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Estimates of Impacts on Lower Boise Valley Drain Discharge with Elimination of Gravity Irrigation

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Introduction

Water quality limitations that have been proposed by the Idaho Department of Environmental Quality (IDEQ) in its development of total maximum daily loads (TMDLs) for water bodies in the Lower Boise River Valley will require that sediment concentrations in several large irrigation drains including Indian, Mason, Fifteen Mile, Willow and Sand Hollow Creeks be reduced by up to 90%. Achieving the proposed sediment reductions may require eliminating or significantly reducing return flows from the irrigated agricultural lands that utilize these drains.[1] Eliminating or reducing return flows from agricultural fields requires cessation of gravity (flood) irrigation by either retiring the land from agricultural production or converting the irrigation method from flood to sprinkler, drip or another irrigation method by which the water applied to the field is consumed by crops through evapotranspiration with minimal loss to the shallow ground water and no surface water runoff. Retiring or converting agricultural lands will eliminate surface return flows and reduce subsurface seepage return flows to the drains.

With the exception of brief spring runoff flows in the historic drainages that predated the irrigation drains, water flows in these constructed irrigation drains rely entirely upon runoff and seepage from the numerous canal systems and from gravity irrigation of agricultural lands in the Boise Valley. The shallow aquifer in the Boise Valley is also largely a consequence of these irrigation practices.[2] Consequently, attaining IDEQ's proposed sediment targets by eliminating surface and reducing subsurface return flows from agricultural fields is likely to significantly reduce drain flows and recharge to the shallow aquifer.

This analysis estimates the reduction in drain discharge if all surface return flows and most on-farm infiltration from the irrigation of agricultural lands in the lower Boise Valley were eliminated.

The basis for this analysis is the unpublished report "A Distributed Parameter Water Budget Data Base for the Lower Boise Valley," prepared by the U.S. Bureau of Reclamation, Pacific Northwest Region, River and Reservoir Operations Group, Boise, Idaho and the Idaho Department of Water Resources, Planning Bureau, Boise, Idaho, Revised January 2008 (hereinafter "Report"). The printed Report is accompanied by Attachment C, a CD-ROM containing Lower Boise Valley GIS water budget data base and shareware, and a PDF copy of the Report.

Some of the analysis in the Report is based upon data from the mid-1990s, but it is the most recent compilation and analysis of drains in the Lower Boise Valley that could be

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[1] Stone, Hawk, State of Idaho Department of Environmental Quality, "Draft Lower Boise River Tributaries, 2013 Addendum, Hydrologic Unit Code 17050114," June 14, 2013, 30.
[2] Stevens, Jennifer A, Stevens Historical Research Associates, "A History of the Boise River Landscape, *Entrepreneurs, Settlers, and Farmers, 1850-1925",* January 2014 Draft.

located. The Report suggests the need for ongoing efforts to update both the data the Report is based upon and also the analysis. Contacts with both the Bureau of Reclamation and the Idaho Department of Water Resources did not disclose any subsequent updates or any ongoing efforts to update the Report.

Assumptions

If gravity application of irrigation water is discontinued in the Lower Boise Valley, the water budget[3] in the Report will be significantly changed. Some of the changes can be projected and some will be unknown until a new water budget analysis is conducted in the Lower Boise River Valley. The following assumptions will be used in an attempt to estimate the impacts that can be projected.

- There will no longer be an agricultural return flow surface water component to the water supply for the drains.
- The on-farm infiltration will be reduced to an amount consistent with current sprinkler irrigated lands.

Analysis

Data for the five drains identified as sediment limited were selected from Attachment C of the Report and analyzed to determine if reductions in drain discharge could be estimated from the available data. All data are in monthly time steps along with annual totals for the various parameters included for each of the drains.

The Willow Creek and Hartley Gulch drain quantities are reported together in Attachment C. A number of attempts were made to separate the drain amounts for Willow Creek and Hartley Gulch, but there was not sufficient data available to separately analyze these drains. The remainder of this report will address only four of the sediment limited drains, Indian, Mason, Fifteen Mile and Sand Hollow Creeks.

Attachment C provided the current discharge of each of the four drains and also the separate surface and ground water components of that discharge. The current discharge for each of the drains is shown in Figures 1 – 4.

On-farm infiltration was also included in Attachment C for each of the four drains. This element is significant because converting from gravity surface irrigation to sprinkler or drip irrigation is expected to reduce the amount of on-farm infiltration.

The last paragraph of Section 2.6.1 on page 21 of the Report estimates the average net ET on sprinkler irrigated lands to be 1.8 acre-feet per acre with average irrigation diversion of 2.1 acre-feet per acre. Assuming sprinkler irrigation does not produce surface runoff, the difference between the 1.8 acre-feet per acre used by the crop and

[3] Water budget in this case refers to the sum total of water entering the Lower Boise River Valley (the area downstream from Lucky Peak Dam), the water leaving the Lower Boise River Valley and any changes to aquifer storage, Report at 1. The water budget in the Report separates the various routes "… spatial and temporal distribution of groundwater (sic) and surface-water usage …" taken as the water is routed through the Lower Boise Valley. Significant reductions of water applied to gravity irrigated lands will alter that spatial and temporal distribution.

the 2.1 acre-feet per acre diverted, or 0.3 acre-feet per acre, is infiltrated to the shallow ground water. For the purposes of this analysis these values are assumed to be uniform within the Lower Boise River Valley. Sprinkler irrigated lands for the various drainage areas were determined by the percentage of sprinkler irrigated lands from each water delivery entity within each drainage basin. Table 1 lists the number of sprinkled acres in each of the drain areas along with the total irrigated acres within the drain area and the percentage of sprinkler irrigated lands.

	Fifteen Mile Creek	Indian Creek	Mason Creek	Sand Hollow Creek
Sprinkler Irrigated Acres	1,082	1,117	1,852	4,436
Total Irrigated Acres	22,408	21,059	35,330	28,138
Percent Sprinkler	4.8%	5.3%	5.2%	15.8%

Table 1. Sprinkler Irrigated and Total Irrigated Acres by Drain Area.

Ground water infiltration for the currently sprinkler irrigated acres was calculated at 0.3 acre-feet per acre of sprinkler irrigated land. The balance of the on-farm infiltration was attributed to the gravity irrigated lands. The reduction in infiltration was calculated by reducing the infiltration for the gravity irrigated lands to 0.3 acre-feet per acre and the new amount of on-farm infiltration was calculated as 0.3 acre-feet per acre for all irrigated lands within each of the drain areas.[4]

Once the reduced on-farm infiltration due to conversion to sprinkler irrigation was determined, a relationship was developed to estimate the reduction in the ground water component of drain discharge. From the data available in Attachment C, the main sources of ground water in the drains appears to be from on-farm infiltration and canal losses. The ground water remaining in the drains after conversion to sprinkler irrigation is estimated by reducing the current ground water in the drains by the ratio of the current combined canal loss and on-farm infiltration to the canal loss[5] and on-farm infiltration after conversion to sprinklers.

Table 2 shows the current components of the discharge, primarily from agricultural return flow, for each drain as well as the projected drain discharge after conversion to sprinkler irrigation. The surface water component is assumed to be zero after conversion to sprinklers so the entire projected drain discharge is supplied by infiltration from sprinkler irrigation and canal seepage loss to the shallow ground water. Table 2 also shows the percent reduction in annual drain discharge as a result of conversion to sprinkler irrigation.

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[4] Attachment C of the Report showed a negative on-farm infiltration for the Indian Creek drain area. The logic for reducing a negative on-farm infiltration by conversion to sprinklers did not yield a meaningful result. As a result, the average change per acre of infiltration from Fifteen Mile and Mason Creeks was used to calculate the new on-farm infiltration for the Indian Creek drain area.

[5] No attempt has been made to estimate whether changes in canal loss would occur as a result of conversion from gravity surface irrigation to sprinkler. No data are available in the Report or are known to exist elsewhere to attempt to estimate whether changes in canal loss would occur.

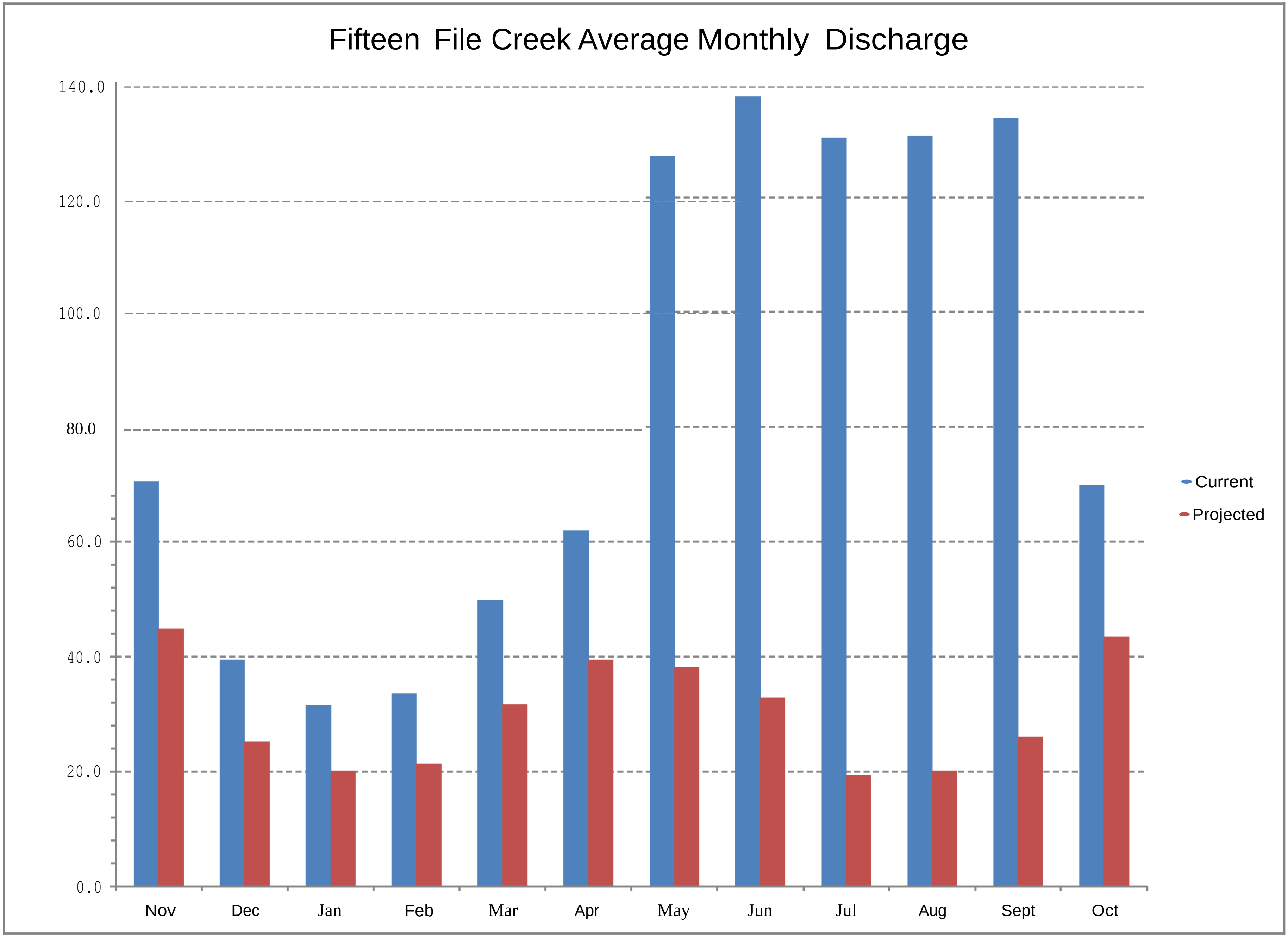
	Fifteen Mile Creek	Indian Creek	Mason Creek	Sand Hollow Creek
Current Surface Water (ac-ft)	27,128	46,770	35,500	54,959
Current Ground Water (ac-ft)	34,360	55,427	43,134	45,132
Current Total Discharge (ac-ft)	61,488	102,197	78,634	100,091
Projected Drain Discharge (ac-ft)	21,886	35,230	18,842	30,708
Percent Reduction	64%	66%	76%	69%

Table 2. Current and Projected Drain Discharge

Finally, the annual totals from Table 2 were redistributed to monthly time steps for plotting. The current and projected drain discharge amounts were converted from acre-feet to cubic feet per second (cfs) for plotting in Figures 1-4. These Figures illustrate that the most dramatic reductions in drain discharges will occur during the irrigation season, from May through September.

The foregoing analysis estimates drain discharges after 100% conversion of agricultural irrigation practices from gravity to sprinkler within the identified drainage basins. Reductions to drain discharges resulting from less extensive conversion to sprinkler may be estimated proportionately from this analysis. If, for example, there is 50% conversion of agricultural irrigation practices from gravity to sprinkler within a drainage basin, the projected drain discharge would be approximately 50% greater than the projected discharge shown in Table 2, and percentage reduction would be approximately 50% less than the percentage shown in Table 2, based upon the data from Attachment C of the Report.

This analysis shows that widespread conversion of gravity irrigation will reduce drain discharges to the Boise River. Flows and water levels within the drains will be correspondingly reduced, though this analysis does not attempt to predict the extent of the reduction at any upstream location in the drains.



Fifteen File Creek Average Monthly Discharge
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sept
Oct
Current
Projected

Figure 1

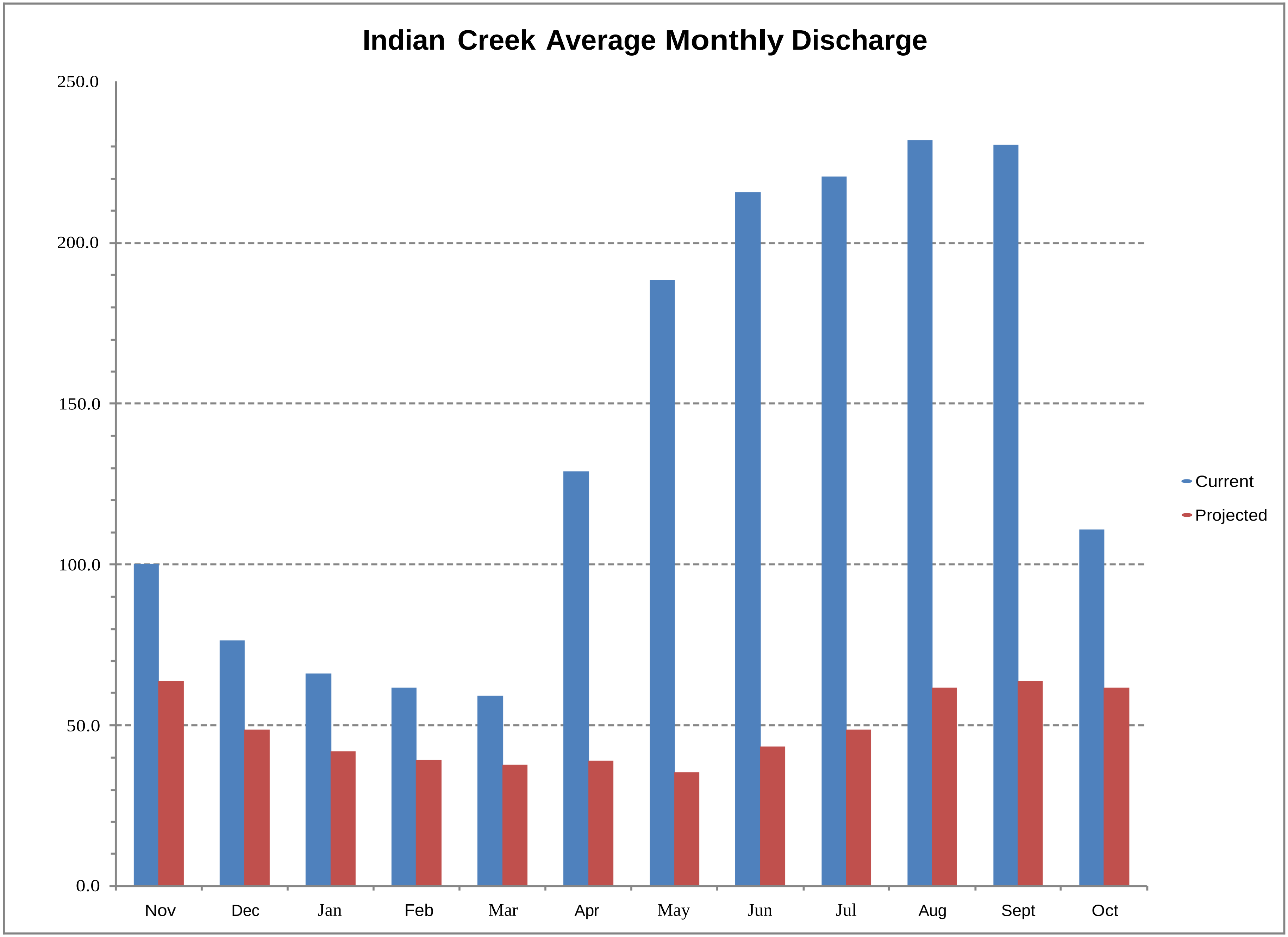

Indian Creek Average Monthly Discharge
250.0
200.0
150.0
100.0
50.0
0.0
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sept
Oct
Current
Projected

Figure 2

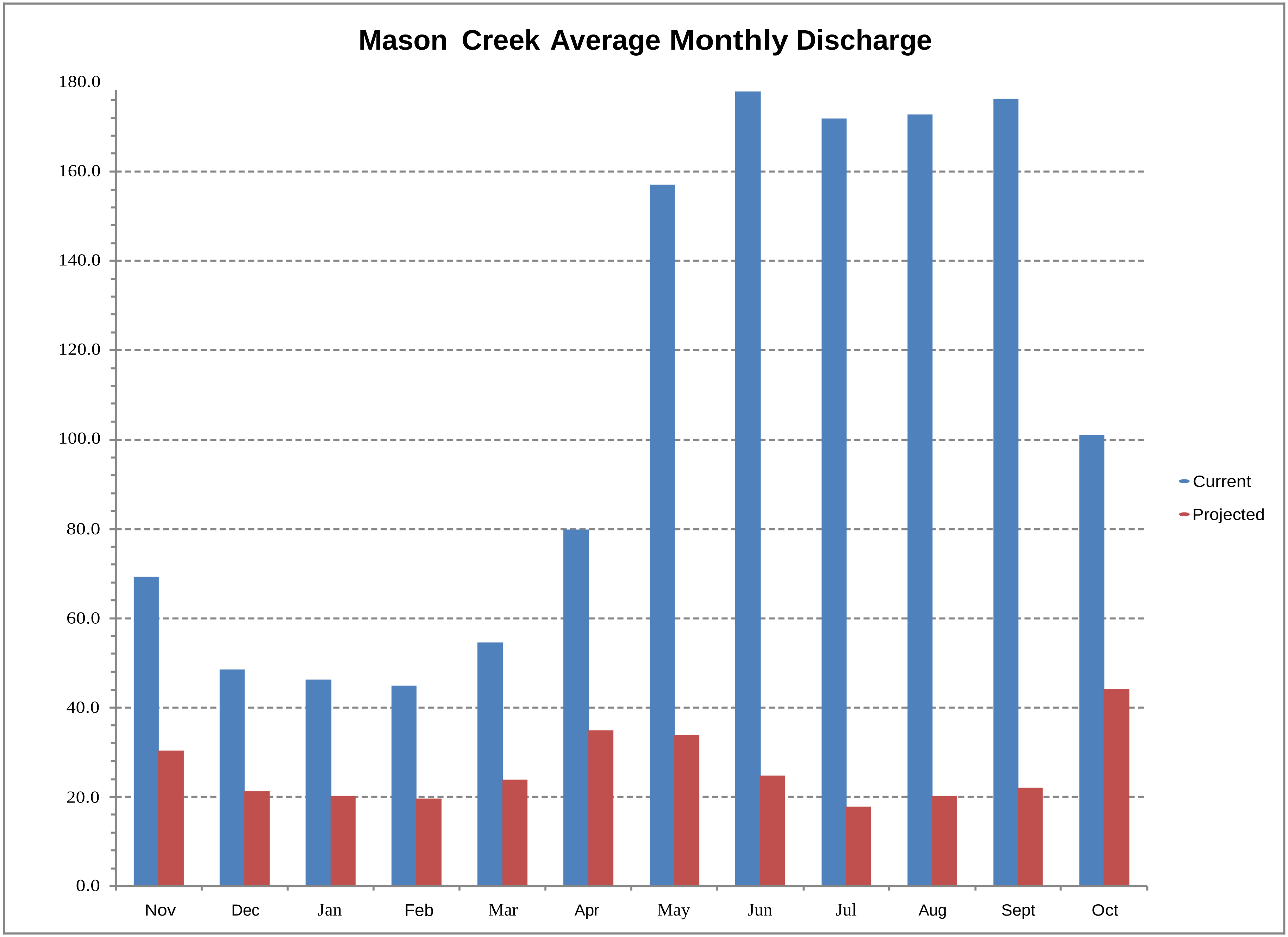

Mason Creek Average Monthly Discharge
180.0
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sept
Oct
Current
Projected

Figure 3

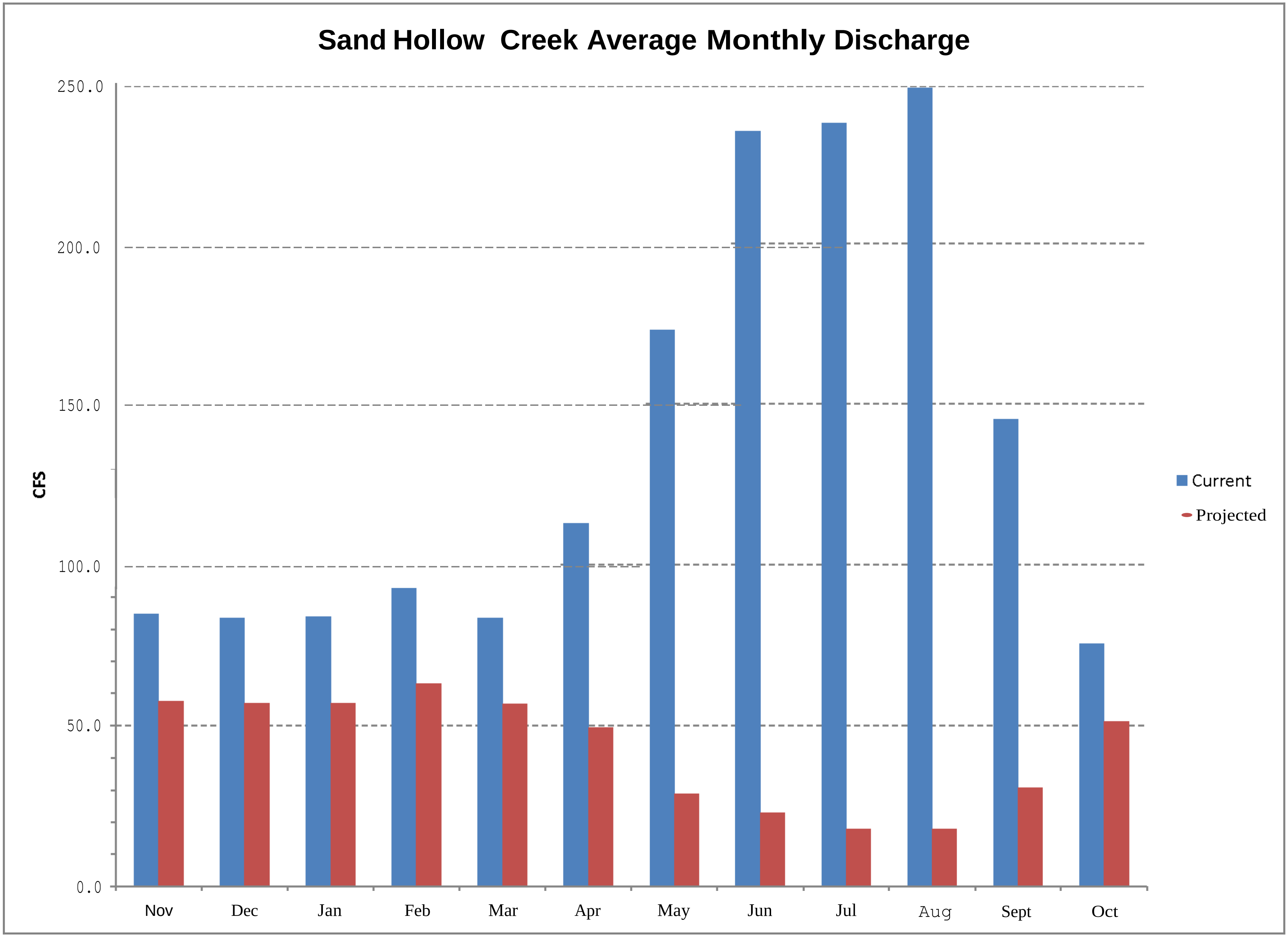

Sand Hollow Creek Average Monthly Discharge
250.0
200.0
150.0
100.0
50.0
0.0
CFS
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sept
Oct
Current
Projected

Figure 4