Appendix E

Conservation Alternatives, No. PN-HFS-006

Municipal Water Conservation Measures and New Non-Potable Water Supply Options, PN-HFS-007

RECLAMATION
Managing Water in the West

Henrys Fork Basin Study
Conservation Alternatives
Technical Series Report No. PN-HFS-006

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

U.S. Department of the Interior
Bureau of Reclamation
Pacific Northwest Region
Boise, Idaho

October 2012

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The mission of the Department of the Interior is to protect and provide access to our Nation's natural and cultural heritage and honor our trust responsibilities to Indian tribes and our commitments to island communities.

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Photographs on front cover: Fly fishing, irrigated agriculture, and swan habitat are important features in the Henrys Fork River basin.

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1.0 ALTERNATIVES INTRODUCTION

1.1 Alternatives Overview

Four water conservation alternatives were evaluated to help meet the water needs of the Henrys Fork River basin: (1) recharge using existing canals; (2) canal automation; (3) installing pipelines or canal linings in irrigation canals; and (4) demand reduction.

A fifth alternative, on-farm conservation practices, which would have evaluated the conversion of surface irrigation systems to sprinkler irrigation systems, was originally planned for analysis. However, due to the lack of extensive surface irrigation systems and the complexity of estimating the reduction of irrigated seepage along with increased crop consumptive use, or reduced canal discharge, this alternative was not evaluated. Based on the analysis of other conservation alternatives, it is probable that this alternative would yield similar results to the piping and lining of irrigation canals except on a much smaller scale.

The primary analysis tool for evaluating conservation alternatives is a computational model (Model) developed Dr. Robert Van Kirk of Humboldt State University. The Model allowed for the analysis of conservation alternatives to be made by changing diversions and by adjusting canal loss rates. Output results from the Model associated with U.S. Geological Survey (USGS) stream gage locations and compare the modeled alternative's stream flow to the current streamflow conditions.

Monthly time-step water budgets of irrigated regions and major river reaches in the Henrys Fork River basin were developed. Water budget components, including stream flow, consumptive use, stream seepage, and groundwater return flows, were developed and documented for the modeling.

The alternatives evaluated were modeled and analyzed with respect to four defined major irrigated regions that represent approximately 80 percent (188,820 acres) of the irrigated lands in the Henrys Fork watershed (Figure 1). These four irrigated regions were developed to facilitate modeling and because detailed information on their historic canal deliveries is known. More detailed descriptions of each conservation alternative are provided in the alternative-specific sections later in this report.

Forty-three diversions were identified within the Henrys Fork River basin (Figure 2), each of which has its daily diversions (in acre-feet) documented for the 30-year period from October 1, 1978, through September 30, 2008. Table 1 is a list of canals, their associated irrigation regions, the average annual diversions in acre-feet from the Henrys Fork, Fall, and Teton rivers, and the estimated number of acres served by those canals. These diversion points correspond to the water budget modeling Dr. Van Kirk developed for the Henrys Fork River basin.

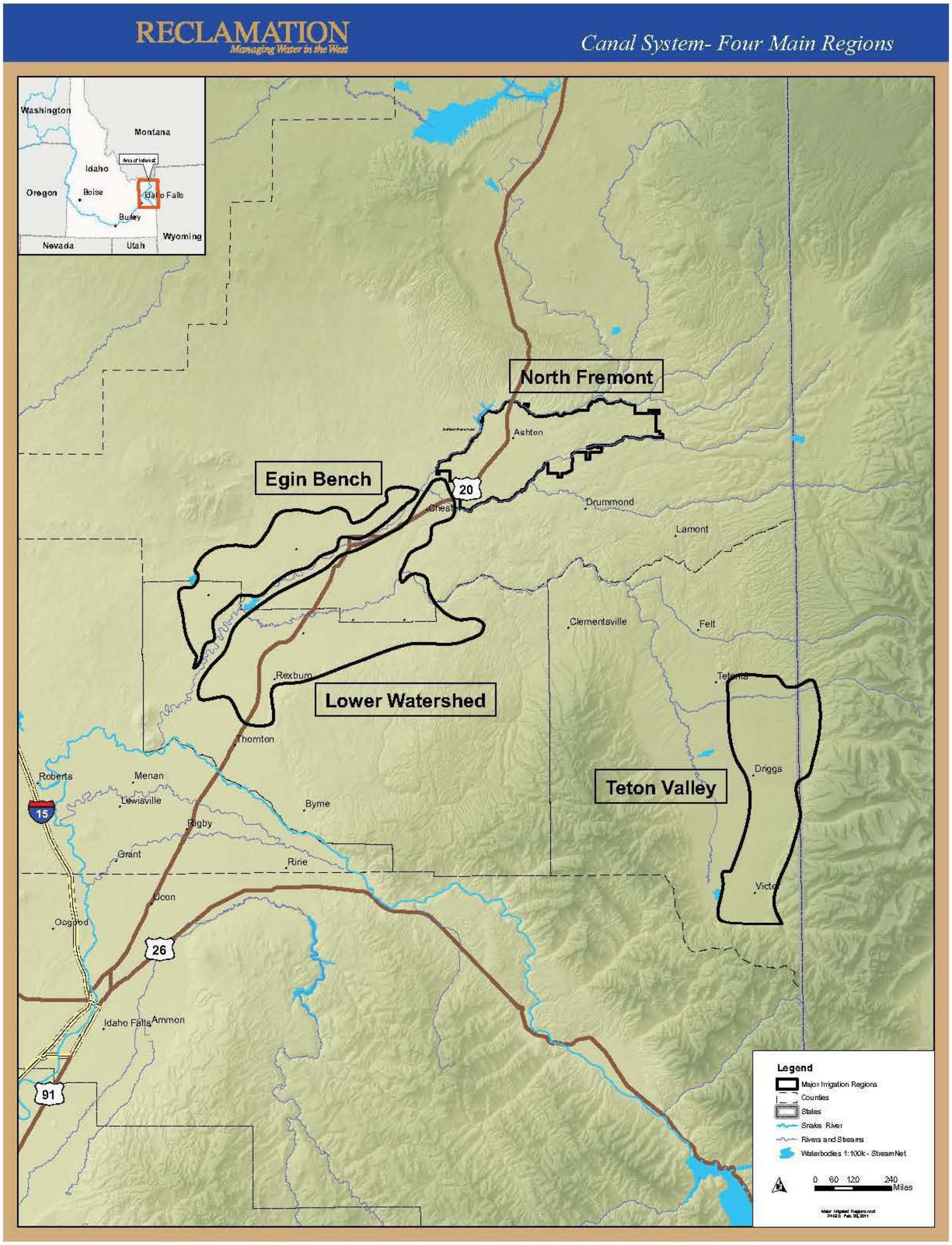

Figure 1. Four major irrigated regions in the Henrys Fork Basin Study area.

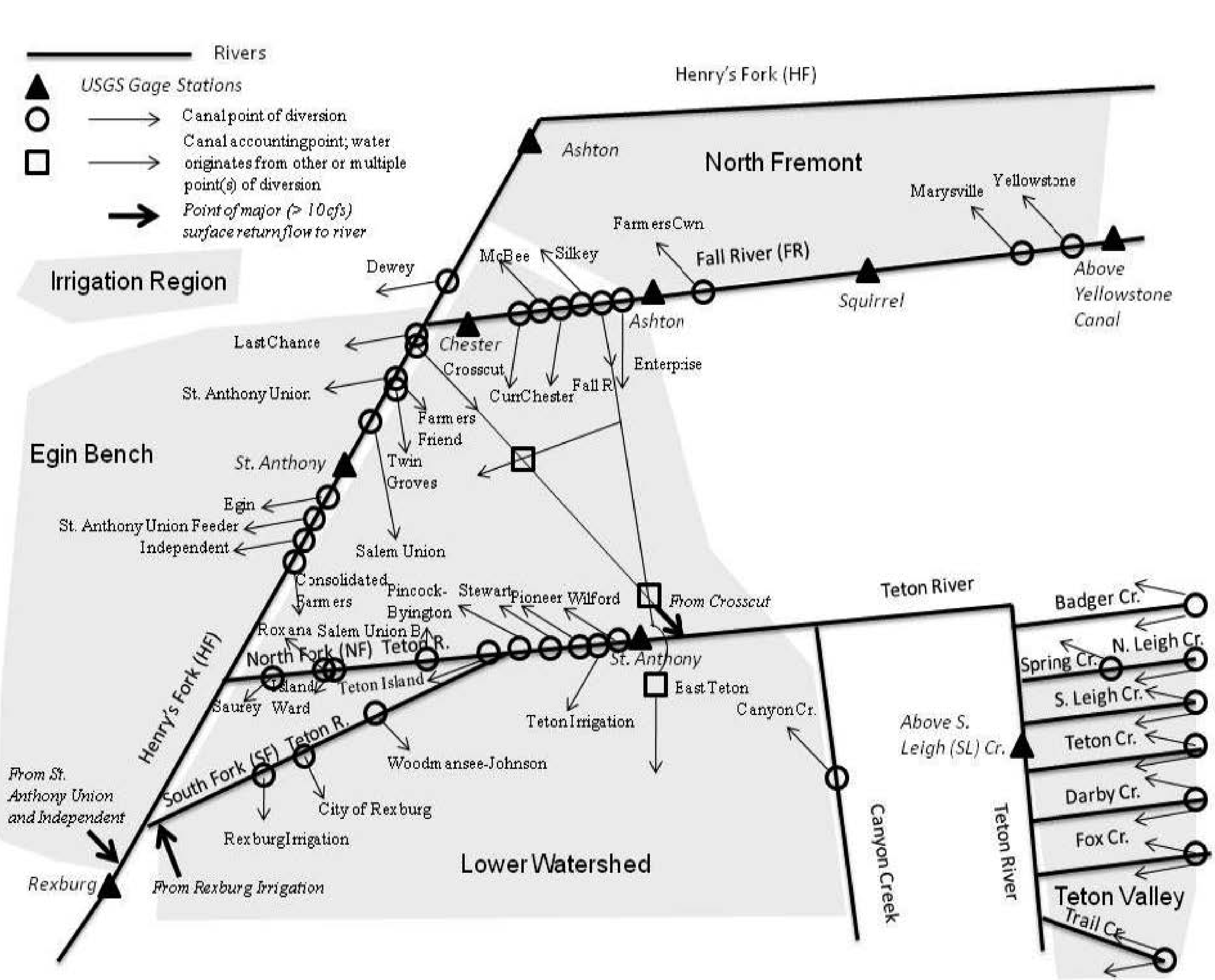

Figure 2. Canal schematic showing 43 diversion points in the Henrys Fork River basin (Van Kirk).

Table 1. Canals by irrigated region, average annual acre-feet diverted, and irrigated acres.

Canal - Diversion	Irrigated Region	Average Annual Acre Feet Diverted	Irrigated Acres	Region Acres
Dewey	Egin Bench	5,417	3,500	
Egin	Egin Bench	99,096	7,287	
Independent	Egin Bench	75,451	5,548	
Last Chance	Egin Bench	22,983	1,690	
St. Anthony Union	Egin Bench	140,353	10,321	
St. Anthony Union Feeder	Egin Bench	29,299	2,154	30,500
Canyon Creek	Lower Watershed	3,805	16	
Chester	Lower Watershed	14,017	1,714	
Consolidated Farmers	Lower Watershed	79,038	9,666	
Crosscut	Lower Watershed	5,350	-	
Curr	Lower Watershed	12,875	1,574	
East Teton	Lower Watershed	22,148	2,709	
Enterprise	Lower Watershed	22,669	2,772	
Fall River	Lower Watershed	68,863	8,433	
Farmers Friend	Lower Watershed	31,861	3,896	
Island Ward	Lower Watershed	13,334	1,631	
McBee	Lower Watershed	414	51	
Pincock-Byington	Lower Watershed	2,548	312	
Pioneer	Lower Watershed	2,263	277	
Rexburg (City of)	Lower Watershed	4,314	528	
Rexburg Irrigation	Lower Watershed	48,442	5,924	
Roxana	Lower Watershed	4,393	537	
Salem Union	Lower Watershed	61,698	7,545	
Salem Union B	Lower Watershed	1,944	238	
Saurey	Lower Watershed	5,571	681	
Silkey	Lower Watershed	5,249	642	
Stewart	Lower Watershed	2,163	265	
Teton Irrigation	Lower Watershed	19,446	2,378	
Teton Island Feeder	Lower Watershed	102,271	12,507	
Twin Groves	Lower Watershed	30,308	3,706	
Wilford	Lower Watershed	38,552	4,715	
Woodmansee-Johnson	Lower Watershed	2,317	283	73,000
Farmers Own	North Fremont	13,711	10,691	
Marysville	North Fremont	25,469	19,859	
Yellowstone	North Fremont	2,502	1,951	32,500
Badger	Teton Valley	5,343	6,011	
Darby Cr.	Teton Valley	11,696	6,244	
Fox Cr.	Teton Valley	8,377	4,459	
N Leigh Cr.	Teton Valley	7,335	3,993	
S Leigh Cr.	Teton Valley	9,985	5,336	
Spring	Teton Valley	7,268	3,000	
Teton Cr.	Teton Valley	28,898	15,596	
Trail Cr.	Teton Valley	14,870	8,181	52,820
		1,113,906		188,820

1.2 Recharge Using Existing Canals

Incidental recharge has been shown to be a key component of instream flows in the Henrys Fork River basin. The Model simulations estimated the impact of using existing canal infrastructure to increase incidental recharge by increasing diversions 20 percent and 40 percent into the 43 canal diversions during the irrigation season. Diversion amounts for the Teton Valley irrigated region were limited to canal capacities and to where sufficient water was available. Diversions for the other three irrigated regions were only limited by canal capacity since the Model assumed that additional water can be released from storage facilities on the Henrys Fork River.

1.3 Canal Automation

Canal automation is an important practice that improves irrigation scheduling and reduces waste (over diverting). The Model was preconfigured to match irrigation diversions with crop consumptive use based on the theoretical crop consumptive use derived from historical evapotranspiration (ET) values for the geographic area served by each of the 43 canal diversions. In order to realize water savings under this scenario, diversions were set to the ET requirement plus losses up to the historical diversions.

1.4 Piping and Lining of Irrigation Canals

Piping and lining of irrigation canals are traditional conservation practices used to reduce canal seepage. The Model simulations assumed a 100-percent reduction in seepage for canals placed in pipes and a 75-percent reduction in seepage for lined canals for each of the 43 canal diversions.

1.5 Demand Reduction

Reduced irrigation demands result in lower water use which may positively impact stream flows. Demand reductions of 25 percent and 50 percent were simulated for each canal by reducing the number of acres being irrigated and by setting diversions to ET demand. Savings are realized based on the ET demand calculation, which is based on the number of acres being irrigated.

1.6 Key Findings

1.6.1 Recharge Using Existing Canals

Model output from this alternative indicated that total annual flows would be reduced in all irrigated regions which would have a negative impact on water supply. However, the Model output indicated that low season flows increased in the Teton Valley and Lower Watershed irrigated region which would have a positive impact on environmental needs. This alternative, modeled only for the irrigation season, is a no-cost alternative.

1.6.2 Canal Automation

Model output from this alternative indicated an increase in the total annual flows in all of the irrigated regions, resulting in a positive impact on water supplies. Canal automation reduces flows during the low flow season in the Teton Valley and Lower Watershed irrigated regions which would have a negative impact on environmental needs. Canal automation costs, estimated for the primary diversion point of each canal in an irrigated region, ranged from $0.8 million to $2.3 million.

1.6.3 Piping and Lining of Canals

Model output from this alternative indicated that the installation of pipelines and the lining of existing irrigation canals reduced the total annual flows in the Teton Valley, Lower Watershed, and Egin Bench irrigated regions which would have a negative impact on water supplies in those regions. However, total annual flows would be increased in the North Fremont region, resulting in a positive impact on water supplies in that region. Piping and lining of irrigation canals would decrease seasonal low flows in the Teton Valley, Lower Watershed, and Egin Bench irrigated regions which would have a negative impact on environmental needs in those regions; however, seasonal low flows would increase in the North Fremont region, resulting in a positive impact on environmental needs in that region.

The installation of pipelines and the lining of existing irrigation canals are expensive, with cost estimations ranging from $97.6 million for lining canals in the North Fremont irrigated region to $953.8 million for installing pipelines in the Lower Watershed region.

1.6.4 Demand Reduction

Model output from this alternative indicated that reducing the number of acres irrigated would increase total annual flows in all of the irrigated regions, resulting in a positive impact on water supplies across the watershed. Demand reduction would reduce seasonal low flows in the Teton Valley irrigated region which would have a negative impact on environmental needs. Seasonal low flows would increase in the North Fremont, Lower Watershed, and Egin Bench regions which would have a positive impact on environmental needs.

The demand reduction costs ranged from $14.8 million with a 25-percent demand reduction in the North Fremont irrigated region to $66.3 million with a 50-percent demand reduction in the Lower Watershed region.

2.0 EVALUATION APPROACHES, ASSUMPTIONS, AND LIMITATIONS

2.1 Description of Modeling for Analysis of Conservation Alternatives

2.1.1 Model Overview

The primary analysis tool for evaluating the conservation alternatives was the computational Model developed Dr. Van Kirk as part of a U.S. Department of Agriculture study. Dr. Van Kirk's Model calculated the water budget changes to the Henrys Fork River basin system given changes in irrigation diversions and canal loss rates and developed output hydrographs for both surface water and groundwater at defined USGS gage locations. Each conservation alternative that was analyzed represented a different diversion scenario. The Model allowed diversions to be altered at any of the 43 canal diversion points depicted in Figure 2. Model output was developed for each conservation alternative for each of the four irrigated regions (Figure 1) and compared to the current system.

The Model is an analytical representation of surface water and groundwater in each basin. Surface water and groundwater are coupled and mass balance is satisfied. Inputs to the Model include, historical or estimated streamflow, historical diversions, canal loss rates, canal capacities, irrigated acres, theoretical ET rates for irrigated acres, crop mix for irrigated acres, and groundwater pumping. The Model can be used to calculate changes to the water budget by adjusting input parameters, such as the diversions and canal loss rates in this study. The amounts of water that are in the streams, diverted, seeps back into the ground, lost to ET, and returns to the river via surface flow is tracked. The groundwater calculation uses the recharge that is estimated from canal and on-farm losses, as well as recharge from other sources such as natural stream channel seepage and direct snowmelt. The calculation computes the amount, timing, and location of return to the river or exit from the watershed via the regional aquifer.

For each conservation alternative, the Model was run for each irrigated region separately and all diversions were adjusted within an irrigated region in the same manner. It is possible to make future model runs where diversions within with a major irrigated region are individually adjusted.

2.1.2 Model Output Locations, Volume Changes and Corresponding Reaches of Concern

The Draft Henrys Fork Watershed Basin Study Water Needs Assessment identified water needs in the basin related to volume and timing (Reclamation 2012). In this report, the model output for each conservation alternative showed a comparison of the current hydrograph (existing stream flow conditions) with each alternative's hydrograph (modeled stream flow conditions). The output hydrographs presented in this report were calculated at USGS gaging stations at or near the downstream boundaries of the irrigated regions that were evaluated.

For each alternative and each output location, the annual volume change in acre-feet for the periods from May 15 through July 15 and July 16 through May 14 were calculated. These two periods generally correspond to peak-flow and non-peak-flow periods which related well to the routine shape of annual hydrographs for rivers and streams in the Henrys Fork River basin.

These changes in volume are presented for each Model component's output location for each conservation alternative. Appendix A has a summary of the volume changes for all of the alternatives evaluated, Appendix B has the output hydrographs for each Model run, and Appendix C has a comparison of annual volume changes related to each conservation alternative. Appendix D has a summary of the impacts of the alternatives on the basin's water needs.

Six stream reaches of concern were documented in the Draft Henrys Fork Watershed Basin Study Water Needs Assessment as stream reaches where flow alterations could potentially impact fisheries:

1. Henrys Lake Outlet
2. Henrys Fork Below Island Park Dam
3. Lower Fall River (downstream of Fall River Canal Diversion)
4. Henrys Fork Downstream of St. Anthony
5. Lower Teton River, North and South Forks
6. Teton Valley Tributaries

Irrigation water taken from tributaries in the Henrys Fork watershed often leave low flows in the streams or even desiccate some streams in the late summer season, impacting fisheries habitat in the tributaries. Increased groundwater recharge due to irrigation activities mitigates the effects farther downstream. The changes in streamflows caused by conservation alternatives were estimated for these stream reaches of concern by associating each reach with a nearby stream gage.

The irrigated regions, along with their respective output locations, and impacted stream reaches of concern are shown in Table 2. By reviewing the change in stream flow volumes for each alternative evaluated, modelers are able to make both a qualitative and quantitative assessment of an alternative's impact to defined basin needs.

Table 2. Irrigated regions with location of model output, and associated stream reaches of concern.

Irrigated Region	Location of Model Output (USGS Gage Station)	Associated Stream Reach of Concern
Teton Valley	St. Anthony (Teton River)	Teton Valley Tributaries
Lower Watershed	Rexburg	Lower Teton River North and South Forks
North Fremont	Chester	Lower Fall River
Egin Bench	Rexburg	Lower Teton River North and South Forks

2.1.3 Historic Diversion Data and "Current" Hydrographs

Model input consisted of average annual diversion data, for the 43 identified diversion points shown in Figure 2, calculated as the average daily stream flow in cubic feet per second and as averaged over the 30-year period from January 1, 1979, through December 31, 2009. For all of the diversions from the Fall River, Henrys Fork River, and the Teton River downstream of Bitch Creek, diversion data in the Water District 1 flow accounting model for water years 1979-2008 were downloaded directly from the Idaho Department of Water Resources (IDWR) web site. Diversion data for the Teton River drainage upstream of Bitch Creek were not available electronically and were not recorded continuously. In this region, diversion rates are recorded once every week or so during the middle of the summer for most water years; however, there are some water years with no records at all. Dr. Van Kirk obtained all diversion data available in hard copy from IDWR by photocopying all of the relevant data from reports in the Water District 1 Watermaster's office and some data collected in recent years by Friends of the Teton River, IDWR's designated measuring authority in Teton Valley. Statistical models based on those data were created to synthesize expected flow data for missing days and years.

The Model used the output hydrograph labeled "current" as a base condition for each of the output (USGS gaging station) locations. The current hydrographs estimated are not 30-year mean hydrographs, but are more representative of the observed USGS gage station flows in recent years. Irrigation practices have changed considerably during the 30-year period, mostly due to conversion of flood irrigation to sprinkler irrigation, so the 30-year mean hydrographs would not accurately reflect the current conditions. The current conditions hydrograph allows the comparison of instream flows for each conservation alternative to present-day conditions with respect to daily cubic feet per second (cfs) and total period acre-feet for a geographically specific location (i.e., present day USGS gaging stations).

2.1.4 Summary of Annual Volume Changes and Impacts to Stream Reaches of Concern

Section 3.0 through Section 6.0 provide detailed information on the model outputs for each conservation alternative as compared to the current conditions and provides a narrative interpretation of the results and the impact (percent change compared to current conditions). Seasonal impacts to stream reaches of concern and impacts to in- and out-of-basin needs are also provided.

2.1.5 Model Peer Review

Under contract with the Bureau of Reclamation (Reclamation), Rocky Mountain Environmental Associates, Inc. (RMEA) provided a peer review of Dr. Van Kirk's models by hydrologist Bryce A. Contor. RMEA specifically evaluated the validity and applicability of Dr. Van Kirk's work to Reclamation's Henrys Fork Basin Study.

The methodology and conclusion of this peer review is presented in *Peer Review of Van Kirk Water USDA Study Products In Support of US Bureau of Reclamation Henrys Fork Basin Special Study* (2011) that stated:

> The USDA Study appears to be a carefully done study based on sound methods and valid data. Its water budget work and products will be useful input to the Special Study, and it provides insightful discussion of Teton Valley hydrology. Much of this discussion has general applicability to the Special Study area. While this peer review offers some suggestions on data sources and methods, adoption of these refinements will not qualitatively change the discussion and conclusions of the USDA Study received as of August 2011.

In his report, Mr. Contor made several suggestions for improving the Model. Dr. Van Kirk subsequently updated the Model, incorporating Mr. Contour's suggestions. As a result, the Model used to evaluate conservation alternatives was the updated version.

2.2 Key Assumptions and Limitations

2.2.1 Modeling Uncertainty

Hydrologic and hydraulic modeling inherently contains assumptions, simplifications, and estimations. The modeling procedure used was appropriate for a reconnaissance-level evaluation of conservation alternatives (Section 2.1.5) and allowed for impacts to be analyzed for many stream reaches in the Henrys Fork River basin. The Model is not linked to the Eastern Snake River Plain Aquifer (ESPA) groundwater model; therefore, related changes in diversions and subsequent changes in groundwater and surface water related to each conservation alternative were not calculated as to how they might meet out-of-basin needs.

2.2.2 Water Rights and Reservoir Operations

Modeling efforts focused on the physical effects to groundwater and surface water hydrology as they related to each conservation alternative. No considerations were made to existing water rights or reservoir operations.

2.2.3 Social Acceptability Uncertainty

While all of the conservation alternative concepts evaluated have been accepted in Idaho, the location and frequency of their adoption have not been uniform. The ESPA Comprehensive Aquifer Management Plan lists all of the conservation practices evaluated as targeted water budget adjustment mechanisms (Idaho Water Resource Board 2009). The social acceptance and subsequent rate of adoption of these conservation practices is expected to be closely tied to economic costs and benefits.

2.2.4 Comparative and Preliminary Cost Estimates

No cost was associated with recharge using existing canals since the physical operation of this alternative only required the canal gates to be set at a higher capacity. However, there may be other charges incurred to implement this alternative which were not included in the cost estimate.

Existing data from previous projects using a limited number of factors and coupled with high level assumptions were used to estimate the costs for installing pipeline and lining in irrigation canals and canal automation. These costs are relative only and should be used only for planning purposes. Canal automation only considered the cost of installing an automated canal gate at the principal river or stream diversion point. To achieve the results depicted by this alternative, more automated gates may be required farther downstream, but for this evaluation, the costs for additional automated gates were not included in the estimate.

For the cost estimations for demand reduction, the determination of the value of irrigation water supplied to an acre of land used is complex and site specific; however, this value was developed in 2008 and has not been updated since then. While this value was developed for a location within the Henrys Fork River basin, the value is representative of the irrigated lands near Rexburg, Idaho and is less representative of the lands at higher elevations in the basin. The demand reduction alternative would be expected to have State and region-wide economic consequences due to its impact on agricultural communities; however, these impacts were not analyzed at this reconnaissance-level analysis.

2.2.5 Environmental Considerations

The Model used for the analysis of each alternative documented the net change in stream flows at Model output locations. As a result, the primary environmental considerations that may be drawn are related to instream environmental needs. Many of the alternatives evaluated would also have environmental impacts in the specific location where an alternative was implemented. Because the location of alternative implementation is not known, no estimation of environmental impacts was made.

2.3 Legal, Institutional, or Policy Constraints

There are many administrative considerations, both legal and institutional, that place restrictive limitations on water related issues. All water rights in the Henrys Fork River basin and downstream would be fully protected and remain unchanged. Existing in-basin and out-of-basin water users would retain all their present water rights and entitlements without modifications. New water rights, if available, would be obtained from the State of Idaho and administered under Idaho State laws.

Local, State and Federal laws and policies must be considered when any water resource project in the Henrys Fork River basin. These include regulatory and administrative requirements related to surface and groundwater rights, property rights, public health and safety, environmental concerns, and resource conservation. The following subsections give a partial listing of Federal and State regulatory guidelines that may pertain to the implementation of any of the proposed conservations alternatives identified through the Henrys Fork Basin Study.

2.3.1 Federal Laws and Executive Orders

Following is only a partial listing of Federal laws and Executive Orders (EO) that may pertain to the implementation of any of the proposed alternatives identified by the Henrys Fork Basin Study:

- Antiquities Act of 1906
- American Indian Religious Freedom Act of 1978
- Archaeological Resources Protection Act of 1979, as amended
- Archaeological and Historic Preservation Act of 1974
- Clean Air Act of 1970, as amended
- Endangered Species Act of 1973, amended in 1979, 1982, and 1988
- Federal Water Pollution Control Act (commonly referred to as the Clean Water Act)
- Fish and Wildlife Coordination Act of 1958, as amended
- Historic Sites Act of 1935
- National Environmental Policy Act of 1969
- National Historical Preservation Act of 1966, as amended
- Native American Graves Protection and Repatriation Act of 1990
- Noise Control Act of 1972, amended in 1978
- Occupational Safety and Health Administration
- Hazard Communication Standards
- Resource Conservation and Recovery Act
- Rivers and Harbors Act of 1899
- Safe Drinking Water Act, Title 28, Public Law 89-72, as amended
- EO 11988 - Floodplain Management

- EO 11990 - Protection of Wetlands
- EO 12875 - Enhancing the Intergovernmental Partnership
- EO 12898 - Federal Actions to Address Environmental Justice

2.3.2 State Laws and Policy

State regulatory processes should be considered in the evaluation of any implementation of any conservation alternatives including, but not limited to, the following:

- The necessary water right permits must be obtained. New consumptive use water rights will require, consistent with Chapter 2, Title 42, Idaho Code, evidence that water is available for appropriation and that the new use will not injure other water users. Water rights in the Henrys Fork and on Snake River are administered in accordance with state law.
- A new project should be consistent with policies set forth in the State Water Plan implemented by the Idaho Water Resource Board (IWRB). Pertinent policies include:
  - State protected river designations: With designating a natural river in accordance with Section 42-1734A, Idaho Code, the following activities are prohibited:
    - Construction or expansion of dams or impoundments;
    - Construction of hydropower projects;
    - Construction of water diversion works;
    - Dredge or placer mining;
    - Alterations of the stream bed; and
    - Mineral or sand and gravel extraction within the stream bed
  - By designating a recreational river, the IWRB shall determine which of the activities prohibited under a natural designation shall be prohibited in the specified reach and may specify the terms and conditions under which activities that are not prohibited may go forward. Designations and their corresponding recommendations are documented in the Henrys Fork Basin Plan, Idaho Water Resource Board, 1992.

- State minimum stream flow water rights: Management of the Snake River consistent with minimum stream flow water rights established at the Milner, Murphy, Weiser, Johnson Bar and Lime Point gaging stations is fundamental to State policy. In addition, a number of minimum stream flow water rights have been developed in the Henrys Fork River basin. Each minimum stream flow was established to address specific management objectives, and together, the minimum stream flows form an integrated plan for management of the basin and Snake River as a whole. The basis and intention of the minimum stream flows as well as the current management of the system should be included in the evaluation of a new project tributary to the Snake River to ensure consistency with the State Water Plan and State regulatory obligations.

- Eastern Snake Plain Aquifer Comprehensive Aquifer Management Plan (ESPA CAMP 2009): The long-term goal of the ESPA CAMP is to incrementally achieve a net water budget change of an additional 600,000 acre-feet annually to the aquifer water budget, with a short-term target of between 200,000 acre-feet and 300,000 acre-feet. A new project in the Henrys Fork River basin should support the ESPA CAMP objectives.

- Pursuant to Section 42-1737, Idaho Code, approval by the IWRB is required for all project proposals involving the impoundment of water in a reservoir with an active storage capacity in excess of ten thousand (10,000) acre-feet.

- Water Quality Certification from the Idaho Department of Health and Welfare in connection with the Federal Clean Water Act.

- Obtain approval of engineering designs, operation, and maintenance through the Idaho Safety of Dams program.

- Stream Channel Alteration Permit for improvements made to the channel to accommodate flood flows and routine releases.

- Coordinate with the IDWR floodplain manager to confirm compliance with the National Flood Insurance Program requirements in Idaho.

County and City Planning and Zoning and environmental regulations are not included in this summary.

3.0 Recharge Using Existing Irrigation Canals Alternative

3.1 Alternative Description

Incidental recharge has a major impact on the rivers and streams of the Henrys Fork River basin. Increased recharge was modeled by diverting more water during the irrigation season using the existing canals. This was modeled for two quantities of increased diversions for each of the four major irrigated regions (Figure 1). Historical diversions were the basis for evaluating recharge using existing canals (Section 2.1.3) and these diversions were increased by 20 percent and 40 percent. Diversions were limited by the amount of available water in the stream or river (Teton Valley region) or the canal's capacity (all regions).

3.2 Model Output Hydrographs

An output summary of all conservation alternatives is presented as Appendix A and individual output hydrographs for all conservation alternatives are presented as Appendix B. The output hydrographs in Appendix B applicable to the recharge using existing canals alternative are:

Table 3. Recharge Using Existing Canals – Output Hydrographs in Appendix B

Output Hydrograph	Percent Diversion Increase	Irrigated Region
B1	20% Diversion Increase	Teton Valley
B1	40% Diversion Increase	Teton Valley
B5	20% Diversion Increase	North Fremont
B5	40% Diversion Increase	North Fremont
B9	20% Diversion Increase	Lower Watershed
B9	40% Diversion Increase	Lower Watershed
B13	20% Diversion Increase	Egin Bench
B13	40% Diversion Increase	Egin Bench

3.3 Cost Estimate

This alternative was formulated to divert additional water during the irrigation season. As a result, no increase in cost for recharge would be expected since recharge using existing canals merely requires the canal operators to adjust the canal gates differently and does not require additional effort or travel time. If other recharge alternatives were considered, additional costs may be incurred, such as when an operator must attend to a canal gate outside the irrigation season. Under Idaho's managed recharge program, a fee is normally paid for irrigators to perform recharge, although Idaho's managed recharge program has been limited to recharge outside of the irrigation season. No consideration of additional charges was made.

3.4 Basin Needs

Recharge using the existing canals has different impacts to the basin needs depending upon the irrigated region where this practice is applied. Appendix D presents the impacts to the basin needs for all conservation alternatives. The Model output for recharge using existing canals show:

- In the North Fremont and Egin Bench regions, recharge using existing irrigation canals reduces annual flows, peak flows, and non-peak flows. There is no positive impact to stream flows for this alternative in these regions.

- In the Teton Valley and Lower Watershed regions, recharge using existing irrigation canals reduces annual flows and peak flows, but increases non-peak flows. While a reduction of annual flows is a negative impact from the perspective of the overall water budget, the increase of non-peak flows is a positive impact during periods of normally low flows. While the benefit to low flows is relatively small, less than a 2 percent non-peak flow increase, the absolute quantity of improved non-peak flows may make a positive impact.

3.5 Evaluation Criteria

3.5.1 Stakeholder Group Measureable Criteria

There are four Stakeholder Group Measurable Criteria.

1. Water Supply: For the Teton Valley, North Fremont, Lower Watershed and Egin Bench irrigated regions, no positive impact.

2. Water Rights: Water rights were not specifically addressed during this level of study, but known legal, institutional, and policy constraints are summarized in Section 2.3.

3. Environmental Considerations: For the Teton Valley and Lower Watershed regions, positive impact due to increases in non-peak flows. For the North Fremont and Egin Bench regions, no positive impact due to a reduction in annual, peak, and non-peak flows.

4. Economics: The estimated reconnaissance-level cost to implement this alternative is presented in Section 3.3. This is a no-cost alternative.

3.5.2 Federal Viability Tests

There are four federal viability tests. The background to evaluate each of these is summarized in the sections above and in the body of the report. Only qualitative, high-level summaries are provided here.

1. Acceptability: To-be-determined (TBD)
2. Effectiveness: TBD
3. Completeness: TBD
4. Efficiency: TBD

4.0 CANAL AUTOMATION ALTERNATIVE

4.1 Alternative Description

Automated canals more accurately adjust and divert water than manual systems and are a useful tool to allow irrigators to match diversion with irrigation requirements. For this alternative evaluation, historical diversions were adjusted to match the crop consumptive use derived from historical ET values for the geographic area. The Model internally calculated the theoretical crop consumption use based on the irrigated regions composite ET. Model runs were performed for each of the four major irrigated regions.

4.2 Model Output Hydrographs

An output summary of all conservation alternatives is presented as Appendix A and individual output hydrographs for all conservation alternatives is presented as Appendix B. The output hydrographs in Appendix B applicable to the canal automation alternative are shown in Table 4.

Table 4. Canal Automation – Output Hydrographs in Appendix B.

Output Hydrograph	Description	Irrigated Region
B2	Model Matches ET	Teton Valley
B6	Model Matches ET	North Fremont
B10	Model Matches ET	Lower Watershed
B14	Model Matches ET	Egin Bench

4.3 Cost Estimate

Costs were developed for the installation of automated canal gates located at the principal canal river or stream diversions. The capacity of the canal gates was set as the maximum daily diversion rate obtained from the 30 years of diversion data described in section 2.1.3. No estimates were made for additional canal gates which may be needed further downstream of the principal diversion to achieve the modeled results.

Costs for the recently automated canal systems installed by the Sunnyside Valley Irrigation District (SVID) near Sunnyside, Washington were used as a bench mark because they were installed with close Reclamation collaboration, had detailed contractor bid results and engineer’s estimates, and were constructed on large canals similar in nature to those within the Henrys Fork River basin. The installations included reworking of headgates, construction of concrete control sections, installation of Langemann radial arm headgates, and the installation of a telemetric data acquisition system. From cost data provided by SVID, it was determined that the installation of the Langemann headgates (Figure 3) accounted for 46.5 percent of total costs. Aqua Systems 2000 provided Langemann headgates cost data for representative sizes of canal diversions within the four irrigated regions, ranging from 200 cfs to 600 cfs.

Figure 3. Langemann Gate – source Aqua Systems 2000 web page - Langemann® Gate | Aqua Systems 2000 Inc.

With total installation costs based on the cost of the Langemann gates developed for 200 cfs to 600 cfs, a regression equation was developed that directly estimates the cost of total automated canal systems per cfs capacity:

$$\text{Cost \$} = \$392/\text{cfs} \times \text{cfs capacity} + \$14{,}988$$

The individual cost for each automated canal, and the sum for each output gaging station is shown in Table 5. Peak flows were estimated for each canal from the daily diversion data discussed in section 2.1.3.

Table 5. Teton Valley irrigated region estimated canal automation cost.

				Cost of Automated Canals by Irrigated Region and Model Output Location			
Canal - Diversion	Irrigated Region	Peak Flow CFS	Automated Canal Costs	Teton Valley @ St. Anthony	Egin Bench @ Rexburg	Lower Watershed @ Rexburg	North Fremont @ Chester
Dewey	Egin Bench	49	$34,208		$ 34,208		
Egin	Egin Bench	439	$187,088		$ 187,088		
Independent	Egin Bench	522	$219,624		$ 219,624		
Last Chance	Egin Bench	136	$68,312		$ 68,312		
St. Anthony Union	Egin Bench	620	$258,040		$ 258,040		
St. Anthony Union Feeder	Egin Bench	261	$117,312		$ 117,312		
Canyon Creek	Lower Watershed	78	$45,576			$ 45,576	
Chester	Lower Watershed	128	$65,176			$ 65,176	
Consolidated Farmers	Lower Watershed	612	$254,904			$ 254,904	
Crosscut	Lower Watershed	322	$141,224			$ 141,224	
Curr	Lower Watershed	76	$44,792			$ 44,792	
East Teton	Lower Watershed	231	$105,552			$ 105,552	
Enterprise	Lower Watershed	168	$80,856			$ 80,856	
Fall River	Lower Watershed	435	$185,520			$ 185,520	
Farmers Friend	Lower Watershed	350	$152,200			$ 152,200	
Island Ward	Lower Watershed	127	$64,784			$ 64,784	
McBee	Lower Watershed	9	$18,528			$ 18,528	
Pincock-Byington	Lower Watershed	32	$27,544			$ 27,544	
Pioneer	Lower Watershed	37	$29,504			$ 29,504	
Rexburg (City of)	Lower Watershed	54	$36,168			$ 36,168	
Rexburg Irrigation	Lower Watershed	324	$142,008			$ 142,008	
Roxana	Lower Watershed	42	$31,464			$ 31,464	
Salem Union	Lower Watershed	339	$147,888			$ 147,888	
Salem Union B	Lower Watershed	38	$29,896			$ 29,896	
Saurey	Lower Watershed	65	$40,480			$ 40,480	
Silkey	Lower Watershed	42	$31,464			$ 31,464	
Stewart	Lower Watershed	47	$33,424			$ 33,424	
Teton Irrigation	Lower Watershed	166	$80,072			$ 80,072	
Teton Island Feeder	Lower Watershed	631	$262,352			$ 262,352	
Twin Groves	Lower Watershed	260	$116,920			$ 116,920	
Wilford	Lower Watershed	279	$124,368			$ 124,368	
Woodmansee-Johnson	Lower Watershed	39	$30,288			$ 30,288	
Farmers Own	North Fremont	112	$58,904				$ 58,904
Marysville	North Fremont	240	$109,080				$ 109,080
Yellowstone	North Fremont	38	$29,896				$ 29,896
Badger	Teton Valley	50	$34,600	$ 34,600			
Darby Cr.	Teton Valley	148	$73,016	$ 73,016			
Fox Cr.	Teton Valley	170	$81,640	$ 81,640			
N Leigh Cr.	Teton Valley	176	$83,992	$ 83,992			
S Leigh Cr.	Teton Valley	360	$156,120	$ 156,120			
Spring	Teton Valley	175	$83,600	$ 83,600			
Teton Cr.	Teton Valley	448	$190,616	$ 190,616			
Trail Cr.	Teton Valley	224	$102,808	$ 102,808			
Totals			$4,211,808	$ 806,392	$ 884,584	$ 2,322,952	$ 197,880

4.4 Basin Needs

Matching irrigation needs by improved diversion management using canal automation has different impacts to the Henrys Fork River basin needs, depending upon the irrigated region where this practice is applied. Appendix D presents the impacts to basin needs for all of the conservation alternatives evaluated. The results for automated canals show:

- For the Teton Valley, North Fremont, Lower Watershed and Egin Bench regions, canal automation increases both total annual and peak flow volumes. This is a positive impact to the overall water budget of the Henrys Fork River basin.

- For the North Fremont region, canal automation increases non-peak flows. The increase of non-peak flows is a positive during periods of normally low flows. While the benefit to low flows is relatively small, less than a 2 percent non-peak flows increase, the absolute quantity of improved non-peak flows may make a positive impact.

- For the Teton Valley, Lower Watershed, and Egin Bench regions, canal automation decrease non-peak flows. This would have a negative environmental impact.

4.5 Evaluation Criteria

4.5.1 Stakeholder Group Measureable Criteria

There are four Stakeholder Group Measurable Criteria.

1. Water Supply: For the Teton Valley, North Fremont, Lower Watershed, and Egin Bench irrigated regions canal automation has a positive impact on annual flows.

2. Water Rights: Water rights were not specifically addressed during this level of study, but known legal, institutional, and policy constraints are summarized in Section 2.3.

3. Environmental Considerations: For the Lower Watershed region, there is a positive impact due to increases in non-peak flows. For the Teton Valley, North Fremont and Egin Bench regions there is a negative impact due to a reduction in non-peak flows.

4. Economics: Automation of principal canal headgates by irrigated region are Teton Valley ($0.8 million), North Fremont ($0.2 million), Lower Watershed ($2.3 million), and the Egin Bench ($0.9 million).

4.5.2 Federal Viability Tests

There are four federal viability tests. The background to evaluate each of these is summarized in the sections above and in the body of the report. Only qualitative, high-level summaries are provided here:

1. Acceptability: To-be-determined (TBD)
2. Effectiveness: TBD
3. Completeness: TBD
4. Efficiency: TBD

5.0 PIPING AND LINING OF IRRIGATION CANALS ALTERNATIVE

5.1 Alternative Description

The installation of pipelines and the lining of irrigation canals to limit water loss due to canal seepage are routine conservation practices. These alternatives were modeled by setting irrigation diversions to ET demand while canal seepage losses were adjusted to simulate the piping and lining of canals; thus, water previously lost to seepage was used for crop irrigation. Canal seepage losses were reduced 100 percent to model pipelines and reduced 75 to model canal linings.

5.2 Model Output Hydrographs

An output summary of all conservation alternatives is presented as Appendix A and individual output hydrographs for all conservation alternatives is presented as Appendix B. The output hydrographs in Appendix B applicable to the piping and lining alternatives are shown in Table 6.

Table 6. Piping and Lining of Irrigation Canals – Output Hydrographs in Appendix B

Output Hydrograph	Description	Irrigated Region
B3	Lining Reduce Canal Seepage 75%	Teton Valley
B3	Piping Reduce Canal Seepage 100%	Teton Valley
B7	Lining Reduce Canal Seepage 75%	North Fremont
B7	Piping Reduce Canal Seepage 100%	North Fremont
B11	Lining Reduce Canal Seepage 75%	Lower Watershed
B11	Piping Reduce Canal Seepage 100%	Lower Watershed
B15	Lining Reduce Canal Seepage 75%	Egin Bench
B15	Piping Reduce Canal Seepage 100%	Egin Bench

5.3 Cost Estimate

The estimated costs for pipelines and canal linings used in the evaluation of this alternative are the same as those developed by CH_2M HILL and documented in the report *Draft Henrys Fork Basin Study New Surface Storage Alternatives, Technical Series No. PN-HFS-002.* For more detail, refer to Exhibit 2-4 and Exhibit 2-5 of that report.

5.3.1 Pipeline Cost Estimate

The cost estimates for pipelines was for steel pipe and based on length, design flow, and diameter. Canal lengths were an input to the water budgets developed by Dr. Van Kirk and discussed in Section 2.1.3; peak flows were estimated for each canal from the daily diversion data discussed in section 2.1.3. Design flows were estimated to vary along the length of the pipeline as shown in Table 7. Table 8 shows the estimated costs of pipelines for canals in each of the four irrigated regions.

Table 7. Estimated Pipeline Segment Design Flows as a Percent of Canal Peak Flow

Percent of Pipeline Length	Design Flow
25%	100% Peak Flow
25%	75% Peak Flow
25%	50% Peak Flow
25%	25% Peak Flow

Table 8. Estimated Cost of Installed Pipelines

Cost are millions of dollars					Cost of Installed Pipelines by Irrigated Region & Model Output Location			
Canal - Diversion	Irrigated Region	Peak Flow CFS	Canal Length (feet)	Pipe Install Costs	Teton Valley @ St. Anthony	Egin Bench @ Rexburg	Lower Watershed @ Rexburg	North Fremont @ Chester
Dewey	Egin Bench	49	37,440	$ 17.2		$ 17.2		
Egin	Egin Bench	439	99,406	$ 114.9		$ 114.9		
Independent	Egin Bench	522	138,266	$ 184.0		$ 184.0		
Last Chance	Egin Bench	136	116,785	$ 64.7		$ 64.7		
St. Anthony Union	Egin Bench	620	124,753	$ 192.1		$ 192.1		
St. Anthony Union Feeder	Egin Bench	261	68,233	$ 53.4		$ 53.4		
Canyon Creek	Lower Watershed	78	92,331	$ 45.5			$ 45.5	
Chester	Lower Watershed	128	26,900	$ 14.6			$ 14.6	
Consolidated Farmers	Lower Watershed	612	45,005	$ 68.5			$ 68.5	
Crosscut	Lower Watershed	322	32,783	$ 29.8			$ 29.8	
Curr	Lower Watershed	76	14,852	$ 7.3			$ 7.3	
East Teton	Lower Watershed	231	41,310	$ 29.8			$ 29.8	
Enterprise	Lower Watershed	168	109,154	$ 65.9			$ 65.9	
Fall River	Lower Watershed	435	132,479	$ 152.1			$ 152.1	
Farmers Friend	Lower Watershed	350	34,754	$ 33.6			$ 33.6	
Island Ward	Lower Watershed	127	71,538	$ 38.8			$ 38.8	
McBee	Lower Watershed	9	12,862	$ 3.8			$ 3.8	
Pincock-Byington	Lower Watershed	32	9,780	$ 4.2			$ 4.2	
Pioneer	Lower Watershed	37	8,666	$ 3.8			$ 3.8	
Rexburg (City of)	Lower Watershed	54	35,392	$ 16.5			$ 16.5	
Rexburg Irrigation	Lower Watershed	324	97,730	$ 89.2			$ 89.2	
Roxana	Lower Watershed	42	18,762	$ 8.4			$ 8.4	
Salem Union	Lower Watershed	339	69,697	$ 65.8			$ 65.8	
Salem Union B	Lower Watershed	38	6,570	$ 2.9			$ 2.9	
Saurey	Lower Watershed	65	9,860	$ 4.7			$ 4.7	
Silkey	Lower Watershed	42	28,211	$ 12.6			$ 12.6	
Stewart	Lower Watershed	47	6,705	$ 3.1			$ 3.1	
Teton Irrigation	Lower Watershed	166	43,959	$ 26.4			$ 26.4	
Teton Island Feeder	Lower Watershed	631	83,833	$ 131.0			$ 131.0	
Twin Groves	Lower Watershed	260	43,831	$ 34.2			$ 34.2	
Wilford	Lower Watershed	279	53,588	$ 43.9			$ 43.9	
Woodmansee-Johnson	Lower Watershed	39	39,022	$ 17.2			$ 17.2	
Farmers Own	North Fremont	112	105,173	$ 55.3				$ 55.3
Marysville	North Fremont	240	133,036	$ 98.7				$ 98.7
Yellowstone	North Fremont	38	29,796	$ 13.1				$ 13.1
Badger	Teton Valley	50	40,000	$ 18.4	$ 18.4			
Darby Cr.	Teton Valley	148	40,251	$ 23.0	$ 23.0			
Fox Cr.	Teton Valley	170	28,790	$ 17.5	$ 17.5			
N Leigh Cr.	Teton Valley	176	41,180	$ 25.4	$ 25.4			
S Leigh Cr.	Teton Valley	360	107,744	$ 106.7	$ 106.7			
Spring	Teton Valley	175	40,000	$ 24.6	$ 24.6			
Teton Cr.	Teton Valley	448	125,356	$ 147.3	$ 147.3			
Trail Cr.	Teton Valley	224	78,788	$ 55.8	$ 55.8			
Totals			2,524,568		$ 418.8	$ 626.4	$ 953.8	$ 167.1

6.3.2 Canal Lining Cost Estimate

Canal costs were based on concrete lining, liner thickness, and wetted area. Liner thickness was based on the Reclamation Canal Design Guide. Canal areas were an input to the water budgets developed by Dr. Van Kirk and discussed in Section 2.1.3. Table 9 shows the estimated costs of canal linings for canals in each of the four irrigated regions.

Table 9. Estimated Cost of Installed Canal Linings

Cost are millions of dollars						Cost of Installed Canal Linings by Irrigated Region & Model Output Location			
Canal - Diversion	Irrigated Region	Peak Flow CFS	Canal Length (feet)	Canal Area (feet squared)	Lining Installation Cost	Teton Valley @ St. Anthony	Egin Bench @ Rexburg	Lower Watershed @ Rexburg	North Fremont @ Chester
Dewey	Egin Bench	49	37,440	575,310	$17.8		$ 17.8		
Egin	Egin Bench	439	99,406	2,322,910	$71.7		$ 71.7		
Independent	Egin Bench	522	138,266	3,192,504	$118.2		$ 118.2		
Last Chance	Egin Bench	136	116,785	1,518,516	$46.9		$ 46.9		
St. Anthony Union	Egin Bench	620	124,753	3,683,307	$136.4		$ 136.4		
St. Anthony Union Feeder	Egin Bench	261	68,233	1,418,121	$43.8		$ 43.8		
Canyon Creek	Lower Watershed	78	92,331	1,102,878	$34.0			$ 34.0	
Chester	Lower Watershed	128	26,900	358,820	$11.1			$ 11.1	
Consolidated Farmers	Lower Watershed	612	45,005	1,247,634	$46.2			$ 46.2	
Crosscut	Lower Watershed	322	32,783	1,019,048	$31.5			$ 31.5	
Curr	Lower Watershed	76	14,852	152,809	$4.7			$ 4.7	
East Teton	Lower Watershed	231	41,310	564,307	$17.4			$ 17.4	
Enterprise	Lower Watershed	168	109,154	2,083,604	$64.3			$ 64.3	
Fall River	Lower Watershed	435	132,479	2,549,180	$78.7			$ 78.7	
Farmers Friend	Lower Watershed	350	34,754	772,315	$23.8			$ 23.8	
Island Ward	Lower Watershed	127	71,538	877,205	$27.1			$ 27.1	
McBee	Lower Watershed	9	12,862	112,853	$3.5			$ 3.5	
Pincock-Byington	Lower Watershed	32	9,780	105,456	$3.3			$ 3.3	
Pioneer	Lower Watershed	37	8,666	104,520	$3.2			$ 3.2	
Rexburg (City of)	Lower Watershed	54	35,392	302,889	$9.3			$ 9.3	
Rexburg Irrigation	Lower Watershed	324	97,730	1,688,559	$52.1			$ 52.1	
Roxana	Lower Watershed	42	18,762	213,811	$6.6			$ 6.6	
Salem Union	Lower Watershed	339	69,697	1,453,631	$44.9			$ 44.9	
Salem Union B	Lower Watershed	38	6,570	100,868	$3.1			$ 3.1	
Saurey	Lower Watershed	65	9,860	104,799	$3.2			$ 3.2	
Silkey	Lower Watershed	42	28,211	298,089	$9.2			$ 9.2	
Stewart	Lower Watershed	47	6,705	75,430	$2.3			$ 2.3	
Teton Irrigation	Lower Watershed	166	43,959	837,517	$25.8			$ 25.8	
Teton Island Feeder	Lower Watershed	631	83,833	1,666,240	$61.7			$ 61.7	
Twin Groves	Lower Watershed	260	43,831	766,389	$23.7			$ 23.7	
Wilford	Lower Watershed	279	53,588	947,118	$29.2			$ 29.2	
Woodmansee-Johnson	Lower Watershed	39	39,022	441,773	$13.6			$ 13.6	
Farmers Own	North Fremont	112	105,173	1,267,461	$39.1				$ 39.1
Marysville	North Fremont	240	133,036	1,573,927	$48.6				$ 48.6
Yellowstone	North Fremont	38	29,796	320,950	$9.9				$ 9.9
Badger	Teton Valley	50	40,000	200,000	$6.2	$ 6.2			
Darby Cr.	Teton Valley	148	40,251	421,817	$13.0	$ 13.0			
Fox Cr.	Teton Valley	170	28,790	220,341	$6.8	$ 6.8			
N Leigh Cr.	Teton Valley	176	41,180	402,260	$12.4	$ 12.4			
S Leigh Cr.	Teton Valley	360	107,744	1,206,204	$37.2	$ 37.2			
Spring	Teton Valley	175	40,000	400,000	$12.3	$ 12.3			
Teton Cr.	Teton Valley	448	125,356	1,448,583	$44.7	$ 44.7			
Trail Cr.	Teton Valley	224	78,788	689,726	$21.3	$ 21.3			
Totals			2,524,568			$ 154.0	$ 434.7	$ 633.7	$ 97.6

5.4 Basin Needs

Recharge using the existing canals has different impacts to the Henrys Fork River basin needs depending upon the irrigated region where this practice is applied. Appendix D presents the impacts to basin needs for all conservation alternatives evaluated. The results for piping and lining of irrigation canals show:

- For the Teton Valley, Lower Watershed, and Egin Bench regions, piping and lining irrigation canals would reduce both total annual and non-peak flows and would have a relatively small impact, from a reduction of less than1 percent to an increase of less than 1 percent on peak flows. The reduction in total annual flows would have a negative impact on the Henrys Fork River basin’s water budget, and the reduction of non-peak flow would have both a negative impact on the Henrys Fork River basin’s water budget and negative environmental impacts.

- In the North Fremont region, piping and lining irrigation canals would increase total annual flows, peak flows, and non-peak flows. This would have positive benefits to both the Henrys Fork River basin’s water budget and positive environmental impacts.

5.5 Evaluation Criteria

5.5.1 Stakeholder Group Measureable Criteria

There are four Stakeholder Group Measurable Criteria.

1. Water Supply: For the Teton Valley, Lower Watershed, and Egin Bench irrigated regions, negative impact due to reduce annual, and non-peak flows. For the North Fremont irrigated region, positive impact due to increase annual and non-peak flows.
2. Water Rights: Water rights were not specifically addressed during this level of study, but known legal, institutional, and policy constraints are summarized in Section 2.3.
3. Environmental Considerations: For the Teton Valley, Lower Watershed, and Egin Bench irrigated regions, negative impact due to reduced non-peak flows. For the North Fremont irrigated region positive impact due to increased non-peak flows.

   Additionally, the installation of pipelines and canals is expected to reduce the number of irrigated induced wetlands within the Henrys Fork Basin, due to decreased canal seepage.
4. Economics: Installing pipelines and lining existing irrigation canals is very expensive. Estimated costs ranged from $97.6 million for lining of the North Fremont irrigated region to $953.8 million for installing pipelines in the Lower Watershed region.

5.5.2 Federal Viability Tests

There are four federal viability tests. The background to evaluate each of these is summarized in the sections above and in the body of the report. Only qualitative, high-level summaries are provided here and in Table 13:

1. Acceptability: To-be-determined (TBD)
2. Effectiveness: TBD
3. Completeness: TBD
4. Efficiency: TBD

6.0 DEMAND REDUCTION ALTERNATIVE

6.1 Alternative Description

The Demand Reduction Alternative evaluated the potential of reducing the number of irrigated acres. Other alternative demand reduction scenarios include changing from one crop type to another with lower irrigation requirements and partial or rotational fallowing systems. Reducing the number of irrigated acres in the demand reduction scenario allowed for both the most direct modeling and cost estimation.

The demand for water was reduced by setting diversions to ET demand and scaling back the irrigated area served by each of the canals. Reductions of irrigated acres were modeled for a 25 percent and 50 percent acreage reduction. Diversions were decreased by the model since ET demand is calculated by multiplying ET data by the irrigated area being served.

6.2 Model Output Hydrographs

An output summary of all conservation alternatives is presented as Appendix A and individual output hydrographs for all conservation alternatives is presented as Appendix B as follows. The output hydrographs in Appendix B applicable to the demand reduction alternative are shown in Table 10.

Table 10. Demand Reduction – Output Hydrographs in Appendix B.

Output Hydrograph	Description	Irrigated Region
B4	Demand Reduction – 25% Reduction	Teton Valley
B4	Demand Reduction – 50% Reduction	Teton Valley
B8	Demand Reduction – 25% Reduction	North Fremont
B8	Demand Reduction – 50% Reduction	North Fremont
B12	Demand Reduction – 25% Reduction	Lower Watershed
B12	Demand Reduction – 50% Reduction	Lower Watershed
B16	Demand Reduction – 25% Reduction	Egin Bench
B16	Demand Reduction – 50% Reduction	Egin Bench

6.3 Cost Estimate

Cost estimates for an acre of demand reduction were based on an evaluation prepared by WestWater Research. On August 28, 2008, the ESPA workgroup had a presentation by WestWater Research entitled *Appraisal Level Economic Analysis for the ESPA Comprehensive Aquifer Management Plan Demand Reduction Options.* WestWater Research developed a multiple regression model that estimated the average value per acre-foot (consumption) based on a "reach gain" zone. WestWater Research's defined "Zone 5" includes a portion of the Henry Fork River basin from the confluence of the Snake River to approximately St. Anthony which is considered representative of the basin. WestWater Research estimated that the average value per acre-foot (consumptive) in Zone 5 is $908. This estimate was based on the assumption of a uniform consumptive water use of 2 acre-feet per acre that is generally applicable within the Henrys Fork River basin (Reclamation 2012). This estimation yields a value of 2 (acre-feet per acre) times $908 (per acre-foot) which equals $1,816 (dollars per acre) for each acre of demand reduction. This estimated value for an acre of demand reduction is considered applicable throughout the Henrys Fork River basin. The estimated cost for the demand reduction alternative is shown in Table 11.

Table 11. Estimated cost for demand reduction. Costs are in millions of dollars.

Irrigated Region	Location of Model Output (USGS Gage Station)	Acres Served	Estimated Cost for 25% Demand Reduction	Estimated Cost for 50% Demand Reduction
Teton Valley	St. Anthony (Teton River)	52,820	$24.0	$48.0
North Fremont	Chester	32,500	$14.8	$29.5
Lower Watershed	Rexburg	73,000	$33.1	$66.3
Egin Bench	Rexburg	30,500	$13.9	$27.7

6.4 Basin Needs

Demand reduction has different impacts to the Henrys Fork River basin needs depending upon the irrigated region where this practice is applied. Appendix D presents the impacts to basin needs for all conservation alternatives evaluated. The results for demand reduction show:

- For the Teton Valley, North Fremont, Lower Watershed, and Egin Bench regions, demand reduction would increase total annual flows and peak period flows. This would have a positive impact on the Henrys Fork River basin's water budget.

- For the North Fremont and Egin Bench regions, demand reduction would increase non-peak period flows. This would have a positive impact on the Henrys Fork River basin's water budget and a positive environmental impact.

- For the Teton Valley and Lower Watershed regions, demand reduction would decrease non-peak period flows. The decrease of non-peak flows would be negative during periods of normally low flows. While the benefit to low flow would be relatively small (less than a 1.5 percent non-peak flow decrease), the absolute quantity of reduced non-peak flow may make a negative impact.

6.5 Evaluation Criteria

6.5.1 Stakeholder Group Measureable Criteria

There are four Stakeholder Group Measurable Criteria.

1. Water Supply: For the Teton Valley, North Fremont, Lower Watershed, and Egin Bench irrigated regions, positive impact due to increased annual flows.

2. Water Rights: Water rights were not specifically addressed during this level of study, but known legal, institutional, and policy constraints are summarized in Section 2.3.

3. Environmental Considerations: For the North Fremont and Egin Bench irrigated regions, positive impact due to increased non-peak flows. For the Teton Valley irrigated region, negative impact due to a decrease in non-peak flows. For the Lower Watershed with a 25-percent demand reduction, negative impact due to a decrease in non-peak flows. For the Lower Watershed with a 50-percent demand reduction, positive impact due to an increase in non-peak flows.

4. Economics: The estimated reconnaissance-level cost to implement this alternative is presented $1,860 per acre of demand reduction. Estimated costs by irrigated region range from $24.0 for a 25-percent demand reduction in the Teton Valley irrigated region to $66.0 million for a 50-percent demand reduction in the Lower Watershed region.

   Additionally, the reduction of irrigated acres in the Henrys Fork River basin would have further economic consequences beyond the consequences to the landowner involved in any transaction to reduce irrigated acreage. Within the basin, significant economic activity occurs that is directly dependent on providing services, support, and materials to irrigated areas, as well as the processing and transport of agricultural farm products. Also, a reduction in the irrigated acres served by canal systems may result in increased operation and maintenance costs for any remaining irrigated acreage served by that canal system.

6.5.2 Federal Viability Tests

There are four federal viability tests. The background to evaluate each of these is summarized in the sections above and in the body of the report. Only qualitative, high-level summaries are provided here and in Table 16:

5. Acceptability: To-be-determined (TBD)
6. Effectiveness: TBD
7. Completeness: TBD
8. Efficiency: TBD

7.0 DATA SOURCES

Bureau of Reclamation. 1967. *Lower Teton Division, Teton Basin Project, Idaho*. Department of the Interior, Bureau of Reclamation, Pacific Northwest Region, Boise, Idaho. July 1967.

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CH2MHill. 2012. *Henrys Fork Basin Study – Surface Storage Alternatives*. March 2012.

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APPENDICES

APPENDIX A

Summary Changes in Volumes of Conservation Alternatives

Evaluation of Conservation Alternatives in the Henrys Fork Basin

[1] The period from May 15 to July 15
[2] The period from July 16 to May 14

Alternative	Sub Alternative	Irrigated Region	Output USGS Gauging Station	Change in Annual Flow	Change in Peak Flow[1]	Change in non-Peak Flow[2]	Impacted Stream Reach of Concern	Annual Flow Impact	Peak Flow Impact	Non-Peak Flow Impact	Appendix Hydrograph	Estimated Cost Millions
				|---------- Acre Feet ----------|				| --------Percent Change ------|				
Canal Automation	Model matches ET	Teton Valley	South Leigh	(195)	5,388	(5,583)	Teton Valley Tributaries	0%	5%	-3%	B1-4	0.4
Demand Reduction	25% Reduction	Teton Valley	South Leigh	7,613	11,188	(3,576)	Teton Valley Tributaries	3%	11%	-2%	B1-8	14.3
Demand Reduction	50% Reduction	Teton Valley	South Leigh	16,531	17,633	(1,102)	Teton Valley Tributaries	6%	17%	-1%	B1-8	28.6
Lining Reduce Canal Seepage	75%	Teton Valley	South Leigh	(19,909)	2,011	(21,920)	Teton Valley Tributaries	-7%	2%	-13%	B1-6	85.8
Pipeline Reduce Canal Seepage	100%	Teton Valley	South Leigh	(28,512)	531	(29,043)	Teton Valley Tributaries	-10%	1%	-17%	B1-6	243.5
Recharge Using Existing Canals	20% Increase	Teton Valley	South Leigh	(2,305)	(4,310)	2,006	Teton Valley Tributaries	-1%	-4%	1%	B1-2	-
Recharge Using Existing Canals	40% Increase	Teton Valley	South Leigh	(3,985)	(8,013)	4,029	Teton Valley Tributaries	-1%	-8%	2%	B1-2	-
Canal Automation	Model matches ET	Teton Valley	St. Anthony	637	7,689	(7,051)	Teton Valley Tributaries	0%	3%	-2%	B1-3	0.8
Demand Reduction	25% Reduction	Teton Valley	St. Anthony	11,829	16,122	(4,294)	Teton Valley Tributaries	2%	6%	-1%	B1-7	24.0
Demand Reduction	50% Reduction	Teton Valley	St. Anthony	24,480	25,426	(947)	Teton Valley Tributaries	4%	10%	0%	B1-7	48.0
Lining Reduce Canal Seepage	75%	Teton Valley	St. Anthony	(23,337)	3,592	(26,929)	Teton Valley Tributaries	-4%	1%	-7%	B1-5	154.0
Pipeline Reduce Canal Seepage	100%	Teton Valley	St. Anthony	(34,146)	1,731	(35,876)	Teton Valley Tributaries	-5%	1%	-10%	B1-5	418.8
Recharge Using Existing Canals	20% Increase	Teton Valley	St. Anthony	(5,278)	(6,816)	1,538	Teton Valley Tributaries	-1%	-3%	0%	B1-1	-
Recharge Using Existing Canals	40% Increase	Teton Valley	St. Anthony	(8,865)	(12,338)	3,473	Teton Valley Tributaries	-1%	-5%	1%	B1-1	-
Canal Automation	Model matches ET	North Fremont	Chester	6,009	1,376	4,633	Lower Fall River	1%	1%	1%	B1-12	0.2
Demand Reduction	25% Reduction	North Fremont	Chester	6,273	1,503	4,770	Lower Fall River	1%	1%	1%	B1-18	14.8
Demand Reduction	50% Reduction	North Fremont	Chester	7,082	1,883	5,199	Lower Fall River	1%	1%	2%	B1-18	29.5
Lining Reduce Canal Seepage	75%	North Fremont	Chester	5,716	1,800	3,916	Lower Fall River	1%	1%	1%	B1-15	97.6
Pipeline Reduce Canal Seepage	100%	North Fremont	Chester	11,405	3,588	7,817	Lower Fall River	2%	2%	2%	B1-15	167.1
Recharge Using Existing Canals	20% Increase	North Fremont	Chester	(8,102)	(2,964)	(5,138)	Lower Fall River	-1%	-1%	-2%	B1-9	-
Recharge Using Existing Canals	40% Increase	North Fremont	Chester	(15,066)	(5,342)	(9,724)	Lower Fall River	-3%	-3%	-3%	B1-9	-

Evaluation of Conservation Alternatives in the Henrys Fork Basin

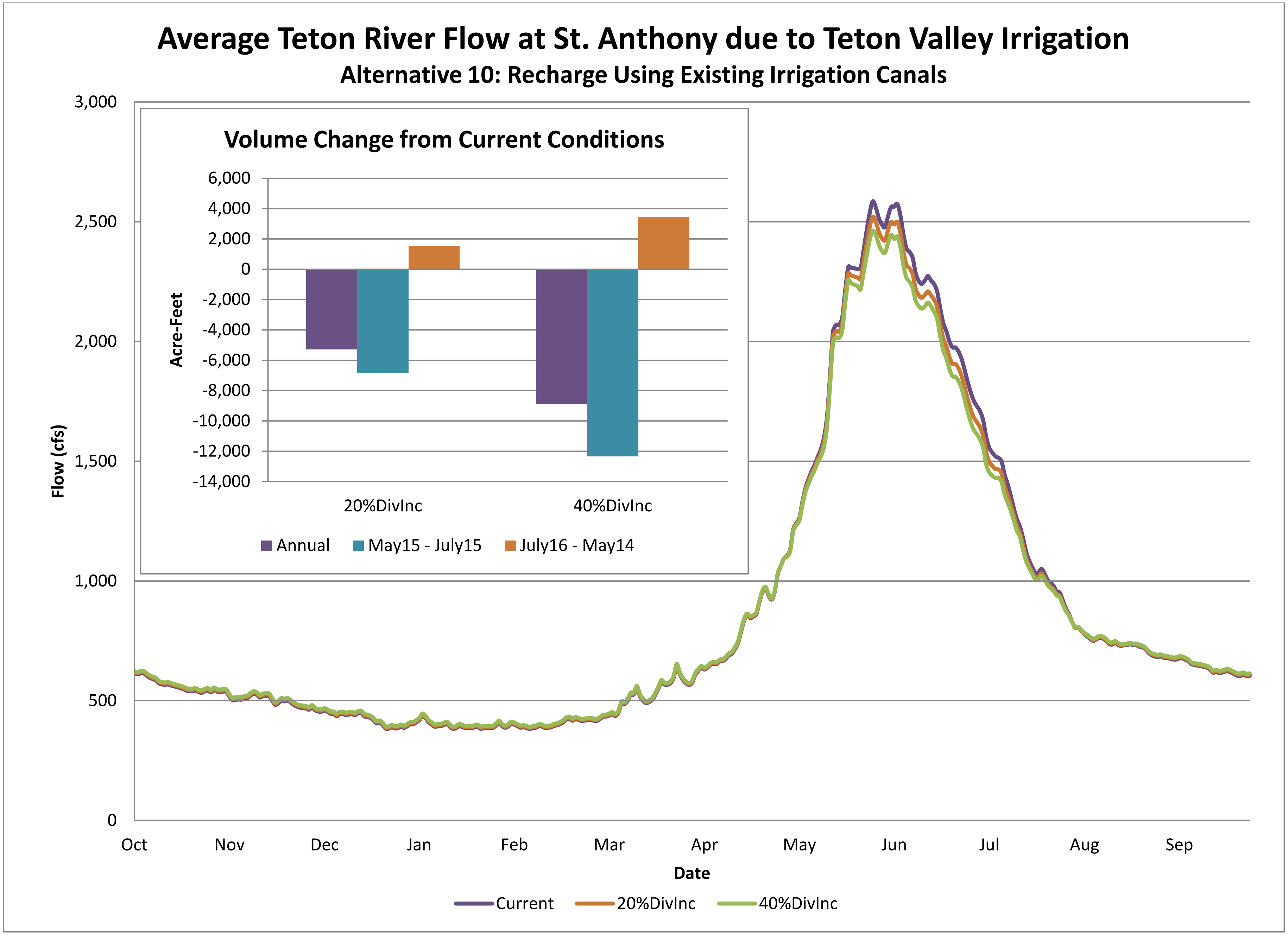
[1] The period from May 15 to July 15

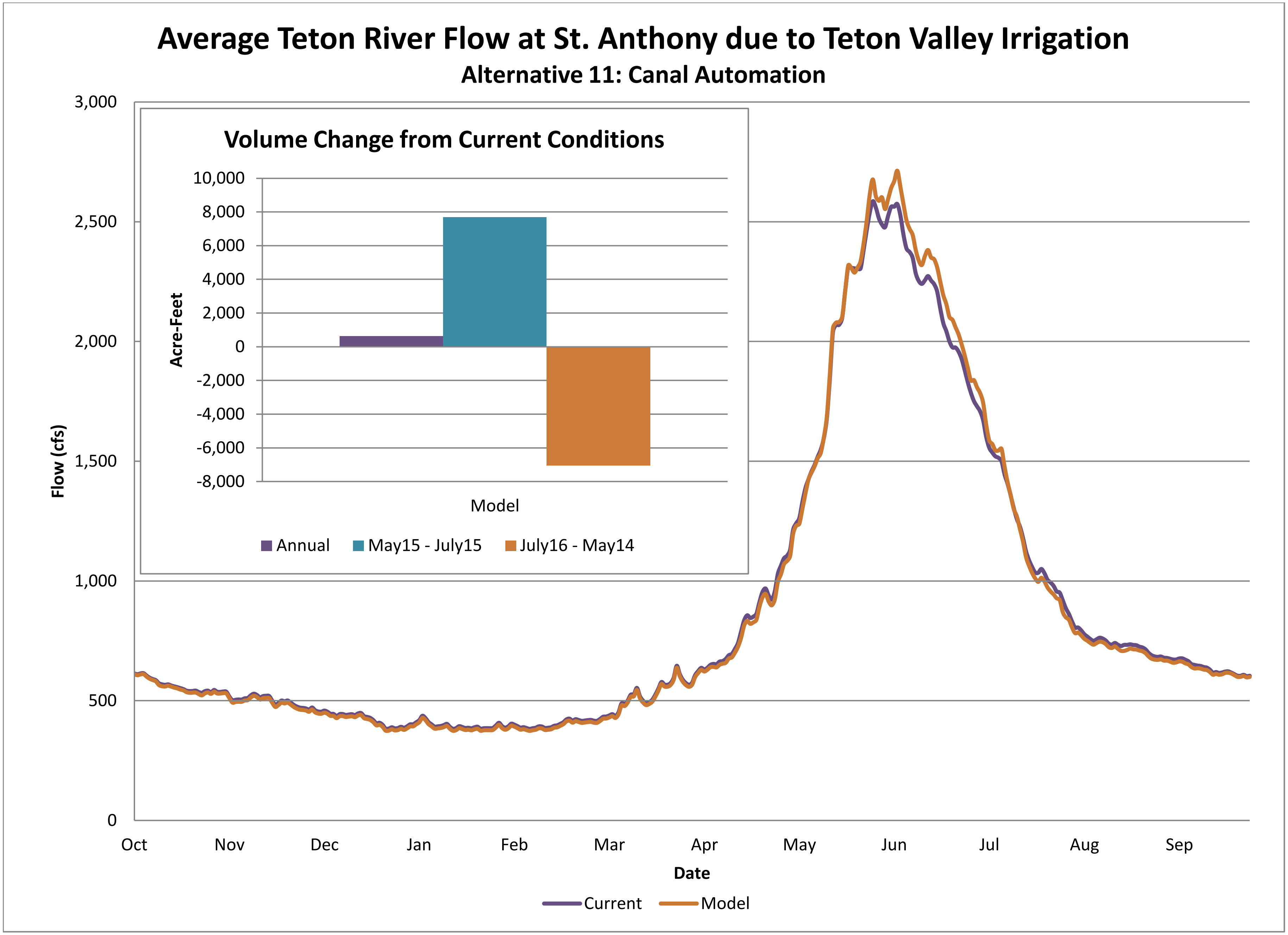
[2] The period from July 16 to May 14

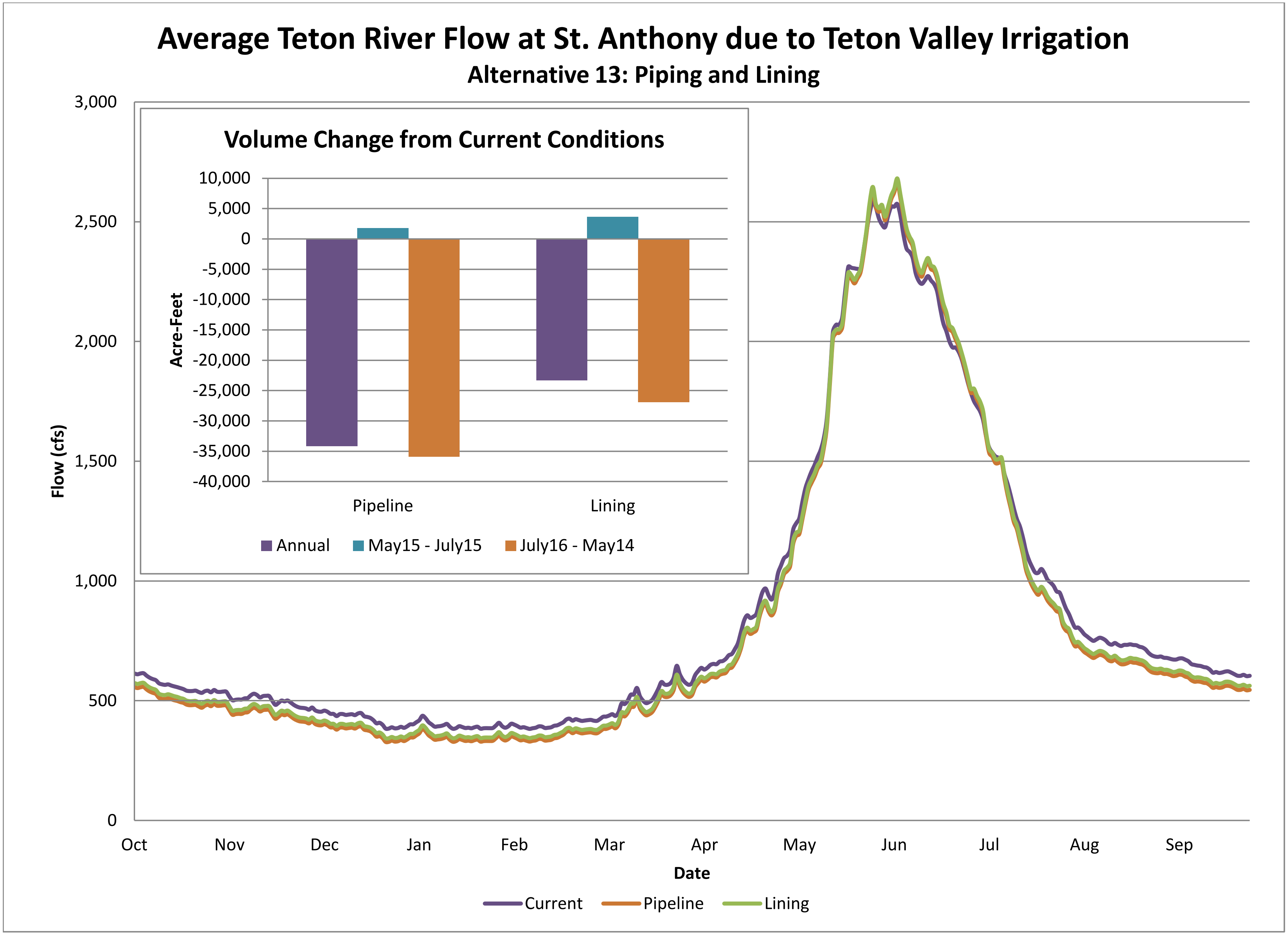
Alternative	Sub Alternative	Irrigated Region	Output USGS Gauging Station	Change in Annual Flow (Acre Feet)	Change in Peak Flow[1] (Acre Feet)	Change in non-Peak Flow[2] (Acre Feet)	Impacted Stream Reach of Concern	Annual Flow Impact (Percent Change)	Peak Flow Impact (Percent Change)	Non-Peak Flow Impact (Percent Change)	Appendix Hydrograph	Estimated Cost Millions
Canal Automation	Model matches ET	Lower Watershed	Rexburg	49,153	80,073	(30,920)	Lower Teton N&S Forks	5%	16%	-3%	B1-14	2.3
Demand Reduction	25% Reduction	Lower Watershed	Rexburg	80,137	92,965	(12,828)	Lower Teton N&S Forks	0%	19%	-1%	B1-20	33.1
Demand Reduction	50% Reduction	Lower Watershed	Rexburg	112,494	106,193	6,300	Lower Teton N&S Forks	-3%	21%	1%	B1-20	66.3
Lining Reduce Canal Seepage	75%	Lower Watershed	Rexburg	(48,506)	(1,873)	(46,633)	Lower Teton N&S Forks	0%	0%	-4%	B1-17	633.7
Pipeline Reduce Canal Seepage	100%	Lower Watershed	Rexburg	(56,315)	3,221	(59,537)	Lower Teton N&S Forks	-2%	1%	-5%	B1-17	953.8
Recharge Using Existing Canals	20% Increase	Lower Watershed	Rexburg	(30,286)	(33,224)	2,938	Lower Teton N&S Forks	0%	-7%	0%	B1-11	-
Recharge Using Existing Canals	40% Increase	Lower Watershed	Rexburg	(55,402)	(62,513)	7,110	Lower Teton N&S Forks	1%	-12%	1%	B1-11	-
Canal Automation	Model matches ET	Egin Bench	Rexburg	23,639	28,524	(4,885)	Lower Teton N&S Forks	1%	6%	0%	B1-13	0.9
Demand Reduction	25% Reduction	Egin Bench	Rexburg	51,116	35,592	15,523	Lower Teton N&S Forks	3%	7%	1%	B1-19	13.8
Demand Reduction	50% Reduction	Egin Bench	Rexburg	79,687	42,879	36,808	Lower Teton N&S Forks	5%	9%	3%	B1-19	27.7
Lining Reduce Canal Seepage	75%	Egin Bench	Rexburg	(36,741)	(2,695)	(34,046)	Lower Teton N&S Forks	-2%	-1%	-3%	B1-16	434.7
Pipeline Reduce Canal Seepage	100%	Egin Bench	Rexburg	(41,764)	210	(41,974)	Lower Teton N&S Forks	-3%	0%	-4%	B1-16	626.4
Recharge Using Existing Canals	20% Increase	Egin Bench	Rexburg	(17,644)	(14,795)	(2,849)	Lower Teton N&S Forks	-1%	-3%	0%	B1-10	-
Recharge Using Existing Canals	40% Increase	Egin Bench	Rexburg	(30,395)	(26,888)	(3,507)	Lower Teton N&S Forks	-2%	-5%	0%	B1-10	-

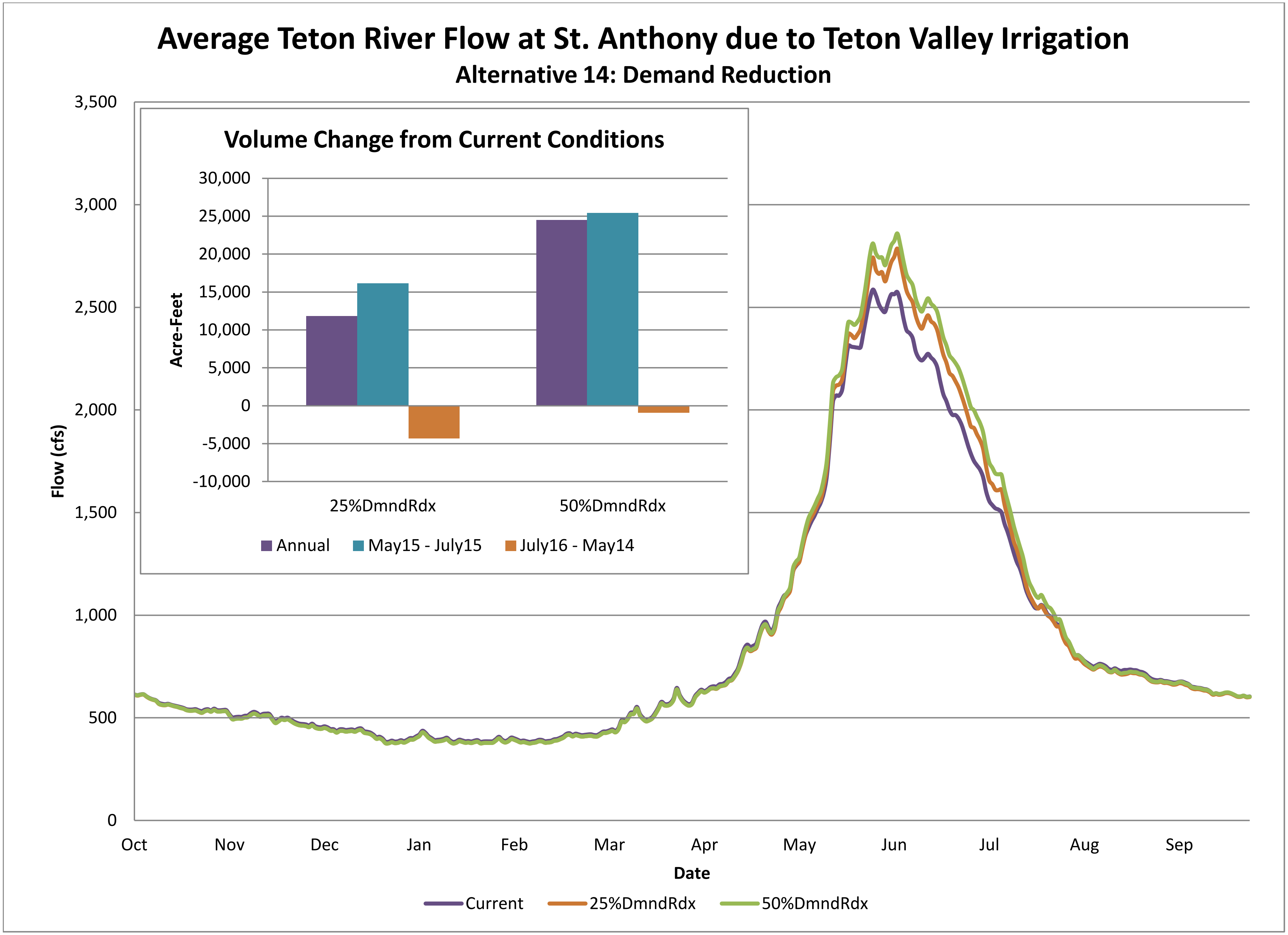
APPENDIX B

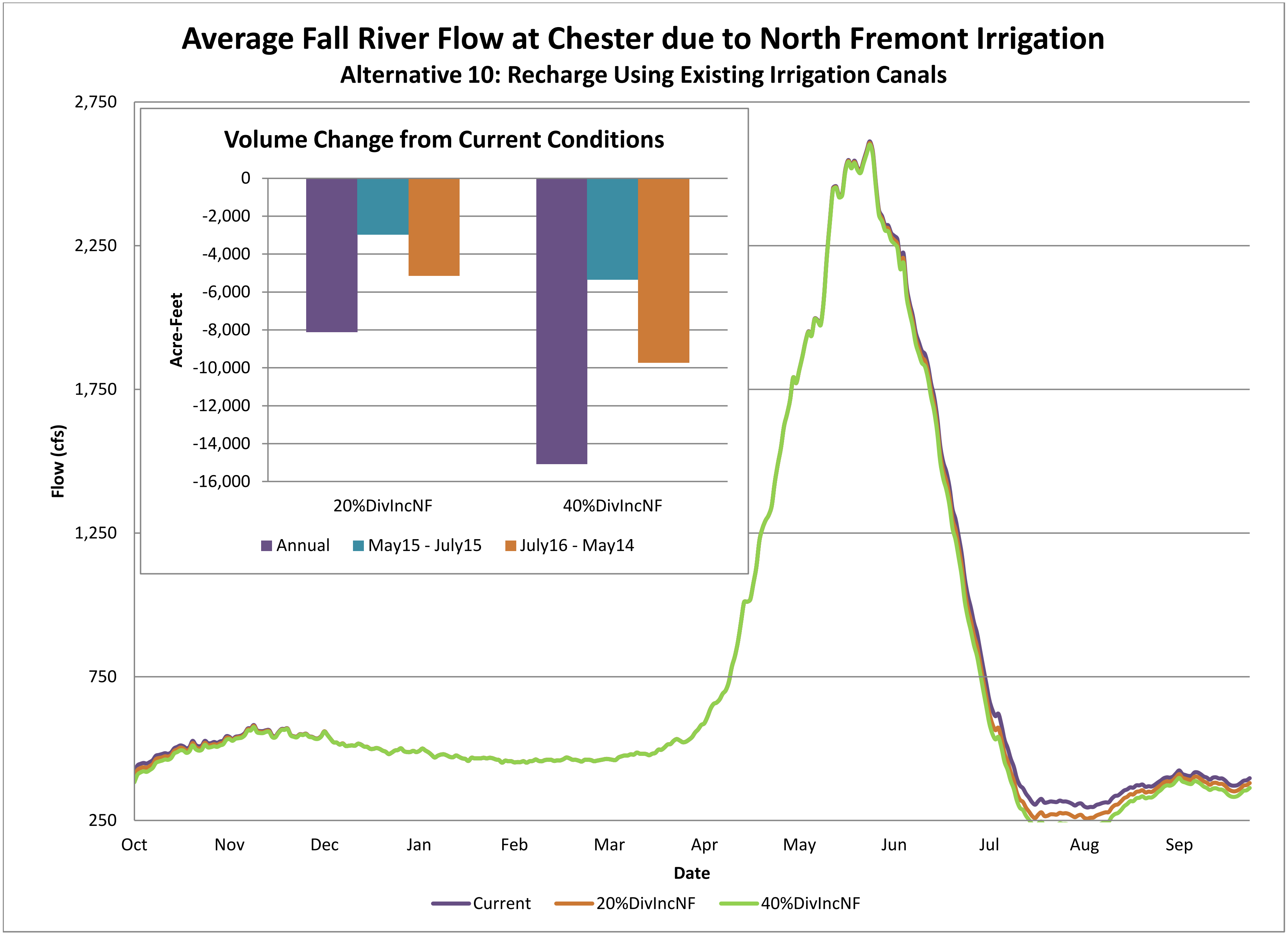
Output Hydrographs for the Conservation Alternatives

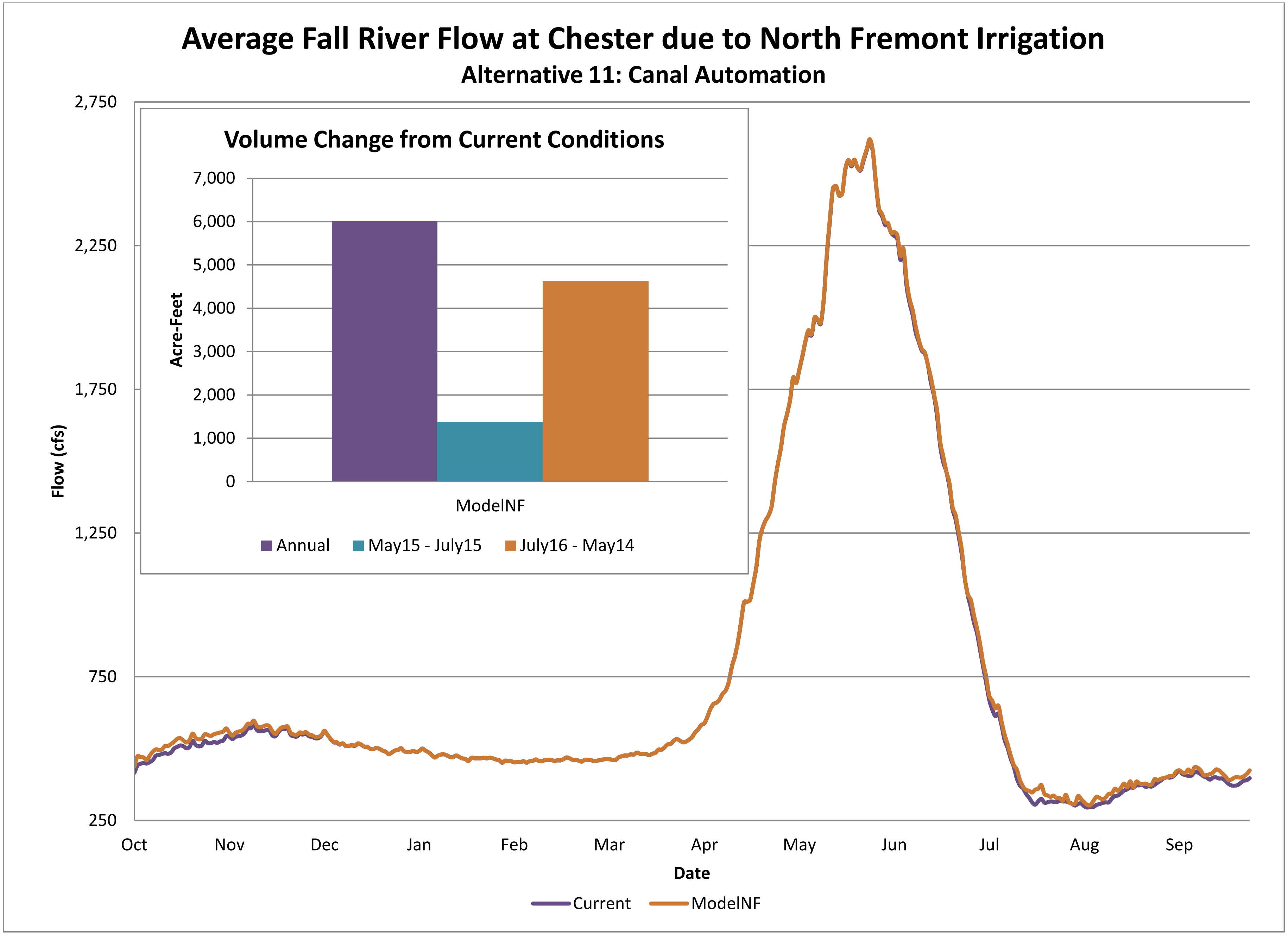

Average Teton River Flow at St. Anthony due to Teton Valley Irrigation
Alternative 10: Recharge Using Existing Irrigation Canals
Volume Change from Current Conditions
Acre-Feet
6,000
4,000
2,000
0
-2,000
-4,000
-6,000
-8,000
-10,000
-12,000
-14,000
20%DivInc
40%DivInc
Annual
May15 - July15
July16 - May14
Flow (cfs)
3,000
2,500
2,000
1,500
1,000
500
0
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Date
Current
20%DivInc
40%DivInc

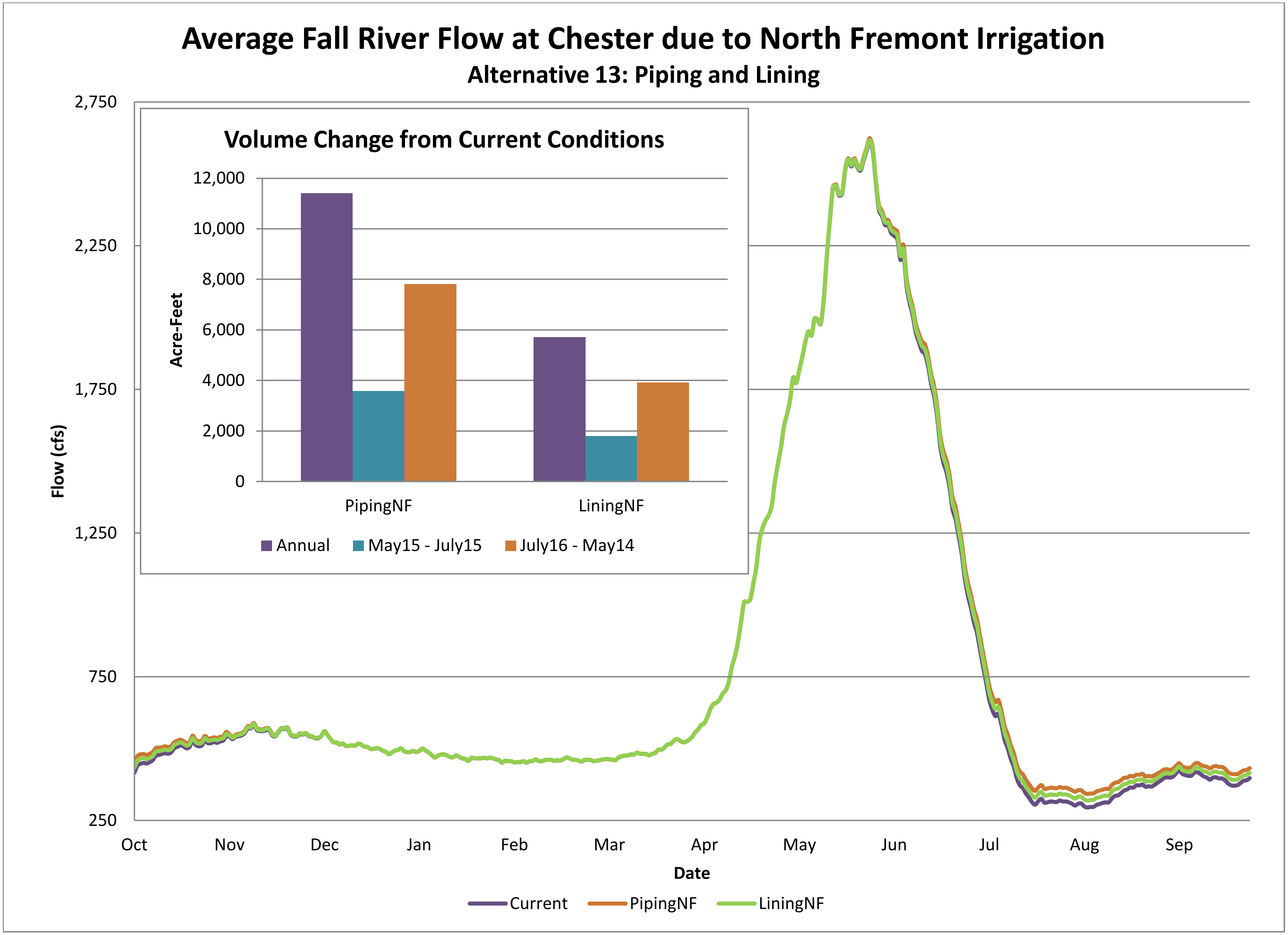

Average Teton River Flow at St. Anthony due to Teton Valley Irrigation
Alternative 11: Canal Automation
Volume Change from Current Conditions
10,000
8,000
6,000
4,000
2,000
0
-2,000
-4,000
-6,000
-8,000
Acre-Feet
Model
Annual
May15 - July15
July16 - May14
3,000
2,500
2,000
1,500
1,000
500
0
Flow (cfs)
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Date
Current
Model

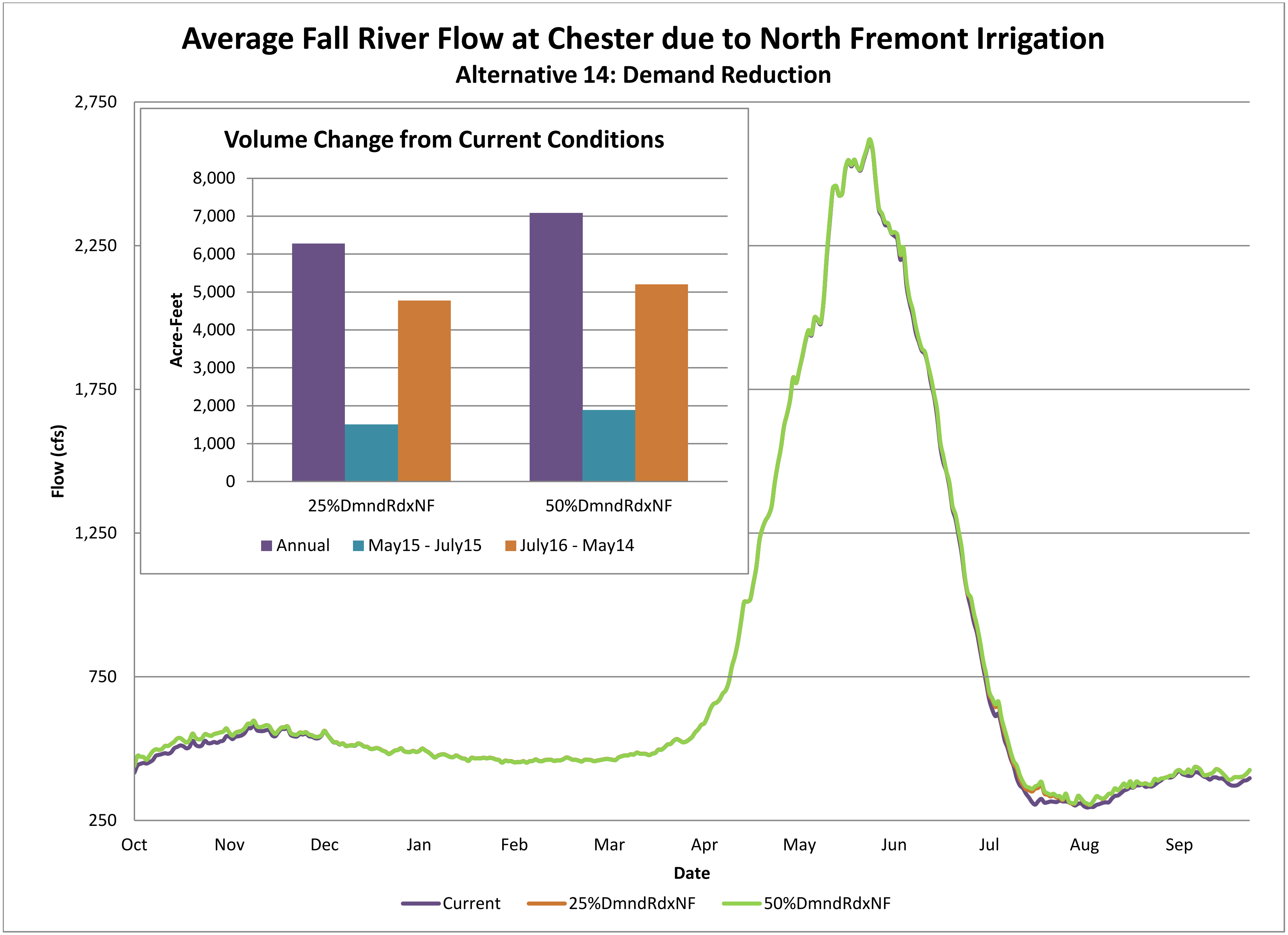

Average Teton River Flow at St. Anthony due to Teton Valley Irrigation
Alternative 13: Piping and Lining
Volume Change from Current Conditions
10,000
5,000
0
-5,000
-10,000
-15,000
-20,000
-25,000
-30,000
-35,000
-40,000
Acre-Feet
Pipeline
Lining
Annual
May15 - July15
July16 - May14
3,000
2,500
2,000
1,500
1,000
500
0
Flow (cfs)
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Date
Current
Pipeline
Lining


Average Teton River Flow at St. Anthony due to Teton Valley Irrigation
Alternative 14: Demand Reduction
Volume Change from Current Conditions
Acre-Feet
30,000
25,000
20,000
15,000
10,000
5,000
0
-5,000
-10,000
25%DmndRdx
50%DmndRdx
Annual
May15 - July15
July16 - May14
Flow (cfs)
3,500
3,000
2,500
2,000
1,500
1,000
500
0
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Date
Current
25%DmndRdx
50%DmndRdx

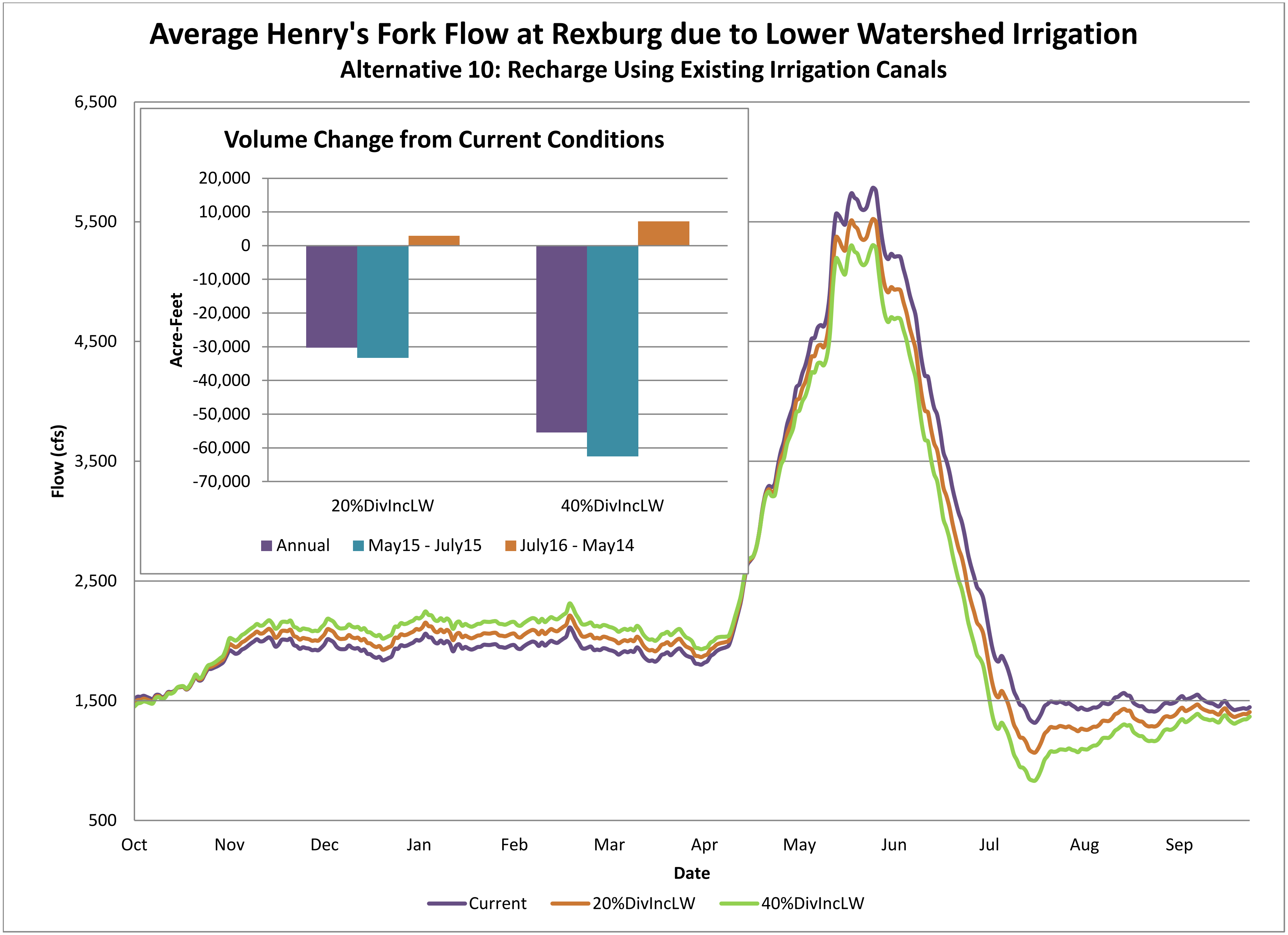

Average Fall River Flow at Chester due to North Fremont Irrigation
Alternative 10: Recharge Using Existing Irrigation Canals
Volume Change from Current Conditions
0
-2,000
-4,000
-6,000
-8,000
-10,000
-12,000
-14,000
-16,000
Acre-Feet
20%DivIncNF
40%DivIncNF
Annual
May15 - July15
July16 - May14
2,750
2,250
1,750
1,250
750
250
Flow (cfs)
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Date
Current
20%DivIncNF
40%DivIncNF

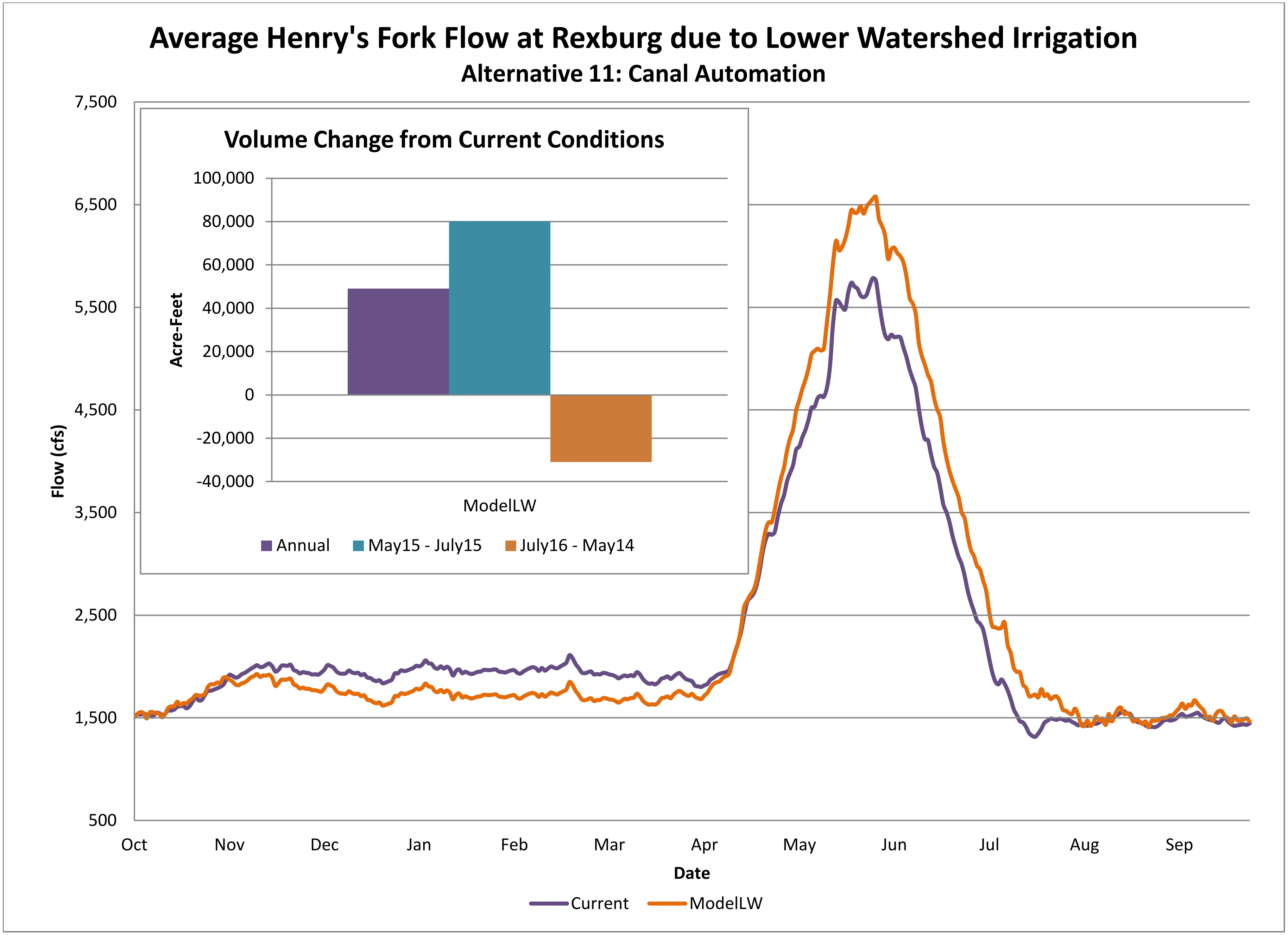

Average Fall River Flow at Chester due to North Fremont Irrigation
Alternative 11: Canal Automation
Volume Change from Current Conditions
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
Acre-Feet
ModelNF
Annual
May15 - July15
July16 - May14
2,750
2,250
1,750
1,250
750
250
Flow (cfs)
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Date
Current
ModelNF


Average Fall River Flow at Chester due to North Fremont Irrigation
Alternative 13: Piping and Lining
Volume Change from Current Conditions
12,000
10,000
8,000
6,000
4,000
2,000
0
Acre-Feet
PipingNF
LiningNF
Annual
May15 - July15
July16 - May14
2,750
2,250
1,750
1,250
750
250
Flow (cfs)
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Date
Current
PipingNF
LiningNF

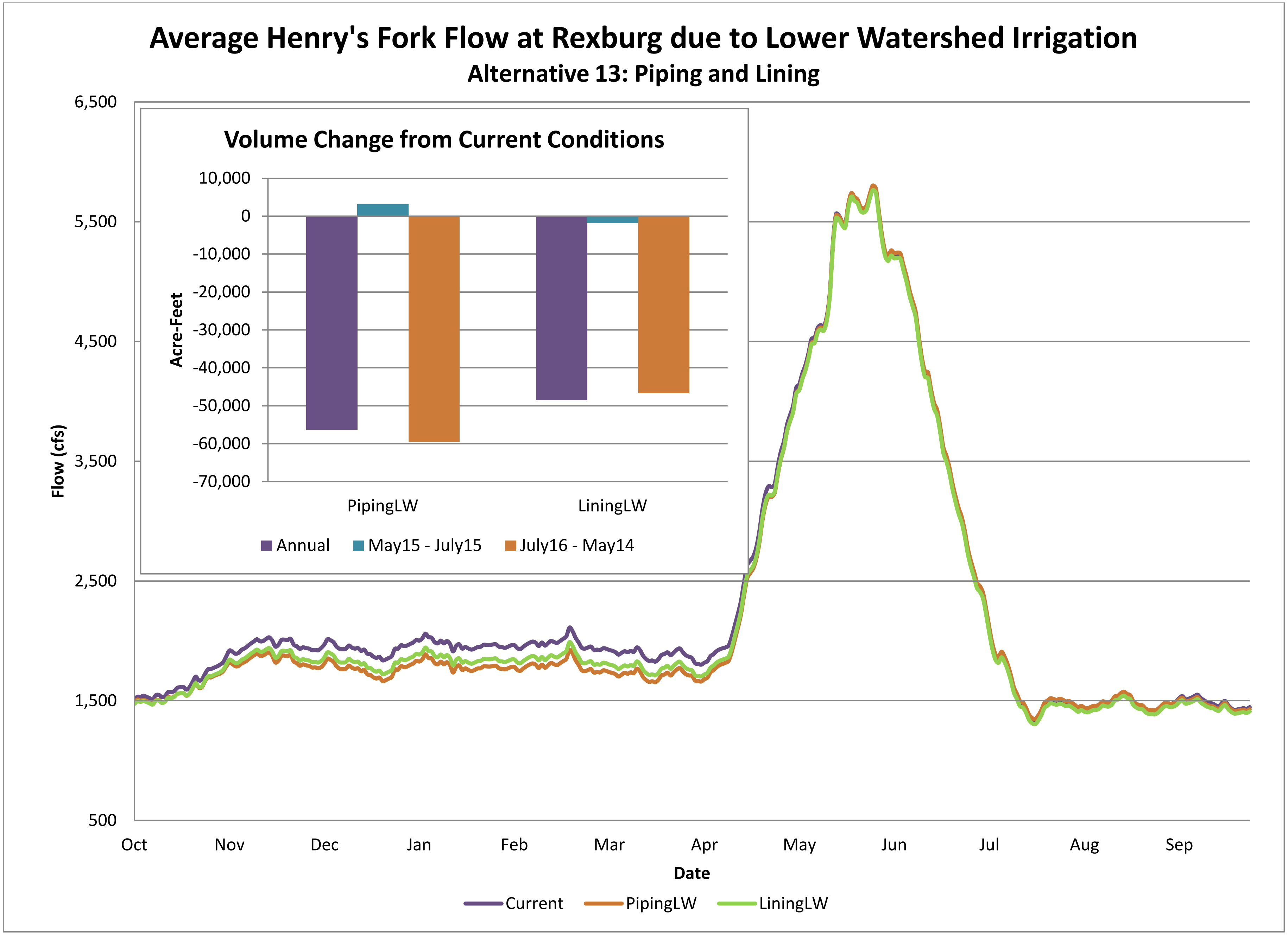


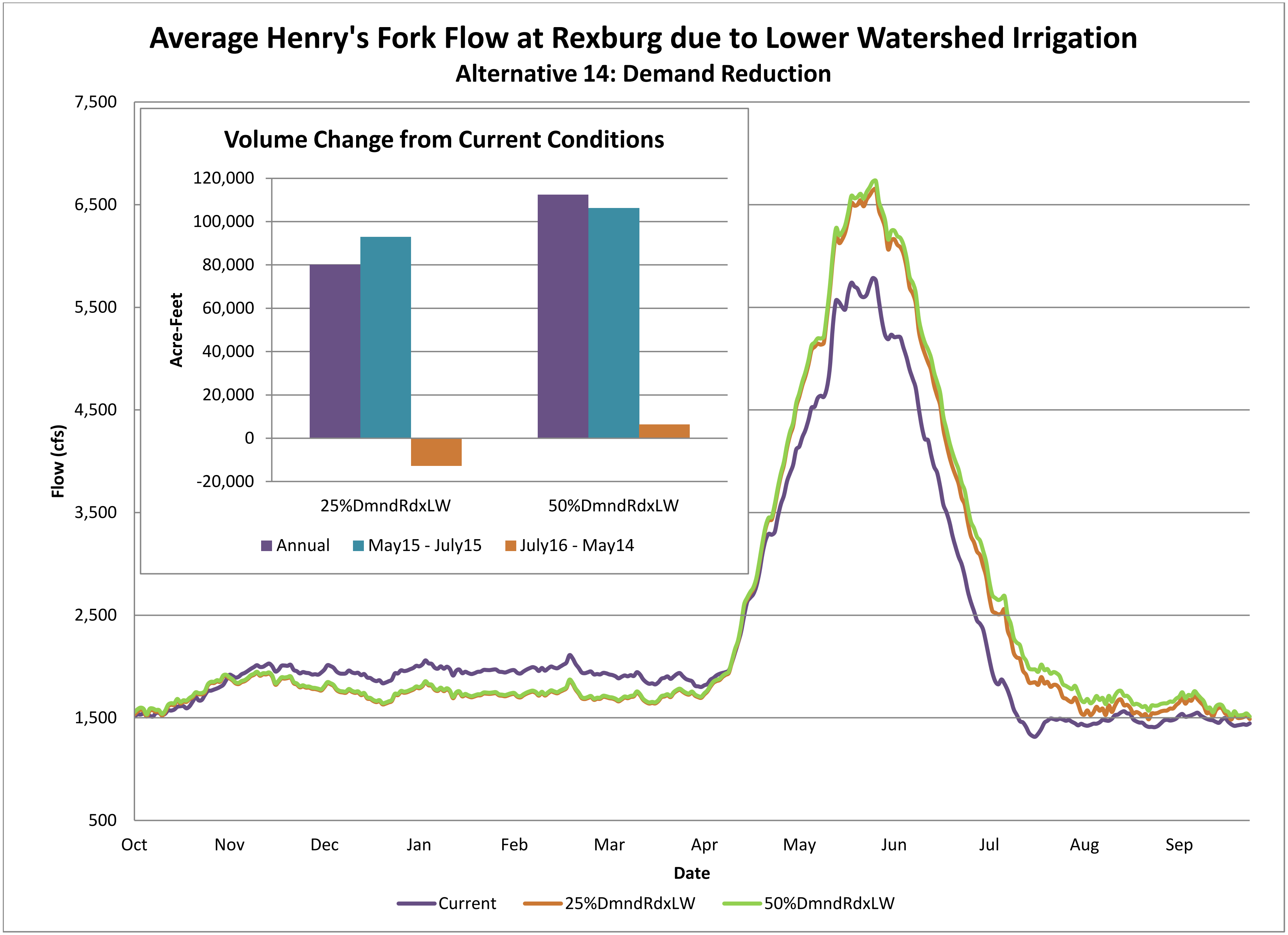
Average Fall River Flow at Chester due to North Fremont Irrigation
Alternative 14: Demand Reduction
Volume Change from Current Conditions
Acre-Feet
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
25%DmndRdxNF
50%DmndRdxNF
Annual
May15 - July15
July16 - May14
Flow (cfs)
2,750
2,250
1,750
1,250
750
250
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Date
Current
25%DmndRdxNF
50%DmndRdxNF

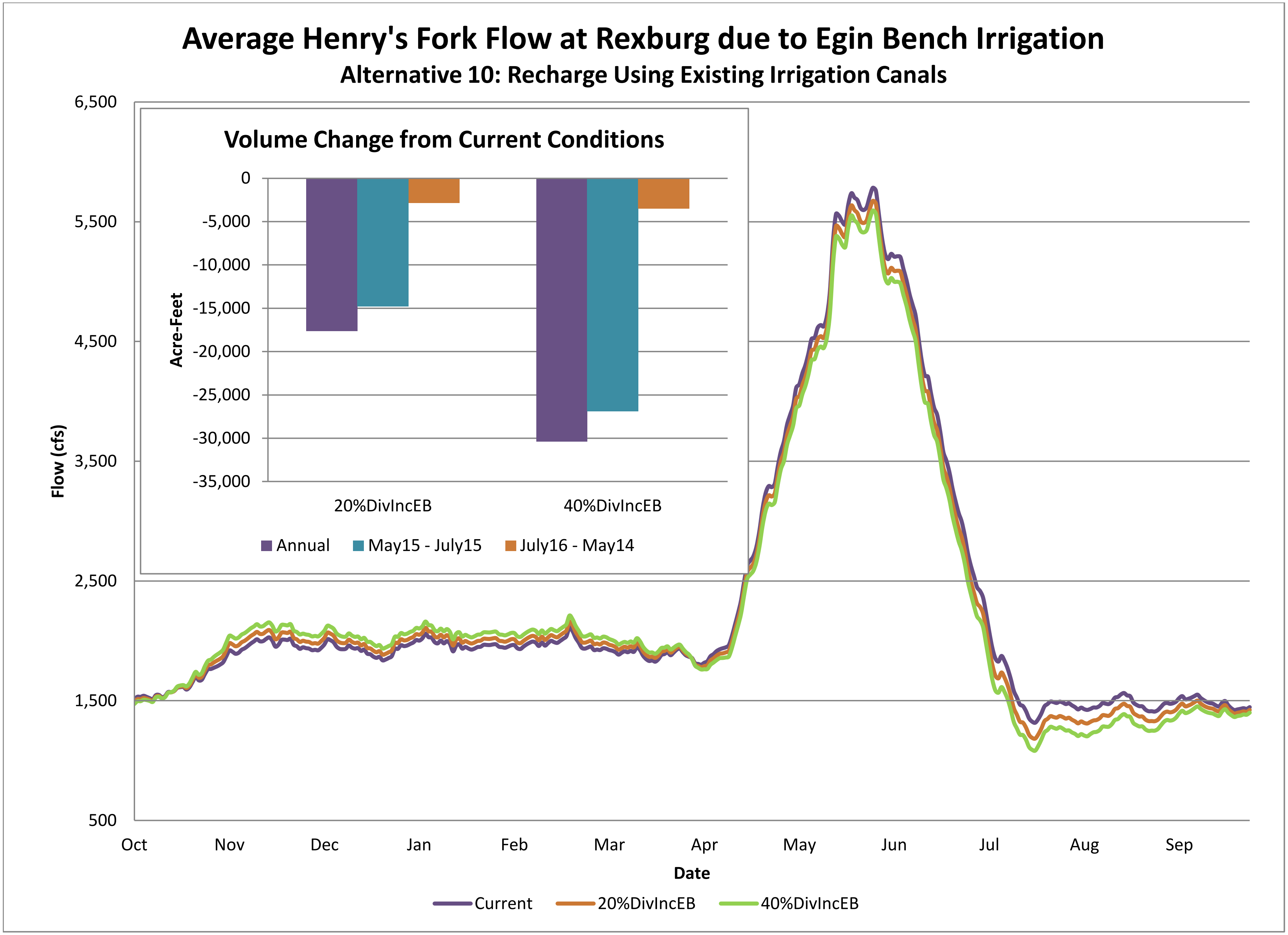

Average Henry's Fork Flow at Rexburg due to Lower Watershed Irrigation
Alternative 10: Recharge Using Existing Irrigation Canals
Volume Change from Current Conditions
20,000
10,000
0
-10,000
-20,000
-30,000
-40,000
-50,000
-60,000
-70,000
Acre-Feet
20%DivIncLW
40%DivIncLW
Annual
May15 - July15
July16 - May14
6,500
5,500
4,500
3,500
2,500
1,500
500
Flow (cfs)
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Date
Current
20%DivIncLW
40%DivIncLW



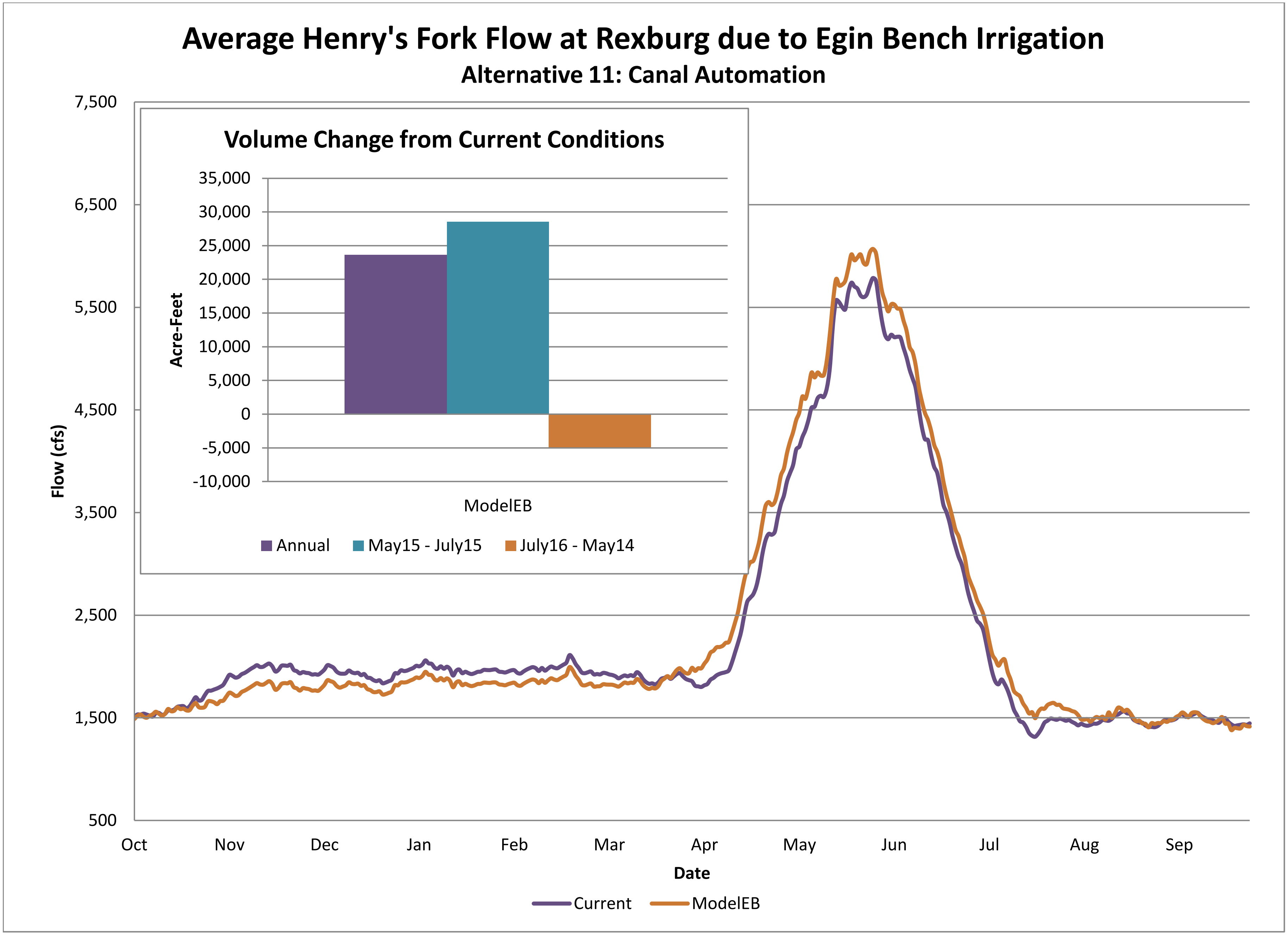
Average Henry's Fork Flow at Rexburg due to Lower Watershed Irrigation
Alternative 11: Canal Automation
Volume Change from Current Conditions
100,000
80,000
60,000
40,000
20,000
0
-20,000
-40,000
Acre-Feet
ModelLW
Annual
May15 - July15
July16 - May14
7,500
6,500
5,500
4,500
3,500
2,500
1,500
500
Flow (cfs)
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Date
Current
ModelLW

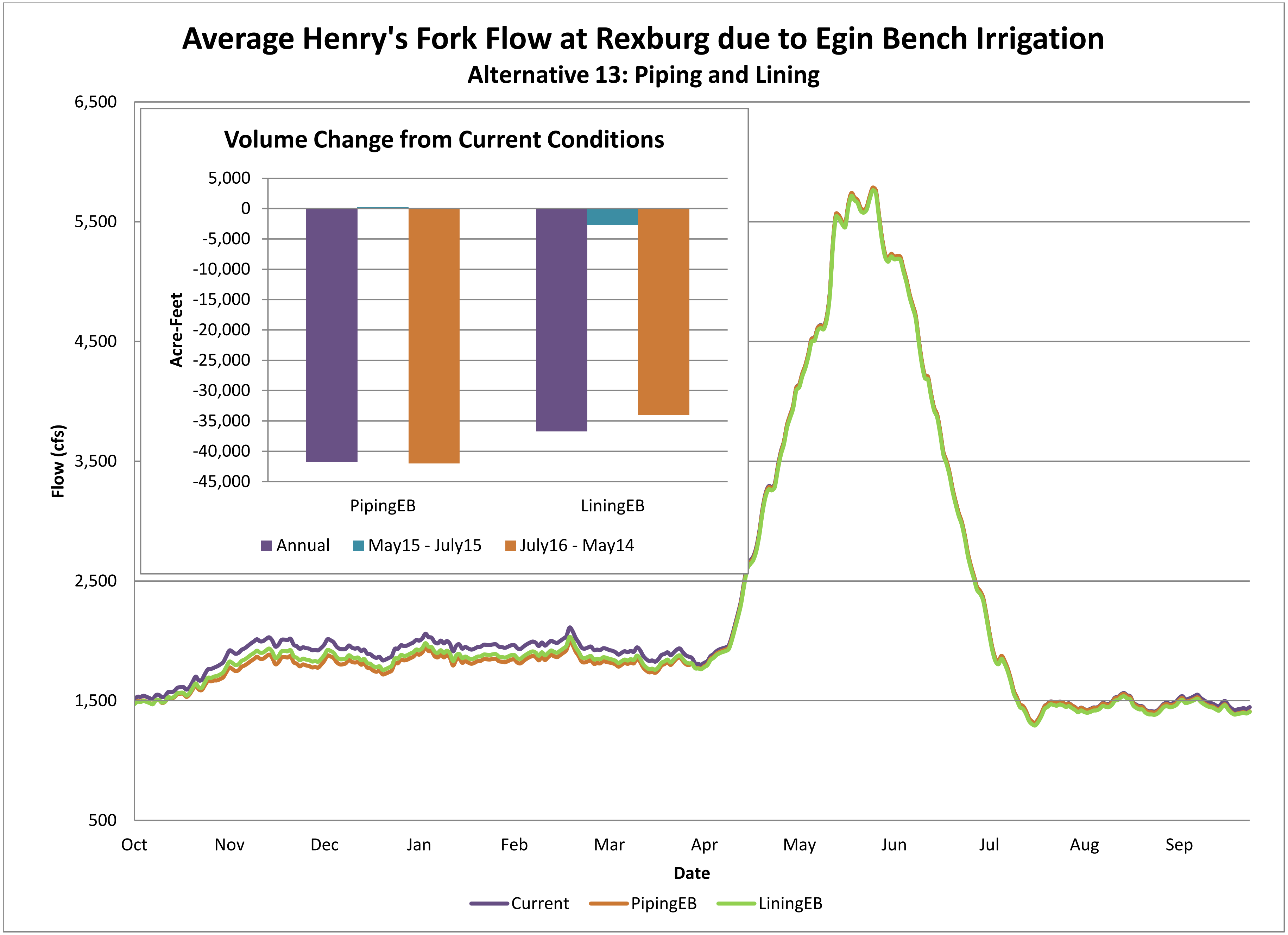

Average Henry's Fork Flow at Rexburg due to Lower Watershed Irrigation
Alternative 13: Piping and Lining
Flow (cfs)
6,500
5,500
4,500
3,500
2,500
1,500
500
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Date
Current
PipingLW
LiningLW
Volume Change from Current Conditions
Acre-Feet
10,000
0
-10,000
-20,000
-30,000
-40,000
-50,000
-60,000
-70,000
PipingLW
LiningLW
Annual
May15 - July15
July16 - May14

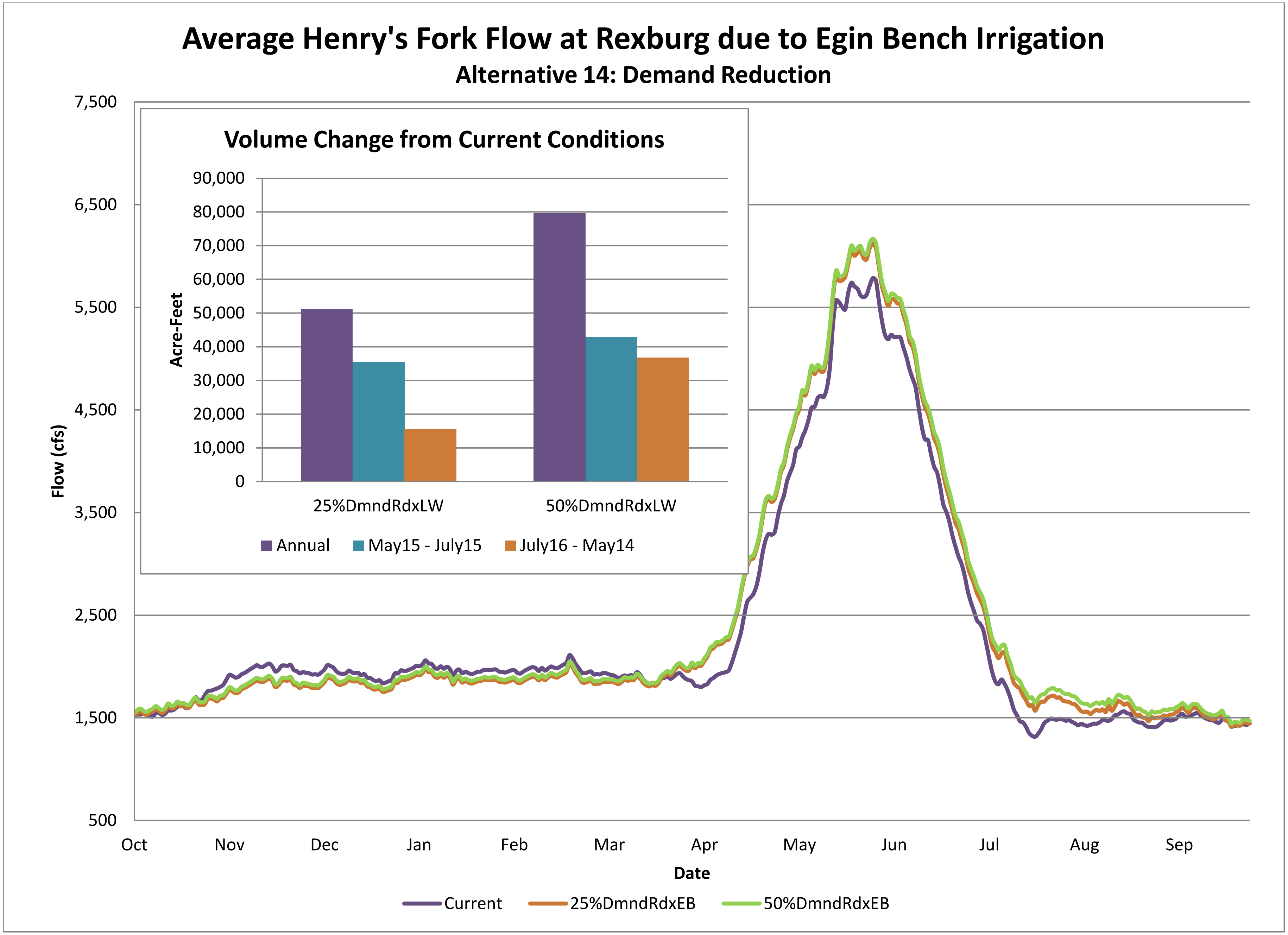

Average Henry's Fork Flow at Rexburg due to Lower Watershed Irrigation
Alternative 14: Demand Reduction
Volume Change from Current Conditions
Acre-Feet
120,000
100,000
80,000
60,000
40,000
20,000
0
-20,000
25%DmndRdxLW
50%DmndRdxLW
Annual
May15 - July15
July16 - May14
Flow (cfs)
7,500
6,500
5,500
4,500
3,500
2,500
1,500
500
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Date
Current
25%DmndRdxLW
50%DmndRdxLW



Average Henry's Fork Flow at Rexburg due to Egin Bench Irrigation
Alternative 10: Recharge Using Existing Irrigation Canals
Flow (cfs)
6,500
5,500
4,500
3,500
2,500
1,500
500
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Date
Current
20%DivIncEB
40%DivIncEB
Volume Change from Current Conditions
Acre-Feet
0
-5,000
-10,000
-15,000
-20,000
-25,000
-30,000
-35,000
20%DivIncEB
40%DivIncEB
Annual
May15 - July15
July16 - May14


Average Henry's Fork Flow at Rexburg due to Egin Bench Irrigation
Alternative 11: Canal Automation
Volume Change from Current Conditions
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
-5,000
-10,000
Acre-Feet
ModelEB
Annual
May15 - July15
July16 - May14
7,500
6,500
5,500
4,500
3,500
2,500
1,500
500
Flow (cfs)
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Date
Current
ModelEB

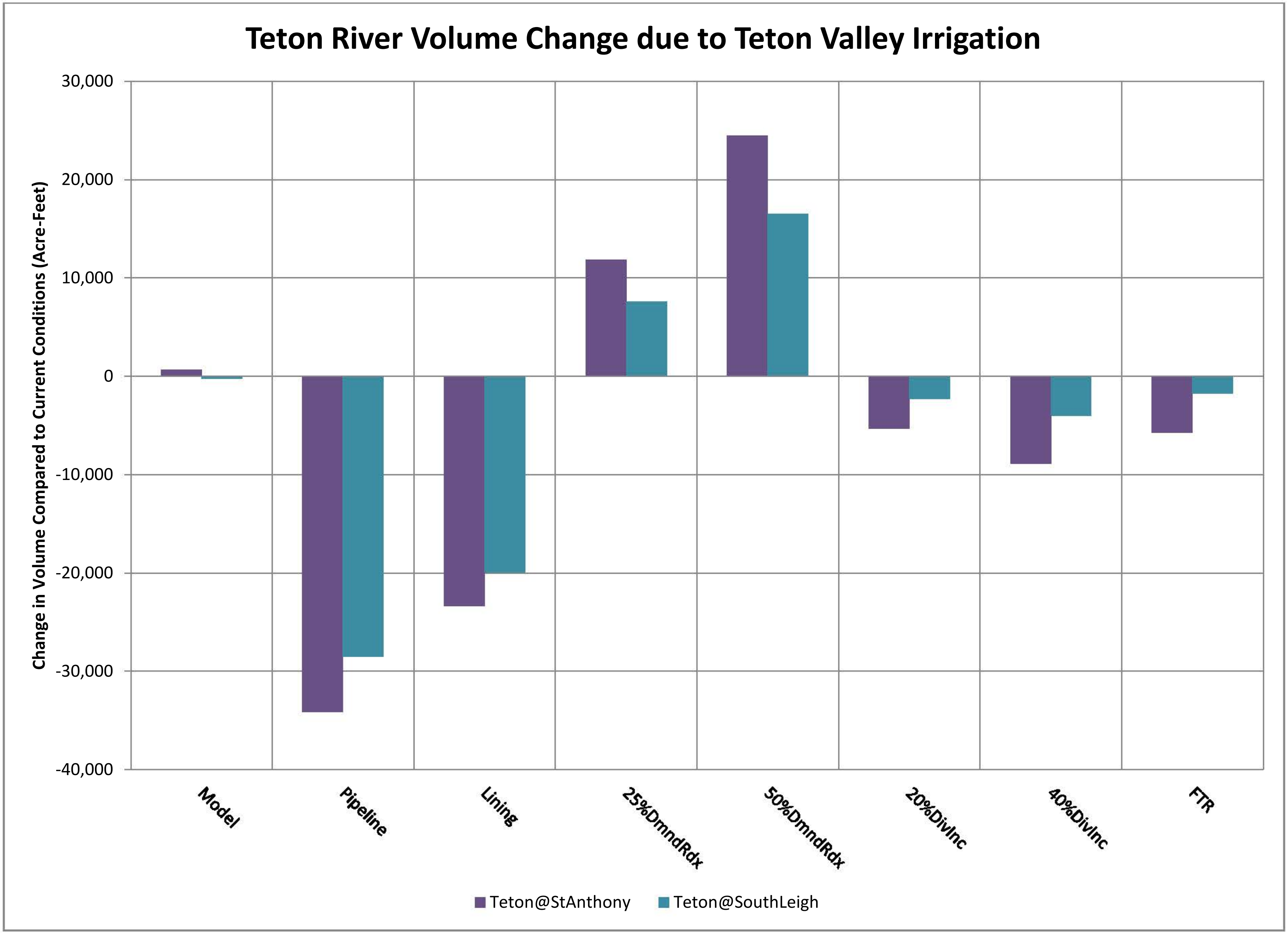

Average Henry's Fork Flow at Rexburg due to Egin Bench Irrigation
Alternative 13: Piping and Lining
Flow (cfs)
6,500
5,500
4,500
3,500
2,500
1,500
500
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Date
Current
PipingEB
LiningEB
Volume Change from Current Conditions
Acre-Feet
5,000
0
-5,000
-10,000
-15,000
-20,000
-25,000
-30,000
-35,000
-40,000
-45,000
PipingEB
LiningEB
Annual
May15 - July15
July16 - May14

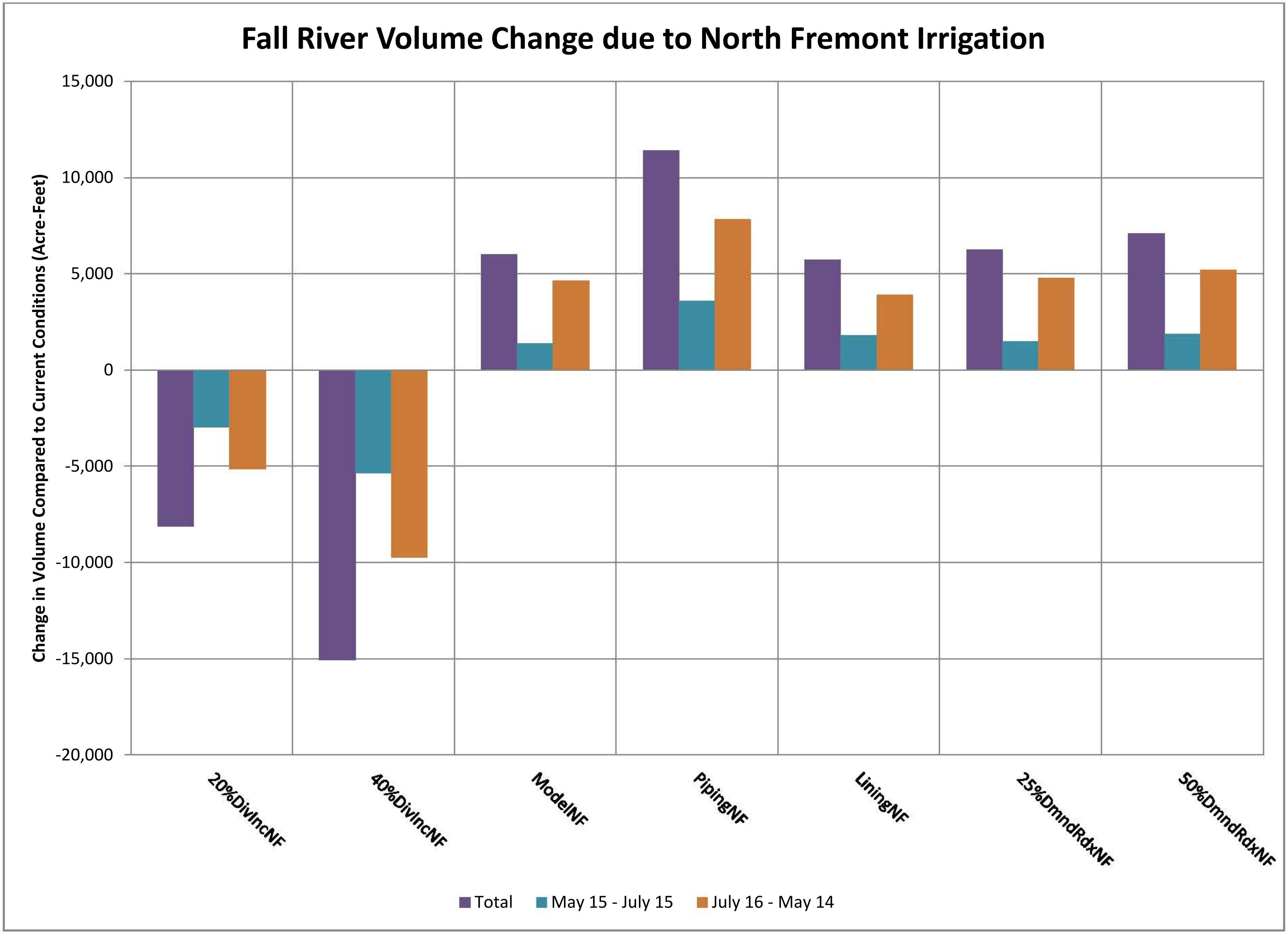


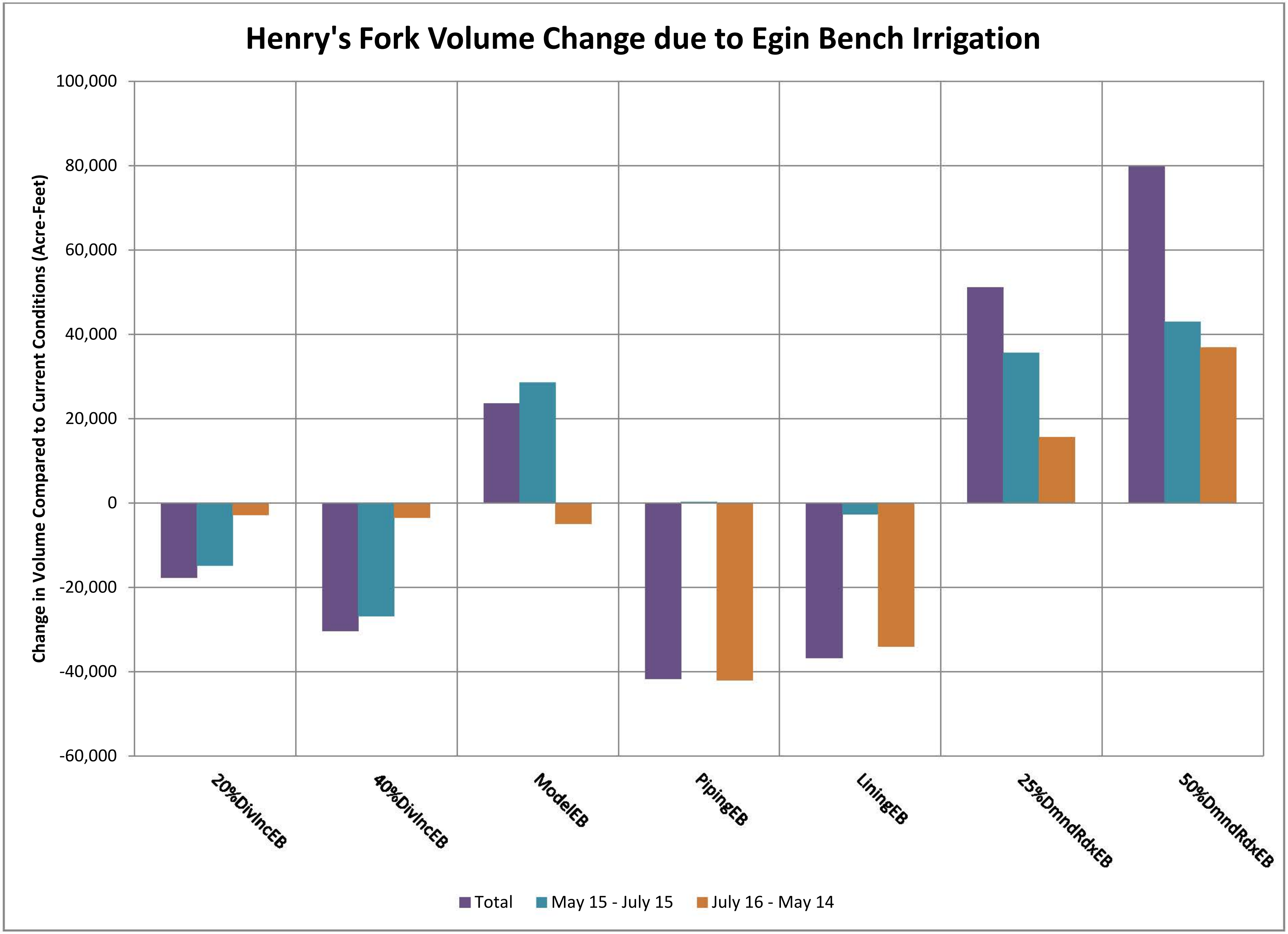
Average Henry's Fork Flow at Rexburg due to Egin Bench Irrigation
Alternative 14: Demand Reduction
Volume Change from Current Conditions
Acre-Feet
90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
25%DmndRdxLW
50%DmndRdxLW
Annual
May15 - July15
July16 - May14
Flow (cfs)
7,500
6,500
5,500
4,500
3,500
2,500
1,500
500
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Date
Current
25%DmndRdxEB
50%DmndRdxEB

APPENDIX C

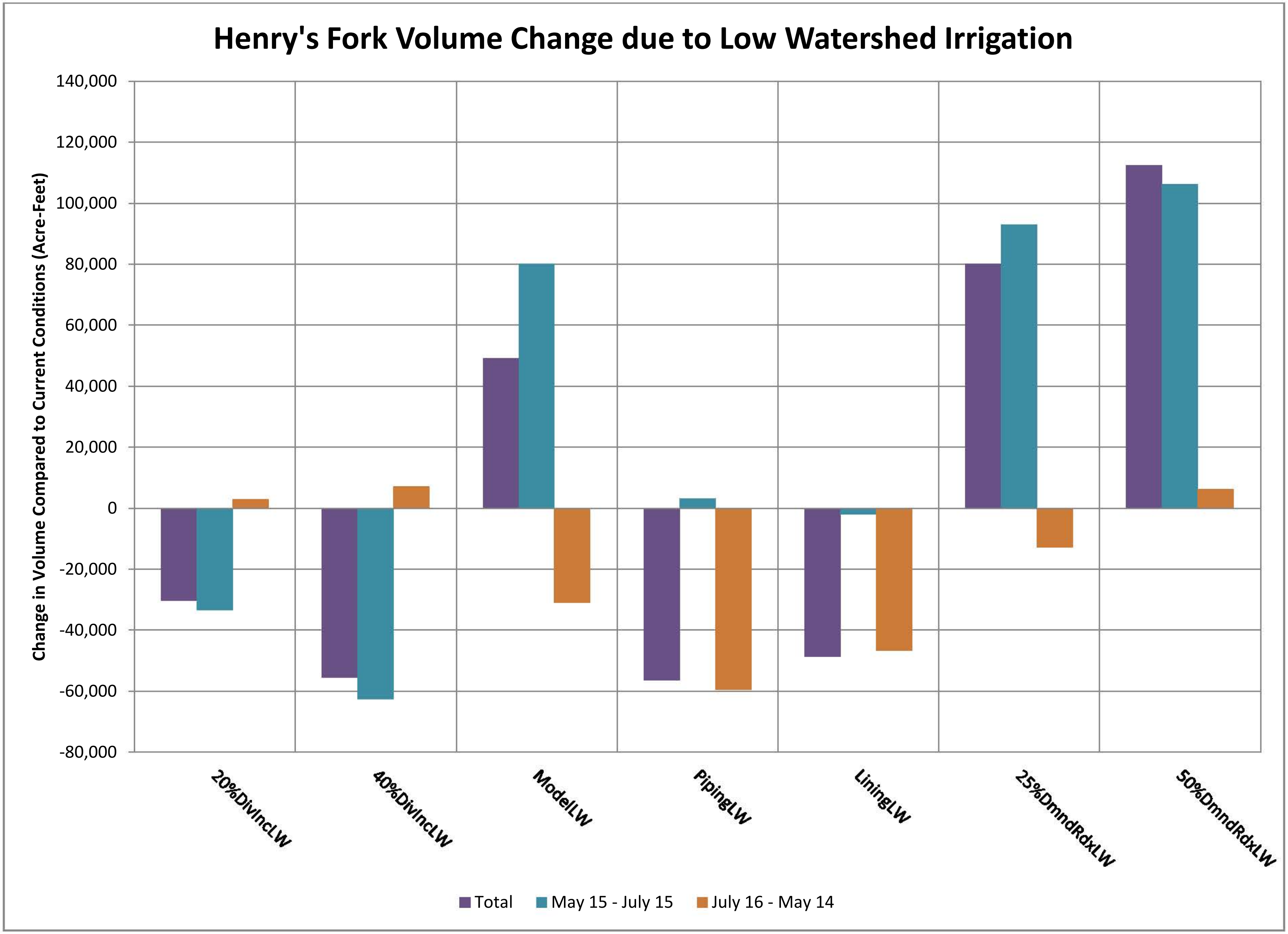
Comparisons of the Annual Volume Changes for the Conservation Alternatives


Teton River Volume Change due to Teton Valley Irrigation
Change in Volume Compared to Current Conditions (Acre-Feet)
30,000
20,000
10,000
0
-10,000
-20,000
-30,000
-40,000
Model
Pipeline
Lining
25%DmndRdx
50%DmndRdx
20%DivInc
40%DivInc
FTR
Teton@StAnthony
Teton@SouthLeigh


Fall River Volume Change due to North Fremont Irrigation
Change in Volume Compared to Current Conditions (Acre-Feet)
15,000
10,000
5,000
0
-5,000
-10,000
-15,000
-20,000
20%DivIncNF
40%DivIncNF
ModelNF
PipingNF
LiningNF
25%DmndRdxNF
50%DmndRdxNF
Total
May 15 - July 15
July 16 - May 14



Henry's Fork Volume Change due to Egin Bench Irrigation
Change in Volume Compared to Current Conditions (Acre-Feet)
100,000
80,000
60,000
40,000
20,000
0
-20,000
-40,000
-60,000
20%DivIncEB
40%DivIncEB
ModelEB
PipingEB
LiningEB
25%DmndRdxEB
50%DmndRdxEB
Total
May 15 - July 15
July 16 - May 14



Henry's Fork Volume Change due to Low Watershed Irrigation
Change in Volume Compared to Current Conditions (Acre-Feet)
140,000
120,000
100,000
80,000
60,000
40,000
20,000
0
-20,000
-40,000
-60,000
-80,000
20%DivIncLW
40%DivIncLW
ModelLW
PipingLW
LiningLW
25%DmndRdxLW
50%DmndRdxLW
Total
May 15 - July 15
July 16 - May 14

APPENDIX D

Impacts of the Conservation Alternatives on the Basin's Needs

Conservation Alternatives - Impacts to Basin Needs

Impacts to Basin Needs - Criteria

Primary Desciptor	**Secondary Descriptor**
Increase Flow Volume - Increase	***Greater Than 5% - Large***
Decrease Flow Volume - Decrease	***Less Than 1% - Small***

Alternative	Sub Alternative	Irrigated Region	Output USGS Gauging Station	Impacted Stream Reach of Concern	Annual Flow Impact	Peak Flow Impact	Non-Peak Flow Impact
Canal Automation	Model matches ET	Teton Valley	South Leigh	Teton Valley Tributaries	***small decrease***	***large increase***	***decrease***
Demand Reduction	25% Reduction	Teton Valley	South Leigh	Teton Valley Tributaries	***increase***	***large increase***	***decrease***
Demand Reduction	50% Reduction	Teton Valley	South Leigh	Teton Valley Tributaries	***large increase***	***large increase***	***decrease***
Lining Reduce Canal Seepage	75%	Teton Valley	South Leigh	Teton Valley Tributaries	***large decrease***	***increase***	***large decrease***
Pipeline Reduce Canal Seepage	100%	Teton Valley	South Leigh	Teton Valley Tributaries	***large decrease***	***small increase***	***large decrease***
Recharge Using Existing Canals	20% Increase	Teton Valley	South Leigh	Teton Valley Tributaries	***small decrease***	***decrease***	***increase***
Recharge Using Existing Canals	40% Increase	Teton Valley	South Leigh	Teton Valley Tributaries	***decrease***	***large decrease***	***increase***
Canal Automation	Model matches ET	Teton Valley	St. Anthony	Teton Valley Tributaries	***small increase***	***increase***	***decrease***
Demand Reduction	25% Reduction	Teton Valley	St. Anthony	Teton Valley Tributaries	***increase***	***large increase***	***decrease***
Demand Reduction	50% Reduction	Teton Valley	St. Anthony	Teton Valley Tributaries	***increase***	***large increase***	***decrease***
Lining Reduce Canal Seepage	75%	Teton Valley	St. Anthony	Teton Valley Tributaries	***decrease***	***increase***	***large decrease***
Pipeline Reduce Canal Seepage	100%	Teton Valley	St. Anthony	Teton Valley Tributaries	***large decrease***	***small increase***	***large decrease***
Recharge Using Existing Canals	20% Increase	Teton Valley	St. Anthony	Teton Valley Tributaries	***small decrease***	***decrease***	***increase***
Recharge Using Existing Canals	40% Increase	Teton Valley	St. Anthony	Teton Valley Tributaries	***decrease***	***decrease***	***increase***

Conservation Alternatives - Impacts to Basin Needs

Alternative	Sub Alternative	Irrigated Region	Output USGS Gauging Station	Impacted Stream Reach of Concern	Annual Flow Impact	Peak Flow Impact	Non-Peak Flow Impact
Canal Automation	Model matches ET	North Fremont	Chester	Lower Fall River	***increase***	***small increase***	***increase***
Demand Reduction	25% Reduction	North Fremont	Chester	Lower Fall River	***increase***	***small increase***	***increase***
Demand Reduction	50% Reduction	North Fremont	Chester	Lower Fall River	***increase***	***increase***	***increase***
Lining Reduce Canal Seepage	75%	North Fremont	Chester	Lower Fall River	***decrease***	***decrease***	***decrease***
Pipeline Reduce Canal Seepage	100%	North Fremont	Chester	Lower Fall River	***decrease***	***decrease***	***decrease***
Recharge Using Existing Canals	20% Increase	North Fremont	Chester	Lower Fall River	***increase***	***large increase***	***decrease***
Recharge Using Existing Canals	40% Increase	North Fremont	Chester	Lower Fall River	***small decrease***	***small decrease***	***small decrease***
Canal Automation	Model matches ET	Lower Watershed	Rexburg	Lower Teton N&S Forks	***decrease***	***large increase***	***increase***
Demand Reduction	25% Reduction	Lower Watershed	Rexburg	Lower Teton N&S Forks	***small decrease***	***small decrease***	***decrease***
Demand Reduction	50% Reduction	Lower Watershed	Rexburg	Lower Teton N&S Forks	***decrease***	***small increase***	***large decrease***
Lining Reduce Canal Seepage	75%	Lower Watershed	Rexburg	Lower Teton N&S Forks	***small decrease***	***large decrease***	***increase***
Pipeline Reduce Canal Seepage	100%	Lower Watershed	Rexburg	Lower Teton N&S Forks	***increase***	***large decrease***	***increase***
Recharge Using Existing Canals	20% Increase	Lower Watershed	Rexburg	Lower Teton N&S Forks	***increase***	***large increase***	***decrease***
Recharge Using Existing Canals	40% Increase	Lower Watershed	Rexburg	Lower Teton N&S Forks	***small decrease***	***small decrease***	***small decrease***
Canal Automation	Model matches ET	Egin Bench	Rexburg	Lower Teton N&S Forks	***increase***	***large increase***	***increase***
Demand Reduction	25% Reduction	Egin Bench	Rexburg	Lower Teton N&S Forks	***decrease***	***small decrease***	***decrease***
Demand Reduction	50% Reduction	Egin Bench	Rexburg	Lower Teton N&S Forks	***decrease***	***small increase***	***decrease***
Lining Reduce Canal Seepage	75%	Egin Bench	Rexburg	Lower Teton N&S Forks	***decrease***	***decrease***	***decrease***
Pipeline Reduce Canal Seepage	100%	Egin Bench	Rexburg	Lower Teton N&S Forks	***decrease***	***large decrease***	***decrease***
Recharge Using Existing Canals	20% Increase	Egin Bench	Rexburg	Lower Teton N&S Forks	***small decrease***	***small decrease***	***small decrease***
Recharge Using Existing Canals	40% Increase	Egin Bench	Rexburg	Lower Teton N&S Forks	***small decrease***	***small decrease***	***small decrease***

Technical Memorandum

Henrys Fork Basin Study Municipal Water Conservation Measures and New Non-potable Water Supply Options

Technical Series PN-HFS-007

Prepared by

CH2M HILL

For

Bureau of Reclamation, Idaho Water Resource Board, and Henrys Fork Watershed Council

November 2012

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1 Alternative Description

This alternative is intended to assess and explore options for conserving water and developing potential new water supply sources in the municipal and industrial sectors of cities within and near the Henrys Fork Basin (the Basin). Growth in domestic, commercial, municipal, and industrial water use is currently considered to be limited by inadequate water supply or an inability to balance use of surface water and groundwater supply portfolios (high costs for additional surface water treatment or non-potable conveyance systems and inability to acquire new groundwater permits).

Current water demands in Idaho Falls, Rexburg, Driggs, and Victor (all located near or within the Basin Study area) were assessed for potential conservation measures and new non-potable water supply (see Exhibit 1). These cities, which represent a range of small to large municipalities in or near the Henrys Fork Basin, were also compared to other Idaho cities that have implemented additional water conservation measures and use non-potable water supply for outdoor water use. The case study cities that were used for comparison purposes were Meridian, Caldwell, and Nampa, Idaho.

The following conservation measures and new non-potable water supply options are outlined in this study and will be discussed further in the following sections:

- Municipal water conservation measures
  - Metering
  - Public education
  - Replace water lines buried above frost depth
- New non-potable water supply
  - Reuse treated domestic wastewater effluent (reclaimed water)
  - Raw water non-potable systems
  - Industrial conservation

2 Key Findings

Implementation of municipal conservation measures and new non-potable water supply options would provide additional water for municipalities in the Basin, although these measures would not increase the total water supply in the Henrys Fork Basin or the Eastern Snake Plain Aquifer, and may actually decrease the water for downstream surface water users. Municipal water conservation measures included in Package 1 (metering, public education, and replacement of water lines currently above frost depth) would provide approximately 19,230 acre-feet (af) per year for municipalities, assuming full implementation in Driggs, Victor, Idaho Falls, and Rexburg. Further water savings (estimated to be on the order of 4,450 af per year) could be achieved through implementation of the new non-potable water supply options included in Package 2 (reclaimed water, non-potable systems, and industrial conservation) in Driggs, Victor, Idaho Falls, and Rexburg, but it is difficult to characterize the cost of implementing these measures. Since growth of these municipalities is currently considered to be limited by inadequate water supply or an inability to balance use of surface water and groundwater supply portfolios, it is assumed that existing groundwater rights would continue to be fully utilized. Consequently, although municipalities would benefit from implementation of both packages, these conservation measures and new non-potable water supply options have the potential to reduce the amount of water currently available to downstream in- and out-of-Basin users. Replacement of lines below the frost depth, while beneficial for municipalities, makes no change to the water budget as water lost from broken lines goes immediately back to the groundwater system. Other conservation measures may result in decreased groundwater pumping by municipalities, but because a large part of their pumped groundwater is discharged through treatment plants to the river, these conservation measures would result in less water being discharged to the river reducing supplies for downstream surface water users. The same issue would exist with using reclaimed water for non-potable uses. Exhibit 2 provides a tabular summary of the key findings.

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EXHIBIT 1
Municipal and Industrial Conservation Alternative Overview

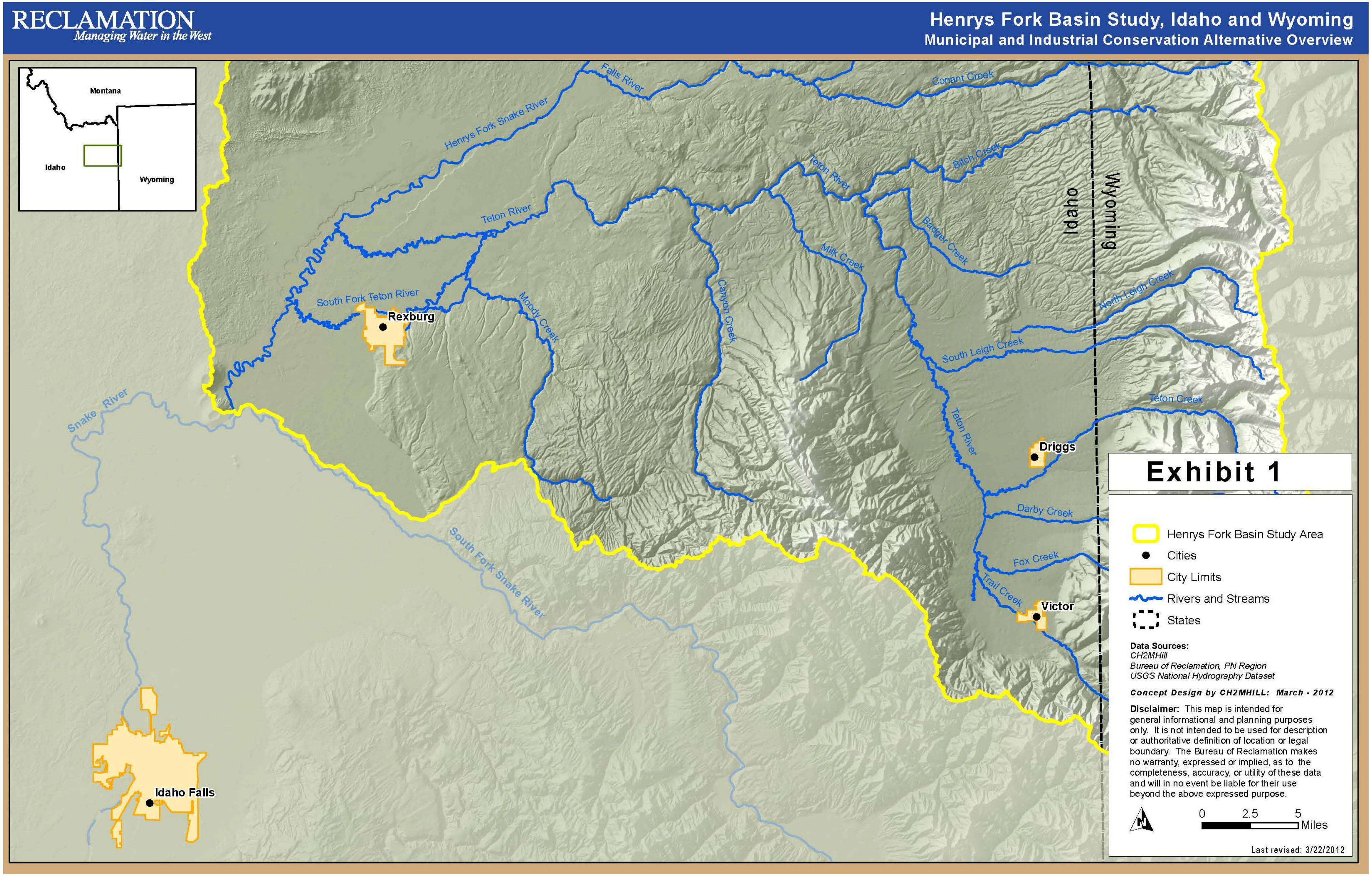

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EXHIBIT 2
Key Findings from the Reconnaissance Evaluation
Municipal and Industrial Conservation Alternative

Estimated Cost per Acre-Foot*	Impact on In-Basin Water Budget*	Impact on Out-of-Basin Water Budget	Change in Connectivity of Impacted River Segment
$300 -$1,100	19,230 af to be conserved annually by the municipalities, but with likely reductions in water available to downstream users.	19,230 af potentially removed from the system and no longer available to downstream users.	Reduced groundwater pumping would have the potential to increase aquifer discharge to adjacent river reaches and improve connectivity of downstream river segments (Teton and Henrys Fork Rivers), but less water may actually be available for downstream uses if, following implementation of the measures, the cities utilize their full rights.

*Cost and water budget impact assumes implementation of Package 1 conservation measures only. Costs for Package 2 new non-potable supply options were not quantified at this stage of the study.

3 Introduction to Potential Municipal Water Conservation Measures and New Non-potable Water Supply Options

3.1 Water Conservation Measures

3.1.1 Metering

Metering provides an economic incentive for people to reduce consumption because of the corresponding impact on utility bills. Some cities in Idaho and throughout the United States have traditionally not metered their customers and charge a flat rate for water service. Charging a flat monthly fee does not encourage users to conserve water because there is no fiscal incentive to reduce water consumption. Many municipalities have meters installed on their connections, but the meters either do not work or the city has chosen not to read the meters and charge based on usage. Metering also allows cities to implement a tiered water rate structure that charges a per-gallon usage fee based upon the amount of water used by the customer. As water usage increases to successive tiers (or a larger water usage bracket), the cost per gallon also increases. A tiered water rate structure aids in water conservation because users will limit the amount of water used to stay within the lower price tier.

3.1.2 Public Education

Public education programs can be an effective means to inform water users of the importance of water conservation. Public education can be implemented through informational brochures, elementary school education programs, or by displaying water conservation information on the city's website. This information will inform the public about the water cycle, the city's water system, key terms, and drinking water and wastewater treatment processes. The programs focus on the importance of water conservation and ways in which they can contribute—including tips on outdoor water usage such as reducing landscape water demands by planting plants that require less water and installing water efficient fixtures such as low water toilets. Education is a powerful tool for increasing public participation in and the effectiveness of other water conservation measures.

3.1.3 Replace Water Lines Buried Above Frost Depth

On the basis of information gathered in this study, some of the cities near or within the Henrys Fork Basin currently have water distribution pipelines buried between 2 and 4 feet below grade. This depth is likely insufficient to prevent pipes from freezing and breaking during cold winter months, resulting in leakage. Replacing water lines below frost depth would result in reduced consumption and help conserve energy because less water would have to be pumped through the system to meet demands.

3.2 New Non-potable Water Supply Options

Municipalities in eastern Idaho are striving to develop sustainable water supplies to support economic growth in their communities. Because of historic depletion of the ESPA, cities are finding that it can be difficult to obtain new groundwater rights from the State of Idaho. Consequently, municipalities have acquired additional surface water rights; however, additional treatment of these surface water sources is costly and State law does not recognize aquifer storage and recovery (ASR), although a work-around exists through use of mitigation plans (see Section 8). The new non-potable water supplies described in the following text provide additional options for municipalities to support additional growth.

3.2.1 Reclaimed Water

To reduce the need for other sources of water, wastewater could be treated to Class A standards and reused as reclaimed water. Reclaimed water could be beneficially reused through land application, supply it to industrial users, or replenishing groundwater supplies through ASR (subject to legal constraints described in Section 8).

3.2.2 Raw Water Non-potable Systems

A dual-pipe system could be constructed in cities near or within the Henrys Fork Basin for irrigating open spaces, parks, or other suitable areas with raw surface water. This new non-potable water supply will decrease the amount of potable water used to satisfy outdoor demands and will help municipalities in the Basin balance their surface water and groundwater supply portfolios. Using non-potable water for irrigation also reduces the need for chemical treatment (for example, chlorine), and other costs associated with treating the water to required drinking water standards. New raw water non-potable systems would be expected to use surface water rights that are currently unused.

3.2.3 Industrial Conservation Example—Breweries/Malting Plants

Because industrial conservation measures are very industry-specific, one example industry, breweries, was examined in further detail during this study. Anheuser-Busch (A-B), a malting company located in Idaho Falls, set a goal in 2010 to reduce water use by 34 percent in their United States breweries. In addition to A-B, the Grupo Modelo malting plant in Idaho Falls could implement similar operations to reduce the amount of water used.

4 Municipal Water and Wastewater Analysis

4.1 Water and Wastewater Data Summary

The data summarized in this section represents peak and average annual flow rates based upon data provided by the municipalities and is not intended to capture seasonal fluctuations (increased water usage during the summer months).

4.1.1 Water Data Summary

The data provided by the cities of Idaho Falls, Rexburg, Driggs, and Victor were used to develop average day demands (ADD), maximum day demands (MDD), and per capita average day and maximum day demands in gallons per capita per day (gpcd). The existing water demands are summarized in Exhibit 3. Exhibit 3 also presents data for several case study cities (Nampa, Meridian, and Caldwell) that have implemented both water conservation measures and developed non-potable supply options.

EXHIBIT 3
Summary of Existing City Water Production
Municipal and Industrial Conservation Alternative

	Cities In and Near the Henrys Fork Basin				Case Study Cities		
	City of Driggs[a]	City of Victor[b]	City of Idaho Falls[c]	City of Rexburg[d]	City of Nampa[e]	City of Meridian[f]	City of Caldwell[g]
Maximum month (million gallons)	409	31	1,717	277	348	476	266
Maximum day (mgd)	13.6	1.0	57.2	9.2	11.6	15.9	8.9
Average month (million gallons)	60	12	692	140	227	251	151
Average day (mgd)	2.0	0.4	23.1	4.7	7.6	8.4	5.0
Population[h]	2,105	1,928	56,813	25,484	81,557	75,092	46,237
Maximum month use (gpcm)	194,300	16,068	30,227	10,870	4,267	6,336	5,746
Average month use (gpcm)	28,504	6,000	12,183	5,480	2,785	3,336	3,261
Maximum day use (gpcd)	6,460	536	1,008	362	142	211	192
Average day use (gpcd)	950	200	406	183	93	111	109

[a] City of Driggs information is based upon data provided by the City of Driggs for the years 2009 through 2011.
[b] City of Victor information is based upon data provided in the City of Victor Water System Environmental Information Document prepared by Sunrise Engineering, Inc. (December 2011).
[c] City of Idaho Falls information is based upon data provided for the years 2009 through 2011.
[d.] City of Rexburg data is based upon 2011 data provided by the City of Rexburg.
[e.] City of Nampa information is based upon 2008 data summarized in The City of Nampa Water Master Plan, December 2010.
[f] City of Meridian information is based upon 2009 data provided by the City of Meridian.
[g] City of Caldwell information is based upon 2007 data provided in The City of Caldwell Water Master Plan, January 2009.
[h] Population data based upon 2010 U.S. Census Bureau data. The City of Driggs population includes a population of about 445 additional people outside the city limits for a total population of approximately 2,105 people.
mgd = million gallons per day
gpcm = gallons per capita per month
gpcd = gallons per capita per day

Average day uses for cities in and near the Henrys Fork Basin ranged from 183 to 950 gpcd. Rexburg was the only in-basin municipality with average day use approaching the value of 150 gpcd typically used in water supply master planning (Kawamura, 2000), and the City's 183 gpcd value may provide a reasonable target for other municipalities in the vicinity to achieve through implementation of basic conservation measures. The case study cities of Nampa, Meridian, and Caldwell are not located near the Henrys Fork Basin, but at 104 gpcd they provide an upper threshold of water savings that may be achieved if all water conservation measures and non-potable supply options (including dual pipe systems) described in Section 3 are implemented.

Although not presented in Exhibit 3, some cities within the Henrys Fork Basin have varying seasonal water usage. For example, data provided by Driggs indicated that water usage was fairly consistent throughout the year and does not drop off during the winter months; however, data provided by Idaho Falls showed that water usage was significantly higher in the summer because of increased irrigation demands.

4.1.2 Wastewater Data Summary

It is important to differentiate between indoor and outdoor water use because the conservation measures and non-potable supply options are generally more effective at reducing outdoor water consumption. Wastewater flows provide an indication of the amount of indoor water use in each municipality, but wastewater flow data may also be affected by inflow and infiltration (I&I), which is defined as surface water and groundwater flowing into the sewer through manhole rims, cracked pipes, poor joints, and manhole walls. Exhibit 4 summarizes wastewater flows for Idaho Falls, Rexburg, Driggs, and Victor.

EXHIBIT 4
Summary of Existing City Wastewater Production
Municipal and Industrial Conservation Alternative

	City of Driggs[a]	City of Victor[b]	City of Idaho Falls[c]	City of Rexburg[d]
Maximum month (mgd)	0.69	0.40	12.40	2.50
Average day (mgd)	0.35	0.20	11.02	2.27
Population[e]	2,105	1,928	77,187	25,484
Maximum day use (gpcd)	328	206	161	98
Average day use (gpcd)	166	101	143	89
Indoor water usage (%)[f]	17%	51%	35%	49%

[a] City of Driggs information is based upon projected data for 2010 wastewater flow into the Driggs Wastewater Treatment Plant less the flow from the City of Victor.
[b] City of Victor information is based upon 2006 to 2009 data tabulated in the City of Victor Interceptor Capacity Analysis and Improvement Recommendations prepared by Sunrise Engineering, Inc. The City of Victor receives irrigation water from the Trail Creek Sprinkler Irrigation Company; therefore all of the potable water produced is indoor usage.
[c] City of Idaho Falls information is based upon data provided by the City of Idaho Falls for 2003 through 2011.
[d] City of Rexburg information is based upon data provided by the City of Rexburg for 2011.
[e] Population data based upon 2010 U.S. Census Bureau data. The City of Idaho Falls WWTF treats wastewater from Ammon, Iona, Lincoln, and Ucon; therefore, the population reflects the inclusion of these communities. The City of Driggs population includes a population of about 445 additional people outside the city limits for a total population of approximately 2,105 people.
[f] Indoor water usage (%) was calculated using the average day indoor use (see Exhibit 4, Average Day Use) and dividing it by the average day use of all potable water (see Exhibit 3, Average Day Use) and multiplying that fraction by 100 to get a percentage.

According to Metcalf & Eddy (2003), the average indoor water use without water conservation practices and devices is 74 gpcd. By using the average indoor water use presented by Metcalf and Eddy and the average total potable water use used in water supply master planning of 150 gpcd (Kawamura, 2000), the average indoor water usage should be approximately 50 percent, as shown in the calculation:

$$Indoor\ Water\ Usage\ = \left(\frac{74\ gpcd}{150\ gpcd}\right) \times 100 = 49.3\%$$

Data from both Victor and Rexburg indicate that their water usage is in alignment with the expected indoor-to-outdoor usage ratio. Driggs and Idaho Falls have lower ratios, indicating (particularly in Driggs), that most of the water used in these communities is outdoors.

4.2 Detailed Water Demand and Usage Review by Municipality

4.2.1 The City of Idaho Falls

Idaho Falls is located on the Snake River just outside the Henrys Fork Basin, and is the largest municipality in the area with a population of just over 56,800 on the basis of the 2010 Census. The Idaho Falls water supply system has a total capacity of 88.6 mgd through operation of 19 wells that pump water from the ESPA. According to the City of Idaho Falls 2010 Comprehensive Plan, water is distributed to approximately 24,500 customers. The water users are primarily residential; however, two large malting plants operate in Idaho Falls—Anheuser-Busch (A-B) and Grupo Modelo. A-B receives a portion of its water from the City, but the majority of the water used at the malting plant is supplied from wells owned and operated by A-B. Grupo Modelo does not receive any water from the City—all water used in the malting plant is supplied from wells owned and operated by Grupo Modelo.

The City of Idaho Falls does not have water service meters for the majority of water users. Rather than charge by the amount of water consumed, each customer pays a flat monthly fee for water service, as shown in Exhibit 5. The lack of metering is reflected in the City's average day use (see Exhibit 3). On average, the City of Idaho Falls uses 406 gpcd, of which only 35 percent can be accounted for as indoor water consumption based on sewer flows (see Exhibit 4); therefore, almost two-thirds of the water produced is consumed as outdoor usage.

On the basis of historical water data, the City of Idaho Falls has elevated water use during the summer months as a result of irrigation needs. This water use trend is typical for municipalities in Idaho.

EXHIBIT 5
Idaho Falls Non-Metered Water Rates*
Municipal and Industrial Conservation Alternative

Customer Classification	Monthly Rate
Single-family dwelling	$21.00
Apartment unit (per unit)	$15.78
Office buildings, banks, bowling alleys, lodges, markets per 1,000 square feet of area	$6.29
Restaurant and fast-food establishments	$55.80
All other non-metered customers per premises or building	$21.00

*Data provided by *City of Idaho Falls Comprehensive Plan* (2010)

4.2.2 The City of Rexburg

Rexburg is located on the South Fork Teton River near the confluence with the Snake River within the Henrys Fork Basin and has a population of approximately 25,500 people on the basis of the 2010 Census. The Rexburg water system is supplied by six wells with a maximum capacity of approximately 14 mgd. According to the City of Rexburg 2020 Comprehensive Plan, water is distributed to approximately 6,500 household customers. The Rexburg community is primarily residential but Brigham Young University-Idaho (BYU-Idaho) is located in the city. BYU-Idaho is the largest private school in Idaho with approximately 15,000 students and is experiencing a growth rate of 1,000 students per year. Rexburg has large housing units under construction near BYU-Idaho to consolidate the population around the campus. These new developments will not have a lot of landscaping and, therefore, will not have a large irrigation demand. Melaleuca, Inc., a wellness supply company, is the largest industry in Rexburg; however, the water usage at Melaleuca was not available for review or considered in this study.

The City of Rexburg has water service meters installed to meter all of their customers' water usage, but charges their water customers a monthly minimum flat fee on the basis of the size of connection (see Exhibit 6). Their flat fee includes a usage allowance of 1,667 gpd, and if users exceed the allowance, they will be charged an additional fee per 1,000 gallons used (see Exhibit 6). Rexburg has replaced all of their water meters for residential and commercial users within the last six years. Areas such as city parks and city owned landscaping is now metered so Rexburg can accurately access their water consumption. Also within the last 5 years, Rexburg has taken an initiative to irrigate larger green spaces such as parks and new schools with non-potable surface water.

EXHIBIT 6
Rexburg Non-Metered Water Rates[a]
Municipal and Industrial Conservation Alternative

Connection Size	Monthly Minimums—In City[b]	Monthly Minimums —Out of City[c]
0.75-inch	$15.62	$20.31
1.0-inch	$39.05	$50.77
1.25-inch	$54.67	$71.07
1.5-inch	$70.29	$91.38
2.0-inch	$101.53	$131.99
3.0-inch	$148.39	$192.91
4.0 inch	$187.44	$243.67
6.0-inch	$374.88	$487.34
8.0-inch	$562.32	$731.02

[a] Data provided by the City of Rexburg (2011).
[b] The in city fee for usage in excess of allowance: $0.99 per 1,000 gallons above 1,667 gpd.
[c] The out of city fee for usage in excess of allowance: $1.49 per 1,000 gallons above 1,667 gpd.

Rexburg has a relatively low average per capita usage when compared to other cities in the Henrys Fork Basin. However, the data provided by the City only included 2011 water and wastewater data, and historical trends may show an increase in the per capita usage. On the basis of 2011 data, the City of Rexburg uses water in a relatively efficient manner. The City, on average, uses 183 gpcd (see Exhibit 3), which may be a reasonable target for other municipalities in the vicinity to achieve through implementation of basic conservation measures. Of the water produced, about 50 percent can be accounted for as indoor water consumption (Exhibit 4); therefore, approximately 50 percent of the average per capita usage is consumed as outdoor usage.

Based upon historical water data, the City of Rexburg has elevated water use during the summer months as a result of irrigation needs. This water use trend is typical for municipalities in the state of Idaho.

4.2.3 The City of Driggs

Driggs is located on the upper Teton River in the Henrys Fork Basin. Driggs has a population of approximately 1,700 people based on the 2010 Census and with 445 additional customers outside the city limits the water service population is approximately 2,105 people. Driggs is mainly residential with a mix of primary and secondary residences. Because Driggs is located near the Teton Mountains, Grand Targhee Ski Resort, and Jackson, Wyoming, many of the residences are second homes that are only occupied during the winter and summer. Driggs supplies customers with potable water from six wells and a local spring, with a total capacity of 4,875 gpm. According to discussion notes from the City of Driggs Water System City Council meeting on May 10, 2010, the City of Driggs has just over 1,200 Equivalent Residential Connections (ERCs).

Driggs has water service meters installed to meter a majority of customer water usage, but charges users a flat fee on the basis of the size of connection (see Exhibit 7). Their flat fee includes a usage allowance in gallons and if the users exceed the allowance, they will be charged an additional $1.00 per 1,000 gallons used.

EXHIBIT 7
Driggs Non-Metered Water Rates
Municipal and Industrial Conservation Alternative

Connection Size	Base Rate[a]	Water Allowance[b]
0.75- or 1.0-inch	$27.00	Includes 10,000 gallons
1.5-inch	$67.50	Includes 25,000 gallons
2.0-inch	$121.50	Includes 45,000 gallons
3.0-inch	$175.50	Includes 65,000 gallons
4.0-inch	$215.99	Includes 80,000 gallons
6.0-inch	$323.99	Includes 120,000 gallons

[a] The fee for usage in excess of allowance: $1.00 per 1,000 gallons.
[b] Data provided by the City of Driggs (2010).

Many of the City's potable water pipes are currently buried at shallow depths between 2 and 4 feet below grade, which is not below the frost depth and poses potential freezing issues. According to the City of Driggs Public Works Director, many of their users (at least half of their customers) are required to continuously run their faucets with a stream of water during winter to prevent pipes in the distribution system from freezing. As a result of the depth of bury, many of the potable water pipes in the City of Driggs are cracked and leak. According to the Director, the soils in the area are predominantly alluvial deposits that drain well; therefore, the water that is leaking through the pipes does not come to the surface to provide an indication of where the leakage may be located.

The potential of water leaking from broken pipes is reflected in the City's average day use (see Exhibit 3). The City of Driggs, on average, uses 950 gpcd. Of the water produced, only 17 percent can be accounted for as indoor water consumption (see Exhibit 4). Therefore over 83 percent of the average per capita usage is likely water leaking from broken pipes, with a fraction of that water being consumed as outdoor usage.

On the basis of historical water data, the City of Driggs has elevated water use during the summer months as a result of irrigation needs and also has elevated water use during the winter months. The City of Driggs has elevated water use during the winter months because of the practice of continuously running faucets to prevent pipes in the distribution system from freezing. This water use trend is not typical for municipalities in the state of Idaho.

4.2.4 The City of Victor

Victor is located on the upper Teton River in the Henrys Fork Basin about 8 miles south of Driggs and includes a population of just over 1,900 people according to the 2010 Census. Victor's service area is mainly primary and secondary residences. As is the case with Driggs, Victor is located near the Teton Mountains, Grand Targhee Ski Resort, and Jackson, Wyoming. Many of the residences are second homes that are only occupied during the winter and summer. Victor has two water sources—the Game Creek Springs and the Willow Creek Well, with production capacities of 350 and 800 gpm respectively. According to the Victor Water System Facilities Planning Study, the city has 971 ERCs.

The City has water service meters installed to meter the majority of customer water usage and has a tiered water rate structure. Victor charges their users a flat fee in addition to a usage fee based upon the amount of water used (see Exhibit 8). If the user exceeds 12,000 gallons in one billing cycle the user will be charged the first tier overage rate, and if the user exceeds 20,000 gallons in one billing cycle the user will be charged the second tier overage rate. A tiered water rate structure is effective in encouraging users to conserve water because there is a fiscal incentive to reduce the amount of water used.

EXHIBIT 8
Victor Metered Water Rates*
Municipal and Industrial Conservation Alternative

Customer Classification	Monthly Rate
Base rate	$24.00 per Equivalent Residential Connection (ERC)
Usage fee	$1.75 per 1,000 gallons of usage up to 12,000 gallons in one Billing Cycle (approximately one month)
First tier overage fee	$2.00 per 1,000 gallons of usage between 13,000 gallons to 20,000 gallons in one Billing Cycle
Second tier overage fee	$3.00 per 1,000 gallons of usage above 20,000 gallons in one Billing Cycle

*Data provided by Victor Water System Environmental Information Document (2011).

As is the case with Driggs, many of Victor's potable water pipes are currently buried at shallow depths between 2 and 4 feet below grade, which is not below the frost depth and poses potential freezing issues. According to the *Victor Water System Environmental Information Document* (2011), "to prevent freezing, the City has its residents continuously run a stream of water in the winter time." Victor has not historically collected water service meter data in the winter time to allow users to run their faucets continually to prevent pipes from freezing; therefore, the customers are charged a flat fee during the winter months rather than a usage fee.

The City of Victor estimates that average per capita usage is 200 gpcd, as shown in Exhibit 3. This usage may be realistic for the City; however, the City of Victor has issues with broken and leaking water pipes as does Driggs. Because actual water usage data were not provided, actual water production data may show a larger average per capita usage because much of the water is likely leaking from the pipes into the ground. On the basis of the assumed average per capita usage, just over 50 percent can be accounted for as indoor water consumption (see Exhibit 4); therefore half of the water produced can be accounted for as outdoor usage.

Victor receives the bulk of their irrigation water from Trail Creek Sprinkler Irrigation Company. The City of Victor has a dual-pipe system. One set of pipelines is owned and operated by the City and supplies potable water throughout Victor. This system is also known as culinary water system. The second set of pipelines is owned and operated by the Trail Creek Sprinkler Irrigation Company and supplies pressurized irrigation water throughout Victor.

As is the case with Driggs, Victor has elevated potable water use during the winter because many users are required to continuously run their faucets with a stream of to prevent pipes in the distribution system from freezing. This water use trend is not typical for municipalities in Idaho.

4.3 Case Studies—Cities Beyond the Henrys Fork Basin that Have Implemented Conservation Measures and Developed Non-potable Supply Options

Several case study cities outside the Henrys Fork Basin, specifically the Cities of Nampa, Meridian, and Caldwell, all located in western Idaho's Treasure Valley, are reviewed here because they have taken steps to conserve water or use other non-potable water sources to meet outdoor demands. These case studies provide an important point of reference to estimate an upper threshold of water savings that may be achieved if all water conservation measures and non-potable supply options (including dual pipe systems) described in Section 3 were implemented.

4.3.1 The City of Caldwell

According to Exhibit 3, Caldwell uses 109 gpcd. Caldwell has meters installed on the majority of their users and charges on the basis of the amount of water used. The City also owns and operates an irrigation district called the Caldwell Municipal Irrigation District. The irrigation district operates and maintains all city pressurized irrigation systems and provides non-potable water for outdoor usage.

4.3.2 The City of Meridian

Meridian has taken great measures to conserve water, as shown in the City's per capita average daily usage of 111 gpcd (see Exhibit 3). The City of Meridian has meters installed on the majority of their users and charges them on the basis of the amount of water used ($1.86 per 1,000 gallons used). Meridian currently has approximately 26,000 water service connections. Non-potable water supply options implemented by the City are described in the following text.

According to the City of Meridian Water Conservation Plan, Meridian has been producing Class A reclaimed water since 2009, and beneficially reuses a portion of the reclaimed water for irrigation at a local park. In fact, one of the City of Meridian's goals is to reclaim and reuse 80 percent of their wastewater by 2030 to decrease water consumption within the municipality (City of Meridian, 2011).

The City currently has a flow-based National Pollutant Discharge Elimination System (NPDES) permit limit which was the initial driver for the reclaimed water program. Meridian has had substantial growth and the City worried that they would meet or exceed the flow limit within a few years. Reusing a portion of their wastewater effluent as reclaimed water decreases the amount of flow being discharged from their wastewater treatment plant, and, therefore, the maximum flow in their NPDES permit would not be exceeded.

Although growth in the City has slowed over the past couple of years, a pending NPDES permit is anticipated and has become the new driver for the program. The permit will have more stringent effluent nutrient limitations resulting from the Snake River-Hells Canyon Total Maximum Daily Load (TMDL) and Boise River phosphorus load allocations. By implementing the reclaimed water program the City's wastewater treatment plant already treats the wastewater to Class A standards; therefore, the program will help the City achieve the anticipated low phosphorus levels. Also, the substantial growth that the City has seen over the past decade has caused concerns about whether potable water production will be limited because of water rights constraints. Implementation of the reclaimed water program will alleviate irrigation and non-potable water demands throughout the City, thereby reducing the demands on the potable water supply.

Meridian plans to reduce the need for other sources of water through the use of reclaimed water in irrigation, dust suppression, toilet flushing, lined surface water features, sanitary sewer flushing, and fire suppression throughout the City. In the future, the City also plans to replenish groundwater supplies through ASR with reclaimed water.

In addition to the City's reclaimed water goals, non-potable irrigation water is supplied to a portion of the users within Meridian. The City of Meridian does not own or operate the pressurized irrigation system. The City of Meridian also has information on their website to educate users on ways they can conserve water.

4.3.3 The City of Nampa

As shown in Exhibit 3, the City of Nampa uses 93 gpcd and currently has approximately 28,000 water service connections. Nampa has meters installed on majority of their users and charges based upon water consumption. Non-potable water supply options implemented by the City are described in the following text.

The City of Nampa has non-potable irrigation water available to residents for outdoor usage. The City of Nampa does not own or operate the pressurized irrigation system. According the Nampa Waterworks website, users can receive violations for overwatering, the City of Nampa Codes Section 8-1-23 Waste of Irrigation Water states, "It is unlawful for any person to allow or permit the waste of irrigation water by allowing said water to flow on or upon any street, alley or other public right-of-way in the City, or by allowing said water to flow on or upon adjacent or adjoining property so as to cause the unnecessary inconvenience or expense to the owner of such adjacent or adjoining property or by using more of said water than good husbandry requires for the maintenance and cultivation of the premises being irrigated. Waste of said water can result in a citation if situation has not been corrected." The City of Nampa has a link on their website to report overwater and will have a technician dispatched to verify overwatering. The City of Nampa also has links on the website that educate users on ways in which they can conserve water.

4.4 Municipal Water and Wastewater Analysis Conclusions

It is evident from the analysis performed for this study that municipalities within or near the Henrys Fork Basin could take additional measures to conserve water. The average day per capita water use in three out of the four municipalities studied was much higher than the value of 150 gpcd typically used in water supply master planning (Kawamura, 2000). All four municipalities have a much higher average day per capita usage than municipalities that are aggressively implementing conservation measures or using non-potable water supplies for outdoor use (for example, Meridian, Nampa, and Caldwell). On the basis of the information collected from the municipalities within or near the Henrys Fork Basin, CH2M HILL concludes the following:

- Water supply to municipal and industrial users in the Henrys Fork Basin is almost exclusively from groundwater sources. Wells are constructed in shallow, often alluvial, aquifers. A portion of the water used in the Henrys Fork Basin includes spring water.
- A low percentage of the water used in these municipalities is indoor usage, which suggests that a majority of the water used is for outdoor purposes such as irrigation.
- A low percentage of the water used in these municipalities is accounted for as industrial use. Idaho Falls has two large industrial water users, the Anheuser-Busch malting plant and Grupo Modelo malting plant; however, these breweries have private wells that they own and operate.
- The municipalities either do not have meters installed on every connection or the municipalities have meters but are not collecting water data and do not charge customers on the basis of the amount of water used. Both practices give little incentive for users to conserve water.
- The smaller municipalities have aging and poorly constructed water distribution systems that do not have proper bury below frost depth, which has led to pipes that have excessive leakage. It is recommended that the smaller municipalities with pipe freezing problems replace distribution systems with pipes at proper depth of bury to reduce leakage and pumping requirements from groundwater supplies.
- Because of the potential freezing issues, many of the water users in small municipalities are advised to continually run faucets to prevent the water lines from freezing during the winter. In addition to the increased pumping requirements, running water through a faucet throughout the winter leads to higher than necessary loading rates at the wastewater treatment plants, which could require larger wastewater facilities than necessary.
- The City of Rexburg makes efficient use of water, averaging 183 gpcd. This value may provide a reasonable target for other municipalities in the vicinity to achieve through implementation of basic conservation measures like metering, education, and replacement of pipes currently buried above frost depth.
- The case study cities, which have an average use of 104 gpcd, provide an upper threshold of water savings that may be achieved if all water conservation measures and non-potable supply options (including dual pipe systems) described in Section 3 are implemented.

On the basis of the conclusions drawn from information provided by the municipalities, the following sections outline measures that can be implemented to conserve water.

5 Implementation of Potential Municipal Water Conservation Measures and New Non-potable Water Supply Options

As stated previously, growth in domestic, commercial, municipal, and industrial water use is currently considered to be limited in the Henrys Fork Basin by inadequate water supply or an inability to balance use of surface water and groundwater supply portfolios. The municipal water conservation measures and new non-potable water supply options discussed in this section may allow for additional growth. Prediction of the specific water usage impact of individual conservation measures and supply options was beyond the scope of this analysis. However, the conservation measures and supply options were evaluated for feasibility of implementation, and two packages were established that would reduce water consumption to two different levels. Package 1 consists of several individual measures that could be taken to help the cities of Driggs, Victor, Idaho Falls, and Rexburg achieve an average per capita water use similar to that typically used in water supply master planning (150 gpcd; Kawamura, 2000). Package 2 consists of new non-potable water supply options that may further reduce water use of municipalities in and near the Basin to similar levels achieved in the case study cities (104 gpcd).

5.1 Package 1—Municipal Water Conservation Measures

Package 1 consists of several water conservation measures, including metering, education, and replacement of pipes currently buried above frost depth. The average day per capita water use in three out of the four municipalities studied was much higher than the value of 150 gpcd typically used in water supply master planning (Kawamura, 2000). This value represents a reasonable target for municipalities in the vicinity (Driggs, Victor, Rexburg, and Idaho Falls) to achieve through implementation of the measures discussed below. Exhibit 9 presents an estimate of the amount of water that could be conserved through implementation of Package 1 conservation measures. Replacement of lines below the frost depth, while beneficial for municipalities, makes no change to the water budget as water lost from broken lines goes immediately back to the groundwater system. Other conservation measures may result in decreased groundwater pumping by municipalities, but because a large part of their pumped groundwater is discharged through treatment plants to the river, these conservation measures would result in less water being discharged to the river reducing supplies for downstream surface water users.

EXHIBIT 9
Summary of Potential Water Saved through Implementation of Package 1 Elements
Municipal and Industrial Conservation Alternative

	Driggs	Victor	Idaho Falls	Rexburg
Population[a]	2,105	1,928	56,813	25,484
Current average day water use (gpcd)	950	200	406	183
Projected future average day water use (gpcd)	150	150	150	150
Projected water savings (gpcd)	800	50	256	33
Projected water savings[b] (af/year)	1,890	110	16,290	940

[a] Population data based upon 2010 U.S. Census Bureau data.
[b] Projected water savings were rounded to the nearest 10 af.

5.1.1 Metering

The concept of metering was introduced in Section 3.1.1. As discussed in Section 4.2, the Cities of Rexburg, Driggs, Victor, and Idaho Falls currently have the following metering and rate structure programs in place:

- Idaho Falls: Does not meter all of their customers because there are not meters installed on majority of their customers. Because there are not meters installed, Idaho Falls charges their customers a flat fee.
- Rexburg: Currently meters all of their customers. Rexburg charges water customers a monthly minimum flat fee based of the size of connection. The flat fee includes a usage allowance in gallons and if the users exceed the allowance, they are charged an additional fee per 1,000 gallons used.

- Driggs: Currently meters the majority of their customers. Driggs charges their water customers a monthly minimum flat fee based of the size of connection. The flat fee includes a usage allowance in gallons and if the users exceed the allowance, they will be charged an additional fee per 1,000 gallons used.
- Victor: Currently meters the majority of their customers. Victor is the only city in the Basin that has implemented a tiered rate structure.

5.1.2 Public Education

The concept of public education is introduced in Section 3.1.2, and additional details are provided in the remainder of this section. Public education programs can be an effective means to inform water users of the importance of water conservation. To inform the public about water conservation many different programs can be developed and implemented. These programs can be as easy as sending informative brochures in utility bills about water conservation or as extensive as implementing outreach programs in elementary schools.

School Outreach

Many cities have been leading highly successful education programs for elementary students, typically Grades 4, 5, or 6, informing elementary students about their local watershed, water treatment, and wastewater treatment programs. These programs educate students through in-class lessons, videos, and field trips that encourage students to learn about the water cycle, their city's water system, key terms, and the processes that go into treating both drinking water and wastewater. Cities within the Henrys Fork Basin can implement similar programs to educate students about the importance of water conservation.

Water Conservation Marketing

The cities within the Henrys Fork Basin can distribute promotional handouts in utility bills or in public locations. Public works employees could give presentations at association meetings (for example, Rotary Club meetings), or at group functions to promote water conservation. Cities can also provide extensive information on water conservation for their customers on the city's website.

Technical Study

The cities within the Henrys Fork Basin can commission a water conservation survey to assess residents' views on water conservation. The purpose of the survey would be to assist the cities in developing water conservation goals for the coming years. The survey findings could be used to develop social marketing strategies for conservation programs to raise awareness and change water use patterns. The City of Victor commissioned a water conservation survey in December 2011 to assess the residents' views on water conservation, and other cities in the Henrys Fork Basin could use the City of Victor's survey as a baseline for their surveys. On the basis of the results of Victor's water conservation survey, majority of the Victor residents believe that it is very important to conserve water. Victor residents believe that the most appropriate water conservation measure to introduce in their community is implementation of a tiered water structure, which charges lower rates for lower water use. On the other hand, they believe the least appropriate conservation measure would be the introduction of mandatory water restrictions during the summer, such as only allowing outside watering on certain days/times. Currently, majority of the residents of Victor water their yard for about hour, every day in the summer.

Provide Information to Reduce Landscaping Water Demands

Cities can inform customers about the types of plants that do not require a lot of water consumption to reduce the amount of water consumed as outdoor use. In addition to education about low water consumption plants, cities can implement land use regulations within city code to encourage landscaping that requires lower water usage for new developments.

5.1.3 Replace Water Lines Buried Above Frost Depth

The concept of water line replacement is introduced in Section 3.1.3, and additional details are provided in the remainder of this section. On the basis of the information gathered in this study, the smaller municipalities in the Henrys Fork Basin (Driggs and Victor) currently have water distribution pipelines buried between 2 and 4 feet below grade. The depth of bury poses potential freezing issues in the winter because the water pipes are not buried below frost depth, which is typically 6 feet below grade. In cities where this is an issue, water users are encouraged to continually run water to prevent the pipes from freezing. By replacing the water lines buried above frost depth, the amount of water used will decrease throughout the year, especially during the winter. Replacing water lines would also decrease the amount of energy that a municipality will need to use to provide water to customers because the wells would not need to pump as much water out of the aquifer to maintain pressure in the system to serve users.

Driggs has already replaced portions of their potable water pipes and buried the new pipes below frost depth at 6 feet below grade. The City of Driggs' Public Works Director stated that after the water lines were replaced and buried below frost depth, the users connected to the new water line did not need to run water continuously in the winter months to prevent the pipes in the distribution system from freezing.

If the pipelines are replaced, municipalities will no longer need to pump as much water through their systems to maintain pressure. Once the pipelines are replaced and buried below frost depth, the municipalities will also no longer need to advise users to continually run faucets during winter months to prevent the potable water pipelines from freezing.

5.2 Package 2—New Non-potable Water Supply Options

Growth in domestic, commercial, municipal, and industrial water use in the Henrys Fork Basin is currently considered to be limited by inadequate water supply or an inability to balance use of surface water and groundwater supply portfolios. Should future economic conditions warrant growth, municipalities in and near the Basin may need to consider in investing in costly additional surface water treatment or non-potable conveyance systems since new groundwater permits have been difficult to acquire.

Package 2 consists of new non-potable water supply options that build on Package 1 presented in the previous section. Assuming the conservation measures from Package 1 have already been implemented and reduced average water use for municipalities in and near the Basin to 150 gpcd (see Exhibit 9), the supply options associated with Package 2 (reclaimed water, raw water non-potable systems, and industrial conservation) may be able to further reduce water consumption. For the sake of this analysis, it was assumed that implementation of the Package 2 elements discussed below would reduce water consumption in municipalities in and near the Basin to 104 gpcd (average water use for the case study cities). Exhibit 10 presents an estimate of the amount of water that could be conserved through implementation of Package 2 elements.

EXHIBIT 10
Summary of Potential Water Saved through Implementation of Package 2 Elements
Municipal and Industrial Conservation Alternative

	Driggs	Victor	Idaho Falls	Rexburg
Population[a]	2,105	1,928	56,813	25,484
Average day water use following Package 1 Implementation (gpcd)	150	150	150	150
Projected future average day water use following Package 2 Implementation (gpcd)	104	104	104	104
Projected water savings (gpcd)	46	46	46	46
Projected water savings[b] (af/year)	110	100	2,930	1,310

[a] Population data based upon 2010 U.S. Census Bureau data.
[b] Projected water savings were rounded to the nearest 10 af.

5.2.1 Reclaimed Water

The concept of reclaimed water is introduced in Section 3.2.1 and additional details are provided in the remainder of this section. Implementing a reclaimed water system requires an advanced wastewater treatment process to produce highly treated wastewater. Reclaimed water can be beneficially reused through land application, supply to industrial users, and replenishing groundwater supplies through ASR (subject to legal constraints described in

Section 8). To reduce the need for other sources of water, wastewater can be treated to Class A standards and reused. The Idaho Department of Environmental Quality has established standards for the reuse of reclaimed water and these standards must be met before a municipality can use reclaimed water. Creating reclaimed water that meets Class A standards would require significant and costly improvements to existing wastewater treatment processes. In addition to increased wastewater treatment, a dual pipe system and a series of pump stations will need to be constructed to convey the reclaimed water to open spaces, parks, other suitable areas for irrigation, or to industrial users for use as non-potable water. Because a large part of the groundwater pumped by the Cities is currently discharged through treatment plants to the river, becoming part of the surface water supply for downstream users, this option would increase supplies for Municipalities at the expense of downstream surface water users.

5.2.2 Raw Water Non-potable Systems

The concept of raw water non-potable systems is introduced in Section 3.2.2, and additional details are provided in the remainder of this section. A dual-pipe system for raw surface water could be constructed in cities near or within the Henrys Fork Basin for irrigating open spaces, parks, or other suitable areas. This new, non-potable water supply would decrease the amount of potable water consumed as outdoor usage. Installing a dual pipe system and a series of pump stations to convey the raw water to open spaces, parks, other suitable areas for irrigation, or to industrial users for use as non-potable water would require costly system improvements. To utilize this new non-potable water supply the municipality would need to more fully utilize existing surface water rights or obtain additional surface water rights to convey water for irrigation purposes. It is unlikely that new surface water rights for irrigation-season uses could be issued without new surface water storage being constructed.

5.2.3 Industrial Conservation Example—Breweries/Malting Plants

The concept of industrial conservation is introduced in Section 3.1.4, and additional details are provided in the remainder of this section. According to A-B's website, A-B has "steadily reduced its global water usage rate over the past year by employing a mix of engineering improvements, operational innovations, and strong awareness and behavior-driven actions to optimize efficiency in every plant."

Many of the A-B breweries in China have been recycling the effluent from the brewery to public housing nearby, similar to reclaimed water. The recycled brewery effluent is used for washrooms, landscaping, and firefighting. According to A-B, they are considering expanding the project to 32 other factories in China. To recycle effluent from breweries in the U.S., the brewery would be required to treat the effluent to Class A standards and acquire a permit to recycle the treated water.

6 Cost Estimate

6.1 Package 1—Municipal Water Conservation Measures

A summary of the total implementation cost and cost per acre-foot of water conserved following implementation of all Package 1 measures is presented in Exhibit 11, and a more detailed breakdown of the cost for each measure is provided in the following sections.

EXHIBIT 11
Cost Estimate for Package 1 Elements
Municipal and Industrial Conservation Alternative

Conservation Measure[b]	Total Implementation Cost[a]				Total
	Driggs	Victor	Idaho Falls	Rexburg	
Metering	$80,000 - $450,000	$70,000 - $410,000	$2,130,000 - $12,070,000	$960,000 - $5,420,000	$3,240,000 - $18,350,000
Education	Minimal	Minimal	Minimal	N/A	Minimal
Replace water lines buried above frost depth	$1,000,000	$1,000,000	N/A	N/A	$2,000,000
Combined Total Implementation Cost					$5,240,000 - $20,350,000
Combined Anticipated Water Savings (af/yr)					19,230
Cost Per Unit Yield[c] ($/af)					300 – 1,100

[a] Total estimated construction costs were rounded to the nearest $10,000.
[b] For detailed cost estimates and source of cost data see Exhibits 12 and 13.
[c] Cost per unit yield was rounded to the nearest $100/af.

6.1.1 Metering

To estimate the cost of meter installation, it was assumed that $750 per connection would cover the cost of the meter, an isolation valve, and the associated installation costs. Exhibit 12 below presents the estimated cost of meter installation for municipalities in and near the Basin. A range of costs was estimated to reflect uncertainty regarding the number of meters currently installed in Idaho Falls and the number of operational meters in Driggs, Victor, and Rexburg.

EXHIBIT 12
Metering Cost Estimate
Municipal and Industrial Conservation Alternative

	Driggs	Victor	Idaho Falls	Rexburg
Population[a]	2,150	1,928	56,813	25,484
Assumed number of connections[b]	702	643	18,938	8,495
Assumed Percentage of Meters to Replace[c]	15% - 85%	15% - 85%	15% - 85%	15% - 85%
Estimated cost per connection[d]	$750	$750	$750	$750
Estimated total cost[e]	$80,000 - $450,000	$70,000 - $410,000	$2,130,000 - $12,070,000	$960,000 - $5,420,000

[a] Population data based upon 2010 U.S. Census Bureau data. The City of Driggs population includes a population of about 445 additional people outside the city limits for a total population of approximately 2,105 people.
[b] Number of connections assumes that an average of three people reside in each household or dwelling.
[c] Rexburg, Driggs, and Victor already have meters in place. However, some meters may need to be replaced because they are not operational.
[d] Cost per connection is based upon data summarized in the City of Victor Water System Facilities Planning Study, April 2011.
[e] Estimated total costs were rounded to the nearest $10,000.

6.1.2 Public Education

The cost of public education is minimal compared to the other conservation alternatives evaluated. The cities near or within the Henrys Fork Basin could implement water conservation education programs for minimal cost.

6.1.3 Replace Water Lines Buried Above Frost Depth

Data reviewed in Section 4.2 indicated that small municipalities in the Basin (Driggs and Victor) have water lines currently buried above frost depth, which leads to freezing, breaking, and leakage. However, this issue does not appear to be prevalent in the larger cities of Rexburg and Idaho Falls. Therefore, cost estimates for pipe replacement were developed for the smaller municipalities only. As stated previously, the City of Driggs replaced portions of their water mains in 2011. Using cost information provided by the City of Driggs, it is estimated that it would cost approximately $100 per linear foot to replace water mains with new 8-inch ductile iron pipelines. This cost includes installation of the water main, engineering, and administrative costs. Exhibit 13 below summarizes the estimated cost of water main replacement for a small municipality (assumed applicable to both Driggs and Victor).

EXHIBIT 13
Water Line Replacement Cost Estimate
Municipal and Industrial Conservation Alternative

	Small Municipality (Driggs[a] or Victor)
Assumed total length of pipe[b] (linear feet)	10,000
Estimated cost per linear foot[c]	$100
Estimated total cost	$1,000,000

[a] Although Driggs replaced a portion of shallow pipes in 2011, this estimate assumes full system pipe replacement.
[b] Total pipe length for Driggs and Victor was not provided, so this value was assumed as being representative of a small municipality.
[c] The cost per linear foot was estimated based upon data provided by the City of Driggs from the 2011 water replacement project. The unit price includes engineering (20%) and administrative costs (5%).

It is estimated that it would cost a small municipality approximately $1 million to replace water lines throughout the city. The cost per acre foot of water saved per year is approximately $700 for a small municipality.

6.2 Package 2—New Non-potable Water Supply Options

As indicated in Section 5.2, growth in domestic, commercial, municipal, and industrial water use in the Henrys Fork Basin is currently considered to be limited by inadequate water supply or an inability to balance use of surface water and groundwater supply portfolios. Should future economic conditions support growth, municipalities in and near the Basin may need to consider in investing in costly additional surface water treatment or non-potable conveyance systems since new groundwater permits have been difficult to acquire.

It is beyond the scope of the current study to acquire all the detailed information necessary to quantify implementation costs for the Package 2 supply options (reclaimed water, raw water non-potable systems, and industrial conservation). However, those costs, which may include wastewater treatment plant upgrades to produce Class A water, construction of additional pump stations, and construction of miles of transmission and distribution pipes to convey the treated wastewater or raw water to the points of application, could be further investigated in a future phase of the study.

7 Basin Water Needs

Municipal water conservation measures associated with Package 1 (metering, public education, and replacement of water lines currently above frost depth) would conserve approximately 19,230 af per year for the municipalities, assuming full implementation in Driggs, Victor, Idaho Falls, and Rexburg. Further municipal savings on the order of 4,450 af per year could be achieved through implementation of the new non-potable water supply options included in Package 2 (reclaimed water, non-potable systems, and industrial conservation) in Driggs, Victor, Idaho Falls, and Rexburg.

Since growth of these municipalities is currently considered to be limited by inadequate water supply or an inability to balance use of surface water and groundwater supply portfolios (high costs for additional surface water treatment or non-potable conveyance systems and inability to acquire new groundwater permits), it is assumed that existing groundwater rights would continue to be fully utilized. Consequently, although municipalities would benefit from implementation of both packages, these conservation measures and new non-potable water supply options have the potential to reduce the amount of water currently available to downstream in- and out-of-basin users. In short, while these measures may provide additional supplies for municipalities, it may come at the expense of other water users in the basin.

Basin water needs are discussed in further detail in the *Draft Henrys Fork Watershed Basin Study Water Needs Assessment* (Bureau of Reclamation, 2012).

8 Legal, Institutional, or Policy Constraints

- **Water Rights.** Although not considered at this level of study, water rights would need to be accounted for prior to utilization of any new surface water source (e.g., raw water non-potable systems).
- **Reclaimed Water.** Appropriate permits would have to be acquired to implement water reuse systems.
- **Aquifer Storage and Recovery.** Although the State of Idaho does not recognize conventional ASR, cities in the Basin could (and in some cases have previously done so) acquire existing surface water shares in a canal system through annexation. An application for a new water right permit could then be accompanied by a mitigation plan through which their surface water shares could be recharged into the groundwater in an amount equal to the City's pumping under their new permit. This scenario was successfully implemented by Micron in the Boise area many years ago.

9 Environmental Benefits and Impacts

Alternatives in this study were evaluated for benefits and impacts related to the following:

- Impacted river segments
- Change in connectivity
- State Aquatic Species of Special Concern (Yellowstone Cutthroat Trout and Rainbow Trout)
- Natural environment (including wildlife habitat impacts, federally listed species, wetlands, State species of concern, and special river designations)

Municipalities in the Basin currently provide customers with water pumped from wells rather than water diverted from surface sources, so implementation of municipal and industrial conservation measures would not be likely to directly impact any river segments. Indirectly, decreased groundwater pumping has the potential to result in increased aquifer discharge to local river segments, effectively enhancing downstream connectivity, but such changes may not be observed if the cities utilize their full rights following implementation of the measures (less water may actually be available for downstream uses). If raw water non-potable systems were implemented, additional water surface water may be withdrawn from local river reaches. Yellowstone cutthroat trout and other natural environment factors listed above are likely to be relatively unaffected by implementation of municipal and industrial conservation measures and new non-potable water supply options.

10 Land Management, Recreation and Infrastructure Impacts and Benefits

Municipal and industrial conservation measures and new non-potable water supply options are unlikely to have substantial benefits or impacts related to land management, recreation, and infrastructure. However, there may be temporary construction impacts to roads during installation of new pipe systems, and

11 Evaluation Criteria

11.1 Stakeholder Group Measurable Criteria

There are four Stakeholder Group Measurable Criteria, with results summarized in Exhibit 14:

- **Water Supply.** The net change for in basin and out of basin water budgets in acre-feet is described in Section 7 and summarized in Section 2.
- **Water Rights.** Water rights were not specifically addressed during this level of study, but known legal, institutional, and policy constraints are summarized in Section 8.
- **Environmental Considerations.** Environmental benefits and impacts are summarized above in Section 9.
- **Economics.** The estimated reconnaissance-level field cost to construct the project is summarized in Section 6.

EXHIBIT 14
Stakeholder Group Measurable Criteria Summary
Municipal and Industrial Conservation Alternative

Stakeholder Group Measurable Criteria	Criteria Characterization
Water supply (in-basin water transfer)	19,230 af/yr
Water supply (out-of-basin water transfer)	Minimal
Legal, institutional, or policy constraints (yes, no)	Yes
Environmental considerations (net positive, negative or neutral)	Neutral
Economics (reconnaissance-level field costs for implementation)	$5,240,000 - $20,350,000

11.2 Federal Viability Tests

The four federal viability tests used to evaluate potential projects are listed below:

- **Acceptability**
- **Effectiveness** (extent to which basin needs are met)
- **Completeness** (extent to which all needs are met)
- **Efficiency** (relative construction/implementation cost per af)

For alternatives that are carried forward to future phases of the Basin Study, the information needed to evaluate each of the criteria listed above will be further developed and refined.

12 Key Assumptions and Limitations

Cost estimates are comparative and preliminary. Future concept refinements could potentially change the ranking of alternatives by cost. Costs are relative and are not intended for budgeting.

13 Data Sources

Water usage and sanitary sewer flow data was collected from the following municipalities in or near the Henrys Fork Basin:

- City of Idaho Falls
- City of Rexburg
- City of Driggs
- City of Victor

13.1.1 City of Idaho Falls

The City of Idaho Falls provided water and wastewater data from the City's supervisory control and data acquisition system and flow meters throughout Idaho Falls. Water production data was provided for 2009 through 2011, and wastewater data was provided for 2003 through 2011. The data provided were helpful to understand the City of Idaho Falls indoor and outdoor water consumption history.

- City of Idaho Falls. 2010. City of Idaho Falls Comprehensive Plan Background Studies.
- Anheuser-Busch Water Conservation. http://www.anheuser-busch.com/s/index.php/our-responsibility/environment-our-earth-our-natural-resources/water/. 23 February 2012.

13.1.2 City of Rexburg

The City of Rexburg provided water and wastewater flow data for 2011. The data provided were helpful to understand the trend of indoor and outdoor water consumption for 2011; however, long term trends could not be developed. For the purposes of this study, the data provided was sufficient to understand the City of Rexburg indoor and outdoor water consumption.

13.1.3 City of Driggs

The City of Driggs provided water production data for 2009 through 2011 and metered data for 2003 through 2009. The City of Driggs also provided the *Driggs Wastewater Treatment Facilities Plan* (2006) as a resource for the City's wastewater data as well as 2011 wastewater flow data. The data and reports provided enough information to understand the City of Driggs water consumption history.

- Nelson Engineering. 2006. *Driggs Wastewater Treatment Facilities Plan*.
- Sunrise Engineering, Inc. 2010. City of Driggs Water System Discussion Notes for Information Presented at the City of Driggs Council Meeting.

13.1.4 City of Victor

The City of Victor water and wastewater data was provided by Sunrise Engineering in Afton, Wyoming. Sunrise Engineering provided the *City of Victor Water System Environmental Information Document* (2011), the *Water System Facilities Planning Study* (2011), and a technical memorandum, *Victor/Driggs Interceptor Capacity Analysis and Improvement Recommendation* (2010). These reports and the technical memorandum provided enough data and information to understand the City of Victor indoor and outdoor water consumption history.

- Sunrise Engineering, Inc. 2010. *City of Victor and City of Driggs Interceptor Capacity Analysis and Improvement Recommendations Technical Memorandum*.
- Sunrise Engineering, Inc. 2011. *City of Victor Water System Environmental Information Document*.
- Sunrise Engineering, Inc. 2011. *City of Victor Water System Facilities Planning Study*.

13.1.5 Other Sources

- Bureau of Reclamation. 2012. *Draft Henrys Fork Watershed Basin Study Water Needs Assessment*. March.
- City of Meridian. 2011. *City of Meridian, Idaho, 2011 Water Conservation Plan*.
- Kawamura, Susumu. 2000. *Integrated Design and Operation of Water Treatment Facilities*. 2nd Edition.
- Metcalf & Eddy. 2003. *Wastewater Engineering Treatment and Reuse*. 4th Edition.