CSKT Compact Technical Working Group

Report of findings

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

presented by John Metesh, MBMG
September 8, 2014

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Contents

99 pages in 20 minutes...

How to judge someone else's work

(a diverse working group gives a diverse perspective
here's an engineer's tale...)

Accuracy: comparison of data to **known values**

eg flow meters, calibration of instruments, spikes of known value...
but NOT, field data, calculations, and models...

Precision: repeatability or **reproducibility**

either repeated measurements **OR**

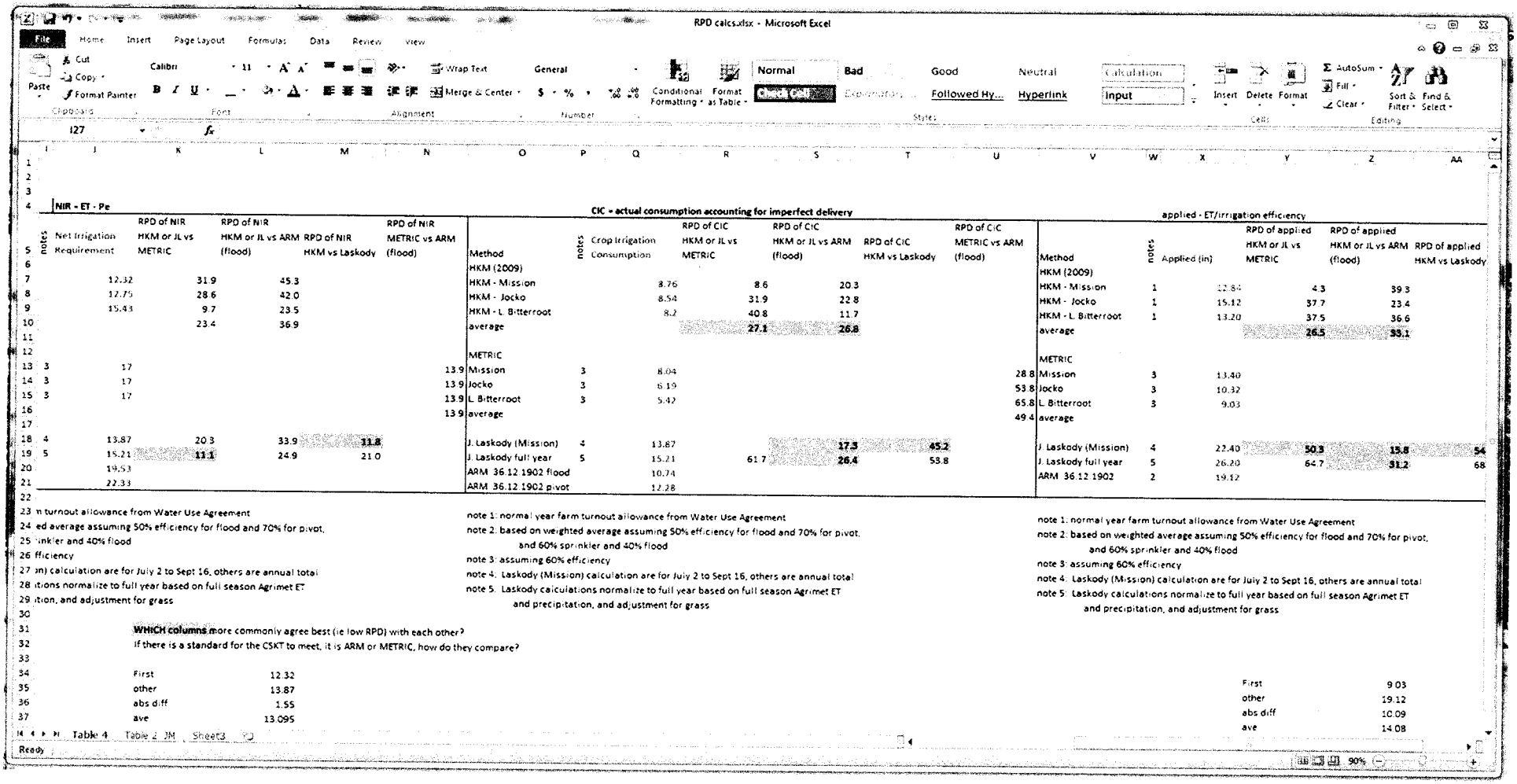
similar results by different methods
consilience
convergence of evidence

Relative (percent) Difference
comparing two results, neither of which can be considered "correct"
= (difference /mean) * 100

Quantification:
Table 4 of the report of findings

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



RPD calcs.xlsx - Microsoft Excel

NIR - ET - Pe

notes	Net Irrigation Requirement	RPD of NIR HKM or JL vs METRIC	RPD of NIR HKM or JL vs ARM (flood)	RPD of NIR HKM vs Laskody	RPD of NIR METRIC vs ARM (flood)
	12.32	31.9	45.3		
	12.75	28.6	42.0		
	15.43	9.7	23.5		
		23.4	36.9		
3	17				13.9
3	17				13.9
3	17				13.9
					13.9
4	13.87	20.3	33.9	11.8	
5	15.21	11.1	24.9	21.0	
	19.53				
	22.33				

note 1: normal year farm turnout allowance from Water Use Agreement
note 2: based on weighted average assuming 50% efficiency for flood and 70% for pivot, and 60% sprinkler and 40% flood
note 3: assuming 60% efficiency
note 4: Laskody (Mission) calculation are for July 2 to Sept 16, others are annual total
note 5: Laskody calculations normalize to full year based on full season Agrimet ET and precipitation, and adjustment for grass

WHICH columns more commonly agree best (ie low RPD) with each other?
If there is a standard for the CSKT to meet, it is ARM or METRIC, how do they compare?

First	12.32
other	13.87
abs diff	1.55
ave	13.095

CIC = actual consumption accounting for imperfect delivery

Method	notes	Crop Irrigation Consumption	RPD of CIC HKM or JL vs METRIC	RPD of CIC HKM or JL vs ARM (flood)	RPD of CIC HKM vs Laskody	RPD of CIC METRIC vs ARM (flood)
HKM (2009)						
HKM - Mission		8.76	8.6	20.3		
HKM - Jocko		8.54	31.9	22.8		
HKM - L. Bitterroot		8.2	40.8	11.7		
average			27.1	26.8		
METRIC						
Mission	3	8.04				28.8
Jocko	3	6.19				53.8
L. Bitterroot	3	5.42				65.8
average						49.4
J. Laskody (Mission)	4	13.87		17.3	45.2	
J. Laskody full year	5	15.21	61.7	26.4	53.8	
ARM 36.12.1902 flood		10.74				
ARM 36.12.1902 pivot		12.28				

note 1: normal year farm turnout allowance from Water Use Agreement
note 2: based on weighted average assuming 50% efficiency for flood and 70% for pivot, and 60% sprinkler and 40% flood
note 3: assuming 60% efficiency
note 4: Laskody (Mission) calculation are for July 2 to Sept 16, others are annual total
note 5: Laskody calculations normalize to full year based on full season Agrimet ET and precipitation, and adjustment for grass

applied - ET/irrigation efficiency

Method	notes	Applied (in)	RPD of applied HKM or JL vs METRIC	RPD of applied HKM or JL vs ARM (flood)	RPD of applied HKM vs Laskody
HKM (2009)					
HKM - Mission	1	12.84	4.3	39.3	
HKM - Jocko	1	15.12	37.7	23.4	
HKM - L. Bitterroot	1	13.20	37.5	36.6	
average			26.5	33.1	
METRIC					
Mission	3	13.40			
Jocko	3	10.32			
L. Bitterroot	3	9.03			
average					
J. Laskody (Mission)	4	22.40	50.3	15.8	54
J. Laskody full year	5	26.20	64.7	31.2	68
ARM 36.12.1902	2	19.12			

note 1: normal year farm turnout allowance from Water Use Agreement
note 2: based on weighted average assuming 50% efficiency for flood and 70% for pivot, and 60% sprinkler and 40% flood
note 3: assuming 60% efficiency
note 4: Laskody (Mission) calculation are for July 2 to Sept 16, others are annual total
note 5: Laskody calculations normalize to full year based on full season Agrimet ET and precipitation, and adjustment for grass

First	9.03
other	19.12
abs diff	10.09
ave	14.08

some definitions...

Evapotranspiration (ET)

total potential water consumption by plants under perfect conditions

Net Irrigation Requirement (NIR)

amount of irrigation water required to fully meet crop needs under site specific conditions,

= ET – Pe

Effective Precipitation (Pe)

precipitation used to offset crop water requirements, precipitation delivered to the roots when needed

Crop Irrigation Consumption (CIC)

water actually consumed by crop (true conditions, less than optimum)

CIC<NIR

some definitions...

Applied water

the amount of water needed to meet CIC. Applied is greater than CIC due to infiltration past roots and irrecoverable losses (eg evaporation).

a.k.a. Farm Turnout Allowance (FTA) in Water Use Agreement

example: Mission area

wet years	12.36 inches
normal years	12.84
dry years	13.68

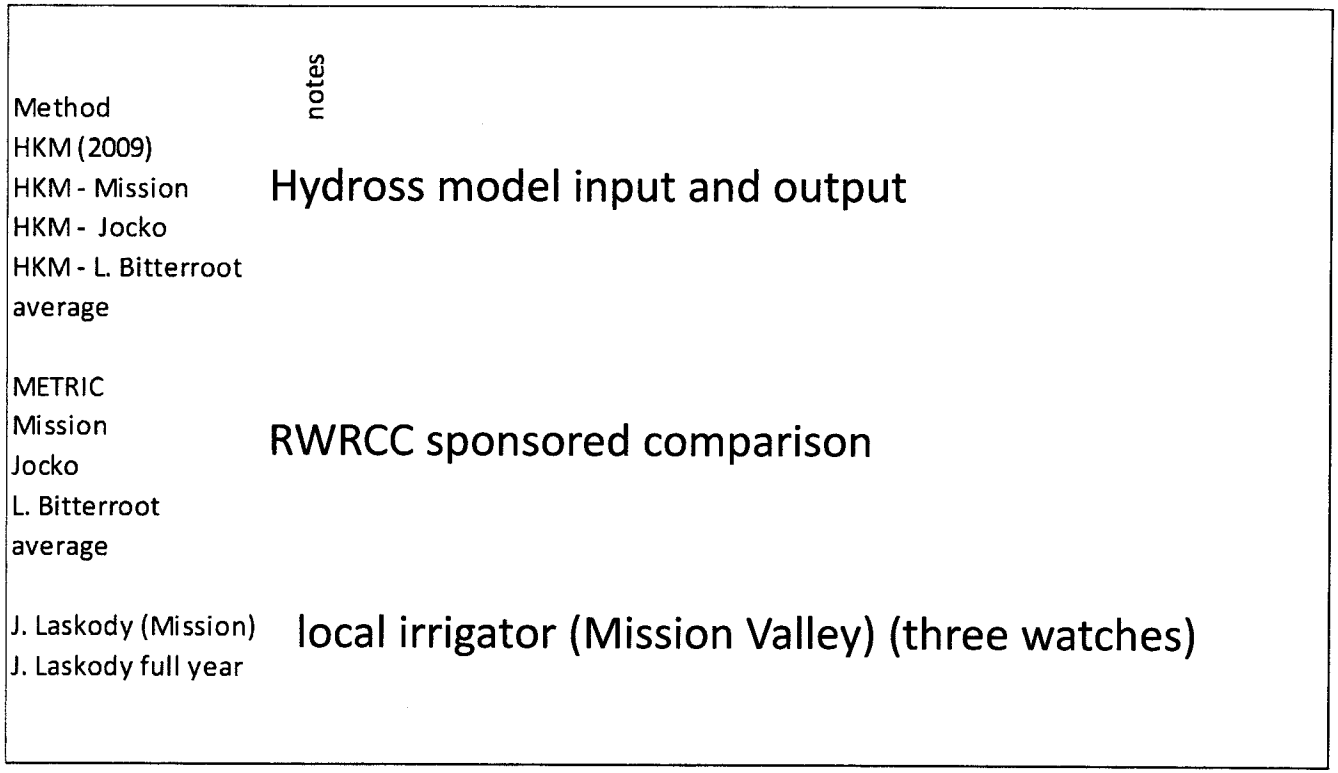
Method	notes
HKM (2009)	
HKM - Mission	
HKM - Jocko	
HKM - L. Bitterroot	
average	

Hydross model input and output (one watch)

Source: Proposed Flathead Indian Irrigation Project Water Use Agreement

Method	notes	
HKM (2009)		
HKM - Mission	Hydross model input and output	
HKM - Jocko		
HKM - L. Bitterroot		
average		
METRIC		
Mission	RWRCC sponsored comparison (two watches)	
Jocko		
L. Bitterroot		
average		

Source: METRIC (Mapping Evapotranspiration at high Resolution with Internalized Calibration); Reserved Water Right Compact Commission, 2014, METRIC eval bg.xls spreadsheet of analysis of METRIC data by Mr. Bill Greiman.



Source: 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. Modification to full year by R Levens (WPIC TWG).

Method	notes
HKM (2009)	Hydross model input and output
HKM - Mission	
HKM - Jocko	
HKM - L. Bitterroot	
average	
METRIC	RWRCC sponsored comparison
Mission	
Jocko	
L. Bitterroot	
average	
J. Laskody (Mission)	local irrigator (Mission Valley)
J. Laskody full year	
ARM 36.12.1902 flood	
ARM 36.12.1902 pivot	since 2009 (four watches)

Source of method: Administrative Rules of Montana (A.R.M.) 36.12.1902: change application historic use, based on USDA NRCS IWR program
Calculations: R Levens and L Dolan, WPIC TWG

Evapotranspiration (ET)

total <u>potential</u> water consumption by plants under perfect conditions

Method	notes	Total ET potential	RPD of ET HKM or JL vs METRIC	RPD of ET HKM or JL vs ARM (flood)	RPD of ET HKM vs Laskody	RPD of ET METRIC vs ARM (flood)
HKM (2009)						
HKM - Mission		23.9	5.7	12.1		
HKM - Jocko		23.9	5.7	12.1		
HKM - L. Bitterroot		23.9	5.7	12.1		
average			5.7	12.1		
METRIC						
Mission		25.3				5.3
Jocko		25.3				5.3
L. Bitterroot		25.3				5.3
average						5.3
J. Laskody (Mission)	4	14.67				
J. Laskody full year	5	24.14	4.7	10.0	1.0	
ARM 36.12.1902 flood		26.68				
ARM 36.12.1902 pivot		26.68				

Net Irrigation Requirement (NIR)

amount of irrigation water required to fully meet crop needs under site specific conditions

Method	notes	Net Irrigation Requirement	RPD of NIR HKM or JL vs METRIC	RPD of NIR HKM or JL vs ARM (flood)	RPD of NIR HKM vs Laskody	RPD of NIR METRIC vs ARM (flood)
HKM (2009)						
HKM - Mission		12.32	31.9	45.3		
HKM - Jocko		12.75	28.6	42.0		
HKM - L. Bitterroot		15.43	9.7	23.5		
average			23.4	36.9		
METRIC						
Mission	3	17				13.9
Jocko	3	17				13.9
L. Bitterroot	3	17				13.9
average						13.9
J. Laskody (Mission)	4	13.87	20.3	33.9	11.8	
J. Laskody full year	5	15.21	11.1	24.9	21.0	
ARM 36.12.1902 flood		19.53				
ARM 36.12.1902 pivot		22.33				

Crop Irrigation Consumption (CIC)

water actually consumed by crop (true conditions, less than optimum)

CIC<NIR

Method	notes	Crop Irrigation Consumption	RPD of CIC HKM or JL vs METRIC	RPD of CIC HKM or JL vs ARM (flood)	RPD of CIC HKM vs Laskody	RPD of CIC METRIC vs ARM (flood)
HKM (2009)						
HKM - Mission		8.76	8.6	20.3		
HKM - Jocko		8.54	31.9	22.8		
HKM - L. Bitterroot		8.2	40.8	11.7		
average			27.1	26.8		
METRIC						
Mission	3	8.04				28.8
Jocko	3	6.19				53.8
L. Bitterroot	3	5.42				65.8
average						49.4
J. Laskody (Mission)	4	13.87		17.3	45.2	
J. Laskody full year	5	15.21	61.7	26.4	53.8	
ARM 36.12.1902 flood		10.74				
ARM 36.12.1902 pivot		12.28				

Applied water

the amount of water needed to meet CIC

a.k.a. Farm Turnout Allowance (FTA) in Water Use Agreement

Method	notes	Applied (in)	RPD of applied HKM or JL vs METRIC	RPD of applied HKM or JL vs ARM (flood)	RPD of applied HKM vs Laskody	RPD of applied METRIC vs ARM (flood)
HKM (2009)						
HKM - Mission	1	12.84	4.3	39.3		
HKM - Jocko	1	15.12	37.7	23.4		
HKM - L. Bitterroot	1	13.20	37.5	36.6		
average			26.5	33.1		
METRIC						
Mission	3	13.40				35.2
Jocko	3	10.32				59.8
L. Bitterroot	3	9.03				71.7
average						55.6
J. Laskody (Mission)	4	22.40	50.3	15.8	54.3	
J. Laskody full year	5	26.20	64.7	31.2	68.4	
ARM 36.12.1902	2	19.12				

METRIC vs ARM may not be the best "standard"

highest vs lowest - all would fit

single or two highest / lowest

ARM only, METRIC only

Examining the differences

crop type

- averages over irrigation district – HKM
- one crop – JLaskody
- crop type not considered, energy only – METRIC
- crop type as specified (same as HKM, but smaller area like JL) – ARM

precipitation (for NIR estimates)

- precip zones (multi-year) extrapolated from AgriMet stations – HKM
- precip not considered – METRIC
- site specific, one year – JLaskody
- average precip, average effective precip from IWR – ARM

irrigation efficiency

- Hydross model output (trial and error, calibration, etc) – HKM
- not considered - METRIC
- site-specific estimation, double duty – JL
- specified for each method - ARM

Examining the differences

general

averages (time, ET etc.) over irrigation district or service area – HKM
one site, one year, one crop – JLaskody
energy based on satellite image with 30m pixels – METRIC
combination of site specific (crop, irrigation) plus management factor – ARM

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).

Issue: HYDROSS model input data – irrigation characteristics
Summary: Irrigation input data used in the modeling appears to be reasonable.

Issue: HYDROSS model input data – crop water consumption
Summary: Estimated crop type percentages were generally verifiable.

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.

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.

Issue: HYDROSS modeling of increases in instream flow from irrigation system improvements
Summary: Stream flow is modeled mostly to increase under operational improvement and irrigation project betterment scenarios.

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.

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.

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.

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

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.

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.

Issue: Land classification and additional duty water

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

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.

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.

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.

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.

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.

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.

V. Responses to Ballance/Regier questions
Presentation to WPIC, July 2014