam Safety Engineer. While there are no specific submittal requirements at this phase of the project, early review by Dam Safety is beneficial. It has been requested that OWRD review comments be provided directly to the District so they could be attached to this report in the District's file and addressed with subsequent design work.

The State Dam Safety Engineer makes determinations as to a dam's established hazard designation. High hazard dams require special Seismic Hazard Analysis, a Dam Failure and Flood Analysis and the development of associated Flood Mapping. Also required for high hazard dams is the development of an Emergency Action Plan. Dam Safety Requirements are established as part of the OWRD Dam Safety review and approval process.

For conceptual design of proposed hydraulic structures, MSA consulted with Dam Safety staff to confirm Dam Safety requirements, to review approach and criteria for preliminary Probable Maximum Flood (PMF) estimation, and to discuss preliminary concepts for the proposed project.

Fish Passage Considerations

Fish passage must be accommodated in new dam projects unless it is determined to be technically infeasible. Current State regulations allow for consideration of a fish passage waiver where infeasibility is proven and where agreed mitigation provides a net benefit to fish.

The District, with the assistance of EES, is currently investigating passage feasibility and possible mitigation opportunities along Drift Creek and nearby streams. Based on initial discussions with Oregon Department of Fish and Wildlife (ODFW), it is understood that additional assessment work and agency reviews are necessary.

Conceptual designs for the prospective dam do not include fish passage facilities. Such provisions, if determined to be required, will be addressed in later project design phases. Design development of any potential fish passage facilities should be accomplished in coordination with aquatic biologists and regulatory agencies and should consider reservoir pool elevation fluctuation, required releases for instream flows, and temperature control. The design of fish passage facilities would influence the operating characteristics of the reservoir and type and location of outlet works for the dam. A requirement for fish passage could adversely affect the feasibility of the project from a cost-benefit perspective.

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SECTION 3

SECTION 3
HYDRAULIC EVALUATION

General

A conceptual level hydraulic evaluation of the reservoir was completed using existing hydrological information and analyses previously performed for this project. The purpose of the hydraulic evaluation was to facilitate the development of concepts, evaluate alternatives, and provide for the general sizing of dam hydraulic structures. The scope of this work included the review of prior hydrological studies, concept development and sizing of the emergency spillway, and conceptual development of outlet works.

Previous and Ongoing Studies

Prior studies were completed to evaluate the hydrology of the basin, assess stream temperature and flows, determine the basin yield and available reservoir storage, and determine required reservoir releases for instream water rights (ecological flows), streambed flushing flows (2-year storm) and District irrigation needs.

A hydrologic runoff analysis for the project site was performed in 2007 by Dr. Bolyvong Tanovan, PhD, P.E., using precipitation records, comparable watershed and stream data, and recent stream flow data collected at new stream gage stations on Drift Creek. Two subsequent updates to this report have been completed using recent additional stream flow data to further develop the runoff yield estimates and reservoir operation projections determined by hydrologic models. Although actual discharge data for Drift Creek is limited, Dr. Tanovan's analyses concluded that the likelihood of an October-April runoff volume of 12,000 AF available for District use is reasonably good.

As required by the Oregon Department of Fish and Wildlife (ODFW), a study was completed by Ellis Ecological Services, Inc. (EES) in 2010 to estimate necessary ecological and channel maintenance flows for Drift Creek downstream of the proposed dam location. Ecological flows are those flows that trigger or support fish migration, spawning, and other habitat conditions. Channel maintenance flows, or flushing flows, are those flows that move the coarse bed size streambed material found downstream of the dam. It was determined that the peak flow for a 2-year flood event, equating to approximately 630 cfs at the proposed dam site, would be adequate for this purpose, and all flows equal to or greater than this should be bypassed by the dam. It was also noted that required releases for ODFW's instream water rights is adequate to trigger upstream fish migration and provides adequate water depths in the reach, therefore no added ecological flows would be required to be released.

As part of current conceptual project work, a study was conducted by Portland State University, led by Dr. Chris Berger, PhD, P.E., to evaluate and model potential water quality impacts to Drift Creek due to the development of the proposed dam. As required by the Oregon Department of Fish and Wildlife (ODFW), flows released from the dam must mimic existing creek flow characteristics. This study looked at various reservoir operation scenarios and the possible effects on stream temperature, dissolved oxygen, organic matter, algae and nutrient levels. Based on modeling results, the study concluded that fish flow releases should pass through the low level outlets to maintain stream temperatures at or below the existing Drift Creek temperatures. The study also concluded that consequently with fish flows released through the low level outlet, dissolved oxygen concentrations in these flow releases would likely be at or near zero during the late summer. An aeration device to oxygenate the water at the reservoir outlets was recommended.

Required Releases

Required reservoir releases have been established by others as discussed above. Maximum peak flow rates for District irrigation demand, ODFW instream water rights (ecological flows), and flushing flows are shown in Table 3-1 below.

Table 3-1
Reservoir Releases

Demand	Maximum Peak Flow Rate (cfs)
District Irrigation Flows	40
ODFW Instream Water Rights	40
Flushing Flows	630

Conceptual Spillway Design

General Spillway Requirements

All dams are required by the Oregon Water Resources Department (OWRD) to be constructed with spillways that allow the maximum anticipated runoff from major storms to pass over the dam safely, without endangering the structural integrity of the dam. Based on the size of the watershed upstream of the proposed dam site and the hydrologic conditions, it is anticipated that a formal reinforced concrete spillway structure will be required. Due to the lack of non-erodible geology, a constructed concrete spillway stilling basin is the safest and most efficient method for energy dissipation.

Based on previous discussions with the OWRD Dam Safety staff, it is anticipated that the proposed dam could be classified as a “high hazard” structure. Accordingly, the dam and its emergency spillway must be designed to safely accommodate the Probable Maximum Flood.

The maximum anticipated runoff is called the Probable Maximum Flood (PMF). It is the flood event that is caused by the Probable Maximum Precipitation (PMP). The PMP is estimated by optimizing atmospheric conditions such as temperature, moisture content, and winds to determine the upper limit of precipitation that the atmosphere can produce for the location being studied. The rainfall depth is distributed over a 72-hour period and a PMF hydrograph is estimated using a model which accounts for local soil runoff characteristics and base flows. Where appropriate, the water contributed by snowmelt is also included in the flood hydrograph.

The PMF is then routed through a model of the reservoir. The reservoir acts as a detention basin, storing a large portion of the PMF in the reservoir, between the crest of the spillway and the top of the dam, for release after the storm ends. The remaining portion passes through the spillway. The spillway discharge capacity determines how high the water level in the reservoir rises above the top of the spillway crest.

Probable Maximum Precipitation Estimation

A preliminary estimate of the PMP depth was determined using the upper Drift Creek drainage basin characteristics and the National Weather Services' *Hydrometeorological Report No. 57* (HMR No. 57) procedure for determining the PMP. The procedures described in HMR No. 57 recommend that the following PMP storms be evaluated to determine the critical probable maximum storm for the watershed:

- All-season 72-hour PMP
- Seasonal 72-hour PMP storm with snow pack

The 72-hour all-season and seasonal PMP depths were determined, without snow pack consideration. The 72-hour all-season scenarios resulted in a total rainfall depth of 21.6 inches. A review of seasonal PMP variation percentages throughout the Pacific Northwest region (HMR No. 57 Figures 15.2-15.8) showed that November through February is the season with the highest precipitation at the Drift Creek Dam site. For this period, no seasonal adjustment to the 72-hour all-season PMP depth is required. An incremental rainfall distribution of the PMP was developed as described in HMR No. 57.

Probable Maximum Flood Estimation

With the assistance of Dr. Bolyvong Tanovan, a preliminary estimated PMF design hydrograph was developed for the proposed reservoir to determine the conceptual configuration of the proposed spillway. Dr. Tanovan utilized two computer models that he developed for prior project work; one modeling the hydrology of the Drift Creek Dam watershed (rainfall-runoff model, FLO4DRIFT), and the second modeling the reservoir pool and dam hydraulic structures (RES4DRIFT). Both project computer models were updated to accommodate a 6-hour time step calculation and to incorporate a spillway structure element for the reservoir.

The estimated PMP rainfall distribution was input into the watershed model to determine the runoff hydrograph for the PMP design storm. This runoff hydrograph was then input into the reservoir model (essentially routed the storm flow through the reservoir) to obtain a PMF outflow hydrograph over the spillway. Flood storage was accommodated based on engineering judgment and standard industry practice for dams of this magnitude. The results of the preliminary modeling determined an estimated peak PMF of approximately 3,800 cfs with a runoff volume of approximately 31,800 AF.

Preliminary Drift Creek Dam Spillway Concept & Size Estimation

Conceptual design of the proposed spillway was based on a similar approach and design criteria used for prior, similar dam projects approved by OWRD Dam Safety. Based on our experience and preliminary PMF determination, an approximate 7 feet of flood storage was incorporated to accommodate the estimated PMF. A reinforced concrete spillway structure with ogee crest is recommended to accommodate the high volume, high velocity flow storm events.

Conceptual sizing of the spillway width was estimated using the reservoir computer model. A maximum water surface elevation of 684 feet (approximately 7 feet above the spillway crest) was established as a design criterion, which would provide flood storage and a required minimum 3 feet of freeboard (distance between the maximum water surface elevation and the dam crest). The spillway width (weir length), which was the design variable, was adjusted with each model run scenario to determine an approximate width with respect to spillway discharge capacity and target head condition. Based on this work, an approximate 50-foot width was determined.

This conceptual level hydraulic evaluation and modeling work considered the following assumptions:

- Snow melt considered negligible;
- Full reservoir condition at time of PMP design storm;
- Outlet/drain piping valves closed so full PMF routes over spillway;
- Preliminary estimate of 7 feet of flood storage

It is recommended that these assumptions be further evaluated and addressed in more detailed hydraulic evaluations completed with future project final design work.

Conceptual Outlet Works Design

Outlet Requirements

Reservoir outlets are sized to allow the maximum required water demand to be withdrawn. For this project, the outlet works must be sized to economically accommodate the various required release flows as discussed above.

Emergency Drain Requirements

A dam's drain structures must be capable of draining the reservoir quickly to minimize the risk of catastrophic failure of the dam and potential damage downstream of the dam, should a structural problem or large leak develop. At a minimum, the emergency drain should be capable of emptying the reservoir within 30 days, in accordance with State guidelines for dam construction.

While the minimum State guidelines allow for calculating the draining time assuming no inflow into the reservoir, it is recommended that normal inflow be included. It is not economically feasible to be able to drain the reservoir within 30 days under all inflow conditions, such as major storm events.

Preliminary Drift Creek Dam Outlet/Drain Concepts & Sizing

Alternative outlet works configurations were considered based on various reservoir uses, anticipated release flows, frequency of releases, and cost considerations. To provide operational flexibility and redundancy, dual combination outlet/drain pipes were considered.

Emergency Rapid Drawdown Requirement

A preliminary hydraulic evaluation of the reservoir was performed to estimate sizing of the proposed outlet/drain piping. For this level of evaluation, no reservoir inflow was considered. Based on this evaluation, two outlet/drain pipes, approximately 48-inch and 36-inch diameters, could pass a combined flow of 630 cfs, at full reservoir stage, and could drain the reservoir pool in an estimated 15 days.

During an emergency drawdown, hydraulically operated sluice gates on the outlet/drain pipes would be fully opened, utilizing the full capacity of the pipes. Should the pipes be required to pass such a high flow, at an estimated resultant velocity of 30 feet per second, it is anticipated that severe damage to the dam outlet works would occur due to cavitation and scour. Such a rapid drawdown could cause sloughing of the dam face and could trigger landslides around the pool perimeter. It is important to note that this is a worst-case scenario, where the reservoir would be required to be drained quickly due to imminent dam failure, and the future condition of the outlet works would not be an overriding consideration.

District & Ecological Flow Considerations

During normal operating conditions, the reservoir outlet works would be required to pass the ODFW instream water right flows and District irrigation flows, each with anticipated flow rates of up to 40 cfs. It is recommended that flows be throttled by upstream control valves and passed through smaller outlet piping connections into the larger combined outlet/drain piping. Multiple outlet ports at low level and mid level reservoir elevations would allow full range of reservoir depth and operational flexibility for water temperature management of releases.

Flushing Flow Considerations

As discussed above, streambed flushing flow releases have been established as the 2-year flood event, approximately 630 cfs, and flows equal to or greater than this should be passed through the dam. While there are no current regulatory requirements that dictate the accommodation of these high flows through reservoir outlet works, such a scenario was considered.

From this assessment several key issues were identified, including velocity considerations within the outlet/drain piping and the economic feasibility considerations of accommodating a large “tunnel” for immediate and frequent large storm releases. To provide for lower, more acceptable (“safer”) velocities, much larger piping, control valves, outlet structures and related appurtenances, such as trash racks and fish screens would be required. Additionally, storm flows would be buffered by the reservoir and would likely require releases of stored water to augment storm outflows. These augmented flow releases will need to be defined with respect to reservoir operating conditions. It is possible that these releases would necessitate drawdown rates that exceed safe recommended rates for the dam and reservoir, putting the earthen embankment and reservoir pool slopes at risk (and landslide areas) for slope failures.

It was recognized that further definition of regulatory guidelines/future requirements is needed, which would need to address magnitude of storms considered, timing/frequency of releases, operational conditions of reservoir during storm events, and storm flow monitoring and control management. At this time, it is recommended that conceptual designs for the prospective dam and reservoir consider passing flushing flow releases and larger storms over the spillway.

Proposed Outlet Works Concept

Based on the above considerations, it is proposed that the Drift Creek dam and reservoir have two large diameter combination outlet/drain pipes with six upstream reservoir outlet ports at multiple elevations. Four control valves and two sluice gates would control flows entering the outlet/drain pipes. Flows would outfall through sluice gates into a common stilling basin for energy dissipation immediately downstream of the dam embankment. Further discussion of these and other key hydraulic structures is presented in Section 5.

SECTION 4

SECTION 4
GEOTECHNICAL ASSESSMENT

General

A conceptual-level geotechnical assessment was completed of the proposed reservoir site by Murray, Smith & Associates, Inc.'s (MSA) geotechnical engineer, GRI Geotechnical & Environmental Consultants (GRI). A report of this assessment and findings are included in Appendix B. The purpose of the preliminary assessment was to investigate the existence of fault-induced ground rupture beneath the dam site, generally assess the risk and impacts of reactivation of mapped landslides, and develop recommendations in support of conceptual designs of the dam and reservoir. The scope of the assessment included review of prior geologic studies and subsurface information, ground-level geologic reconnaissance, test trench and pit excavations, laboratory tests, and engineering analyses and recommendations.

Geotechnical Investigation Results and Preliminary Recommendations

Although significant additional preliminary and final design level geotechnical investigations and engineering are required, the following conclusions and recommendations indicate that the site appears to be generally favorable from a geotechnical and geological perspective.

1. Geotechnical observations at the site and subsurface explorations did not disclose evidence of past fault-related ground rupture beneath the dam footprint. The potential for fault-related ground rupture within the dam footprint is judged to be low.

2. Based on geotechnical observations at the site, limited subsurface explorations, and review of work by others at the site, the hillsides adjacent to the pool area are reported to be mantled and underlain by landslide debris, or weathered rock and soil that had a high risk of slope instability. Landslides mapped through previous work on this project and based on observations revealed that topography indicative of past landslide activity extends west of Victor Point Road SE in some areas. Given these large areas of potential slope instability around the pool, it is not judged to be practical or cost-effective to design mitigation approaches for future possible pool-induced landslides. It is advised that such risk be part of the overall project implementation considerations.

3. Additional exploration work should be accomplished to further evaluate potential borrow areas away from the proposed embankment location. The amount of borrow material available around the dam footprint appears limited to about 2 to 4 feet below the ground surface. To prevent pool floor leakage, borrow areas should be limited in depth to leave at least a 2-foot thick layer of relatively impermeable fine-grained soil above weathered bedrock.

4. Based on the preliminary assessment results and our team's experience with similar projects, it is judged that the proposed earthfill embankment section is feasible and may be constructed with an adequate factor of safety for internal slope stability. However, to safely and economically construct the embankment, a well thought out and sequenced plan of construction work, including foundation preparation, excavation dewatering, select use of available borrow materials, internal drainage and filters, and slope protection will be required.

Recommended Future Geotechnical Work Program

Moving forward through the design process, additional geotechnical assessments will be required, building upon previous work. Recommended geotechnical work includes the following tasks:

- *Preliminary Design* – Building upon the site investigations performed during conceptual design, deep subsurface explorations are recommended to further assess the onsite soil characteristics. Borings, drilled to depths up to 100 feet, should be used to obtain soil samples and install piezometers to log the piezometric pressure. A permanent inclinometer should be installed in the landslide near the left dam abutment at Victor Point Road to monitor ground stability.

- *Seismic Hazard Studies* – A review of existing information regarding the seismicity of the proposed reservoir site should be carried out in order to estimate the ground response during a design earthquake event. Attention should be paid to the potential for amplification of incoming seismic energy throughout the dam and reservoir site and the peak ground/bedrock acceleration should be determined.

- *Final Design Studies* – Final design work should include an evaluation of the final dam embankment footprint and areas which require landslide buttressing. Soil samples from previously identified borrow areas should be tested further in a laboratory to verify their suitability for embankment material. Water seepage through the proposed embankment should be evaluated to determine if a drainage blanket within the embankment is necessary. Slope stability analyses should be performed for static and seismic loading conditions. Additional, more detailed geotechnical recommendations should be developed to support final dam and reservoir designs.

SECTION 5

SECTION 5
DAM AND RESERVOIR CONCEPTUAL DESIGN

General

Conceptual design engineering was conducted to establish, evaluate and present proposed concepts for the contemplated Drift Creek dam and reservoir. Conceptual designs expanded on project work completed to date and incorporated conceptual hydraulic evaluation and conceptual geotechnical engineering work performed under this scope of work. Design work included review of prior studies and project information, site reconnaissance, evaluation of various conceptual alternatives, development of design recommendations, preparation of conceptual design drawings, and development of conceptual level cost estimates and project schedule. Estimated costs and schedule are discussed in later sections of this report.

Previous Studies

Previous studies determined the size and location of the proposed Drift Creek Dam, based on the geology and topography of the site and a target storage volume of 12,000 AF to meet the irrigation water supply needs of the District.

In 2005, Stuntzner Engineering & Forestry, LLC (Stuntzner) assisted the District with an initial feasibility study for the prospective dam and reservoir. This initial investigation built upon previous siting investigations in 1969 by the Pacific Northwest River Basins Commission – Willamette Basin Task Force. Using USGS topographic contours, Stuntzner located the Drift Creek dam at a point where the valley narrowed, minimizing the size of the dam and founding the embankment on basalt rock. H.G. Schlicker & Associates, Inc. assisted Stuntzner with initial geologic assessments and recommendations. Based on the topography of the site, Stuntzner determined that more than the initially considered 8,000 AF volume could be impounded.

In 2007, Stuntzner developed estimated reservoir pool stage-storage data for a 12,000 AF reservoir volume, based on electronic topographic data created by 3DI West from aerial photography. The estimation used 2-foot contours at the dam site location to develop the stage-storage data with 10-foot stage increments. A maximum dam height of 680 feet was used which accommodated only 3 feet between the normal high water surface elevation and the dam crest, with no consideration for storage of flood events. This preliminary crest elevation determined an approximate dam height of 65 feet.

Site Reconnaissance

A site visit was conducted on March 2, 2011 with representatives from MSA and GRI to familiarize the project team with field conditions in accessible key areas of the reservoir inundation area and dam site. Permission to access private property at the dam site and along the east side of the reservoir pool area was obtained by Ellis Ecological Services, Inc. The proposed dam would inundate a valley with a fairly flat bottom surrounded by rolling forested hills. An existing farmhouse and a cattle enclosure are the only structures within the reservoir inundation area. The valley floor is agricultural land, supporting cattle and grass seed crops. Evergreen trees along the eastern side of the valley were observed to be slightly askew, indicating mild slope movement along the length of the reservoir. Topography on the west side of the reservoir, observed from across the valley, indicates similar slope movement. The dam site appears to be located on an outcrop of basalt rock at a narrowing in the valley. Potential borrow areas were identified for future geotechnical analysis in the relatively flat cattle pasture just upstream of the proposed dam site.

Key Project Elements

A list of key project elements follows, some of which have been addressed in previous sections of this report and are summarized below.

Earthen Dam

The District previously established the Drift Creek Dam to be an earthen dam, located near the intersection of Fox Road and Victor Point Road in a narrow valley. Conceptual dam design work determined that an approximately 70-foot high dam embankment is required to impound 12,000 acre-feet of water. The proposed dam crest would be about 20-feet wide, approximately 850 feet long with an elevation of about 687 feet, which is seven feet higher than the crest elevation proposed in previous studies. The revised dam crest elevation would accommodate the Probable Maximum Flood while allowing for a minimum 3 feet of freeboard between the maximum water surface elevation and the dam crest.

Conceptually, the embankment dam structure would be founded on bedrock and consist of a homogeneous impervious core constructed with locally available materials, with a downstream slope of approximately 2H:1V and an upstream slope of approximately 2.5H:1V. For slope protection, the upstream and downstream faces of the embankment would be overlaid with riprap and crushed rock, respectively. Within the dam embankment, a granular drainage blanket with a perforated drain piping system is recommended to control seepage and groundwater levels. Based on the proposed basic dam geometry, the total fill volume of the dam embankment is estimated at approximately 130,000 cubic yards.

Overflow/Emergency Spillway

An overflow/emergency spillway is required to safely pass large storm events through the reservoir. Based on the size of the watershed upstream of the proposed Drift Creek dam site and expected hydrologic conditions, it is anticipated that a high capacity reinforced concrete spillway structure will be required. The general requirements and preliminary hydraulic evaluation for the proposed spillway are discussed in Section 3.

Based on our conceptual level hydraulic evaluation of the reservoir, a concrete spillway structure with ogee crest is recommended. Conceptually, the spillway would be a cast-in-place concrete structure, approximately 300 feet long and 50 feet wide at the crest, with a concrete stilling basin section at the base of the structure for energy dissipation of flows prior to discharging to Drift Creek. Final design of the proposed spillway will require a detailed hydraulic engineering analysis to further define the key design elements of the spillway including approach channel, ogee weir crest, conveyance chute, spillway stilling basin and return channel to Drift Creek.

Because of the favorable geologic conditions at the dam site, the proposed spillway could be located at either abutment. To better accommodate access to control structures and a more ideal location for the diversion structure, the left abutment was selected.

Outlet Works

As discussed in Section 3, the outlet works for the proposed dam will need to accommodate multiple uses with varying release requirements. The various uses including irrigation supply, stream flow augmentation, and flood control will impact the design and operation of the outlet works and control systems. The outlet works would generally consist of screened outlet structures, piping through the dam, and hydraulically controlled valves and gates for flow control. The hydraulic operating system would be located in an operations building where electrical instrumentation and control would be housed. Operation could be accomplished either on-site and/or remotely via a telemetry based control system.

Outlet/Drain Piping

Based on the conceptual alternatives and preliminary sizing assessment of proposed outlet works structures as discussed in Section 3, two parallel combination outlet/drain pipes, approximately 36-inch and 48-inch diameters, are recommended. These pipes would be sized to allow the ability to rehabilitate the pipes in the future using a lining system. Piping material considerations could include heavy wall reinforced concrete pressure pipe or concrete encased steel pipe. The average estimated length of each outlet/drain pipe would be approximately 360 feet.

The proposed conceptual piping and outlet works configuration is shown on the Conceptual Design Drawings included in Appendix A. Dual, low level, combination use piping with multiple outlet ports allows for redundancy and operational flexibility of the system and reservoir storage supply. It should be noted, however, that other options could be considered which may better accommodate future established uses and reservoir operational requirements as defined with later project design phases.

Control Valves, Sluice Gates & Fish Screens

Control valves are proposed at the upstream outlets in the reservoir. These valves would control reservoir releases through the mid and low level outlet ports. Long radius elbow body valves are recommended, which are specialized valves designed to handle high head conditions in a raw water application. The operating range requirements of this system is anticipated to be between 1 cfs to 40 cfs, depending on the District's water needs and the ecological flow rate required downstream. Multiple parallel valves may be required to serve this wide operating flow range, with one smaller valve for low flows, and one larger valve for high flows. The preliminary recommendation is for an 8-inch low-flow valve for flows ranging from 1 cfs to 7 cfs, and a 20-inch valve for high release rates between 7 cfs and 40 cfs.

Each valve pair would be located within a cast-in-place concrete outlet structure with a trash rack to protect the outlet works from debris during reservoir draining and low level reservoir operations. In addition, large stainless steel drum screens at control valve connections are recommended to protect fish from the outlet works. These screens should be designed with a screen slot size capable of passing the required 40 cfs flow rate and with a maximum screen flow-through velocity of 0.5 fps to prevent fish from being pulled into the outlet works. Fish screen systems should incorporate an automated cleaning system such as an airburst system.

Sluice gates are recommended at each end (upstream and downstream) of the reservoir drain pipes. These large sluice gates would operate fully open or closed for the purpose of draining the reservoir. Additionally, sluice gates are recommended to isolate flows entering the diversion structure. All sluice gates on the upstream side of the dam embankment are anticipated to be hydraulically operated while downstream gates would include manual operators. An air vent system is recommended for each upstream control valve and sluice gate to prevent a vacuum condition in the outlet/drain pipes.

Diversion Structure

Conceptual designs incorporate a diversion structure as part of the proposed outlet works configuration. This structure, located at the downstream toe of the embankment, would allow flows to be collected and routed into a raw water transmission pipeline, conveying irrigation water from the proposed Drift Creek Dam site to the District's service area. The proposed structure would be cast-in-place concrete with associated piping connections to both reservoir outlet/drain pipes for redundancy and flexibility for reservoir operations and maintenance activities.

Stilling Basin

A stilling basin at the reservoir outlet works and spillway outfalls is required for energy dissipation and for creek bottom/ bank protection. A riprap lined basin is recommended, and conceptually would be constructed within and around the creek channel at these outfall locations. A general outline of the basin has been included on the Conceptual Design Drawings. The stilling basin configuration will create a pool of standing water which will dissipate energy in the discharge flows prior to flows re-entering Drift Creek. The basin will be heavily armored with large diameter riprap boulders to prevent scour in the basin.

Aeration Considerations

As discussed in Section 3, a study was conducted by Portland State University to evaluate and model potential water quality impacts to Drift Creek due to the development of the proposed dam. Based on the modeling work, it was recommended that all fish flow releases should pass through the low level outlets, and an aeration device should be utilized to oxygenate the water discharging to the creek.

Various alternatives could be considered for aeration provisions including mechanical devices or outfall stilling basin modifications. One option to consider might be the use of a fixed cone valve (Howell-Bunger Valve) or a ring jet valve. Water with low dissolved oxygen content can be aerated very effectively when discharged into the atmosphere through Howell-Bunger Valves. It is recommended that further analysis be conducted during future design work to evaluate alternatives and determine best option for the project.

Road Relocations

The Drift Creek dam and reservoir project must include provisions for construction access and modifications to existing roadways impacted by embankment construction. Certain private properties and potentially the County right-of-way will be affected.

Victor Point Road Realignment

Conceptual designs indicate the need to relocate Victor Point Road. As discussed above, the conceptual dam crest elevation has been revised from that considered in previous studies in order to accommodate the Probable Maximum Flood. The proposed “raise” allows room for storm surges while maintaining the target storage volume of 12,000 AF with a normal high water surface elevation of 677 feet. The revised crest elevation of approximately 687 feet is higher than Victor Point Road, and dam embankment fills appear to impact the existing roadway. It appears that approximately 800 lineal feet of Victor Point Road would need to be relocated approximately 100 feet to the west. Road relocation considerations would likely include slope stabilization measures along the roadway slope nearest the dam and would impact private property and require adjustment of the public right-of-way.

Conceptual designs reflect a conservative scenario from a permitting perspective. Although it is preferred to avoid relocating Victor Point Road, moving the existing roadway away from the dam and reservoir site is beneficial. This would likely reduce the potential risk of roadway structural failure due to possible reactivation of landslides and would likely reduce the extent of slope stabilization measures required for the road.

As discussed in Section 3, the conceptual design of the spillway applied a similar design approach used for similar recent dam projects as was judged appropriate by OWRD Dam Safety. However, to reduce or possibly avoid impacts to Victor Point Road, it may be feasible to lower the dam crest, widen the spillway and reduce flood storage considerations, within practical limitations. This may provide for a cost savings for the dam embankment and roadway relocation but will likely come at an increased cost to spillway construction. An optimization analysis is recommended as part of subsequent project design work to assess alternatives and compare costs. Additionally, as an alternative, the District could consider reducing the storage volume goal and respective dam height, recognizing however, the need to maintain storage volume for ODFW instream water rights releases.

Access Roads

Access roads are required to allow District maintenance personnel and trucks access to dam abutments, the spillway, and the outlet works. Options for constructing access roads off of both Victor Point Road and Fox Road were considered, with access off of Fox Road being the recommended alternative. An existing dirt road extends approximately 800 feet from Fox Road southeasterly to the proposed dam site. This road may be utilized for access to the northwest side of the dam, as shown on Sheet EMB-1, the Embankment Site Plan. A 10-foot wide, approximately 500 foot long access road would extend across the downstream embankment slope (at approximate elevation 640 feet) to the spillway, eliminating the need to construct a bridge over Drift Creek. A second proposed gravel access road approximately 150 feet long would lead off of Fox Road to allow access to the operations building on the north end of the dam crest.

Landslide Mitigation

As part of conceptual geotechnical assessment work, prior reporting of mapped landslides was reviewed and hillside conditions at the site were generally investigated for evidence of slope instability. A discussion of related site observations, findings and recommendations is presented in a technical memorandum prepared by GRI included in Appendix B.

Based on geotechnical findings, large portions of the reservoir pool perimeter are reported to or appear to exhibit poor slope stability. The general limits of reported landslides and areas of potential slope instability are shown on the Conceptual Design Drawings. Although it is not practical or cost effective to mitigate these large areas for future possible pool-induced landslides, there are two key areas of concern which should be further evaluated for landslide/slope stability mitigation.

A large previously mapped ancient landslide on the west side of the project site appears to extend from the proposed reservoir pool area to the west past Victor Point Road. Reactivation of this landslide will likely result from filling and operating the reservoir. Based on the conceptual configuration of the dam, the left abutment would extend within this impact area. Consequently, roadway relocation designs for Victor Point Road will need to consider slope stabilization measures such as an anchored wall along the slope nearest the dam.

Another area of concern is the hillside below a potential archeological site identified in prior cultural investigation work and reporting for the project. This potential site is generally described as located above the eastern middle portion of the project area. The District has completed a Cultural Resources study for the project area and has submitted an evaluation to the Oregon State Historic Preservation Office for review. It is understood that a landslide in this vicinity could impact the potential site within the slide limits. As such, it is recommended that the hillside below this potential site be further investigated to evaluate the risk of slope failure and potential impact to upslope area and to determine specific mitigation measures required, if warranted.

Borrow Sources

One of the primary economic advantages of an earthen dam is that the construction materials already exist on-site. Based on the conceptual geotechnical work completed under this scope, it appears that suitable construction materials exist at the proposed site to support construction of an earthen dam. Test pits excavated in the valley floor near the embankment identified layers of clayey silt and decomposed sedimentary rock which appear suitable for use as impermeable embankment fill material. However, additional exploration work will be required to verify that suitable quantities of borrow material exist at the site. Granular material for slope protection and embankment filter drain will need to come from off site. The nearby quarry on Victor Point Road may be a suitable source for these materials and should be further investigated with subsequent project design work.

Creek Diversion During Construction

It is anticipated that Drift Creek flows will need to be preserved during dam and reservoir construction activities. Flows would need to be bypassed around work zones and coordinated with staged dam embankment work. According to the Oregon Department of Fish and Wildlife (ODFW) guidelines, the in-water work period for the Pudding River Watershed is from June 1 to September 15. The extent and duration of creek diversion activities will be stipulated by project permitting.

MSA

SECTION 6

SECTION 6
RAW WATER CONVEYANCE

General

There are two key means by which stored water in the proposed Drift Creek Reservoir can be conveyed to the District's water service area for distribution. An extensive raw water pipeline could be constructed between the dam site and the District service area, potentially serving much of the District by gravity. Alternatively, Drift Creek and possibly the Pudding River could be used as a natural conveyance channel, with summertime reservoir releases being withdrawn downstream by means of new intake and pumping facilities.

Previous Studies

In 2007, MSA worked with the District to complete an Overall Project Planning Assessment report to establish an overall project direction, with a focus on evaluating raw water conveyance alternatives and related costs. Comparative cost estimates for water conveyance alternatives indicated that a creek/river conveyance and downstream pumping station concept is of significantly lesser cost, both on an initial project cost basis and a present worth cost basis, than a gravity piped water transmission system, considering the present worth value of long term operations and maintenance costs, power costs and future replacement costs for major equipment. At the time, the District considered a Pudding River Pumping Station system alternative to be least desirable from a water quality perspective. It was recommended that the matter be further reviewed by the District in light of apparent costs.

The following year, in 2008, MSA completed the Preliminary Transmission Pipeline Routing Analysis technical memorandum. The purpose of this grant funded study was to further develop the transmission pipeline alternatives, focusing on assessing and defining potential pipeline routing alternatives. Several alternative pipeline alignments were assessed between the proposed Drift Creek Dam and the District's irrigation water distribution system. While the District desires to develop a piped water transmission system that would deliver irrigation water to the District by gravity, the initial construction cost of the required 10-mile pipeline is recognized as a significant challenge.

It should also be noted that considerable planning work remains to be done toward the establishment of an irrigation distribution system. Preliminary discussions with District Board representatives indicate a wide range of alternatives that might be considered involving the use of new Drift Creek Project facilities and capacity in combination with existing individual groundwater and surface water rights.

Conceptual Design Considerations

At this time, the District is still considering a final decision on a water transmission methodology to deliver raw water from the proposed Drift Creek Reservoir to the District's distribution system. Therefore, the conceptual design of the Drift Creek Dam outlet works allows for flexibility and may accommodate either discharging District irrigation releases into Drift Creek or routing flow through a diversion structure and into a raw water transmission pipeline at the base of the dam.

The proposed diversion structure, located on the north bank of Drift Creek at the toe of the dam embankment as shown on the Conceptual Design Drawings in Appendix A, would be connected to both reservoir outlet/drain pipes allowing the option to route flow from either or both outlet/drain pipes and multiple reservoir outlets. In-line valves on piping entering the structure would be used to isolate and bypass flows to the creek.

MSA

SECTION 7

SECTION 7
PRELIMINARY COST ESTIMATES

General

The development of the Drift Creek Project represents a major capital undertaking. Each of the three major project elements; the Drift Creek Dam, the stored water conveyance system and the irrigation distribution system, are multi-million dollar propositions. In advance of any construction, is the significant cost of project engineering, environmental assessments, property acquisition and permitting. Following construction are the significant costs of on-going system management, operation and maintenance.

Conceptual level project cost estimates for the planned dam and reservoir are presented herein. These estimated costs are budgetary estimates based preliminary concepts. The cost estimates are opinions of cost only, as final costs of the projects will vary depending upon labor and material costs, market conditions for construction, regulatory requirements, final project scope, project schedule and other factors.

Estimated Dam and Reservoir Project Costs

Estimated project costs for the dam and reservoir are based on engineering judgments as to current probable construction costs. These preliminary construction costs estimates are based on general assumptions and MSA's recent construction experience on similar projects in the local Willamette Valley area. Estimates assume the use of private construction contractors and conventional public procurement/contracting procedures. As estimates are not based on detailed designs, appropriate contingencies and other provisions for engineering and administration are incorporated to enable estimates to be suitable for general planning and budgeting purposes.

Project costs consist of estimated construction costs in 2011 dollars, plus an aggregate 45 percent allowance for engineering, permitting, administration and contingencies. The "45 percent" allowance that is then added to basic construction costs to develop estimates of "project costs", as referenced herein, may be generally broken down as follows:

Construction Contingencies.. 25%
Engineering (Design and Construction Management) 15%
Permitting.. 2.5%
Administration/Legal/Misc.. 2.5%
TOTAL @ 45 %

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 future reference, the June 2011 ENR CCI of 8757.87 for the Seattle area construction market (the nearest market ENR monitors) may be used in the future to update cost estimates in this report.

The estimated construction costs have been separated into the following major categories:

- Mobilization – consists of moving in, bonds, insurance, cleanup and moving out.
- Site Preparation – consists of tree removal, clearing and grubbing, stripping and stockpiling topsoil, haul roads, and general erosion control and dewatering facilities
- Dam Excavation/Embankment Construction – consists of excavating an average 10 feet below dam embankment to rock foundation; excavating and placing impervious fill for dam embankment and abutments from borrow material obtained from reservoir pool area; preparation, hauling and placing rock surfacing/armoring from nearby quarry.
- Spillway – consists of excavation, construction of concrete spillway weir, chute and stilling basin.
- Hydraulic Structures, Valves and Piping – consists of outlet/drain piping, outlet control valves, sluice gates, outlet structures, fish screens and air burst cleaning system, diversion structure, and excavated rock lined outfall/stilling basin.
- Operations Building, Hydraulic Operating System, and Electrical Instrumentation & Control – consists of small pre-engineered package-style building with electronic signaling and recording equipment, hydraulic power unit, SCADA equipment and stand-by power generator.
- Access Roads/Roadway Relocations – consists of relocating County roads and provisions for new access off Fox Road to hydraulic and diversion structures at base of dam and access to control building at the dam crest.
- Landslide Mitigation – consists of anchored wall along relocated portion of Victor Point Road (approximately 1,000 lf) and compacted soil-amended buttress (assuming 50ft x 500ft area, total 25,000 cy) at base of hillside below potential archeological site.

The locations of the proposed dam and reservoir improvements are shown on the Conceptual Design Drawings included in Appendix A. A summary of the estimated project costs is presented in Table 7-1. These costs are based on the construction timeline as shown in the preliminary construction schedule included in Section 8.

Table 7-1
Estimated Project Costs for the Drift Creek Dam and Reservoir

Item	Description	Units	Quantity	Unit Cost	Total Cost	Estimated Cost
1	**Mobilization**	**LS**	**1**	**$1,000,000**	**$1,000,000**	**$1,000,000**
2	**Site Preparation**					**$2,020,000**
	Clearing, Grubbing, Stripping and Stockpiling	Acres	360	$4,500	$1,620,000	
	Erosion Control, Dewatering & Misc.	LS	1	$400,000	$400,000	
3	**Dam Excavation/Embankment Construction**					**$2,693,500**
	Common Excavation	CY	68,000	$4.50	$306,000	
	Impervious Fill Material	CY	190,000	$10.00	$1,900,000	
	Drainage Blanket	CY	7,000	$30.00	$210,000	
	Crushed Rock Slope Protection	CY	1,500	$25.00	$37,500	
	Riprap Slope Protection	CY	12,000	$20.00	$240,000	
4	**Spillway**					**$3,560,000**
	Common Excavation/Rock Excavation	CY	17,000	$55	$935,000	
	Structural Backfill	CY	5,000	$75	$375,000	
	Concrete Spillway Structure	CY	2,500	$700	$1,750,000	
	Miscellaneous Spillway Components	LS	1	$500,000	$500,000	
5	**Hydraulic Structures, Valves and Piping**					**$2,547,000**
	48-inch Diameter Steel Pipe	LF	390	$800	$312,000	
	36-inch Diameter Steel Pipe	LF	350	$600	$210,000	
	Sluice Gates	EA	4	$30,000	$120,000	
	Control Valves	EA	8	$75,000	$600,000	
	Fish Screens & Air Cleaning System	EA	4	$75,000	$300,000	
	Upstream Control Valve Structures	EA	4	$70,000	$280,000	
	Upstream/Downstream Drain Structures	EA	4	$60,000	$240,000	
	Diversion Structure, Piping, and Valves	LS	1	$200,000	$200,000	
	Stilling Basin	SY	3,000	$95	$285,000	
6	**Operations Building, Hydraulic Operating System, Electrical Instrumentation & Control**					**$500,000**
	Hydraulic Operating System	LS	1	$100,000	$100,000	
	Operations Building and Electrical Instrumentation and Control	LS	1	$400,000	$400,000	
7	**Access Roads/Roadway Relocations**					**$320,000**
	Victor Point Road Relocation	LF	800	$200	$160,000	
	Access Roads	LF	2,000	$80	$160,000	

8	**Landslide Mitigation**					**$1,250,000**
	Victor Point Road Anchored Wall	LS	1	$750,000	$750,000	
	Eastern Buttress (Potential Cultural Site)	CY	25,000	$20	$500,000	
Estimated Construction Costs Subtotal						$13,890,500
Engineering, Administration, and Construction Contingency @ 45% of Total Construction Cost						$6,250,000
Total Estimated Project Cost (Dam/Reservoir only, 2011 $'s)						**$20,140,500**
Rounded						**$20,000,000**

Footnote:
Budgetary estimate does not include cost estimates for property acquisition, environmental mitigation, permitting or fish passage mitigation.

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SECTION 8

SECTION 8
PRELIMINARY PROJECT SCHEDULE

General

Attached is a proposed project schedule showing the time periods for the key tasks required to complete preliminary and final engineering and construction for the Drift Creek dam and reservoir. The schedule assumes concurrent execution of multiple work tasks to achieve desired project milestones. It is recognized, however, that project financing along with permitting and regulatory approvals are critical path items and will dictate the overall project schedule.

A two to three year construction period is anticipated. Due to the moisture sensitive fine-grained soils on site, the placement and compaction of borrow material in the dam embankment will be limited to periods of extended dry weather, which typically occur from about mid-June to mid-September. As such, two or more summer construction seasons may be required to complete earthwork construction.

EAST VALLEY WATER DISTRICT
DRIFT CREEK DAM AND RESERVOIR CONCEPTUAL DESIGN
PRELIMINARY PROJECT SCHEDULE

Task Name	Start	Finish
Preliminary Project Development Phase		
Water Rights Permit Applications	1/3	12/30
Environmental Assessments	Jan 2006	12/30
Fish Passage/Waiver Assessment & Agency Review	1/3	12/30
Funding Assessment/Financing Procurement	Jan 2008	10/28
Conceptual Dam and Reservoir Design	2/1	6/30
Land Use Permit Applications	1/3	9/30
Preliminary Engineering/Environmental Permitting Phase		
NEPA Environmental Document Preparation	1/3	12/31
Permits & Approvals (Local, State & Federal)	1/3	6/28
Property/Easement Acquisition	1/1	9/30
Supplementary Geotechnical Investigations	6/4	12/31
Preliminary Engineering	6/1	12/28
Final Engineering Phase		
Design Surveys	1/1	2/28
Final Design	1/1	9/30
Dam Safety Approvals	4/1	9/30
Bidding Phase		
Advertise/Award	10/1	12/31
Complete Contract Preparations	1/1	2/28
Construction Phase		
Construction	3/3	9/1
Fill Completed Reservoir	10/3	1/31
Obtain Water Rights Certificates		

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SECTION 9

SECTION 9
SUMMARY

General

This section presents a summary of the findings and recommendations presented in previous sections for the prospective Drift Creek dam and reservoir, including recommended next steps for further project implementation.

Summary of Findings and Recommendations

The conceptual design work completed under the scope of this project has developed preliminary concepts for a prospective dam and reservoir project on Drift Creek as outlined below.

- ***Dam Embankment*** - Conceptual design engineering has established the basic shape and footprint of the dam as well as a conceptual internal "picture" of the embankment. An approximately 70-foot high, 850-foot long dam embankment would be required to impound 12,000 AF of water. It is anticipated that sufficient suitable material to construct the conceptualized dam exists at the site.

- ***Geotechnical Assessment*** - The proposed dam and reservoir appears feasible from a geologic and geotechnical engineering perspective. Subsurface excavations beneath the dam footprint did not reveal evidence of past fault-related ground rupture.

- ***Preliminary PMF Determination*** - A preliminary estimation of the Probable Maximum Flood (PMF) was completed for conceptual sizing of an overflow/emergency spillway. Future design work should include more detailed hydrologic/hydraulic modeling to further refine preliminary estimates.

- ***Emergency Spillway*** - A high capacity reinforced concrete spillway structure is recommended. Conceptual hydraulic evaluation and modeling work estimate an approximate 50-foot wide spillway would be required to safely convey the full PMF. A concrete spillway stilling basin is recommended for adequate energy dissipation. A detailed hydraulic design of the spillway and stilling basin will be required as part of final design work.

- ***Outlet Works Configuration*** - Alternative outlet works configurations were considered. Dual outlet/drain pipes with multiple outlet ports, upstream control valves and downstream diversion structure are recommended to accommodate the multiple uses and contemplated reservoir operation/release scenarios. Large drum-style fish screen systems are recommended for mid and low level outlets.

- ***Drain Requirements*** - A preliminary hydraulic evaluation of the reservoir was performed to size the proposed outlet/drain piping to allow rapid drawdown of the reservoir in an emergency situation. Based on this evaluation, two large outlet/drain pipes, 36-inch and 48-inch diameters, are recommended and would accommodate draining the reservoir within a 30 day period in accordance with State guidelines.

- ***Preliminary Costs*** - Initial early budgetary cost estimates were further developed to reflect conceptual level designs. The eventual realization of the project relies heavily on the ability of the District to secure financing for the overall project.

- ***Schedule Considerations*** - A preliminary project schedule for the dam and reservoir was developed identifying timelines for preliminary design, final design and construction work. The proposed schedule incorporates the District's anticipated timeframes and milestones for permitting, water rights and other administrative tasks as well as a target construction advertise date of Fall 2013.

Recommended Next Steps

To proceed with dam and reservoir final design, additional preliminary work is needed, including additional environmental and permitting assessments, further geotechnical investigations, supplementary surveying, right-of-way assessment and acquisition, water rights procurement, regulatory reviews, environmental mitigation assessment and planning, and additional project funding assessment and procurement. The following next step tasks are recommended.

- ***Fish Passage*** - complete assessments and negotiations with regulatory agencies to obtain fish passage/ waiver conclusion
- ***Geotechnical Investigations*** - complete supplemental site investigations, preliminary engineering and analyses, and seismic hazard studies as identified in the recommended future geotechnical work program included in Section 4.
- ***Raw Water Transmission*** - determine final decision for raw water conveyance method
- ***Distribution System*** - complete assessment and planning for water distribution system to District customers
- ***Preliminary Engineering*** - proceed with preliminary design engineering work, coordinating with environmental studies and permitting process
- ***Water Rights*** - prepare and file water rights applications for processing through the Oregon Water Resources Department
- ***Property Easement/Acquisition*** - program to secure required property and easements
- ***Preliminary Regulatory Approvals and Permits*** - complete required preliminary assessments, prepare various preliminary permit applications, and negotiate various approvals with respective agencies
- ***Project Financing*** - continue funding assessments and financing assistance planning/ acquisition to support further project development

MSA

APPENDIX

MSA

APPENDIX A
Conceptual Design Drawings

EAST VALLEY WATER DISTRICT
DRIFT CREEK DAM AND RESERVOIR
CONCEPTUAL DESIGN

JUNE 2011

INDEX OF DRAWINGS

GENERAL

1	G-1	TITLE SHEET, VICINITY MAP, INDEX OF DRAWINGS, LEGEND & ABBREVIATIONS
2	G-2	PROJECT OVERVIEW / SITE PLAN

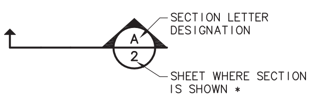
EMBANKMENT

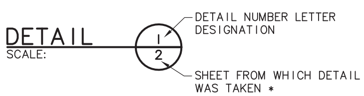
3	EMB-1	EMBANKMENT SITE PLAN
4	EMB-2	EMBANKMENT TYPICAL SECTION

CIVIL

5	C-1	HYDRAULIC STRUCTURES AND CIVIL SITE PLAN

SECTION AND DETAIL DESIGNATIONS





* NOTE: IF PLAN AND SECTION FOR DETAIL CALL-OUT AND DETAIL ARE SHOWN ON THE SAME DRAWING, DRAWING NUMBER IS REPLACED WITH A DASH.

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Murray, Smith & Associates, Inc.
Engineers/Planners
121 S.W. Salmon, Suite 900
Portland, Oregon 97204
PHONE 503-225-9010
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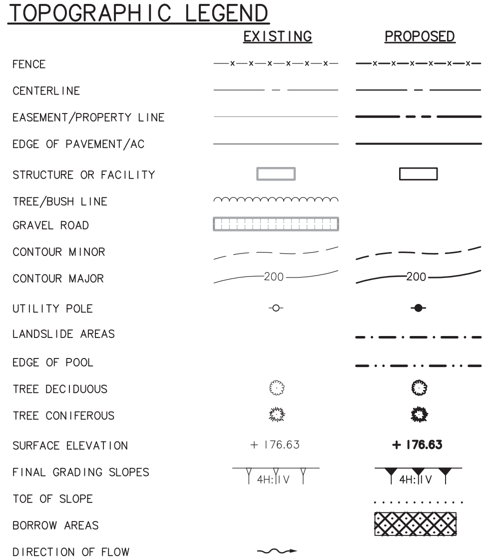
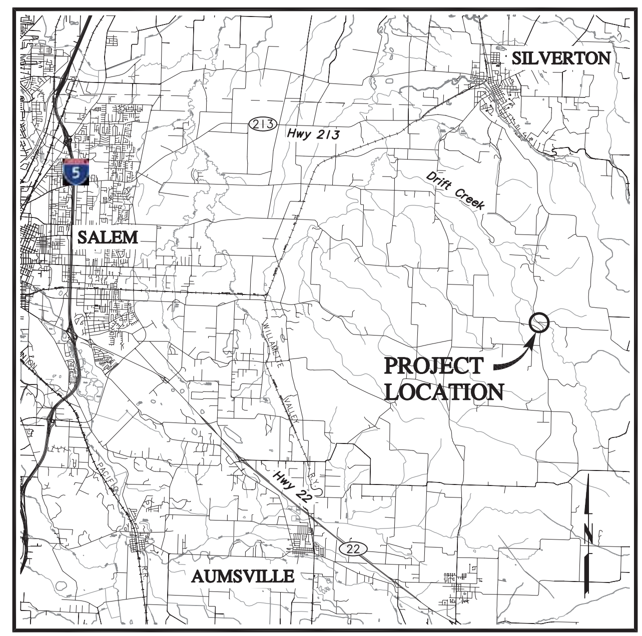
ABBREVIATIONS

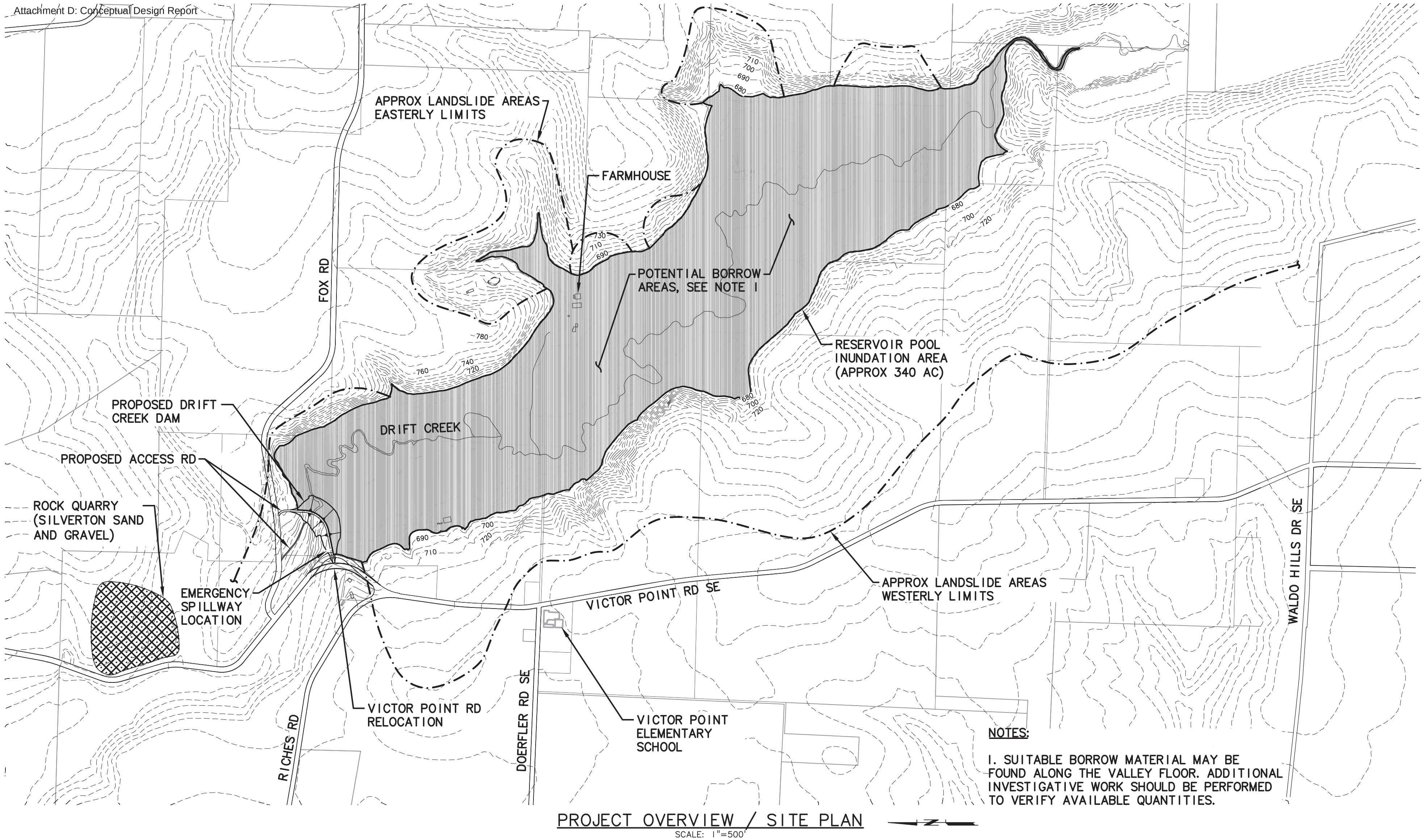
AC	ACRES
ALIGN	ALIGNMENT
APPROX	APPROXIMATELY
APWA	AMERICAN PUBLIC WORKS ASSOCIATION
AWWA	AMERICAN WATER WORKS ASSOCIATION
CI	CAST IRON
℄	CENTERLINE
CND	CONDUIT
CONC	CONCRETE
COORD	COORDINATE(S)
DET	DETAIL
DIA	DIAMETER
DR	DRIVE
DWG	DRAWING
EL	ELEVATION
EXIST	EXISTING
EXIST GR	EXISTING GRADE
FIN GR	FINISH GRADE
FT	FEET
GRVL	GRAVEL
IE	INVERT ELEVATION
LF	LINEAR FEET
LT	LEFT
MAX	MAXIMUM
MIN	MINIMUM
NO.	NUMBER
NTS	NOT TO SCALE
RD	ROAD
R/W	RIGHT-OF-WAY
RT	RIGHT
SHT	SHEET
SL	SLOPE
STA	STATION
THK	THICK
TYP	TYPICAL
W/	WITH

TOPOGRAPHIC LEGEND





VICINITY MAP
SCALE: 1"=8,000'



NOTES:

1. SUITABLE BORROW MATERIAL MAY BE FOUND ALONG THE VALLEY FLOOR. ADDITIONAL INVESTIGATIVE WORK SHOULD BE PERFORMED TO VERIFY AVAILABLE QUANTITIES.

PROJECT OVERVIEW / SITE PLAN

SCALE: 1"=500'

NO.	DATE	BY	REVISION

NOTICE: 0 ½ 1 — IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

TSC DESIGNED / DAK DRAWN / WSE CHECKED

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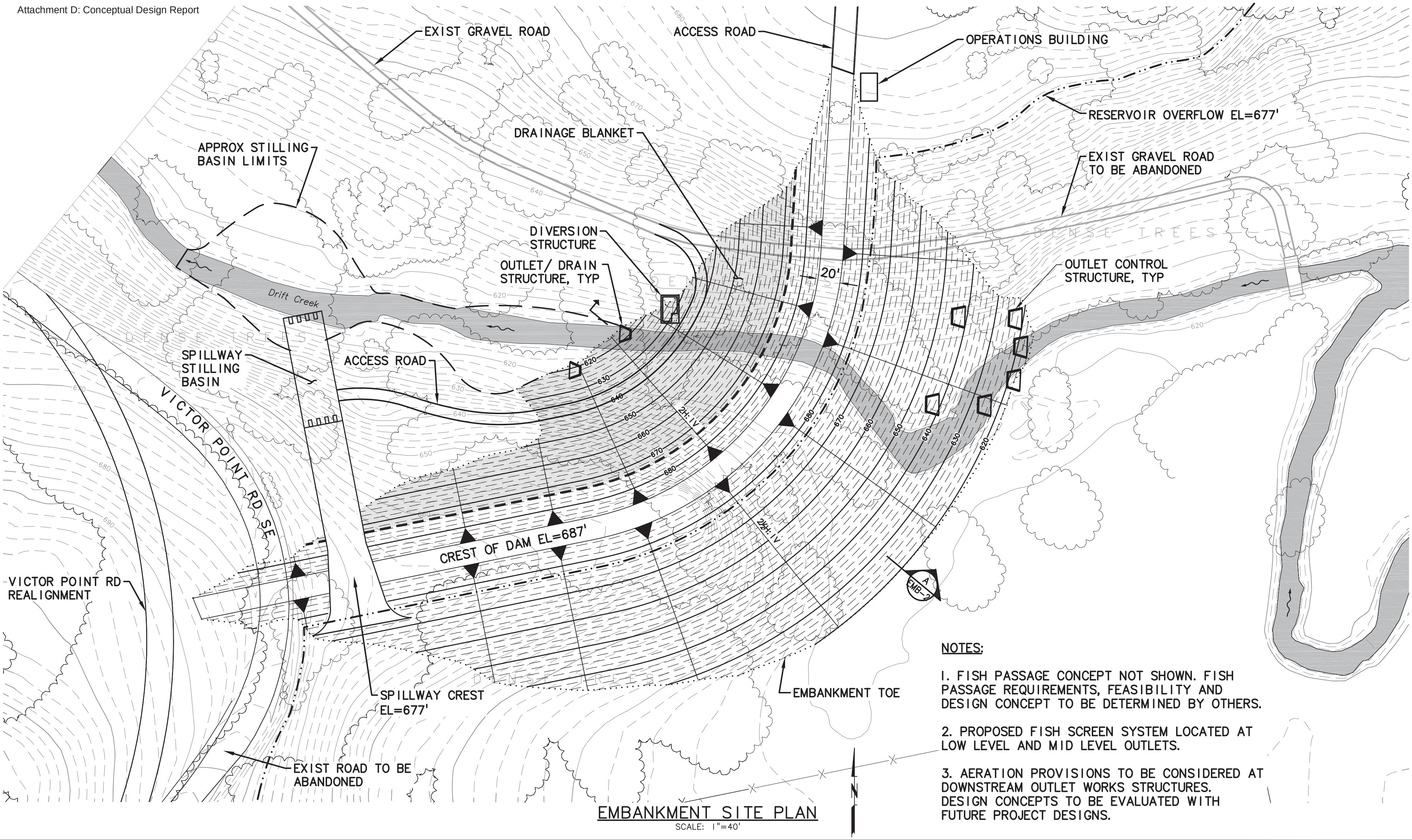
EAST VALLEY WATER DISTRICT
DRIFT CREEK DAM AND RESERVOIR
CONCEPTUAL DESIGN

PROJECT OVERVIEW / SITE PLAN

PROJECT NO.: 11-1195.204 | SCALE: AS SHOWN | DATE: JUNE 2011

SHEET G-2

2 of 5



EMBANKMENT SITE PLAN

SCALE: 1"=40'

NOTES:

1. FISH PASSAGE CONCEPT NOT SHOWN. FISH PASSAGE REQUIREMENTS, FEASIBILITY AND DESIGN CONCEPT TO BE DETERMINED BY OTHERS.

2. PROPOSED FISH SCREEN SYSTEM LOCATED AT LOW LEVEL AND MID LEVEL OUTLETS.

3. AERATION PROVISIONS TO BE CONSIDERED AT DOWNSTREAM OUTLET WORKS STRUCTURES. DESIGN CONCEPTS TO BE EVALUATED WITH FUTURE PROJECT DESIGNS.

NO.	DATE	BY	REVISION

NOTICE
0 ½ 1
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DAK DRAWN
KGC CHECKED

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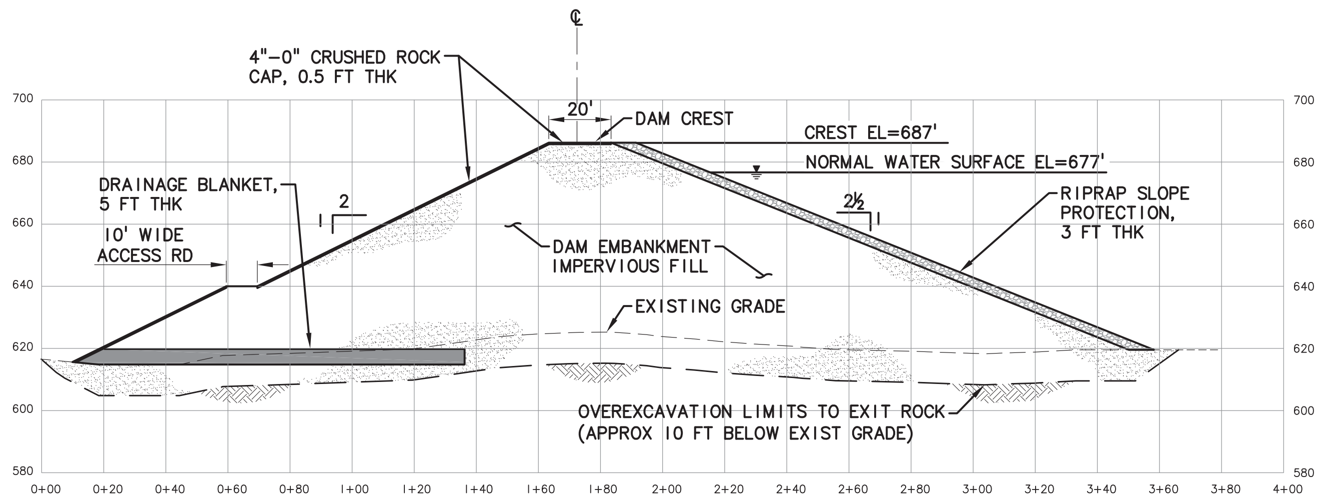
EAST VALLEY WATER DISTRICT
DRIFT CREEK DAM AND RESERVOIR
CONCEPTUAL DESIGN

EMBANKMENT SITE PLAN

PROJECT NO.: 11-1195.204 SCALE: AS SHOWN DATE: JUNE 2011

SHEET EMB-1
3 of 5



NOTE: PROPOSED HYDRAULIC STRUCTURES NOT SHOWN FOR CLARITY.

EMBANKMENT TYPICAL SECTION

SCALE: 1"=20' HORIZ, 1"=20' VERT

NO.	DATE	BY	REVISION

NOTICE
0 ½ 1
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DAK — DRAWN
KGC — CHECKED

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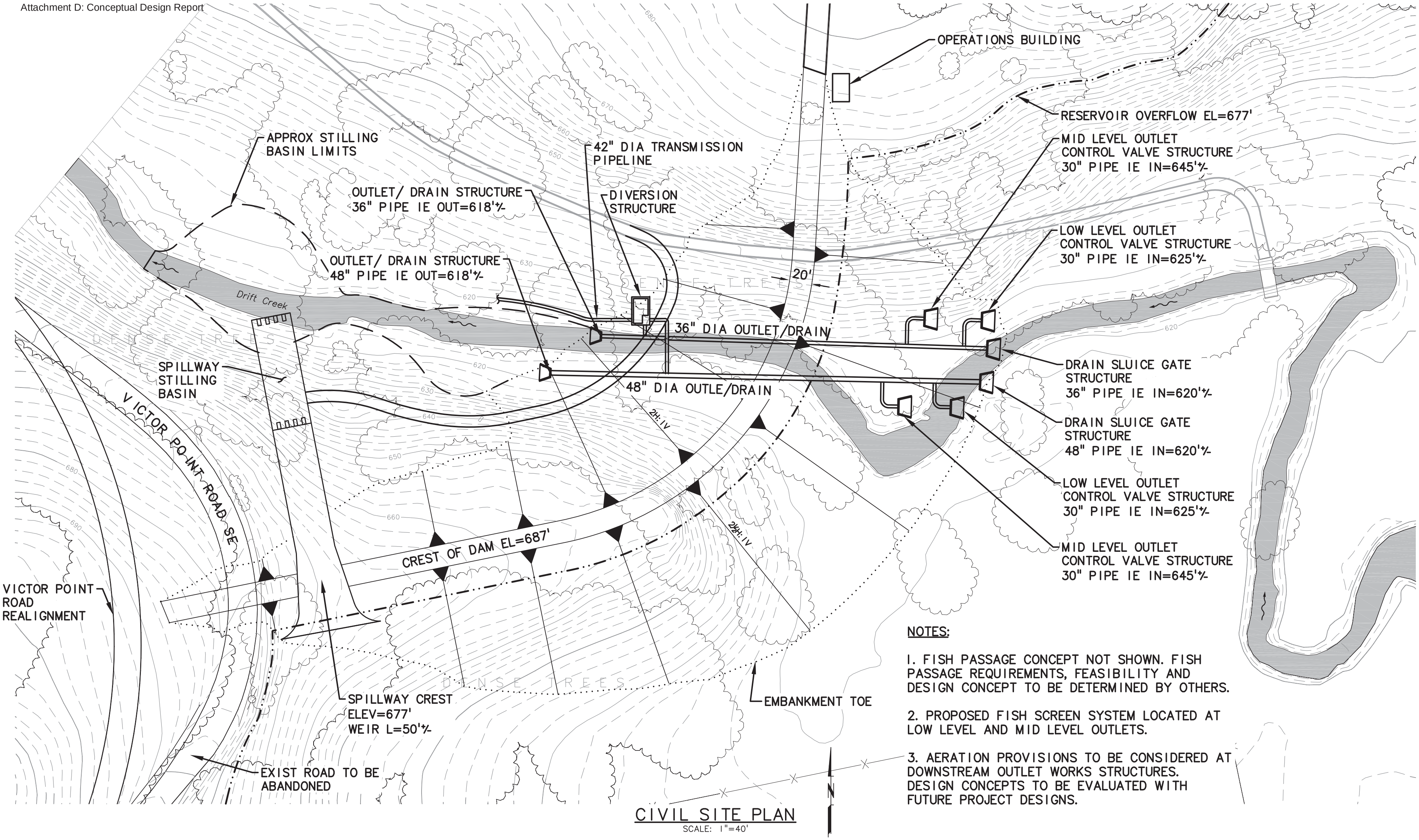
EAST VALLEY WATER DISTRICT DRIFT CREEK DAM AND RESERVOIR CONCEPTUAL DESIGN

EMBANKMENT TYPICAL SECTION

PROJECT NO.: 11-1195.204 SCALE: AS SHOWN DATE: JUNE 2011

SHEET EMB-2



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JUNE 2011
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EAST VALLEY WATER DISTRICT DRIFT CREEK DAM AND RESERVOIR CONCEPTUAL DESIGN

HYDRAULIC STRUCTURES AND CIVIL SITE PLAN

PROJECT NO.: 11-1195.204 | SCALE: AS SHOWN | DATE: JUNE 2011

SHEET C-1

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APPENDIX B
Conceptual Level Geotechnical and Geological Investigation Report (GRI)

MSA

GRI
9725 SW Beaverton-Hillsdale Hwy, Suite 140
Beaverton, OR 97005-3364
p| 503-641-3478 f| 503-644-8034

June 17, 2011 5186 GEOTECHNICAL RPT CONCEPTUAL DESIGN

Murray, Smith & Associates, Inc.
121 SW Salmon Street, Suite 900
Portland, OR 97204

Attention: Kate Conrad, PE

SUBJECT: Geotechnical Consultation
Phase 1 Conceptual Design - Fatal Flaw Evaluation
Drift Creek Dam
Marion County, Oregon

At your request, GRI has provided geotechnical consultation for Phase 1 Conceptual Design of the proposed Drift Creek dam. The project site is located about 6 miles south of Silverton, Oregon, in a rural portion of the Waldo Hills. The general location of the site is shown on the Vicinity Map, Figure 1. The East Valley Water District will be the owner/operator of this facility, and the reservoir will be used to store water for irrigation.

The purpose of this consultation was to further evaluate two previously identified potential "fatal flaws" associated with design and construction of the proposed dam: 1) at least two fault lineaments have been mapped in the area of the dam site (Tolan and Beeson, 1999), and it is necessary to demonstrate that these faults are inactive with respect to ground rupture beneath the dam; and 2) landslides have been mapped on the west side of the reservoir; reactivation of these landslides will likely result from filling and operating the reservoir. Concurrent with our field work, we also provided the design team with general geotechnical input as requested.

Our work included a review of available information, a ground-level reconnaissance, focused subsurface explorations, laboratory testing, and engineering analyses. This report describes the work accomplished and our field explorations and laboratory testing program, and provides our findings and conclusions regarding the fault lineaments, landslide potential on the margins of the reservoir, and general considerations for design and construction of the reservoir. Our work was completed in general accordance with our proposal dated December 15, 2010.

Phase 2 will be a preliminary design and will be an expansion of the existing conceptual design studies. Phase 3 will be a detailed seismic hazard analysis, which will evaluate the response of the embankment under seismic loading. Phase 4 will be final design studies and reporting and will include assisting Murray, Smith & Associates, Inc. (MSA) in the preparation of construction drawings and specifications and the contract documents suitable for permitting and bidding the project.

BACKGROUND

Previous geotechnical work and geologic mapping have been completed for the project and in the project area by others. Our consultation included review of the following reports by others:

"Engineering Geologic Information for Feasibility of Proposed Drift Creek Dam, Silverton area, Oregon," prepared by H. G. Schlicker & Associates, Inc. for Stuntzner Engineering, June 24, 2005 (Schlicker)

"Geotechnical Reconnaissance, Drift Creek Reservoir and Dam, Victor Point, Oregon," prepared by Siemens & Associates for Black Rock Consulting, July 24, 2009 (Siemens)

The Schlicker report documents the site geology and subsurface conditions around the dam site and pool. Their work indicates the dam site is underlain by basalt rock and interbedded alluvial sediments of the Drift Creek drainage (silt, sand, cobbles, and wood debris). Explorations completed in the pool area indicate the presence of silt, sand, and clay, underlain by weathered sedimentary rock. Schlicker also mapped several large areas along the western pool perimeter as being old landslides and notes that stability of the reservoir valley slopes would likely decrease as the pool was filled. Some of these large landslide areas are on the order of 2,500 by 2,000 ft in plan, or roughly 100 acres in size.

The Siemens report documents additional reconnaissance work that suggests portions of the eastern pool perimeter are steep and prone to slope instability. Geophysical work near the dam site indicates the likely presence of alluvial sediments, weathered sedimentary rock, and basalt rock.

SITE DESCRIPTION

Topography

The proposed reservoir site is located in the Waldo Hills upland area of the Willamette Valley. Drift Creek drains toward the northwest from higher elevation areas to the southeast. At the dam site, the topography narrows and the width of the Drift Creek valley constricts from about 1,000 to 100 ft. Available topographic information indicates the valley floor at the dam site is at about elevation 620 ft, and valley/pool perimeter ranges from about elevation 800 to 1,000 ft. Where observable and not covered by trees or dense vegetation, slopes along the majority of the pool area are irregular (hummocky).

Geology

The dam site is underlain by Tertiary volcanic and sedimentary rocks. The volcanic rocks are part of the Columbia River Basalt Group, and the sedimentary rocks are locally referred to as Scotts Mills Formation. U.S. Geological Survey (USGS) geological mapping for the site is provided on the Geologic Map, Figure 2. Essentially the entire pool area is underlain by relatively weak, weathered sedimentary rock.

The Oregon Department of Geology and Mineral Industries State Landslide Inventory does not show mapped landslides within or adjacent to the pool area. However, the state landslide inventory is not comprehensive, and local areas around the site, in particular steeply sloping areas underlain by sedimentary rocks, have been mapped as landslides. As noted above, Schlicker and Siemens have mapped or interpreted large portions of the pool perimeter as ancient landslides or areas prone to slope instability.

Fault Potential

USGS mapping indicates the presence of two bedrock fault lineaments north of the site in the Drift Creek drainage (Tolan and Beeson, 1999). The fault traces trend toward the location of the proposed dam, but the USGS mapping ends before (west of) the project site. These faults are not considered to have Holocene displacement (U.S. Geological Survey, 2011).

Groundwater

This site exhibits characteristics of shallow groundwater levels, including seeps, springs, and wet depressions with attendant water-loving plants. We expect that surficial groundwater levels approach the ground surface during the wet, winter season and during periods of prolonged or intense rainfall. Regional aquifers in this area are typically located deep in the basalt underlying the area.

PROJECT DESCRIPTION

The 12,000 acre-ft design developed by MSA includes an embankment up to about 65 ft high from toe to crest (crest elevation 687 ft) and about 700 ft long, constructed across the Drift Creek drainage. The proposed embankment volume will be on the order of 127,000 cubic yards. A Preliminary Grading Plan and Typical Dam Section of the proposed improvements are provided on Figures 3 and 4. The overflow spillway will be constructed on the left abutment to direct water into the drainage northwest of the reservoir. We anticipate that sufficient material to construct the conceptualized embankment can be obtained from the reservoir pool area away from the proposed dam. Granular materials suitable for use in internal drains and as riprap slope protection will need to come from off site. Victor Point Road SE is located adjacent to the west limit of the dam and will require relocation westward away from the pool. Based on topographic information, cuts on the order of 20 ft in height may be required to achieve design grades for the relocated Victor Point Road SE.

SURFACE RECONNAISSANCE

The surficial conditions of the project site and slopes uphill and downhill of the site were evaluated during site visits in March and June 2011, by an engineering geologist and geotechnical engineer from GRI. During these visits, evidence of past landslide activity in the pool area was observed, including a large headscarp west of the site, west of Victor Point Road SE, and irregular (hummocky) topography throughout the slopes along the western and eastern sides of the pool. Exposures of weathered sedimentary rock were observed in the mid-eastern portion of the pool area. Relatively hard basalt rock is exposed along the nose of the ridge at the left (west) abutment.

FIELD EXPLORATIONS

General

On June 7, 2011, subsurface materials were evaluated with two test pits, designated TP-GRI-1 and TP-GRI-2, using a small trackhoe excavator with rubber tracks supplied and operated by Dan J. Fischer Excavating, Inc. of Forest Grove, Oregon. The approximate locations of the test pits are shown on Figure 3. All field explorations were observed by a geotechnical engineer and engineering geologist from GRI, who collected samples and maintained detailed logs of the materials and conditions encountered during the course of the work. Samples recovered from the test pits were returned to our laboratory for further examination and physical testing.

Fault Potential Evaluation

To evaluate the potential presence of geologic features that may indicate the potential for fault rupture below the dam, a relatively long trench was excavated perpendicular to the narrow topographic area near the dam footprint. The location of this exploration, designated trench TP-GRI-1, is shown on Figure 3. This trench measured a total of 230 ft and was completed in accordance with a pre-approved team work plan. The trench was excavated to a depth of 3 to 4 ft and encountered a surficial 2-ft-thick layer of dark brown, clayey silt that contains many fine roots and has a blocky texture. The dark brown unit is underlain by a 1- to 2-ft-thick layer of light brown, clayey silt. The light brown, clayey silt transitioned into decomposed sedimentary rock near the bottom of the excavation along the total length of the trench. The decomposed sedimentary rock has weathered to the consistency of stiff soil. Near the midpoint of the trench, a short section was excavated to a depth of about 9 ft and the decomposed sedimentary rock continued to the bottom of the excavation. Light groundwater seepage was encountered at a depth of 2.5 to 4 ft below the ground surface.

No indications of fault rupture, shearing, displaced soil horizons, or other indications of faulting were observed.

Supplemental Borrow Area Test Pit

To evaluate the thickness of potential borrow materials, a test pit was excavated in the pool area on June 7, 2011. The location of this exploration, designated test pit TP-GRI-2, is shown on Figure 3. The test pit was excavated to a depth of 5 ft and encountered a surficial 2-ft-thick layer of dark brown, clayey silt underlain by a 2-ft-thick layer of light brown, clayey silt. At a depth of 4 ft, the light brown, clayey silt transitioned into decomposed sedimentary rock. Heavy groundwater seepage was encountered at a depth of 4 to 5 ft below the ground surface.

LABORATORY AND FIELD TESTING

General

Samples obtained from the test pits were returned to our laboratory where the physical characteristics of the samples were further documented. The laboratory testing program included natural moisture content and Atterberg limits. Torvane shear strength testing was completed in the field. The following paragraphs describe the testing program in more detail.

Natural Moisture Content

The natural moisture content of the materials encountered in the test pits was determined in conformance with ASTM D 2216. The results are summarized below:

Test Pit	Sample	Depth, ft	Moisture Content, %	Soil Type
GRI-TP-1	S-1	1	39	Clayey SILT
	S-2	3	38	Clayey SILT
GRI-TP-2	S-1	1	38	Clayey SILT
	S-2	3	52	Clayey SILT
	S-3	5	52	Decomposed sedimentary rock

Atterberg Limits

Atterberg limits tests were performed on representative samples in conformance with ASTM D 4318. The test results are shown on Figure 5.

Torvane Shear Strength

The approximate undrained shear strength of relatively undisturbed soil samples was determined using a Torvane shear device. The Torvane is a hand-held apparatus with vanes that are inserted into the soil. The torque required to fail the soil in shear around the vanes is measured using a calibrated spring.

Multiple Torvane results indicate the clayey soils from test pit GRI-TP-1 have an approximate undrained shear strength of 0.50 tsf. This value is typical for relatively fine-grained soils with moderate to low strength.

FINDINGS AND CONCLUSIONS

Based on our review of the project plans, previous work by others, and our implemented scope of work, we have developed the following findings and conclusions:

1) Our observations at the site and our subsurface explorations did not disclose evidence of past fault-related ground rupture beneath the footprint of the dam. In our opinion, the potential for fault-related ground rupture within the footprint of the dam is low.

2) Our observations at the site, subsurface explorations, and review of work by others at the site indicate the hillsides adjacent to the pool area are mantled and underlain by landslide debris or weathered rock and soil that have a high risk of slope instability. Landslides mapped through previous work on this project and our observations revealed that topography indicative of past landslide activity extends west of Victor Point Road SE in some areas. In our opinion, given these large areas of potential slope instability around the pool, it is not practical or cost-effective to design mitigation approaches for future possible pool-induced landslides. The owner must accept this risk as part of the overall project implementation.

3) Additional exploration work should be accomplished to further evaluate potential borrow areas away from the embankment (outside the area shown on Figure 3). The amount of borrow material available around the footprint of the dam appears limited to about 2 to 4 ft below the ground surface. To prevent pool floor leakage, borrow areas should be limited in depth to leave at least a 2-ft-thick layer of relatively impermeable fine-grained soil above weathered bedrock.

4) Based on the results of our work and experience with similar projects, it is our opinion the proposed earthfill embankment section is feasible and may be constructed with an adequate factor of safety for internal slope stability. However, to safely and economically construct the embankment, a well thought-out and sequenced plan of construction work, including foundation preparation, excavation dewatering, select use of available borrow materials, internal drainage and filters, and slope protection, will be required.

CONSTRUCTION RECOMMENDATIONS

Seasonal Construction - Earthwork and Excavation

The fine-grained soils and weathered sedimentary rock at the site are suitable for construction of the proposed homogeneous embankment; however, they are also moisture-sensitive and will be difficult to place and compact when the moisture content of the materials is significantly above optimum. It appears that the in-place moisture content of the soils is above the optimum moisture content for compaction, and the soils will require considerable drying or amendment with lime or cement to improve the workability of the material for placement as compacted structural fill. In our opinion, with or without the use of soil additives, placement and compaction of fine-grained soil at this site will be limited to periods of extended dry weather, which typically occur from about mid-June to mid-September. As a result, this project may require two or more summer construction seasons for completion of the dam earthworks.

Site Preparation

We recommend the foundation and abutments for the proposed embankment should be cleared of timber, grubbed, and stripped of vegetation. Foundation conditions should be evaluated by the geotechnical engineer at the time of site preparation. Based on observation of the soil exposed in the test pits, the upper 2 ft of soil contains many fine roots and has a blocky texture. For the portion of the embankment footprint established on the relatively flat area near the elevation of the bottom of the pool, we recommend removing the soil from the embankment footprint to expose the underlying decomposed sedimentary rock. Exposed subgrade beneath the embankment should be scarified to a depth of about 12 in. and compacted to a minimum of 95% of the maximum dry density at a moisture content within the range of 2% below to 4% above the optimum moisture content as determined by ASTM D 698.

Areas of seepage encountered within the limits of the embankment should be evaluated by the geotechnical engineer for recommended remedial action.

Cuts and Fills

Permanent cut and fill slopes should have a design slope of 2H:1V or flatter. Deep cuts for the embankment footprint will encounter shallow groundwater and weathered sedimentary rock. Based on the presence of basalt in the dam area, it is likely that trackhoe excavators will be needed to make the excavations. Excavation of weathered sedimentary rock will likely require the use of a medium-size (Cat D-7) or larger bulldozer equipped with a ripper.

On-site fine-grained soils and weathered sedimentary rock are suitable for use in structural fill. Basalt boulders should not be used in fill within the reservoir embankment. All structural fill placed on the site should be approved for placement by a qualified geotechnical engineer. The soil placed in the embankment should be free of organic material. Structural fill should be placed in 6- to 9-in.-thick lifts (before compaction) for fine-grained soil (silt and decomposed siltstone) and 9- to 12-in.-thick lifts (before compaction) for granular materials.

Fine-grained soils and weathered siltstone fill should be compacted using a large (Cat 815) or larger static segmented-pad compactor. Pieces of weathered sedimentary rock that are gravel-size or larger should break down with several passes of the segmented-pad compactor. Use of single-drum vibratory compactors fitted with segmented pads should not be allowed for compaction of fine-grained soils. Fine-grained fill should be compacted to at least 95% of the maximum dry density at a moisture content within the range of 2% below to 4% above the optimum moisture content as determined by ASTM D 698. Actual compaction procedures should be determined in the field at the time of construction by building a test section of the embankment fill material. Fills of fine-grained materials with an outer slope steeper than about 3H:1V should be overbuilt by a thickness of about 2 ft and then cut back to the final grade. It must be recognized that the moisture content of the on-site fine-grained soils and the weathered sedimentary rock is well above optimum, and the materials will require significant drying or amendment with lime or cement prior to placement and compaction.

Granular fill constructed of sand- to gravel-size material should be compacted using a large, smooth-drum vibratory roller to at least 95% of the maximum dry density as determined by ASTM D 698. Coarse granular fill from 3 to 12 in. in diameter may also be compacted into place with a large, smooth-drum roller or by track-walking with a large bulldozer until well keyed.

Side slopes of temporary cuts deeper than 4 ft should not be constructed steeper than 1H:1V. Cut and fill slopes composed of fine-grained materials will be extremely susceptible to erosion. All slopes should be revegetated or otherwise protected as soon as practical following construction. Surface water should be directed away from the slopes.

Haul Roads

Our experience indicates the fine-grained soils that mantle the site are sensitive to moisture content. Typically, when these soils are in excess of 4 to 5% of their optimum moisture content, construction traffic will remold, rut, and soften the soil and limit its use as a construction haul road. For this reason, we recommend that all construction traffic be limited to movement on granular work pads and haul roads during the season when the moisture content of surface soils is significantly above optimum.

In our opinion, a 12-in.-thick granular work pad should be sufficient to prevent disturbance of the subgrade by lighter construction equipment and limited traffic by dump trucks. Haul roads and other high-density traffic areas will require at least 18 to 24 in. of crushed rock to prevent subgrade deterioration. Any subgrade soils that are disturbed by construction activity should be overexcavated to firm soil and backfilled with coarse, granular compacted structural fill. Any granular fill placed for haul roads within the footprint of the embankment should be removed before constructing embankment fill. Haul road requirements will be reduced if work is accomplished during the driest months of the year.

Geotextiles may be used between the granular haul road materials and the underlying fine-grained subgrade soils as a separation filter to prevent the movement of fines into the crushed rock. Use of these fabrics may improve haul road performance and reduce maintenance, particularly during wet-weather conditions.

Construction Dewatering

Construction dewatering will be essential for project completion. Based on our experience, we are of the opinion that the majority of the excavation can be completed by ditching and pumping from sumps located within the excavation. However, use of this approach will require that the excavation proceed slowly enough for the hydrostatic pressures behind the excavation face to dissipate and the groundwater surface to lower as construction proceeds. The anticipated quantity of water is difficult to estimate, since the majority of the flow, in our opinion, will come from discrete zones, cracks, and fissures in the soil and rock masses, with a very small percentage actually seeping through the soil and rock mass. Consequently, we are of the opinion that the groundwater surface behind the excavation face should fall relatively quickly following completion of the excavation at any given elevation. However, given the nature of the local geology, we also anticipate that large localized flows of groundwater may also be encountered. These concentrated flows could result in areas of instability of the cut face. It may be possible to manage these large flows by placing a layer of free-draining granular material on the exposed face of the excavation. However, if this approach is not able to maintain the stability of the face of the excavation, it will likely be necessary to install a system of relief wells above the top of excavation, or install a series of horizontal drains in the cut face. Regardless of the approach to dewatering, it will be essential to keep the bottom of the excavation free of standing water and monitor the excavation for any increases in water entering the excavation. As previously noted, areas of seepage encountered within the limits of the embankment should be evaluated by the geotechnical engineer for recommended remedial action.

Embankment Drains

Permanent control of seepage through the embankment and management of groundwater levels below the embankment will be important to the stability of the structure. An internal drainage system should be constructed to lower water pressures within the downstream shell of the structure. The proposed drainage consists of a drainage blanket composed of clean, open-graded granular material that daylights at the elevation of the toe of the embankment and extends to about the centerline of the embankment.

To reduce the risk of piping of the fine-grained embankment material into the drain material leading to clogging of the drain, a filter material will need to be installed between the drain and the surrounding soil. Gradation and thickness of the filter material should be determined after a drain material has been selected. A series of perforated drain pipes should be installed on about 20-ft centers in the drainage material at the downhill toe of the drainage blanket. Water in these pipes should be collected and hard-piped to a discharge point located away from the toe of the reservoir embankment.

Embankment Slope Protection

Sloped portions of the embankment sides exposed to water should be lined with riprap to reduce erosion at the waterline and turbidity. The slope protection should extend from an elevation at least 2 ft below the normal low-water operating level of the reservoir to a point 2 ft above the normal high pool. The riprap should be bedded on a layer of pervious, well-graded gravel or crushed rock with material diameters ranging from about $^{3}/_{16}$ to $3^{1}/_{2}$ in. Gradations of the blanket material can be more accurately determined once a slope protection material is selected. This bedding layer should be placed in a single lift that achieves a thickness of at least 12 in. after compaction, measured perpendicular to the slope.

Riprap placed on the embankment should have a minimum thickness of 24 in. measured perpendicular to the slope and should meet the following criteria: maximum size should equal 100 pounds, of which 30 to 40% of the material should be 60 to 100 lbs; 60 to 70% of the material should be 25 to 60 lbs; and less than 10% of the material should be under 25 lbs. The riprap should be placed in a manner to produce a uniform thickness of well-keyed, dense, uniformly distributed rock fragments.

The downstream surface of the embankment may be protected from erosion using a 6-in.-thick cap of 4-in.-minus crushed rock. Outside the area of the spillway, the surface may also be protected by planting a suitable cover of grass or other shallow rooted, low-lying ground-cover vegetation. The downstream slope should be protected from the crest of the dam to the lower limits of the embankment slope.

The surfaces of the embankment should be kept free of deeply rooted vegetation such as trees. The embankment should also be kept free of animal burrows. Downstream surfaces of the embankment and areas within 50 ft downstream of the embankment should be kept free of brushy vegetation that inhibits observations of seeps and springs that may develop following reservoir filling.

LIMITATIONS

This report has been prepared to aid the owner and engineer in the conceptual planning, design, and construction of this project. The scope is limited to the specific project and location described herein, and our description of the project represents our understanding of the significant aspects of the project relevant to the earthwork and design and construction of the dam. In the event that any changes in the design and location of the dam as outlined in this report are planned, we should be given the opportunity to review the changes and to modify or reaffirm the conclusions and recommendations of this report in writing. Additional exploration and geotechnical work will be required as part of the Final Design.

The findings, conclusions, and recommendations submitted in this report are based on the data obtained from the test pits made at the locations indicated on Figure 3 and from other sources of information discussed in this report. In the performance of these types of projects, specific information is obtained at specific locations at specific times. However, it is acknowledged that variations in soil and rock conditions may exist between test pit locations. This report does not reflect any variations that may occur between these explorations. The nature and extent of variation may not become evident until construction. If, during construction, subsurface conditions different from those encountered in the explorations are observed or encountered, we should be advised at once so that we can observe and review these conditions and reconsider our recommendations where necessary.

Please contact the undersigned if you have any questions or comments regarding this report, or if we can be of further assistance to you.

Submitted for GRI,

George A. Freitag, CEG
Associate

Michael J. Zimmerman, PE, CEG
Senior Engineer/Geologist

David D. Driscoll, PE, GE
Principal Engineer

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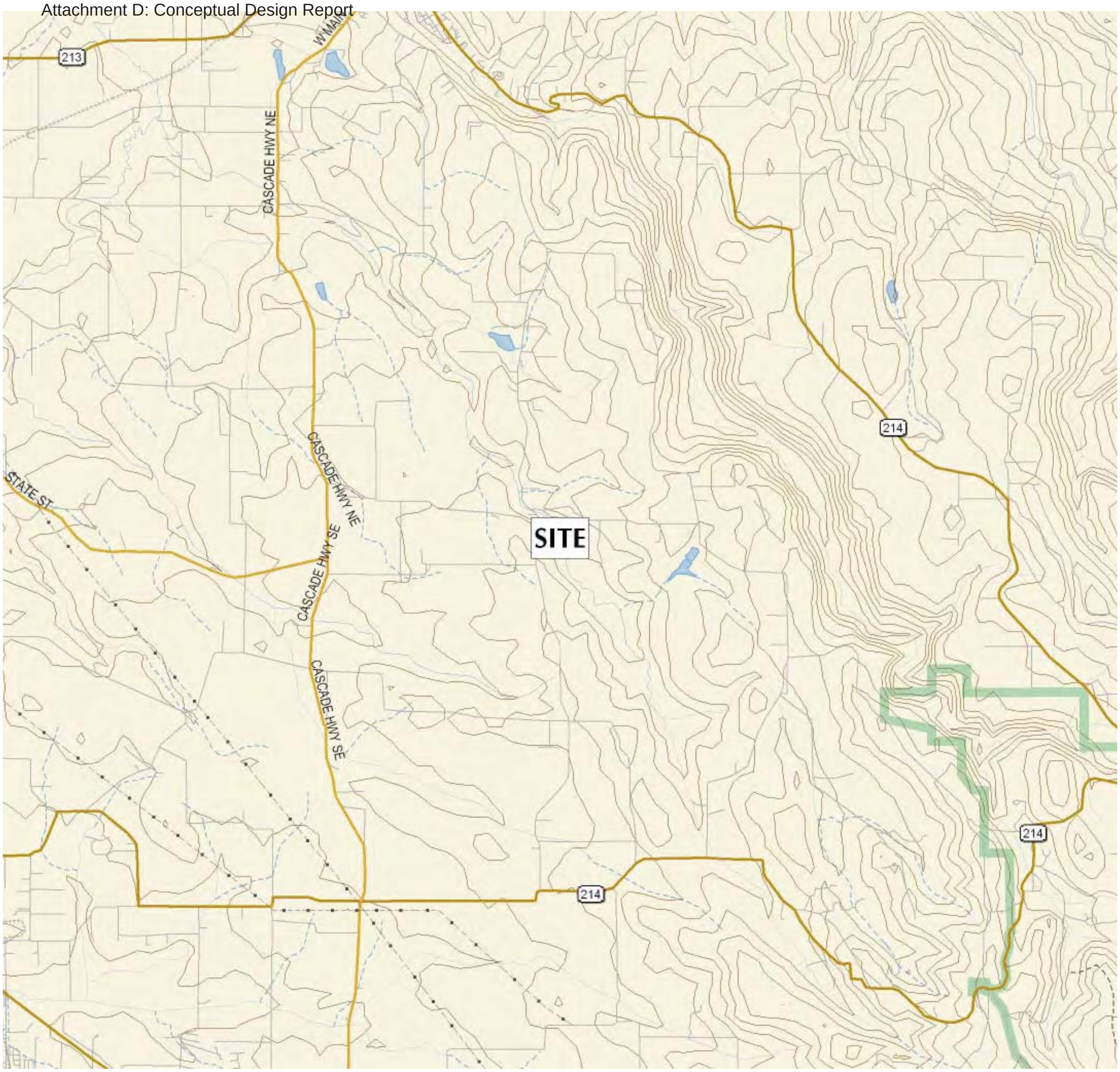
O'Connor, J. E., Sarna-Wojcicki, A., Wozniak, K, C., Polette, D. J., and Fleck, R. J., 2001, Origin, Extent, and Thickness of Quaternary Geologic Units in the Willamette Valley, Oregon: U.S. Geological Survey, Professional Paper 1620.

Tolan, T. L., and Beeson, M. H., 1999, Geologic Map of the Scotts Mills, Silverton, and Stayton Northeast 7.5 Minute Quadrangles, Oregon. Scale 1:24,000: U.S. Geological Survey, Open-file Report 99-141.

U.S. Geological Survey, 2006, Quaternary Fault and Fold Database for the United States, Accessed June 10, 2011, from USGS Web Site: http//earthquakes.usgs.gov/regional/qfaults/

This document has been submitted electronically.



DELORME 3-D TOPOQUADS, OREGON
DRAKE CROSSING, OREG. (3bb) 2004

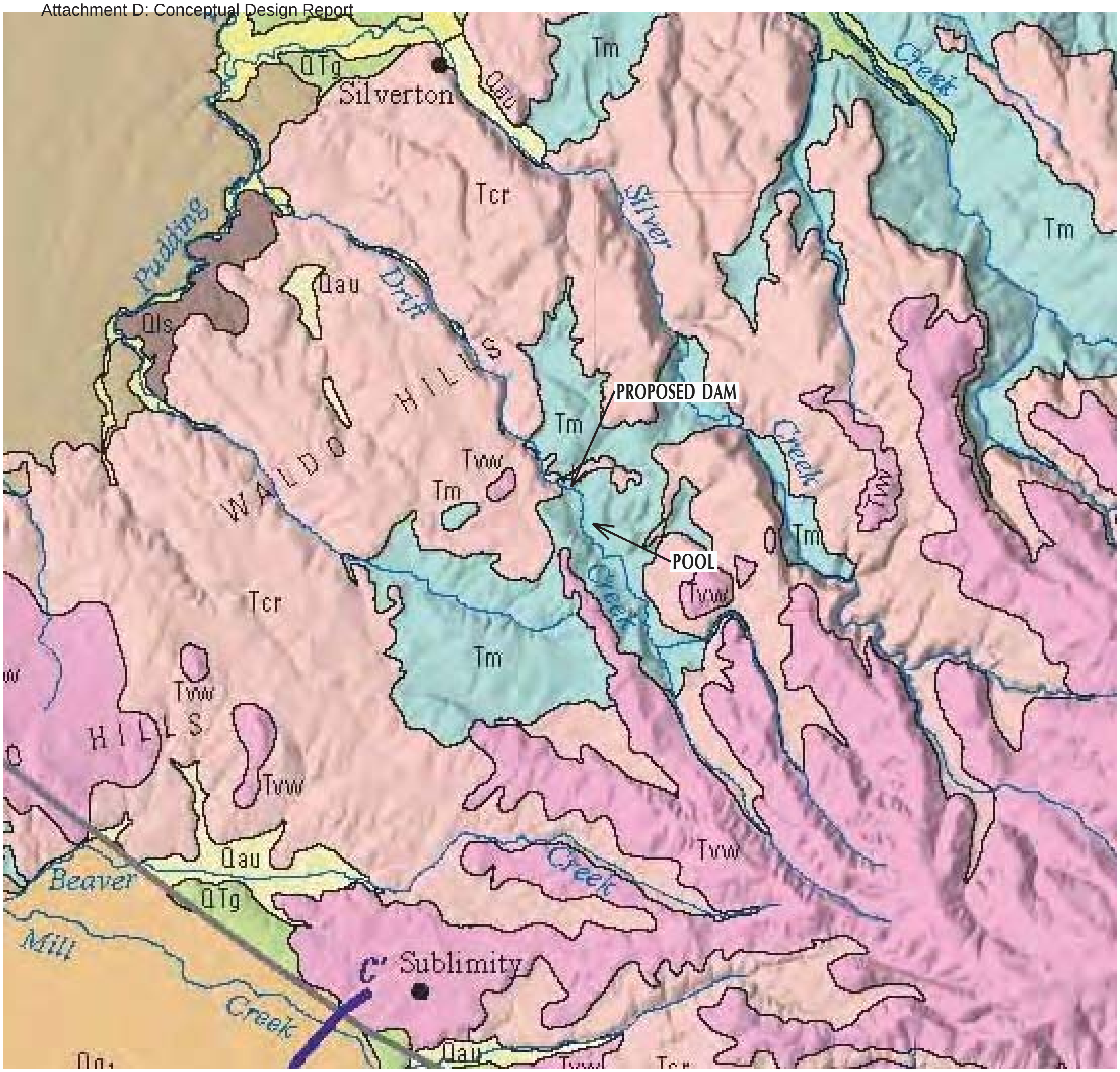
North

0 2 4 MILES

GRI MURRAY, SMITH & ASSOCIATES, INC.
DRIFT CREEK DAM CONCEPTUAL DESIGN

VICINITY MAP

JUNE 2011 JOB NO. 5186 FIG. 1



LEGEND

Tcr — **Columbia River Basalt Group (Miocene)**—Lava flows of dark gray to black, locally porphyritic basalt. Locally deeply weathered. Mostly between 16 and 15 Ma in northern Willamette Valley (M.H. Beeson, Portland State University, written communication, 1998). Also includes small areas of alluvium, colluvium, loess, and landslide debris. Distribution after Gannett and Caldwell (1998).

Tm — **Marine sedimentary rocks (lower Miocene to Eocene)**—Marine sandstone, siltstone, shale, and claystone, with lesser conglomerate, locally tuffaceous. Also includes numerous small mafic intrusions, and small areas of alluvium, colluvium, loess, and landslide debris. Distribution after Gannett and Caldwell (1998).

FROM: O'CONNOR AND OTHERS, DATED 2001

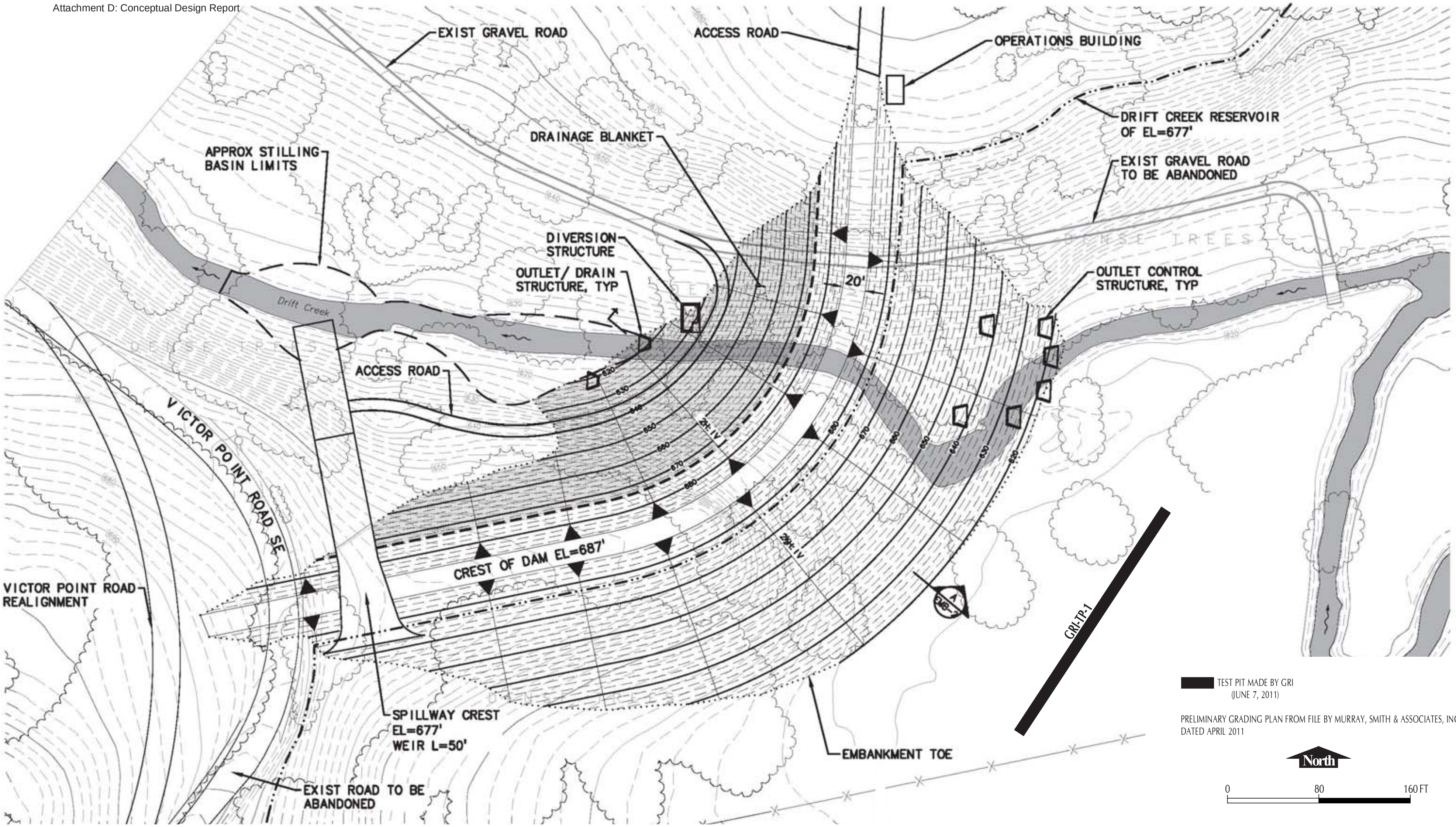
GRI MURRAY, SMITH & ASSOCIATES, INC.
DRIFT CREEK DAM CONCEPTUAL DESIGN

North

0 2.5 5 MILES

GEOLOGIC MAP

JUNE 2011 JOB NO. 5186 FIG. 2



TEST PIT MADE BY GRI (JUNE 7, 2011)

PRELIMINARY GRADING PLAN FROM FILE BY MURRAY, SMITH & ASSOCIATES, INC., DATED APRIL 2011

North

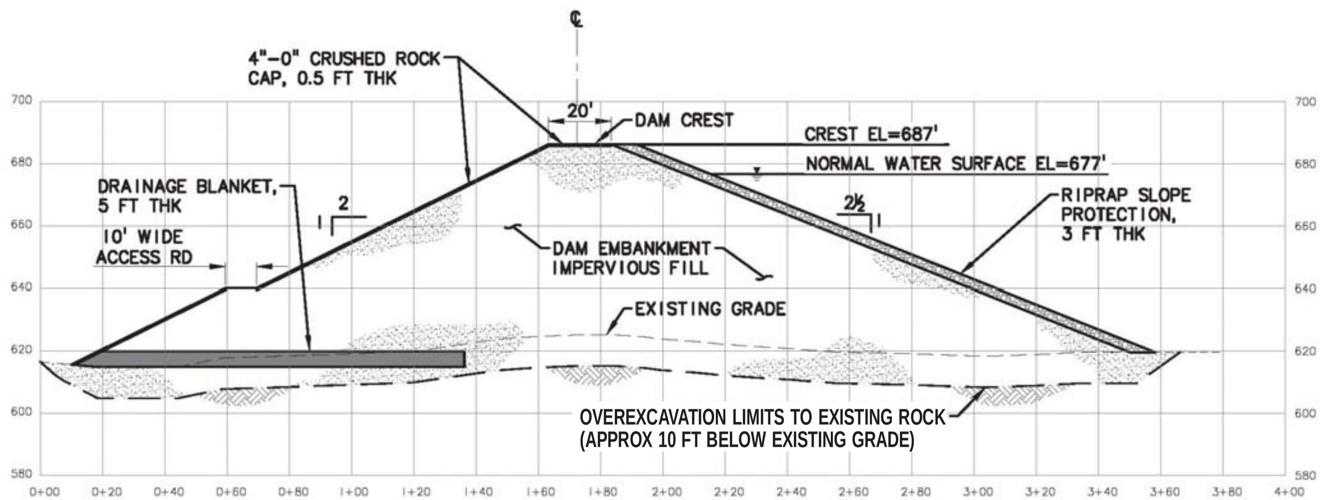
0 80 160 FT

GRI-TP-2

GRI MURRAY, SMITH & ASSOCIATES, INC.
DRIFT CREEK DAM CONCEPTUAL DESIGN

PRELIMINARY GRADING PLAN

JUNE 2011 JOB NO. 5186 FIG. 3



NOTE: PROPOSED HYDRAULIC STRUCTURES NOT SHOWN FOR CLARITY.

TYPICAL DAM SECTION FROM FILE BY MURRAY, SMITH & ASSOCIATES, INC., DATED APRIL 2011

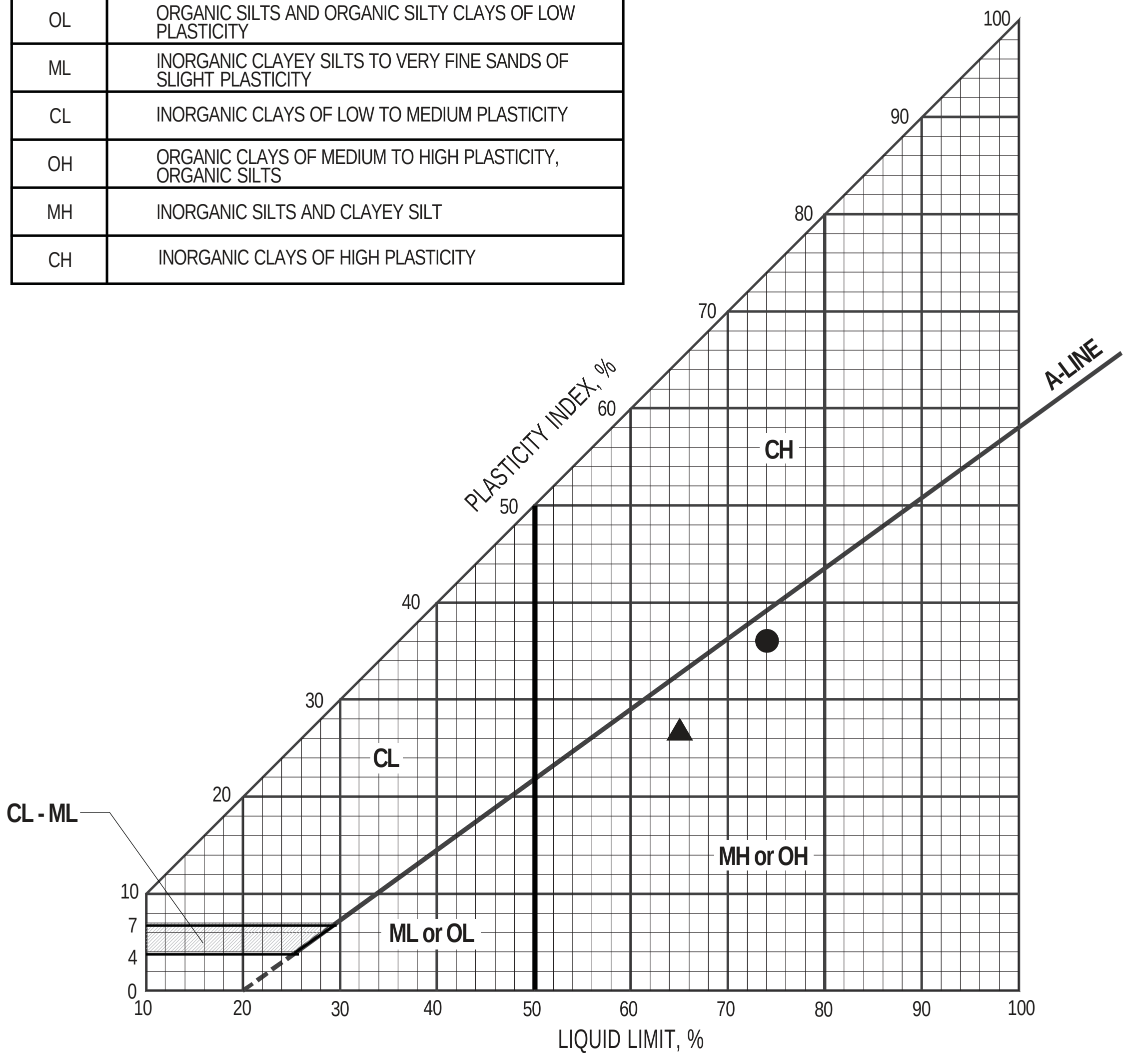
GRI

MURRAY, SMITH & ASSOCIATES, INC.
DRIFT CREEK DAM CONCEPTUAL DESIGN

TYPICAL DAM SECTION

JUNE 2011 | JOB NO. 5186 | FIG. 4

GROUP SYMBOL	UNIFIED SOIL CLASSIFICATION FINE-GRAINED SOIL GROUPS
OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
ML	INORGANIC CLAYEY SILTS TO VERY FINE SANDS OF SLIGHT PLASTICITY
CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY
OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
MH	INORGANIC SILTS AND CLAYEY SILT
CH	INORGANIC CLAYS OF HIGH PLASTICITY



SYMBOL	LOCATION	SAMPLE	MOISTURE CONTENT,%	SOIL DESCRIPTION
●	TP-2	S-2	52	BROWN SILT; TRACE CLAY, TRACE TO SOME MEDIUM- TO COARSE-GRAINED SAND
▲	TP-2	S-3	52	LIGHT BROWN SILT; TRACE TO SOME CLAY, TRACE MEDIUM- TO COARSE-GRAINED SAND, SCATTERED FINE GRAVEL (WEATHERED ROCK)

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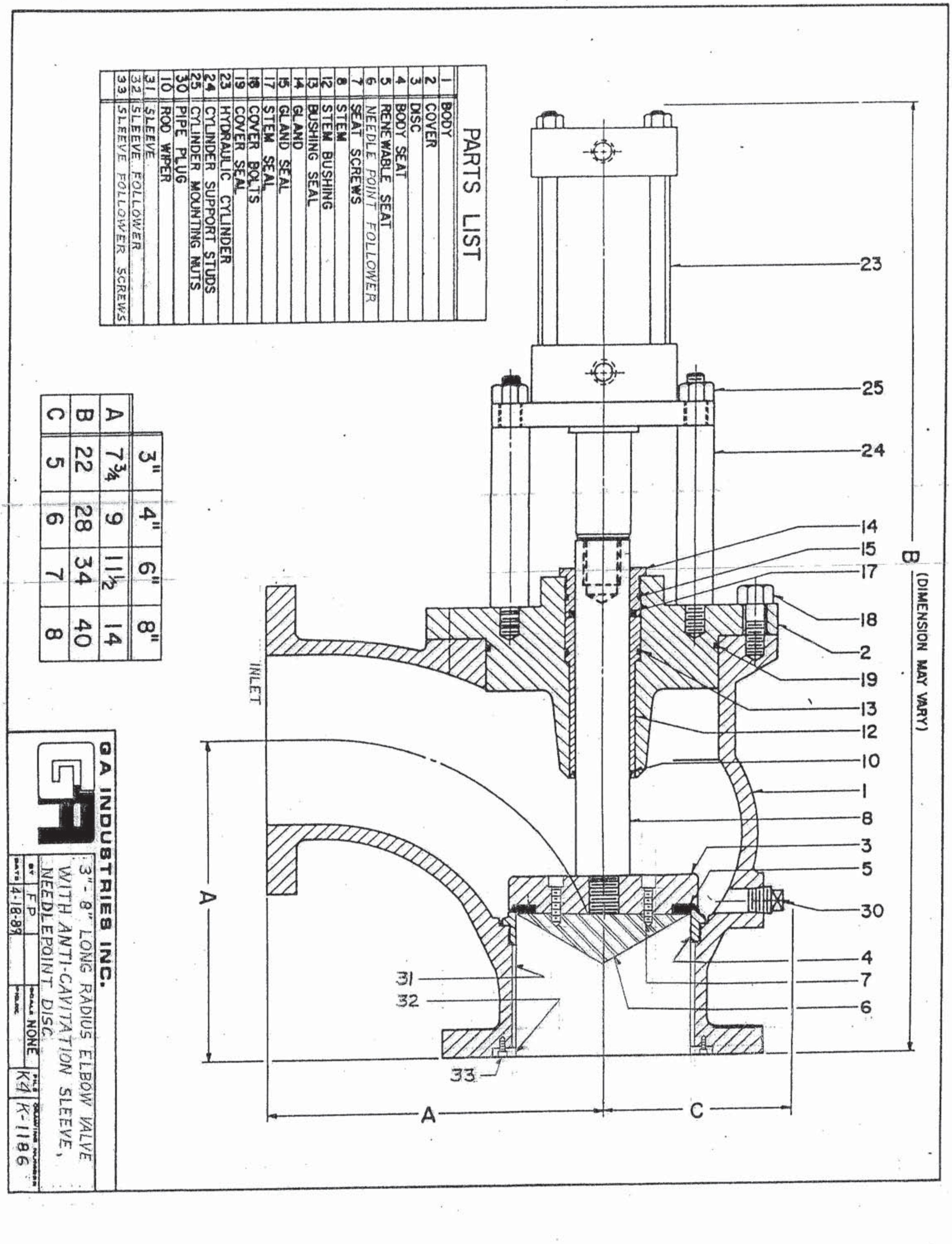
MURRAY, SMITH & ASSOCIATES, INC.
DRIFT CREEK DAM CONCEPTUAL DESIGN

PLASTICITY CHART

JUNE 2011 JOB NO. 5186 FIG. 5

MSA

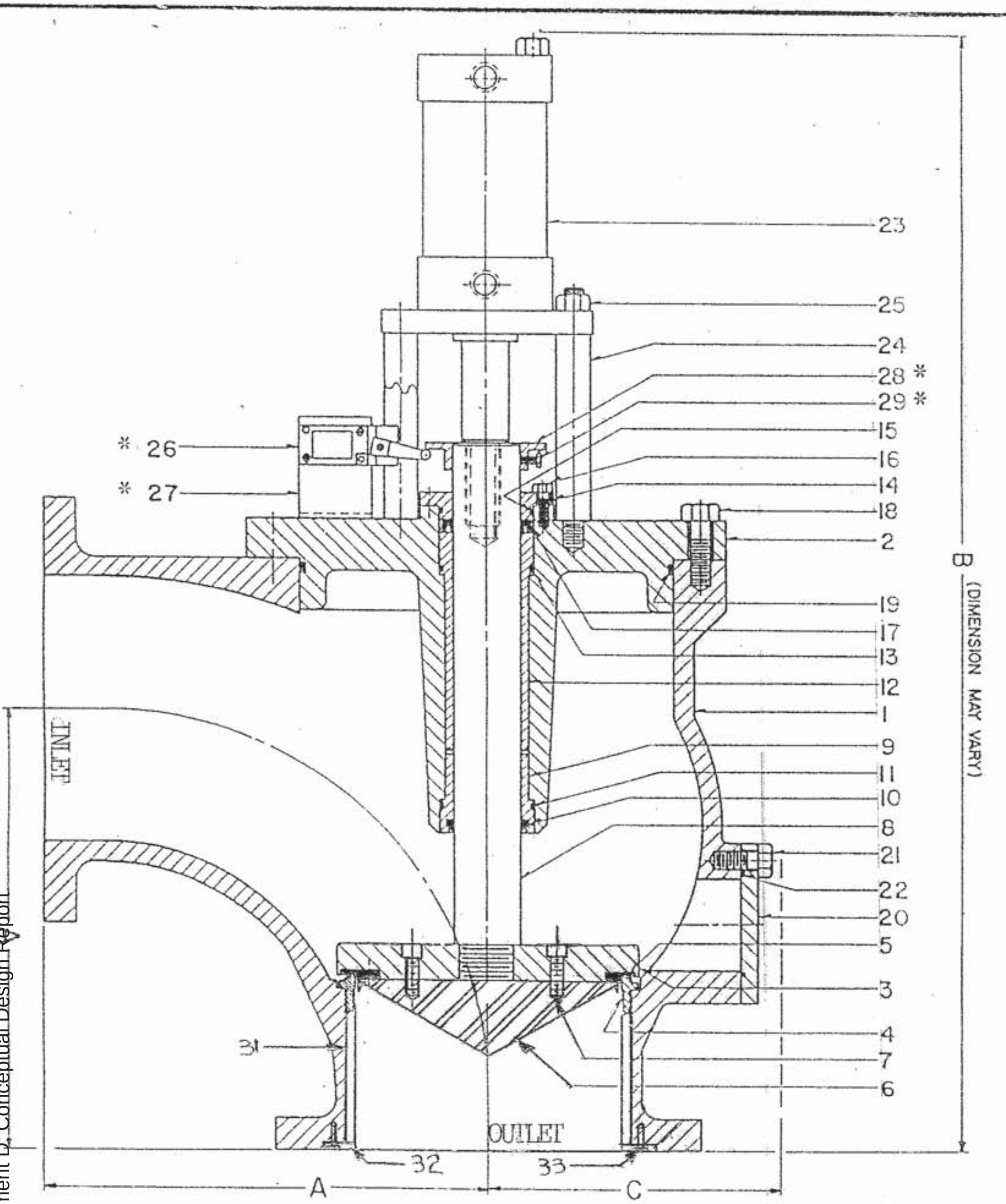
APPENDIX C
Mechanical and Equipment Product Information



PARTS LIST

1	BODY
2	COVER
3	DISC
4	BODY SEAT
5	RENEWABLE SEAT
6	NEEDLE POINT FOLLOWER
7	SEAT SCREWS
8	STEM
12	STEM BUSHING
13	BUSHING SEAL
14	GLAND
15	GLAND SEAL
17	STEM SEAL
18	COVER BOLTS
19	COVER SEAL
23	HYDRAULIC CYLINDER
24	CYLINDER SUPPORT STUDS
25	CYLINDER MOUNTING NUTS
30	PIPE PLUG
10	ROD WIPER
31	SLEEVE
32	SLEEVE FOLLOWER
33	SLEEVE FOLLOWER SCREWS

	3"	4"	6"	8"
A	7¾	9	11½	14
B	22	28	34	40
C	5	6	7	8



1	BODY	17	STEM SEAL
2	COVER	18	COVER BOLTS
3	DISC	19	COVER SEAL
4	BODY SEAT	20	ACCESS COVER
5	RENEWABLE SEAT	21	ACCESS COVER BOLTS
6	SEAT FOLLOWER	22	ACCESS COVER SEAL
7	SEAT SCREWS	23	HYDRAULIC CYLINDER
8	STEM	24	CYLINDER SUPPORT STUDS
9	STEM BUSHING (LOWER)	25	CYLINDER MOUNTING NUTS
10	ROD WIPER	26	LIMIT SWITCH
11	LOWER BUSHING SEAL	27	LIMIT SWITCH BRACKET
12	UPPER STEM BUSHING	28	LIMIT SWITCH TRIP PLATE
13	UPPER BUSHING SEAL	29	L.S. TRIP PLATE SET SCREW
14	GLAND	31	SLEEVE
15	GLAND SEAL	32	SLEEVE FOLLOWER
16	GLAND SCREWS	33	SLEEVE FOLLOWER SCREW

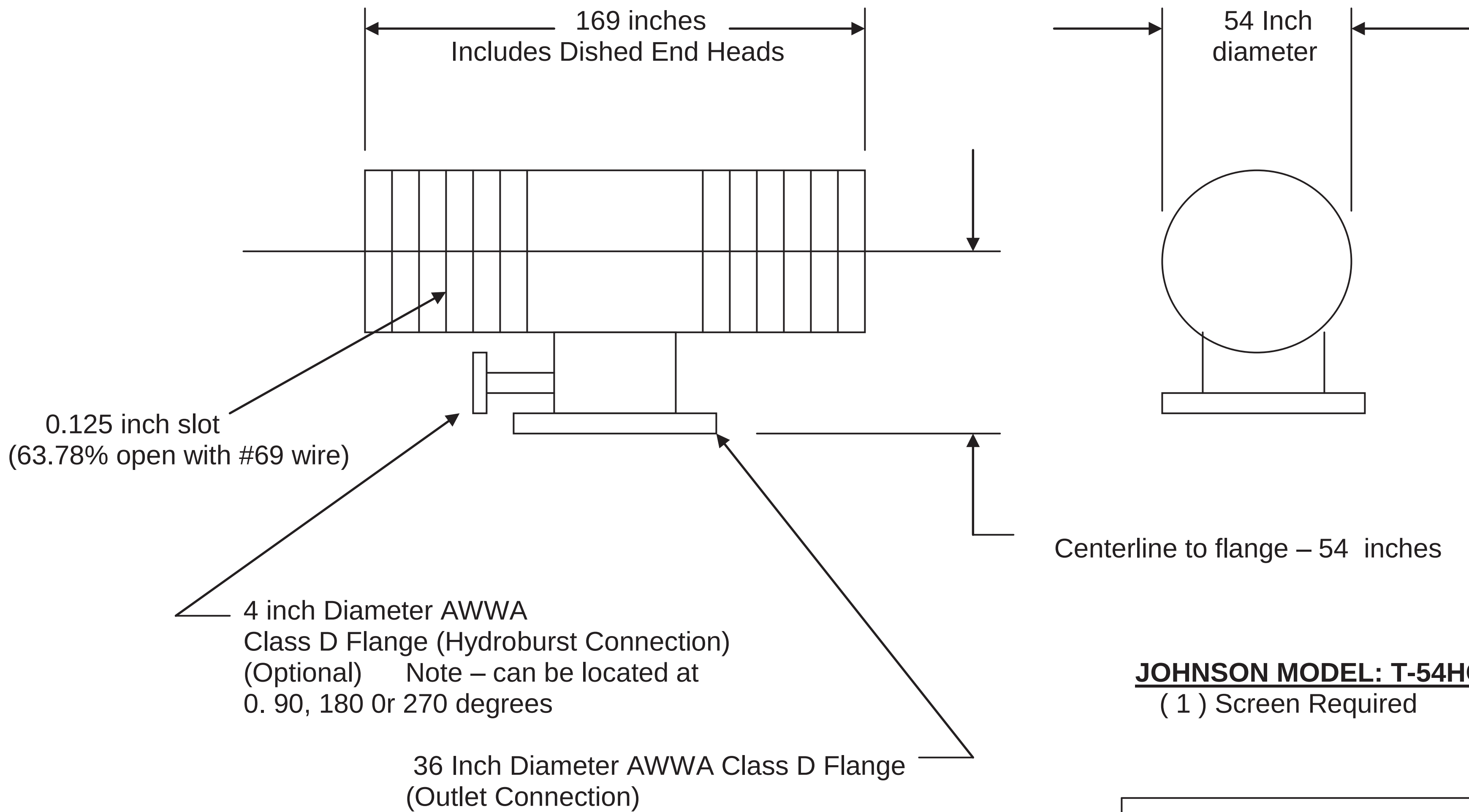
*Note: PARTS 26 – 29 ARE OPTIONAL

	10"	12"	14"	16"	18"	20"	24"	
A	16½	19	21½	24	26½	29	34	
B	46	58	64	69	78	84	92	
C	11	13	16	17	21	23	24	

G. A. INDUSTRIES, INC. MARS, PA.

10"-24" L.R. ELBOW VALVE WITH ANTI-CAVITATION SLEEVE, NEEDLEPOINT DISC

BY	DAB	SCALE	NONE	FILE	DRAWING NO.
DATE	12-5-91	FIG. NO.		K5	K-1235



JOHNSON MODEL: T-54HCE
(1) Screen Required

Estimated Total Headloss = 0.552 psi
Approximate Weight = 7,480 lbs.
Material = 304 stainless steel

Design Flow = 40 CFS (18,000 gpm)
Design Slot Velocity = 0.5 Max.
Design Slot Velocity = 0.49 Actual Max.

Intake Screen Dimensions
Haskins Reservoir
Johnson screens™

A Weatherford Company

RODNEY HUNT

Rodney Hunt

A ZURN *Company*

Sluice Gate Dimensions

SLUICE GATE

Dimensions

RODNEY HUNT

Presented in this brochure are the actual dimensions for sluice gates that are suitable for the design head listed.

The sluice gates listed are not the only sluice gates available from Rodney Hunt, but are the most common sizes and design heads. For information on sluice gates not listed, please contact the Rodney Hunt representative in your area, or call us directly at 978-544-2511.

Design Head Vs. Operating Head

The design head is the maximum head the gate has been designed to withstand.

The operating head is the head under which the gate is to be opened and closed. The operating head is used to determine the size of hoist and stem that is required to operate the gate and should be listed in the project specifications in addition to The design heads.

How to specify

Because of the number of gates involved, the heads for which these gates are suitable, and the several configurations in which the gate can be furnished, the best way to describe the sluice gate is by size of gate and the head for which it is designed, such as 60" x 72", 130-45. Special series gates should be described by size and series number, such as 8 x 8 Series B-240.

General Notes

The dimensions listed are the actual dimensions, to the nearest 1/4", of the size of gate listed, and the head for which that gate is designed. Rodney Hunt will furnish the gate shown in the table for all applications where the head is equal to or less than the design head indicated.

In some instances, several gates are listed for the same size, but with different design heads. This has been done to enable Rodney Hunt to provide the most economically designed gate for the specific design head application.

Installation Clearance

All sluice gates listed in the tables can be installed where the installation clearance along each side and along the bottom of the gate is 1". The flanges of the gate can be drilled so that the attaching studs extend to the front of the gate where they are easily accessible.

Where flange frame gates are required, such as where the gate must be mounted on a circular pipe flange, the recommended installation clearance is 8" on each side and beneath the bottom of the gate.

SLUICE GATE

Dimensions

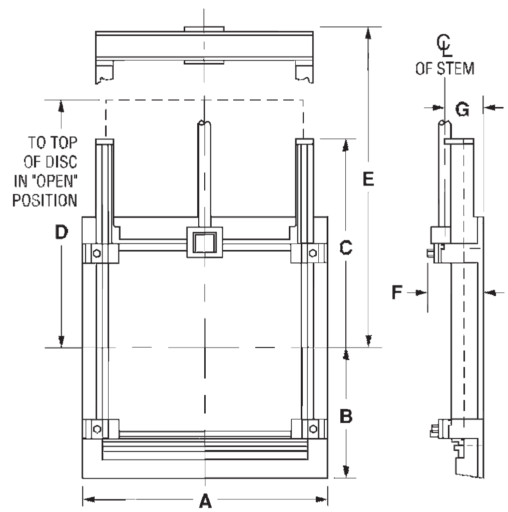
RODNEY HUNT®

SLUICE GATES

Sizes 36" - 42" - 48"

SIZE WIDTH x HEIGHT INCHES (MILLIMETERS)	DESIGN HEAD FT. SEAT	 UNSEAT	DIMENSIONS A	 B	 C	 D	 E	 F	 G
36 x18 (900 x 450)	88	40	46 (168)	14 (356)	20 (508)	33 (838)	40 (1016)	81/2 (216)	6 (159)
36 x 24 (900 x 600)	82	30	46 (1168)	17 (432)	26 (660)	42 (1067)	49 (1245)	8-1/2 (216)	6-1/4 (210)
36 x 30 (900 x 750)	60	36	46 (1168)	20 (508)	32 (813)	51 (1295)	58-1/4 (1480)	9-1/2 (241)	6-1/4 (210)
36 x 36 (900 x 900)	60	30	46 (1168)	23 (584)	38 (965)	60 (1524)	67-3/4 (1721)	9-1/2 (241)	6-1/4 (210)
36 x 42 (900x1050)	76	43	47-1/2 (1207)	26 (660)	44 (1118)	69 (1753)	82 (2083)	9-1/2 (241)	6-1/4 (210)
36 x 48 (900 x 1200)	65	30	47-1/2 (1207)	29 (737)	50 (1270)	78 (1981)	91 (2311)	10 (254)	6-1/4 (210)
36 x 48 (900 x 1200)	240	95	49-1/2 (1257)	30-3/4 (781)	51-1/2 (1308)	81-1/2 (2070)	93-1/2 (2375)	15-1/4 (387)	9-1/2 (241)
36 x 60 (900 x 1500)	213	84	49-1/2 (1257)	36-3/4 (933)	63-1/2 (1613)	99-1/2 (2527)	111-1/2 (2832)	16-1/2 (419)	9-1/2 (241)
36 x 72 (900 x 1800)	244	10	149-1/2 (1257)	42-3/4 (1086)	75-1/2 (1918)	117-1/2 (2985)	129-1/2 (3289)	16-1/2 (419)	9-1/2 (241)
42 x 24 (1050 x 1050)	90	21	53-1/2 (1359)	17 (432)	26 (660)	42 (1067)	48-1/4 (1226)	8-1/2 (216)	6 (152)
42 x 30 (1050 x 750)	88	25	53-1/2 (1359)	20 (508)	32 (813)	51 (1295)	58-1/4 (1480)	9-1/4 (235)	6-1/4 (210)
42 x 36 (1050 x 900)	88	24	53-1/2 (1359)	23 (584)	38 (965)	60 (1524)	67-3/4 (1721)	9-1/2 (241)	6-1/4 (210)
42 x 42 (1050 x 1050)	87	23	53-1/2 (1359)	26 (660)	44 (1118)	69 (1753)	82 (2083)	9-1/2 (241)	6-1/4 (210)
42 x 48 (1050 x 1200)	80	20	53-1/2 (1359)	29 (737)	50 (1270)	78 (1981)	91 (2311)	10 (254)	6-1/4 (210)
48 x 24 (1200 x 600)	58	21	59-1/2 (1511)	17 (432)	26 (660)	42 (1067)	49 (1245)	8-1/2 (216)	6-1/4 (159)
48 x 30 (1200 x 750)	60	32	59-1/2 (1511)	20 (508)	32 (813)	51 (1295)	58-1/4 (1480)	9-1/4 (235)	6-1/4 (159)
48 x 36 (1200 x 900)	62	27	59-1/2 (1511)	23 (584)	38 (965)	60 (1524)	67-3/4 (1721)	9-1/2 (241)	6-1/4 (159)
48 x 42 (1200 x 1050)	65	32	59-1/2 (1511)	26 (660)	44 (1118)	69 (1753)	82 (2083)	9-1/2 (241)	6-1/4 (159)
48 x 48 (1200 x 1200)	69	16	59-1/2 (1511)	29 (737)	50 (1270)	78 (1981)	91 (2311)	10 (254)	6-1/4 (159)
48 x 48 (1200 x 1200)	150	60	61-1/2 (1562)	30-3/4 (781)	51-1/2 (1308)	8-1/2 (2070)	93-1/2 (2375)	15-1/4 (387)	9-1/2 (241)
48 x 54 (1200 x 1350)	150	60	61-1/2 (1562)	33-3/4 (857)	57-1/2 (1461)	90-1/2 (2299)	102-1/2 (2604)	15-1/4 (387)	9-1/2 (241)
48 x 60 (1200x1500)	150	60	61-1/2 (1562)	36-3/4 (933)	63-1/2 (1613)	99-1/2 (2527)	111-1/2 (2832)	16-1/2 (419)	9-1/2 (241)
48 x 72 (1200x1800)	150	60	63-1/2 (1562)	42-3/4 (1086)	69-1/2 (1765)	117-1/2 (2985)	129-1/2 (3289)	16-1/2 (419)	9-1/2 (241)
48 x 84 (1200x210)	150	60	61-1/2 (1562)	48-3/4 (1238)	75-1/2 (1918)	135-1/2 (3442)	147-1/2 (3747)	17-3/4 (451)	9-1/2 (241)
48 x 96 (1200 x 2400)	150	60	63-1/2 (1562)	54-3/4 (1391)	81-1/2 (2070)	153-1/2 (3899)	165-1/2 (4204)	17-3/4 (451)	9-1/2 (241)

For gates 36" (900 mm) - 48" (1200 mm) to be mounted on pipe flanges, the dimensions "F" and "G" are increased as follows:
36" (900 mm) -increase 3-1/2" (89 mm)
42" (1050 mm) -increase 4" (102 mm)
48" (1200 mm) -Increase 4-1/4" (108 mm)



RODNEY HUNT®

Rodney Hunt

A ZURN *Company*

Fixed Cone Valves

Howell-Bunger® and Ring Jet Valves

Fixed Cone

Valves

RODNEY HUNT®

Rodney Hunt Howell-Bunger® Valve: Over Half a Century of Dependable Service

The Rodney Hunt Howell-Bunger® (fixed cone) valve manufactured today is remarkably similar to the first designs introduced by C. H. Howell and H. P. Bunger in 1935. Their first units were two 48" valves installed at El Vado Dam in Charna, New Mexico. Shortly thereafter, the S. Morgan Smith Company obtained the patent rights and proceeded to further develop these valves. The S. Morgan Smith Company was purchased by Allis-Chalmers Corporation in 1959 and subsequently the Valve Division of Allis-Chalmers was purchased by AC Valve in 1988. In 1990 Rodney Hunt Company acquired all product lines of AC Valve, continuing the design established by Mssrs. Howell and Bunger in 1935. As of 1978, over 250 Howell-Bunger® Valves had been built and were successfully installed in applications ranging from an 8" valve with 1400' of head, to a 108" valve with 471' of head. The largest Howell-Bunger® Valve built to date is a 112" valve with 209' of head. The Howell-Bunger® Valve has been the valve of choice where easy control of water flow under free discharge is demanded.

Located in Orange, Massachusetts, Rodney Hunt facilities include a modern foundry, advanced fabrication and machining areas, complete hydraulic actuation capabilities, and hydrostatic test facilities. Design expertise and a commitment to ongoing technological developments help Rodney Hunt achieve outstanding levels of quality and value in every project. Rodney Hunt Company is an international leader in the design and manufacture of cast and fabricated gates, valves, and actuation equipment for liquid control applications. Founded in 1840, Rodney Hunt products can be found in thousands of projects around the world.

Valve Operation

The Howell-Bunger Valve is typically operated by a manual, electric or hydraulic actuator mounted above the bevel gear. The bevel gear transmits torque to the drive shafts on either side, which operate through the actuator on each side, turning the operating screw which slide the cylinder gate forward to restrict or shut-off flow, and backward to open the valve for full flow. In the open or partially open position, flow is directed radially outward around the deflector head. The resulting spray pattern effectively dissipates hydraulic energy and allows a free flow discharge without erosion damage to the surrounding area.

Howell-Bunger® and Ring Jet Valves Provide Reliable Service in Demanding Applications

Howell-Bunger® Valves are used to pass a controlled amount of water downstream with no damage to the immediate environment. Howell-Bunger and Ring-Jet Valves are ideally suited for power projects, flood control structures, irrigation facilities, and to drain reservoirs or ponds. Water with low dissolved oxygen content, a characteristic of discharges from impoundments, can be aerated very effectively when discharged into the atmosphere through Howell-Bunger Valves.

Typical Howell-Bunger® and Ring Jet Valve Applications

- Power
- Flood control
- Irrigation
- Storm water
- Turbine bypass
- Water aeration
- Treatment plant discharge

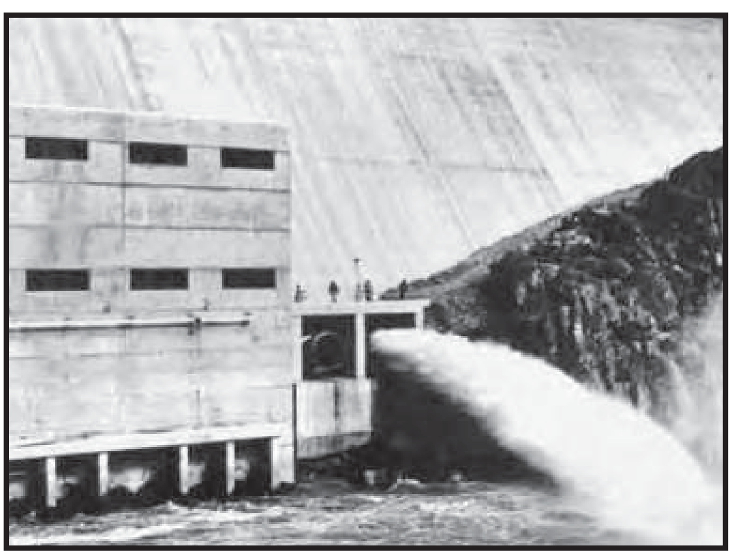
Howell-Bunger® Valves:

Easy, efficient control of water under free discharge.

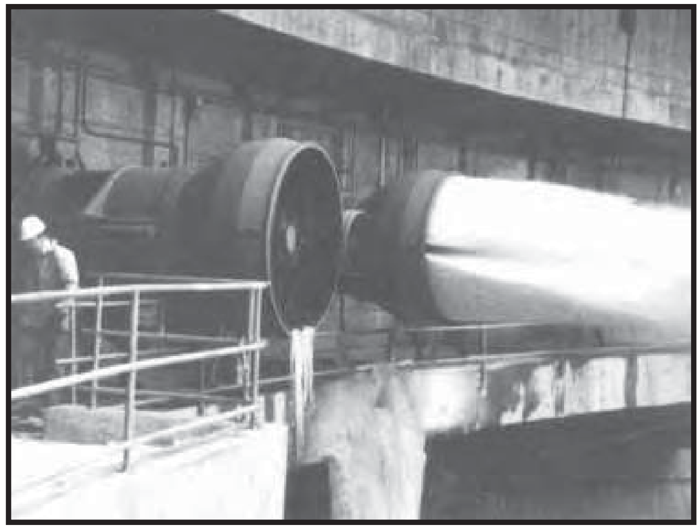
Howell-Bunger® Valves are proven performers in applications requiring control of water under free discharge (into the atmosphere). The radial discharge capacity of the valve eliminates the need to overcome hydrostatic forces common to most valves, and has made the Howell-Bunger® Valve the leader among balanced free-discharge valves. The Howell-Bunger® Valve is also lower in cost than any other type of balanced free-discharge valve.

The low-maintenance valve provides efficient free-discharge operation for high and low heads, and operates through the entire stroke range without vibration or pitting. The valve's high coefficient of discharge allows the use of smaller than line-size valves, reducing construction costs. The cylinder gate that seats against the fixed cone requires little effort to operate, and is the only moving part of the assembly in contact with water flow.

The Howell-Bunger® Valve controls and dissipates enormous amounts of energy by breaking up the discharge water into a large, hollow, expanding jet. Adaptable to almost any type of actuator, Rodney Hunt can provide manual, hydraulic, or electric options. For stations located in remote areas, Howell-Bunger® Valves can be equipped with remote control devices that open or close the valves to hold a pre-determined constant level upstream or downstream of the valves.



One of two Ring-Jet Valves used for irrigation bypass at Tulloch Dam, California. Shown here at full discharge under 145 feet of head.



Battery of Ring-Jet Valves controls flow while dissipating energy and reducing spray – even in cold climates.

Howell-Bunger® Valves are presently being used as relief valves on hydraulic turbines. They may be adapted to cold climates by properly designing discharge chambers and/or using electric heaters on the cylinder gate. Howell-Bunger Valves can be used for submerged applications.

Ring-Jet Valves: The compact answer for minimizing spray while controlling discharge.

Ring-Jet Valves are similar to the Howell-Bunger® Valve, with an important difference. Instead of dispersing the discharge spray like the Howell-Bunger Valve, the Ring-Jet Valve incorporates an integral steel hood that concentrates the discharge spray into a “jet.” These hoods reduce the spray while also providing satisfactory dissipation of energy.

With uncomplicated construction, radially balanced hydraulic design, and easy operation, the Ring-Jet Valve very nearly matches the high discharge co-efficient of the Howell-Bunger Valve. The Ring-Jet “hood” effectively cuts objectionable spray, keeps the operating mechanism dry, and reduces space requirements.

Ring-Jet Valves are not suitable for use in submerged applications, nor at heads above 175 feet.

RODNEY HUNT®

Sizing and Dimensions

The size of the valve is determined by the minimum available net head at the valve inlet and the maximum discharge flow required. Net head is the distance between the head water elevation and the centerline of the valve (or if the valve is submerged – the tail water elevation) less the inlet, conduit, bend or other friction losses. The graph below shows the maximum calculated discharge for valve sizes 8 inch to 108 inches, based on net heads up to 500 feet.

This graph is based on an average coefficient of discharge of .85. Maximum discharge values for other heads can be determined from the formula:

$$Q = C \times \sqrt{2gH} \times A$$

where Q = Cubic feet per second (cfs)
C = coefficient of discharge with valve full open = .85
g = acceleration due to gravity = 32.2
H = net head in feet.
A = area of valve in square feet (based on nominal inside diameter).

Using a coefficient of discharger of .85, this formula can also be expressed as:

$$Q = .85 \times \frac{\pi D^2}{4} \times \sqrt{2gH}$$

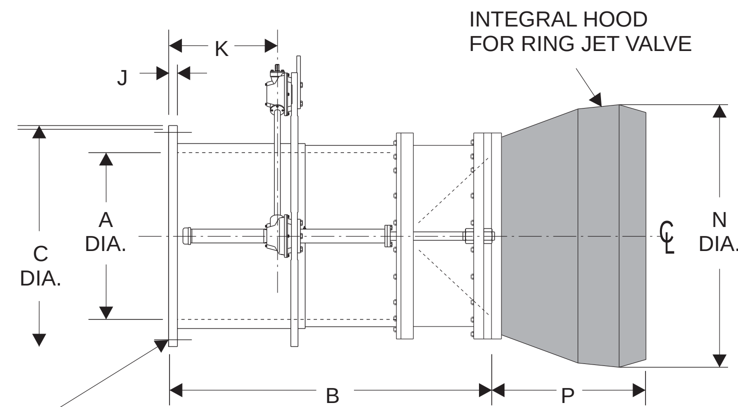
Ring-Jet Sizing

Use the following formula to size Ring-Jet Valves (C = .78):

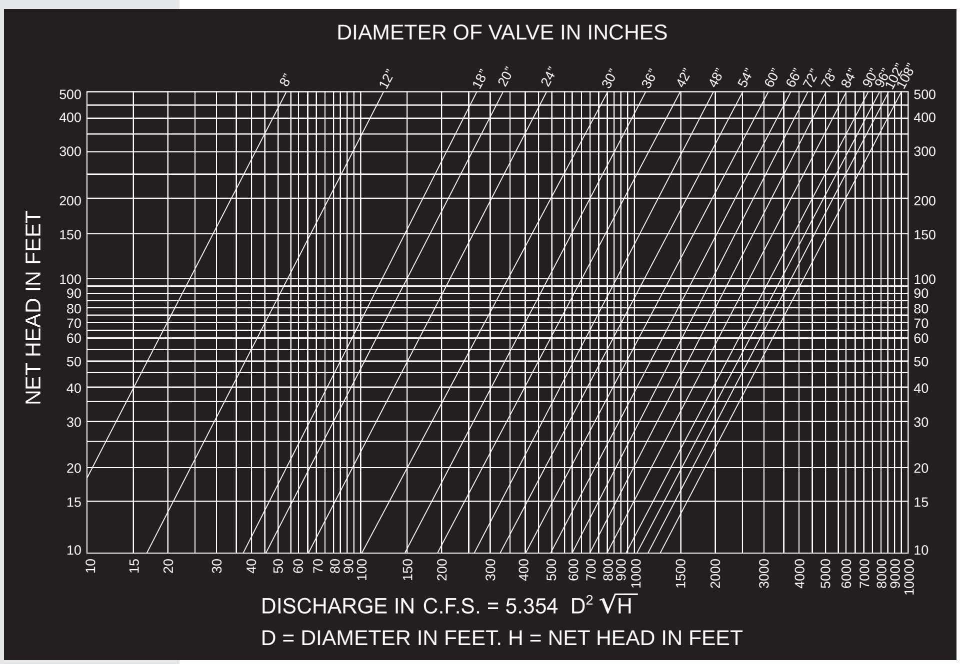
$$Q = .78 \times \frac{\pi D^2}{4} \times \sqrt{2gH}$$

where Q = discharge in cfs
D = diameter in feet

* C207 CLASS D (175 PSI.)								RING JET VALVE	
A	B	* C	* D	* G	* H	* J	K	N	P
6	28	11.00	9.00	8	0.87	0.69	8	11	6
8	30	13.50	11.75	8	0.87	0.69	8	14	8
10	32	16.00	14.25	12	1.00	0.69	8	18	10
12	38	19.00	17.00	12	1.00	0.82	10	21	12
14	40	21.00	18.75	12	1.12	0.93	10	25	14
16	42	23.50	21.25	16	1.12	1.00	10	29	16
18	48	25.00	22.75	16	1.25	1.06	12	32	18
20	50	27.50	25.00	20	1.25	1.12	12	35	20
24	54	32.00	29.50	20	1.37	1.25	12	42	24
30	64	38.75	36.00	28	1.37	1.50	14	52	30
36	70	46.00	42.75	32	1.62	1.62	14	62	36
42	76	53.00	49.50	36	1.62	1.75	14	72	42
48	86	59.50	56.00	44	1.62	1.75	16	82	48
54	92	66.25	62.75	44	1.87	2.12	16	92	54
60	102	73.00	69.25	52	1.87	2.25	18	102	60
66	108	80.00	76.00	52	1.87	2.50	18	112	66
72	118	86.50	82.00	60	1.87	2.62	20	122	72
78	124	93.00	89.00	64	2.12	2.75	22	USE SEPARATE HOOD	
84	134	99.72	95.00	64	2.12	2.75	22		
90	140	106.50	102.00	68	2.37	3.00	22		
96	150	113.25	108.50	68	2.37	3.00	24		



G NO. OF HOLES
H DIAMETER
D BOLT CIRCLE DIAMETER, STRADDLES CENTER LINE



VALVE SELECTION CHART. To determine discharge of any size valve, follow horizontal line for given head to point where it crosses diagonal line representing valve size. From this point, follow vertical line to bottom of chart, and read discharge in cfs.

MSA

APPENDIX D
Preliminary Technical Specifications List

APPENDIX D
PRELIMINARY TECHNICAL SPECIFICATION LIST

Division 1 - General Requirements

01100 Special Provisions
01150 Construction Sequencing
01200 Measurement and Payment
01590 Engineer's Field Office
01650 Flushing and Testing
01651 System Start-Up, Testing and Operation

Division 2 - Sitework

02010 Subsurface Investigations
02030 Demolition
02100 Site Preparation, Clearing, Grubbing and Stripping
02140 Dewatering
02160 Excavation Support Systems
02200 Earthwork
02201 Dam Embankment Excavation and Backfill
02202 Landslide Stabilization
02203 Stockpiling
02204 Geotextiles
02206 Impervious Fill Borrow Area
02207 On-Site Disposal Area
02215 Riprap and Slope Protection
02221 Excavating, Backfilling and Compacting for Structures
02222 Excavating, Backfilling and Compacting for Utilities
02230 Roadway Construction
02651 Steel Pipe
02653 Steel Pipe - Fabricated Specials
02700 Storm Drainage Facilities
02800 Steel Fences and Gates
02930 Surface Restoration and Erosion Control

Division 3 - Concrete
03100 Concrete Formwork
03200 Reinforcement Steel
03290 Joints in Concrete
03300 Cast-in-Place Concrete
03315 Grout
03400 Precast Concrete

Division 4 - Masonry

04100 Mortar and Grout

Division 5 - Metals

05500 Metal Fabrications

Division 6 - Wood and Plastics

06050 Fasteners and Adhesives
06100 Rough Carpentry

Division 7 - Thermal and Moisture Protections

07920 Sealants and Caulking

Division 8 – NOT USED

Division 9 - Finishes

09800 Protective Coatings

Division 10 - NOT USED

Division 11 - Equipment

11000 Equipment, General
11101 Hydraulic Valve Operating System
11112 Intake Screens and Air Backwash System
11200 Miscellaneous Operations and Control Building Equipment
11900 Fall Prevention System

Division 12 - NOT USED

Division 13 - NOT USED

Division 14 - NOT USED

Division 15 - Mechanical

15000 Piping, General
15100 Valves, General
15103 Control Valves
15107 Miscellaneous Valves
15156 Sluice Gates

Division 16 - Electrical
16010 Electrical - General Provisions

16100 Electrical - Basic Materials and Methods
16200 Electrical - Standby Generator
16400 Electrical - Service and Distribution
16500 Electrical - Lighting

Division 17 - Instrumentation
17100 Instrumentation and Control System

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APPENDIX E
Common Abbreviations

APPENDIX E
COMMON ABBREVIATIONS

AF	Acre Feet
ADD	Average Daily Demand
BA	Biological Assessment
BLM	Bureau of Land Management
BO	Biological Opinion
BOR	Bureau of Reclamation
cfs	cubic feet per second
COE	Corps of Engineers
CWA	Clean Water Act
DEQ	Department of Environmental Quality
DSL	Division of State Lands
EPA	Environmental Protection Agency
ESA	Endangered Species Act
EVWD	East Valley Water District
FERC	Federal Energy Regulatory Commission
fps	feet per second
gpcd	gallons per capita day
gpm	gallons per minute
HP	Horsepower
IFIM	Instream Flow Incremental Methodology
MDD	Maximum Daily Demand
MG	Million Gallons
mgd	million gallons per day
NEPA	National Environmental Policy Act
NOAA-Fisheries	National Oceanic and Atmospheric Administration - Fisheries
OAR	Oregon Administrative Rules
ODFW	Oregon Department of Fish and Wildlife
OEDD	Oregon Economic Development Department
OHD	Oregon Health Division
ORS	Oregon Revised Statutes
OWRD	Oregon Water Resources Department
RCC	Roller Compacted Concrete
RM	River Mile
SDWA	Safe Drinking Water Act
S,T,E	Sensitive, Threatened and Endangered
TMDL	Total Maximum Daily Load
UGB	Urban Growth Boundary
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
WTP	Water Treatment Plant

MSA

APPENDIX F
References

APPENDIX F
REFERENCES

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Runoff Yield Analysis for Drift Creek Site "A" Near Silverton, Oregon (Update #1), Dr. Bolyvong Tanovan, PhD, P.E., May 2010.

Runoff Yield Analysis for Drift Creek Site "A" Near Silverton, Oregon (Update #2), Dr. Bolyvong Tanovan, PhD, P.E., February 2011.

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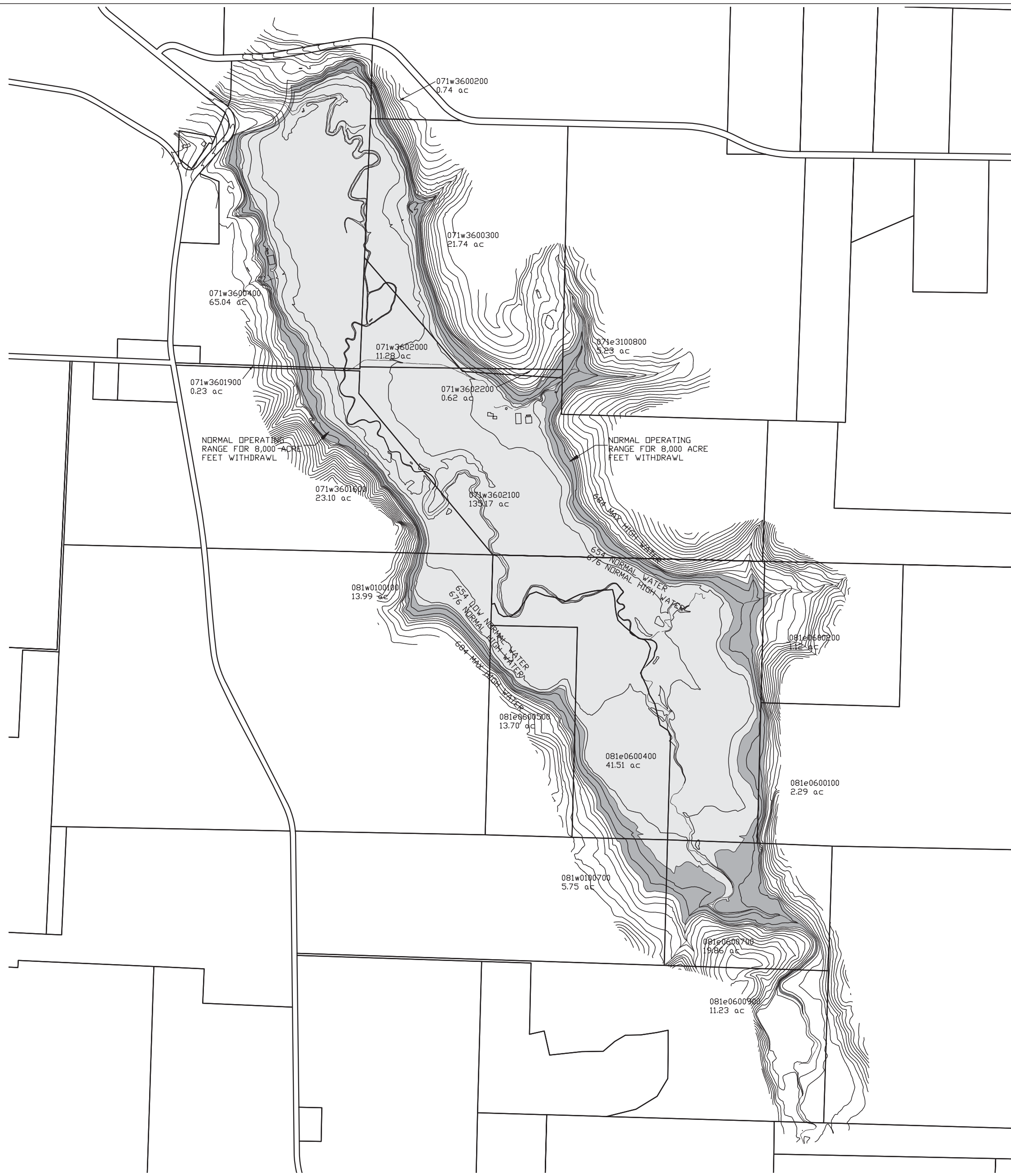
Attachment E: Project Map

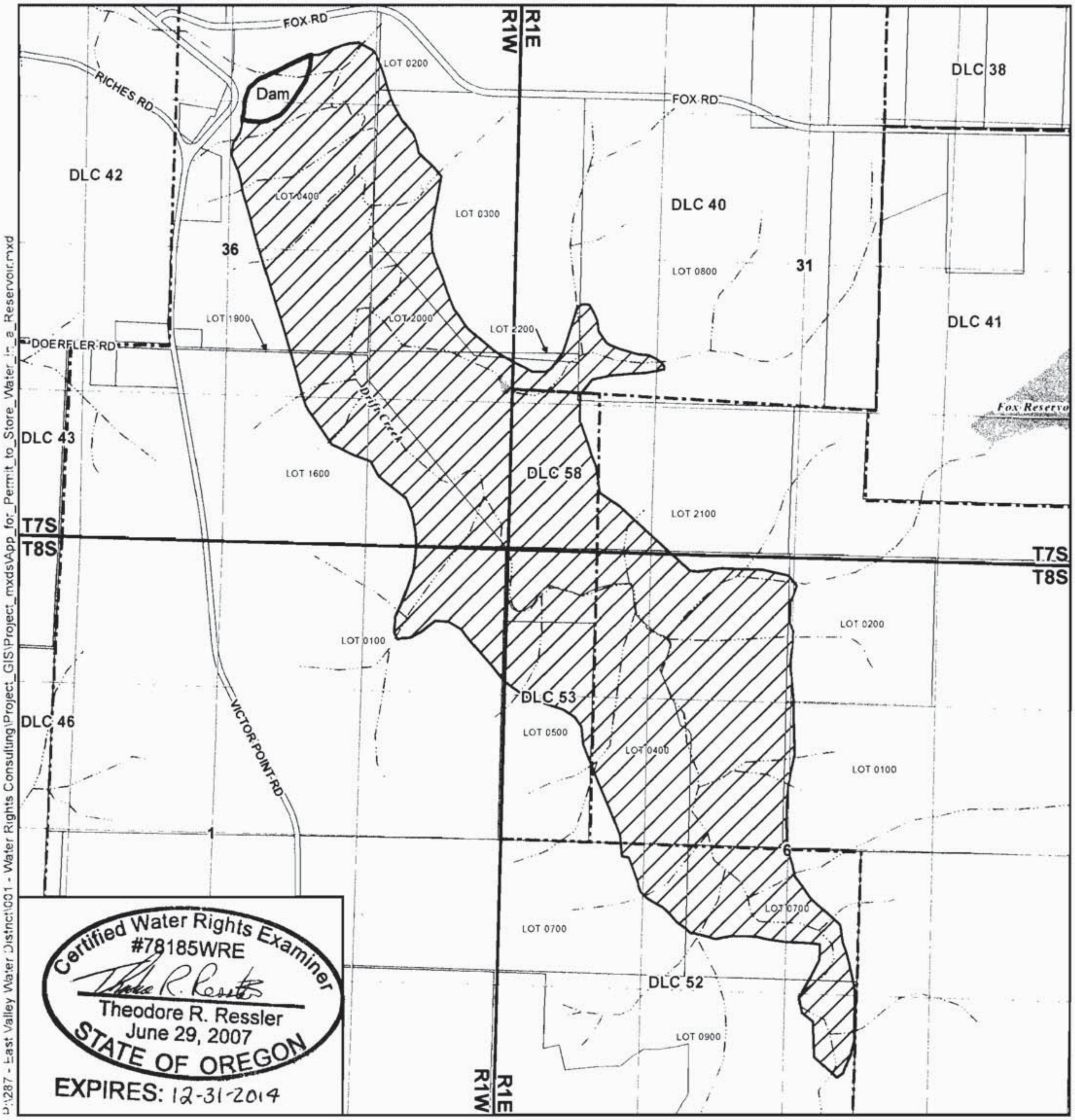


BLACK ROCK CONSULTING INC
20380 HALFWAY RD. STE. 1, BEND, OR 97701
PHONE: 541-480-6257 FAX: 866-591-1513

EAST VALLEY WATER DISTRICT		
RESERVOIR		
DESIGN/CHECKED: KLC	SCALE: 1" = 500'	C-1
DRAWN: SK	REV. DATE: 6-9-14	

Application for a Permit to Store Water in a Reservoir
In the Name of: East Valley Water District

Section 36, Township 7 South, Range 1 West (W.M.); Section 31, Township 7 South, Range 1 East (W.M.); Section 1, Township 8 South, Range 1 West (W.M.); Section 6, Township 8 South, Range 1 East (W.M.)



Legend

- Proposed Dam
- Proposed Reservoir
- Tax Lots
- Existing Waterbodies
- Existing Watercourses

FEB 21 2013

Data Sources
Marion County GIS, Oregon Geospatial Data Clearinghouse

Disclaimer
This map was prepared for the purpose of identifying the location of a water right only and it is not intended to provide legal dimensions or location of property ownership lines.

Location Description for Proposed Dam

Proposed Dam
Located 3,990 feet North and 355 feet East from the S1/4 corner of Section 36, Township 7 South, Range 1 West (W.M.)

N

Scale
0 330 660 1,320
1 inch equals 1,320 feet

GSI Water Solutions, Inc.

Table 1. Drift Creek Storage Project - Federal and State Permit Acquisition

Potential permits	Regulated activity	Approval timeline	Preliminary Permit Considerations and Issues	Level of Information Needed
FEDERAL				
USACE Section 404, Clean Water Act Individual Permit (Joint application with Oregon Department of State Lands [DSL])	Discharges of dredged or fill material associated with excavation, backfill, or bedding for utility lines, including intake and outfall structures. Section 404 permitting is part of the joint permit application process.	Individual permit is typically 120 days after complete application is submitted and subsequent to completion of ESA consultation and receipt of state water quality certification	• A pre-application meeting with USACE and other permitting agencies will help determine what measures might need to be taken into consideration during project design. • Delineations of wetlands and waters (streams and jurisdictional ditches) have been completed and will be part of the permit application. • Compensatory mitigation will be needed to replace permanent lost aquatic resource functions and area for the project (33 Code of Federal Regulations (CFR) Parts 325 and 332 and 40 CFR Part 230). • Permit will be issued only after Section 7; ESA consultation is complete (see below).	Project drawings to include mitigation, borrow, disposal and staging areas. Quantities of removal/fill. Construction phasing/timing, methodologies, BMPs.
USACE National Environmental Policy Act (NEPA) For the Corps Section 404 Action	Section 404 permit triggers the need for a NEPA document Decision Document is part of the Section 404 permit	Concurrent with Section 404 review process	• The following assumptions will need to be discussed with the Corps: - An Environmental Assessment (EA) would be prepared for the project since the permitted activity would not result in significant environmental impacts when taking into account mitigation measures. - District would refine the EA submitted by the District and then prepare a mitigated Finding of No Significant Impact (FONSI). - Corps' NEPA regulations state that the scope of analysis under NEPA should address the "specific activity requiring a [Corps] permit and those portions of the entire project over which the [Corps] has sufficient control and responsibility to warrant Federal review.	Alternative Analysis, Conceptual Design and Impact Analysis
NMFS Section 7, ESA	Section 7 of the ESA requires all federal agencies to ensure that any actions they authorize are not likely to jeopardize a listed species or adversely modify its critical habitat. USACE must consult with NMFS.	120 days or more after submittal to USACE, and typically 210 days or more after submittal to NMFS	• There is potential for listed steelhead, which may trigger Section 7 Consultation. • The project will likely require the District to prepare a Biological Assessment (BA) that addresses the project's impacts to anadromous fish • USACE is the lead agency that coordinates a review of the BA by the appropriate regulatory agency (NMFS). • NMFS will prepare and issue a Biological Opinion (BiOp) that may include special provisions (conditions) for project construction to avoid negative impacts on listed species. • It is assumed that consultation with USFWS will not be needed because no threatened or endangered plants or native fish species are present in the project area.	BA will include: description of action, impacts, construction methodology, timing/phasing, analysis of effects.

Table 1. Drift Creek Storage Project - Federal and State Permit Acquisition

Potential permits	Regulated activity	Approval timeline	Preliminary Permit Considerations and Issues	Level of Information Needed
NMFS Magnuson Stevens Fishery Conservation and Management Act	Section 305(b) directs all federal agencies to consult with NMFS on all actions or proposed actions that may adversely affect Essential Fish Habitat.	120 days or more after submittal to USACE, and typically 180 days or more after submittal to NMFS	• BA prepared by the District will cover both Section 7 ESA and the Magnuson Stevens Act. • BiOp issued by NMFS will include consultation for Essential Fish Habitat.	Identification of Essential Fish Habitat, Effects Analysis, Determination.
Migratory Bird Treaty Act (USFWS)	Avoid take of migratory birds	Concurrent with Section 404 review process	• Identify portions of the project that may impact migratory bird nesting habitat • Align construction schedule (clearing or disturbance of trees that occurs in migratory bird habitat) with times when birds are not nesting (March through August)	Identify impacts and avoidance minimization & mitigation strategy for migratory bird nesting habitat (trees and shrubs).
STATE				
Oregon Department of Water Resources (OWRD) Dam Safety Requirement (ORS 690-20-035)	Dam Construction and Operation	Timeframe minimum of 30 days – guidance says that OWRD will review and approve plans in a 2-3 month timeframe	• The State Dam Safety Engineer will determine the dam's established hazard designation. During preliminary discussions with OWRD, it is anticipated that the dam structure will be a "high hazard" structure. If the dam is a high hazard dam the following will be required: (1) Special Seismic Hazard Analysis, (2) Dam Failure and Flood Analysis and the development of associated Flood Mapping and (3) an Emergency Action Plan. • Dam Safety Requirements are established as part of the OWRD Dam Safety review and approval process. • Must request design criteria from OWRD	Early review by Dam Safety will be beneficial 90% Design Plans
Oregon Department of Fish and Wildlife (ODFW) Fish Passage Waiver	If fish passage is not provided at the project then a fish passage waiver will be required	Typically 2-3 months	• Regulations allow for consideration of a fish passage waiver where infeasibility is proven and where agreed mitigation provides a net benefit to fish. • District may want to do some habitat enhancement downstream of the dam site as part of the mitigation requirements for a fish passage waiver. If spawning and rearing habitat for cutthroat trout, Coho salmon and steelhead trout were improved in this reach, more than sufficient flow should be available through ODFW's instream flow water right to allow access to such habitat improvements.	Species presence, impacts and description of the mitigation

Table 1. Drift Creek Storage Project - Federal and State Permit Acquisition

Potential permits	Regulated activity	Approval timeline	Preliminary Permit Considerations and Issues	Level of Information Needed
Oregon Department of Environmental Quality (DEQ) Clean Water Act Section 401/Water Quality Certification Permit	Any activity requiring discharge into waters of the state must receive water quality certification.	Concurrent with Section 404 review process	• A water quality review memorandum should be prepared to include bathymetric analysis of the proposed reservoir, summary and analysis of Drift Creek temperature data and review instream water tights and summertime base flow discharge needs. Meet with DEQ after information is compiled. • The 401 Water Quality Certification application will include the existing condition and the proposed project's impact on water quality. The application will also need to identify measures to avoid or mitigate water quality violations or contributions to violations. The project may require that protective measures such as bank stabilization be incorporated into project construction and operational plans to comply with state water quality standards. • This application will be one component of the Joint Permit Application that will be submitted to DSL & the Corps.	Description of action, impacts, construction methodology, timing/phasing, analysis of effects.
Oregon Department of Fish and Wildlife Oregon State ESA	Any taking of state listed species on state-leased, state-owned, or state easement lands is regulated under Oregon State ESA.	Concurrent with Section 404 review process	• ESA management planning is limited to state agencies. • Need to consider if potential impacts intersect with state owned, leased, or easement lands. • It is unlikely that state listed species are within the footprint of DSL land ownership (stream footprint).	Description of action, impacts, construction methodology, timing/phasing, analysis of effects.
Oregon State Historic Preservation Office (SHPO)	If archeological resources are found along the project corridor or at any of the construction sites	Phase 1 would take 6 months and if required a Phase II investigation can take 3 to 6 months	• Phase 1 studies completed by AINW have identified the need to conduct shovel testing (Phase II) in areas that there is a high probability areas for cultural resources. Based on Phase II findings, final mitigation would be determined. Mitigation would focus on avoiding the cultural resources. • Even if no cultural resources are found, the construction specifications will still need to include discovery provisions to address cultural resources if they are found during construction. • Recommend that the project have an MOU in-place prior to construction to manage inadvertent discovery of cultural resources. MOU would be between District, SHPO, Corps and possibly Tribes. • Corps will initiate consultation with affected Tribes.	Conceptual Design – plan view of Project footprint

Table 1. Drift Creek Storage Project - Federal and State Permit Acquisition

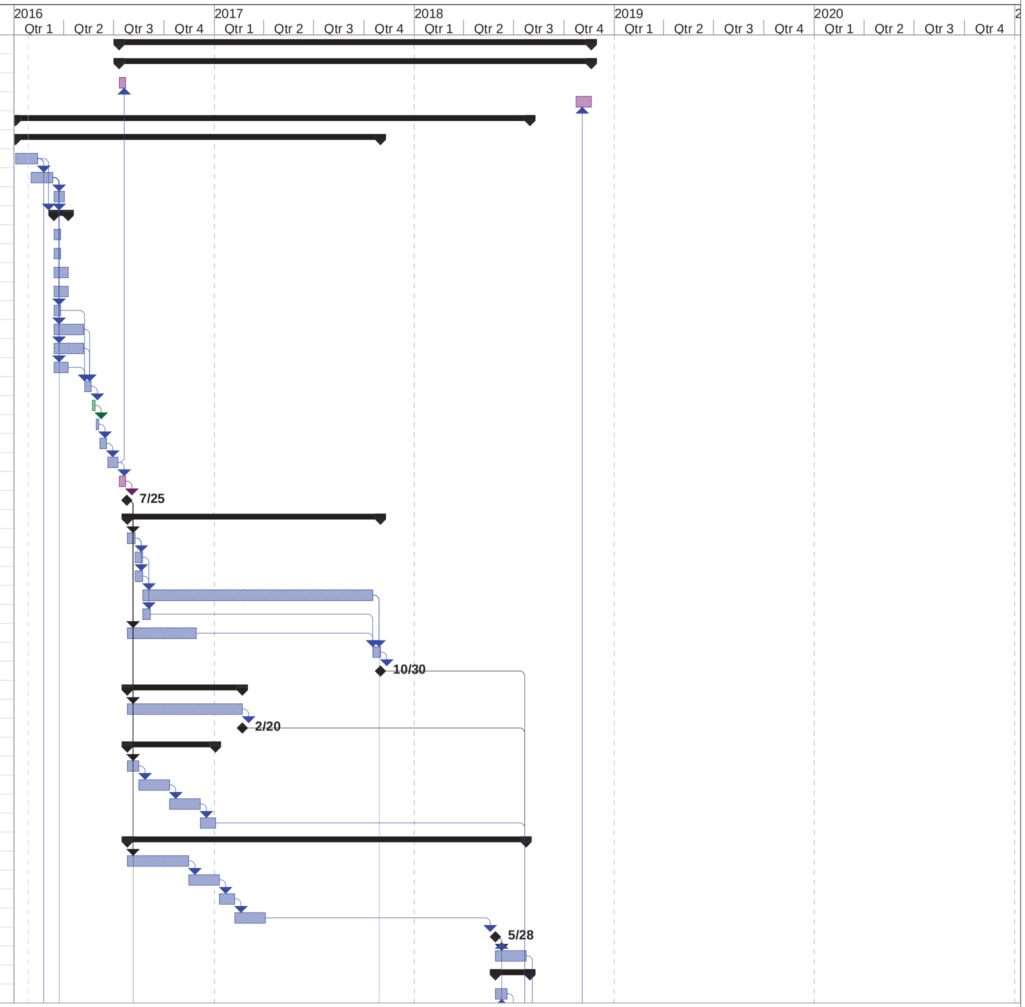
Potential permits	Regulated activity	Approval timeline	Preliminary Permit Considerations and Issues	Level of Information Needed
Oregon Department of State Lands (DSL) Removal/Fill Permit (Joint application with USACE)	It is estimated that 23 acres of wetlands will be impacted. Drift Creek flows will need to be bypassed during construction. In-Water Work Period Compliance	Application completeness within 30 days of receipt and issue decision within 90 days of the completeness determination.	• Prior to submission of the DSL Removal/Fill Permit, submit wetland delineation to DSL for their concurrence. • The project will require submittal of a wetland and waterways compensatory mitigation plan and a site restoration plan for joint approval by USACE and DSL. • In-water work period for the other Pudding River Tributaries is from June 1 to September 30. • Drift Creek flows will need to be preserved during dam and reservoir construction. Flows would need to be bypassed around work zones. The extent and duration of creek diversion activities will need to be determined prior to the development of project permit document. • DSL will coordinate with ODFW & DEQ to secure approvals, concurrence and additional permit conditions associated with other state laws and regulations.	Project drawings to include mitigation, borrow, disposal and staging areas. Quantities of removal/fill. Construction phasing/timing, methodologies, BMPs.
Oregon Dept. of Fish and Wildlife (ODFW)	ODFW 2001 Draft Guidance for Implementing the Fish and Wildlife Mitigation Policy In consultation with NMFS on the BiOp	Comments provided to NMFS and DSL	ODFW Habitat Mitigation Policy (Oregon Administrative Rules 635-415) outlines habitat approaches that prescribe some actions for specific habitat types. There are Strategy Species Conservation Actions, but these do not always mention how these species habitats will be maintained or protected or take into account most salmonids.	Description of action, impacts, construction methodology, timing/phasing, analysis of effects.
Oregon Department of Environmental Quality (ODEQ) Clean Water Act Section 402 National Pollutant Discharge Elimination System (NPDES) #1200-C Construction Stormwater Permit	Construction activities, including clearing, grading, and excavation, that disturb one or more acres of land.	2-3 month process that depends on revisions and the *ever* changing *unwritten* requirements of DEQ	• The project will require a Construction Stormwater Permit (1200-C) from ODEQ. • 1200-C permit involves submitting a comprehensive application form, a Land Use Compatibility Statement, and Erosion and Sediment Control Plans that meet ODEQ Best Management Practices requirements.	90% or 100% Design, but specifically the ESCP and LUCS

Table 1. Drift Creek Storage Project - Federal and State Permit Acquisition

Potential permits	Regulated activity	Approval timeline	Preliminary Permit Considerations and Issues	Level of Information Needed
Oregon Water Resources Department (OWRD) Acquisition of Storage and Secondary Water Rights	Storage and secondary water rights applications would require protection of instream values.	Depends on OWRD workload and possible Third Party Challenges	• District will need to acquire both reservoir and secondary water rights. • Proposed Final Order was issued by OWRD on July 22, 2014.	Conceptual Design and Operation of the Reservoir
OWRD Water Supply Development Fund (Grant or Loan)	Application of SB 839 Water Supply Development Funding	District can consider application requirements in the preparation of environmental and design documentation.	• District may need to have an approved WMCP prior to submission of application. • Dedication of 25% of stored water must be used for instream use or demonstrate environmental benefits. • Application will be scored and ranked based on the public benefit scoring (economic, environmental and community). • Application will need to identify interim and long-term performance benchmarks for the project. • Seasonally varying flows for Drift Creek will need to be established by OWRD & ODFW.	30% Design and Specific Application Requirements

Drift Creek Water Supply Project Project
Project Implementation Schedule
Prepared on January 11, 2016

ID	Task Name	Duration	Start	Finish	Predecessors
1	**Communication Activities**	**616 days**	**Mon 7/11/16**	**Mon 11/19/18**	
2	**Public Meetings**	**616 days**	**Mon 7/11/16**	**Mon 11/19/18**	
3	**Public Meeting Related to Draft JPA**	10 days	Mon 7/11/16	Fri 7/22/16	23
4	**Public Meeting Related to Project Construction**	20 days	Tue 10/23/18	Mon 11/19/18	81
5	**Prepare Environmental Permit Documentation**	**671 days**	**Mon 1/4/16**	**Mon 7/30/18**	
6	**Prepare Corps and DSL Joint Permit Application (JPA)**	**476 days**	**Mon 1/4/16**	**Mon 10/30/17**	
7	Prepare and Refine Environmental Studies	30 days	Mon 1/4/16	Fri 2/12/16	
8	Develop Draft Project Description (drawings, quantities, construction phasing and methods	30 days	Mon 2/1/16	Fri 3/11/16	7FS-10 days
9	Prepare Preliminary Erosion and Sediment Control Plan (BMP List & Description)	15 days	Mon 3/14/16	Fri 4/1/16	8
10	**Prepare Draft Impacts Analysis**	**20 days**	**Mon 3/14/16**	**Fri 4/8/16**	**7,8**
11	Prepare Migratory Bird Treaty Act Avoidance/Mitigation Plan	10 days	Mon 3/14/16	Fri 3/25/16	
12	Prepare Oregon ESA Impact Analysis	10 days	Mon 3/14/16	Fri 3/25/16	
13	Prepare ODFW Mitigation Policy Impact Analysis	20 days	Mon 3/14/16	Fri 4/8/16	
14	Prepare ESA Fisheries Impact Analysis	20 days	Mon 3/14/16	Fri 4/8/16	
15	Prepare Sediment Evaluation Framework for 401 WQ Certification	10 days	Mon 3/14/16	Fri 3/25/16	8
16	Prepare Draft Biological Assessment (BA)	40 days	Mon 3/14/16	Fri 5/6/16	8
17	Develop Draft Mitigation Plan	40 days	Mon 3/14/16	Fri 5/6/16	8
18	Prepare Draft Environmental Assessment (EA)	20 days	Mon 3/14/16	Fri 4/8/16	8
19	Prepare Draft Joint Permit Application (JPA)	10 days	Mon 5/9/16	Fri 5/20/16	16,17,18,15
20	**Meet w/District & Project Team to Review & Discuss Draft JPA**	**5 days**	**Mon 5/23/16**	**Fri 5/27/16**	19
21	Refine Draft JPA based in District and Consultant Team Comments	5 days	Mon 5/30/16	Fri 6/3/16	20
22	**Meet w/Kaizen Group to Review & Discuss Draft JPA**	**10 days**	**Mon 6/6/16**	**Fri 6/17/16**	21
23	Revise Draft JPA Based on Kaizen Group Comments	15 days	Mon 6/20/16	Fri 7/8/16	22
24	**Communication and Outreach Related to Draft JPA**	**10 days**	**Mon 7/11/16**	**Fri 7/22/16**	23
25	**Submit JPA to Corps and DSL**	1 day	Mon 7/25/16	Mon 7/25/16	24
26	**Corps Section 404 Permit / 401 Water Quality Certification Approval**	**330 days**	**Tue 7/26/16**	**Mon 10/30/17**	
27	Corps Reviews Permit Application for Completeness	10 days	Tue 7/26/16	Mon 8/8/16	25
28	Corps Transmits BA to NMFS	10 days	Tue 8/9/16	Mon 8/22/16	27
29	Corps Transmits Water Quality Information to DEQ	10 days	Tue 8/9/16	Mon 8/22/16	27
30	NMFS Prepares and Issues Biological Opinion	300 days	Tue 8/23/16	Mon 10/16/17	28
31	DEQ Prepares 401 WQ Certification	10 days	Tue 8/23/16	Mon 9/5/16	29
32	Corps Application Review & Preparation of Preliminary Permit	90 days	Tue 7/26/16	Mon 11/28/16	25
33	Corps Prepares Permit Authorization	10 days	Tue 10/17/17	Mon 10/30/17	32,30,31
34	**USACE Permit Authorized**	**0 days**	**Mon 10/30/17**	**Mon 10/30/17**	33
35	**DSL Removal Fill Permit Approval**	**150 days**	**Tue 7/26/16**	**Mon 2/20/17**	
36	DSL Application Review & Preparation of Permit	150 days	Tue 7/26/16	Mon 2/20/17	25
37	**DSL Permit Authorized**	**0 days**	**Mon 2/20/17**	**Mon 2/20/17**	36
38	**ODFW Fish Passage Waiver Approval**	**115 days**	**Tue 7/26/16**	**Mon 1/2/17**	
39	Prepare Draft Fish Passage Waiver for ODFW Review	15 days	Tue 7/26/16	Mon 8/15/16	25
40	Conversation with ODFW Concerning Details of Fish Passage Waiver and Mitigation	40 days	Tue 8/16/16	Mon 10/10/16	39
41	Prepare Final Fish Passage Waiver and Submit to ODFW	40 days	Tue 10/11/16	Mon 12/5/16	40
42	**ODFW Commission Approves Fish Passage Waiver**	**20 days**	**Tue 12/6/16**	**Mon 1/2/17**	41
43	**OWRD Dam Safety Approval**	**520 days**	**Tue 7/26/16**	**Mon 7/23/18**	
44	Prepare and Submit Preliminary Information Required for "High Hazard" Structure to OWR	80 days	Tue 7/26/16	Mon 11/14/16	25
45	OWRD Review and Comment on Preliminary Information	40 days	Tue 11/15/16	Mon 1/9/17	44
46	Revise and Submit Information Required for "High Hazard" Structure to OWRD	20 days	Tue 1/10/17	Mon 2/6/17	45
47	OWRD Review and Approval if "High Hazard" Dam Analysis	40 days	Tue 2/7/17	Mon 4/3/17	46
48	Submit Design Package for Dam and Appurtenance Structures to OWRD	0 days	Mon 5/28/18	Mon 5/28/18	77,47
49	**OWRD Review and Approval of Design Package**	**40 days**	**Tue 5/29/18**	**Mon 7/23/18**	48
50	**DEQ 402 NPDES/1200-C Permit Approval**	**45 days**	**Tue 5/29/18**	**Mon 7/30/18**	
51	Prepare Draft 1200-C Application	15 days	Tue 5/29/18	Mon 6/18/18	77

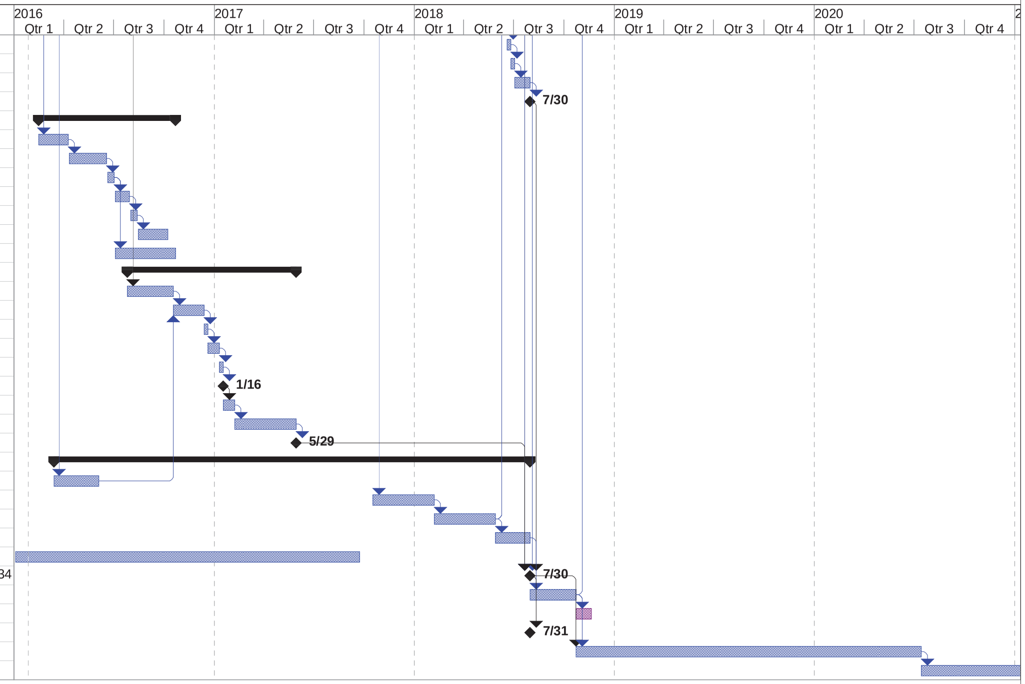


Task Legend: District (EVWD) Decision Point and Meeting
Kaizen Group Review and Meeting or Regulatory Approval
Communication and Outreach Activity

Task	External Tasks	Duration-only	External Tasks
Split	External MileTask	Manual Summary Rollup	External Milestone
Milestone	Inactive Milestone	Manual Summary	Progress
Summary	Inactive Summary	Start-only	Split
Project Summary	Manual Task	Finish-only	

Drift Creek Water Supply Project Project
Project Implementation Schedule
Prepared on January 11, 2016

ID	Task Name	Duration	Start	Finish	Predecessors
52	District and Consultant Team Review of Draft 1200-C Application Review	5 days	Tue 6/19/18	Mon 6/25/18	51
53	Prepare Final 1200-C Application	5 days	Tue 6/26/18	Mon 7/2/18	52
54	Submit Final 1200-C Application DEQ Review	20 days	Tue 7/3/18	Mon 7/30/18	53
55	1200-C Permit Authorization	0 days	Mon 7/30/18	Mon 7/30/18	54
56	**SHPO Concurrence & Cultural Resources MOU**	**180 days**	**Mon 2/15/16**	**Fri 10/21/16**	
57	Corps & SHPO Tribal Coordination	40 days	Mon 2/15/16	Fri 4/8/16	7
58	Prepare Section 106 Survey and Documentation	50 days	Mon 4/11/16	Fri 6/17/16	57
59	Receive Determination of Eligibility (DOE)	10 days	Mon 6/20/16	Fri 7/1/16	58
60	District and Project Team Review of DOE	20 days	Mon 7/4/16	Fri 7/29/16	59
61	Revise Draft DOE & Submit to SHPO	10 days	Mon 8/1/16	Fri 8/12/16	60
62	SHPO Review/Coordination/Concurrence	40 days	Mon 8/15/16	Fri 10/7/16	61
63	Develop and Sign Cultural Resources MOU for Construction	80 days	Mon 7/4/16	Fri 10/21/16	59
64	**Marion County Land Use Permit Approval**	**220 days**	**Tue 7/26/16**	**Mon 5/29/17**	
65	Pre-Application Meeting	60 days	Tue 7/26/16	Mon 10/17/16	25
66	Prepare Draft Permit Application	40 days	Tue 10/18/16	Mon 12/12/16	65,75
67	Submit Draft Land Use Application to District & Consultant Team	5 days	Tue 12/13/16	Mon 12/19/16	66
68	District and Consultant Review of Draft Land Use Application	15 days	Tue 12/20/16	Mon 1/9/17	67
69	Finalize Land Use Application	5 days	Tue 1/10/17	Mon 1/16/17	68
70	Submit Land Use Application to Marion County	0 days	Mon 1/16/17	Mon 1/16/17	69
71	Completeness Review	15 days	Tue 1/17/17	Mon 2/6/17	70
72	Review Period	80 days	Tue 2/7/17	Mon 5/29/17	71
73	Land Use Permit Issued	0 days	Mon 5/29/17	Mon 5/29/17	72
74	**Design Dam, Appurtenances and Mitigation**	**621 days**	**Mon 3/14/16**	**Mon 7/30/18**	
75	Prepare 30% Design Documentation	60 days	Mon 3/14/16	Fri 6/3/16	8
76	Prepare 60% Design Documentation	80 days	Tue 10/17/17	Mon 2/5/18	30
77	Prepare 90% Design Documentation	80 days	Tue 2/6/18	Mon 5/28/18	76
78	Prepare 100% Design Documentation	45 days	Tue 5/29/18	Mon 7/30/18	77
79	**Final Orders for Water Rights**	**450 days**	**Mon 1/4/16**	**Fri 9/22/17**	
80	**Permits and Clearance In-Hand**	**0 days**	**Mon 7/30/18**	**Mon 7/30/18**	37,42,49,55,73,34
81	**Advertise/Bid/Award/NTP**	60 days	Tue 7/31/18	Mon 10/22/18	78
82	**Communication and Outreach Related to Project Construction**	**20 days**	**Tue 10/23/18**	**Mon 11/19/18**	81
83	**Construction**	500 days	Tue 7/31/18	Mon 6/29/20	80
84	**Construction Monitoring**	450 days	Tue 10/23/18	Mon 7/13/20	81,80
85	**Post - Construction Monitoring**	1045 days	Tue 7/14/20	Mon 7/15/24	84



Task Legend: District (EVWD) Decision Point and Meeting
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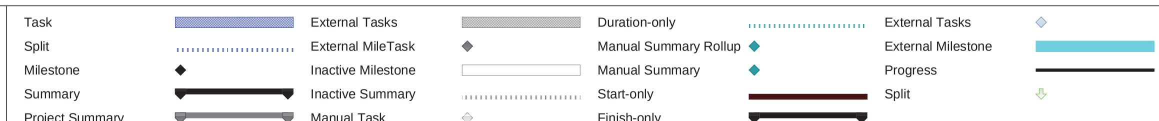

East Valley Water District
Balance Sheet
As of January 11, 2016

	Jan 11, 16
ASSETS	
Current Assets	
Checking/Savings	
Checking - Pioneer Trust	22,522.46
Umpqua Bank account	86,691.13
Total Checking/Savings	109,213.59
Accounts Receivable	
Accounts Receivable	59,319.25
Total Accounts Receivable	59,319.25
Total Current Assets	168,532.84
TOTAL ASSETS	**168,532.84**
LIABILITIES & EQUITY	
Liabilities	
Current Liabilities	
Accounts Payable	
Accounts Payable	5,000.00
Total Accounts Payable	5,000.00
Total Current Liabilities	5,000.00
Total Liabilities	5,000.00
Equity	
Retained Earnings	171,303.69
Net Income	-7,770.85
Total Equity	163,532.84
TOTAL LIABILITIES & EQUITY	**168,532.84**

VIC GILLIAM
STATE REPRESENTATIVE
DISTRICT 18

STATE OF OREGON 1859

HOUSE OF REPRESENTATIVES

July 29, 2015

Nancy Pustis
Water Conservation, Reuse &Storage Program
Oregon Department of Water Resources
725 Summer Street NE, Suite A
Salem, Oregon 97301-1266

Dear Ms. Pustis,

Please consider this letter of support for the East Valley Water District (EVWD) grant application. The grant is designed to fund the costs of planning studies that evaluate the feasibility of developing water conservation, reuse or storage projects.

I am interested in the results of such a study since EVWD members as well as Victor Point area landowners are in or near House District 18. Like so many Oregonians in our vital agricultural and nursery fields, EVWD's expectations for long-term water supply are limited and the outlook only worsens; however, the results of this type of analysis could shed light on feasible alternatives for water in the future.

Thank you for this opportunity and I hope you will give every possible consideration to the EVWD grant application.

Sincerely,

Vic Gilliam
State Representative

Cc: Dave Bielenberg
Duane Eder
Mark Dickman

NORPAC

NORPAC FOODS INC.

3225 25th St. SE
Salem, OR 97302-1133
PO Box 14444
Salem, OR 97309-5012
503-480-2100

July 30, 2015

Jon Unger, Grant Specialist
Oregon Water Resources Department
725 Summer Street NE, Suite A
Salem, OR 97301

Dear Mr. Unger,

In the recent past, NORPAC Foods, Inc. has submitted letters in support of the East Valley Water District's grant request under the SB 1069 Program. That grant was awarded and tremendous work followed however, more remains to be done. Meanwhile, very real water shortages persist.

NORPAC continues to support this critical community water supply effort, and urges the Oregon Department of Water Resources and its Commission to again partner with the East Valley Water District through this grant program.

NORPAC has grown from a small group of Oregon farmers to a nationally recognized farmer-owned cooperative processing and marketing premium quality vegetable and fruit products. Our 240 farmer-members farm 45,000 acres and, with our associate farmers and processors, produce over 600 million pounds of product annually.

Many of the farmers who produce for NORPAC are also members of the East Valley Water District. Production agriculture is reliant on irrigation. Growers in the Mount Angel and Silverton areas in Marion County are operating under the very real constraints of conditional groundwater permits, over-appropriated streams and declining aquifers. Farm operations are located within three areas listed by the department as "Groundwater Limited," which provides few alternatives for additional water supply.

The project proposed in the East Valley Water District's grant application will, in part, address off-channel storage alternatives and analyze storage required to provide ecological flows. NORPAC supports the District's request for continued funding partnership through this grant, enabling further development of a solution to a problem growing more severe with time.

Thank you for your support of this proactive request.

Sincerely,

George F. Smith
President and CEO

Oregon Water Resources Congress
795 Winter St. NE | Salem, OR 97301 | Phone: 503-363-0121 | Fax: 503-371-4926 | www.owrc.or

July 31, 2015

John Unger
Oregon Water Resources Department
725 Summer Street NE, Suite A
Salem, Oregon 97301

Dear Mr. Unger:

The Oregon Water Resources Congress (OWRC) is writing in support of the East Valley Water District's grant application for its Drift Creek Water Storage Project in Silverton, Oregon. OWRC urges the Oregon Water Resources Department (WRD) to provide matching funds for this project from the Water Conservation, Reuse, and Storage grant program established under SB 1069.

OWRC is a nonprofit association representing irrigation districts, water control districts, improvement districts, drainage districts, and other agricultural water suppliers. These local government entities operate complex water management systems, including water supply reservoirs, canals, pipelines, and hydropower production, and deliver water to roughly 1/3 of all irrigated land in Oregon. OWRC has been promoting the protection and use of water rights and the wise stewardship of water resources on behalf of agricultural water suppliers for over 100 years. As such, we are highly supportive of long-term water supply planning and development efforts like the one being undertaken by the East Valley Water District.

In the 2008 Legislative Session, OWRC was part of the original coalition of agricultural groups that successfully advocated for the passage and funding of SB 1069 resulting in the Water Conservation, Reuse, and Storage grant program. Since its inception, this grant program has funded many worthwhile feasibility projects, including previous work by the East Valley Water District. The East Valley Water District's Drift Creek Water Storage Project is exactly the type of planning effort OWRC and its partners imagined when we advocated for the passage of SB 1069, and we believe it meets the fundamental intent behind that bill.

The Drift Creek Water Storage Project is an ongoing endeavor started by the district to develop a new water supply in Silverton, Mt. Angel and Molalla in Marion County. The project seeks to develop an alternative water supply for existing farmers and alleviate usage pressure on already strained groundwater systems. Due to limited water availability in the area, local farmers have little recourse and are increasingly challenged with finding adequate water supplies to irrigate crops in one of the most fertile areas of the Willamette Valley. Additionally, providing funding for this project has the potential to benefit not only the farmers and other agricultural water users within the district, but also provide environmental benefits to fish and wildlife through cooler surface water temperatures.

The East Valley Water District's Drift Creek Water Storage Project is a highly worthwhile project that will provide economic, social, and environmental benefits to the local watershed and the users that rely upon it as well as accrue to the broader population of Oregon. This type of project is also an essential element to implementing with the Oregon's Integrated Water Resources Strategy (IWRS) and WRD's ongoing efforts to meet Oregon's long-term water needs. Continuing support of the East Valley Water District's Drift Creek Water Storage Project aligns well with the IWRS and its recommended action to improve access to built storage.

Specifically, the requested funding will go towards the following key study components: (1) further alternatives analysis on potential off-stream storage opportunities; (2) further evaluation of the project's ability to provide "ecological flows" downstream to promote healthier stream ecology; (3) elk studies; (4) phase II cultural resources analysis. Each of these areas are important aspects in determining the feasibility of the project, including addressing questions from project opposition. OWRC wholeheartedly recommends continued support and full funding of the East Valley Water District's Drift Creek Water Storage Project from the Water Conservation, Reuse, and Storage grant program.

Sincerely,
April Snell
Executive Director