CSKT Compact Technical Working Group

Report of findings

Technical review of proposed CSKT water rights settlement for the Water Policy Interim Committee

8/26/2014

Contents

Introduction
Background

The Montana Legislature's Water Policy Interim Committee (WPIC) is reviewing the proposed Water Rights Compact Entered into by the Confederated Salish and Kootenai Tribes, the State of Montana and the United States of America as part of its 2013-2014 work.

Reps. Nancy Balance and Keith Regier and other legislators asked the WPIC to review the compact and assess possible outcomes. The request included questions related to legal, socioeconomic and environmental aspects of the agreement. Within those topics were questions related to the scientific and technical information upon which the proposed agreement is based. The request covered the compact as well as the Flathead Indian Irrigation Project Water Use Agreement.

In May 2014, the WPIC asked John Metesh, director of the Montana Bureau of Mines and Geology, to assemble a work group to answer questions within the groups' area of expertise, to assess modeling used to form the basis of the compact settlement, and address other relevant scientific and technical aspects of the proposed settlement.

Findings

Included in this draft report are answers to the questions posed by Balance and Regier as well as summary findings and overviews of the technical and scientific topics discussed.

With some qualifications outlined in the following pages, the modeling used to build a quantitative foundation for the CSKT water rights settlement is reasonable. Additional modeling is necessary for irrigation to practically function under the terms of the proposed compact.

The discussions are technical in nature as necessitated by the topic at hand. Summary statements are provided, but the full measure of the work by this TWG lies in the detailed discussions. Consensus on every topic or finding is not assumed by the TWG. Each topic was initiated by a member and vetted by the rest of the group. Review and editing did not result in deletions of topics or of facts found by a particular member, but rather, clarification and additional facts on that topic. If there is indeed consensus, it is due to the strong evidence of fact found by the group; in other words, the facts found were rather obvious to this group.

Technical Working Group Process

The Technical Working Group (TWG) consists of six members who are professionals in the areas of hydrology, geohydrology, irrigation, and instream flow:

- John Metesh, Montana Bureau of Mines and Geology, chair
- Andrew Brummond, Fish Wildlife and Parks
- Larry Dolan, Department of Natural Resources and Conservation
- Russell Levens, Department of Natural Resources and Conservation

- Mike McLane, Fish Wildlife and Parks
- Kirk Waren, Montana Bureau of Mines and Geology
- Legislative staff provided administrative support.

The TWG met 10 times. All meetings were open to the public and available for viewing on the Legislature's website. Presenters included the Reserved Water Right Compact Commission (RWRCC) staff, representatives of the Confederated Salish and Kootenai Tribes, opponents of the proposed compact, and other members of the public.

The TWG reviewed published and non-published materials provided by the parties to the negotiations and invited public presenters. The TWG is grateful to those that presented technical data and analysis to the TWG and answered many questions. The TWG also heard considerable input on legal, policy and other non-technical issues relating to the proposed compact. While the information provided the TWG with some context on the various issues surrounding the proposed compact, the TWG's charge was of a more technical nature.

Some commenters encouraged the TWG to provide recommendations on further study and changes to the proposed compact. Although the TWG acknowledged these suggestions, members determined many of these recommendations to be outside the charge given the TWG and beyond the time limitations by WPIC, and the TWG was limited on aspects of further study by the time it had allocated to it.

The TWG generally restricted the scope of its evaluation to topics within their area of expertise and makes no legal evaluations of the proposed compact or its attachments

<u>Assumptions and Parameters</u>

The Proposed Compact

The TWG recognizes that to evaluate the scientific and technical aspects of the proposed compact and the water use agreement, a basic understanding of the compact process is necessary. The proposed compact is a negotiated settlement through which the parties to the agreement sought settlement of the water rights associated with the tribes and the reservation.

Settlements, by their nature, represent a compromise that defines a solution while protecting to the greatest extent the priorities, rights, interests, or values of all parties. The proposed compact, like other Montana tribal water tight compacts, includes attributes that may not typically be found in a rigid interpretation of the purposes of the reservation and the quantification of the amount of water needed to fulfill those purposes. The TWG recognizes that processes or procedures that are frequently used in tribal water right litigation models that are not employed in the CSKT settlement process. This includes identifying practicable irrigable acres and undertaking significant data collection and analysis to define instream flow hydrographs that support critical aquatic life habitat requirements.

The working group's analysis of the proposed compact focused on the water use agreement with specific emphasis on:

- development and use of a HYDROSS Model including the adequacy of data used in this model and an assessment of two model outputs – the farm turnout allowances and river diversion allowances;
- instream flow values in the compact; and
- adaptive management concepts.

The proposed compact identifies, quantifies, and prioritizes tribal water rights, including aboriginal, federal reserved rights and, potentially, tribally held state-based rights. Also part of the settlement are agreements to allocate water to tribal- and state-based water rights in times of shortage, with special attention to coordination with the Flathead Indian Irrigation Project (FIIP). The agreements are included as the Unitary Administration and Management Ordinance and the Flathead Indian Irrigation Project Water Use Agreement.

The HYDROSS Model

The U.S. Bureau of Reclamation's Hydrologic River Operations Study model (HYDROSS) is a monthly hydrologic accounting model often used in simulating the operations of river/irrigation systems for planning purposes. It simulates the effects of existing proposed water demands on water The model allows the manipulation water demands at various points in the system (nodes) to predict the potential impact on other nodes. Three HYDROSS models cover the major components of the FIIP: the Mission, the Jocko, and the Little Bitterroot.

The HYDROSS model runs, especially those for the areas of the Flathead Indian Reservation east of the Flathead River and associated within and in the vicinity of the Jocko and Mission Irrigation Districts, were used to:

- model the gross on farm water deliveries or Farm Turnout Allowances (FTAs).
- estimate the water conserved through operational improvements to existing irrigation distribution system and its management such as reductions in tail-water leaving canals and elimination of non-irrigation season diversion of stock water.
- evaluate opportunities to improve instream flows through both operational management and future rehabilitation and betterment projects.

The HYDROSS analysis defined for the compact:

- River Diversion Allowances (RDAs), which incorporate operational improvements to the irrigation projects, but continue to deliver to the irrigators, as a whole, their existing and historic water supplies at the Farm Turnout
- Instream flow values (instream flow rights for wet, dry and normal conditions) that replace the current interim instream flows for those streams or stream reaches that are supply and are integrated within the Jocko and Mission Irrigation Districts.

Objectives and Conditions Affecting Analysis and Modeling

- Reserved Water Right Compact Commission's broad objectives include:
  - protect state based water rights,
  - define future water supplies for state based future water uses,
  - define federal water rights – existing and future uses;
  - define parameters for future management, allocation of rights and administration of water within the federal reservation that considered both federal reserved and state based water rights.
- The CSKT expresses both legal and cultural interests in maintaining a fishery and protection of instream flows.
- The CSKT desires, through the compact, to protect and maintain the existing irrigated agriculture.
- CSKT and RWRCC staff note that existing irrigation infrastructure and administration are inefficient and in critical need or rehabilitation and modernization.
- The existing water supply conditions and an interest in maintaining existing active irrigation and improving instream flows led to a focus on improving water use efficiency, which resulted in a decision to analyze and model existing water supplies and use.
- Model runs were used to evaluate the opportunities to improve water use and management in such a way as to meet existing irrigation demands but also improve instream flows.
- Interim instream flow water right values were defined in management instituted in 1987 on many streams within the Flathead Indian Reservation.
- Implementation of the interim instream flows and management to those targets limited irrigation diversions late in the season and in low-water periods.
- Due to the existing level of water development in the FIIP area, the need to critically and scientifically define instream flows hydrographs based upon habitat needs was negated. Instead, previously defined interim instream flows values were used as a starting point and increases in flow that could be achieved through water conservation and water management. Improvements were also used to define enforceable instream flows and targets.
- The effort of defining potentially irrigable acres, which is part-and-parcel to a non-negotiated quantification of a reserved tribal right, does not appear in the compact or modeling documents. If the water supply for existing irrigated acreage is not sufficient to provide full service water supply to existing levels irrigation and interim instream flow targets there seems to be little gained in an effort define additional areas are technically irrigable under a senior federal reserved water right.
- The settlement agreement and modeling documents generally do not include a technical quantification of the discharge levels required to provide and maintain the full habitat for native fish in many stream reaches. Some technical quantification was used to determine instream flow levels outside of the Flathead Indian Irrigation Projects area of influence.

I. HYDROSS

Issue: Use of HYDROSS Models

Summary: As used in the for the CSKT water rights settlement, HYDROSS modeling is a suitable planning model. However additional modeling will be necessary to create an operational plan for the Flathead Indian Irrigation Project (FIIP).

Background: Three separate models were developed with the HYDROSS software to simulate the following major components of the FIIP: the Jocko model, the Mission area model, and the Little Bitterroot model. According to the Bureau of Reclamation and Texas A&M University in their Hydrologic Modeling Inventory, HYDROSS is a "surface water supply model developed to assist in planning studies for evaluating existing and proposed demands on a river system by simulating the effect of existing and proposed features on the historical natural hydrology" (Texas A&M University and Bureau of Reclamation undated). The HYDROSS models operate at a monthly time-step in sequential order (results from one month depend on the system state at the end of the previous month) and sequential space (results at one station depend on what is happening upstream and/or downstream), and priority (earlier water right dates are allowed water before later water right dates). The model can be used to simulate physical features of a river basin (such as irrigation diversions, conveyance, and storage) with input hydrology data, diversion demands, instream flow targets, and other constraints and operational criteria. The scale that the model can be used for is user determined, but typically for a river-basin management area. The HYDROSS modeling software was developed by the Bureau of Reclamation to represent complex river systems and management strategies and has been used in a progression of versions for about 30 years. In the case of the proposed CSKT compact, results from the HYDROSS model were used in quantifying instream flow targets and allowable irrigation water volumes, and to develop future improved management scenarios as described in the WUA. Here are some general facts we have found concerning the HYDROSS models and modeling.

The HYDROSS modeling software is suitable for representing the components of the FIIP and for running planning scenarios to provide information concerning how frequently instream flow targets might be reached and associated constraints on irrigation water supplies. The models developed appear suitable for simulating how irrigation efficiency improvements and operational improvements might increase flow on some stream reaches, and how these improvements would affect irrigation water use.

The three HYDROSS models are comprehensive and include the major physical features of the systems, such as streams, reservoirs, irrigation canals and blocks of irrigated land (service areas rather than individual water users). The models are not designed to simulate the flow through every irrigation lateral or the delivery of water to every farm turnout.

The models are scale-independent water accounting models that use a mass-balance approach, where water inputs to the model and individual accounting nodes are balanced by water outflows. Model nodes, which represent irrigation diversions, have distinctive source and discharge point, with the irrigation served varying in size from a few acres to hundreds of acres.

The models did not employ optimization algorithms, rather scenarios were run in an iterative manner until results appeared to achieve instream flow, irrigation delivery, and water management objectives.

The models themselves cannot determine whether or not the irrigation efficiency and operational improvements needed to increase instream flow are achievable.

The models are primarily surface water models and the simulation of groundwater flow is simplified and restricted to the modeling of stream channel and irrigation canal seepage losses and returns, and groundwater return flow from irrigation. Groundwater gains to the system, in some cases, were added through input files to the models.

The HYDROSS models, in their present form, are not suitable for use as operational model of the FIIP system. It is anticipated that an operational model(s) of the FIIP system would be needed to for adaptive management and to administer the WMA. An operational model should be run at a daily time-step and it does not appear that HYDROSS, in its present form, has this capability. There are other modeling software packages available that could be used to develop daily time-step operational model of the FIIP.

References

Texas A&M University and Bureau of Reclamation undated. Hydrologic Modeling Inventory Website. http://hydrologicmodels.tamu.edu/

Issue: HYDROSS model input data – irrigation characteristics

Summary: Irrigation input data used in the modeling appears to be reasonable.

Background: The HYDROSS models simulate irrigation water diversions and deliveries based on irrigation demands, and operations associated with filling the reservoirs on the system and delivering water from this storage to meet irrigation demands. In order to accurately model historic irrigation use and to produce credible future scenarios, the inputs to the model that represent the physical characteristics of the system should be a reasonable representation of actual project characteristics. Furthermore, the model rules that simulate the timing and delivery of water for irrigation and operations of the reservoirs must reflect actual operations of the system. This report contains some facts we found concerning how the HYDROSS models simulates operations in the Flathead Indian Irrigation Project. Some of the facts concerning inputs to the models, such as crop irrigation requirements, will be discussed in other sections of this report.

Irrigated acreages are a basis for simulating irrigation diversions in the model. Project-wide acreage input to the model, and the assignment of this acreage to irrigation blocks served by the various canals and laterals, need to be accurate and representative of the system. Inputs to the latest versions of the HYDOSS models are based on 2009 irrigated acreage, as mapped by the tribe and their consultants. Earlier versions of the model used mid-1990s irrigated acres, and the model was calibrated with these mid-1990s acres.

On-farm irrigation system efficiencies used in the HYDROSS modeling varied based on system type, month, and location in the FIIP. Sprinkler irrigation efficiencies used ranged from 60-80 percent, while flood irrigation efficiencies ranged from 35-50 percent. The Montana Irrigator's Pocket Guide lists irrigation applications efficiencies that range from 50-85 percent for sprinkler systems, and 15-75 percent for the flood systems. The efficiencies for wild flood systems, which range from 15-35 percent in the Pocket Guide, might be overstated in the HYDROSS models. The sprinkler field efficiencies are within the range that typically is used.

Canal seepage losses were simulated based on the length of the canal and a per-mile loss rate. Per-mile loss rates used range from 0.5 percent to 5 percent. Lateral efficiencies used seem to be based on a similar method, with the per-mile percentage loss ranging from zero percent (pipelines) to 1 percent. The 2009 DNRC Canal Seepage Study was used to develop percent-per-mile magnitudes and patterns of loss for main canals.

Canal capacity limitations were input to the model based on maximum recorded diversions for the various canals. Canal diversion capacities also seem to have been adjusted, in some instances, so that maximum diversions to some irrigation units better matched crop irrigation as determined through the DNRC METRIC Study (DOWL HKM 2012).

Return flow was lagged over a 12-month period following irrigation, with the greatest amount returning to the source the first month following irrigation and rates decreasing by month until the end of the period. It appears that the lagging applied to all return flow, and there was not separation of surface and groundwater returns.

Irrecoverable losses (for example water evaporated during irrigation application or losses to evapotranspiration by non-target plants) were accounted for in the models at 5 percent for the Jocko model, and 10 percent for the Mission and Little Bitterroot models.

Stream reaches also were simulated in the HYDROSS models; in some cases, these losses could be simulated to return to a downstream location in the model.

References

DOWL HKM 2012. HYDROSS model Baseline Conditions documentation for the Mission, Jocko, and Little Bitterroot models.

Montana Pocket Irrigators Guide. National center for Appropriate Technology, Butte, MT. Irrigation system efficiency tables are adapted from University of Idaho Extension Service irrigation scheduling tables.

Issue: HYDROSS model input data – crop water consumption

Summary: Estimated crop type percentages were generally verifiable.

One of basic input datasets for the HYDROSS model is some form of Net Irrigation Requirement (NIR) based, in part, on crop type. Reliable estimates of NIR require good information for the distribution of crop type.

Background: From the presentation by Wade Irion (HKM) June 12: NIR was calculated as equal to Potential Evapotranspiration by crops (ETp) less effective precipitation (– Pe) for that area. Thus, crop evapotranspiration (ETp) based on crop type and climate, is central to estimates of historic/current use by irrigators. Crop type was derived crop reports for each irrigation district. The METRIC analysis provided a support for the model output by comparing crop consumption. METRIC is largely independent of crop type and estimates water consumption by applying an energy factor to raster satellite images. As a simplistic check of the input side of the HYDROSS model, a Cropland Data Layer was examined.

<u>Alternative crop type delineation</u>

A raster image of USDA NRCS data known as the Cropland Data Layer (CDL), a rasterized crop-specific land cover data layer (see quoted abstract), for 2013 clipped to each of the water use areas. Each pixel in the raster data is a nominal 30-by-30 meters; thus, the acreage of each pixel was calculated as 0.22 acres (4046.87 square meters per acre). Crop acreage was determined from the count of each pixel identified as a specific vegetation value in the original NRCS raster image. The Initial data generated from this process included all crop types such as evergreen forest, shrub land, open water, and developed/open space as well as agricultural crops used in the CSKT analysis. The crop type was then tabulated and all but the agriculture crops were eliminated to include only grassland/pasture, alfalfa, and the various grain crops; this was done for each service area within the Mission, Jocko, and Little Bitterroot districts. It is important to note that there was no distinction made for irrigated or non-irrigated acreage. Table 1 presents the details for the Mission district; this level of detail was not provided by CSKT for its analysis. Table 2 presents a summary of each of the three major irrigation districts compared to those presented by CSKT in its June 12, 2014 presentation.

Table 1: Acreage percentage for each service area within the Mission Water Use Area.

Hellroaring	
Grassland/pasture	60 percent
Alfalfa	27
Spring Wheat	13
Lower Crow	
Grassland/pasture	61
Alfalfa	22
Spring Wheat	11
Corn	6
Lower Mission	
Grassland/pasture	94
Other mixed	6
Pablo Feeder Canal	
Grassland/pasture	57
Alfalfa	34
Spring Wheat	9
Upper Crow Creek	
Grassland/pasture	49
Alfalfa	32
Spring Wheat	13
Other hay/ non Alf	6
Upper Mission Creek	
Grassland/pasture	58
Alfalfa	37
Other hay/ non Alf	6

Table 2. Comparison of acreage determination for each crop within the major water use areas

	CDL	CSKT
Mission		
Grassland/pasture*	59	76 percent
Alfalfa	32	17
Spring Wheat	6	5
Other	3	2
Jocko		
Grassland/pasture	88	83
Alfalfa	10	15
Other	2	2
Little Bitterroot		
Grassland/pasture	81	89
Alfalfa	18	10
Other	1	1

**CSKT differentiated between pasture and timothy grass, NRCS does not.*

The two methods show good agreement for the Jocko and Little Bitterroot water use areas. There was a difference of about 17 percent (relative difference of 25 percent) for grasslands/pasture in the Mission water use area. The complexity of land use and a large number of smaller parcels reduces the reliability of counting pixels in some areas. Ground truth surveys would be needed to improve the CDL data in these areas.

As noted, NIR estimates for grasslands/pasture and alfalfa can be significantly different. Comparison of an independent method of estimate crop distribution substantiates the method used by CSKT.

This aspect of the HDYROSS model input is deemed reasonable based on this analysis.

References

Metadata Abstract for USDA NRCS raster data used for estimating crop acreage for 2013: The USDA, NASS Cropland Data Layer (CDL) is a raster, geo-referenced, crop-specific land cover data layer. The 2013 CDL has a ground resolution of 30 meters. The CDL is produced using satellite imagery from the Landsat 8 OLI/TIRS sensor, Landsat 7 ETM+ sensor, and the Disaster Monitoring Constellation (DMC) DEIMOS-1 and UK2 sensors collected during the current growing season. Some CDL states used additional satellite imagery and ancillary inputs to supplement and improve the classification. These additional sources can include the United States Geological Survey (USGS) National Elevation Dataset (NED), the imperviousness and canopy data layers from the USGS National Land Cover Database 2006 (NLCD 2006), and the National Aeronautics and Space Administration (NASA) Moderate Resolution Imaging Spectroradiometer (MODIS) 250 meter 16 day Normalized Difference Vegetation Index (NDVI) composites. Agricultural training and validation data are derived from the Farm Service Agency

(FSA) Common Land Unit (CLU) Program. The NLCD 2006 is used as non-agricultural training and validation data. Please refer to the "Supplemental Information" section of this metadata file for a complete list of all imagery, ancillary data, and training/validation data used to generate this state's CDL.

The strength and emphasis of the CDL is agricultural land cover. Please note that no farmer reported data are derivable from the Cropland Data Layer.

Purpose: The purpose of the Cropland Data Layer Program is to use satellite imagery to (1) provide acreage estimates to the Agricultural Statistics Board for the state's major commodities; and (2) produce digital, crop-specific, categorized geo-referenced output products.

Issue: HYDROSS model input data – irrigation type

Summary: Estimated total irrigated acreage could not be verified using an alternative method. The values used for irrigated acreage by CSKT are significantly larger than those generated by alternative methods.

Irrigation type (flood, pivot, and sprinkler) and its associated efficiency were raised as a potential weak area of input to the HYDROSS model. Moreover, the CSKT Compact relies on the determination of irrigated acres (130,000 acres in the Flathead Indian Irrigation Project (FIIP)); the HYDROSS modeling also include substantial non-FIIP acres that include private/secretarial water rights. The reliability of these estimates can be evaluated in by comparing estimates by other methods.

Background: The irrigated acreages in 2009 derived from various sources:

- 174,094: (active and idle): presentation by Wade Iiron (HKM) June 12, 2014
- 174,060: (irrigated, no designation, no information) spreadsheet by Bill Greiman, Reserved Water Rights Compact Commission staff
- 176,890: (total in coverage): GIS data provided by CSKT, also known as Historically Irrigated Acreage (HIA)

It should be noted that these would include FIIP project and non-project acres. It also probably includes land that (maybe about 15 percent of the total) that might be fallow any given year. As a simple check of the distribution of irrigation methods, an alternative data set was applied to the Water Use Agreement (WUA).

<u>Alternative determination of irrigated acreage</u>

The Montana Department of Revenue uses the Final Land Unit Classification system (FLU) for property valuation for agriculture and forest land. Data are available through the Montana State Library Natural Resource Information System database. The FLU for 2013 was used to determine total irrigated acreage within the CSKT Proposed Water Use Area.

The acreage of any land irrigated by any method in 2013, identified by the FLU, clipped to the boundaries of the WUA, totaled 120,114 acres. The difference of more than 50,000 acres is much larger than would be expecting from differences irrigation practices over a four-year period. Comparison of the FLU-irrigated acreage to the HIA indicates that the largest difference was in the grasslands/pasture areas; that is, FLU-excluded areas designated by the HIA as irrigated grasslands/pasture.

Examination of the HIA attribute database by RWWCC and for this exercise shows considerable detail for more than 5,000 parcels. The HIA identified many areas as under some type of irrigation that was excluded by the FLU layer.

The method used by CSKT for estimating the total irrigated acreage (HIA layer) in the WUA produces a much greater values. As such, estimates of NIR as to the HYDROSS model would also be much higher.

The HYDROSS modeling baseline run used a total of 149,341 acres and the 2009 Irrigated Lands Mapping run used 140,615 acres; this same acreage was used for the future operational and betterment scenarios.

References

Metadata description for Final Land Unit Classification: The Department of Revenue Agriculture and FLU data is used for property valuation for agriculture and forest land on private properties in Montana. The data is used with the NRCS SURRGO and NASIS soil databases, a DOR GIS dataset of forest productivity and the Department of Revenue statewide cadastral GIS databases to determine productivity for agriculture and forest land on private parcels.

<u>Description</u>

The Department of Revenue Final Land Unit Classification is a classification of private agricultural land into one of six uses, fallow, hay, grazing, irrigated, continuously cropped and forest, with forest additionally classified as commercial or non-commercial and irrigated land classified as being flood, pivot, or sprinkler. The data is used in property valuation for agriculture and forest land on private properties. Final Land Unit Classification data may exist in exempt or public land as a result of data conversion processes but no effort has been made to significantly edit, adjust, delete or enhance data to private parcel standards in exempt parcels. Linework was digitized, edited and updated by DOR GIS Technicians. NAIP 2005 imagery was the primary source used to delineate the features. Secondary sources were NAIP 2006 where available, NAIP Infrared 2005 imagery, 1999-2003 Black and White DOQQ, USGS DRG, and DOR agriculture information and documentation. Using photo interpretation, DOR Technicians attributed each Linework polygon based one of the 6 uses mentioned above. During the summer of 2006 and 2007, DOR Agriculture Appraisers field checked much of the linework and classifications. Discrepancies are documented on hardcopy maps used in the field check effort. The data was then updated based on feedback from the field check. In early 2009, all agriculture producers who own private parcels in the state were mailed maps of their parcels ag/forest use with instructions to return maps that were incorrectly classified. DOR GIS Techs updated the database based on the feedback from landowners, DOR Appraisers discovering classification changes during field work and/or analysis of new imagery where available. Since 2010, the data continues to be actively updated on a yearly basis using the most current NAIP imagery available and/or per land classification change requests from landowners and DOR county ag and forest appraisal staff. The data changes are completed by DOR GIS staff assigned to maintain specific counties. Typically, there are land classification changes on between 3,000 to 5,000 geocoded parcels each year. In 2010, a new classification was implemented, the "X" attribute. This classification/attribute is used for larger commercial operations such as gravel pits, golf courses, mines, etc. The delineation of commercial features is requested by DOR county appraisers who wish to more accurately calculate certain classification acres on a parcel for certain property valuation situations. The features are digitized via photo interpretation using NAIP imagery and in consolation of DOR appraisers.

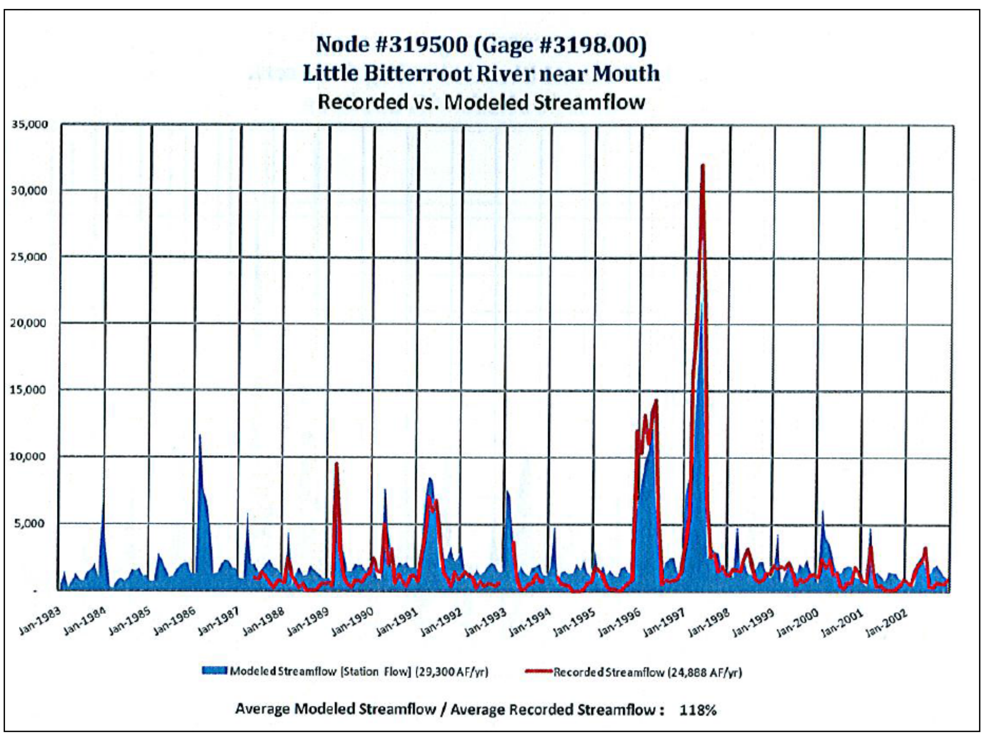
Issue: HYDROSS model output data as a water-balance check on irrigation consumption

Summary: Differences exist between modeled and measured values of water outflows from each irrigation district.

Background: The HYDROSS models account for water flowing into the systems as well as flow out of the system. The primary losses of water from the modeled systems should be due to irrigation consumption, as well as some losses to reservoir evaporation and possible some losses to groundwater. If irrigation consumption and other losses are being satisfactorily simulated, modeled outflow from the lower-most river reaches should match, relatively closely, that which has been recorded as leaving the system at downstream gaging stations. As a check, modeled and simulated flow was compared for a representative station for each of the three HYDROSS models: the Little Bitterroot, Jocko, and Mission. The graphs and discussions below describe some of our findings. All the presented graphs have been copied from the DOWL HKM 2012 HYDROSS Model Baseline Conditions reports.

<u>Little Bitterroot River Model</u>

Figure 1

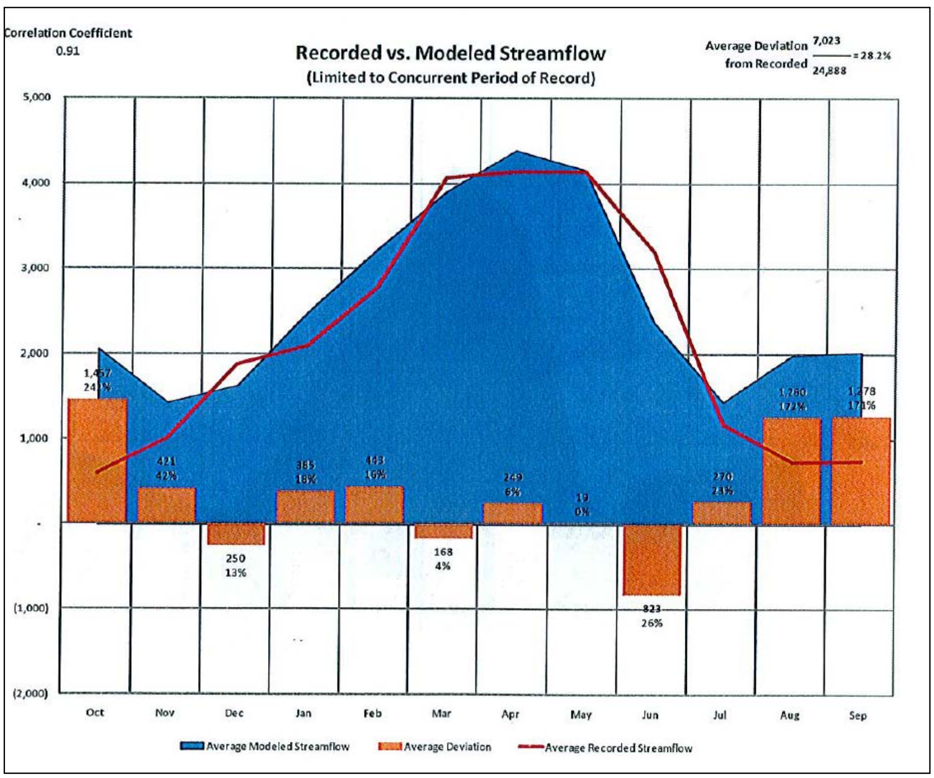


The average modeled flow near the mouth of the Little Bitterroot River is about 118 percent higher than gaged flow for the overlapping period of record (see Figure 1). Figure 2 examines averages and deviations from averages by month, and it seems that the model generally is overestimating streamflow during the August through September period and underestimating flow during June. Deviations during the other months are smaller in comparison. On an average annual basis, the model seems to be overestimating Little Bitterroot river outflow by about 4,500 acre-feet per year. The differences between modeled and measured values could be the result of one or more of the following factors:

- underestimation of irrigation depletions
- overestimation of natural inflow to the system
- natural losses in the system that the model is not properly simulating

The Little Bitterroot might be the best area we have on the Flathead Indian Irrigation Project (FIIP) to make this type of comparison because the lower gage and associated modeling node are downstream of all of the irrigation.

Figure 2



Jocko Model

An accounting of the flow through the Jocko Basin area is more complex than the Little Bitterroot basin because water is imported into and exported out of the basin and because there are some irrigated lands and irrigation return flow below the lower-most gaging station on the stream. For this comparison, the lowermost Jocko River gaging station and associated model node output are compared (see Figure 3). Visually, at least, the modeled flow appears to closely follow the gaged flow and overall is only about 3 percent higher. Overestimation of flow greater than 10 percent occurs during the August through November period. Flow is underestimated, by greater than 10 percent, during March and April. On an average annual basis, the model seems to be overestimating flow at this station by about 4,800 acre-feet per year. As with the Little Bitterroot model, the differences between modeled and measured values (Figure 4) could be the result of one or more of the following factors:

- underestimation of irrigation depletions
- overestimation of natural inflow to the system
- natural losses in the system that the model is not properly simulating

Figure 3

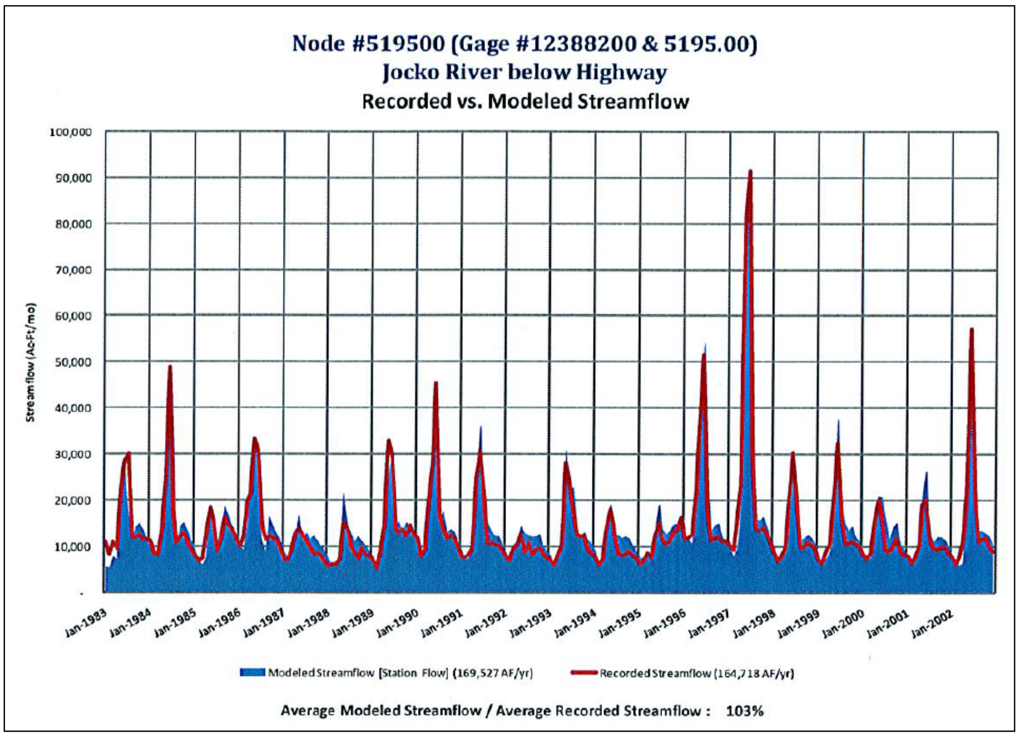
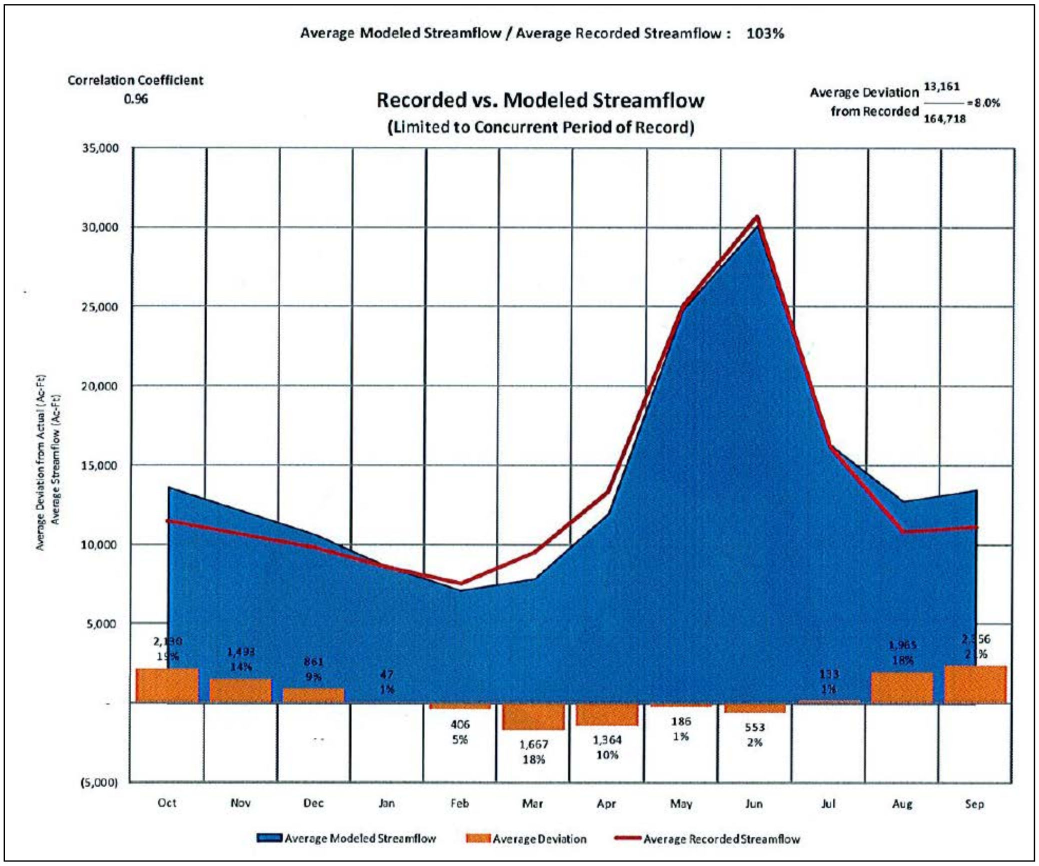


Figure 4



Mission Model

The Mission area model probably is the most complex and there isn't any one modeling point that represents the majority of the outflow. One model node that captures a good portion of the outflow from the systems is at the Mission Creek gage near Moiese. Modeled flow at this station is generally lower than the gaged flow (Figure 5). There is some overestimation of flow occurring for the August through November period. Flow is underestimated at greater than 10 percent during January through March and May. Overall, on an average annual basis, the model seems to be underestimating flow by about 4,800 acre-feet per year. The differences between modeled and measured values (Figure 6) could be the result of one or more of the following factors:

- Not all inflow is being accounted for in the model.
- Irrigation return flow is not being precisely simulated by the model.

Figure 5

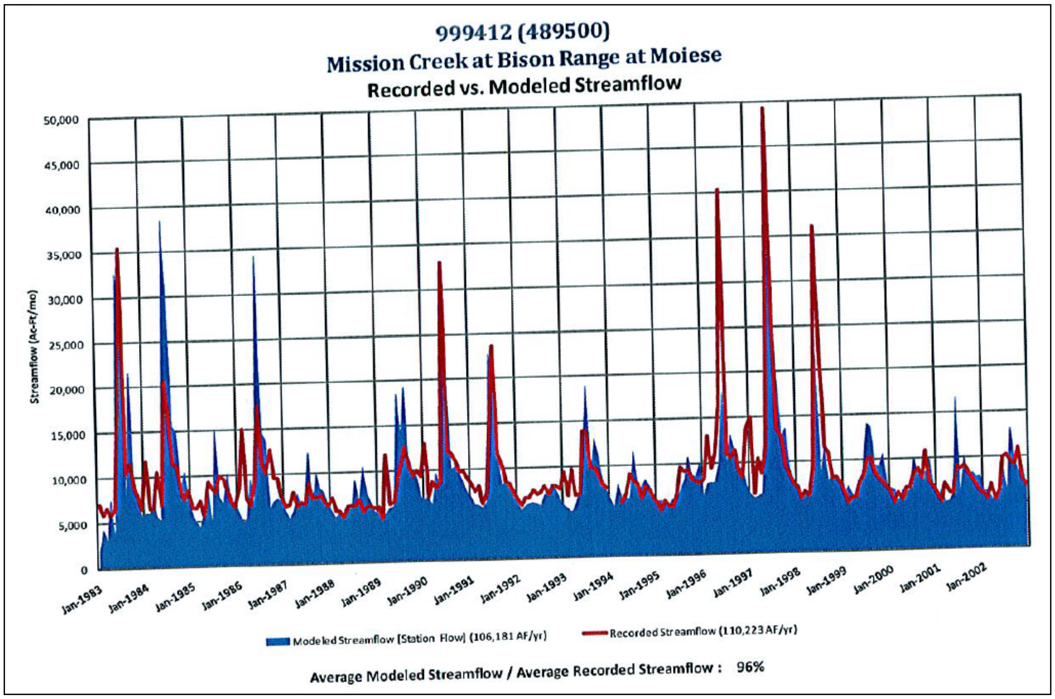
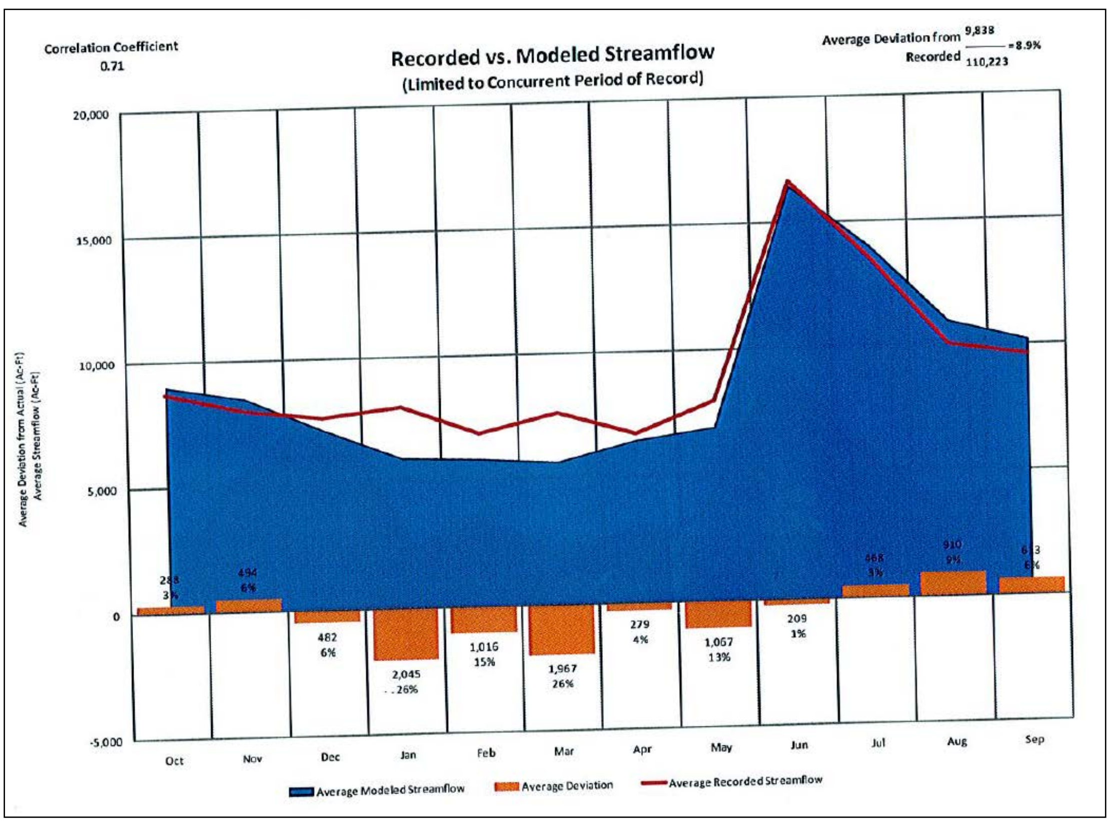


Figure 6



Issue: HYDROSS modeling of increases in instream flow from irrigation system improvements

Summary: Streamflow is modeled mostly to increase under operational improvement and irrigation project betterment scenarios

Background: Objectives of the proposed Water Use Agreement would be to increase the flow of many stream reaches, first through operational improvements and then through betterment of irrigation infrastructure. The HYDROSS models were used to simulate how instream flow might increase under future scenarios, by comparing improved operational and betterment scenarios to baseline conditions. The following are some pertinent facts concerning this issue:

- The model is capable of simulating and tracking streamflow increases, at model node locations, that might occur under operational and irrigation efficiency improvements.
- For most monitoring points, streamflow is modeled to increase under operational improvement and betterment scenarios, although there are some modeled decreases in streamflow at some locations for some year types.
- Under the operational improvements alternatives, much of the reduced overall diversions on some streams, and associated increases in streamflow, would be due to the elimination of stock water diversions and non-essential flow through the canals which would not occur under the anticipated future operations.
- Although, under the operational improvements and betterment scenarios, modeled crop consumption for the Flathead Indian Irrigation Project (FIIP) was not simulated to be reduced on average, there are individual irrigation blocks that are simulated to have reduced consumption. Decreases in crop consumption seem more likely to occur under the private (non-FIIP) irrigation blocks.
- The model results seem to indicate that operational and efficiency improvements might result in an overall increase in irrigation water consumption on the FIIP.
- An iterative process of running various modeled operational and improvement scenarios, until what were considered reasonable, achievable improved instream flow results were reached, seems to have been used to develop Minimum Enforceable and Target Instream Flows for the various stream reaches.

Issue: HYDROSS model – calibration

Summary: Model calibration was discussed as well as examined and found to be generally satisfactory, but a more detailed discussion of calibration and sensitivity in the reports was wanting.

Background: The HYDROSS models were calibrated to baseline conditions but there are two iterations of the baseline run. The first baseline runs model the systems based on supplying irrigation demands to acreages considered to be irrigated during the mid-1990s. These were the model runs to which the models were calibrated. Later, the "baseline" was updated to simulate irrigation as represented in a 2009 irrigated lands mapping, but it does not appear that further calibration adjustments were made to the models during this baseline update. Goals of model calibration were to better match 1983-2002 model results to the historic records for end-of-month reservoir storage, gaged streamflow, and recorded canal diversions. Other goals of calibration were to better match irrigation water consumption with that estimated by the DNRC funded METRIC study, and to check that water budgets and mass balances were reasonable. Here are some of the facts we found concerning the calibration of the three HYDROSS models.

- The models were calibrated by adjusting input parameters over numerous iterations (model runs) and checking model output until model results best matched, overall, historic hydrologic and water use data from the time period modeled.
- Some of the parameters adjusted during calibration included canal capacities, river reach efficiencies, on-farm efficiencies, lateral efficiencies, and canal efficiencies. Return flow lag patterns were calibrated based on flow records for Jocko Spring Creek and Ronan Spring Creek, which are streams mostly driven by irrigation return flow. DNRC canal seepage loss measurement results were used to calibrate canal conveyance efficiencies.
- Although discussed during Technical Working Group meetings and discussed briefly in each baseline report a more detailed discussion of the calibration process could have been provided. The comparison of modeled to measured data (residuals) was presented in graphical form with some analysis of correlation coefficients and deviations of modeled versus recorded flows, but more information as to the range, distribution, and acceptable limits of residuals (e.g. within stream discharge measurement error or by some other measure) would be helpful.
- Canal capacity limits were initially set using infrastructure capacity limits and diversion records. For some internal areas in the FIIP and for private irrigation diversions, where canal measurement data were not available, results from the DNRC METRIC study were used make adjustments to infrastructure capacity so that diverted amounts better matched METRIC-estimated crop irrigation consumption.
- There were no statistical analyses conducted to test model sensitivity to adjustment in irrigation modeling parameters. The modelers instead seem to have focused on the calibration adjustment of parameters through multiple iterations and at multiple locations. During this process, the modelers checked model output results to determine if a parameter might have been adjusted beyond the bounds of what might be reasonable.

- The models are able to reasonably simulate the historic end-of-month contents of the various reservoirs in the system.
- The ability of the models to closely replicate historic streamflow is more variable and might be the result of inexactness in estimating water consumption or in accounting for all inflow. It also could be partially the result of modeling an irrigation and river system on a monthly basis, where available streamflow and irrigation demands vary significantly within a month.
- Overall, the models do a good job at simulating historic canal diversions within the limitation discussed in our findings.
- The calibration was based on a mid-1990s irrigated land base while the baseline run used for comparison to future water management scenarios used a 2009 irrigated lands mapping base. The differences in irrigation consumption modeled with the two baseline scenarios is summarized in the table below. Overall, modeled irrigation consumption was about 4 percent less for the 2009 irrigated lands baseline.

Table 3: Comparison of Acres and Irrigation Crop Consumption for Baseline and 2009 Irrigated Lands Mapping Model Runs. (From HKM HYDROSS Model baseline and 2009 irrigated lands modeling reports).

HYDROSS Model	Baseline Models			2009 Irrigated Lands Adjusted Models		
	Acres	AF	AF/acre	Acres	AF	AF/acre
Mission	113,105	81,018	0.72	109,140	79,548	0.73
Jocko	14,685	10,016	0.68	12,648	8,997	0.71
Little Bitterroot	21,551	14,360	0.67	18,827	12,942	0.69

- Water shortages were modeled. This resulted in modeled irrigation use being much less than the theoretical water demand.

Issue: Independent HYDROSS model evaluation and practical consideration concerning potential compact implementation

Summary: Independent analysis by RWRCC staff validates many aspects of the modeling effort, but also demonstrates the limitations of the model.

Background: During three working group meetings (May 28, June 5, and June 10), Bill Greiman, retired agricultural engineer staff for the Reserved Water Right Compact Commission (RWRCC), presented background on the purpose and general approach taken by DOWL-HKM in developing the HYDROSS model as well as an independent evaluation. From his perspective, the HYDROSS model was developed to characterize instream flows and deliveries for irrigation under current operations, and simulate and compare the potential for improved instream flows with operational and efficiency improvements to the Flathead Indian Irrigation Project (FIIP). The main premise of Greiman's evaluation is that HYDROSS, while suitable for planning and quantifying seasonal water deliveries and monthly average instream flows under current conditions, it does not represent irrigation practices in sufficient detail or include flexibility adequate to guide allocation of water between irrigation deliveries and instream flows under varying water supplies within the irrigation season and between years. The HYDROSS modeling does demonstrate that irrigation can be maintained at current levels and instream flow improved using an operational model and adaptive management using water-supply forecasts.

For his evaluation, Greiman constructed models in spreadsheets for different components of the FIIP at a daily time step using stream flow input data provided by CSKT and output from HYDROSS model runs to simulate irrigation practices and instream flows for example years. He compared his model results to the results of the HYDROSS model and presented representational hydrographs of instream flows for the Jocko River at K Canal to the Technical Working Group for various hydrologic conditions. These representational hydrographs were constructed from historic gaged flow data to represent the daily pattern of flow that might be maintained at instream flow monitoring sites and an annual volume equal to the summation of the monthly Target Instream Flows (TIFs) as calculated using HYDROSS and included in the proposed Water Use Agreement (WUA). One premise behind this exercise is that the representative hydrographs might be a better representation of instream flows that could be maintained on a practical basis and, therefore, a guide for implementing allocation of water between irrigation and instream flows based on current practices than the monthly planning values determined by HYDROSS.

Greiman also incorporated precipitation and snowpack data to illustrate how forecasting could be incorporated in an adaptive management approach to balance fisheries and irrigation needs consistent with the broad requirements in the water use agreement. Other findings by Greiman on this topic include the following:

- Because of the variability within a month of natural flow conditions and irrigation project operations, it will be difficult maintain the TIFs and possibly the Minimum Enforceable Flows (MIFs) on a day-to-day basis. There needs to be some flexibility on how the instream flows are to be met. Potentially, daily deviations above and below the MIFs and TIFs could be balanced monthly, or even seasonally in the case of TIFs, to match the volumetric instream flow summations for the same periods. The adaptive management section of the WUA (Appendix B) outlines a process for addressing this variability with the implementation of the TIFs.

- It may be difficult for operators to maintain TIFs for individual years within a year-type category. For instance, it might be relatively easy to maintain TIFs during a wetter year that falls in the "normal year" category but much more difficult to do so during a year that is on the drier end of this same category. There might need to be some additional flexibility with the MIFs when conditions are on the dry end within a year-type category. The Adaptive Management section of the WUA addresses these types of concern.
- Maintaining late season (late July through early September) TIFs and even MIFs probably will be challenging, especially during drier years. A system where credits can be accumulated for instream flow deliveries above target early in the season, to offset below target but still reasonable instream flows later in the season, might be worth consideration.
- Detailed real-time measurement of stream flows and diversions will be key to identifying operational improvements and to implementing adaptive management.
- Probably some of the best opportunities for increasing streamflow through operational improvements would be in the Jocko system where existing diversions can be as high as 4-7 acre-feet per acre irrigated.

Greiman also presented a detailed presentation of the METRIC analysis used by RWWCC to substantiate estimates of crop water use. METRIC was used as an alternative method to estimate crop water consumption estimates by DOWL-HKM that used energy balance and climate; Greiman opined that the comparison of the two methods were applicable and that the METRIC analysis supported the crop consumptive use numbers calculated in HYDROSS.

The TWG used information from Greiman's presentations and data to prepare for subsequent presentations from CSKT and others. Findings of the TWG on analyses by Greiman:

- Overall, the information and analyses by Mr. Greiman proved highly useful in evaluating the CSKT HYDROSS model specifically and the proposed water use agreement in general. Moreover, his presentations provided and direct comparison of the two modeling approaches. It is regrettable that these analyses were not put into report form; it is understood by the TWG that much of this information was not considered in prior reviews of the compact.

II. Irrigation water demand and use

Issue: Net Irrigation Requirement and Crop Consumptive Use

Summary: Estimated crop consumptive use is significantly less than the estimated net irrigation requirement; an independent study of crop use correlates to the modeling used for the settlement.

Background: Net irrigation requirement (NIR) is crop water demand from irrigation after accounting for the contribution by precipitation and assuming that plant growth is not limited by water or nutrient availability, or soil properties. Net irrigation requirement varies with climate conditions and crop type, and is calculated using engineering equations and site specific weather data.

Crop consumptive use is the actual water consumed from irrigation which is invariably less than net irrigation requirement because of limited water delivery, imperfect irrigation or fertilization, soil water retention properties, and/or other factors that limit irrigation efficiency. Crop consumptive use is calculated in HYDROSS from input that includes diversions, irrigated acreage, net irrigation requirements, crop mix, and conveyance and application efficiencies.

As a check, crop consumptive use values calculated in HYDROSS were compared by HKM and the Reserved Water Rights Compact Commission (RWRCC) to information from Landsat satellite imagery using the METRIC (Mapping Evapotranspiration at high Resolution using Internalized Calculations) evaluation methodology obtained for Flathead Indian Irrigation Project (FIIP) by the RWRCC. The METRIC methodology uses thermal imaging technology from Landsat with Agrimet weather data to calculate actual evapotranspiration (ET) by crops. Subtraction of the effective contribution of precipitation from ET yields an estimate of crop consumptive use independent of and comparable to HYDROSS.

Important conclusion regarding net irrigation requirement and crop consumptive use:

- Overall, crop consumptive use is substantially below net irrigation requirement, most likely resulting from limited water supply, inefficient water delivery to crops resulting from canal capacity limitations and field-level water management.
- Crop consumptive use calculated using METRIC compares well to the results of HYDROSS on a seasonal basis.

The following is a summary of estimates of NIR and crop consumptive use.

- HKM derived NIR input files to the HYDROSS model by computing reference evapotranspiration (ET) with the Hargreaves Equation calibrated to the FAO-56 Penman-Monteith Equation (HKM 2014) for a specific mix of crops and then by subtracting effective precipitation. Values in Table 1 are for the St. Ignatius weather station to facilitate comparison with Montana DNRC consumptive use rules. A management factor was not applied by HKM in the process of deriving these NIR input file or determining farm turnout values in the water use agreement.

- HKM based their analyses on the proportion of sprinkler versus flood irrigation and associated application efficiencies, and net irrigation requirement for a specific mix of crops. They used 67 percent sprinkler irrigation and 33 percent flood irrigation for the Mission District and 58 percent sprinkler irrigation and 42 percent flood irrigation for the Jocko District with associated application efficiencies that varied by district and by month. They used efficiencies of 45 percent to 50 percent for flood irrigation and 75 percent to 80 percent for sprinkler irrigation. HKM varied crop patterns by area ranging that are dominated by pasture (54 percent to 64 percent) and grass and alfalfa (25 percent to 36 percent), with small amounts of spring grains and winter wheat.
- RWRCC contracted with the University of Idaho to use the METRIC method for calculating ET on irrigated lands within the Flathead Indian Irrigation Project. The METRIC analysis employs a surface energy balance method using Landsat satellite images and weather data to calculate ET on 30 meter pixels. In basic terms, METRIC calculates ET as the residual of the energy balance at the ground surface where:

  ET = net radiation – heat lost to air – heat lost to ground

  RWRCC staff used METRIC to assess management factors equal to the percent of maximum reference crop ET. RWRCC staff evaluated crop consumptive use from management factors, maximum reference crop ET calculated using the Penman-Monteith equation (Greiman, 2012), crop mix, irrigated acreage and estimates of effective precipitation. Data from the RWRCC assessment used in this report were provided in a spreadsheet titled Metric_eval_bg. Values of NIR and crop consumption in the following table are averages of three years of data.

- Jerry Laskody used data from the St. Ignatius Airport Agrimet station for pasture grass to evaluate ET and NIR on his property for 2012. He also provided estimates of water application based on soil-water holding capacity, irrigation records, and water delivery rates. Laskody calculated total ET of 14.67 inches, NIR of 13.87 inches, and application of 22.4 inches during July, August, and September based on efficiencies of 60 to 70 percent. He reported additional application of 3.7 inches in May, but did not account for additional crop water use. The primary difference in the crop consumption estimate by Laskody is the low effective precipitation relative to values used by others.

  Laskody's property is double-duty, normally allowing him 24 inches of water under current FIIP practices. Furthermore, evidence from aerial photography indicates that Mr. Laskody's property was one of the higher producing properties in the area.

- Montana DNRC rules for evaluating historic use (Section 36.12.1902, ARM) employs an estimate of crop consumptive use based on a comparison of historical alfalfa hay production to obtainable alfalfa yields. Alfalfa production data are obtained by county from the U.S. Department of Agriculture National Agricultural Statistics Service (NASS). ET and NIR data are generated using the USDA Natural Resources Conservation Service

(NRCS) Irrigation Water Requirements (IWR) program. The obtainable yield for a county is estimated by dividing the net irrigation requirement calculated in IWR for a dry year by 6 inches per ton water requirement for alfalfa. Management factors are evaluated by dividing the county-wide alfalfa hay yields from the NASS data by obtainable yield. The management factor is an estimate of the percent of the obtainable yield producers typically obtain in a given county and is used to determine the percent of net irrigation requirement actually consumed by a crop.

Values listed in Table 4 are for data from the National Weather Service weather station at St. Ignatius. NIR values assume ½ inch and 1 inch of carryover moisture for pivot and flood irrigation respectively. Carryover moisture accounts for water stored in the soil profile at the start of an irrigation season prior to irrigation as well as irrigation water applied at the end of the irrigation season that is not consumed.

Table 4

Method	Total ET (in)	NIR (in)	MF (%)	Crop Irrigation Consumption (in)	Applied (in)
HKM (2009)					
HKM - Mission	23.90	12.32		8.76	12.84*
HKM - Jocko	23.90	12.75		8.54	15.12*
HKM - L. Bitterroot	23.90	15.43		8.20	13.20*
METRIC					
Mission	25.30	17.00	56 - 66	8.04	13.40***
Jocko	25.30	17.00	56 - 66	6.19	10.32***
L. Bitterroot	25.30	17.00	56 - 66	5.42	9.03***
J. Laskody	14.67****	13.87****		13.87	22.4
ARM 36.12.1902	26.98	19.53 – 22.33 (flood – pivot)	55	11.66	19.12**

** normal year farm turnout allowance from Water Use Agreement*

*** assuming 50 percent efficiency for flood and 70 percent for pivot, and 60 percent sprinkler and 40 percent flood*

**** assuming 60 percent efficiency*

***** for July 2 to Sept. 16 period*

References

RWCC, 2014. METRIC eval bg.xls spreadsheet of analysis of METRIC data.

HKM, 2014. June 6, 2014 Memorandum from Wade Irion P.E, DOWL HKM to John Carter and Rhonda Swaney, CSKT Legal Department.

HKM, 2014. June 12, 2014. Technical basis for proposed Flathead Indian Irrigation Project water use agreement. Presentation to WPIC CSKT Technical Working Group.

Laskody, J.R., June 25, 2014. Matching irrigation water delivery on irrigated pasture to local transpiration and a comparison with the proposed CSKT compact water use agreement irrigation water delivery-St. Ignatius, MT July – September, 2012. Presentation to WPIC CSKT Technical Working Group.

Neibling, Howard. 1997. Irrigation Systems for Idaho Agriculture. University of Idaho College of Agriculture. CIS 1055.

Issue: Discussion of Evapotranspiration

Summary: An independent evaluation of crop consumptive use estimated some values but did not impose arbitrary reductions.

Background: There seems to be some confusion concerning how irrigation water demands and use were simulated for the Flathead Indian Irrigation Project (FIIP) with the HYDROSS models. Concern was expressed that the crop net irrigation requirements (NIR) input files to the HYDROSS model might have had a "management factor" incorporated into them, prior to running the model, under the assumption that the FIIP is a "deficit irrigation project."

Here are some of the facts we have found concerning this issue of concern:

- "Management factor" is defined as the percent of maximum net irrigation requirement that can be achieved at a particular location as a result of limited water availability at the field scale, soil conditions, and/or less than optimum irrigation practices.
- NIR input files to the HYDROS model were derived by computing reference evapotranspiration (ET) with the Hargreaves Equation calibrated to the FAO-56 Penman-Monteith Equation (DOWL HKM 2014) and then by subtracting effective precipitation. A management factor was not applied in the process of deriving these NIR input file.
- Overall, crop irrigation water consumption was modeled to be substantially below that which would be needed to fully satisfy the NIRs on the FIIP. In other words, water shortages were modeled. Reasons for these shortages appear to be inadequate available water supplies, canal capacity limitations, and possibly other factors.
- There was some discussion of the METRIC analysis (Mapping Evapotranspiration at high Resolution with Internalized Calibration) by the University of Idaho that was used to estimate evapotranspiration in the Mission Valley under contract with the Montana Reserved Water Rights Compact Commission. The METRIC analysis, which generated a management factor term to scale actual ET to theoretical maximum ET based on energy balance calculations using satellite imagery, was not used in developing the NIR input files to the HYDROS model. It was used by the RWCC as a check to see if the HYDOS modeled baseline total crop water use on the FIIP was similar to that estimated using the METRIC approach. However, for some internal areas in the FIIP and for private irrigation diversions, where canal measurement data were not available, results from the DNRC METRIC study were used make adjustments to lateral canal capacities so that diverted amounts for the associated irrigation blocks better matched METRIC-estimated crop irrigation consumption. (DOWL HKM 2014b).

References

DOWL HKM, 2014. June 6, 2014 Memorandum from Wade Irion P.E, DOWL HKM to John Carter and Rhonda Swaney, CSKT Legal Department.

DOWL HKM, 2014b. August 18, 2014 email correspondence from Wade Irion, HKM to Larry Dolan, DNRC.

Issue: Farm Turnout Allowances (FTA)

Summary: "Farm turnout allowance" is the legally enforceable volume of water project operators must deliver to farm turnouts under the terms of the proposed settlement.

Background: Farm turnout allowances refer to the legally enforceable volume of water that project operators must deliver to farm turnouts. FTAs are the water delivered to the field and not the water consumed by crops. FTAs include field losses, some of which ultimately return to the system, due to irrigation inefficiencies. The proposed Water Use Agreement (WUA), Appendix A, defines FTAs for the three areas in the Flathead Indian Irrigation Project (FIIP) and for three hydrologic conditions. Here are some of the facts we have found concerning this issue of concern:

- Page A-16 of the WUA defines per acre FTAs for different areas in the FIIP under varying hydrologic conditions ranging from 1.03 to 1.30 acre-feet per acre. There also is a maximum FTA of 1.40 acre-feet per acre.
- Page 11 of the WUA states that the FIIP shall serve no more than 130,000 acres of irrigation.
- The weighted average FTAs for the FIIP (pro-rated based on the acreage irrigated in each area) are about 1.07 acre-feet per acre for wet years, 1.09 acre-feet per acre for normal years, and 1.15 acre-feet per acre for dry years.
- Based on these weighted average FTAs and the WUA maximum acreage limitation of 130,000 acres, the FIIP project-wide summation of FIIP FTAs by year type would be as follows: 139,100 acre-feet for wet years; 141,700 acre-feet for normal years, and 149,500 acre-feet for dry years.
- If it were assumed that all irrigated lands were able to reach a maximum FTA of 1.40 acre-feet per acre, the summation of the maximum FTAs for the FIIP (130,000 acres maximum) would be 182,000 acre-feet.
- Water made available through the Flathead River pumps may be acquired by irrigators in excess of the annual FTAs under terms and conditions established by the CMA (WUA Section XIX., 56).

Issue: River Diversion Allowances (RDA)

Summary: Proposed "river diversion allowances" appear to be within the range of recent historic diversions and should meet proposed volumes for "farm turnout allowances," even when accounting for proposed operational improvements and efficiencies.

Background: River diversion allowances refer to the volume of water that is allowed under the proposed WUA to be diverted or pumped from the various water sources for use in the FIIP. River diversion allowances, in total and for a given portion of the Flathead Indian Irrigation Project (FIIP), should exceed the FTAs because RDAs include canal seepage losses, operational spills, and other factors. Because the RDAs would place an upper limit on what the irrigators in the FIIP will be able to divert or from source streams, a FIIP-wide comparison might provide some useful information. Here is some important information we have found concerning this issue:

- Without including Flathead River pumping and incremental inflow (spring, small tributary, some waste-water and routed canal flows) total river diversion allowances for the FIIP would be as follows: 225,900 acre-feet for wet years, 218,700 acre-feet for average years, and 194,700 acre-feet for dry years. (Water Use Agreement (WUA), Appendix A3: River Diversion Allowances)
- River Diversion Allowances, while based somewhat on measured diversion, have been adjusted for the Jocko and Mission project area using modeling results. River Diversion Allowances Reflect, "operational improvements are represented by limiting irrigation diversions to the crop-based demand (including canal, lateral and on-farm inefficient) with a 3 percent allowance for operational waste. (Jocko HYDSROSS Model Operational Improvements – Alternative 2, Run Date 11/17/2011 DOWL HKM July 2012)
- River Diversion Allowances reflect other operational modifications that are envisioned with Compact implementation. These operational improvements are defined in part XII of the Water Use Agreement. In summary, the following operational changes would be implemented to reduce river diversions:
    - eliminating shoulder season diversions for stock water
    - Improving accuracy by physically managing and measuring water deliveries. Examples provided via presentations included:
        - Eliminated or significantly reduced end of canal discharges. (This will require infrastructure improvements from refinement of diversion controls, internal delivery improvements and increase monitoring most efficiently accomplished with automated gates and real time flow monitoring.)
        - Modification of internal secondary pump diversions. There apparently are numerous locations where deliveries of water, well in excess of pumping rate, are currently provided to maintain head over the pump intakes to prevent cavitation (Makepeace and Greiman presentations). Having off-canal sumps or pits to pump from would result in water savings.
- Adding incremental inflow raises the total RDA amounts to the following: 276,220 acre-feet for wet years, 260,600 acre-feet for average years, and 227,400 acre-feet for dry

years. However there appears to be some double-counting of already diverted water when incremental inflow is added.

- It is difficult to make a direct comparison of the amount of water that has been diverted by the FIIP historically to that which would be allowed for in the RDAs. HKM, a CSKT consultant, provided information on primary 1983-2002 annual average diversions which totaled to 197,824 acre-feet from all sources for 112,981 acres of FIIP irrigation, or about 1.75 acre-feet diverted per acre (DOWL-HKM, 2014). About 25,500 acre-feet per year of this amount could be attributed to Flathead River pumping, leaving about 172,300 acre-feet, or 1.53 acre-feet per acre from the other sources. Although diversion records were used for the Little Bitterroot, Jocko, and Mission areas, the irrigated acres accounted for in these summations were not all inclusive and seem to be about 10-15 percent less than the FIIP total. Another important consideration is that, based on graphs presented by Seth Makepeace of the CSKT tribe at the July 17 meeting of the Technical Working Group, annual diversions for a particular year might typically fluctuate about 20 percent above or below the average.
- We could find no definitive information documenting higher total FIIP project diversions prior to 1983.
    - A document stamped by the BIA on December 23, 1946, with the title "Reservation – Flathead: Project – Flathead" contains a table with the FIIP water supply for irrigation "Grand Total" listed at 490,859 acre-feet. However, this appears to be, at least partially, based on estimates of the source water supply rather than measured diversions.
    - A June 1946 BIA report lists total project diversions at the land for 1911 through 1923 with an average of 99,895 acre-feet and a maximum of 113,114 acre-feet. A table in that same report lists average annual deliveries based on watermasters' reports for the 1933-1946 period, which sum to 122,402 acre-feet. Again, these are deliveries to the farm headgate (more comparable to farm turnout allowances) and would not include conveyance system losses between the river headgate and farm turnouts, such as seepage and operational spills.
    - In his July 17, 2014 presentation to the TWG, Seth Makepeace with the CSKT Tribes presented some farm delivery totals for the Little Bitterroot and Mission Valley portions of the FIIP. Visually, the 1970s diversions appeared to be somewhat higher than those during the 1980s, although the 1970s were generally good water supply years, with the exception of 1977 which was a dry year.
    - Diversion levels pre-1987, prior to the establishment of interim instream flow requirements, may have been somewhat higher than those since that time because the interim instream flow requirements likely reduce diversions some during times of low flow.
- The proposed WUA provides for a total of 65,000 acre-feet (about 35,000 acre-feet higher than current average pumping levels) available to the FIIP through the Flathead River Pumping Plant. (Pumping Costs are proposed to be subsidized as described in Part XX., Low Cost Block of Power, of the Water Use Agreement.)
- Pumping from the Flathead River can reduce reliance on other water sources. Increased pumping from the Flathead River has the potential to substantially reduce the amount of

water that needs to be supplied to Pablo Reservoir by tributary sources, which now accounts for about half of the inflow to Pablo Reservoir. This could, in turn, reduce the need for diversions to the Mission area from the Jocko via the Tabor Canal.

- Page 11 of the WUA states that the FIIP shall serve no more than 130,000 acres of irrigation.
- The table below summarizes FIIP total diversion allowances by year type, with and without incremental inflow and with and without Flathead River pumping. It also includes a FIIP project average acre-feet-per-acre annual diversion, which might be realized under the RDA.
- Averaged over the project, the 65,000 AF Flathead River Pumping Plant allowance might add up to another 0.5 feet per-acre to the total volume of water available to irrigators. However, not all irrigators would have direct access to this water.
- Little Bitterroot area irrigators might be the most limited, as measured by total diversions allowed at the river headgate per acre. In the case of the Little Bitterroot area, the RDAs might result in a similar limitation to total diversions as the FTAs.
- RDAs exceed FTAs by year-type as follows: 86,800 acre-feet for wet years, 77,000 acre-feet for average years, and 45,200 acre-feet for dry years. These differences do not include incremental inflow or any pumping from the Flathead River.

Table 5: River diversion allowance summation

	River Diversion Allowance in acre-feet by Year Type (acre-feet per acre in parenthesis*)		
	Wet Year	Normal Year	Dry Year
Sum of RDAs – no incremental inflow	225,900 (1.74)	218,700 (1.68)	194,700 (1.50)
Sum of RDAs – with incremental inflow	276,220 (2.12)	260,600 (2.0)	227,400 (1.75)
Sum of RDAs – no incremental inflow + Flathead River Pumping	290,900 (2.24)	283,700 (2.18)	259,700 (2.00)
Sum of RDAs – with incremental inflow + Flathead River Pumping	341,220 (2.62)	325,600 (2.50)	292,400 (2.25)

** Assumes total FIIP irrigated area of 130,000 acres*

References

BIA 1946. Report on Conditions Found to Exist on the Flathead Irrigation Project, Montana; Volume 1.

DOWL HKM 2014. August 18 and August 19, 2014 email correspondence between Wade Irion of HKM and Larry Dolan of DNRC.

Issue: Land classification and additional duty water

Summary: Proposed irrigation allowances under the terms of the settlement may replicate the current extra duty system.

Background: Concerns have been raised that the proposed farm turnout allowance (FTA) is equalized across irrigation districts for wet, average, and dry years and does not consider the current land classification and duty system. In other words, the current duty system would be eliminated under the proposed Water Use Agreement and replaced by standardized Farm Turnout Allowances (FTAs) for each of the following areas of the Flathead Indian Irrigation Project (FIIP): the Mission, the Jocko, and the Little Bitterroot.

- The commissioners of the irrigation districts of the FIIP are responsible for the equitable and just apportionment of water in compliance with regulations governing federal irrigation projects (Section 85-7-1911, MCA). Equitable does not necessarily mean equal. For the FIIP, like other federal irrigation projects, this equitable apportionment is accomplished by classifying lands according to the amount of water that is needed to raise a crop based on several factors including the slope of the land, the levelness of the land and the ability of the soil to hold or store water for future use by plants. Based on the classification, duties of water are assigned with land that are level with little slope comprising heavier soils able to hold more water being assigned less water ("single duty"). Lands that are progressively less level, steeper in slope, and comprising lighter soils with limited ability to store water are assigned higher duties (e.g., "double duty" or two times the water). The higher duties were initially assigned because flood irrigation, which was prevalent at the time, requires more water to effectively irrigate unleveled and steeper lands and lighter soils requires more frequent irrigations because of the limited ability of the soil to hold or store water.
- Classification of land in the FIIP apparently last occurred in the mid-1940s. Concurrently with the land classification a water duty system was employed with single-, 1.25-, 1.5-, 1.75-, double-, 2.3- and triple-duty. The duties of water assigned on the FIIP appear to reflect a land classification predicated on all irrigation being flood, which was likely the case in the 1940s. This same duty system is apparently still in place today.
- Sprinkler irrigation under proper management enables a water user to overcome some of the disadvantages of unleveled land, steeper slopes and lighter soils. Unlike flood irrigation, sprinkler systems are relatively unhampered in applying irrigation water uniformly on unleveled land and steeper slopes. The amount of water applied can be regulated to match the ability of the soil to hold the water applied.
- Each year the volume of water per acre or annual duty is set for the units of the FIIP based on available water supply. For example the 2014 duty is 1.05 acre feet per acre. Single duty lands are to receive 1.05 acre feet per acre with higher duty lands receiving there proportionally higher amount of water (i.e. double-duty land is to receive 2.1 acre feet per acre). During times of shortages, water deliveries per-acre are reduced with higher duty lands receiving a proportionately higher amount of water (i.e. double-duty land would receive twice as much water as single-duty land).

- The land classification/duty system allows higher-duty lands now being sprinkler irrigated to potentially achieve higher yields than single- or lower-duty lands during times of water shortage.
- Under the proposed Water Use Agreement, irrigation unit per acre water deliveries to the farm (FTAs) would range from 1.03-1.3 acre-feet per acre based on year type and FIIP area, with maximum FTAs of 1.4 acre-feet per acre.
- The proposed WUA allows for variability within the FIIP irrigation distribution works, and for soil and climate variability, by allowing a maximum Measured Water Use Allowance (MWUA) of up to 2.0 acre-feet per acre for an individual farm turnout, as long as the average diversion for farm turnouts does not exceed the amounts specified in the FTAs.
- Water would be made available (up to 65,000 acre-feet per year), to portions of the FIIP, through use of the Flathead River pumps. This water could be available in excess to the FTAs described above.
- The FJBC reportedly in negotiating the Water Use Agreement advocated for elimination of the existing duty system of water apportionment instead favoring equal duties across each project area (i.e. Little Bitterroot, Jocko and Mission & Flathead). The FJBC reportedly no longer favors elimination of the present duty system.

References

BIA 1946. Report on Conditions Found to Exist on the Flathead Irrigation Project, Montana; Volume 1.

III. Instream rights

Issue: Quantification of on-reservation instream flow rights

Summary: Increased instream flows required under the settlement are the amounts left after operational improvements and betterment of the irrigation project -- not as the result of applying a hydrologically based instream flow methodology.

Background: The proposed compact contemplates instream flow water rights on the Flathead Indian Reservation. Questions have arisen as to how the amounts for these water rights were determined.

- There are three location categories of on-Reservation instream water rights; natural, Flathead Indian Irrigation Project (FIIP) related and other non-FIIP related:
  - Natural flow rights cover streams high in the watershed above diversions and reflect maintenance of the existing natural flow conditions without anthropogenic influence.
  - FIIP-related instream rights occur in stream reaches below FIIP diversions and directly influenced by the operations of FIIP.
  - Other non-FIIP related instream rights cover stream reaches outside the FIIP area of influence, meaning they are not influenced directly by FIIP diversions.

  All of these instream flows have a time immemorial priority date under the proposed compact.
- The FIIP-related instream flow levels as prescribed in the Water Use Agreement (WUA) are based on the streamflow remaining after irrigation diversions have occurred. These instream rights include water added due to the benefits of operational improvements (e.g. elimination of shoulder season stockwater diversion, reducing ditch tail-water loss to 3 percent, and increased pumping from the Flathead pumping station). No specified instream flow methodology was used to derive the WUA instream flow values. Rather, they are defined as the water left instream after irrigation operational and betterment improvements to the FIIP have occurred.
- The current interim instream flows will continue to be used and the FIIP WUA instream flow values will be deferred for at least five years after funding is appropriated for operational improvements.
- The FIIP-related values, particularly in summer and early fall, reflect irrigation depletions and still are substantially lower than that which would have naturally occurred, in most cases. However, in some stream reaches, the use of streams to convey water to or from storage reservoirs inflates these numbers above that which would have naturally occurred.
- When compared to instream flows generated using a hydrology based instream flow methodology used in British Columbia at four sites where U.S. Geological Survey streamflow data is available, the FIIP-related values are lower than those generated using the recognized methodology. This methodology was selected because it provides monthly instream flow values that are directly comparable to the proposed instream flow values. Further no additional field data collection is needed as it can be applied to existing hydrologic data (20 years of daily natural flow data is needed). Lastly, the method is recommended for use across British Columbia including the Flathead River basin which is contiguous with the Flathead basin of Montana.

- A more dated instream flow methodology, the Tennant instream flow method as modified by Tessman, also provides monthly instream flow values based on past hydrologic data that can be compared directly to the proposed instream flow values.

Table 6

Situation	Minimum Monthly Flow
MMF[a] < MAF[b]	MMF
MMF > 40% MAF , and 40% MMF < 40% MAF	40% MAF
40% MMF > 40% MAF	40% MMF

[a] *MMF = mean monthly flow*

[b] *MAF = mean annual flow.*

Table 6 reflects the application of the Tennant method with Tessman's modification. This method yields more conservative instream flow values than the British Columbia method. This method was also applied to the same 4 sites.

- On whole across the FIIP instream flows generated using recognized methodologies would likely result in higher instream flows with less water available for irrigation than if the proposed FIIP related instream flow values are used.
- While not directly based on specific instream flow methodologies, the FIIP related WUA instream flows do exhibit the intra and inter-annual variability that is a recognized cornerstone of instream flow science. This is accomplished by the variable monthly flow rates that generally follow the shape of the natural hydrograph and by the different dry (MEF), normal and wet year instream flow levels.
- The "other" non-FIIP related instream rights are predominantly based on the Tennant instream flow methodology as modified by Tessman shown above. Although it was applied to wet year data as opposed to mean data for the period of record.

References

Annear, T., I. Chisholm, H. Beecher, A. Locke, and 12 other authors. 2004. Instream Flows For Riverine Resources Stewardship, Revised Edition. Instream Flow Council, Cheyenne, WY.

Brummond, A. August 1, 2014a, Memorandum to WPIC CSKT Technical Working Group, Evaluation of CSKT Instream Flow Levels for Streams with USGS Gages.

Issue: "Robust river" standard

Summary: "Robust river" or the "robust river standard" are not defined in the proposed settlement nor terms used by experts. Proposed increased instream flow values do not present a threat to channel stability, irrigation infrastructure or the fishery.

Background: Questions have arisen regarding the application of the "Robust River Standard" in developing instream flow values. There is concern that the related high stream flows would negatively impact channel stability and irrigation infrastructure as well as the fishery.

- The terms "Robust river" or "robust river standard" are not used or defined in the proposed compact or supporting documentation. Neither are they generally accepted terms regularly used by professional instream flow scientists. To some the terms mean a healthy, fully-functioning river ecosystem while to others it apparently means a high flow maintained over an abnormally extended period of time. The latter interpretation seems to be the reason for the concern with respect to negative high flow impacts on channel stability, irrigation infrastructure and the fishery.
- The proposed instream flows are generally higher than the current interim instream flows. The interim instream flows are base-flow values below which instream flow should not drop during natural low-flow periods. The interim instream flows do not reflect the higher flows needed during times of the year to provide for a healthy stream ecosystem.
- Flows substantially higher than interim and higher than proposed instream flows are already occurring due to natural events and the use of streams to move water to and from storage reservoirs. The proposed instream flows do not present a threat to channel stability, irrigation infrastructure, or the fishery as they would not result in flows above naturally and already occurring levels and time periods.

References

Brummond, A. Aug. 1, 2014a, memorandum to WPIC CSKT Technical Working Group, Evaluation of CSKT Instream Flow Levels for Streams with USGS Gages.

Issue: Fishery conditions

Summary: Independent studies show modifications of the reservation river systems for irrigation have suppressed native fish populations.

Background: Public comment directed to the Technical Working Group (TWG) raised questions relative to the fishery conditions within the Flathead Reservation and more specifically need of instream flow above the interim instream flow levels set in 1987. The assertion to the TWG there has been no evidence provided of inadequate stream flows to support fishery habitat and not reports of declining fishery conditions that have been defined or evaluated through the water right compacting process.

The TWG, based upon individual experiences in other locals, expects to see current native fishery conditions somewhat compromised by the development and heavy use of water for irrigation and in addition to impacts from other forms of resource development. Such changes are seen in many of the state's river systems having similar levels of development. At the urging received through public comment the TWG did conduct a basic literature review concerning fisheries conditions on the reservation. Two summary documents were reviewed they included:

1. Biological Opinion for Bull Trout and Bull Trout Critical habitat Flathead Indian Irrigation Project – Operation Maintenance and Transfer 2009, U.S. Fish and Wildlife Service, Montana Field Office, December 14, 2009
2. Flathead River Subbasin Summary, prepared for Northwest Power Planning Council, Lynn Ducharme, Team Leader, September 29, 2000

The U.S. Fish and Wildlife Service prepared their document in response to the Bureau of Indian Affairs request for consultation. The biological opinion reviewed the direct and indirect effects to bull trout that may occur as a result of changes in the operations and maintenance of the Flathead Indian Irrigation Project (FIIP) under a proposed transfer of operations to a new management entity on the Flathead Indian Reservation, the Cooperative Management Entity (CME).

The Flathead River Subbasin Summary is a combination literature review and interview of mangers of fish and wildlife resources within the Flathead Subbasin and was prepared for the Northwest Power Planning Council. Lynn Ducharme of the CSKT was the subbasin team leader with ten biologists, four from Montana Fish, Wildlife and Parks and six from the CSKT, as contributing authors.[1]

Findings from literature review:

- The reservation has a native fishery resource that includes, but is not limited to, whitefish, westslope cutthroat trout and bull trout. However, like many Montana other stream systems, includes a populations of non-native fish species including, but not

[1] Contributing authors included Dale Becker CSKT, Lynn Ducharme CSKT, Lee Evarts, CSKT, Grant Grisak, MFWP, Barry Hansen CSKT, Brian Lipscomb, CSKT, Brian Marotz, MFWP, Clint Muhlfeld, MFT
Art Soukkala, CSKT and Alan Wood, MFWP

limited to, pike and several non-native trout species (brook, rainbow, rainbow-cut hybrid, lake and brown trout). (Ducharme 2000)

- Westslope cutthroat trout is listed as a species of special concern and bull trout is considered a threatened species under the Endangered Species Act (ESA) both are native resident species with existing but suppressed populations. (USFWS 2009)
- US Fish and Wildlife Service, in defining bull trout populations, report that six of the 14 designated local bull trout populations in the consolidated Lower Clark Fork Core Area are found within the Flathead Reservation (i.e., Post Creek , Mission Creek, Dry Creek, South Fork Jocko, Middle Fork Jocko, North Fork Jocko) (USFWS 2009)
- Habitat fragmentation has resulted from irrigation diversions within the reservation boundaries and Clark Fork River main stem dams downstream of the reservation. Both anthropogenic modifications to the river system suppress native fish populations, especially bull trout. (Ducharme 2000)
- FIIP storage reservoirs, irrigation canals, dams and other facilities have eliminated the connection between many of the tributary streams in the action area with the lower Flathead River and Clark Fork River System. (USFWS 2009)
- Other impacts within the reservation boundary include irrigation dewatering, riparian degradation, channelization, entrainment, and competition from exotic species. (Ducharme 2000)
- Native fish populations are often isolated to the headwaters of tributary streams where out migration can occur but barriers often limit access back to native spawning areas. (Ducharme 2000)
- The Jocko River's bull trout population is currently classified as "functioning at unacceptable risk" (Evarts, CSKT, pers. com. 2000). Primary causes for this ranking are identified as habitat fragmentation from irrigation diversions within the Jocko drainage and main stem Clark Fork River dams. Other impacts include irrigation dewatering, riparian degradation, channelization, and competition from exotic species." (Ducharme 2000)
- Baseline habitats for North and Middle Fork of the Jocko, Mission Creek and Post Creek have baseline habitat conditions that are all functioning at unacceptable levels creating risk for bull trout populations. Instream flows, for both peak and base flows conditions, were defined as inadequate. (USFWS 2009)
- Decades of FIIP operations impacting stream flow regimes (magnitude, frequency, duration, time and rate of change) have been significantly altered with substantial effect to stream channel geomorphology, water temperature sediment, riparian vegetation and other ecological processes. (USFWS 2009)
- Where the FIIP irrigation system incorporates or interacts with both diverted and non-diverted streams without upstream storage reservoirs, the primary impacts arise from water above designated interim instream flows being diverted away for irrigation during both spring and summer. (USFWS 2009)
- Prior to the establishment of minimum stream flows on the FIIP project, stream dewatering below irrigation diversion was a significant issue and regularly affected native fish populations. Since the mid 1980s, the magnitude of impacts from stream

dewatering has been small. The dewatering event documented was attributed to human error in regulating Mission Reservoir. The proposed changes in the management entity included specific minimization measures to address chronic problems sites where minim instream flow levels have been difficult to maintain. (USFWS 2009)

- Instream flows are a determining factor for stream health and stability. Ensuring and adequate flow regime (with inter- and intra-annual variability) that mimics the natural hydrograph allows streams to form stable channels, develop appropriate pool to riffle ratios, develop and adequate stream channel meander patter and maintain or restore other process that sustain natural right characteristics would be beneficial. (USFWS 2009)
- "The ultimate objection should be to make every effort to reestablish and sustain natural stream flows and related ecological processes. Under the proposed action (change in FIIP operations under the CME) the FIIP will maintain or improved upon the existing flow regime and will implement project that will improve water management and conserve water in the systems. That water will then be directed towards achieving greater instream flow conditions for bull trout (as compared to existing conditions and the pervious instream flow levels). ….While the FIIP will not be able to achieve natural conditions, the expectation is that they will improve the current condition over time and will continue to see measurable improvement to instream flow in the future." (USFWS 2009 p39).

References

(noted above)

Issue: Changes in legal demand of water due to new proposed off-Reservation instream rights

Summary: Proposed off-reservation water rights for the tribe generally would not change the legal demands of water beyond recognized agency thresholds.

Background: Off-Reservation instream flow water rights have been proposed for the lower Clark Fork, Swan and Kootenai rivers; Big, Boulder and Sutton creeks, all tributaries to Lake Koocanusa; and Steep Creek, a tributary to Big Creek. Concerns have been raised that these instream rights would close or preclude new appropriations of water in these basins and would result in existing water users being called upon to cease diversion when flows drop below the level of the instream rights. Questions regarding how these rights were quantified have also been raised.

- The proposed compact does not close any basin to new appropriations of water.
- On the main-steam Clark Fork and Kootenai Rivers, calls on existing water rights based on the proposed instream rights would be limited to irrigation water rights. This would include irrigation rights from groundwater connected to the rivers pumping at a rate in excess of 100 gallons per minute (gpm).
- The proposed CSKT instream right for the lower Clark Fork River of 5,000 cubic feet per second (cfs) matches the minimum flow required under the Federal Energy Regulatory Commission license for Cabinet Gorge Dam. If this minimum flow requirement were to be reduced under the FERC license, under the conditions of the proposed Compact the CSKT instream flow right would be reduced to the same level.

  Flow in the Clark Fork River exceeds 5,000 cfs during the normal irrigation period of April through September in even very dry years (the driest year in 20 on a statistical basis), making a call on Clark Fork River irrigators unlikely. With respect to the ability for water users to obtain a new water right permit, the proposed Clark Fork River instream flow right would not push water demand in the Clark Fork beyond what is available for five of 10 years, which is most often the threshold used in water right permitting. However, the CSKT, like any other senior water right holder, would have the opportunity to object to new permit applications based on their instream flow rights. The Technical Working Group cannot speculate on whether the CSKT would object to new permit applications and, if they did, whether their objections might ultimately preclude new permit applications.

- The proposed instream right for the Kootenai River would not be in effect unless protocols for operations of Libby Dam under requirements of the federal Endangered Species Act are lifted. The instream right is approximately the daily flow level that is met or exceeded one out of 10 years, meaning in about nine out 10 years the instream flow right is met. Calls on existing water rights would potentially occur very infrequently. With respect to the ability for water users to obtain a new water right permit, the proposed Kootenai River instream flow right would not push water demand in the Kootenai beyond what is available for five of 10 years, which is most often the threshold used in water right permitting. However, other parties have the opportunity to object to new permit applications. The Technical Work Group cannot speculate on whether other parties would object to new permit applications and, if they did, whether their objections might ultimately preclude new permit applications.

- Calls on existing water rights based on the proposed instream right for the Swan River would be limited to irrigation rights including those from groundwater connected to surface water pumping at a rate in excess of 100 gpm. Unlike the Clark Fork and Kootenai rivers this call could extend to tributaries in the Swan River basin. The instream right is essentially the daily flow level that is met or exceeded two out of 10 years; meaning in about eight out 10 years the instream flow right is met, while on a statistical basis existing water rights may be subject to call in about two out of 10 years. With respect to the ability for water users to obtain a new water right permit, the proposed Swan River instream flow right would not push water demand in the Swan beyond what is available in five of 10 years, which is most often the threshold used in water right permitting. However, other parties have the opportunity to object to new permit applications. The Technical Working Group cannot speculate on whether other parties would object to new permit applications and, if they did, whether their objections might ultimately preclude new permit applications.
- Quantification or the selection of the approximate 80th percentile exceedance flow for the Swan River instream right was based very roughly on the Alberta Desk-top Method. However, a strict application of the Alberta Desktop Method would yield higher instream flow values in normal an wetter years allowing no more than 15 percent of the natural flow to be diverted.
- Big, Boulder, Steep and Sutton creeks all lie entirely on U.S. Forest Service lands and do not have any private water rights diverting from them. The quantifications of these rights are designed to protect the existing natural flow regime in these streams. It is unlikely new water users could obtain a water right from these streams with the proposed compact in place.

References

Brummond, A. Aug. 1, 2014b, Memorandum to WPIC CSKT Technical Working Group, Changes in legal water demand due to CSKT Compact.

DFO. 2004. Synopsis of Instream Flow Thresholds for Fish and Fish Habitat as Guidelines for Reviewing Proposed Water Uses. British Columbia Ministry of Water, Land and Air Protection (MWLAP), Ministry of Sustainable Resource Management (MSRM), Land and Water BC Inc. (LWBC), and Fisheries and Oceans Canada (DFO)

Locke, A. and Paul, A. 2011. A Desk-top Method for Establishing Environmental Flow in Alberta Rivers and Streams. Alberta Environment and Alberta Sustainable Resource Development.

Issue: Quantification of proposed water rights co-owned by Montana Department of Fish, Wildlife and Parks

Summary: Various methods and models were used to quantify off-reservation water rights, which are proposed to be shared with the tribe.

Background: The proposed compact contemplates that several existing instream (Rock Creek, Blackfoot River, Flathead River and its forks, and Bitterroot River) and in-lake water rights (Clearwater Chain of Lakes, Upsata Lake, Harpers Lake and Browns Lake) held by Montana Department of Fish, Wildlife & Parks (FWP) would be co-owned by the CSKT. Questions have arisen as to the methodologies used to quantify these water rights.

- The "Murphy" instream flow water rights for the Blackfoot, South Fork, Middle Fork, North Fork and main stem Flathead Rivers, and Rock Creek are based on the dominant discharge/channel morphology concept (high flow period, or generally April through July) and wetted perimeter method (low flow period, or August through March). The dominant discharge/channel morphology concept focuses on the need for higher flows for bed load movement and sediment transport which are essential functions in maintaining good fish habitat in a river. For the high flow period monthly flows equating to that which are exceed during eight out of 10 years were selected to provide for sufficient channel forming function while still allowing for a reasonable level of new water development in most years. The wetted perimeter method used for the lower flow period is now recognized in statute (Section 85-20-1401, MCA) which defines it as follows:

  > *"Wetted Perimeter Methodology" means an instream flow methodology for fisheries flow based on habitat for food production in the shallow, fast-moving water of a stream. The wetted perimeter is the distance across the bottom and sides of a stream channel, measured at a riffle area that is in contact with the water. A graph of the wetted perimeter versus discharge generally yields two inflection points. The upper inflection point of the graph is the level above which large increases in discharge result in a small increase of the wetted perimeter. The lower inflection point of the graph is the level below which small decreases in discharge result in large decreases of the wetted perimeter.*

  The wetted perimeter method has long been recognized in Montana as a practical means of determining instream flows during the base or low-flow portion of the year and serves as the basis for over 200 instream flow reservations held by FWP. The results of the aforementioned analysis was compared to the notices of appropriation filed in the local county courthouses for the Murphy rights and the claimed flow rate was reduced where the instream flow methodology suggested a value lower that that found in the notice of appropriation.

- The Bitterroot River public recreation water rights filed in accordance with Section 85-2-223, MCA, are based on the dominant discharge/channel morphology concept discussed above as well as the flow necessary for floating of the river and preservation of existing winter flows. Unlike the Murphy right rivers previously discussed (possibly excluding the Blackfoot River), existing irrigation has a significant impact on flow observed in the Bitterroot River. For that reason the mean monthly streamflow was used to determine the necessary flow needed in the high flow period (May and June) instead of the relatively lower 80th percentile exceedance (eight out of 10 year) flow that was used for the Murphy right rivers. For the July-September period the flow is that necessary to maintain adequate depth (1-2 feet) for floating over riffles. During the winter period the mean monthly streamflow again serves as the basis for the instream flow value as it provides adequate habitat during periods when ice can severely limit available impact causing significant negative impact to the fishery.
- A water quality model designed to prevent eutrophication, a water temperature model and fish passage depths were used to quantify the monthly volumes of water for the Clearwater chain of lakes (Salmon, Placid, Seeley, Inez, Alva, Rainy and Clearwater lakes).
- For Upsata, Harpers and Browns lakes the Supreme Court Claim Examination Rule was applied that provides for quantification of a fish and wildlife lake equal to a volume of water equal to the capacity of the lake plus annual evaporation.

References

Water Right Statements of Claim files for the Bitterroot, Blackfoot, South Fork, Middle Fork, North Fork and main stem Flathead Rivers, Rock Creek, Upsata, Harpers and Browns Lakes and the Clearwater chain of lakes (Salmon, Placid, Seeley, Inez, Alva, Rainy and Clearwater Lakes).

Supreme Court Claim Examination Rule 29(c).

Brummond, A., Knotek, W., Flynn, K. 2014. Water Right Volumes Necessary to Support Recreation on the Clearwater Chain of Lakes. Montana Fish, Wildlife & Parks

Issue: Quantification of Upper Clark Fork Instream Flow (Milltown Dam water right)

Summary: Under terms of the proposed settlement, a co-owned Milltown Dam instream right may allow for calls on junior users, although it appears the rights to call would be limited.

Background: The proposed compact contemplates converting the existing Milltown Dam hydropower water right to an instream flow fishery water right. The water right would be co-owned by the State and the Confederated Salish and Kootenai Tribes. (Montana Department of Fish, Wildlife and Parks (FWP) would manage the state's undivided interest in this water right.) Questions have arisen as to the methodologies used to quantify these water rights. The water right associated with the Milltown Dam is one of those water rights.

The Milltown Dam hydropower water right claims was acquired by the state through the settlement of natural resources damage claims related to Milltown Dam and contaminated sediments accumulated in the reservoir pool.[2] The Milltown Dam water right is a 2,000 cubic feet per second (cfs) water right with a priority date of December 11, 1904.

The former Milltown Dam water right has a maximum flow rate of 2,000 cfs. Through the Compact the Milltown hydropower right split and changed to an instream flow purpose. This action creates two separate active and enforceable water rights. One water right is specifically allocated to only the Blackfoot River and enforcement limited to that drainage. The other instream flow right is limited to only to the Clark Fork River and can be enforced only within that drainage. The flow rate for each these two now separate flow rates is defined by the compact and is based upon historic hydrologic records.

The hydrologic records were used to create an enforceable hydrograph. (The daily details of this hydrograph and daily flow are an appendix to the compact.) This hydrograph defines daily flow allocation for each of these now separate water rights. During spring runoff that Blackfoot River, instream flow water right can be as high as 1,167 cfs and Clark Fork portion 833 cfs. (The instream flow right during runoff is 2,000 cfs when combined at the rivers confluence.) However during base flow period the flow rate for the Blackfoot instream flow water right is reduced to 700 cfs on July 25. The Clark Fork instream flow water right is limited to a maximum of 500 cfs on Aug. 4. These base flow instream flow values remain constant until the next year's snow melt period. (The sum of the two water rights during base flow is 1,200 cfs)

Enforcement if the Upper Clark Fork instream flow water rights is further limited by the compact. In water-short periods the instream flow water right can only be enforced against:

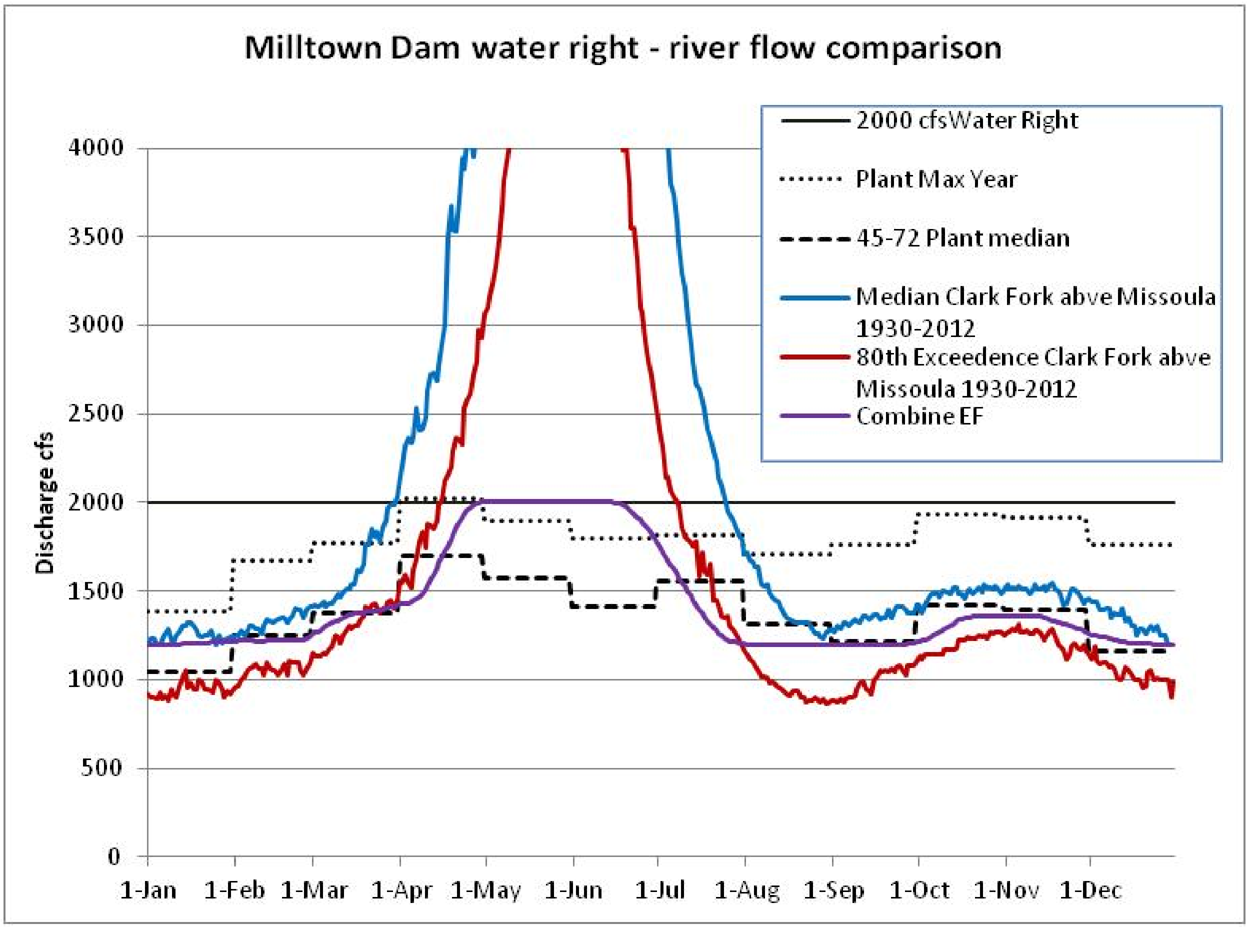
---

[2] The State of Montana acquired the Milltown water right along with other properties as part of the Milltown Dam natural resources damage settlement as defined in Consent Decree for the Milltown Site, United States of America vs. Atlantic Richfield Company (ARCO) and Northwestern Corporation (NWC), Civil Action No. CV89-039-BU-SHE, United States District Court for the District of Montana Butte Division.

- water rights developed after the compact is adopted and therefor junior to the compact,
- only irrigation water rights developed before the compact is adopted. All irrigation uses relying upon surface water or groundwater, provided that groundwater diversion is greater than 100 gallons per minute (gpm).

In Figure 7 the Blackfoot and Clark Fork instream flow rights have been added and displayed as the purple line. This also these instream flow demands to be compared to the historic operations of the Milltown Dams as well as statistical values of stream discharge at that same location, as measured at the United State Geologic Stream gauge.

Figure 7



The existing hydropower right for the Milltown Dam is 2,000 cfs, but the actual water usage and hence the extent of the water right may be somewhat less. Figure 7 shows in dashed lines the median of water run through the hydropower plant during the 1945-1972 period as well as the highest volume year during the same time period. It also shows the median and 80th exceedance hydrographs for the Clark Fork River below Milltown.

Under the Natural Resources Damage settlement, the state of Montana is required to protect the value of the Milltown Dam water right. It is the state's intent and objective to convert this water right to instream flow to protect water quantities and habitat improvements. Therefor if not converted to instream flow through the compact, the state will use the “change of use” process to convert this instream flow, hydropower right to an instream flow fisheries water use. If the Milltown Dam water right were changed to instream flow outside of the CSKT Compact a strong argument can be made that the demand for water, whether based on the median, highest year or some other hydrograph would exceed the demand of 1,200 cfs proposed in the Compact. The CSKT compact proposal for the Milltown Dam water right provides less likelihood that existing water users will be called when irrigation demand is highest in late summer compared to likely outcomes of the Milltown Dam water right being changed to instream flow through the regular administrative process.

References

(noted above)

IV. Aquifer characterization

Issue: Values for return flows, stream depletion, canal loss, etc.; and potential impacts of operational improvements to groundwater wells

Summary: Although groundwater modeling conducted to support the proposed settlement could not be fully evaluated due to a lack of information, groundwater levels may decline locally as a result of operational improvement to the irrigation project and increased efficiency of use.

Background: How are irrigation return flow factors, rates, and volumes calculated or estimated, and are they used as input values for the HYDROSS model, or are they a calculated result of the model?

Irrigation return flows, stream depletion, canal loss, and groundwater evaluations noted in presentations:

- According to Dowl-HKM presentations (2012 and 2014), key model inputs included Flathead Indian Irrigation Project (FIIP) irrigation system canal losses. The presentations refers to several studies:
    - Canal seepage study from DNRC
    - Stream seepage runs from CSKT
    - SS Papadopulos & Associates (SSPA) groundwater modeling work
    - Surface Water Budget is also balanced with groundwater budget

The 2014 presentation includes a slide elaborating on the last point above, that the surface water budget is also balanced with the groundwater budget, further noting that elements from the HYDROSS models used by SSPA groundwater modeler included:

- total stream and canal inflows
- irrigated acreage
- crop water use
- canal and site losses to seepage
- reach/diversion loss to seepage
- total stream and canal outflows

The 2014 presentation describes groundwater monitoring conducted at up to 72 wells starting in 1982, with data maintained in the Montana Bureau of Mines and Geology (MBMG) Ground Water Information Center (GWIC) database. Also, water quality sampling was performed under contract with MBMG during aquifer characterization studies in the mid-1990s.

<u>Groundwater modeling described in presentation</u>

A slide show from a presentation by Deborah L. Hathaway, P.E., S.S. Papadopoulos & Assoc., Inc., May 26, 2010, provides a summary description of groundwater modeling efforts for the Jocko Basin, Mission Valley, and Little Bitterroot Valley. Most illustrations of results include "work in progress, results subject to change" labels. Based on the illustrations and presentation, the groundwater modeling was reasonably comprehensive, and appears to have included most elements that an experienced modeler would expect for basin-scale modeling designed to evaluate or analyze the groundwater budget and groundwater-surface water interactions. Model inputs are stated to include recharge from leaking canals and streams, excess water from irrigated fields, mountain front recharge, and groundwater inflow. Model input features include groundwater withdrawals from wells and riparian transpiration. Hydraulic conductivities were entered for various zones based on geologic units. No values are provided for any of the model recharge or sink features or hydraulic conductivities. No details about the model grid size, number of layers, and layer thickness or configuration are provided, however the available figures at least imply a reasonable grid cell size for such large-area models.

One slide with numerical data provides gains and losses for the upper and lower Jocko River. Gains in the lower Jocko River average around 30,000 acre-feet per year, or 41 cubic feet per second (cfs). Another slide shows the potential elimination of 2,400 acre-feet per year in canal losses for the Jocko basin – which represents perhaps 8 cfs per month for a five-month irrigation season – by lining of canals. The groundwater model reportedly indicates this would result in decrease in flow in the Jocko River of about 1,800 acre-feet per year, and groundwater level declines of up to a few feet at designated observation points in the basin. There are colorful groundwater level elevation maps compared with mapped potentiometric surfaces that both look reasonable for such a basin-scale effort. The slides include numerous examples of model results for a variety of scenarios which, based on my impression of the model scales and inputs, are appropriate applications of basin scale models.

In summary, the slide show provides information suggesting that the groundwater models are probably reasonable for general evaluations of groundwater budgets at a basin scale, and evaluating groundwater-surface water interactions. However, comprehensive data tables and descriptions of model details, including aquifer characteristics such as hydraulic conductivity, transmissivity, and storage coefficients typically expected in a report accompanying models of this nature, are unavailable. Therefore the groundwater flow models cannot be fully evaluated.

<u>HYDROSS model</u>

Reviewing the report: "Mission HYDROSS Model Baseline Conditions, Run Date 8/27/2010" reveals the following information.

In the Model Structure section at the beginning of the report, it is stated (in Section 1.2.4.3) that the physical description of the study area is represented through a network identifying the following:

- how the stations connect
- physical facilities (reservoirs, power plants, canals, etc.)
- location of water allocation demands (diversions, instream flow requirements)
- location of return flows back to the system.

Schematic diagrams illustrate the nature of stations used in the model network. According to these diagrams, return flows and other gains are added to upstream inflows to stations. Stations may or may not include a reservoir with potentially changing water content, diversions, evaporation, and reach losses. Water discharges from stations as "flow to next station."

For each station, a variety of actions are modeled. Pertaining to return flows, these actions include the assignments of percentages of canal loss to return flow and site loss to return flow. Reach losses, schematically shown to occur near the downstream end of each station, are explained in Section 1.2.13. According to this section, reach losses are used to simulate the loss of surface water within the stream channel to groundwater. Not all of the reach losses are required to return to a designated station downstream. The reach loss return flows can be lagged up to eleven months and cannot return in the same month.

A table presented as Section 1.3 Model Limitations in the report notes that HYDROSS "doesn't explicitly simulate groundwater/surface water interrelationships except for irrigation and stream reach loss return flows. According to the table, this limitation is overcome in the modeling effort by this approach: "Use other gains/losses file(s) to simulate natural groundwater inflows and maintain close coordination with the groundwater modeling expert (S.S.P.A)."

Natural groundwater flows to five nodes are presented in Section 2.2. Most tables have the same values for every month, and because the tables are presented only for 1983, these same values are use throughout the modeled time frame, as explained in Section 1.2.4.2. The natural groundwater inflow (gains) are provided as negative numbers in units of cubic feet per second and range from minus 3 cfs to minus 22 cfs. This section notes that these natural groundwater inflows were derived in close coordination with the groundwater modeling expert, and a later in the report (Section 3.1.3) explains that where necessary, groundwater inflows are injected at the downstream end of certain reaches to bring the model results into closer agreement with the measured flows, as the only other unexplained source of water.

Canal seepage losses were assigned in the model by assigning percent losses per mile of canal for specific canals, and then determining canal efficiencies for each canal reach based on the assigned percentage of loss and either their reach lengths or service acreage. The assigned loss percentages are stated to be based on the 2009 DNRC Canal Seepage Study. Such losses were either applied directly to modeled canal reaches studied, or by using them as a general guide for assigning loss percentages to other modeled canal reaches. The table in Section 2.3.7.3 of the report lists the resulting canal efficiencies applied to diversion canals. The nomenclature of modeled canal reaches and that used in the DNRC makes it problematic to directly compare the numbers used in the Mission HYDROSS model with the DNRC study results; however Section 2.3.7.3 indicates that longer canal reaches typically have decreased efficiencies, as would be expected.

Site efficiencies were derived from lateral and on-farm irrigation estimates as described in some detail in the report. The resulting efficiencies assigned are listed in a table in Section 2.3.8.4.

Return flows from canals, sites, and stream reaches are distributed back to specified destination nodes. Tables in Section 2.7 of the report specify lag times for return flow delays from canals and sites (one table) and from reach losses (a second table). The return flows can only occur in the 12 months following their origin. No explanation is provided as to how the lag times were determined. However, they are generally greatest in the months following their generation and decrease in subsequent months. About 90 percent of modeled return flows occur within seven months of modeled time. In this same section, additional tables specify for each node with return flows, the destination node or nodes and percentage of return flows assigned.

The flows modeled as groundwater inflows, and listed as Imports from Natural GW (groundwater) in Section 3.2.3 (a table showing the average annual mass balance), may include irrigation return flows that exceed the 11 to 12 month lag times that HYDROSS can model. Many of the stations where groundwater inflow is applied appear to be located downstream of sizeable irrigated areas, based on the model schematic (Section 1.5).

Discussion

Return flows modeled in the HYDROSS Mission Model are based on assigned canal and site efficiencies based approximately upon expected ranges of canal efficiencies and the observed stream flows at sites downstream of modeled irrigated areas. Stream losses contribute additional return flows to downstream reaches. In some cases, what may be return flows exceeding the 11 to 12 month duration capability of the HYDROSS return flow scheme, probably contribute to assigned groundwater inflows at certain stations downstream of large irrigated areas. Thus, return flows are generated from input values that control their source. From these values, and the assigned distribution of return flows from one model station to other downstream stations, and based on specified lag times, HYDROSS calculates the amounts that show up as flow in downstream stations.

Overall, the return flow rates and volumes, and the lag times used in the model seem within reason. However, the lack of details provided concerning the groundwater model effort and results limits our ability to thoroughly evaluate the issue from a groundwater perspective. The adequacy of return flow responses in the surface water hydrographs should best be evaluated by hydrologists.

Potential impacts of FIIP operational improvements to groundwater wells

Generally, public water supply wells, municipal wells, and other high-yield wells are engineered with some buffer for modest groundwater level declines. The operational improvements are expected to eliminate some recharge to aquifers because such improvements are deliberate efforts to reduce diversions from streams and use water more efficiently. Many operational improvements, such as the installation of measuring devices should have little impact on groundwater levels. Improved irrigation efficiencies and stockwater mitigation plans involving the elimination stockwater deliveries are more significant threats to aquifer recharge. But, since these changes generally would not be expected to completely remove irrigation delivery systems and associated irrigation, the groundwater level declines should be modest in nature, perhaps on the order of less than 10 feet or 20 feet of decline from current levels. Engineered wells, as described above would normally be expected to withstand such modest declines. Shallow, privately owned wells located outside of floodplains or modern alluvial settings would be the most susceptible to problems related to groundwater level declines of a couple tens of feet. Groundwater levels in wells within floodplains and modern alluvial settings tend to be stabilized by the presence of nearby streams and a naturally shallow water table, limiting the magnitude of water level changes caused by irrigation activities.

The Montana Bureau of Mines and Geology Groundwater Assessment Atlas 2 (Lafave and others, 2004) describes hydrogeologic subareas of the Flathead Lake groundwater characterization area, three of which correspond closely to the three areas of the FIIP: the Mission, Jocko, and Little Bitterroot. The following information is derived from the atlas.

In the Mission hydrogeologic subarea, about 15 percent of wells are completed in shallow alluvial aquifers. These wells are completed in stream-deposited materials associated with Mud, Post and Mission creeks. These will typically be the types of wells in alluvial settings that should be minimally impacted by operational changes. About 40 percent of the wells in the Jocko subarea are completed in shallow alluvial aquifers, but in addition to shallow alluvial aquifers associated with the Jocko River, many of these wells are completed in alluvial fans emanating from a number of smaller creeks. About 70 wells were completed in shallow alluvial aquifers in this area and less than 50 feet deep. There are only about 35 wells that are less than 50 feet deep in the Little Bitterroot subarea. These approximately 105 wells that are less than 50 feet deep may be at higher risk than those in the alluvium of larger river valleys.

Almost 55 percent of wells in the Mission area, and some 37 percent in the Jocko area completed in intermediate aquifers, which are described as many discontinuous layers of sand and gravel within the glacial-lake sediments. Most of these wells are reportedly in the range of 50 to 250 feet deep. From the figures in the report, it is estimated that about 110 wells in the Mission area and about 20 in the Jocko area intermediate aquifer are less than 50 feet deep.

Based only on their shallow total depth and geologic setting, the shallow alluvial wells located away from major river valleys (around 105 wells), and the shallowest intermediate depth wells (about 130 wells) may represent wells most susceptible to impacts from changes in operational changes in irrigation activities that affect groundwater levels. These wells would also represent those having the highest risk of problems associated with groundwater level declines related to to other, more physical changes to the irrigation projects, such as lining canals or building pipelines. Because such impacts will be localized and depend on many variables, how many will actually be impacted to the extent that pumps need to be lowered, or wells deepened is unknown. However, better estimates could be generated based on the nature and location of any operational changes proposed. The SSPA groundwater model may be useful in evaluating such impacts.

Throughout these areas, deeper aquifers are typically available to serve as groundwater sources. In general, groundwater yields tend to diminish with the depths drilled, but will usually suffice for domestic and stock uses. Replacing any impacted high-yield wells might be more challenging.

References

DOWL HKM 2012. Mission HYDROSS Model Baseline Conditions, Run Date 8/27/2010

DOWL HKM, 2012. Technical Basis for Flathead Indian Irrigation Project Water Use Agreement, September 4, 2012 – Polson

DOWL HKM, 2014. Technical Basis for Flathead Indian Irrigation Project Water Use Agreement, June 12, 2014 – Helena

LaFave, J.I., Smith, L.N., and Patton, T.W., 2004, Ground-water resources of the Flathead Lake Area: Flathead, Lake, and parts of Missoula and Sanders counties. Part A- Descriptive overview: Montana Bureau of Mines and Geology Montana Ground-water Assessment Atlas 2A, 132 p.

S.S. Papadopoulos & Assoc., Inc., 2010. Preliminary Report on Groundwater Assessments for the Flathead Indian Reservation, Montana. Presentation by Deborah L. Hathaway, P.E., May 26, 2010

V. Responses to Ballance/Regier questions

Presentation to WPIC, July 2014

Introduction

In its April 28, 2014 letter to the Water Policy Interim Committee (WPIC), Representatives Nancy Ballance and Keith Regier requested a review of three areas of the Confederated Salish and Kootenai Tribes water rights compact (Compact): 1) Economic, 2) Environmental, and 3) Legal. In its May 12-13 meeting, the WPIC assigned the questions related to environments to a Technical Working Group (TWG) to be led by the Montana Bureau of Mines and Geology. In addition, the TWG was assigned review of the technical aspects of the compacts with particular effort on the data and related modeling effort used to determine allocation of water described in the CSKT Compact. Upon approval of the work plan, the TWG will present a draft report of findings to WPIC at its August 2014 meeting; meanwhile, the TWG has reviewed the questions posed by Representatives Balance and Regier and presents a draft response herein. The questions and subordinate questions are presented verbatim in bold type; the TWG response follows and any materials used to reference are cited at the end of each response.

The TWG welcomes revision, clarification, or restatement of any questions, particularly those deemed by the TWG as outside its scope or expertise.

1. Water Use Agreement

a. What are the physical and economic impacts of a change of use from irrigation to instream flow on shallow ground water levels and water wells?

TWG response regarding the physical impacts:

The Compact assumes a reduction of river diversions resulting from increased efficiency of irrigation and elimination of diversions for stock at the start and end of the irrigation season (referred to as shoulder flows); the change in irrigation practices (for example, reduction/elimination of shoulder flows and improvements in water conveyance) does not change the beneficial use of the water. The reductions of the diversion amounts that result from the improvements in conveyance and increases in the efficiency of application will simply not be diverted; these savings simply increase instream flow.

There are many published and unpublished reports that describe the various physical impacts of diverting surface water for irrigation for areas throughout western Montana. In general, most of the main stem river valleys in Montana are subject to artificial groundwater recharge from irrigation canals and flood irrigation. For example, groundwater levels in the lower Beaverhead River area below Dillon are 40 feet higher when the East Bench Irrigation Canal is in operation (Metesh, 2012). Similar or smaller responses are documented in the Helena area (Waren and others, 2012), the Bitterroot valley (Smith 2006), and the Stillwater River valley (Kuzara and others, 2012). Groundwater studies within the Compact area documented fluctuations on the order of 20 feet in response to irrigation canals, but as much as 40 feet of fluctuation on a seasonal basis (Patton and others, 2003; Smith and others, 2000). Hydrogeologic conditions of the Mission and Jocko valley-fill aquifers are locally complex, but in general there is a shallow and deep aquifer available for development. Groundwater response to changes in irrigation practices should be evaluated with site-specific information related to aquifer properties and canal bed properties that affect seepage loss. It is equally true when evaluating potential mitigation/offset such as local aquifer storage/recovery projects. Although not available for review by the TWG, groundwater flow models constructed by CSKT would likely provide at least a preliminary assessment.

TWG response regarding the economic impacts:

The TWG cannot directly address the question of economic impacts. The conservation of water through increased efficiency is a common effort of late throughout Montana; however, the cost-benefit analysis is very likely site specific.

References

Kuzara, S., Meredith, E., Gunderson, P., 2012, Aquifers and Streams of the Stillwater–Rosebud Watersheds, Montana Bureau of Mines and Geology: Open-File Report 611, 130 p.

Metesh. J., 2012, Hydrogeology related to exempt wells in Montana: A Report to the 2010–2012 Water Policy Interim Committee of the Montana legislature: Montana Bureau of Mines and Geology Open-File Report 612, 24 p.

Patton, T.W., Smith, L.N., and LaFave, J.I., 2003, Ground-water resources of the Flathead Lake area: Flathead, Lake, Sanders, and Missoula counties, Montana: Montana Bureau of Mines and Geology Information Pamphlet 4, 4 p.

Smith, L.N., LaFave, J.I., Carstarphen, C.A., Mason, D.J., and Richter, M.G., 2000, Ground-water resources of the Flathead Lake Area: Flathead, Lake, and parts of Missoula and Sanders counties. Part B- Maps (open-file versions): Montana Bureau of Mines and Geology Montana Ground-water Assessment Atlas 2B, 11 sheets.

Smith, L.N., 2006, Patterns of water-level fluctuations, Lolo-Bitterroot area, Mineral, Missoula, and Ravalli counties, Montana (open-file version), Montana Bureau of Mines and Geology: Ground-Water Assessment Atlas 4B-10, 1 sheet(s), 1:350,000.

Waren, K. Bobst, A., Swierc, J., Madison. J.D., 2012, Hydrogeologic Investigation of the North Hills Study Area, Lewis and Clark County, Montana, Interpretive Report, Montana Bureau of Mines and Geology: Open-File Report 610, 99 p.

i. How are wetlands (to) be maintained?

TWG response:

The general relationship between groundwater and wetlands is well understood and wetlands are defined and inventoried under narrow criteria for groundwater, surface water and biotic conditions. In a manner similar to wells, irrigation systems throughout the western part of the state have created artificial wetlands as well as enhanced natural wetlands. The glacial history and geomorphology of the Flathead basin is especially suitable for shallow groundwater-fed depressions that support wetlands. Inventories of natural and artificial wetlands have been conducted using National Wetland Inventory protocols under contract with CSKT.

As with the impact of irrigation changes on shallow groundwater, increased efficiency of irrigation and the resultant reduction of stream diversions have the potential to affect wetlands hydrology. Development of site-specific data and models provide for sound evaluation of alternatives and their effects on local wetlands; as noted, CSKT has developed groundwater-flow models for the Mission and Jocko River areas, but the TWG was not provided details of those models.

b. What is a 'robust river' standard?

i. What are the impacts of a 'robust river' (page compact) standard for fish survival, stream bank stability, erosion, and integrity of irrigation structures? Increasing quadrupling instream flow in compact

TWG response:

The TWG finds no reference to the term "robust river standard" in the compact documents, nor is the term in general use by hydrologists or fisheries scientists. The concept of a healthy river is often described in terms of stream morphology (e.g. Rosgen's Stream Classification) and biota health. These are the apparent objectives of the adaptive management policy in the compact.

The CSKT Compact operates on the application of a three-part plan:

1. determination of current use by irrigation,
2. improvement of the irrigation system which will lead to…
3. …reduction of river diversions that meet current demands but provide increased instream flow.

The benchmark for the Compact is maintaining current irrigation beneficial use, not instream flow requirements based on any standard. The TWG and attendees discussed several aspects of water-right compacts with other tribes in other states, potential application of fisheries-based instream flows in this Compact, as well as the origin for the current interim instream flow standard that is in practice. The TWG and attendees also discussed methods for determining instream flow levels and the implication of applying methods aimed at "fish survival" versus those that provide for a healthy functioning fishery. Clearly, application of instream flow methodologies to all of the stream involved is far outside the present design, but in the interest of assessing the proposed instream flow levels, TWG member Andrew Brummond (FWP) prepared a draft analysis of instream flow for South Crow, Mission, and Big Knife creeks within the Compact area on the basis of one recognized hydrology-based instream flow methodology (Brummond, 2014). In short, application of comprehensive instream flow methodologies would lead to a closer relationship between the Minimum Enforceable Flow (MEF) and the natural (pre-irrigation) hydrograph. The MEF are based on existing stream flow below diversions plus additional stream flow derived from operational improvements to the management of the irrigation systems. On whole, the MEF values are lower than instream flow values that would be derived using recognized instream flow methodologies which would yield instream flow levels nearer to the natural hydrograph.

In some months MEFs and Target Instream Flow (TIF) values are considerably higher than the current interim instream flow values. However, stream flow levels considerably higher than the interim instream flow values as wells as the proposed instream flow values area already occurring. The proposed instream flow values are not higher than those already occurring or that occurred naturally and would not negatively impact fish survival, stream bank stability, erosion or the integrity of irrigation structures.

References

Brummond, A., July 1, 2014 Memorandum to CSKT TWG, Draft Evaluation of CSKT Instream Flow Levels.

c. What is the standard for instream flow cited in the water abstracts? Is the standard focused on fish survival, habitat maintenance, or something else?

TWG response regarding the first question:

"Instream flow" is defined as: "CSKT water right recognized in Article III.C.1.d.ii (the FIIP Nodes) of the Compact that is allocated here in this Agreement to stream flows reserved for fish and wildlife purposes, with a time immemorial priority date." Specific values have been declared in Minimal Enforceable Flows (MEF) and Target Instream Flows (TIF) in Appendix A1 of the Water Use Agreement (WUA).

The term instream flow has several qualifiers:

- The interim instream flow was established at 27 sites in the FIIP in the late 1980s and is a single, year-round value at each site.
- Minimum Enforceable Flows (MEF) are part of the proposed WUA and incorporate seasonal variability at each site. They are comprised of existing stream flow below diversions plus additional stream flow derived from operational improvements to the management of the irrigation systems. Operational improvements are defined as improved management of FIIP facilities, including the incorporation of measurement of on-farm deliveries, implementation of water management accounting, management of stockwater deliveries, improved adherence to instream flows, dedicated efforts to reduce flows in FIIP waste ways, enhanced efficiencies, and upgraded measurement and management.
- Target Instream Flows (TIF) are applied in wet or normal years. MEF and TIF were determined from the HDYROSS modeling effort in a three-step process: 1) establish water supply required for existing crop irrigation consumptive use, 2) identify potential improvements to current system that would reduce diversion requirements while maintaining current crop irrigation consumptive use, and 3) establish the new increased instream flow (TIF and MEF) resulting from the improvements in step 2. TIF and MEF sites were established at sites that will be monitored as part of the Adaptive Management program.

Thus, no standard or instream flow methodology was used to establish MEF or TIF; both are described as the instream flow remaining after improvement of efficiency that results from operational and physical improvements to the irrigation system.

TWG response with regard to second question:

Although interim instream flows were based on fisheries criteria, neither fish survival nor habitat maintenance was to be used as standards in the CSKT Compact. If however, improvements to the irrigation system yield instream flows sufficient to meet the proposed instream flow levels, excess stream flow could be available for additional diversion – again, this is within the adaptive management plan and would require monitoring and measurements.

References

Presentation to TWG by CSKT and RWCC

Online presentations by CSKT and RWCC

Proposed CSKT water rights compact

Proposed Water Use Agreement

d. What are the growth inducing or socioeconomic growth inhibiting impacts of the on reservation "robust river" standard for instream flow (economic)

TWG response:

As noted, the term "robust river" is not an applicable standard within the experience of the TWG, nor is it defined in the CSKT Compact documents. Regardless of any standard applied or, as stated in the Compact, the increased instream flow from improvements, the question of socioeconomic growth induction or inhibition impacts is well outside the discussion of the TWG.

The Compact implies that there will be no reduction in production from irrigated lands, but there will be increased instream flow beneficial to fish habitat. The overall objective of the TWG is to determine the level of confidence in the values used as consumption by irrigated lands.

e. Is there enough information available to definitively determine the 'water savings' components of irrigation rehabilitation?

TWG response:

The HYDROSS model constructed by CSKT and the management model constructed by RWCC made estimates of water savings based on specific assumptions. For example, the increased instream flow from reducing or eliminating shoulder water returns by replacing early/late canal operation for stockwater with groundwater wells was estimated for several areas. Other examples provided included lining canals to reduce loss, improvement of diversion structures etc. were also provided. Although the proposed CSKT water rights settlement outlines several projects, no details are provided; however, implementation of these projects is to be addressed in the adaptive management plan.

Thus, definitive determinations of water savings has not been made; as noted in the discussion of shallow groundwater levels and wetlands, site specific information will provide the basis for sound, if not definitive, estimates of water savings in a given project.

f. Is there a process to ensure that extra duty water will be received by those who apply for it?

i. Does or will the time period for this application for extra duty water (5 years risk the economic viability of his/her agricultural operation?

ii. Could there be an added charge for this water?

TWG response:

These questions cannot be addressed directly by the TWG they refer to issues within management of the compact and are certainly negotiable by parties to the compact. As such, a negotiable value or procedure is outside the scope of the TWG. On that note, the TWG did discuss the issue of extra duty water as it was included in the HYDROSS model effort. As noted in the question, there is a deferral period during which extra-duty water "shall be continued as practiced by CME [Cooperative Management Entity] management". Section XV.41 of the Water Use Agreement:

> XV. DEFERRAL FOR IMPLEMENTATION OF THE FARM TURNOUT ALLOWANCE (FTA) AND MINIMUM INSTREAM FLOW (MEF)
>
> 41. The implementation of the FTA and MEFs, along with the delivery of the other priorities in Section 22 shall be deferred. During the deferral period the following conditions shall apply:
>
> > (a) The annual quota and extra-duty water delivery systems shall be continued as practiced by CME management;
> >
> > (b) On-farm measurement systems to measure irrigation water delivered under the FIIP shall be installed;
> >
> > (c) The on-farm efficiency fund established by this Agreement shall prioritize improvements which upgrade irrigation systems from flood irrigation to sprinkler irrigation, and irrigation efficiency improvements to extra-duty water users;
> >
> > (d) Measurement of FIIP irrigation water delivery by the Project Operator and measurement of on-farm surface water runoff by the CSKT shall occur with the permission of the land owner in accordance with Section 6 when such measurement requires access to private property;

The TWG also notes that Sections VIII.25.e and f of the WUA outline the procedures for on-farm measured water use allowances for sites that require more water. Although this section outlines the general criteria to be used in determining whether or not a measured water use allowance would be granted, it leaves undefined the specific criteria values that would be applied. This leaves uncertainty for individual water users as to whether or not they would ultimately qualify for a measured water use allowance.

Taken at face value by the TWG, there is no apparent risk as proposed in the subordinate question because the project in question would receive its current duty during the deferral period. Again, outside the expertise of the TWG, but appears to be addressed in the Compact. The TWG notes here, and will again in several issues, there is a difference between the concept of current crop consumptive use and current water delivery volumes/rates. This difference is not always clear to various other groups that have reviewed the Compact.

2. Off-reservation instream flow claims

a. What are the growth inducing or growth inhibiting impacts of the off-reservation instream flow claims?

i. Is there enough information to assess this question, including the aspects of basin closure, call results?

ii. How many times in 20 years will an irrigator be called on its water rights?

TWG response:

As noted in the response to questions related to growth, these questions are outside the knowledge of the TWG. However, with respect to the number of "calls" on the water rights of any irrigator, the TWG discussed the number of calls under current interim instream rights. Under the terms of the proposed Compact, calls are limited to surface water irrigation rights and groundwater irrigation rights diverting over 100 gpm.

TWG member, Mr. Andrew Brummond (FWP) provided an evaluation of water demand in the presence of the Compact (Brummond, 2014a). His analysis compared median and varying percentile flow to the Compact instream values for the Lower Clark Fork, the Swan, the Kootenai (Libby Dam removed). Based on the period of record flows and the existing water right claims outside the Compact, flows on these rivers would fall below the CSKT Compact instream flow value:

- One year in 20 on the Lower Clark Fork, but outside the normal irrigation season
- Two years in 10 on the Swan

Other rights would be held in co-ownership with Montana Department of Fish, Wildlife and Parks (FWP); because these are existing water rights held by FWP the legal demand for water remains unchanged.

Under the proposed Compact, the existing hydropower rights for the Milltown Dam would be changed to instream flow to benefit the fishery. The tribe and FWP would be co-owners of these rights as well. If the Compact is not approved, these rights would most likely be changed to instream flow by FWP and/or the Natural Resource Damage Program. Such a change would likely result in instream flow levels higher than that proposed in the compact based on a review of the historic hydropower water use and the instream flow needs of the fishery. The net result is the proposed compact would result in a decreased demand on existing water users in comparison to a change to instream flow outside of the compact.

References

Brummond, A. July 1, 2014a, Memorandum to WPIC CSKT Technical Working Group, Draft Changes in legal water demand due to CSKT Compact.

3. Compact

a. What precedential components of the proposed Compact would commit the state to future actions with significant impacts or a decision in principle about such future actions?

b. What are the growth inducing or growth inhibiting impacts of the proposed Compact?

c. Does the proposed Compact or any part thereof restrict the use of private property, or impose undue governmental regulation that would prohibit the use and enjoyment of private property?

d. Are there alternatives to the proposed CSKT Compact that were not considered which would minimize or eliminate impacts to the human environment?

TWG response:

This question and its subordinate questions were discussed at length by the TWG and meeting attendees. Although important questions, clearly a technical review of future commitments, the impact on growth, and the impact on private property rights are beyond the experience of a technical working group. The TWG has and will focus its efforts on developing a level of confidence for the modeling effort, evaluation of historic irrigation use, the background data, and some of the direct applications of the model.

V. Responses to Ballance/Regier questions

Evaluation of CSKT instream flow levels

Note: The following is an expanded response

Following is a restatement of questions posed by Representatives Ballance and Regier under 1b and 1c of the Water Use Agreement section of the Environmental Analysis portion:

- Will the instream flow levels listed in the Water Use Agreement, which are generally larger than the present interim instream flow levels, impact fish survival, stream bank stability, erosion and the integrity of irrigation structures?
- What is the basis for the instream flow levels listed in the Water Use Agreement and are they reasonable?

With respect to the first question, the existing interim instream flow levels are not measurements of the actual flow that now occur, but rather minimum targets below which flow should not drop. The interim instream flow levels are the same value year round and do not follow the shape of the hydrograph already occurring in these streams. During the higher flow months when ample water is available, these interim levels are already vastly exceeded by actual stream flow. For some streams during times of lower flow the interim instream flow levels greatly exceed the amount of flow naturally occurring in the stream.

Increased streamflow resulting from improved management and betterment projects will be very modest in respect to higher instream flows already occurring and would not be expected to significantly change the impacts to stream bank stability, erosion and the integrity of irrigation structures. Rarely do higher flows have a negative impact on the fishery, and even then the short term negative impacts of very high flow are overshadowed by the long term benefits to stream morphology and fish habitat. Fish are well adapted to tolerating high flows which are important in channel forming function and riparian processes that are critical in providing and maintaining fishery habitat. The modest expected increase in instream flow due to management changes and betterment projects would be expected to benefit the fishery.

With respect to the second question, the basis of the instream flow levels is the water currently left instream plus water added by improved management and betterment projects. Based on the information provide to the Technical Working Group it has been established that no specific instream flow methodology has been applied to arrive at these values. However, this does not necessarily mean that the Water Use Agreement (WUA) instream flow levels are not representative of the fishery needs.

The ecological integrity of a stream is dependent on the natural flow regime which directly affects the water quality, energy sources, physical habitat and biotic interactions. (Poff, et. al. 1997) The natural flow regime includes hydrologic timing, magnitude and variability (both intra and inter-annual). Anthropogenic modifications of the natural flow regime can affect water quality, energy sources, physical habitat and biotic interactions which in turn impact the health and integrity of the fishery. The WUA instream flow hydrographs do generally tend to follow the shape of the natural hydrograph with the highest flows occurring in late spring and the lowest flows in late winter, consistent with the natural flow regime paradigm. Additionally, they include recognition of different types of years (i.e. dry, normal, wet) accounting for some level of inter-annual variability. While no specific instream flow methodology has been directly applied, the instream flow hydrographs are generally supported by the recognized instream flow principle of providing intra following the shape of the natural hydrograph and inter-annual variability providing variances between years with differing water supply conditions.

Instream flow methodologies can range from complex and data intensive field studies such as Physical Habitat Simulation (PHABSIM) to office based methods relying on existing hydrologic data. In the case at hand limited time and resources prevents the working group of having the luxury of examining the proposed instream flow hydrographs for every stream let alone using a high effort field methodology such as PHABSIM. What is available is the application of office-based techniques to sentinel U.S. Geological Survey (USGS) stream gages located just above Flathead Indian Irrigation Project (FIIP) diversions. These sentential gages are located in the watershed where there is little or no anthropogenic influence due to the diversions or introduction of water.

I located 4 of these sentinel gages to develop instream flow values for the purpose of comparing them to the Water Use Agreement (WUA) instream flow hydrographs. The first office-based instream flow methodology I chose was developed for use in British Columbia (DFO, 2004). It is applicable to all rivers across BC. As the Flathead River is shared between British Columbia and Montana, the methodology's applicability rightfully extends into the Flathead basin of Montana as well.

For the purpose of this memorandum I refer to this method developed in British Columbia as the "BC method," although others commonly refer to it as the "DFO method." This method relies on existing natural hydrologic data. This data can come either from a sentinel gage or can be synthesized. The methodology develops instream flow values on a monthly time step. In addition it limits the maximum diversion rate or rather it sets the maximum amount that by which the stream or river can be depleted even if the set instream flow level is being met. This helps to preserve the high flows that are important in sediment transport as well as channel form and function.

Figure 8: Methodology for calculating instream flow levels. From: DFO, 2004

The steps in calculating the proposed flow threshold are as follows:

1. determine fish-bearing status of streams in the impact area,
2. obtain 20 or more years of continuous **natural** daily flow records (i.e., corrected for existing water uses),
3. calculate the 80th percentile flow over the period of record to set the maximum diversion rate,
4. calculate the median of mean daily flows during each calendar month,
5. order monthly values from step 4 in sequence from lowest to highest,
6. set the flow threshold in the lowest flow month to 90th percentile of mean daily flows in that month,
7. set the flow threshold in the highest flow month to 20th percentile of mean daily flows in that month,
8. set the flow threshold for all other months as a percentile of mean daily flows in that month, where the percentile is calculated according to the formula:

$$90-\left[\left(\frac{median_i - median_{min}}{median_{max} - median_{min}}\right)\times(90-20)\right]$$

where
$median_i$ is the median of mean daily flows for month i,
$median_{min}$ is the month of lowest median flows,
$median_{max}$ is the month of highest median flows.

Using this formula the percentile for each month will vary between 20th and 90th.

The excerpt in Figure 8 gives the details of the methodology.

Another somewhat more dated office-based instream flow methodology is the Tennant method as modified by Tessman (Tessman, 1980). Like the BC method it provides monthly flow recommendations, although it is somewhat more generalized in its approach.

Table 8 – Tennant Method as modified by Tessman

Situation	**Minimum Monthly Flow**
MMF[a] < MAF[b]	MMF
MMF > 40% MAF , and 40% MMF < 40% MAF	40% MAF
40% MMF > 40% MAF	40% MMF

[a] *MMF = mean monthly flow*

[b] *MAF = mean annual flow.*

Table 8 reflects the Tennant method with Tessman's modification. This method yields more conservative instream flow values than the BC method. Like the BC method it relies on data from a sentinel gage or from a synthesized natural hydrograph. It is based on mean monthly and annual discharge data as opposed to daily discharge data. Tennants approach on which Tessman relies was based on field data analysis of rivers in Montana, Wyoming and Nebraska including both cold and warm-water fisheries.

The first stream I chose to analyze was South Crow Creek which has a currently active USGS gage No. 12375900 (see Figure 11). I applied the BC method and the Tennant method as modified by Tessman to discharge data from water years 1983-2013. The following Figures 9 and 10 shows the results (labeled as BC method and Tessman) in comparison to the interim, minimum enforceable (MEF), normal and wet year instream flow values. The figures also show the actual flow measured below the Feeder Canal as well as a bankfull value as derived by USGS (Lawlor, 2004). Figure 10 is the same as Figure 9, except the vertical scale is reduced to better show the difference in the bar heights.

The maximum diversion rate is 27 cubic feet per second (cfs), the 80th percentile of all daily flow values. Analysis of the discharge data indicates that in May-August, the maximum diversion rate of 27 cfs would limit diversion beyond the monthly instream flow value. For example with a June the instream flow value of 50 cfs, when flow is above 77 cfs, the diversion of water is further limited by the 27 cfs diversion maximum. In order to account for this in the figures, the average of the daily amount that the actual flow exceeds 70 cfs is added to the monthly instream flow valued. In the case of June, 11.6 cfs in added to the instream flow value to more accurately portray the recommended instream flow level. This same approach to dealing with the diversion limit was applied to the subsequent two analyses as well.

In all months except February, the BC method yields a recommended instream flow level higher than the MEF, normal and wet years WUA values for South Crow Creek. For February the BC method is slightly lower than the WUA wet year value. In April, May and July, the BC method prescribes a flow substantially higher than even the WUA wet year value. In comparison to the BC method, the WUA values are reasonable if not too low.

The Tessman approach yields values in most months in the range of normal and wet year WUA values. However, the values generally exceed and in some months greatly exceed the MEF WUA values with the exception of April and August where they are lower. This suggests the MEF WUA values may be inadequate.

Figure 9: South Crow Creek comparison of instream flow values -- full range

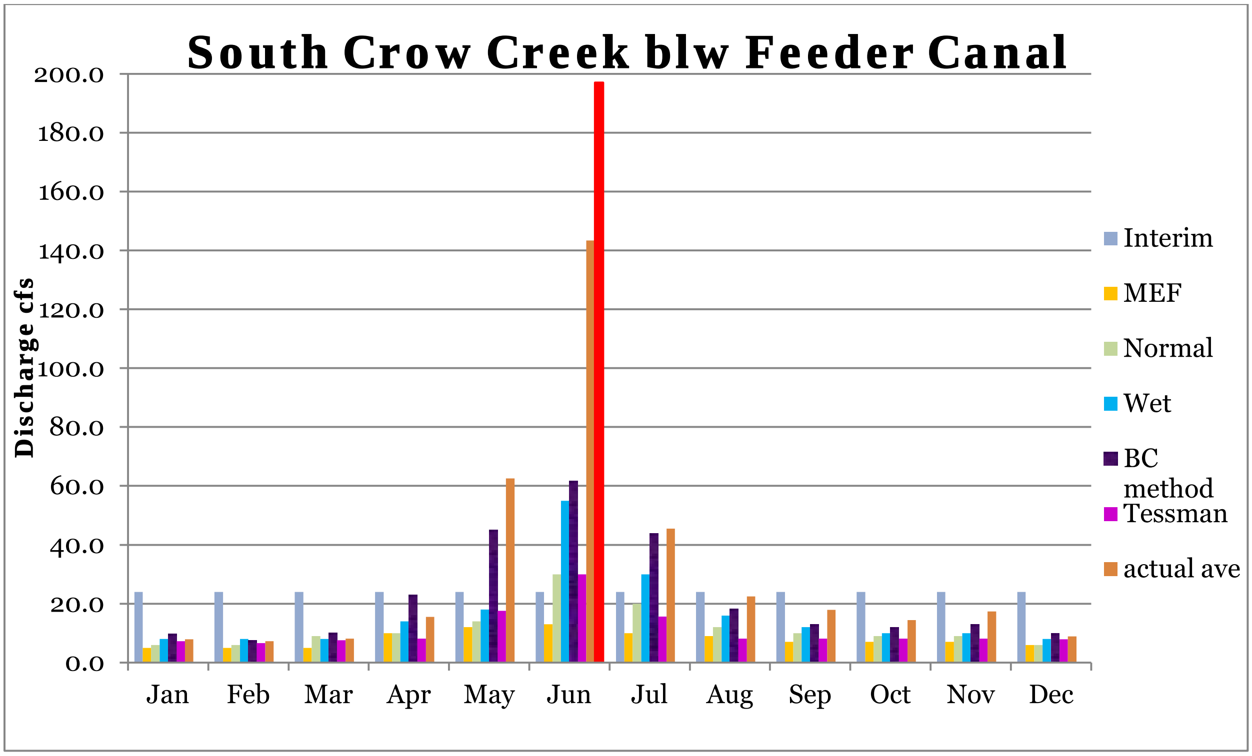


Figure 10: South Crow Creek comparison of instream flow values -- 70 cfs max range

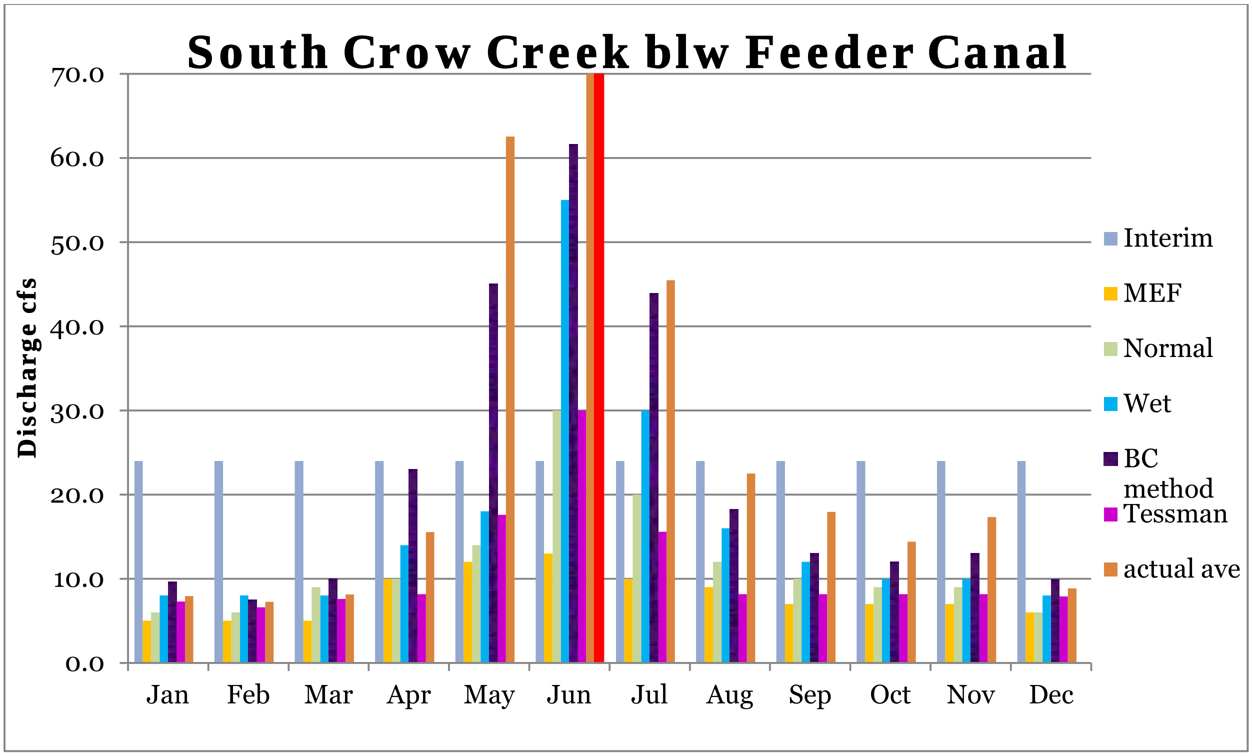
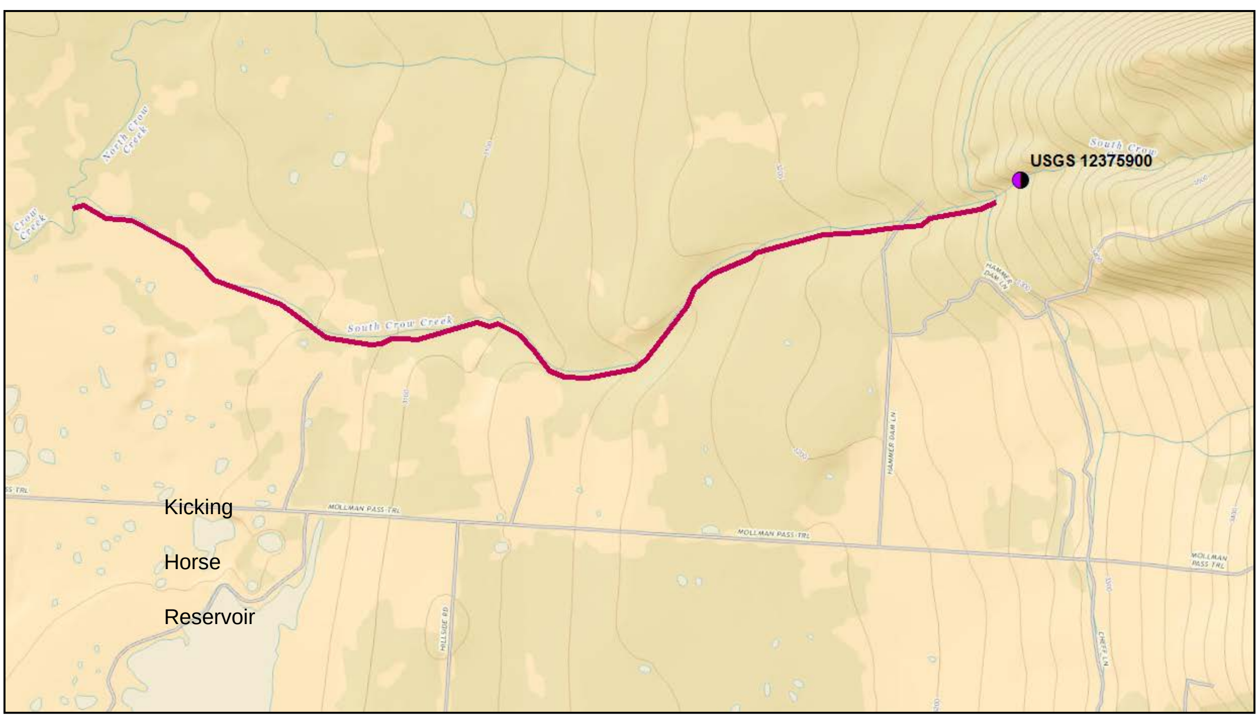


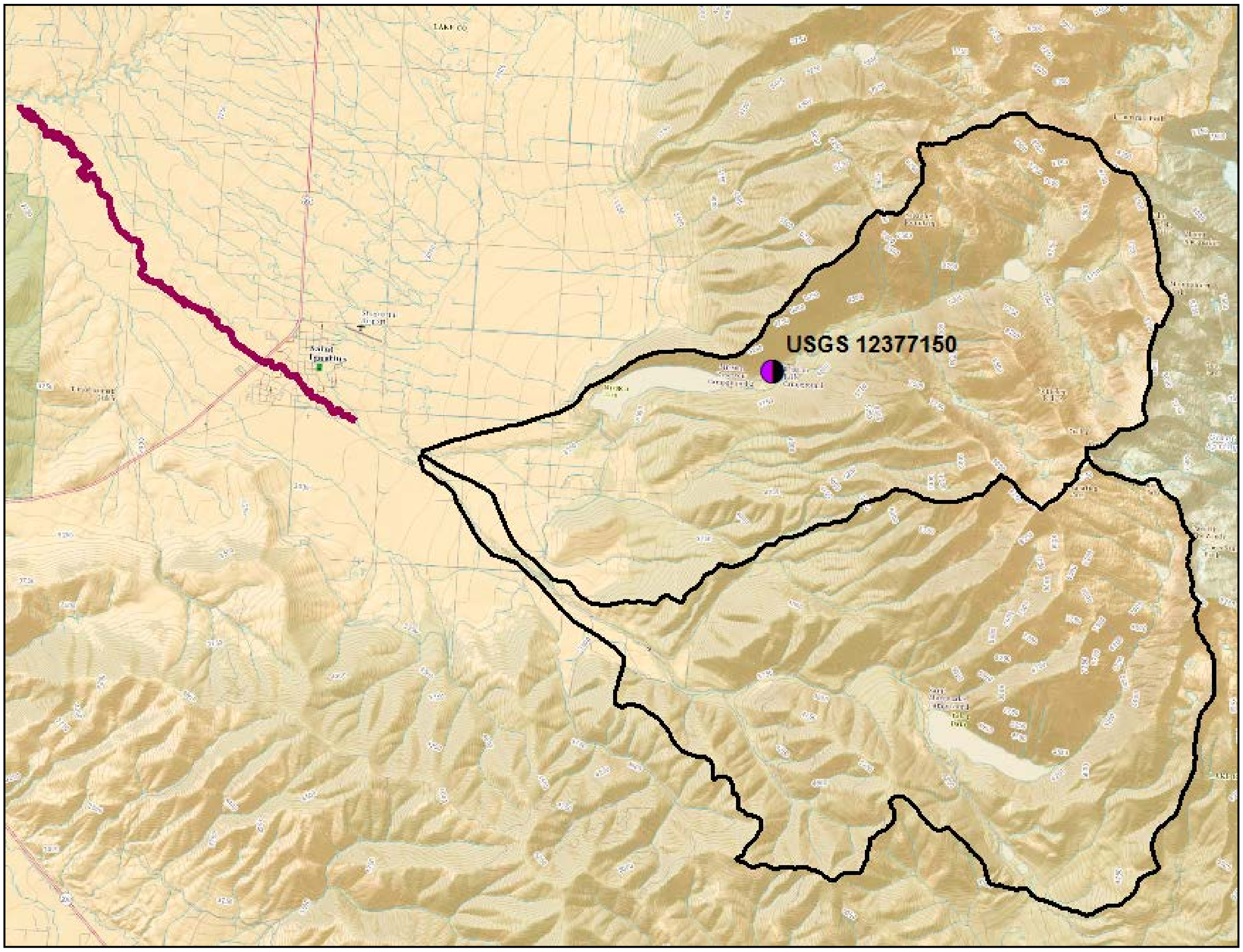
Figure 11: South Crow Creek area of analysis



In the Technical Working Group meetings the term “robust river standard” has come up. It is clear this means different things to different people. To some it means sufficient flow in a river to meet long-term ecosystems needs while to others it seems to mean a bankfull flow at all times. This bankfull definition may be partially the impetus behind the restated first question. Certainly if the instream flow levels were set to a bankfull level and somehow that amount of water was introduced into the stream at all times, irrigation infrastructure and the riparian and aquatic ecosystem would suffer. The WUA instream flow levels do not approach the 197 cfs bankfull value for South Crow Creek. Only the actual measured instream flow below the Feeder Canal comes close. This flow is unnaturally high due most likely to the transport of water to Kicking Horse Reservoir or Crow Creek Reservoir which is fed from a canal tapping South Crow Creek. The WUA instream flow levels would not in any way threaten the channel integrity of South Crow Creek or the associated irrigation infrastructure.

The next stream I analyzed Mission Creek which has a currently active USGS gage No. 12377150 located above Mission Reservoir (see Figure 12). In this case I looked at WUA instream flow levels somewhat further downstream on Mission Creek in the reach above Post Creek and below the 6C Canal. The drainage area at this location is considerably larger at this location than at the USGS station, due in large part to the addition of the Dry Creek watershed that is slightly larger than the Mission Creek watershed as measured from the confluence of the two streams. Figure 5 shows the two watersheds as well as the instream flow reach of interest.

Figure 12: Mission Creek area of analysis



For the purposes of this limited analysis I estimated the monthly discharge at the USGS gage and the confluence of Dry and Mission Creeks using basin characteristic equations. (Parret and Cartier, 1990). Using these average monthly discharge estimates I calculated the ratio between the two sites for each month and then multiplied this ratio times the monthly values calculated using the BC method at the Mission USGS gage to extrapolate the result of the BC method to the reach of Mission Creek immediately downstream of the confluence of Mission and Dry Creeks and above the 6C Canal. The bankfull discharge was estimated by multiplying the USGS derived bankfull value for the Mission USGS gage of 480 cfs (Lawlor, 2004) by the monthly ratio calculated for June yielding a value of 753 cfs.

The following figures 13 and 14 show the results for Mission Creek below the 6C Canal of the two instream flow methods in comparison to the interim, MEF, normal and wet year instream flow values. The figures also show the actual flow measured below the 6C Canal as well as a bankfull estimate As before, Figure 13 is the same as Figure 14, except the vertical scale is reduced to better show the difference in the bar heights.

In this situation the BC method yields a recommended instream flow higher than the MEF, normal and wet years WUA values for this reach of Mission Creek with the exception of the wet year value for October. The Tessman approach (results from USGS gage multiplied by same ratios as with BC method) also yields higher values than the WUA values with the exception of the August through November period where they are lower than the normal and wet year WUA values. The analysis WUA values and in particular in MEF WUA values may be inadequate to fully provide for the fishery.

Figure 13: Mission Creek comparison of instream flow values -- full range

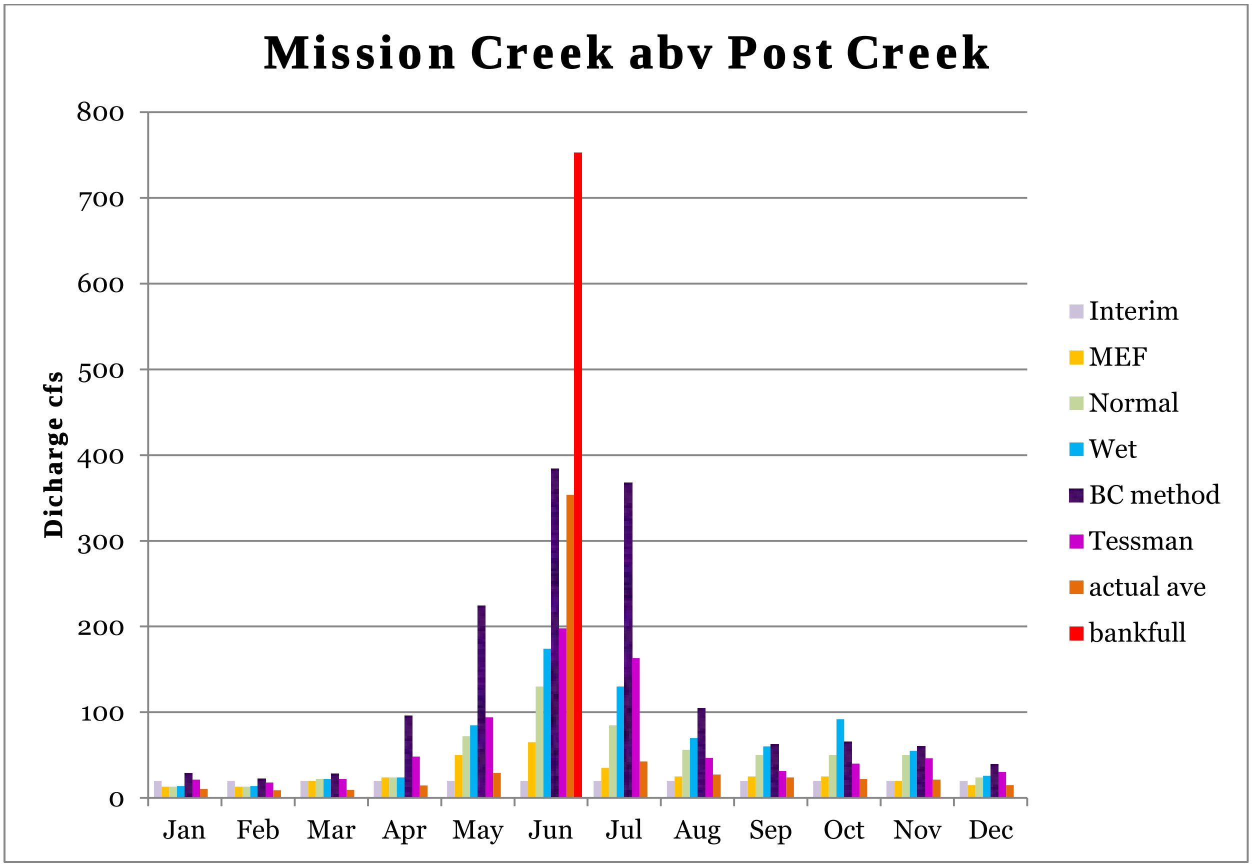
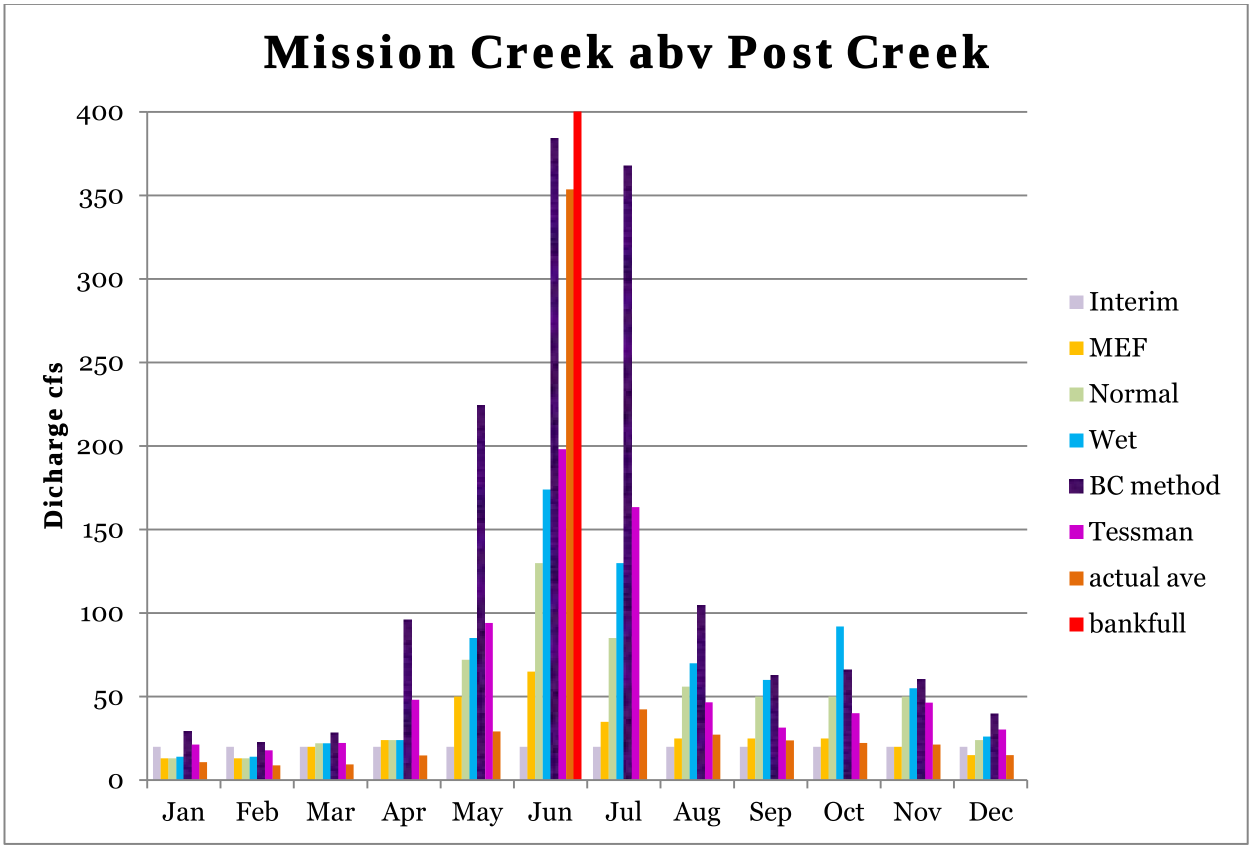


Figure 14: Mission Creek comparison of instream flow values -- 200 cfs max range



I do not have sufficient understanding of the impact of water imported from the Jocko basin as well as stored water to evaluate how these factors may have influenced the development of the WUA instream flow levels. These factors may serve to inflate the October instream flow values. Overall the WUA values are reasonable.

As with South Crow Creek, the bankfull discharge value vastly exceeds the instream flow values. Attaining the instream flow values would not be expected to in any way threaten the channel integrity of Mission Creek.

Big Knife Creek is located in the Jocko watershed. USGS gage No. 12383500 is located on Big Knife Creek upstream of the Upper Jocko S Canal. This gage is no longer in use but operated for water years 1983-2010. Figure 15 shows the area on interest.

The BC method and Tessman approach using discharge data from water years 1983-2010 yielded the values shown in Figure 16. As with the other similar figures, the interim and MEF instream flow values, the bankfull valued calculated by USGS and the actual average flow measured below the Upper Jocko S Canal are displayed as well. Normal and wet year instream flow values are not shown as none have been proposed for this site.

Figure 15: Big Knife Creek area of analysis

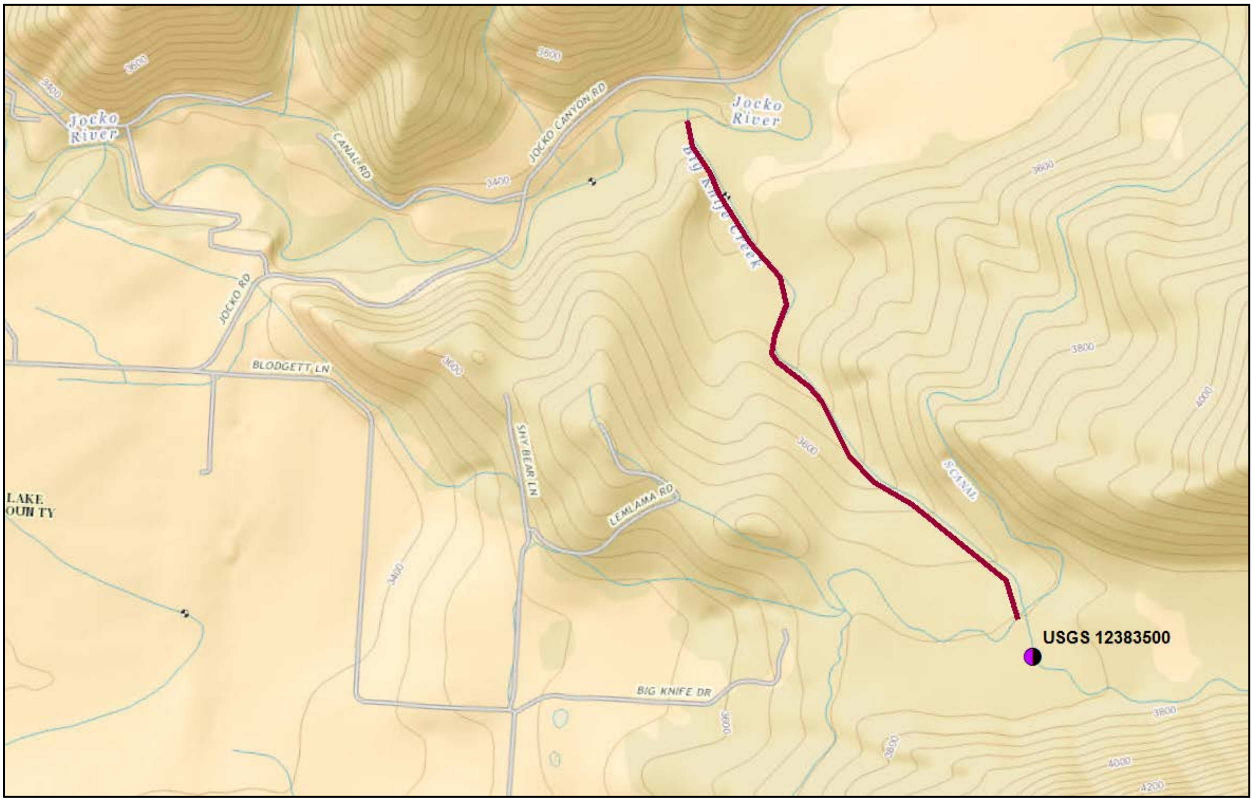
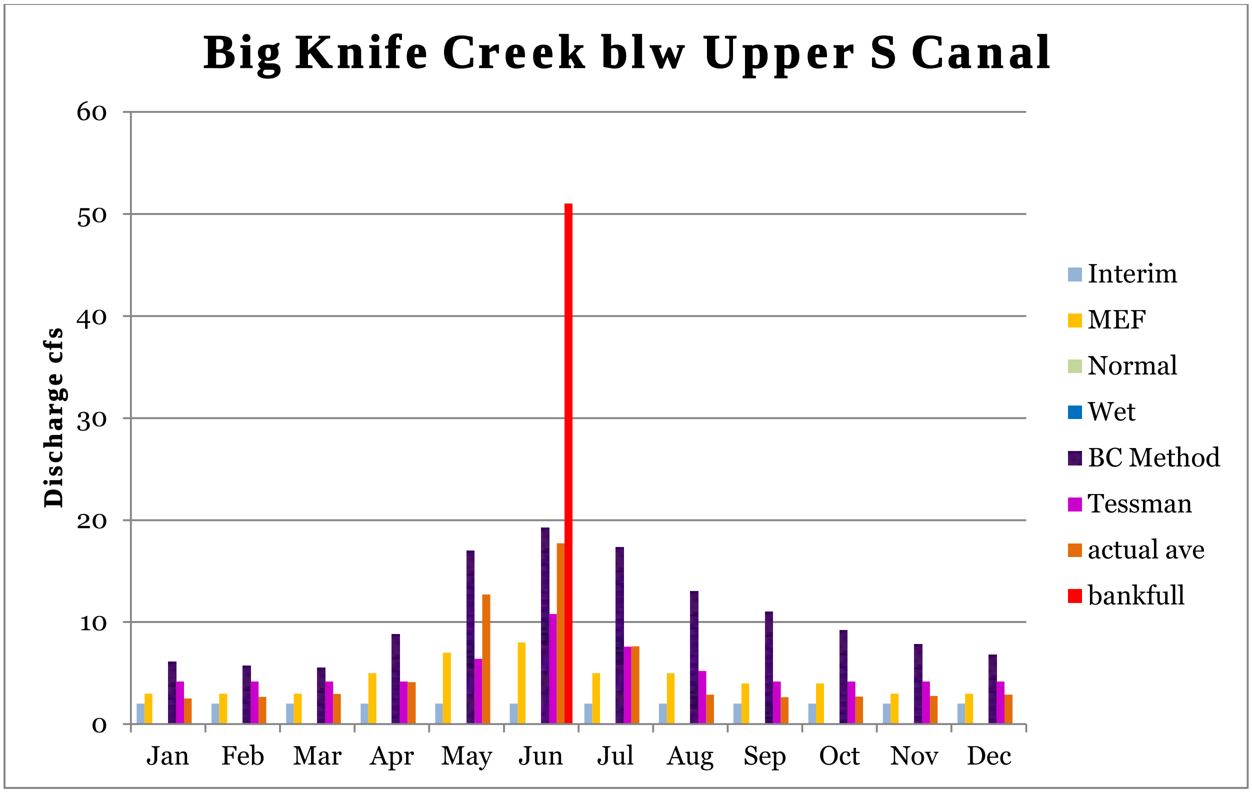


Figure 16: Big Knife Creek comparison of instream flow values

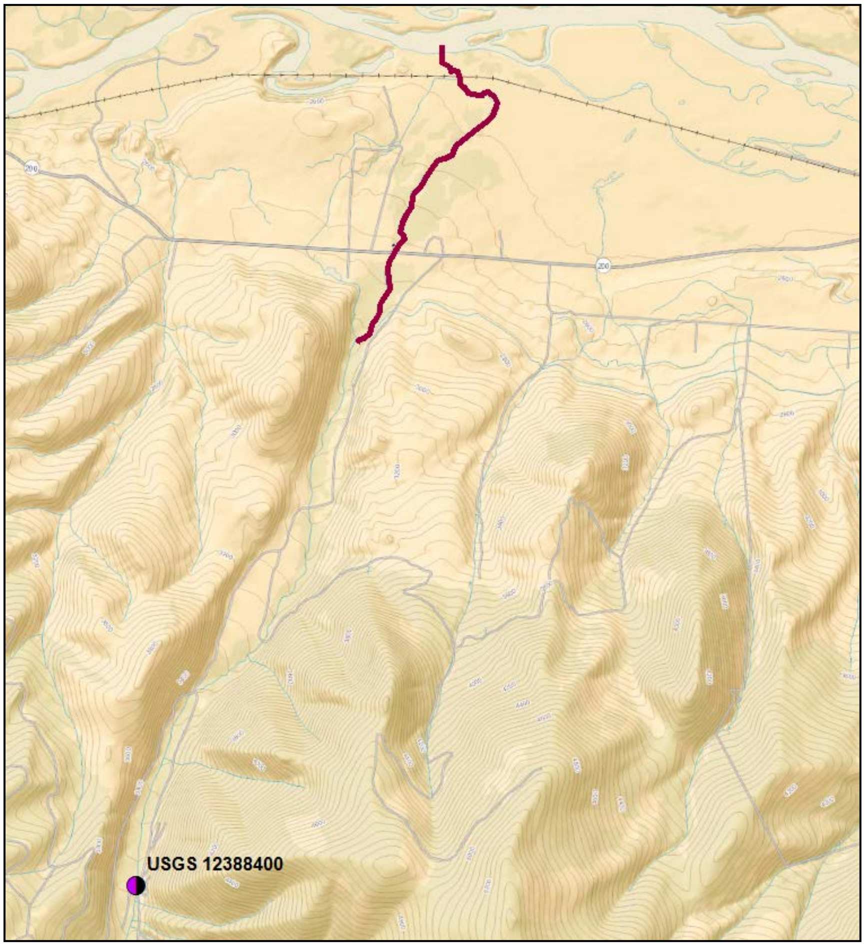


The BC method yields a recommended instream flow level higher than the MEF WUA values for Big Knife Creek in all months. This indicates that the MEF values are low and may not allow Big Knife Creek to attain its full fishery potential. The Tessman approach generally bears out values similar and slightly higher than the MEF WUA values. However, in April and May they are slightly lower.

For Big Knife Creek the bankfull discharge value determined by USGS (Lawlor, 2004) vastly exceeds the instream flow values. Attaining the MEF instream flow values would not be expected to in any way threaten the channel integrity of Big Knife Creek. In fact, care should be taken that on occasion Big Knife Creek does reach bankfull flow to assure property stream function.

The final stream reach evaluated is on Revais Creek, a tributary to the Flathead River downstream of the Jocko River. This is the only other stream where a USGS station with a sufficient period of record corresponded to an instream flow reach of the proposed Compact. Figure 17 shows the area of interest while figures 18 and 19 show the results of the application of the BC method in comparison to the MEF WUA instream flow values, with full and partial ordinate scales respectively. Unlike other charts, I did not locate any recent actual flow data for the instream reach, however I did locate USGS data collected from 1911-1919 at a gage site located at Highway 200 which is displayed along with the bankfull, USGS derived value. (Lawlor, 2004) No interim instream flow value is shown as none exists and no normal or wet year instream flow values are shown as none have been proposed for Revais Creek.

Figure 17: Revais Creek area of analysis



Like Big Knife Creek, the BC method yields a recommended instream flow level considerably higher than the MEF WUA values for Revais Creek in all months. The Tessman approach for Revais Creek also produced values considerably higher than the MEF WUA values. The 1911-1919 USGS data collected at Highway 200 exceeds the BC method recommended instream flow in all months except February. During the irrigation season the flow in present times would be expected to be considerably less as the 1911-1919 USGS data predates the Jocko Irrigation District's construction of the Revais Canal in the 1920s diverting upstream from the gage site. Furthermore, when comparing the average annual discharge at a long-term downstream gage (Clark Fork River near Plains 12389000), it was about 18 percent higher for the 1911-1919 period when compared to the 1983-2010 period. Assuming the water yield of Revais Creek followed this pattern, natural flows would be expected to be somewhat lower for 1983-2010 than the 1911-1919 period. Even given these consideration, the MEF is substantially lower than these values indicating that continued irrigation diversion would be favored over instream flow. The MEF values appear low and may not allow Revais Creek to attain its full fishery potential.

Figure 18: Revais Creek comparison of instream flow values

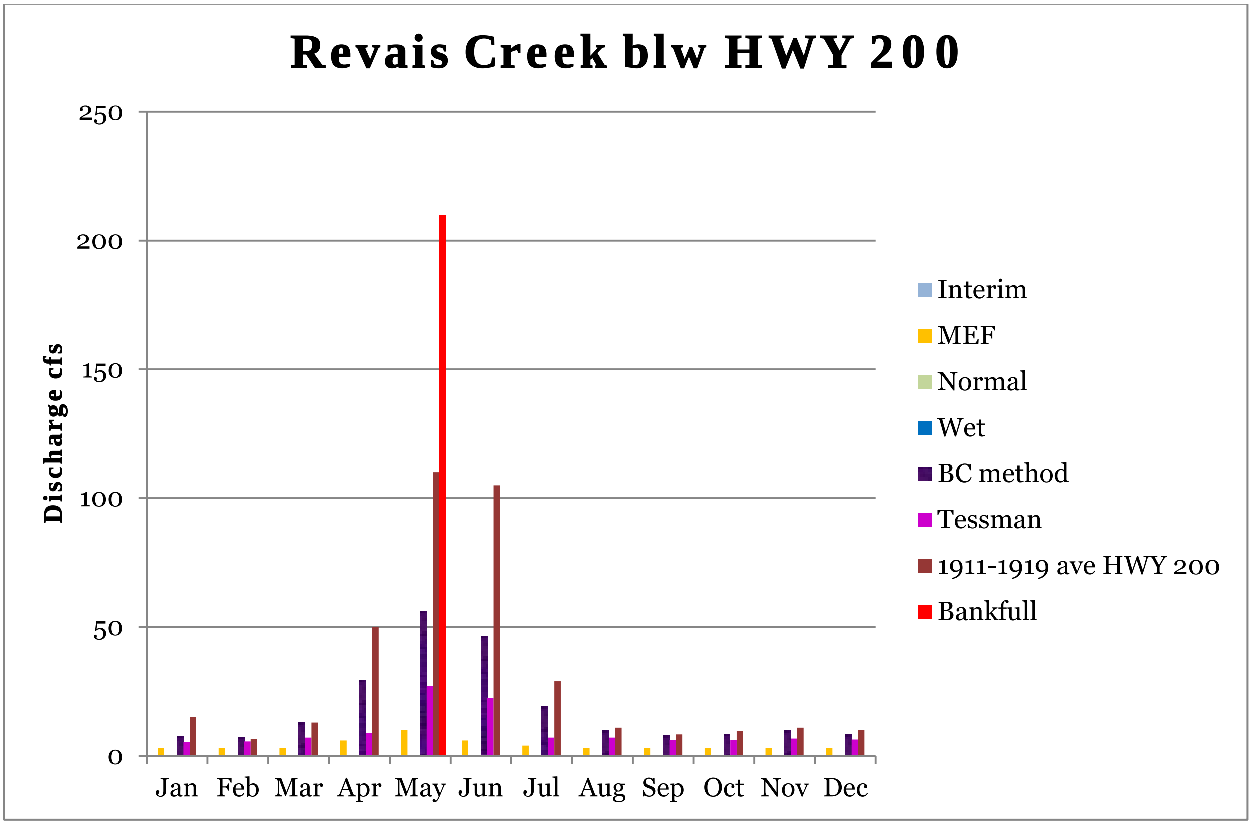
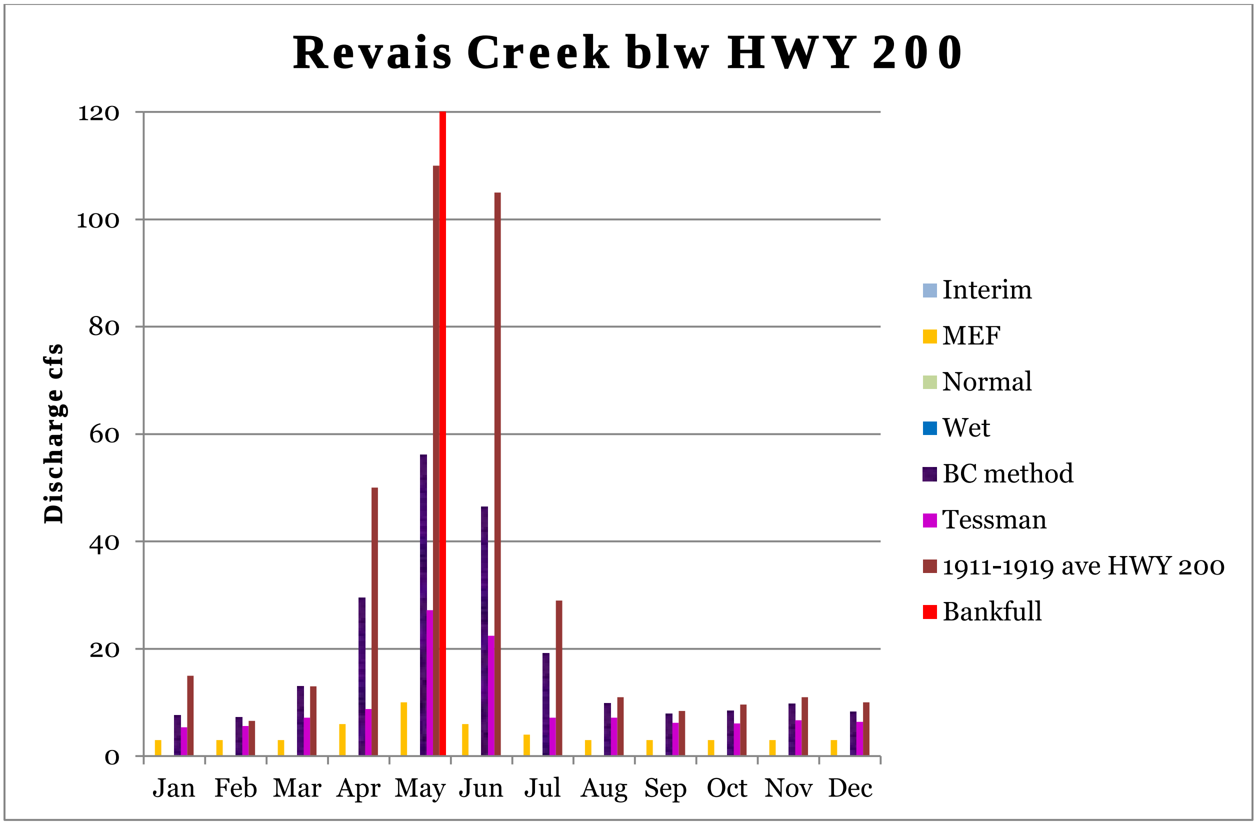


Figure 19: Revais Creek comparison of instream flow values -- 120 cfs max range



<u>Conclusions</u>

The comparisons to the BC method indicate that the WUA instream flow values are reasonable if not too low with the greatest divergence being instream flow values being considerably too low for Big Knife and Revais creeks. In comparison to the Tessman approach the WUA instream flow values are reasonable except the MEF values are generally too low.

Across the FIIP a more comprehensive, field-based instream flow assessment would likely yield results bringing recommended instream flow levels closer to the natural hydrograph that the proposed WUA instream flow values. In some areas within the FIIP where significant amounts of water are introduced as streams act as carriers of water diverted or released from other sources, this could lead to instream flow values somewhat lower than that which is presently occurring during most times. However, looking as the FIIP as a whole, a more comprehensive instream flow evaluation would most likely lead to more water being left instream and leaving the FIIP with less water available for irrigators overall than if the proposed WUA instream flow values are used. Based on the preceding analysis in this report and the general application of fundamental instream flow principles such as the natural flow paradigm, the instream flow levels proposed in the WUA are reasonable.

In all the streams investigated, streamflow already greatly exceeds the WUA instream flow levels during some time periods. Application of the WUA levels would not threaten the channel integrity of the streams investigated. Across the FIIP, the introduction of out of basin water and stored water likely poses more of a threat than achieving the WUA instream flow levels. Achieving the proposed WUA instream flow levels will not likely negatively impact fish survival, stream bank stability, erosion and the integrity of irrigation structures. In some cases it may improve stream bank stability and reduce erosion as the introduction of irrigation wastewater into streams is reduced and the need to carry previously diverted or stored water in streams is reduced.

References

Annear, T., I. Chisholm, H. Beecher, A. Locke, and 12 other authors. 2004. Instream flows for riverine resources stewardship, revised edition. Instream Flow Council, Cheyenne, WY.

DFO. 2004. Synopsis of instream flow thresholds for fish and fish habitat as guidelines for reviewing proposed water uses. British Columbia Ministry of Water, Land and Air Protection (MWLAP), Ministry of Sustainable Resource Management (MSRM), Land and Water BC Inc. (LWBC), and Fisheries and Oceans Canada (DFO)

Lawlor, S.M. 2004. Determination of channel-morphology characteristics, bankfull discharge, and various design-peak discharges in western Montana. Scientific Investigations Report 2004-5263. U.S. Geological Survey, Reston, VA.

Parret, C., K.D. Cartier. 1990. Methods for estimating monthly streamflow characteristics at ungauged sites in western Montana. U.S. Geologic Survey Water-Supply Paper 2365.

Poff, N.L., J.D. Allan, M.B. Bain, J.R. Karr, and others. 1997. The natural flow regime: A paradigm for river conservation and restoration. Bioscience 47(11):769-784

Tessman, S.A. 1980. Environmental assessments, technical appendix E in environmental use sector reconnaissance elements of the western Dakotas region of South Dakota study. Brookings, SD: South Dakota State University; Water Resources Research Institute.

V. Responses to Ballance/Regier questions

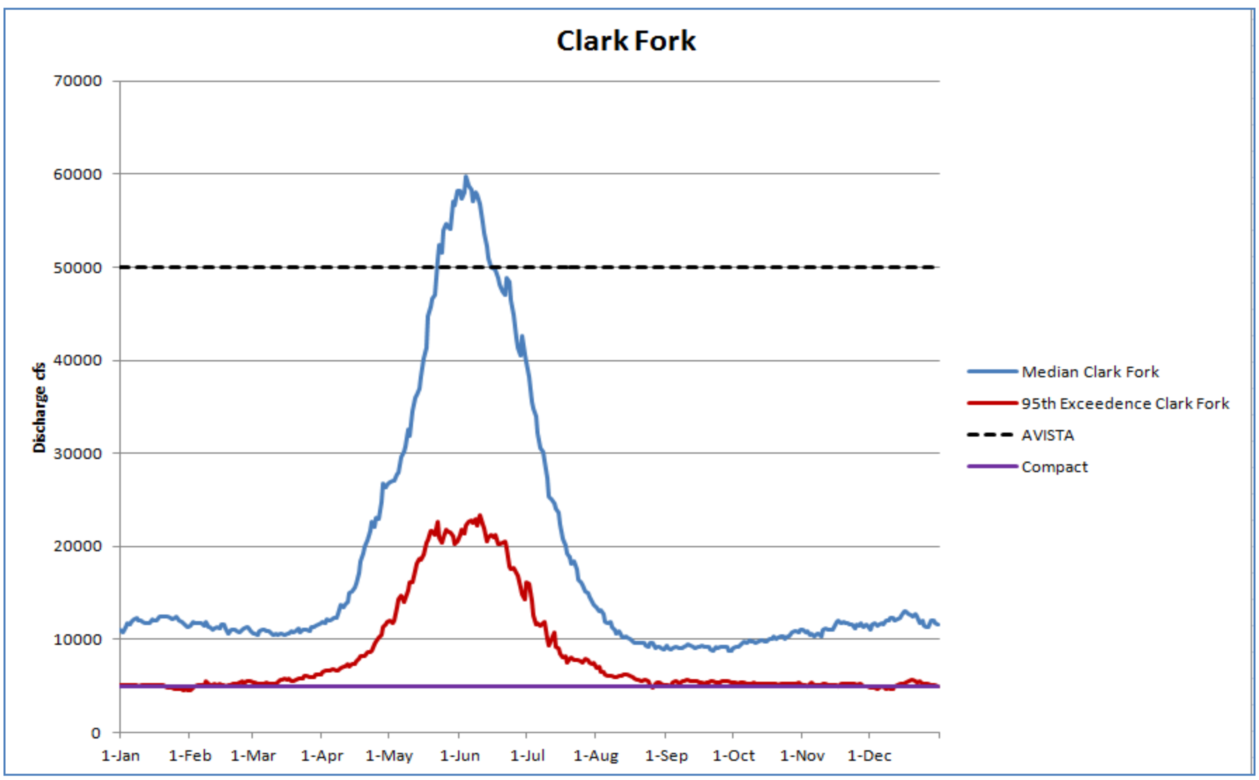
Changes in legal water demand due to CSKT compact

Note: The following is an expanded response

A question posed by Rep. Nancy Balance and Rep. Keith Regier to the Water Policy Interim Committee in May discusses basin closures and the potential for call on existing water users. While the compact does not include basin closures that further preclude the ability to apply for a new water right, changes in legal availability of water can potentially affect the ability to obtain a new water right. The question regarding the chances of existing water users being called is as much a socio-political question as a hydrologic or legal question. In other words just because the physical and legal circumstances that would allow for a call exist, does not mean that the senior water user will always make call.

Both the limiting impact on new water rights and the potential for call on existing water rights can be considered by examining the legal water demand that already exists and then determining how the proposed instream flow water rights outside of the Flathead Indian Reservation would impact the legal availability of water. The following charts explore this issue with respect to rivers where off-reservation instream flow water rights are proposed.

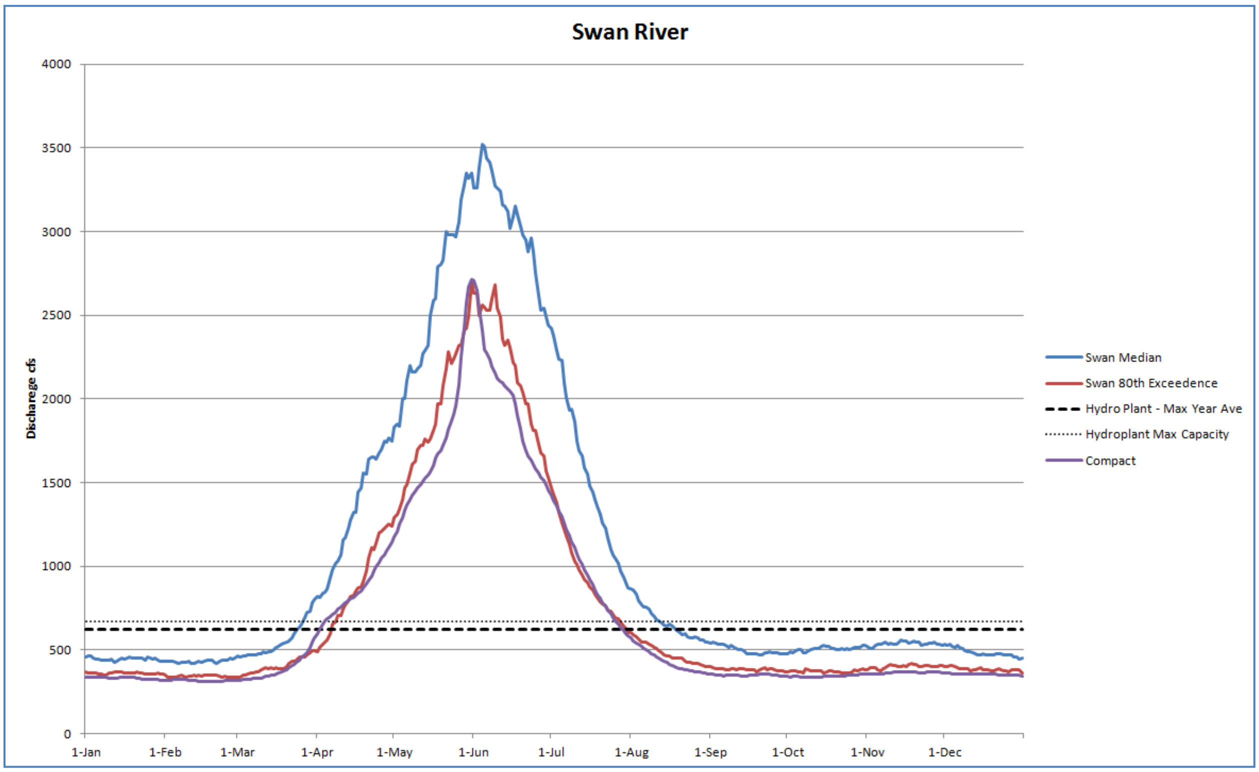
Figure 20



The 5,000 cubic feet per second, off-reservation instream right for the lower Clark Fork River does not impact potential legal water demand for water (see Figure 20). The legal demand in the lower Clark Fork is dominated by Avista's existing water rights, which total 50,000 cfs. The proposed CSKT water right is not additive to the Avista rights, but runs concurrently. Presently there is a very narrow window in May and June when Avista's 50,000 cfs hydropower water rights at Noxon Rapids are fully satisfied on a median basis. The proposed CSKT right would not narrow this window.

Only in about one of 20 years on a statistical basis the Clark Fork River drops to the 5,000 cfs level during roughly September through mid-March. As this is outside the normal irrigation season, it is unlikely an irrigator would be called based on the 5,000 cfs right.

Figure 21



For the Swan River during approximately the April through August period the legal demand for water is increased by the proposed CSKT instream water right beyond current levels. During the remainder of the year stream flows normally do not exceed the existing water right demand of Pacificorp's Big Fork Hydropower Plant (see Figure 21). Surface water and groundwater irrigators over 100 gpm may be subject to call more often. On a statistical basis this could occur in about two out of 10 years.

A review of Department of Revenue records finds that in the Swan River basin finds 180.5 acres classified as irrigated and 811.6 acres classified as wild hay land. Land that is actually irrigated and harvested for hay but is not farmed is sometimes classified as wild hay land. These 811.6 acres may well include some areas that are not irrigated. While not an exact measurement of actual irrigation that may be subject to call, it provides some idea of the limited nature of irrigation in the Swan River basin. Figure 22 shows the parcels associated with the irrigation and wild hay land. The bulk of the parcels are located in the northern end of the basin.

Figure 22

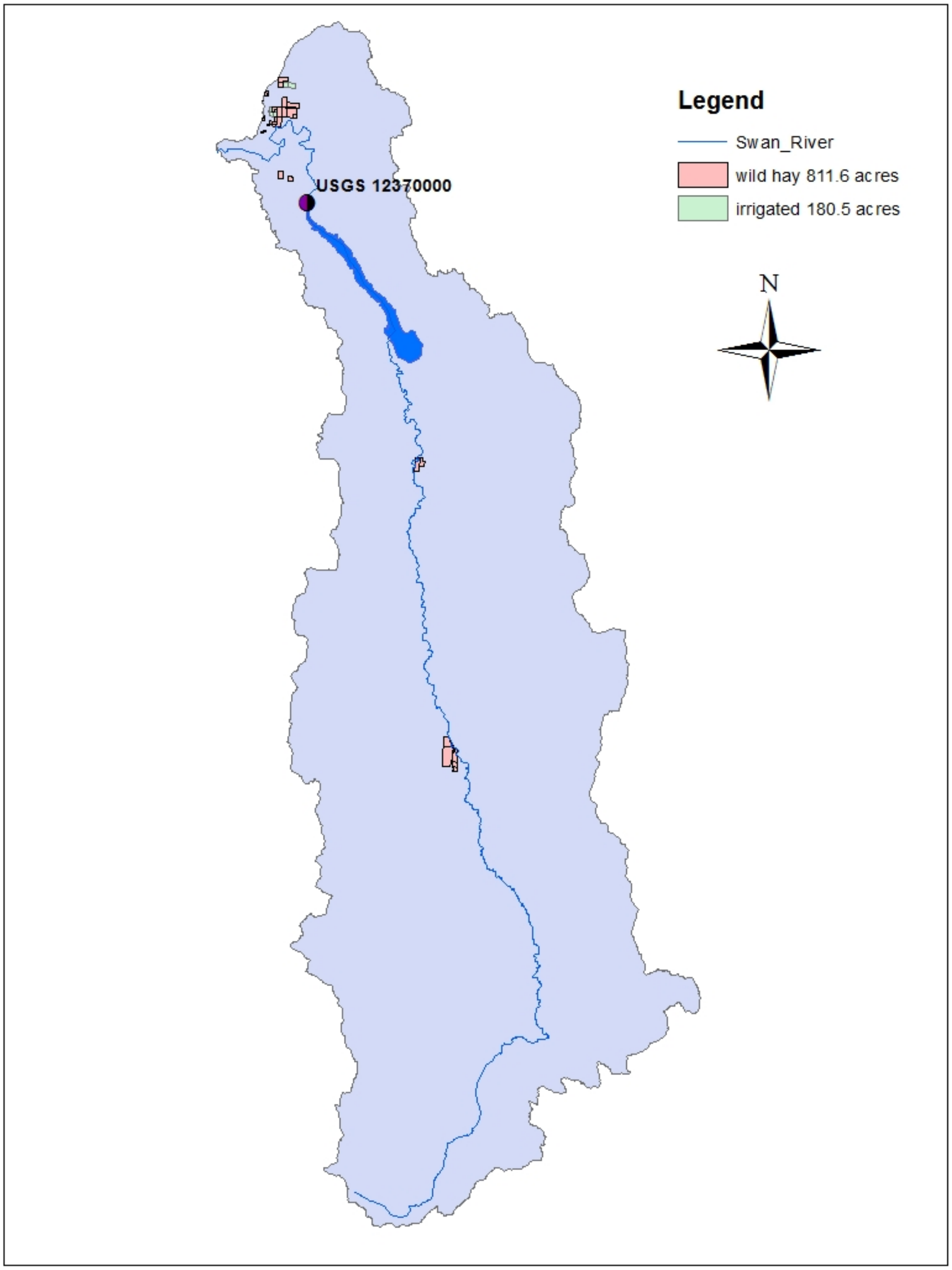
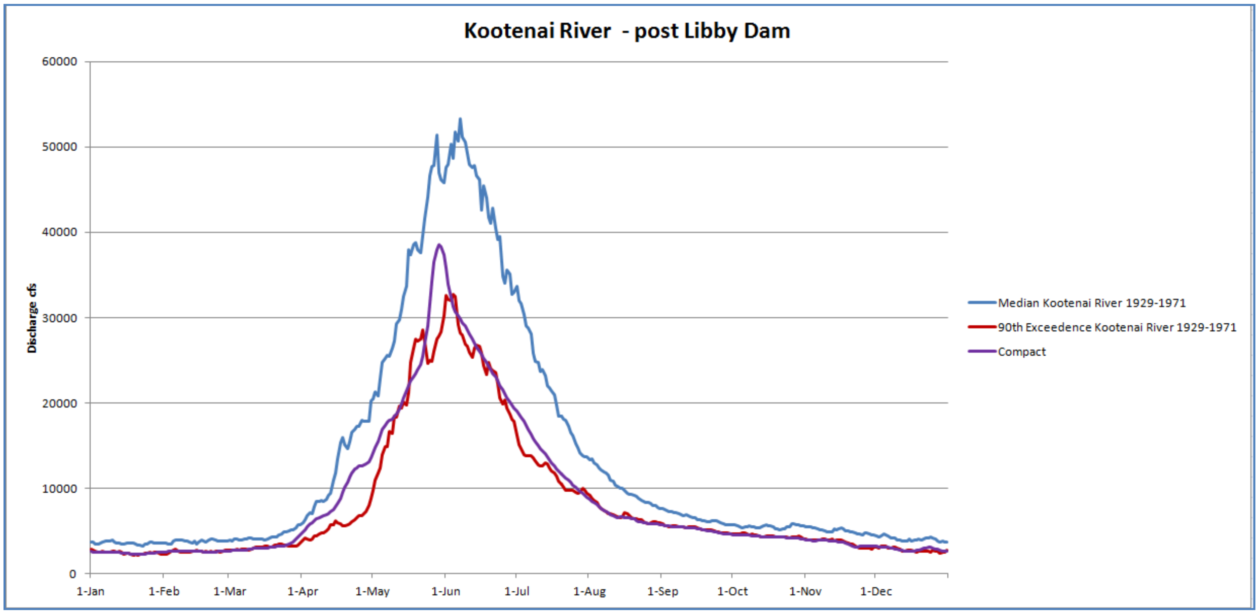


Figure 23



In the event that Libby Dam were removed at some point in the future, Kootenai River surface water and groundwater irrigators over 100 gallons per minute (gpm) may be subject to call in about one of 10 years (see Figure 23). Department of Revenue records show 62.4 acres classified as irrigated and 91.8 acres classified as wild hay land adjacent to the Kootenai River (see Figure 24).

Figure 24

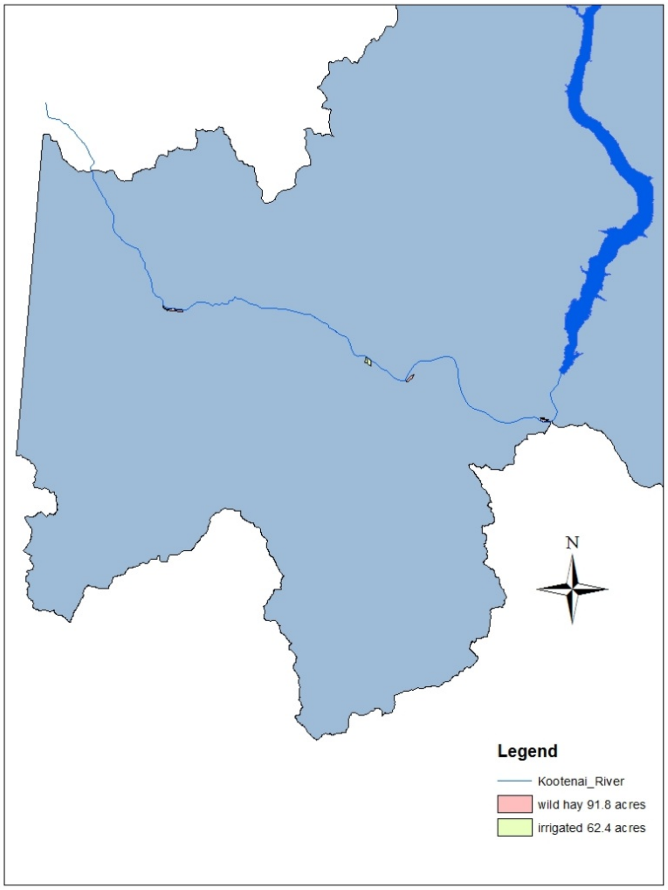
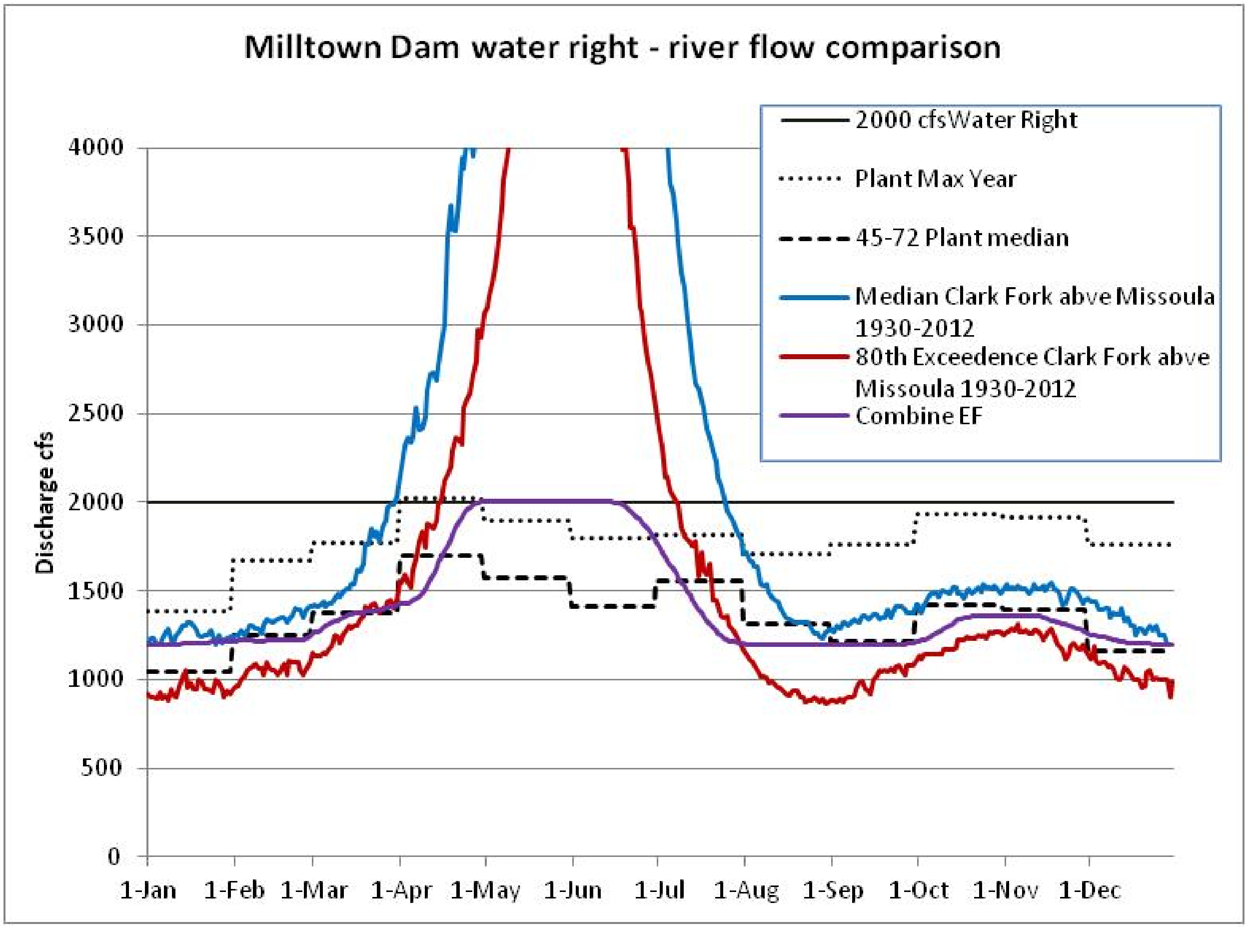

N
Legend
Kootenai_River
wild hay 91.8 acres
irrigated 62.4 acres

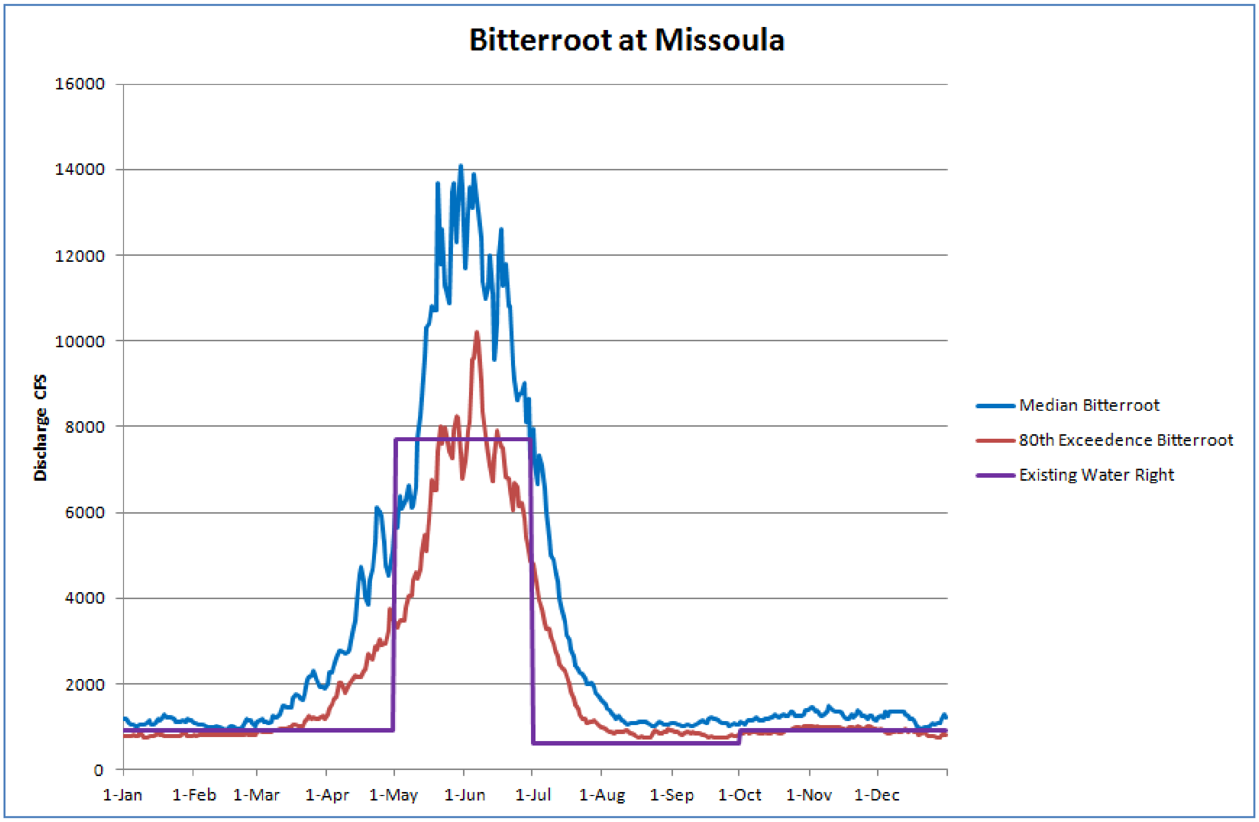
Figure 25



The proposed instream flow level for the Clark Fork River at Milltown is between the Blackfoot and Clark Fork rivers. The existing hydropower right for the Milltown Dam is 2,000 cfs, but the actual water usage and hence the extent of the water right may be somewhat less in most months (see Figure 25). The chart above shows in dashed lines the median of water run through the hydropower plant during the 1945-1972 period as well as the highest volume year during the same time period. It also shows the median and 80th exceedance hydrographs for the Clark Fork below Milltown.

If the Milltown Dam water right were changed to instream flow outside of the CSKT Compact a strong argument can be made that the demand for water, whether based on the median, highest year or some other hydrograph would exceed the demand as proposed in the Compact in critical months such as August. The CSKT Compact proposal for the Milltown Dam water right provides less likelihood that existing water users will be called when irrigation demand is highest in late summer when compared to likely outcomes of the Milltown Dam water right being changed to instream flow through the regular administrative process.

Figure 26



The proposed CSKT off-reservation instream flow rights for the Bitterroot River would be a co-ownership of existing instream water rights held by the Montana Department of Fish, Wildlife and Parks. This does not impact potential legal water demand for Bitterroot River. These existing water rights can be the basis for a call in about two out of 10 years (see Figure 26). These water rights are junior in priority to most water users in the basin and all of the large irrigation water rights from the Bitterroot River.

Other off-reservation instream flow water rights

Co-ownership with FWP of existing Murphy Rights on the forks and main stem Flathead River would not change the existing legal demand. The same is true for Murphy Rights on the Blackfoot River and Rock Creek as well as other public recreation water rights held by FWP in the Blackfoot basin.