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
Pacific Northwest Region
Boise, Idaho

October 2012

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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.

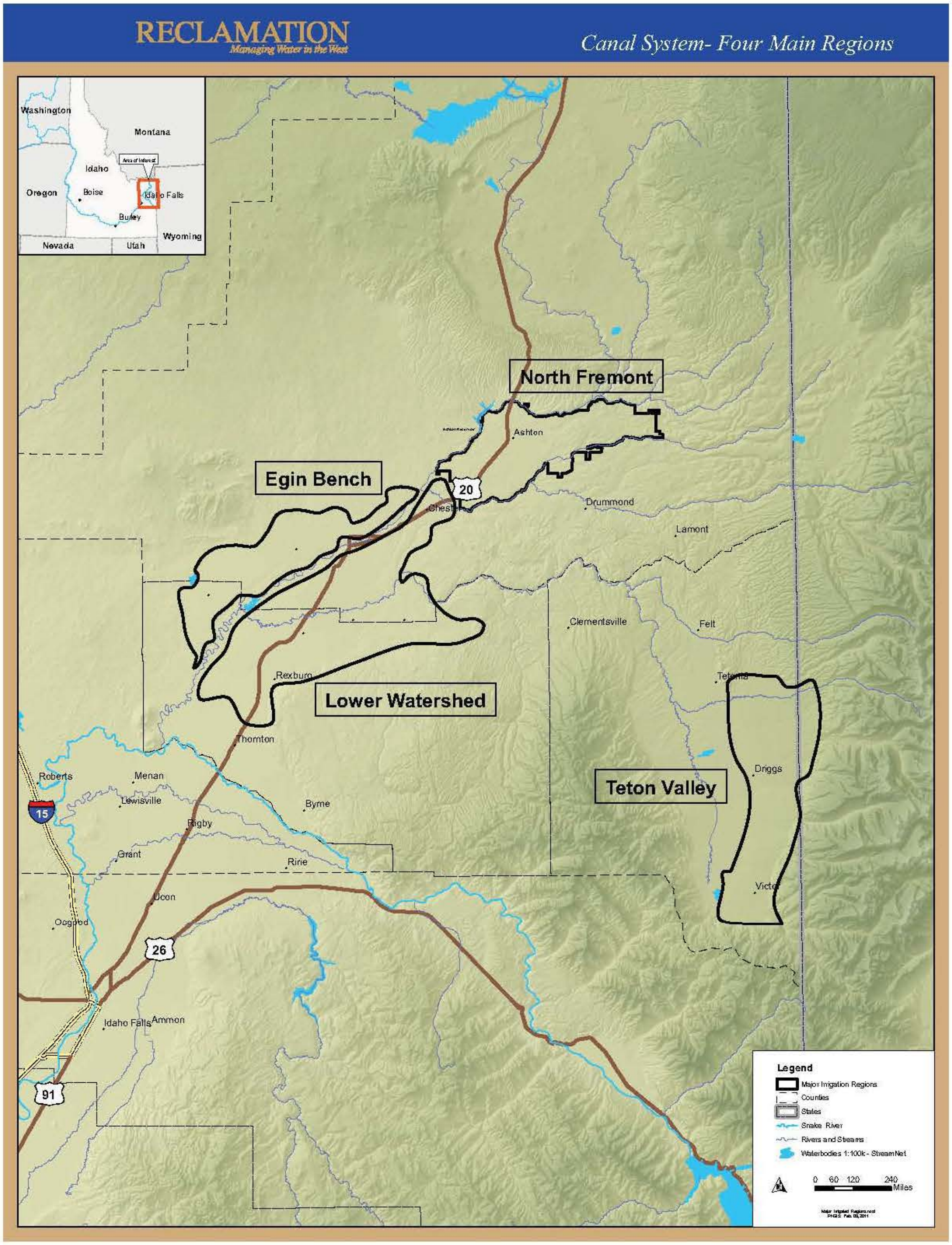

Figure 1. Four major irrigated regions in the Henrys Fork Basin Study area.

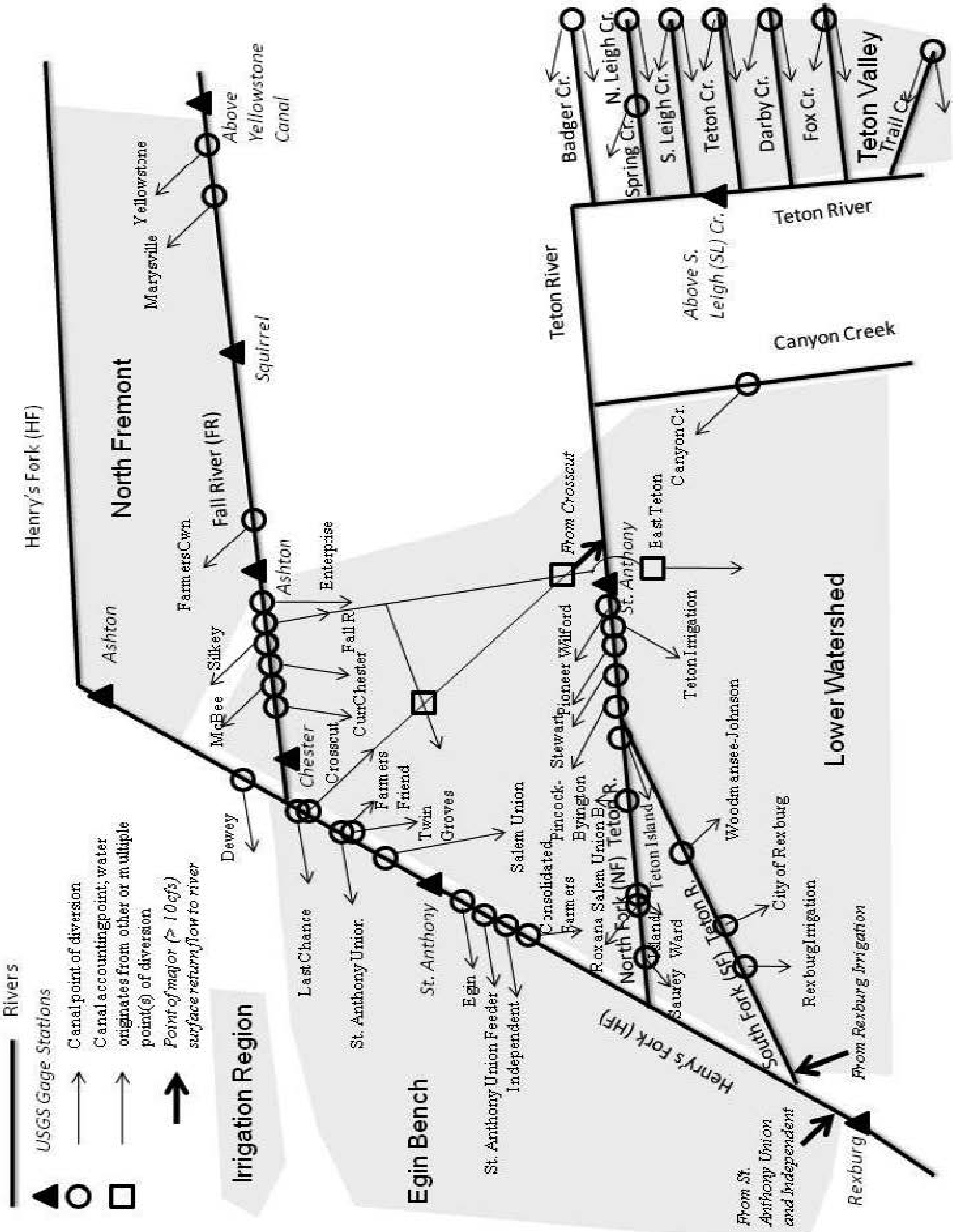

Figure 2. Canal schematic showing 43 diversion points in the Henrys Fork River basin (Van Kirk).

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:

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

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

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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

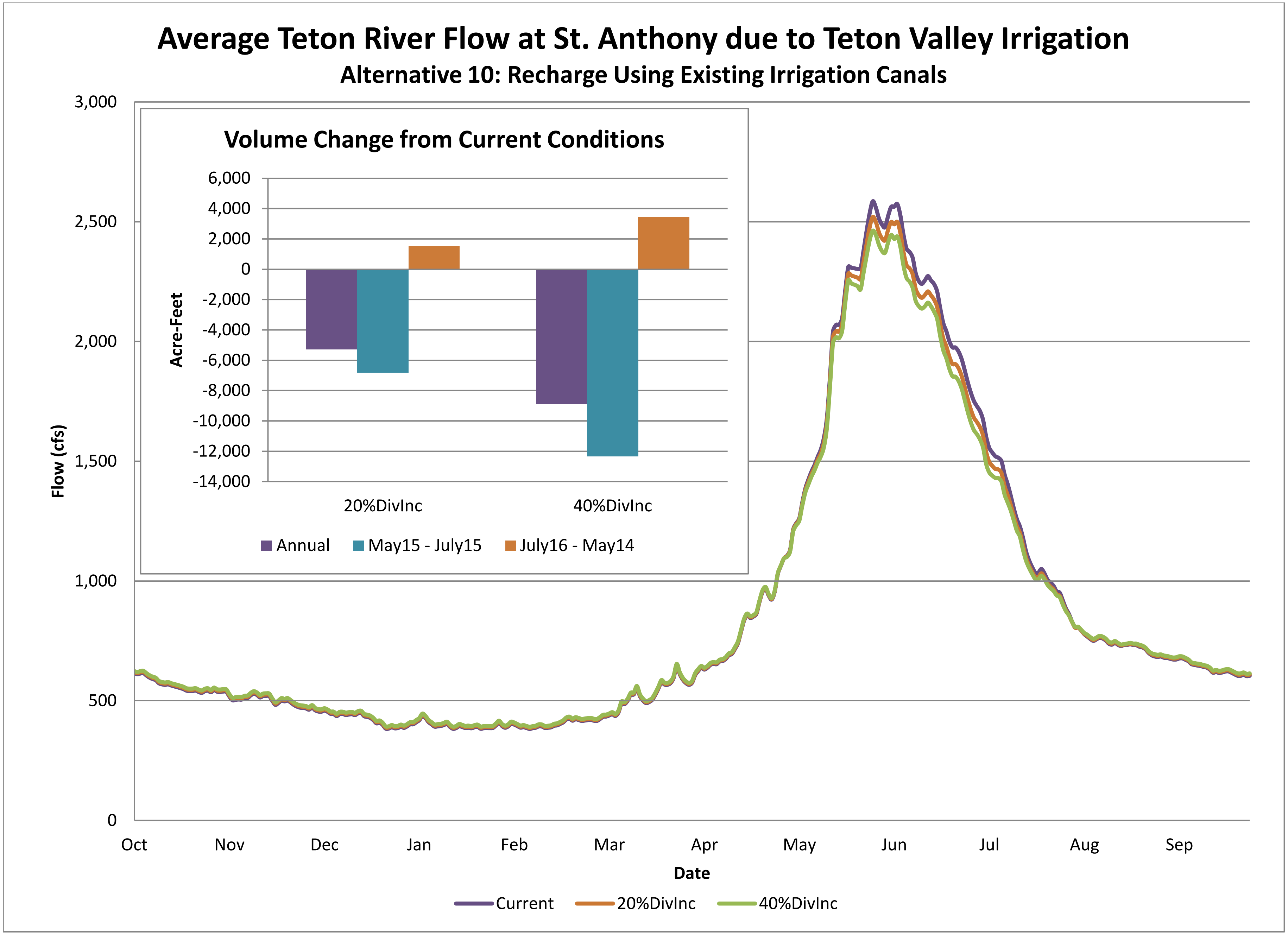
[1] The period from May 15 to July 15

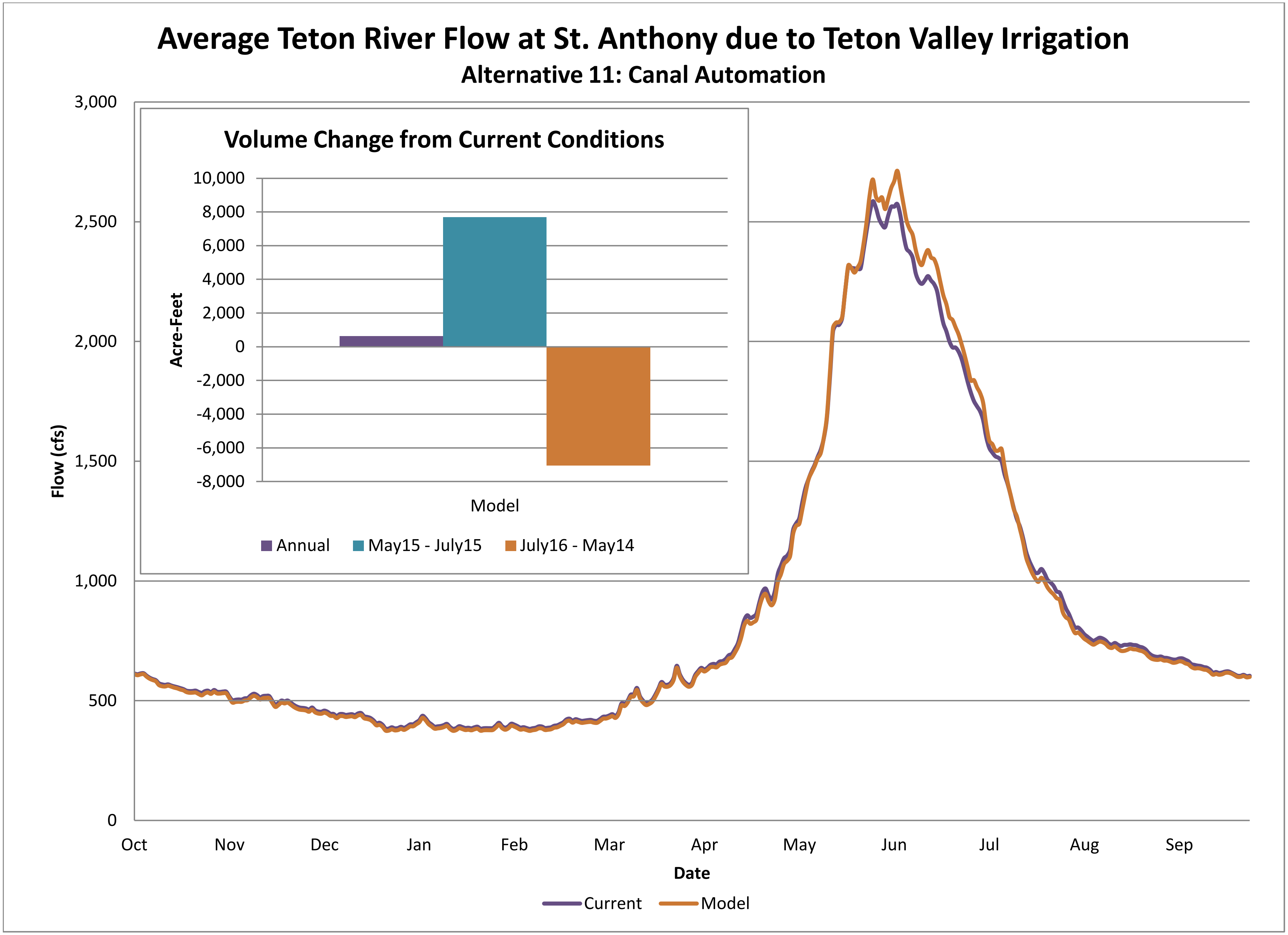
[2] The period from July 16 to May 14

				Acre Feet				Percent Change				
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**
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	-

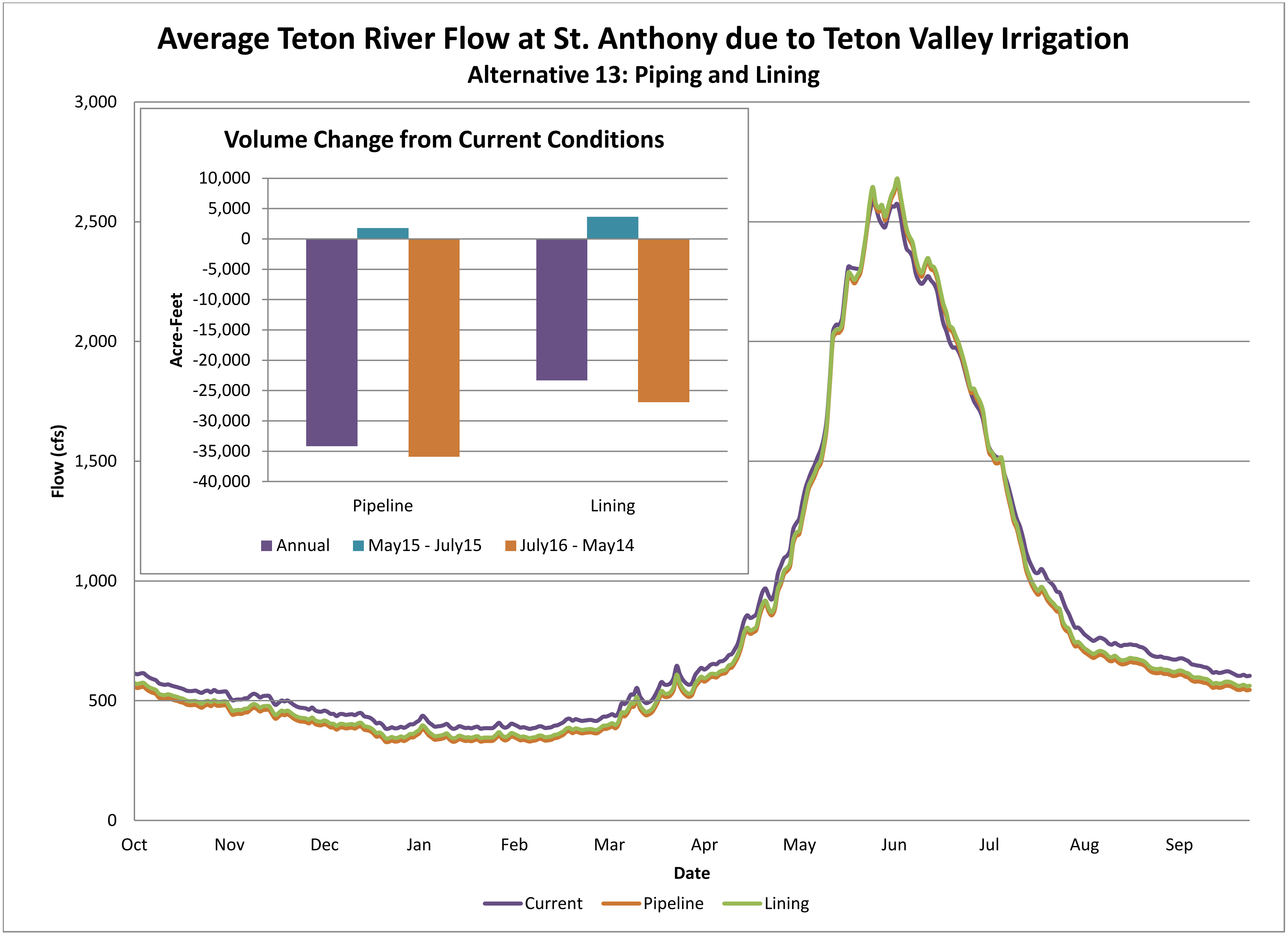
APPENDIX B

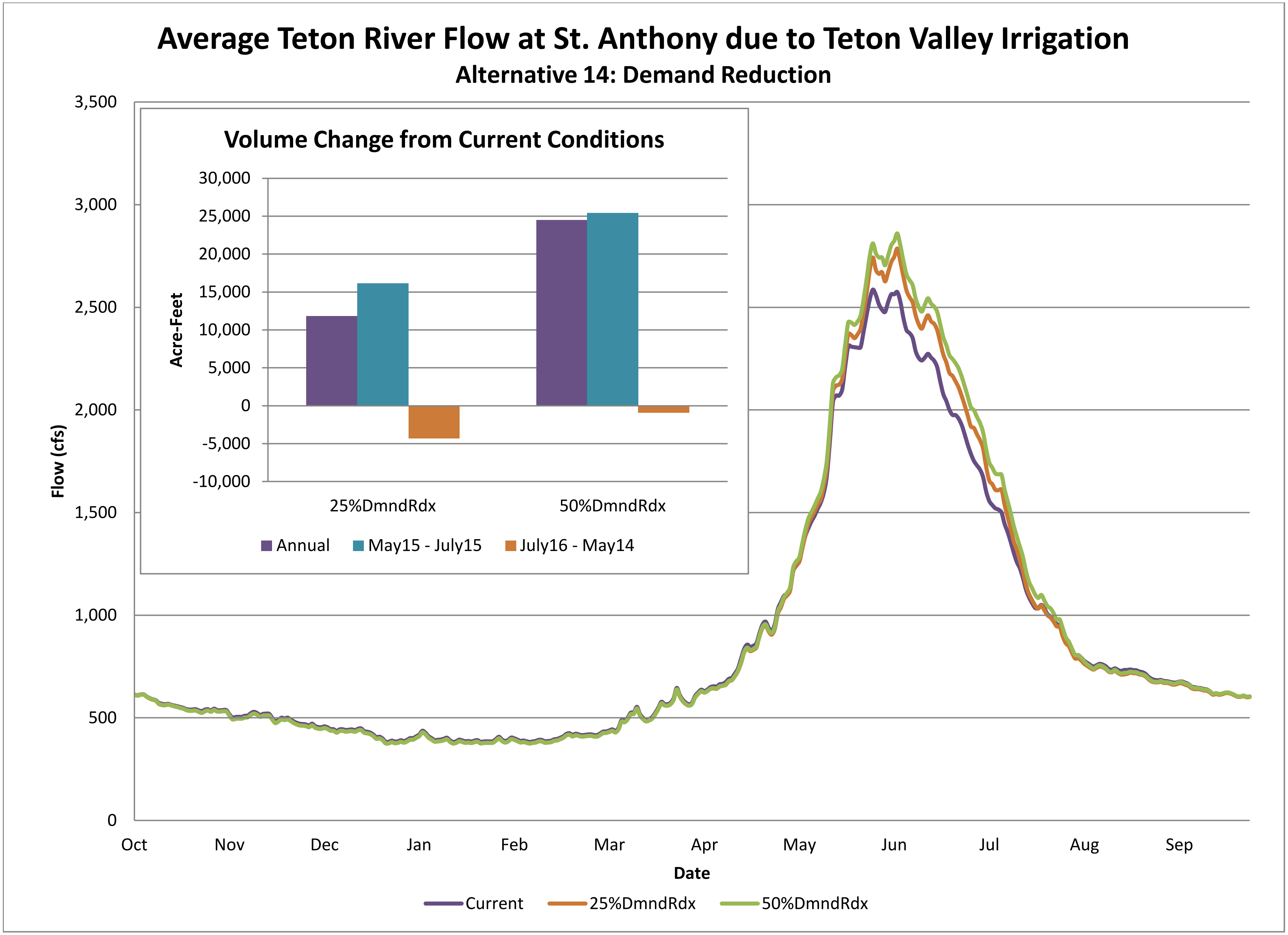
Output Hydrographs for the Conservation Alternatives

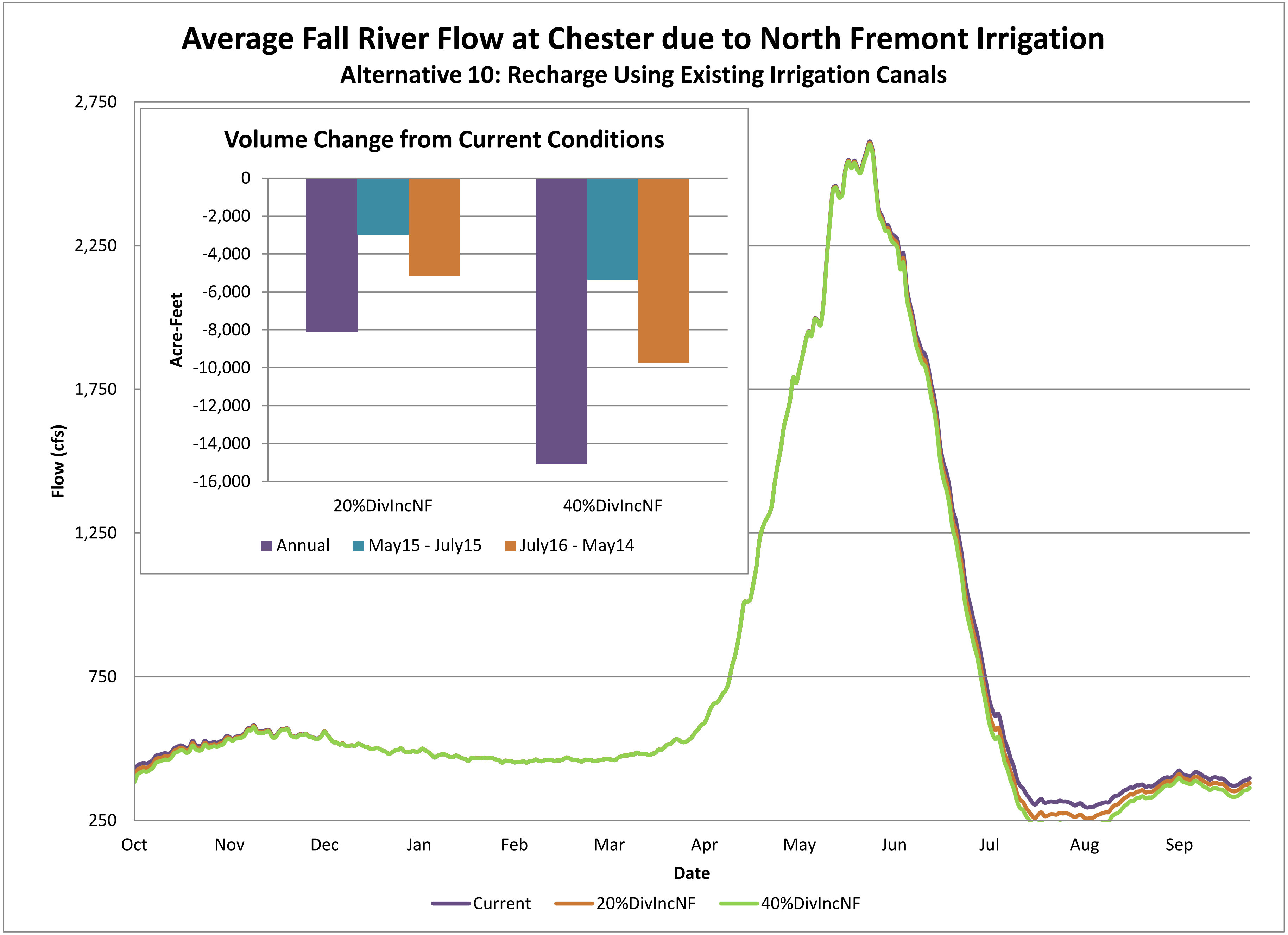

Average Teton River Flow at St. Anthony due to Teton Valley Irrigation
Alternative 10: Recharge Using Existing Irrigation Canals
Volume Change from Current Conditions
6,000
4,000
2,000
0
-2,000
-4,000
-6,000
-8,000
-10,000
-12,000
-14,000
Acre-Feet
20%DivInc
40%DivInc
Annual
May15 - July15
July16 - May14
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
20%DivInc
40%DivInc

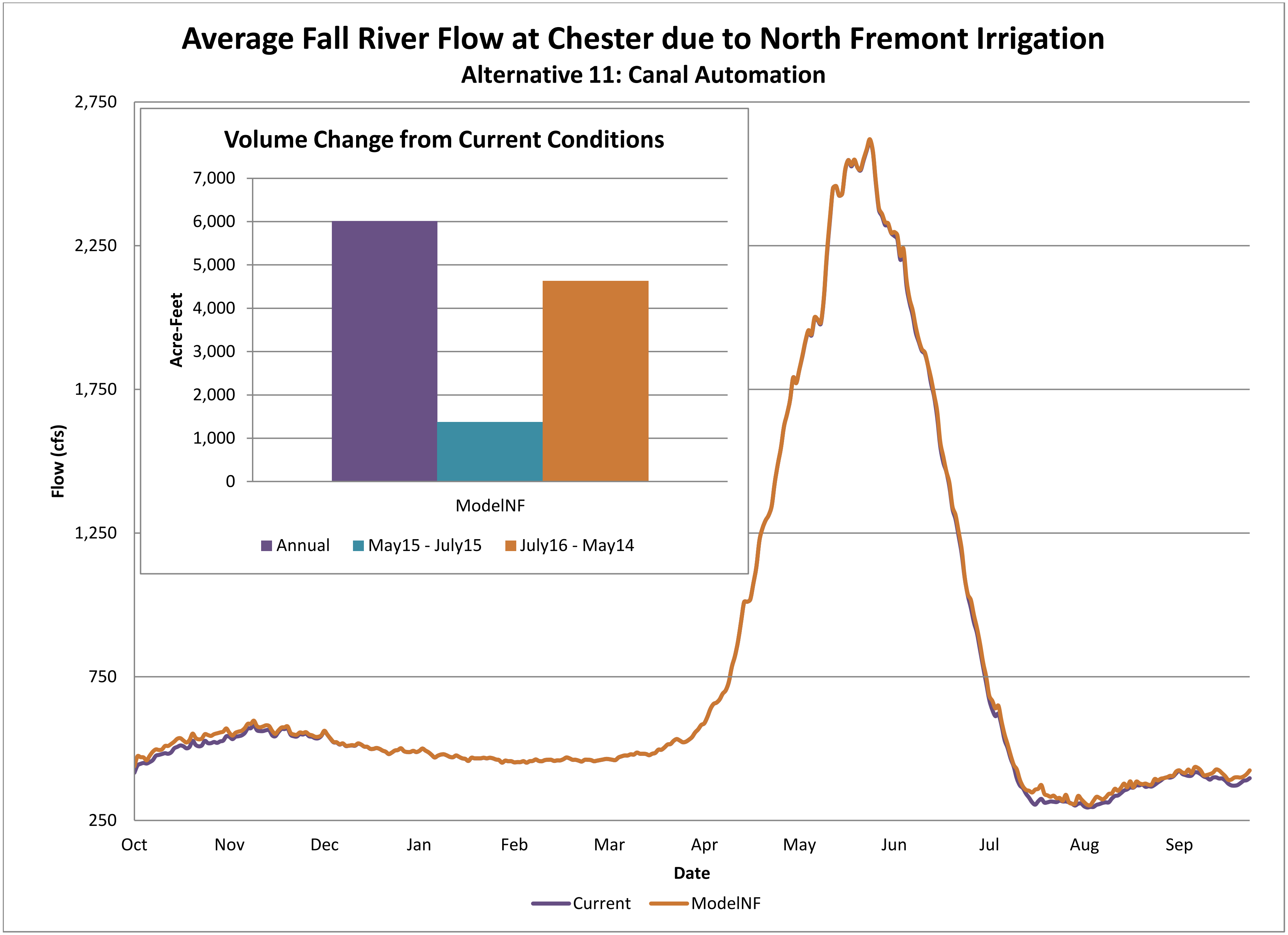


Average Teton River Flow at St. Anthony due to Teton Valley Irrigation
Alternative 11: Canal Automation
Flow (cfs)
3,000
2,500
2,000
1,500
1,000
500
0
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Date
Current
Model
Volume Change from Current Conditions
Acre-Feet
10,000
8,000
6,000
4,000
2,000
0
-2,000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

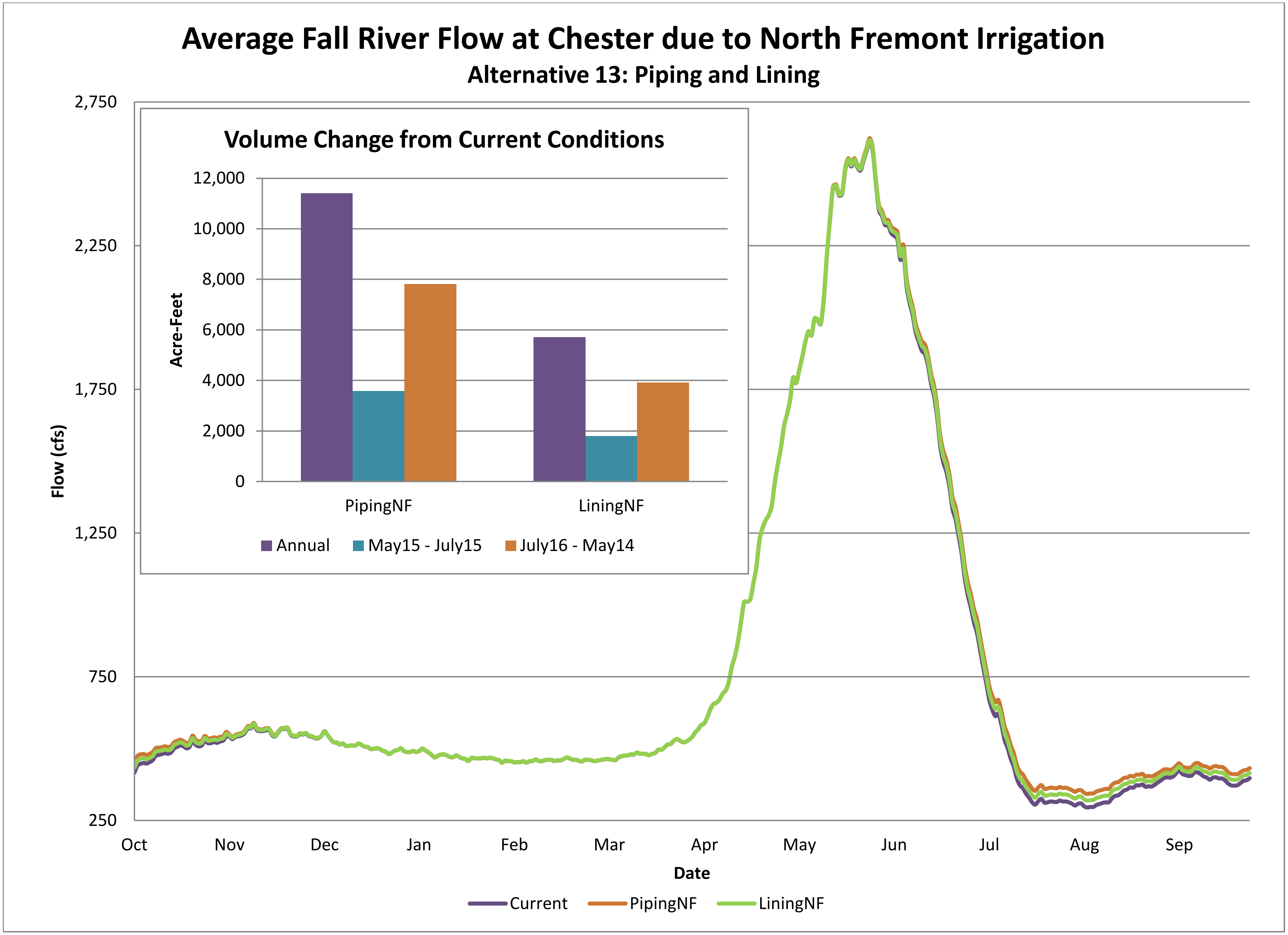

Average Teton River Flow at St. Anthony due to Teton Valley Irrigation
Alternative 13: Piping and Lining
Flow (cfs)
3,000
2,500
2,000
1,500
1,000
500
0
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Date
Current
Pipeline
Lining
Volume Change from Current Conditions
Acre-Feet
10,000
5,000
0
-5,000
-10,000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

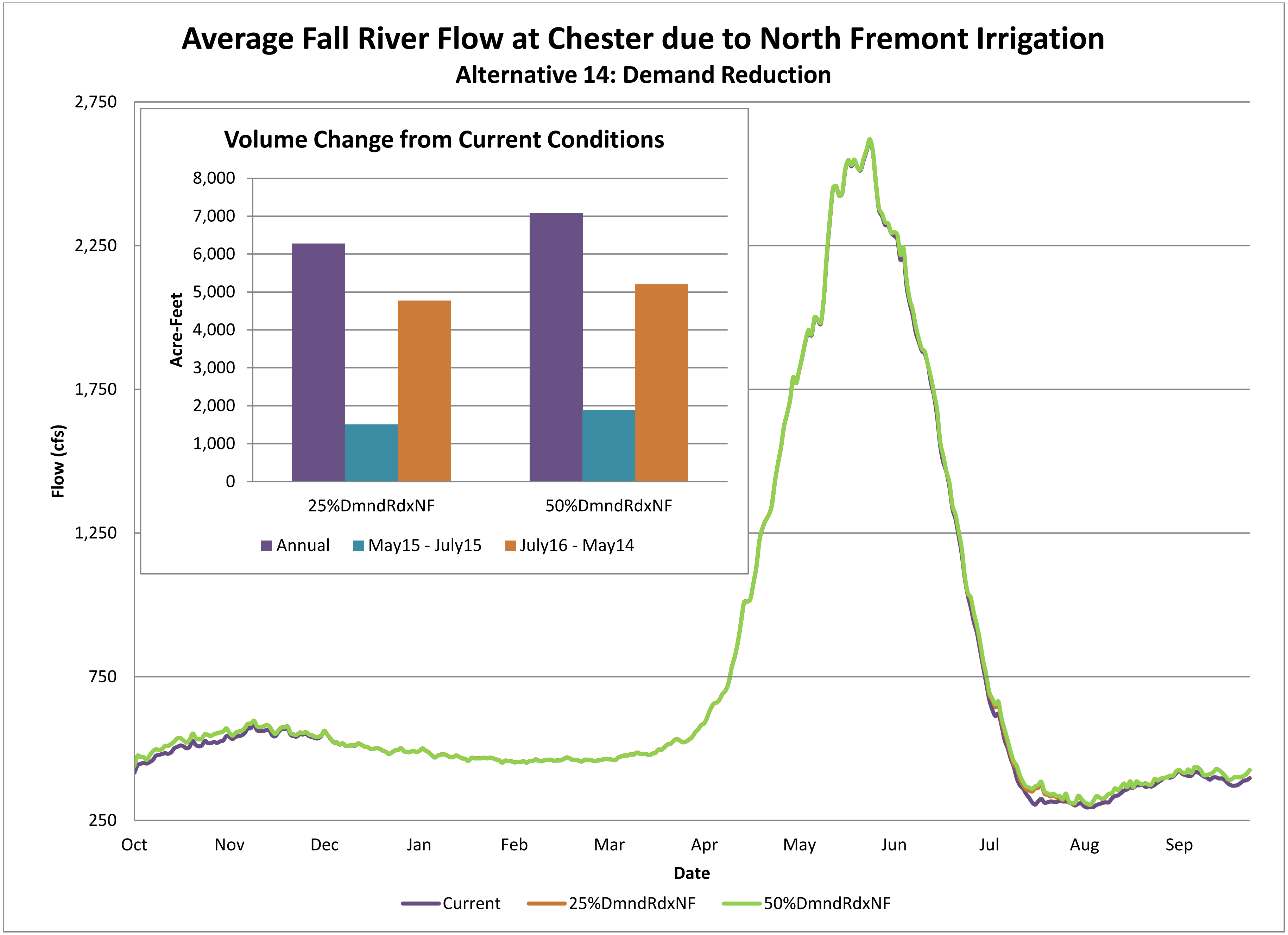

Average Teton River Flow at St. Anthony due to Teton Valley Irrigation
Alternative 14: Demand Reduction
Volume Change from Current Conditions
Acre-Feet
30,000
25,000
20,000
15,000
10,000
5,000
0
-5,000
-10,000
25%DmndRdx
50%DmndRdx
Annual
May15 - July15
July16 - May14
Flow (cfs)
3,500
3,000
2,500
2,000
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
Acre-Feet
0
-2,000
-4,000
-6,000
-8,000
-10,000
-12,000
-14,000
-16,000
20%DivIncNF
40%DivIncNF
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
20%DivIncNF
40%DivIncNF

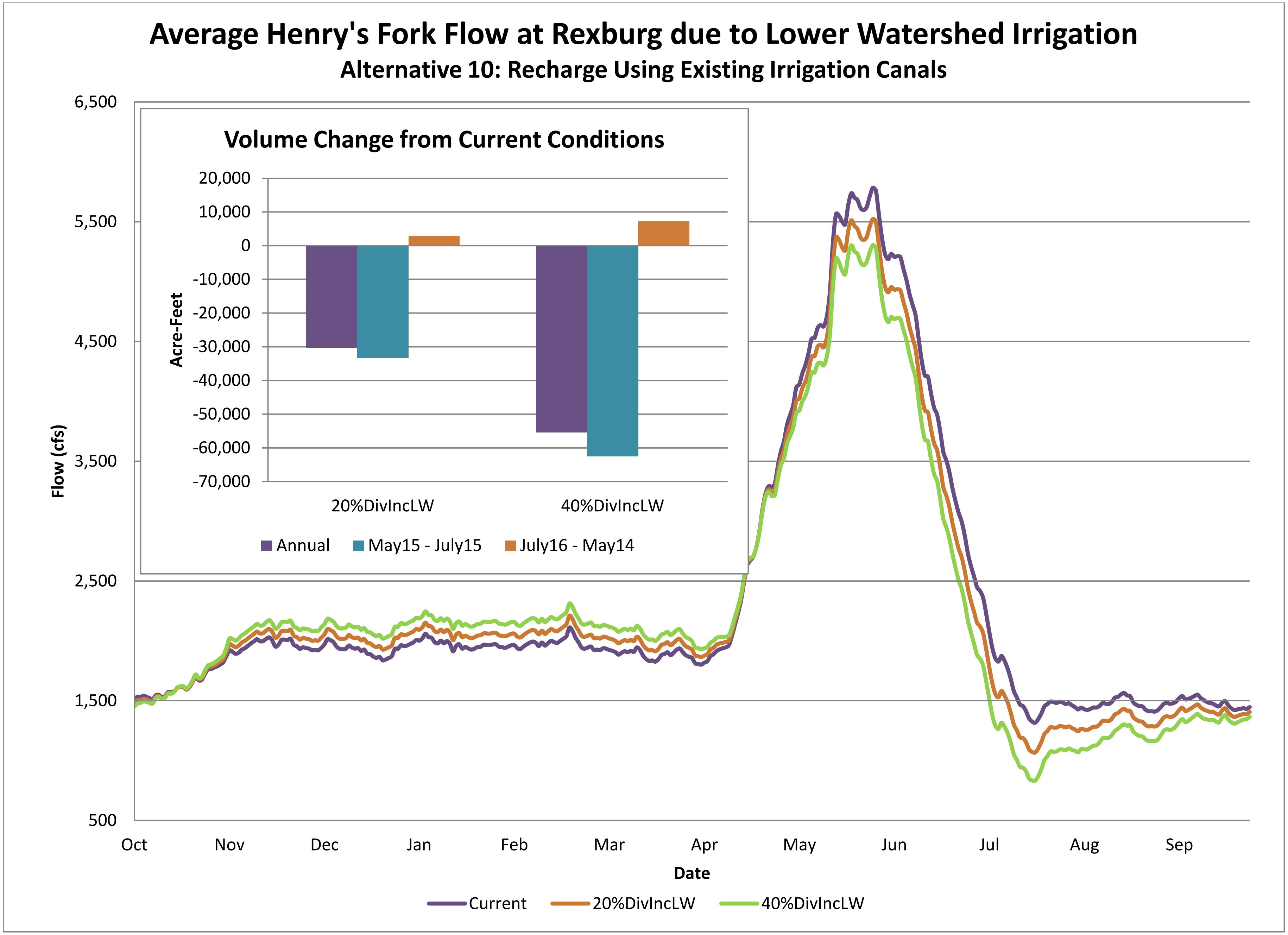


Average Fall River Flow at Chester due to North Fremont Irrigation
Alternative 11: Canal Automation
Flow (cfs)
2,750
2,250
1,750
1,250
750
250
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Date
Current
ModelNF
Volume Change from Current Conditions
Acre-Feet
7,000
6,000
5,000
4,000
3,000
2,000
1,000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

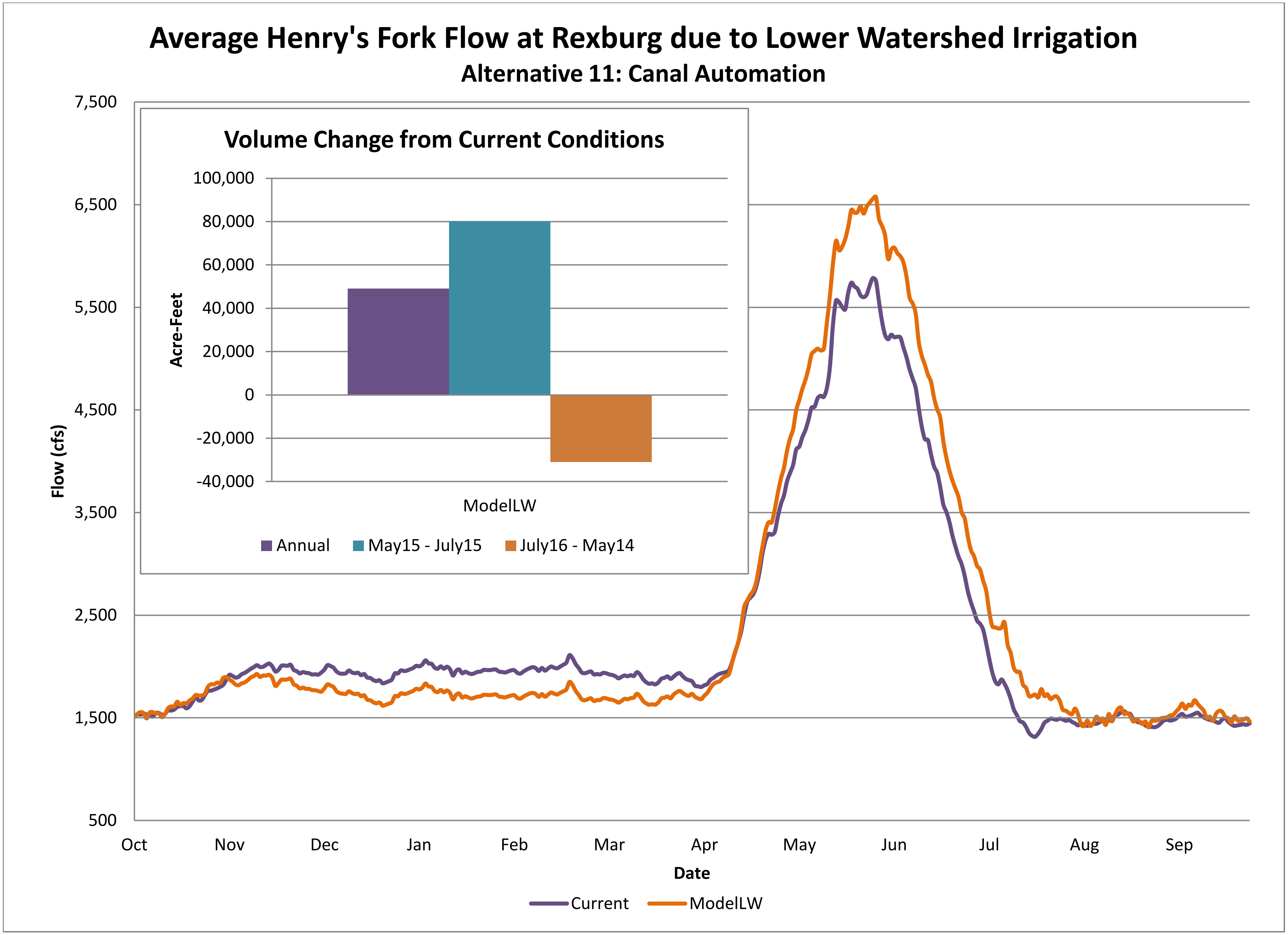

Average Fall River Flow at Chester due to North Fremont Irrigation
Alternative 13: Piping and Lining
Volume Change from Current Conditions
Acre-Feet
12,000
10,000
8,000
6,000
4,000
2,000
0
PipingNF
LiningNF
Annual
May15 - July15
July16 - May14
Flow (cfs)
2,750
2,250
1,750
1,250
750
250
Oct
Nov
Dec
Jan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



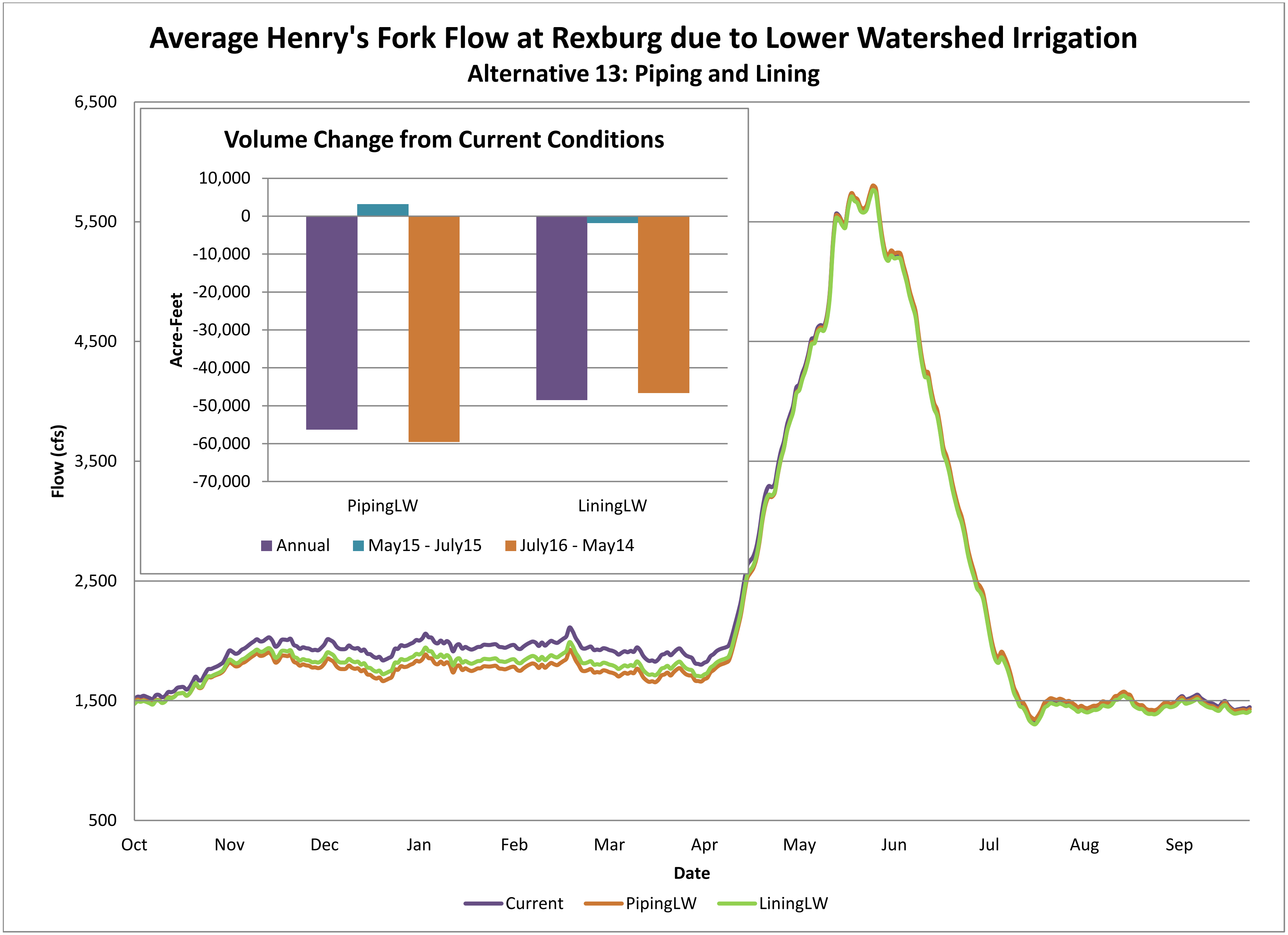
Average Fall River Flow at Chester due to North Fremont Irrigation
Alternative 14: Demand Reduction
Volume Change from Current Conditions
Acre-Feet
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
25%DmndRdxNF
50%DmndRdxNF
Annual
May15 - July15
July16 - May14
Flow (cfs)
2,750
2,250
1,750
1,250
750
250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

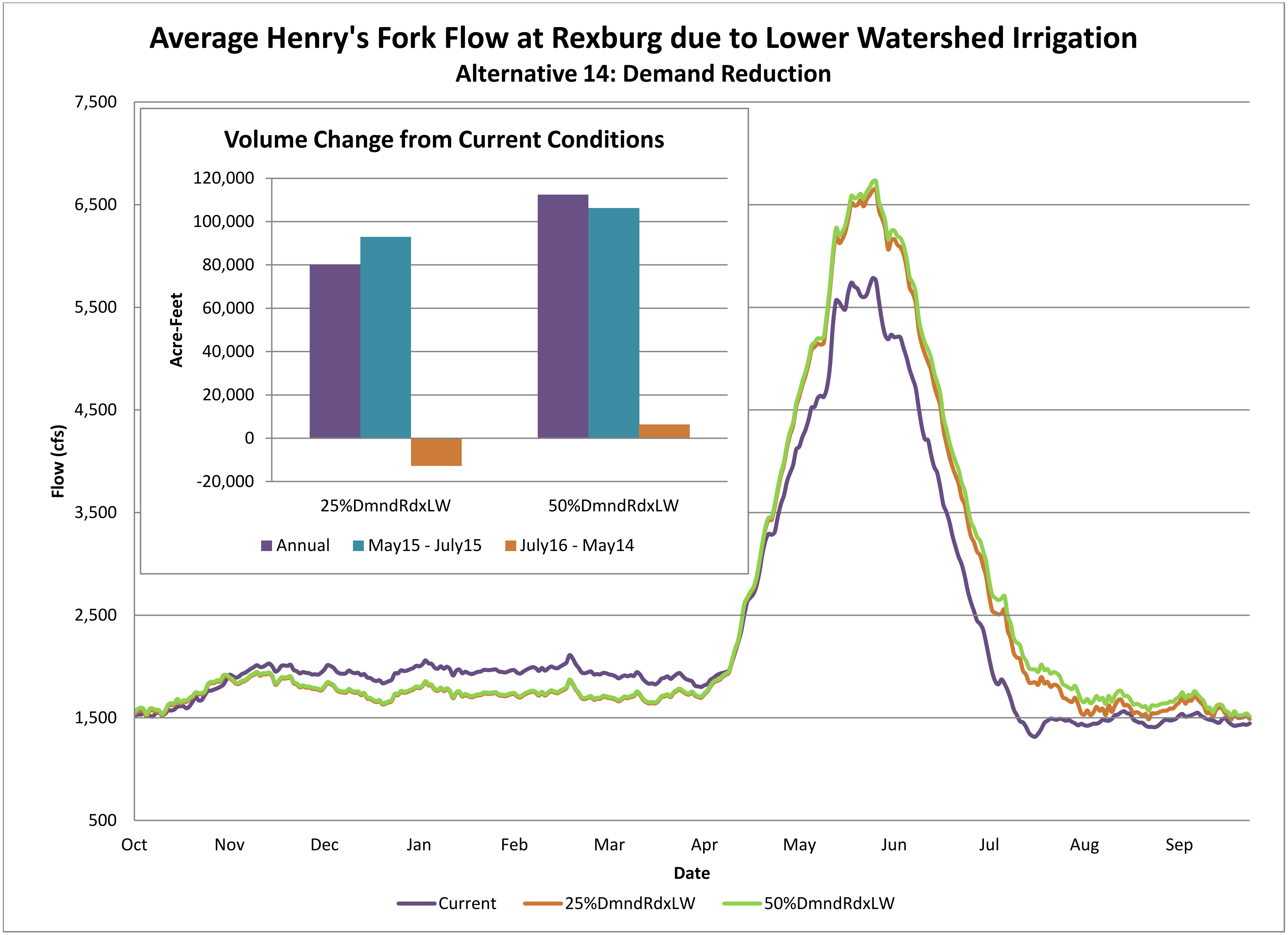


Average Henry's Fork Flow at Rexburg due to Lower Watershed Irrigation
Alternative 10: Recharge Using Existing Irrigation Canals
Flow (cfs)
6,500
5,500
4,500
3,500
2,500
1,500
500
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Date
Current
20%DivIncLW
40%DivIncLW
Volume Change from Current Conditions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

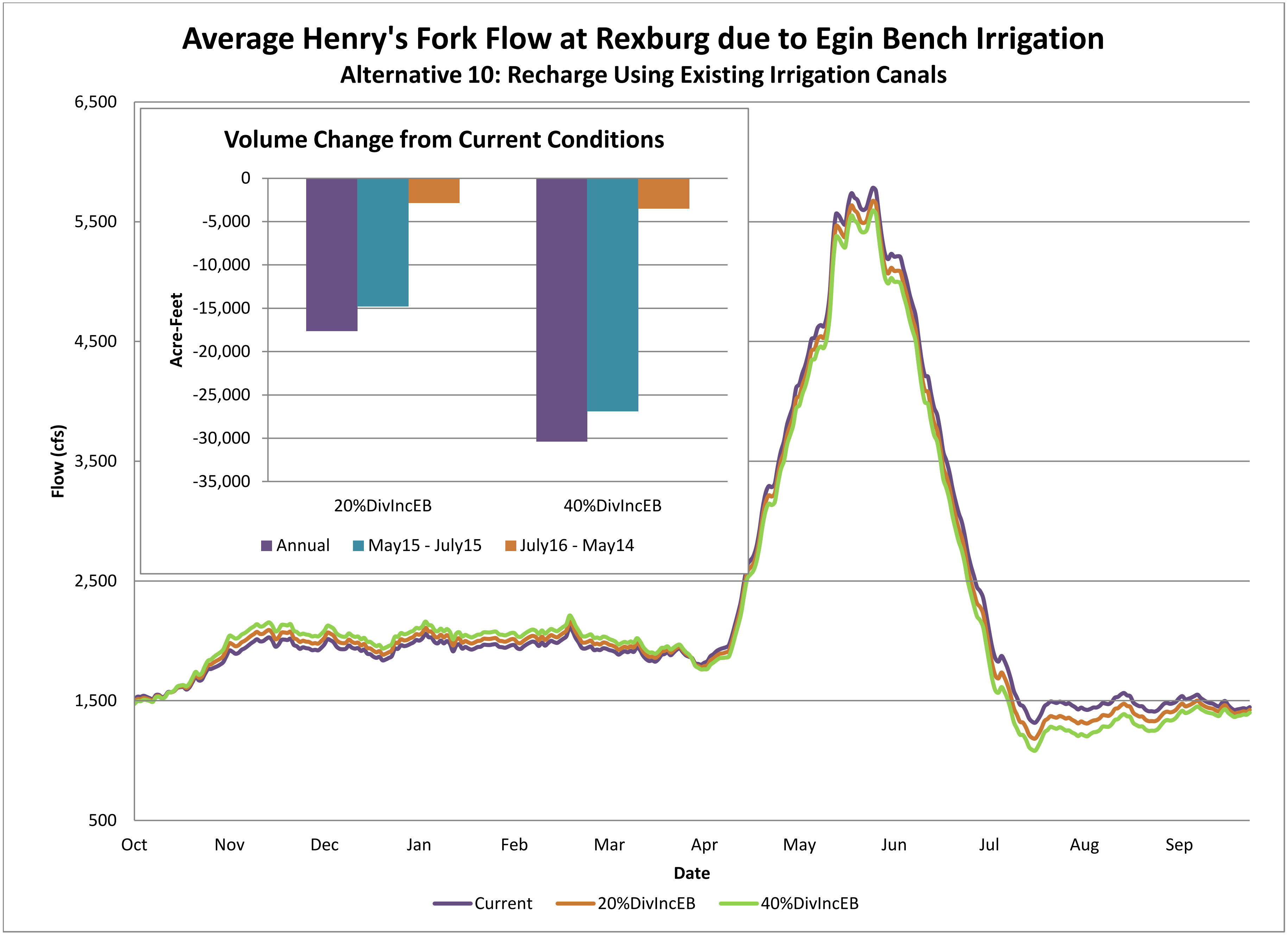


Average Henry's Fork Flow at Rexburg due to Lower Watershed Irrigation
Alternative 11: Canal Automation
Volume Change from Current Conditions
100,000
80,000
60,000
40,000
20,000
0
-20,000
-40,000
Acre-Feet
ModelLW
Annual
May15 - July15
July16 - May14
7,500
6,500
5,500
4,500
3,500
2,500
1,500
500
Flow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

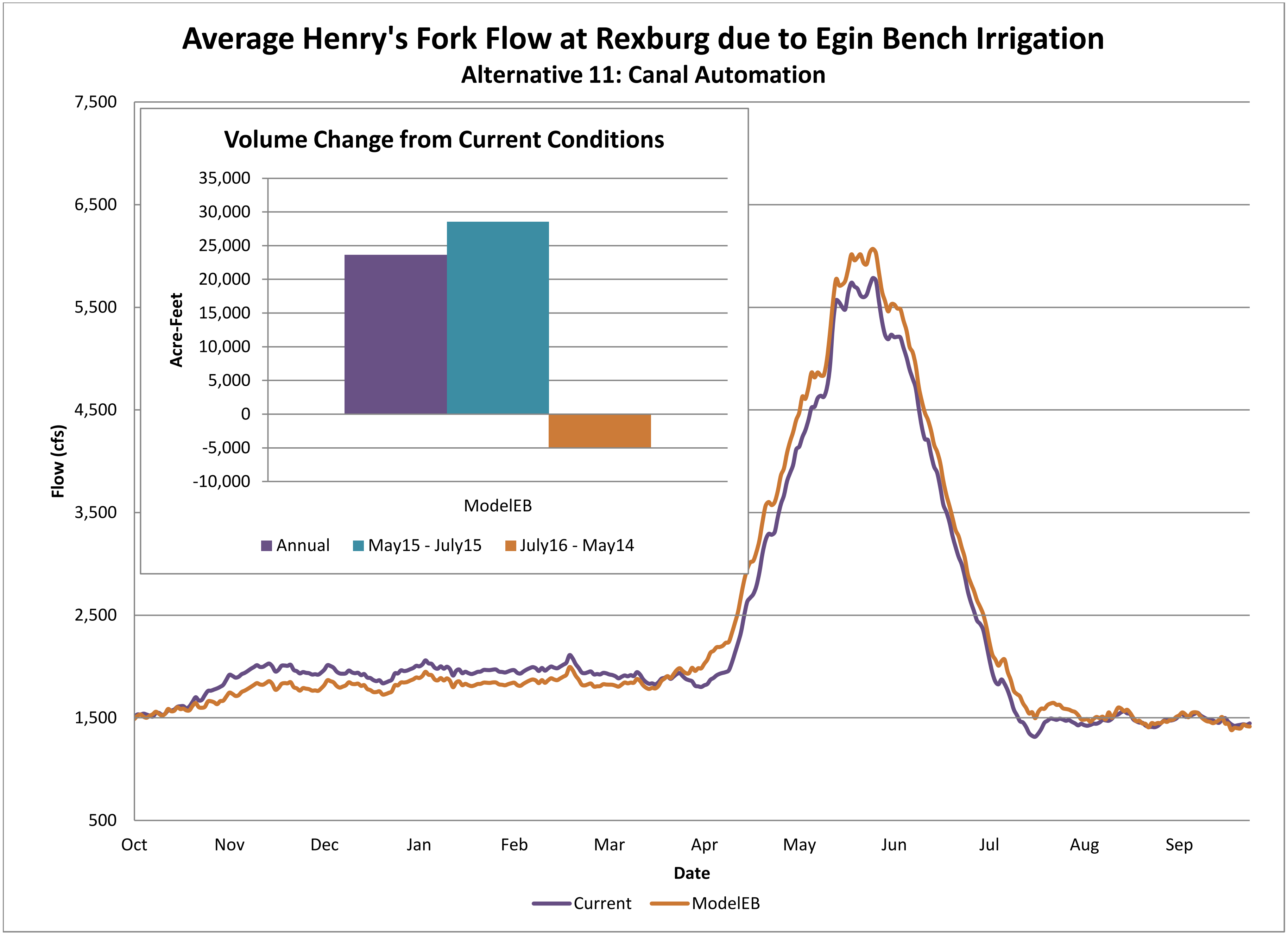

Average Henry's Fork Flow at Rexburg due to Lower Watershed Irrigation
Alternative 13: Piping and Lining
Flow (cfs)
6,500
5,500
4,500
3,500
2,500
1,500
500
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Date
Current
PipingLW
LiningLW
Volume Change from Current Conditions
Acre-Feet
10,000
0
-10,000
-20,000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

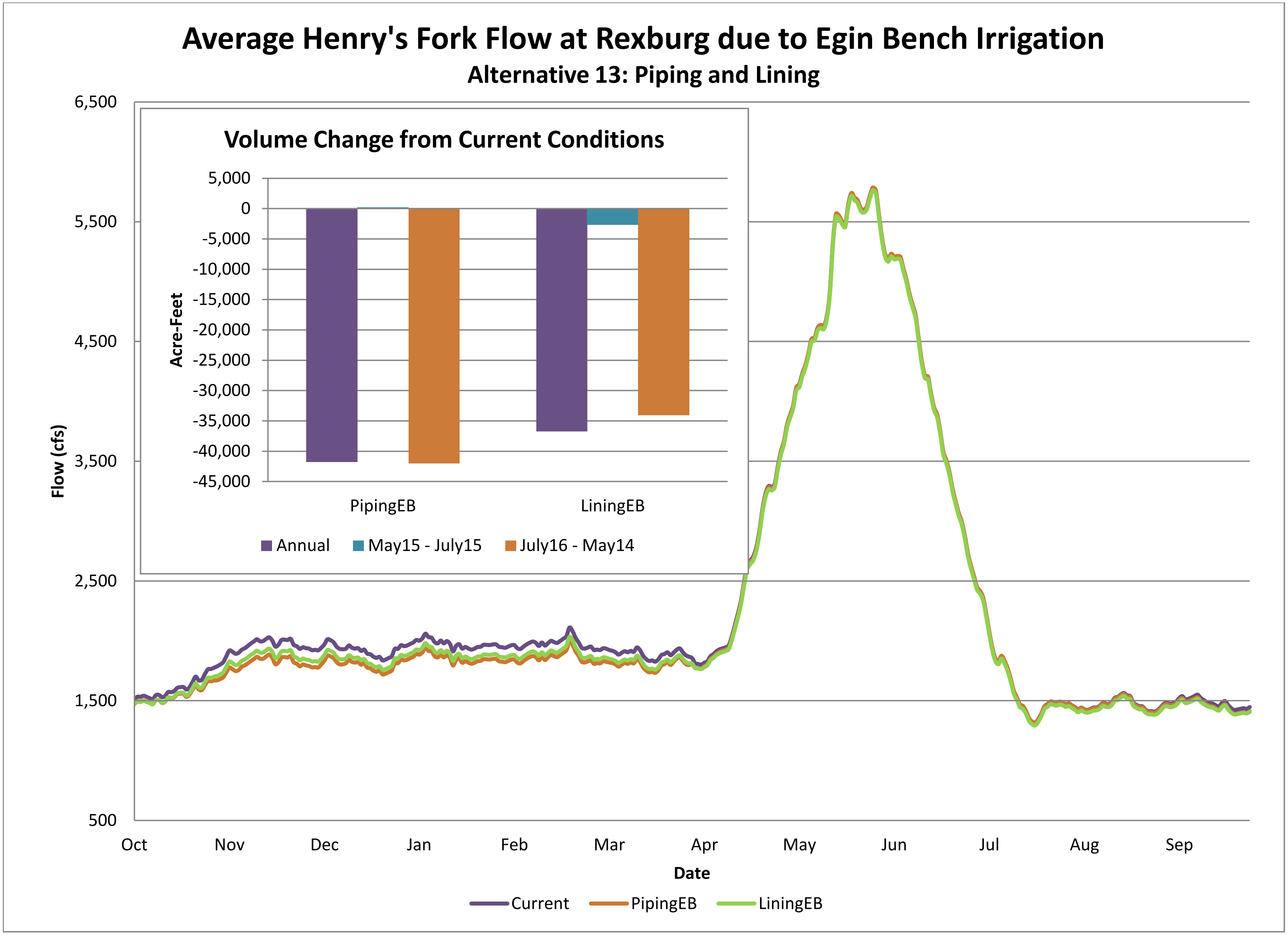


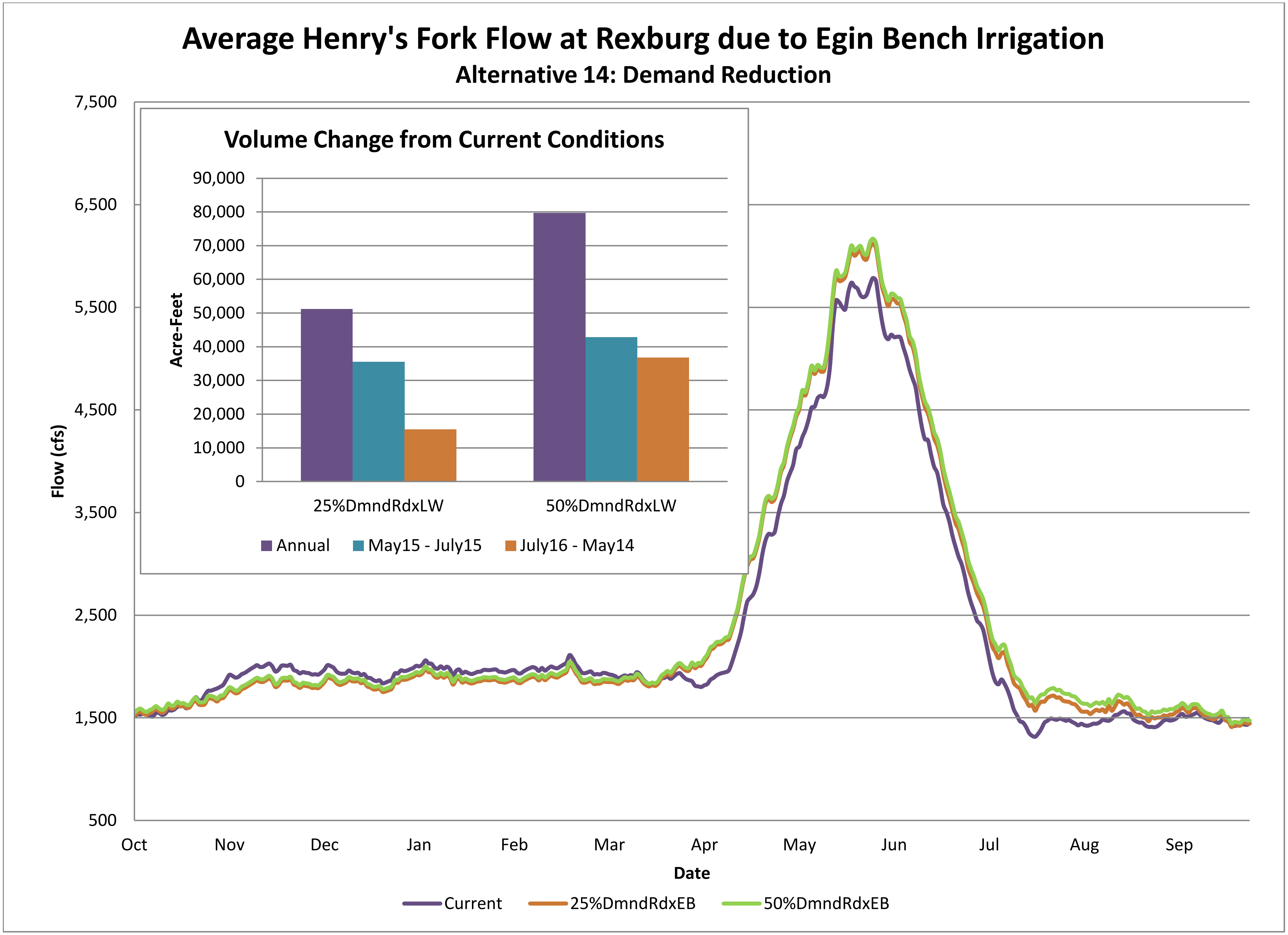
Average Henry's Fork Flow at Rexburg due to Lower Watershed Irrigation
Alternative 14: Demand Reduction
Volume Change from Current Conditions
Acre-Feet
120,000
100,000
80,000
60,000
40,000
20,000
0
-20,000
25%DmndRdxLW
50%DmndRdxLW
Annual
May15 - July15
July16 - May14
Flow (cfs)
7,500
6,500
5,500
4,500
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

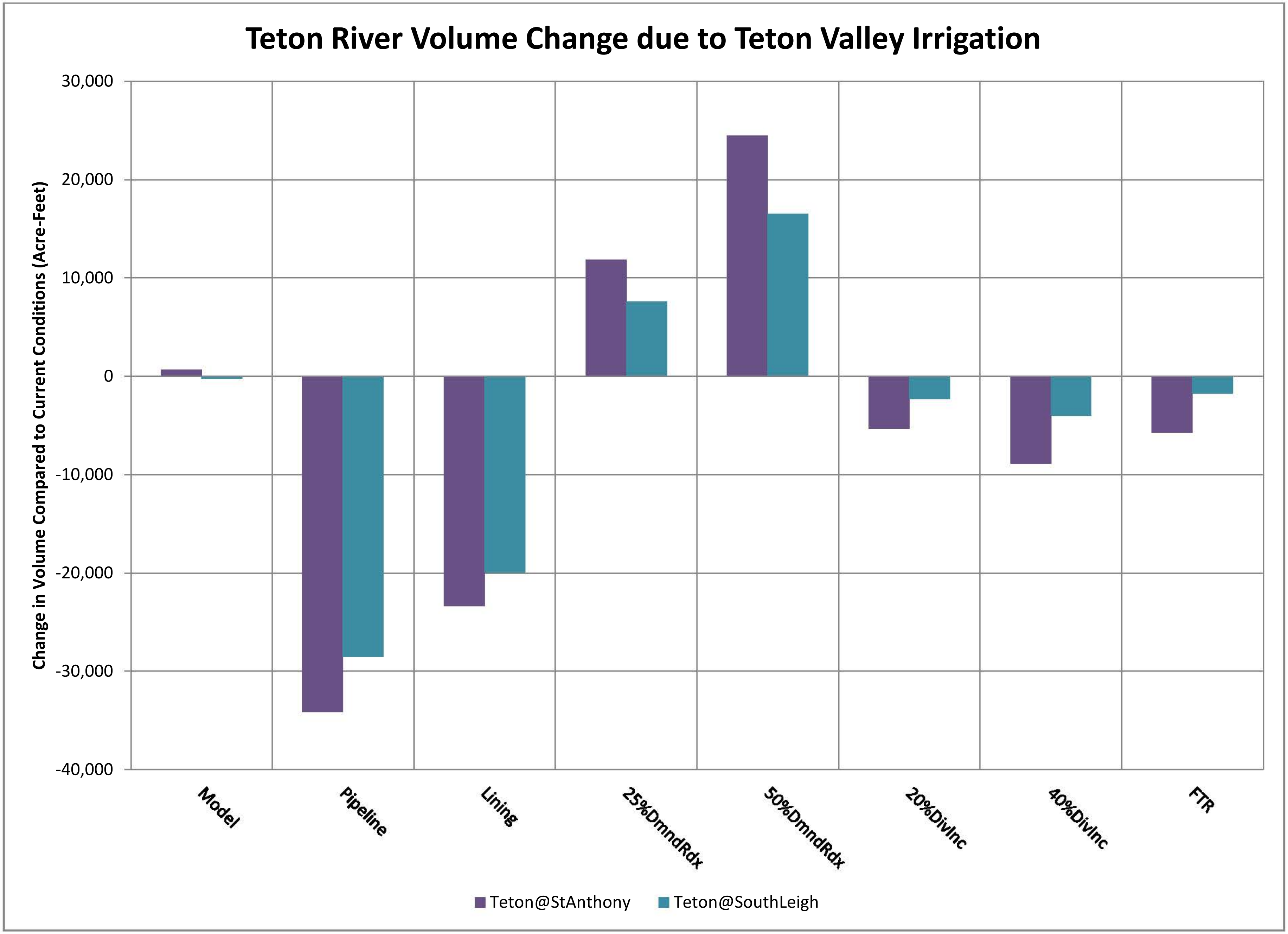

Average Henry's Fork Flow at Rexburg due to Egin Bench Irrigation
Alternative 11: Canal Automation
Volume Change from Current Conditions
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
-5,000
-10,000
Acre-Feet
ModelEB
Annual
May15 - July15
July16 - May14
7,500
6,500
5,500
4,500
3,500
2,500
1,500
500
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
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
PipingEB
LiningEB
Volume Change from Current Conditions
5,000
0
-5,000
-10,000
-15,000
-20,000
-25,000
-30,000
-35,000
-40,000
-45,000
Acre-Feet
PipingEB
LiningEB
Annual
May15 - July15
July16 - May14

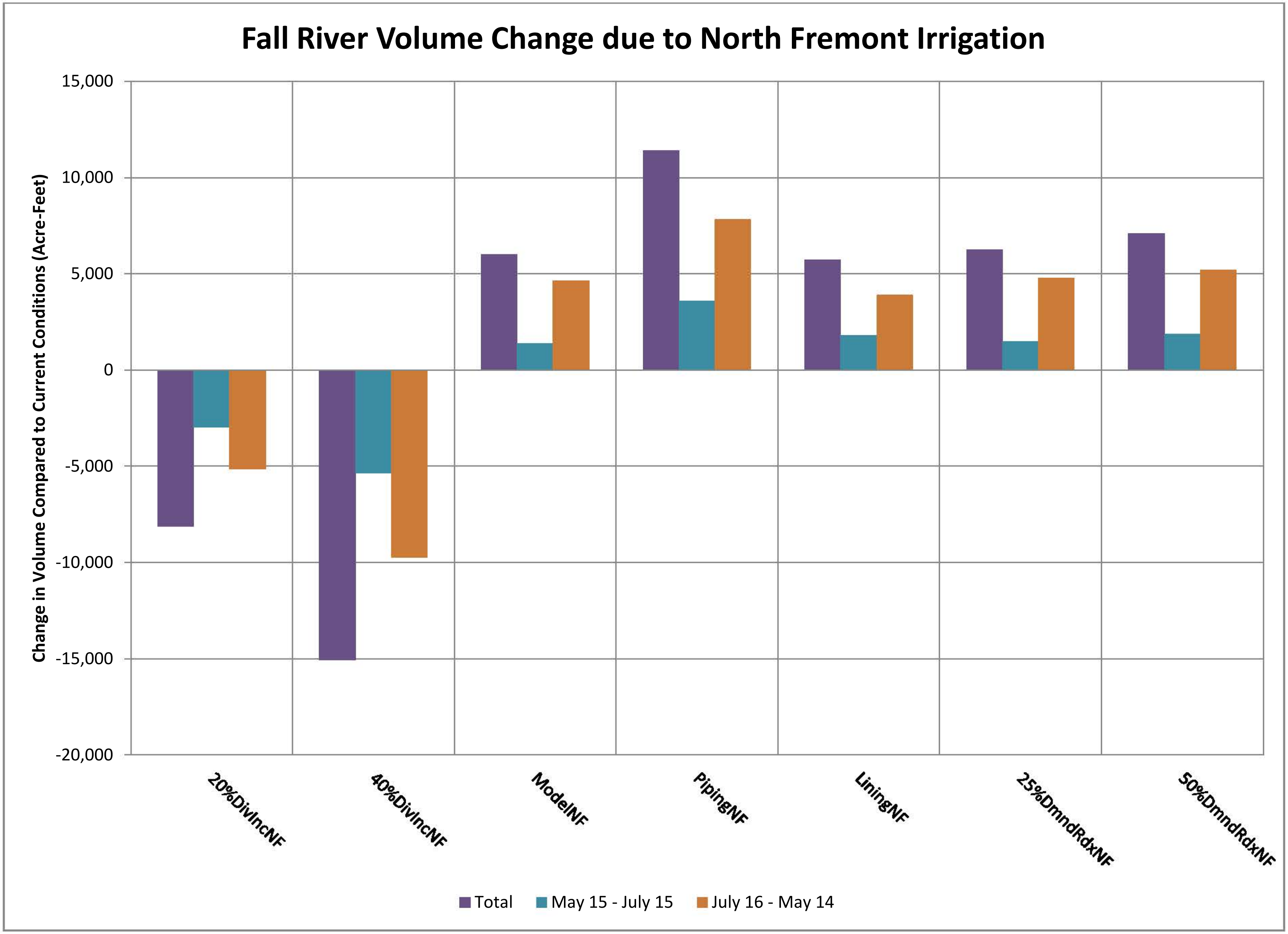

Average Henry's Fork Flow at Rexburg due to Egin Bench Irrigation
Alternative 14: Demand Reduction
Volume Change from Current Conditions
Acre-Feet
90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
25%DmndRdxLW
50%DmndRdxLW
Annual
May15 - July15
July16 - May14
Flow (cfs)
7,500
6,500
5,500
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

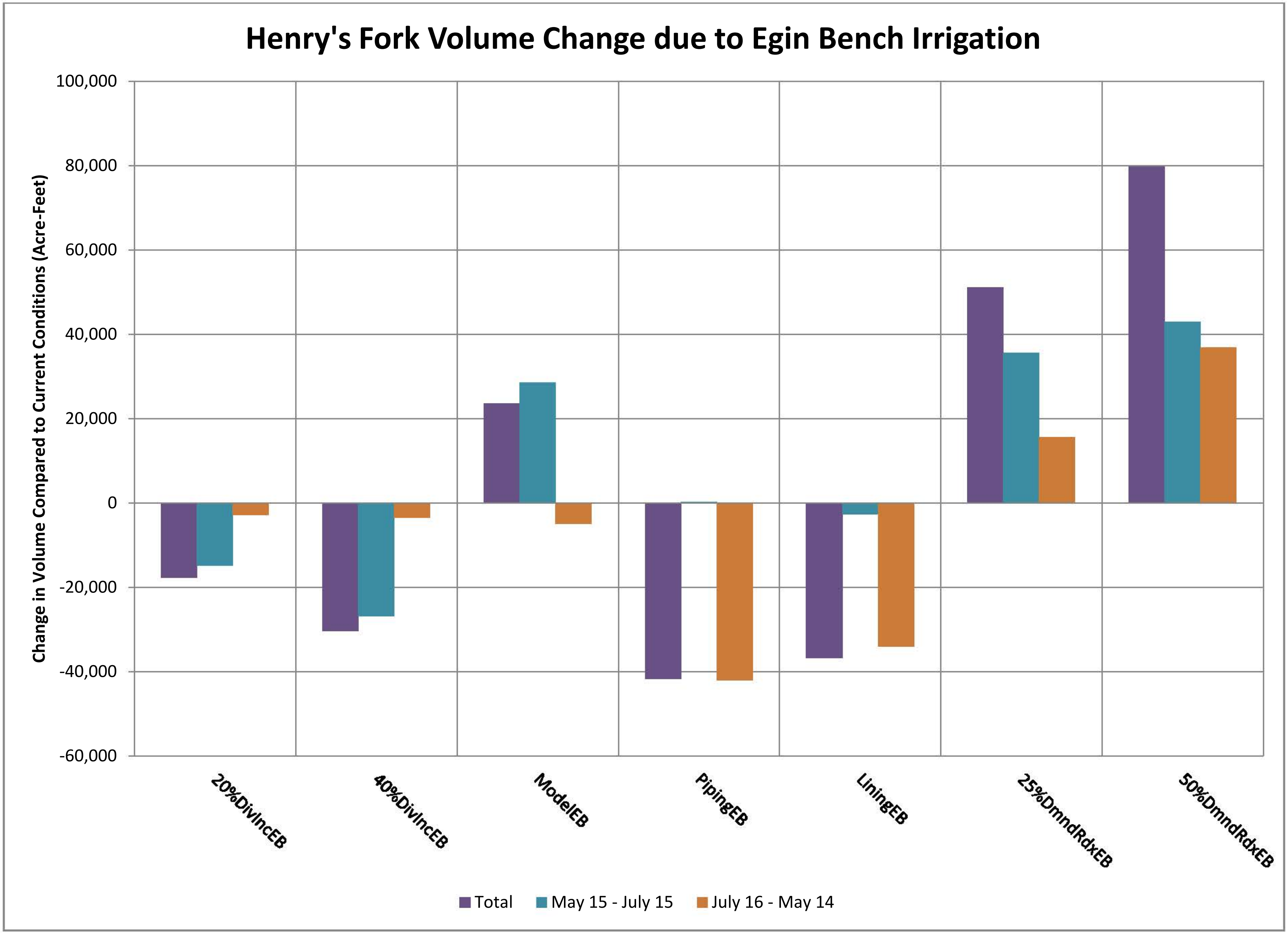
Comparisons of the Annual Volume Changes for the Conservation Alternatives

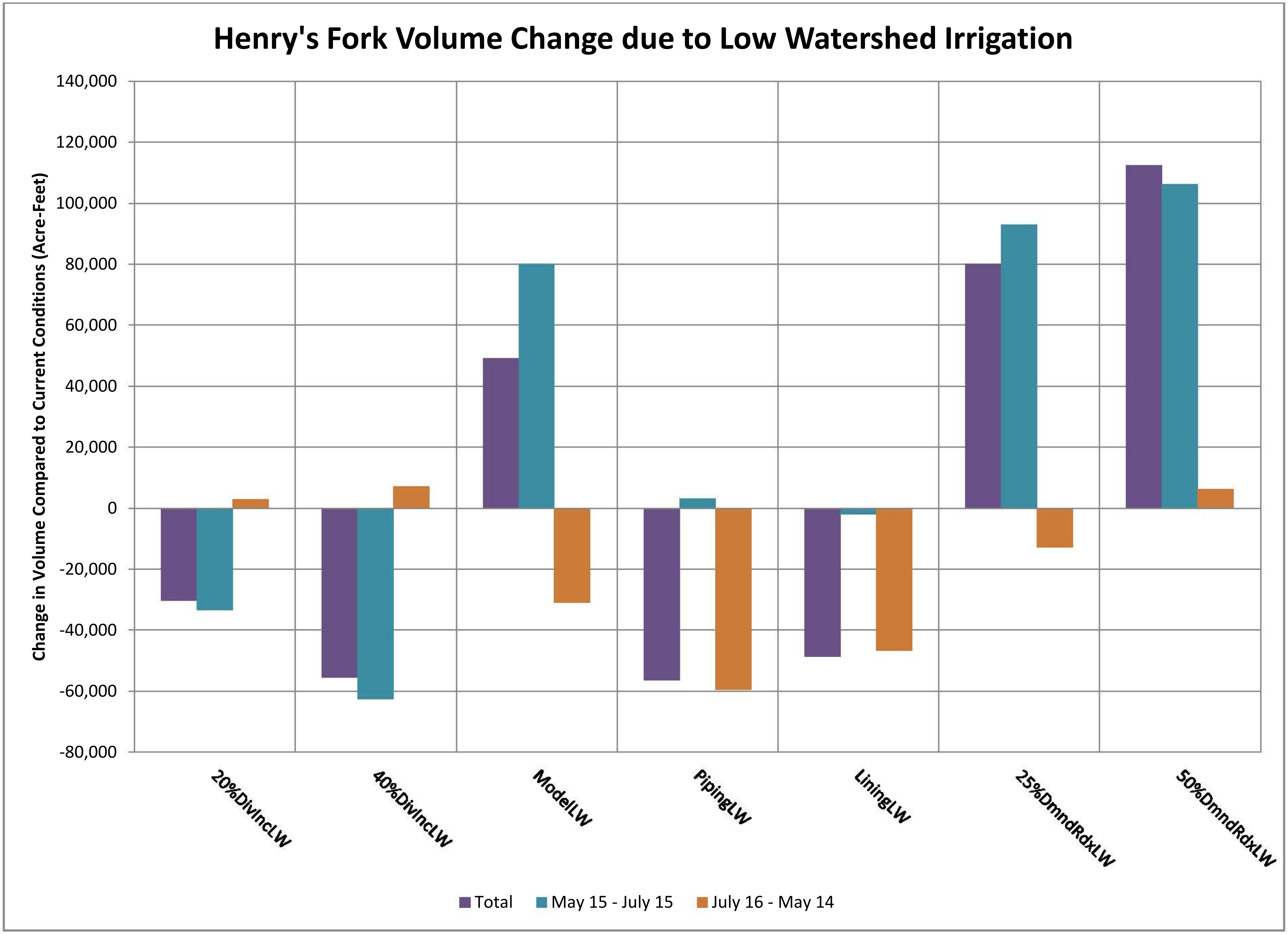


Teton River Volume Change due to Teton Valley Irrigation
Change in Volume Compared to Current Conditions (Acre-Feet)
30,000
20,000
10,000
0
-10,000
-20,000
-30,000
-40,000
Model
Pipeline
Lining
25%DmndRdx
50%DmndRdx
20%DivInc
40%DivInc
FTR
Teton@StAnthony
Teton@SouthLeigh



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
140,000
120,000
100,000
80,000
60,000
40,000
20,000
0
-20,000
-40,000
-60,000
-80,000
Change in Volume Compared to Current Conditions (Acre-Feet)
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***