TECHNICAL BASIS FOR PROPOSED FLATHEAD INDIAN IRRIGATION PROJECT WATER USE AGREEMENT

JUNE 12, 2014 - HELENA

Approach to Quantifying Existing Water Use

- Water Accounting Models are used to track all of the individual elements that comprise the Reservation-wide water budget

  - Used the HYDROSS (Hydrologic River Operation Study System) software program developed by the Great Plains Region of the USBR

  - Accounts for monthly flow for every measurable stream, monthly diversion for every Project and Private Ditch, ditch losses, crop consumption, reservoir storage, stream seepage losses and gains, etc…

Basis of Water Allocation

1. Provide Adequate Water Supply to Match Existing Project-wide Crop Irrigation Consumption

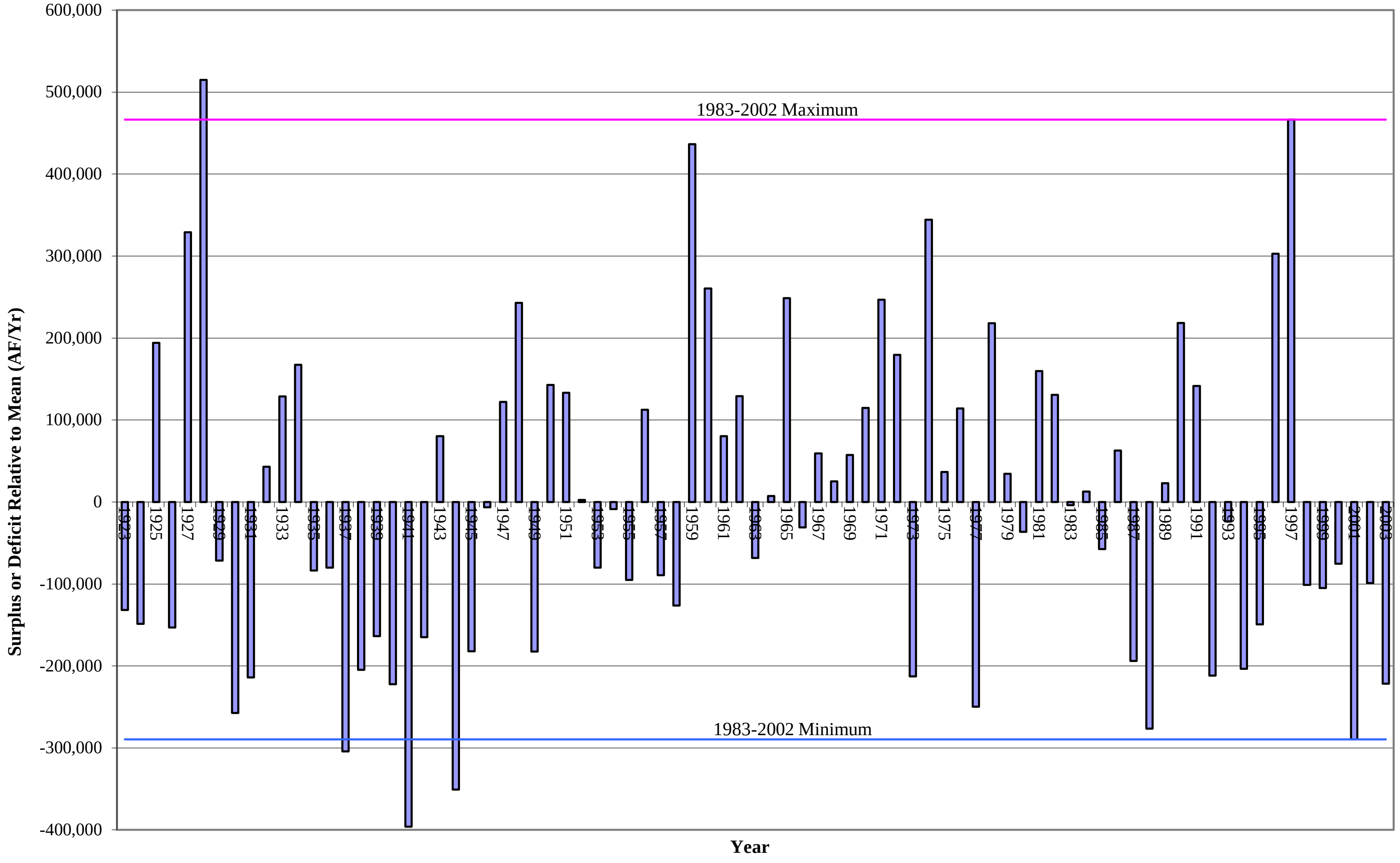
2. Identify Potential Water Conservation Improvements to Project Water Distribution Operations

3. Determine the remaining streamflow available for Minimum Instream Flows (MEFs) and Target Instream Flows (TIFs) after implementing Project Improvements

Water Accounting Models

- 1983 – 2002 Study Period (240 months of data)
- Model Structure
- Key Model Inputs
  - Natural Flows
  - Irrigated Lands Mapping
  - FIIP Irrigation System Configuration
    - Canal Capacities
    - Canal Losses
    - Irrigation Service Areas
  - Crop Water Requirements
- Results of Water Accounting Model
- Calibration and Other Reasonableness Checks
- Water Available through FIIP Operational Improvements

Deviations from Average Streamflow
Swan River near Big Fork (#12370000)



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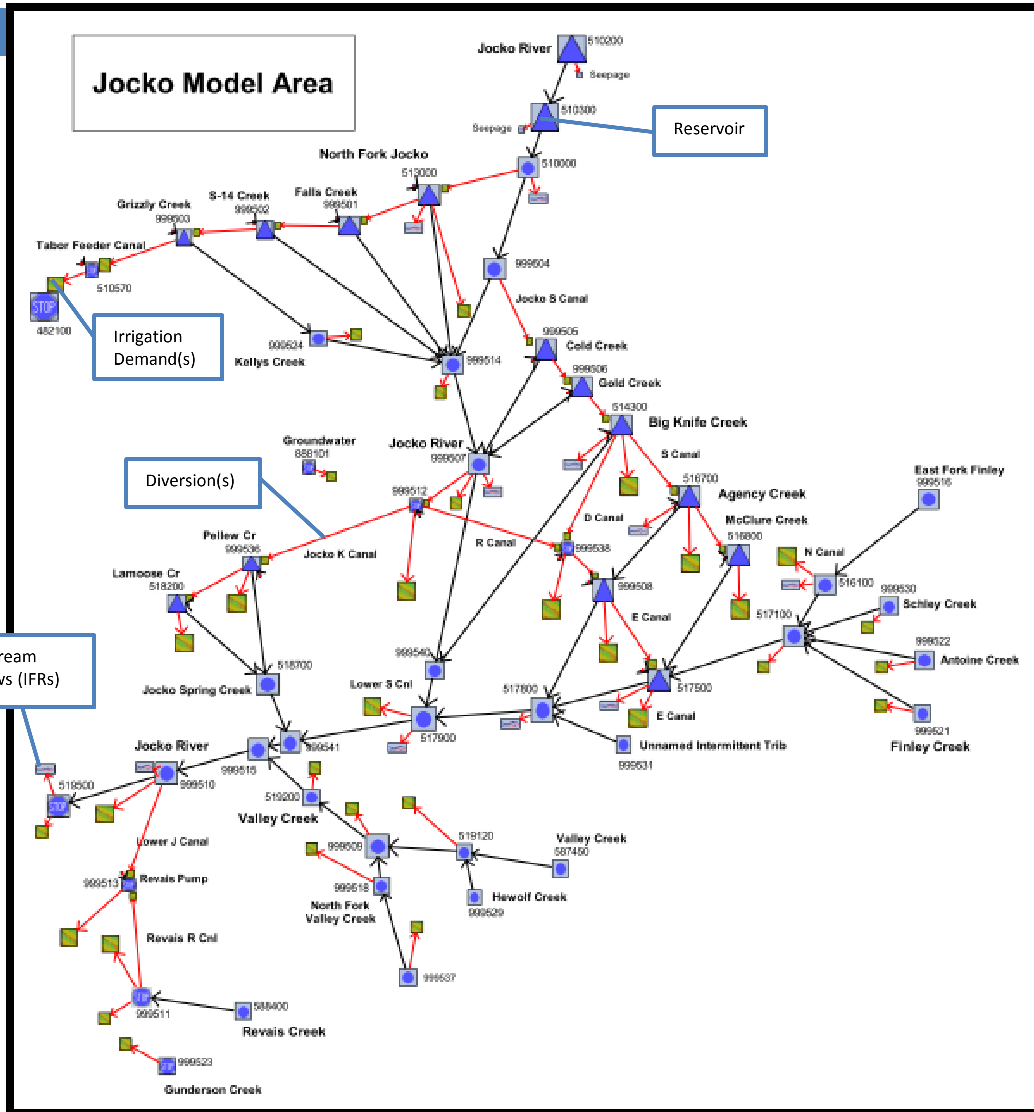
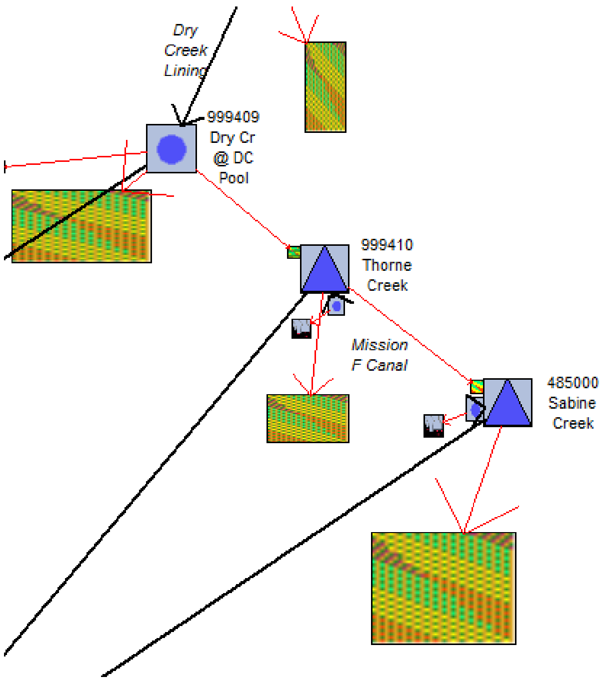
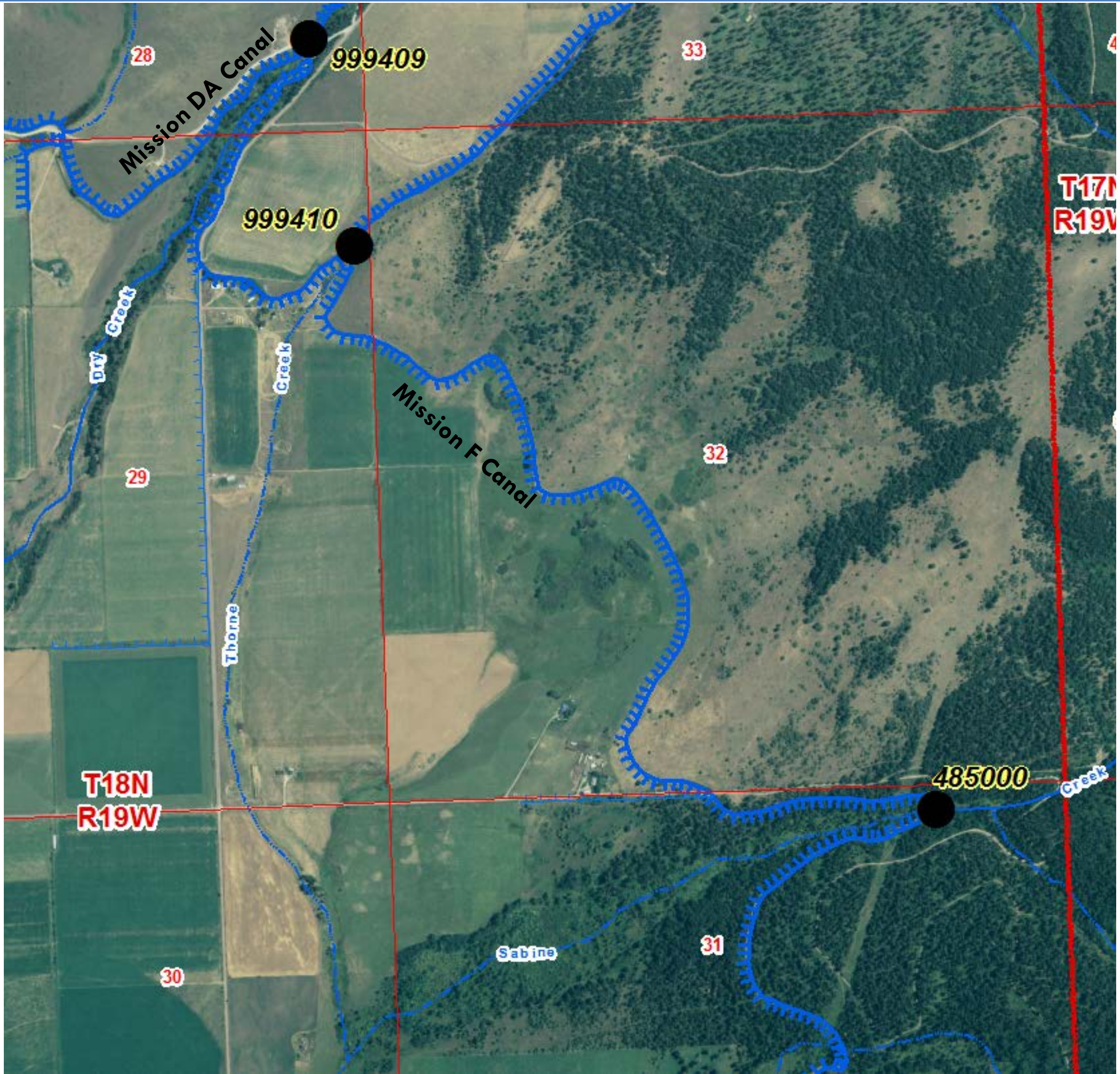
Jocko Model Schematic



Mission Area Model Schematic

Schematic Diagram





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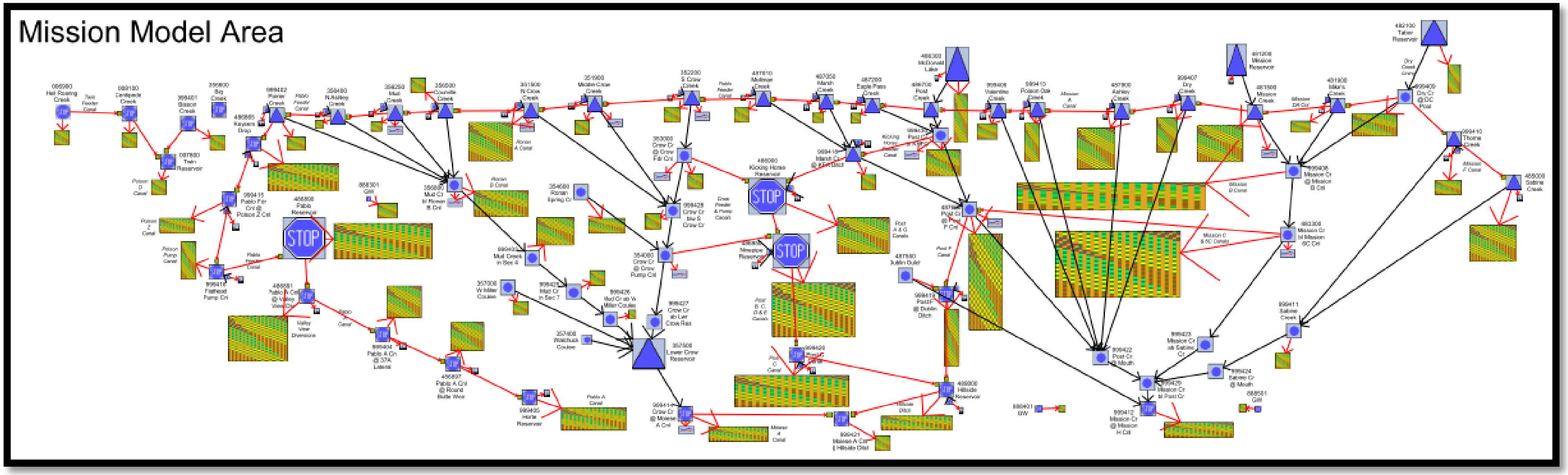
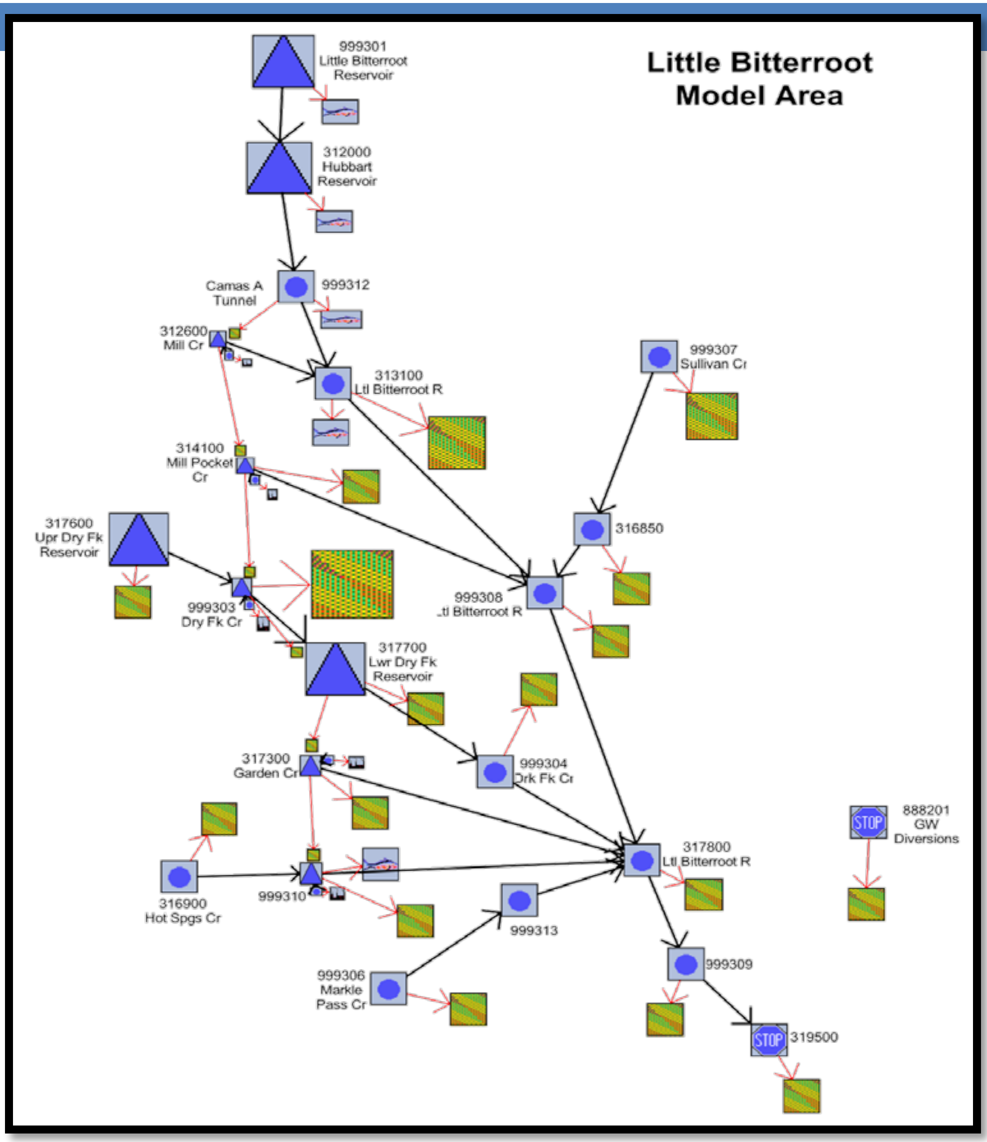


Little Bitterroot Model Schematic



Water Accounting Models

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Jocko Model Average Annual Flow (1983 – 2002 Study Period)

Model Node		Natural (AF/yr)	Current (AF/yr)
510000	Middle Fork Jocko River below Tabor Feeder Canal	18,704	18,750
510200	Middle Fork Jocko River below Black Lake	9,160	15,155
510300	Middle Fork Jocko River below Lower Jocko Lake	12,355	18,290
513000	North Fork Jocko River below Tabor Feeder Canal	37,389	14,062
514300	Big Knife Creek below Jocko S Canal	7,463	5,603
516100	East Fork Finley Creek below Jocko N Canal	7,638	6,357
516700	Agency Creek below Jocko S Canal	8,416	4,735
516800	McClure Creek below Jocko S Canal	352	440
517100	Finley Creek below East Fork Finley Creek	15,829	13,807
517500	Finley Creek below Jocko E Canal	17,064	15,470
517800	Finley Creek at Mouth	24,324	21,570
517900	Jocko River below Lower Jocko S Canal	177,352	117,689
518200	Lamoose Creek below Jocko K Canal	430	223
518700	Jocko Spring Creek near Mouth	10,297	16,143
519120	Valley Creek below Morin Ditch	13,127	12,921
519200	Valley Creek near Mouth	18,235	17,179
519500	Jocko River below Highway	205,883	172,358

Jocko Model Average Annual Flow (1983 – 2002 Study Period)

Model Node		Natural (AF/yr)	Current (AF/yr)
587450	Valley Creek near Arlee	9,025	9,025
588400	Revais Creek below West Fork Revais Creek	13,114	13,099
999501	Falls Creek below Tabor Feeder Canal	4,437	1,337
999502	S-14 Creek below Tabor Feeder Canal	719	166
999503	Grizzly Creek below Tabor Feeder Canal	1,030	223
999504	Jocko River below Jocko S Canal	64,164	58,864
999505	Cold Creek below Jocko S Canal	1,969	539
999506	Gold Creek below Jocko S Canal	2,395	710
999507	Jocko River below Jocko K Canal	131,437	73,662
999508	Agency Creek below Jocko E Canal	8,416	3,141
999509	Valley Creek below North Fork Valley Creek	18,235	17,504
999510	Jocko River below Lower J Canal	205,883	165,242
999511	Revais Creek below Revais R Canal	14,197	11,210
999514	Jocko River below North Fork Jocko River	114,887	87,319
999515	Jocko River below Valley Creek	205,883	173,236
999516	East Fork Finley Creek below Finley Lakes	1,047	1,047
999518	North Fork Valley Creek below Mackey Ditch	5,108	4,689

Jocko Model Average Annual Flow (1983 – 2002 Study Period)

Model Node		Natural (AF/yr)	Current (AF/yr)
999521	Finley Creek below Frog Creek	1,400	547
999522	Antoine Creek	1,486	1,450
999523	Gunderson Creek	451	412
999524	Kellys Creek at Mouth	2,366	5,670
999529	Hewolf Creek	2,211	2,201
999530	Schley Creek below Doney Ditch	1,006	992
999531	Unnamed intermittent tributary to Finley Creek	396	1,442
999536	Pellew Creek below Jocko K Canal	161	151
999537	North Fork Valley Creek	3,542	835
999540	Jocko River above Finley Creek	153,027	100,928
999541	Jocko River above Valley Creek	187,648	155,833

Mission Valley Model Average Annual Flow (1983 – 2002 Study Period)

Model Node		Natural (AF/yr)	Current (AF/yr)
6900	Hellroaring Creek below Twin Feeder Canal	7,889	6,979
8100	Centipede Creek below Twin Feeder Canal	979	99
351500	North Crow Creek below Pablo Feeder Canal	26,955	8,730
351900	Middle Crow Creek below Pablo Feeder Canal	4,626	932
352200	South Crow Creek below Pablo Feeder Canal	14,340	19,740
353000	South Crow Creek below South Crow Feeder Canal	14,340	8,896
354000	Crow Creek below Crow Creek Pump Canal	48,803	29,472
354600	Ronan Spring Creek near Mouth	8,194	12,937
356250	Mud Creek below Pablo Feeder Canal	3,786	2,830
356400	North Ashley Creek below Pablo Feeder Canal	110	36
356500	Courville Creek below Pablo Feeder Canal	6,814	3,959
356600	Big Creek at Mouth	0	0
356800	Mud Creek below Ronan B Canal	15,074	2,635
357000	West Miller Coulee near Mouth	0	1,682
357400	Walchuck Coulee near Mouth	0	2,474
357500	Crow Creek below Lower Crow Reservoir	69,509	48,970
481200	Mission Creek below Mission Reservoir	36,572	36,434
481500	Mission Creek below Mission A Canal	34,722	30,064

Mission Valley Model Average Annual Flow (1983 – 2002 Study Period)

Model Node		Natural (AF/yr)	Current (AF/yr)
481900	Mike's Creek below Mission DA Canal	2,538	298
482100	Dry Creek below Tabor Reservoir	11,360	38,670
483300	Mission Creek below Mission 6C Canal	59,814	23,742
485000	Sabine Creek below Mission F Canal	212	1
486300	Post Creek below McDonald Reservoir	51,990	51,675
486700	Post Creek below Pablo Feeder Canal	51,990	36,588
487010	Mollman Creek below Pablo Feeder Canal	3,602	3,239
487050	Marsh Creek below Pablo Feeder Canal	1,652	712
487200	Eagle Pass Creek below Pablo Feeder Canal	1,997	7,153
487550	Dublin Gulch below Dublin Ditch	0	1,444
487600	Post Creek below Post F Canal	59,239	25,420
487900	Ashley Creek below Mission A Canal	8,064	10,564
489000	Coleman Coulee below Hillside Reservoir	0	3,192
999401	Bisson Creek near Mouth	0	0
999402	Poirier Creek below Pablo Feeder Canal	200	88
999403	Mud Creek in Sec 4 T20N R20W	15,074	9,422
999405	Spring Creek below Horte Reservoir	0	1,242
999406	Valentine Creek below Mission A Canal	496	1,911

Mission Valley Model Average Annual Flow (1983 – 2002 Study Period)

Model Node		Natural (AF/yr)	Current (AF/yr)
999407	Dry Creek below Mission A Canal	712	168
999408	Mission Creek below Mission B Canal	56,441	32,329
999409	Dry Creek below Mission DA Canal	24,428	8,395
999410	Thorne Creek below Mission F Canal	1,105	968
999411	Sabine Creek above Pistol Creek	1,316	1,567
999412	Mission Creek below Mission H Canal	154,989	108,116
999413	Poison Oak Creek below Mission A Canal	820	164
999414	Crow Creek below Moiese A Canal	69,509	35,707
999418	Marsh Creek below Kicking Horse Feeder Canal	5,254	2,406
999422	Post Creek at Mouth	85,260	72,730
999423	Mission Creek above Sabine Creek	63,556	28,053
999424	Sabine Creek at Mouth	7,020	9,147
999425	Mud Creek in Sec 7 T20N R20W	15,074	8,369
999426	Mud Creek above West Miller Coulee	20,806	13,401
999427	Crow Creek above Lower Crow Reservoir	48,703	29,472
999428	Crow Creek below South Crow Creek	45,921	18,747
999429	Mission Creek below Post Creek	148,044	104,434
999430	Post Creek below Kicking Horse Feeder Canal	53,987	27,122

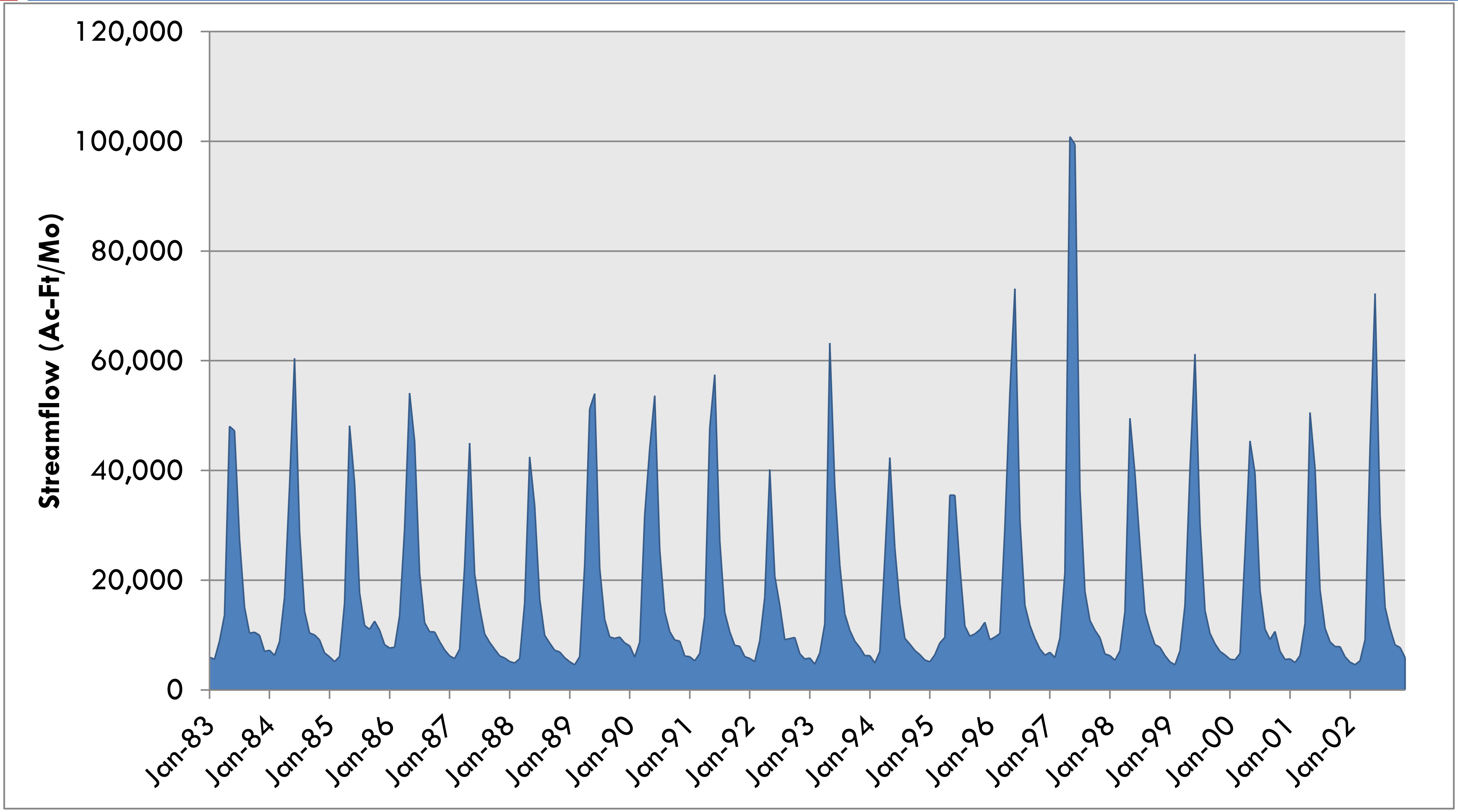
Little Bitterroot Model Average Annual Flow (1983 – 2002 Study Period)

Model Node		Natural (AF/yr)	Current (AF/yr)
312000	Little Bitterroot River below Hubbart Reservoir	24,242	19,974
312600	Mill Creek below Camas A Canal	6,598	8,086
313100	Little Bitterroot River below Camas A Canal below Mill Creek	32,748	11,108
314100	Mill Pocket Creek below Camas A Canal	129	179
316850	Sullivan Creek at Mouth near Lonepine	2,363	2,006
316900	Hot Springs Creek above Camas C Canal	705	567
317300	Garden Creek below Camas C Canal	829	117
317600	Dry Fork Creek below Upper Dry Fork Reservoir	525	2,510
317700	Dry Fork Creek below Lower Dry Fork Reservoir	1,200	2,294
317800	Little Bitterroot River below Hot Springs Creek	45,463	29,959
319500	Little Bitterroot River below Whiskey Creek near Mouth	45,463	31,306

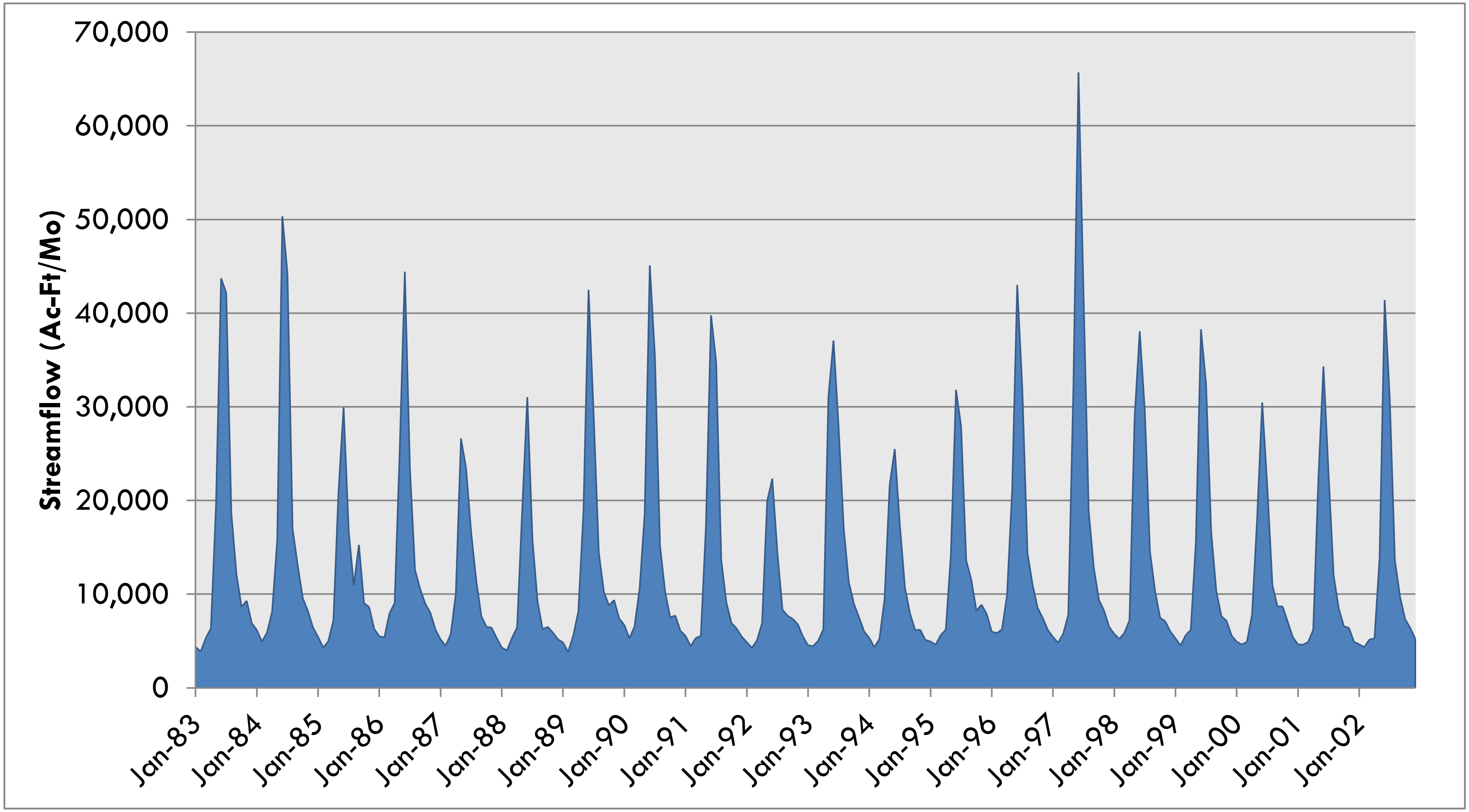
Little Bitterroot Model Average Annual Flow (1983 – 2002 Study Period)

Model Node		Natural (AF/yr)	Current (AF/yr)
999301	Little Bitterroot River below Little Bitterroot Reservoir	11,787	7,913
999303	Dry Fork Creek below Camas B & D Canals	617	9,368
999304	Dry Fork Creek at Mouth	1,200	3,334
999306	Markle Pass Creek near Private Diversions	68	49
999307	Sullivan Creek near Niarada	2,363	1,846
999308	Little Bitterroot River below Sullivan Creek	34,909	14,866
999309	Little Bitterroot River below Oliver Gulch	45,463	31,032
999310	Hot Springs Creek below Camas C Canal	1,213	1,122
999312	Little Bitterroot River below Camas A Canal (above Mill Creek)	26,171	5,616
999313	Markle Pass Creek near Mouth	643	1,943

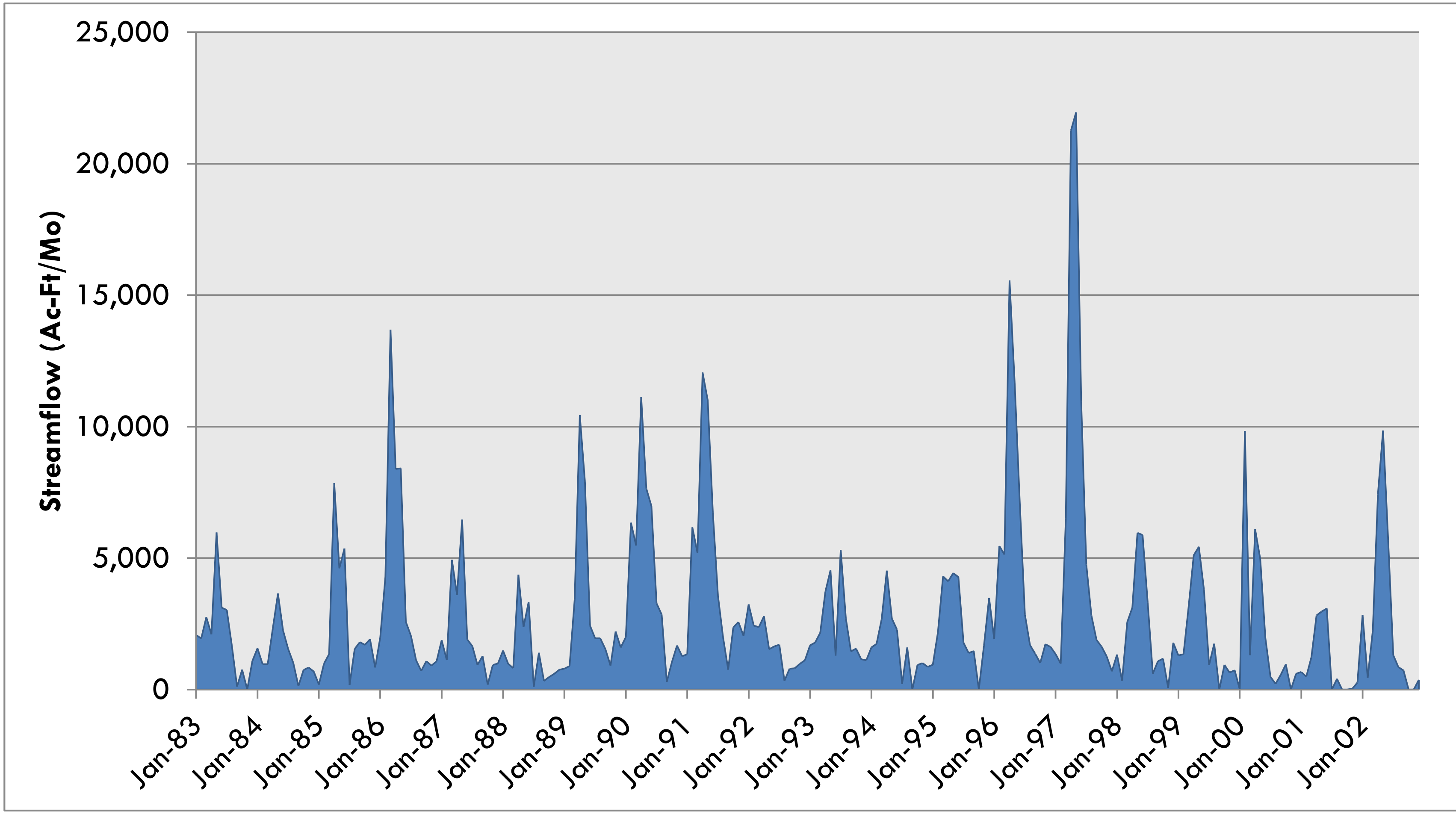
Natural Flow for Jocko River at Mouth (519500)



Natural Flow for Mission Creek near Mouth (489500)



Natural Flow for Little Bitterroot River below Mill Creek (313100)



Water Accounting Models

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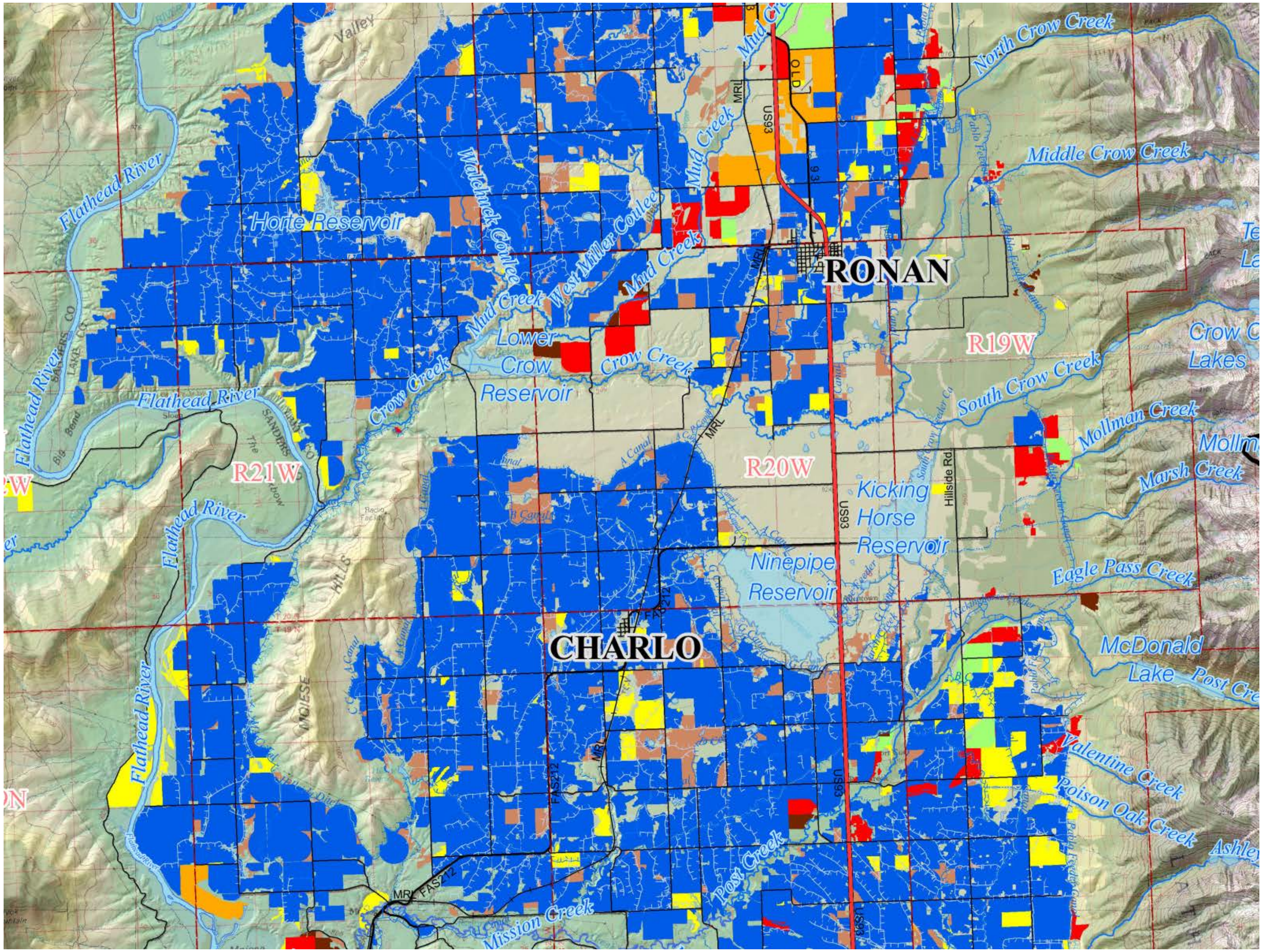
Mapping of Current Irrigation



Water Accounting Models

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- ☐ Key Model Inputs
  - ✓ Natural Flows
  - ✓ Irrigated Lands Mapping
  - ☐ **FIIP Irrigation System Configuration**
    - Canal Capacities (From Canal Diversion Records)
    - Canal Losses (Guided by DNRC Canal Seepage Study)
    - Irrigation Service Areas
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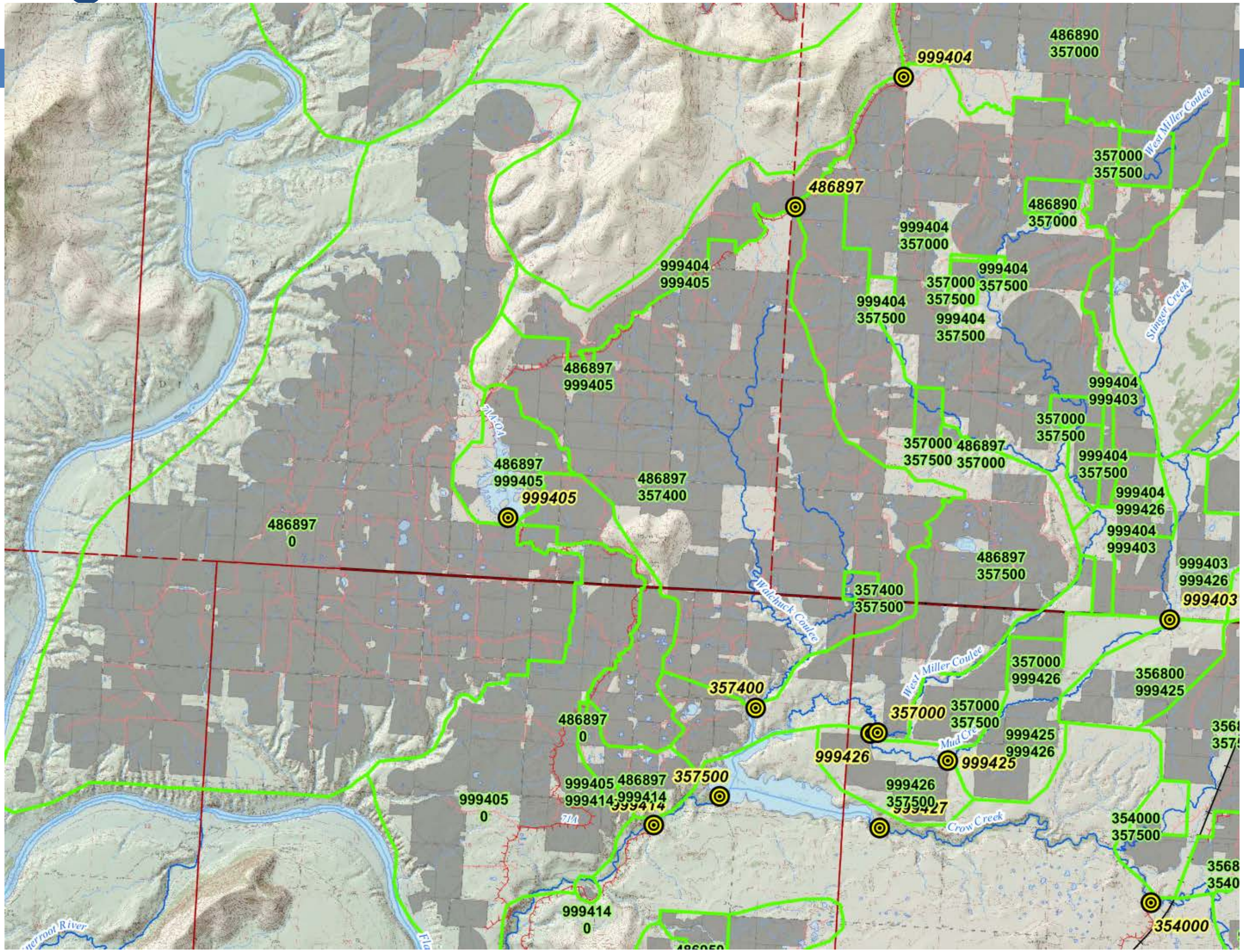
Irrigation Service Areas



On-Farm Efficiencies

- Mapped sprinkler irrigation separately from flood irrigation

- On-farm efficiencies represent existing irrigation methods, soils, and water management

On-Farm Efficiencies in Percent

	Type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
High	Flood (High)	40	40	40	40	40	45	45	50	50	45	40	40
	Sprinkler (High)	65	65	65	65	70	75	75	80	80	75	70	70
Low	Flood (Low)	35	35	35	35	35	40	40	45	45	40	35	35
	Sprinkler (Low)	60	60	60	60	65	70	70	75	75	70	65	65

Generally outside of irrigation season and not used.

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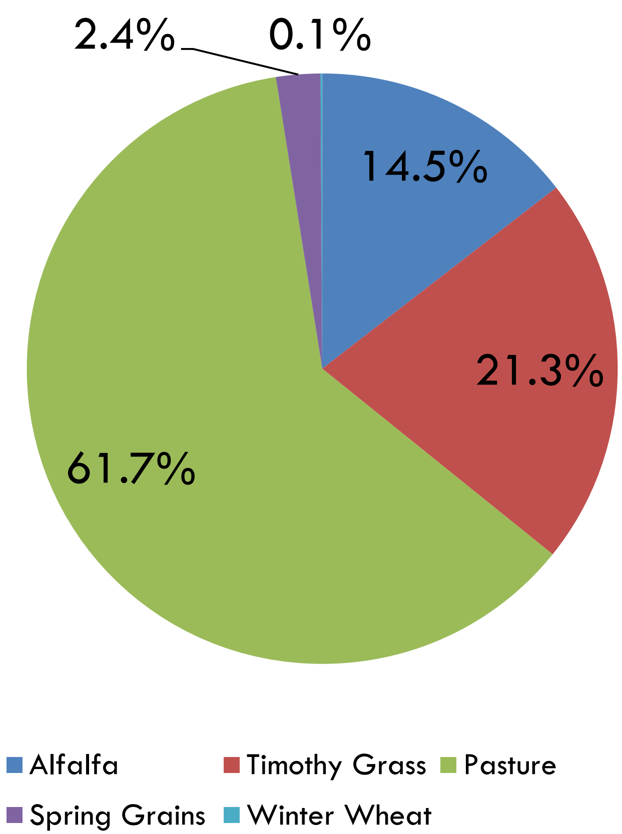
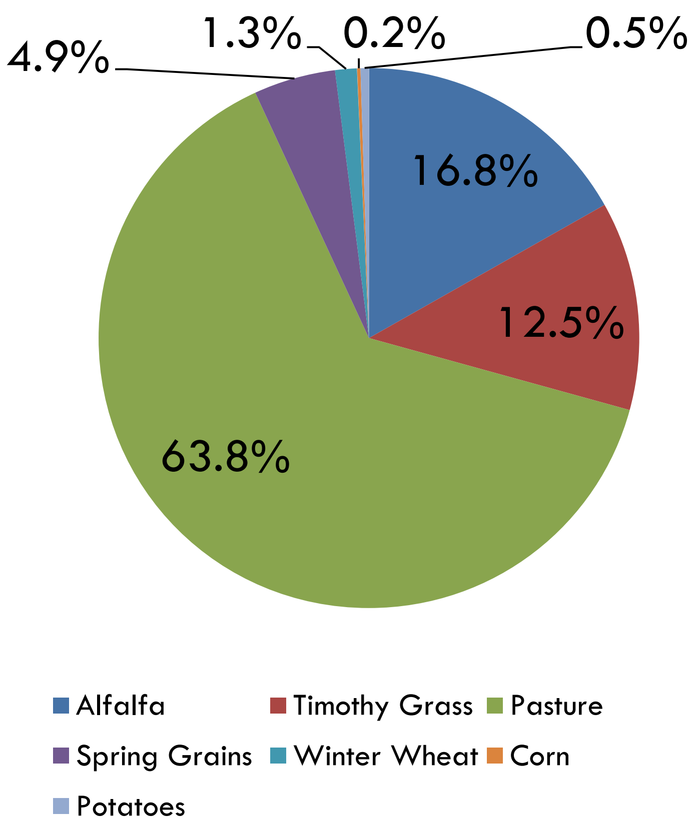
Crop Distribution

Jocko Cropping Pattern

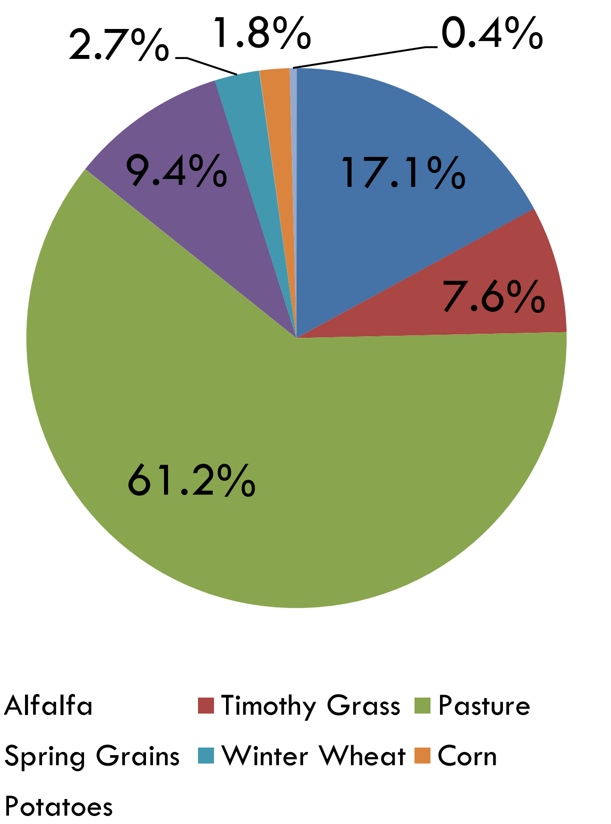


Mission Cropping Pattern

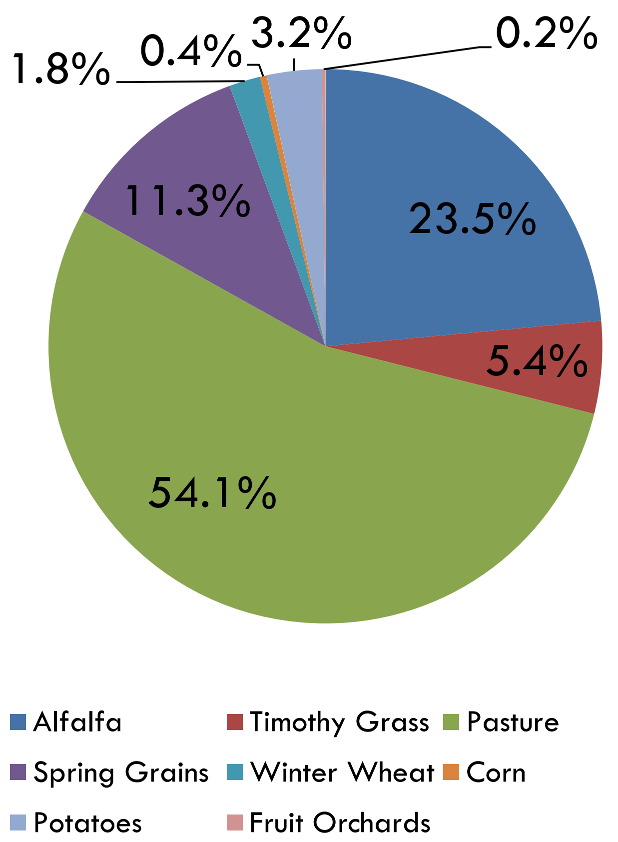


Crop Distribution

Post Division Cropping Pattern

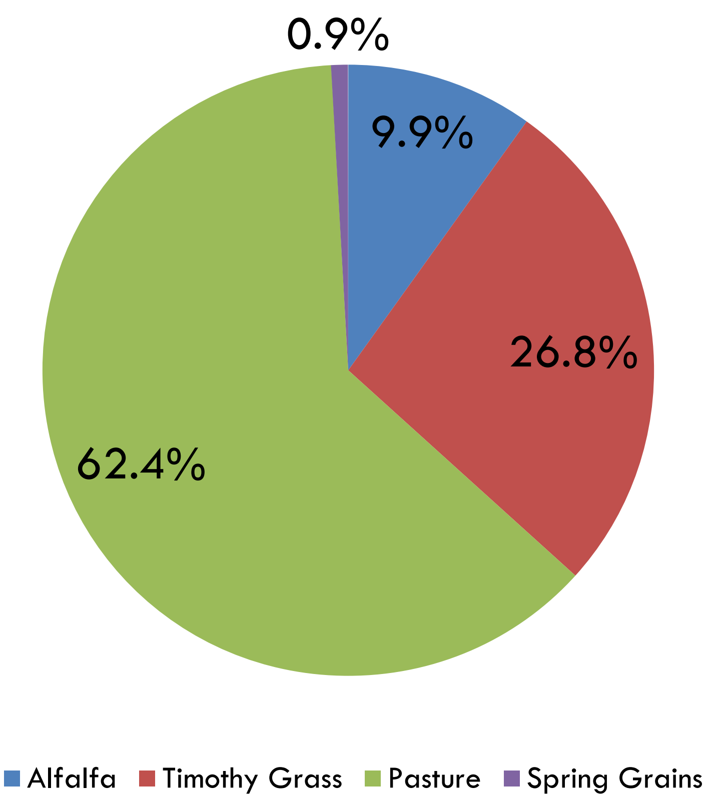


Pablo Division Cropping Pattern



Crop Distribution

Little Bitterroot Cropping Pattern



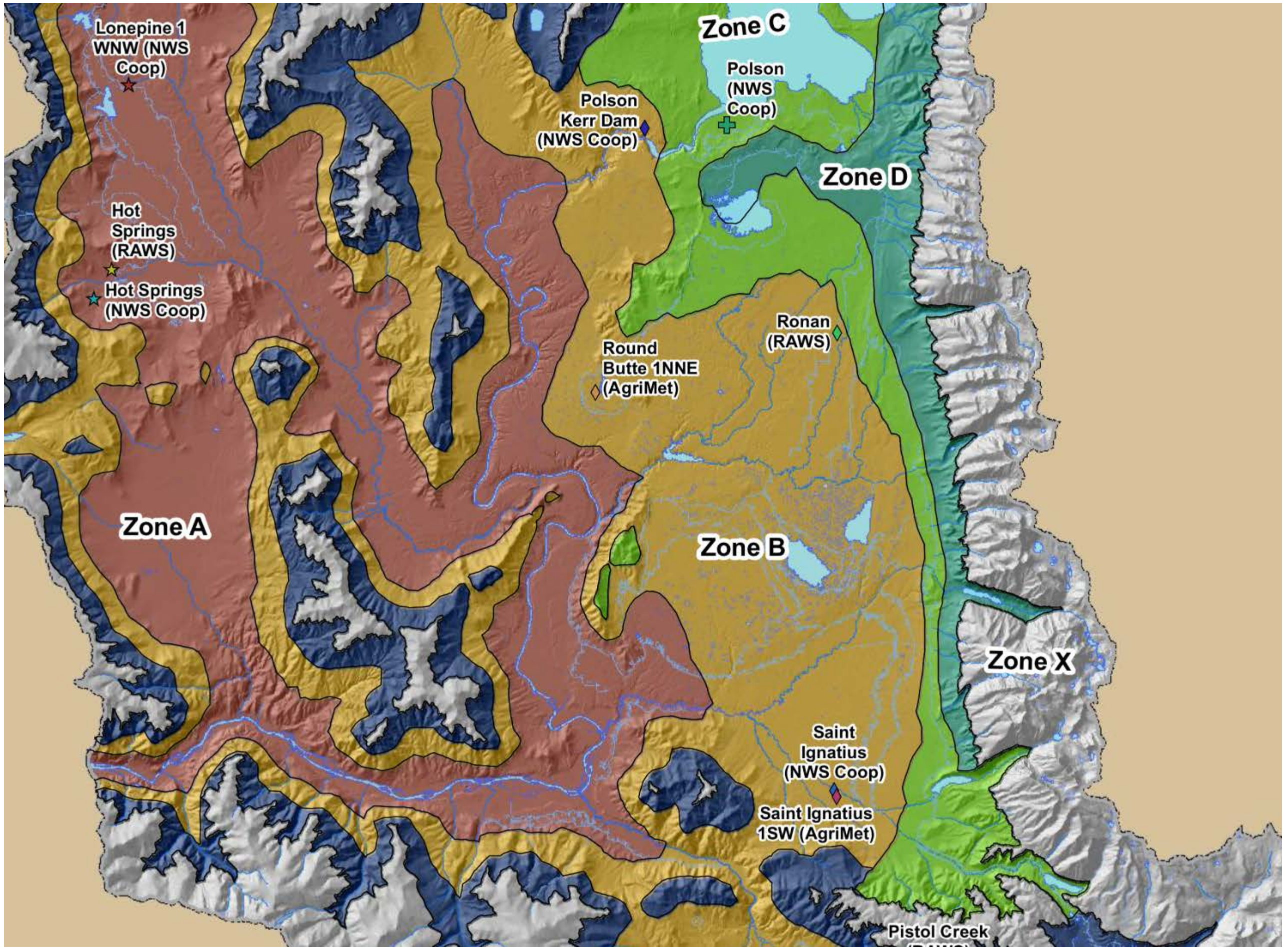
Crop Water Requirements
Climatic Data

- Regional NWS Stations: Missoula and Kalispell
- USBR AgriMet Stations: St. Ignatius and Round Butte
- BLM/USFS RAWS Stations: Jette, Hot Springs, Ronan, Pistol Creek, Point 6, and Plains
- NWS Coop Stations: Bigfork 13 S, Polson, Polson Kerr Dam, St. Ignatius, Lonepine, and Hot Springs

Crop Water Requirements
Climatic Zones

- Utilized Climate work by Oregon State University as a tool in delineating climatic zones
  - Utilizes average monthly maximum and minimum temperature and precipitation normals (1971 – 2000) for each 800 x 800-meter grid cell across the Reservation
  - Assigned local climatic stations to represent each climatic zone

Climatic Zones



1990's Irrigated Acreage by Model Area and Climatic Zone

Model Area	Zone A	Zone B	Zone C	Zone D	Zone E	Total
Jocko	2,529	14,750	0	0	100	**17,379**
Little Bitterroot	23,295	103	0	0	0	**23,397**
Mission: Mission	570	20,877	4,417	4	0	**25,869**
Mission: Pablo	6,720	37,753	14,215	3,670	0	**62,358**
Mission: Post	11,673	24,695	469	6	0	**36,843**
Unmodeled	5,328	902	1,585	369	66	**8,248**
Total	**50,115**	**99,079**	**20,686**	**4,047**	**166**	**174,094**

Note: includes active and idle and Project and Private irrigation

Definitions

- **Potential Evapotranspiration (ET)**
  - Consists of three components:
    - Water evaporated from the soil surface,
    - Water intercepted by the plants, and
    - Water transpired by the plants
  - Assumes full water supply and ideal water management
- **Effective Precipitation (Pe)**
  - Precipitation used to offset crop water requirements
- **Net Irrigation Requirement (NIR)**
  - Irrigation water required to fully meet the maximum potential crop consumption (ET – Pe)
- **Crop Irrigation Consumption (CIC)**
  - Irrigation water consumed by the crop
  - Typically less than NIR due to less than perfect water management and less than full water supply

Crop Evapotranspiration (ET) in inches (1983 – 2002) [April – October]

Crop	Zone A	Zone B	Zone C	Zone D	Zone E
Alfalfa Hay	23.71	23.24	23.58	22.71	24.59
Timothy Grass Hay	23.82	23.21	23.28	22.08	24.17
Pasture Grass	22.12	21.37	21.21	19.88	21.99
Winter Wheat	21.78	20.62	20.06	18.49	20.66
Spring Grains	17.47	16.55	17.05	14.82	16.54
Corn (Grain)	24.04	22.83	22.09	20.33	22.83
Corn (Silage)	23.66	22.47	21.74	19.99	22.47
Potatoes	25.06	23.79	22.98	21.19	23.79
Fruit Orchards	30.03	29.38	29.65	27.65	30.77

Comparison of Alfalfa ET Estimates

Weather Station	DNRC Flood/ Wheeline/ Handline ET (inches)	DNRC Center Pivot ET (inches)	DOWL HKM ET (inches)
Bigfork	17.37	20.61	22.71
Polson	20.46	23.23	23.58
Polson Kerr Dam	21.37	24.08	24.23
St. Ignatius (NWS)	19.53	22.33	22.96
St. Ignatius			23.90
Round Butte			22.44
Hot Springs			23.42

DNRC values taken from NRCS Irrigation Water Requirements (IWR) software results obtained from the Montana Rule 36.12.1902 (Change Application – Historic Use)

Optimum July Net Irrigation Requirement (NIR) for Alfalfa in inches (1983 – 2002)

Zone	Station	Elevation (Ft)	Average July Alfalfa ET	Average July Effective Precip.	Average July Alfalfa NIR
A	Hot Springs	2780	6.56	1.06	5.50
A	Hot Springs (RAWS)	2960	6.36	1.01	5.35
A	Lonepine	2880	6.16	0.58	5.58
A	Plains (RAWS)	2400	6.58	0.98	5.60
B	Ronan (RAWS)	3060	6.00	1.42	4.58
B	Round Butte (AgriMET)	3040	5.94	1.04	4.90
B	Polson Kerr Dam	2730	6.13	1.36	4.77
B	St. Ignatius	2900	6.35	1.43	4.91
B	St. Ignatius (AgriMET)	2990	6.09	1.40	4.69
C	Polson	2990	5.93	1.15	4.77
D	Bigfork	2910	5.43	1.80	3.63
E	Jette	3600	6.10	1.32	4.78

Optimum Net Irrigation Requirement (NIR) for Alfalfa in inches (1983 – 2002)

Zone	Station	Elevation (Ft)	Average Apr-Oct Alfalfa ET	Average Apr-Oct Precip.	Average Apr-Oct Effective Precip.	Average Apr-Oct Alfalfa NIR by Station	Average Apr-Oct Alfalfa NIR by Zone
A	Hot Springs	2780	23.42	8.15	7.35	16.07	16.73
A	Hot Springs (RAWS)	2960	24.54	7.56	6.97	17.58	
A	Lonepine	2880	21.43	7.24	6.20	15.23	
A	Plains (RAWS)	2400	25.46	7.72	7.40	18.05	
B	Ronan (RAWS)	3060	22.64	10.89	9.24	13.40	14.07
B	Round Butte (AgriMET)	3040	22.44	9.71	8.39	14.06	
B	Polson Kerr Dam	2730	24.23	10.61	9.48	14.75	
B	St. Ignatius	2900	22.96	11.62	9.13	13.83	
B	St. Ignatius (AgriMET)	2990	23.90	10.82	9.61	14.30	
C	Polson	2990	23.58	10.68	9.49	14.08	14.08
D	Bigfork	2910	22.71	14.57	12.01	10.70	10.70
E	Jette	3600	24.59	11.82	10.40	14.19	14.19

Optimum Net Irrigation Requirement (NIR) in inches by Crop and Climatic Zone (1983 – 2002) [Apr – Oct]

Crop	Zone A	Zone B	Zone C	Zone D	Zone E
Alfalfa Hay	16.73	14.07	14.08	10.70	14.19
Timothy Grass Hay	16.53	13.65	13.57	10.01	13.61
Pasture Grass	14.80	11.58	11.34	7.86	11.28
Winter Wheat	16.32	13.01	12.62	8.71	12.51
Spring Grains	12.11	9.75	9.53	6.87	9.45
Corn (Grain)	18.10	15.25	14.61	11.31	14.77
Corn (Silage)	18.08	15.21	14.57	11.29	14.74
Potatoes	18.76	15.45	14.79	11.31	14.97
Fruit Orchards	22.69	19.43	19.50	14.95	19.63

Optimum Net Irrigation Requirement by Model Area and Climatic Zone (1983 – 2002) [April – October]

Model Area	Zone A	Zone B	Zone C	Zone D	Zone E	Area Wtd. Avg.
Jocko	15.38	12.34	12.18	8.71	12.16	**12.78**
Little Bitterroot	15.43	12.37	12.20	8.71	12.18	**15.42**
Mission: Mission	15.25	12.21	12.03	8.59	12.01	**12.25**
Mission: Pablo	15.22	12.25	12.07	8.69	12.05	**12.32**
Mission: Post	15.12	12.11	11.91	8.51	11.89	**13.06**

Note: includes active and idle and Project and Private irrigation

Water Accounting Models

- ✓ 1983 – 2002 Study Period (240 months of data)
- ✓ Model Structure
- ✓ Key Model Inputs
  - ✓ Natural Flows
  - ✓ Irrigated Lands Mapping
  - ✓ FIIP Irrigation System Configuration
    - Canal Capacities
    - Canal Losses
    - Irrigation Service Areas
  - ✓ Crop Water Requirements
- ☐ **Results of Water Accounting Model**
- ☐ Calibration and Other Reasonableness Checks
- ☐ Water Available through FIIP Operational Improvements

Overall Water Budget - Jocko Model Area 1983 – 2002

Parameter	Average Annual Volume (Ac-Ft)
Inflows (Runoff)	198,250
Inflows (Natural GW)	22,502
Imports (Placid Canal)	6,055
Depletions	14,970
Crop Consumption	8,997
Diversion Losses to Basin	5,630
Reach Losses to Basin	223
Evaporation	121
Exports (Tabor Feeder Canal)	27,701
Change in Storage	36
Outflow	184,100
Water Balance	**0 (0.0%)**

Overall Water Budget - Mission Model Area 1983 – 2002

Parameter	Average Annual Volume (Ac-Ft)
Inflows (Runoff)	215,184
Inflows (Natural GW)	34,619
Imports (Tabor Feeder & Flathead Pump Canals)	53,192
Change in Storage	480
Depletions	131,711
Crop Consumption	78,393
Diversion Losses to Basin	35,676
Reach Losses to Basin	12,185
Evaporation	5,458
Outflow	171,764
Water Balance	**0 (0.0%)**

Overall Water Budget - Little Bitterroot Model Area - 1983 – 2002

Parameter	Average Annual Volume (Ac-Ft)
Inflows (Runoff)	39,124
Inflows (Valley Floor Snowmelt Runoff)	6,669
Imports (Alder & McGinnis Ditches)	3,038
Change in Storage	540
Depletions	18,066
Crop Consumption	11,797
Diversion Losses to Basin	628
Reach Losses to Basin	114
Evaporation	5,526
Outflow	31,306
Water Balance	**0 (0.0%)**

Water Accounting Models

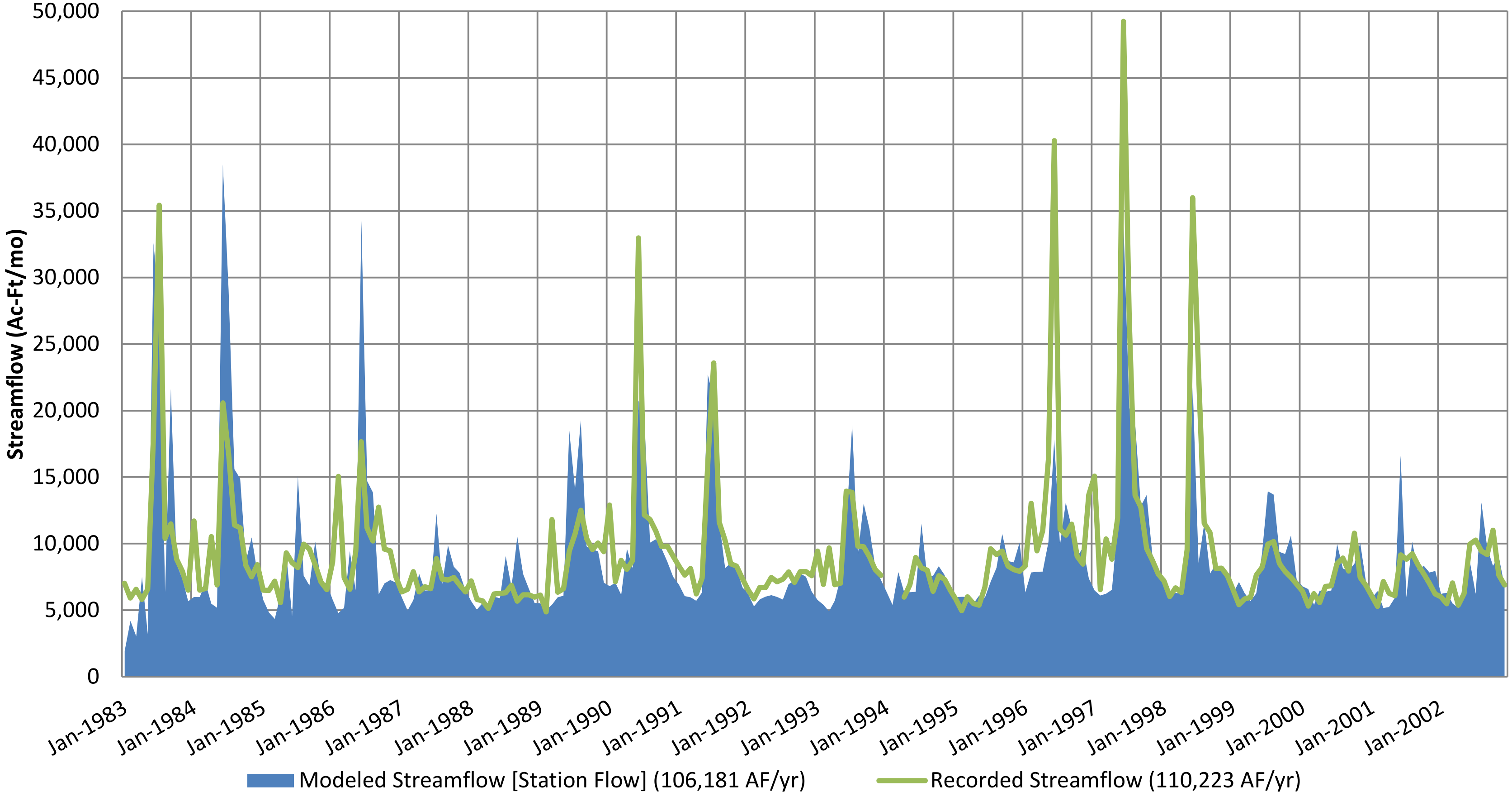
- ✓ 1983 – 2002 Study Period (240 months of data)
- ✓ Model Structure
- ✓ Key Model Inputs
  - ✓ Natural Flows
  - ✓ Irrigated Lands Mapping
  - ✓ FIIP Irrigation System Configuration
    - ✓ Canal Capacities
    - ✓ Canal Losses
    - ✓ Irrigation Service Areas
  - ✓ Crop Water Requirements
- ✓ Results of Water Accounting Model
- □ **Calibration and Other Reasonableness Checks**
- □ Water Available through FIIP Operational Improvements

Calibration and Other Reasonableness Checks

- Calibrated to Historic records
  - Streamflow (36 sites)
  - Diversions (47 sites)
  - Ditch Tailwater (5 sites)
  - Reservoir Storage (14 sites)
- Canal seepage study from DNRC
- Stream seepage runs from CSKT
- Crop Irrigation Consumption
  - Water Budget checks based on Canal Diversion Records
  - DNRC County Management Factor
  - DNRC METRIC study of actual Crop Water Use in 2006-2008
- S.S. Papadopulos & Associates (SSPA) Ground Water Modeling Work

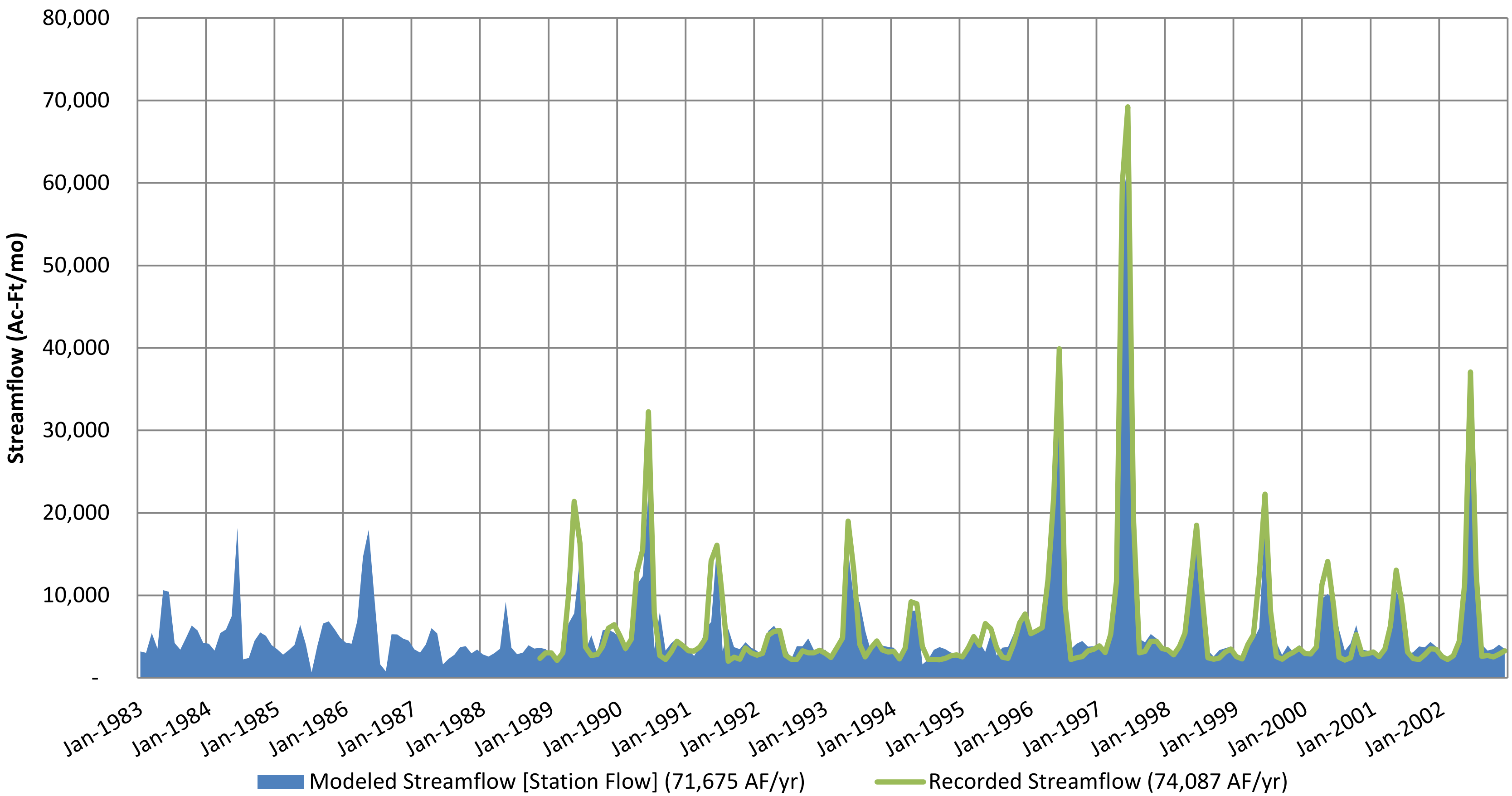
Mission Creek at Bison Range at Moiese

Gage #4895.00 (Model Node #999412)



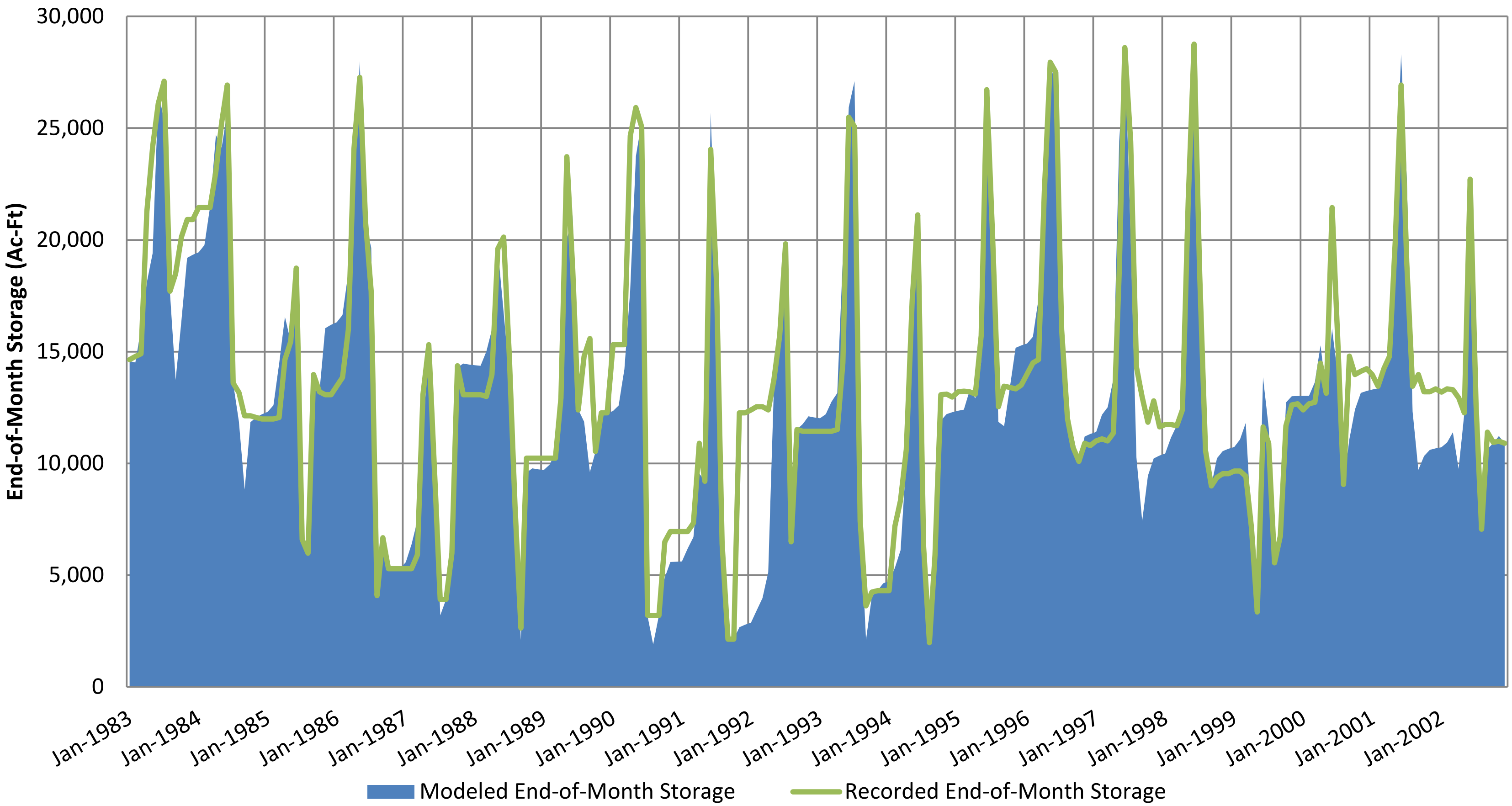
Jocko River below Jocko K Canal

Gage #5149.00 (Model Node #999507)



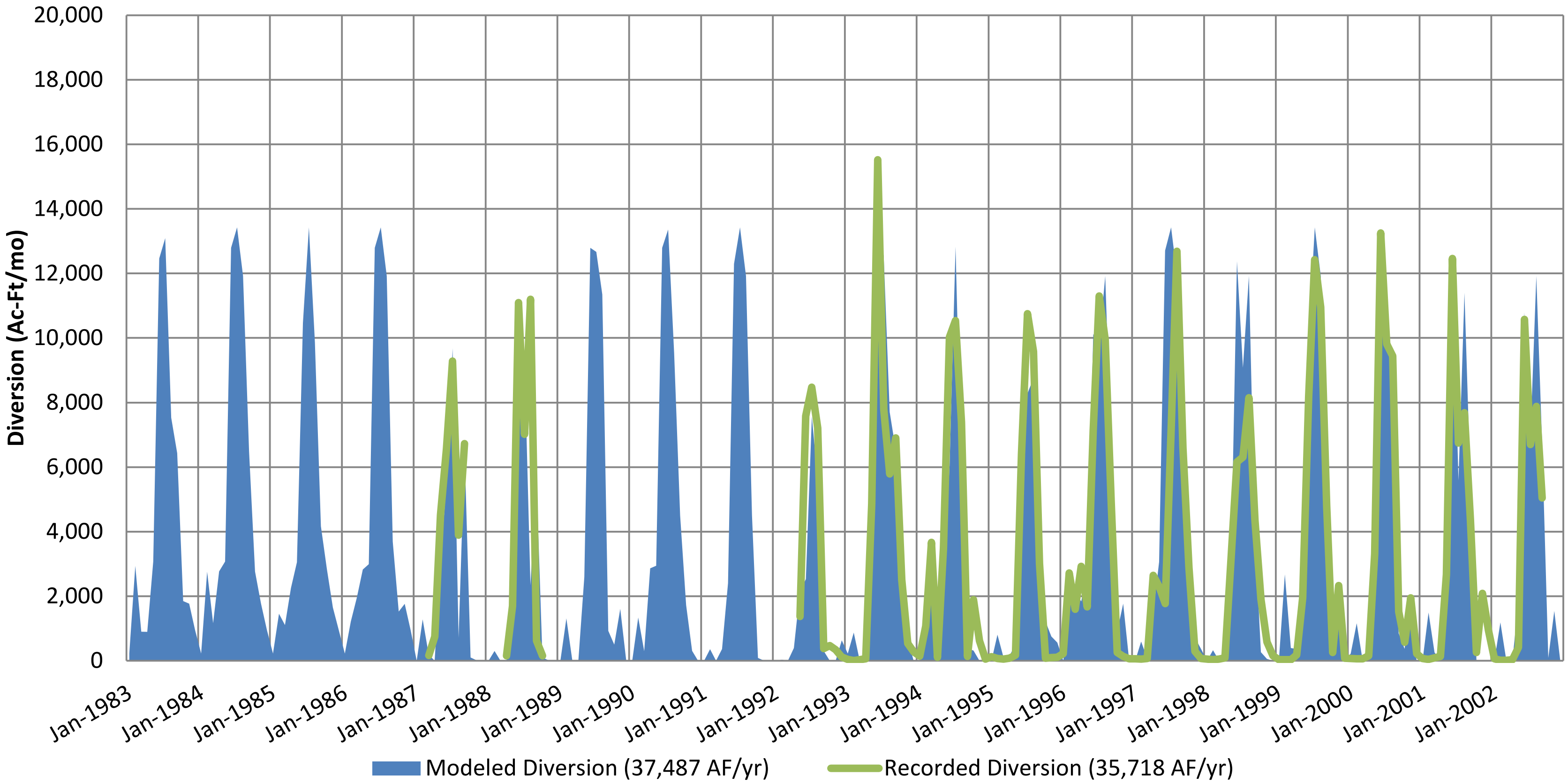
Pablo Reservoir

Gage #Pablo (Model Node #486890)



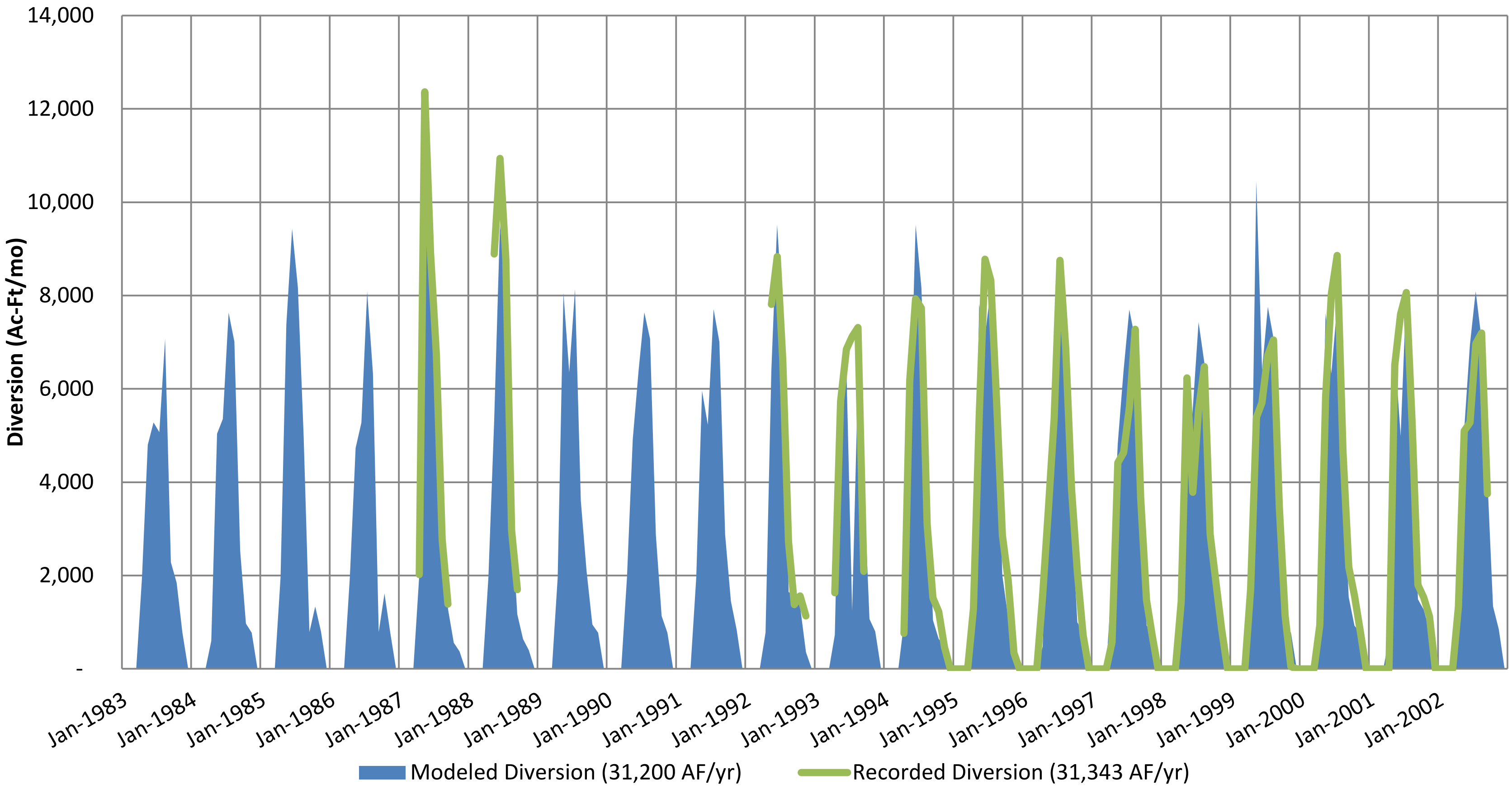
Mission A Canal below Headworks

Gage #4814.10 (Model Node #481500)



Jocko K Canal below Headworks

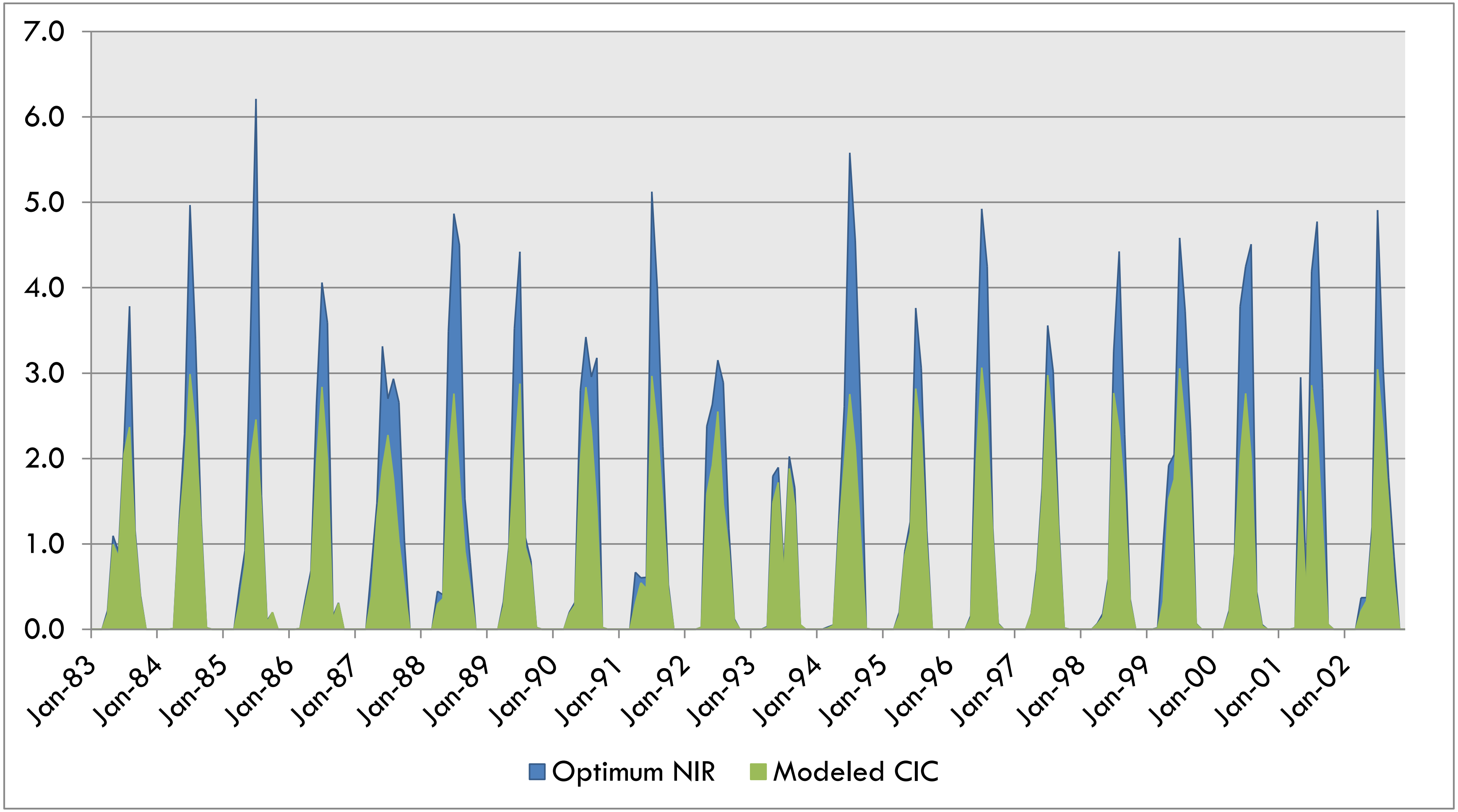
Gage #5140.00 (Model Node #999507)



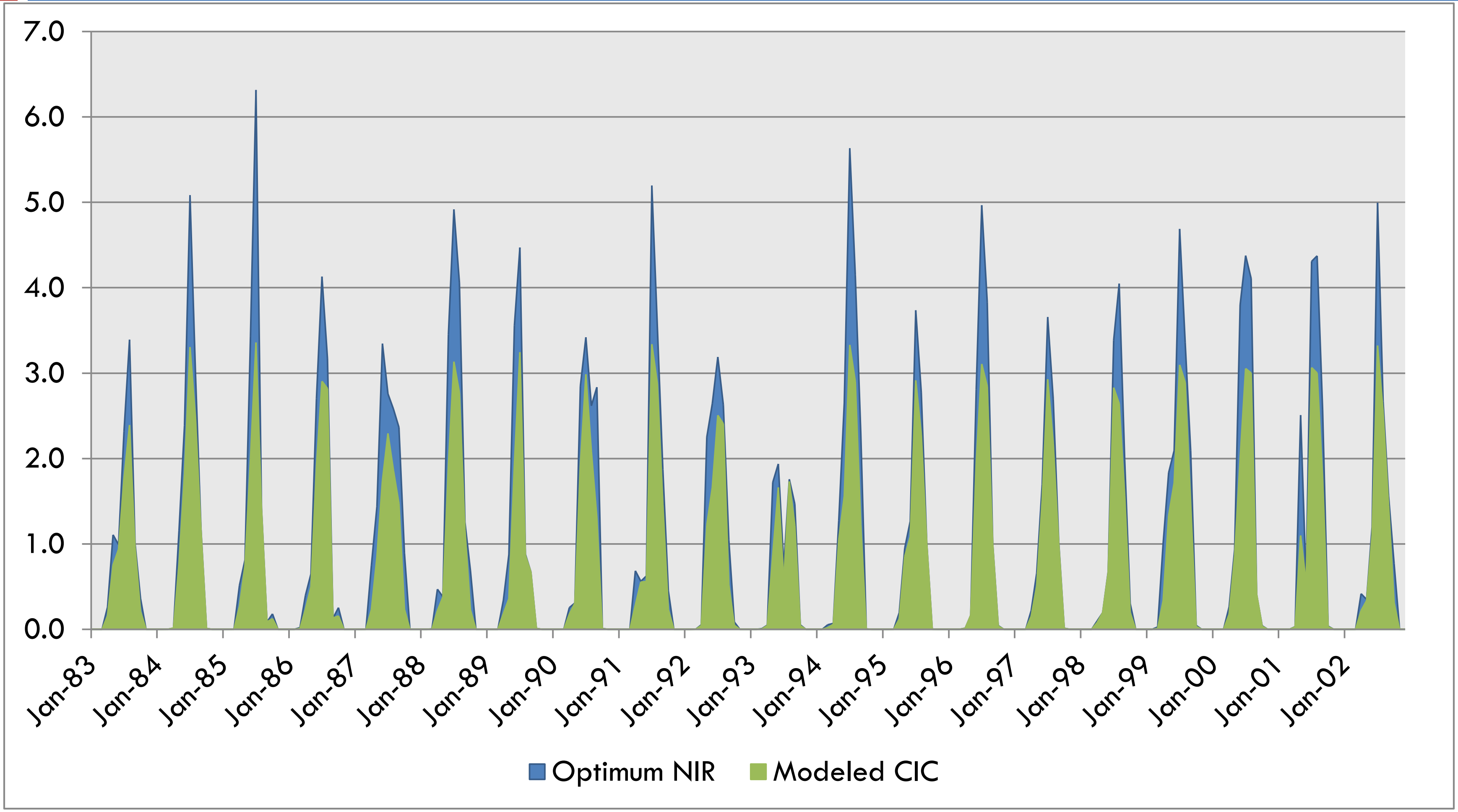
Crop Irrigation Consumption (CIC)

- FIIP is not a full water supply project and irrigation water management is generally less than perfect, as is typical for many irrigation projects
  - *"Using the data thus obtained for average flows and applying the needs of the better quality lands on the basis of the duty of water as determined in this investigation, it was found that existing supplies will provide only enough water to irrigate 120,000 acres, assuming good management by the project and optimum use of water by farm operators." (Walker Report, 1946)*
    - Active Irrigation across the Reservation now totals 144,900 acres (123,300 acres in FIIP alone)
    - The Walker Report also gave no consideration to leaving any water in the streams for ecological purposes
  - *"Most local irrigators do not have sufficient irrigation water available to satisfy crop water needs and are therefore practicing deficit irrigation." (Land and Water Consulting, 1994)*
    - Table 2 of that report indicates that existing crop consumption is roughly 70% of optimum
- These findings are consistent with the findings from our Water Budget Modeling

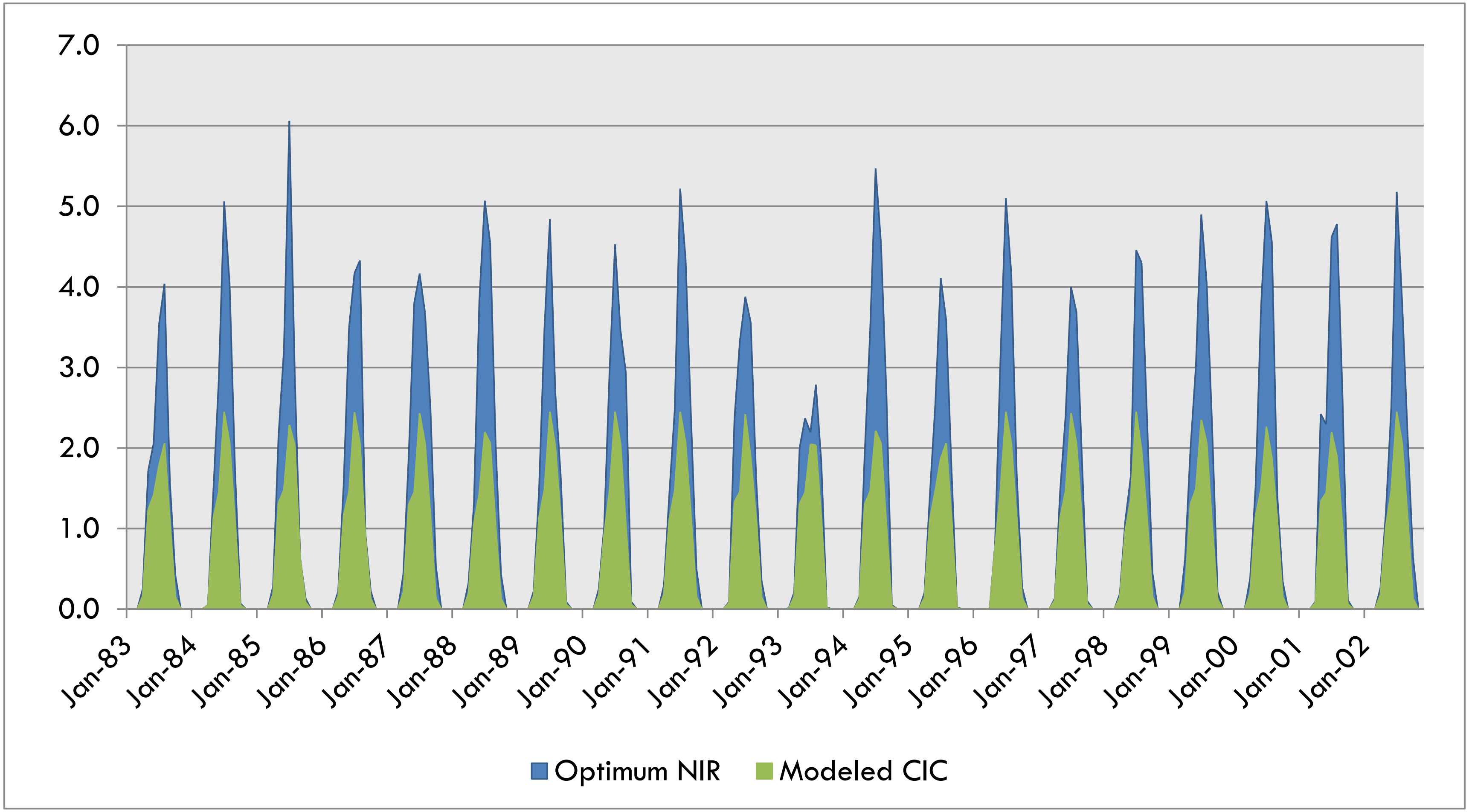
Optimum NIR vs. Crop Irrigation Consumption (Inches per Acre per Month) - Jocko



Optimum NIR vs. Crop Irrigation Consumption (Inches per Acre per Month) - Mission



Optimum NIR vs. Crop Irrigation Consumption (Inches per Acre per Month) – Little Bitterroot



Recorded Diversions (1983 – 2002)

Diversion	Average Stream Diversion Volume	1990's Acres	Stream Diversion Ac-Ft/Acre
Camas A Canal near Niarada (3111.00)	16,931	13,069	1.30
Camas B Canal @ Headworks above Lower Dry Fork Reservoir (3176.10)	7,936	6,449	1.23
Camas C Canal @ Headworks below Lower Dry Fork Reservoir (3177.10)	6,096	5,734	1.06
Mission F Canal @ Headworks (4829.00)	3,992	1,980	2.02
Mission B Canal near Headworks (4827.10)	3,674	3,214	1.14
Mission C Canal (4829.10) + Mission 6C Canal (4831.50) near Headworks	9,256	7,540	1.23
Post F Canal near Headworks (4875.10)	4,265	4,362	0.98
Post G Canal @ Headworks below Kicking Horse Reservoir (4869.30)	3,771	2,289	1.65

Recorded Diversions (1983 – 2002)

Diversion	Average Stream Diversion Volume	1990's Acres	Stream Diversion Ac-Ft/Acre
Post C Canal @ Headworks below Ninepipe Reservoir (4869.60)	12,401	10,053	1.23
Post D Canal @ Headworks below Ninepipe Reservoir (4869.70)	7,210	5,243	1.38
Mission H Canal @ Headworks below Mission Creek (4892.50)	2,079	402	5.17
Ronan A Canal @ Headworks (4868.35)	2,206	1,581	1.40
Ronan B Canal @ Headworks (3567.10)	2,939	3,331	0.88
Pablo A Canal below Pablo Reservoir (4868.91)	50,807	37,741	1.35
Valley View Inflow from Pablo Reservoir (4868.95)	12,976	9,150	1.42
Pablo A Canal @ Round Butte Weir (4868.97)	28,410	19,273	1.47
Moiese A Canal @ Headworks (3585.00)	15,078	6,482	2.33
Twin Feeder Canal below Centipede Creek (66.00)	1,588	1,182	1.34
Polson D Canal @ Headworks below Twin Reservoir (78.10)	1,320	935	1.41

Crop Irrigation Consumption (CIC)

- The Montana DNRC in their Water Right rules administered throughout the State similarly recognize that actual crop irrigation consumption is typically less than the potential maximum (Rule: 36.12.1902)

- The **County Management Factor (CMF)** provides an estimate of the proportion of historical crop irrigation use to potential ET

County	Lake	Sanders
CMF 1964-1973	55.0%	58.8%
CMF 1973-2006	69.2%	69.1%
CMF 1997-2006	68.7%	62.8%

County Management Factor (CMF) obtained from the Montana Rule 36.12.1902 (Change Application – Historic Use)

Crop Irrigation Consumption (CIC)

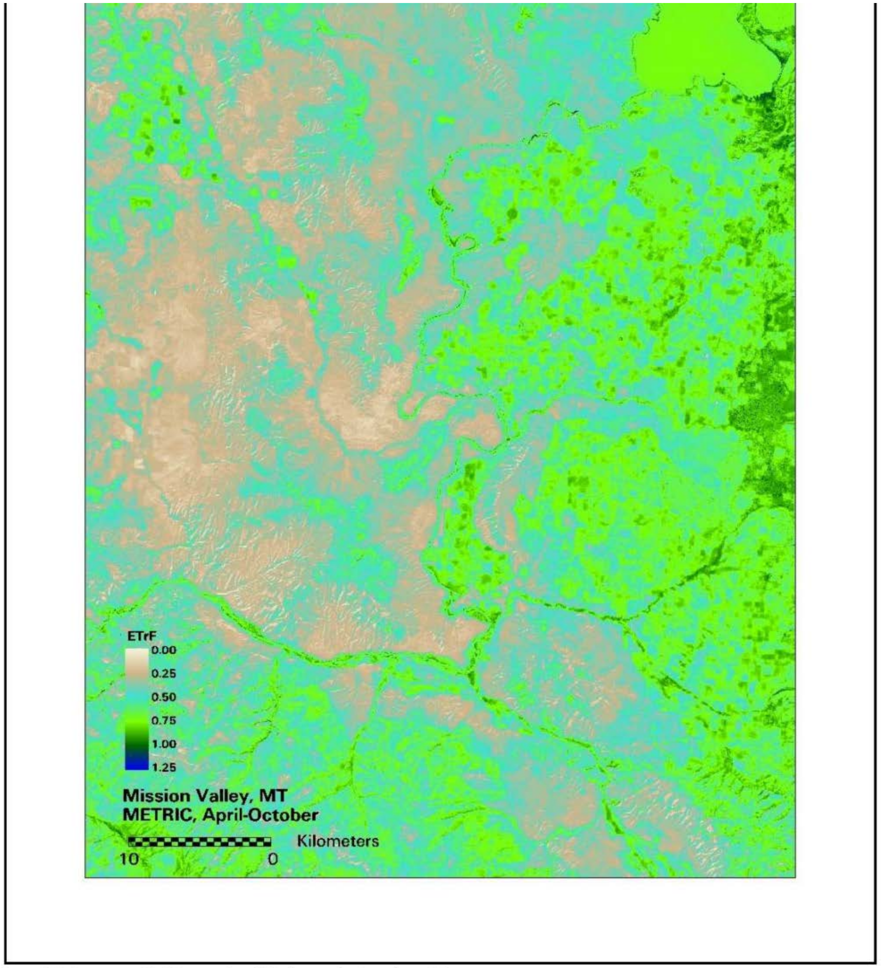
- Also confirmed by results from the METRIC study sponsored by Montana DNRC and performed by Dr. Richard Allen of the University of Idaho

  - METRIC uses the energy balance equation
    Evapotranspiration (ET) = Net Radiation – Soil Heat Flux – Heating of Air
    - Parameters are measured directly using Landsat imagery
      - Spectral reflectance
      - Thermal radiance
      - Vegetation Index
      - Net radiation
    - Applied in conjunction with Potential ET at ground stations to determine ratio of measured ET to potential maximum ET
    - Used Landsat Images from 2006, 2007 and 2008

  - DOWL HKM used this information as a cross-check against the Crop Irrigation Consumption (CIC) determined through the water budget calculations

Crop Irrigation Consumption (CIC)

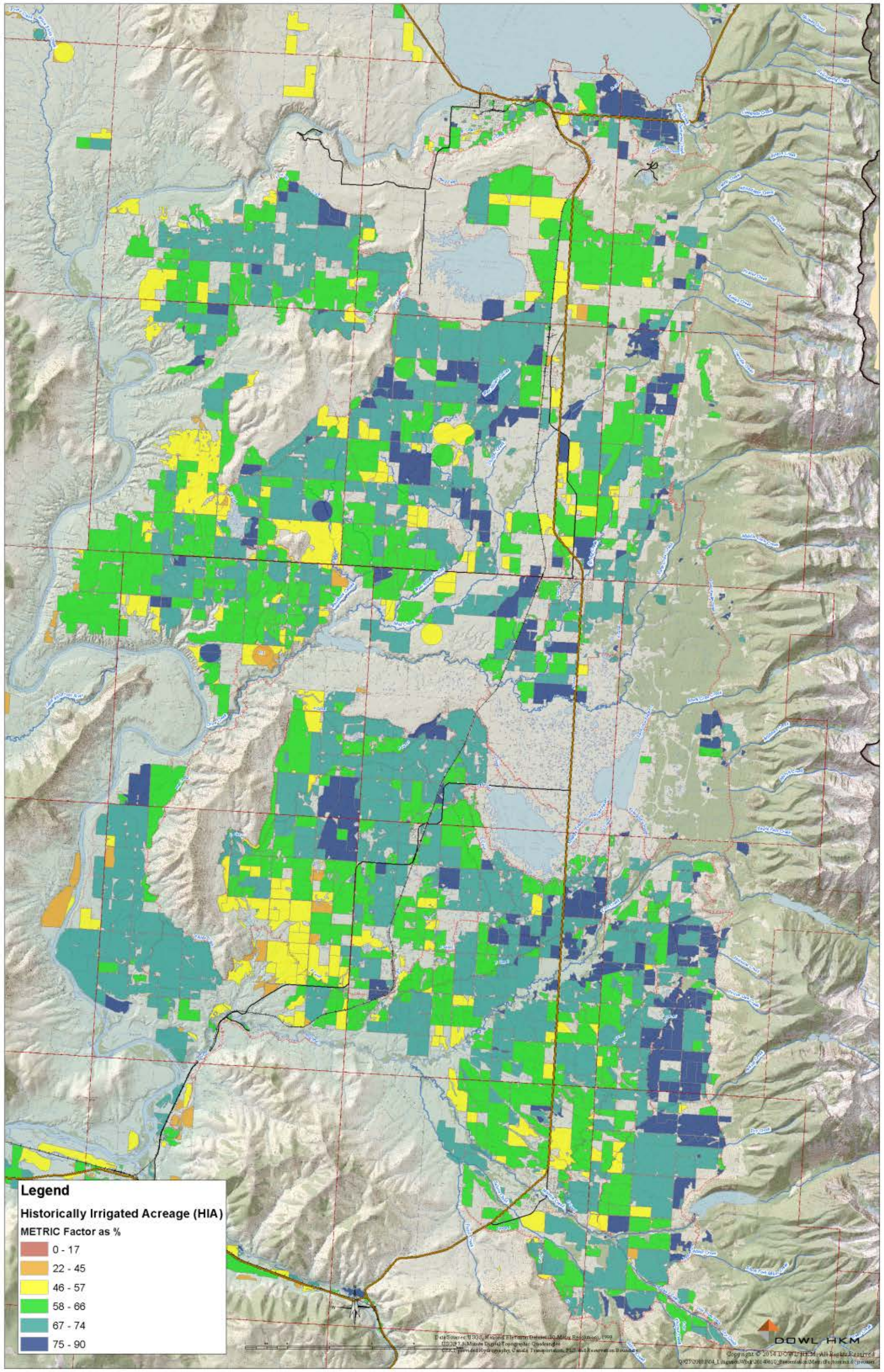
- Image taken from METRIC report shows the average seasonal METRIC Factor used to multiply against the Theoretical Crop ET in order to obtain Actual Crop ET



Panel 8. Average ET_rF over April 1 through October 31.

Crop Irrigation Consumption (CIC)

- Average Seasonal METRIC Factor for each Mapped Irrigation Parcel



Surface Water / Ground Water Modeling Coordination

- Surface Water Budget is also balanced with Groundwater Budget
- Elements from HYDROSS Models used by Ground Water modeler (SSPA)
  - Total Stream and Canal Inflows
  - Irrigated Acreage
  - Crop Water Use
  - Canal & Site Losses to Seepage
  - Reach / Diversion Loss to Seepage
  - Total Stream and Canal Outflows

Water Accounting Models

- ✓ 1983 – 2002 Study Period (240 months of data)
- ✓ Model Structure
- ✓ Key Model Inputs
  - ✓ Natural Flows
  - ✓ Irrigated Lands Mapping
  - ✓ FIIP Irrigation System Configuration
    - ✓ Canal Capacities
    - ✓ Canal Losses
    - ✓ Irrigation Service Areas
  - ✓ Crop Water Requirements
- ✓ Results of Water Accounting Model
- ✓ Calibration and Other Reasonableness Checks
- □ **Water Available through FIIP Operational Improvements**

Operational Improvements

- Objectives
  - Improve FIIP water distribution operations
    - Operate FIIP based on crop demands, with allowance for existing on-farm, lateral and canal inefficiencies and reasonable levels of operational waste
    - Maintain existing levels of FIIP Crop Irrigation Consumption (CIC)
    - Distribute water gained through operational improvements to enhance instream flows, as guided by Fishery objectives

Operational Improvements

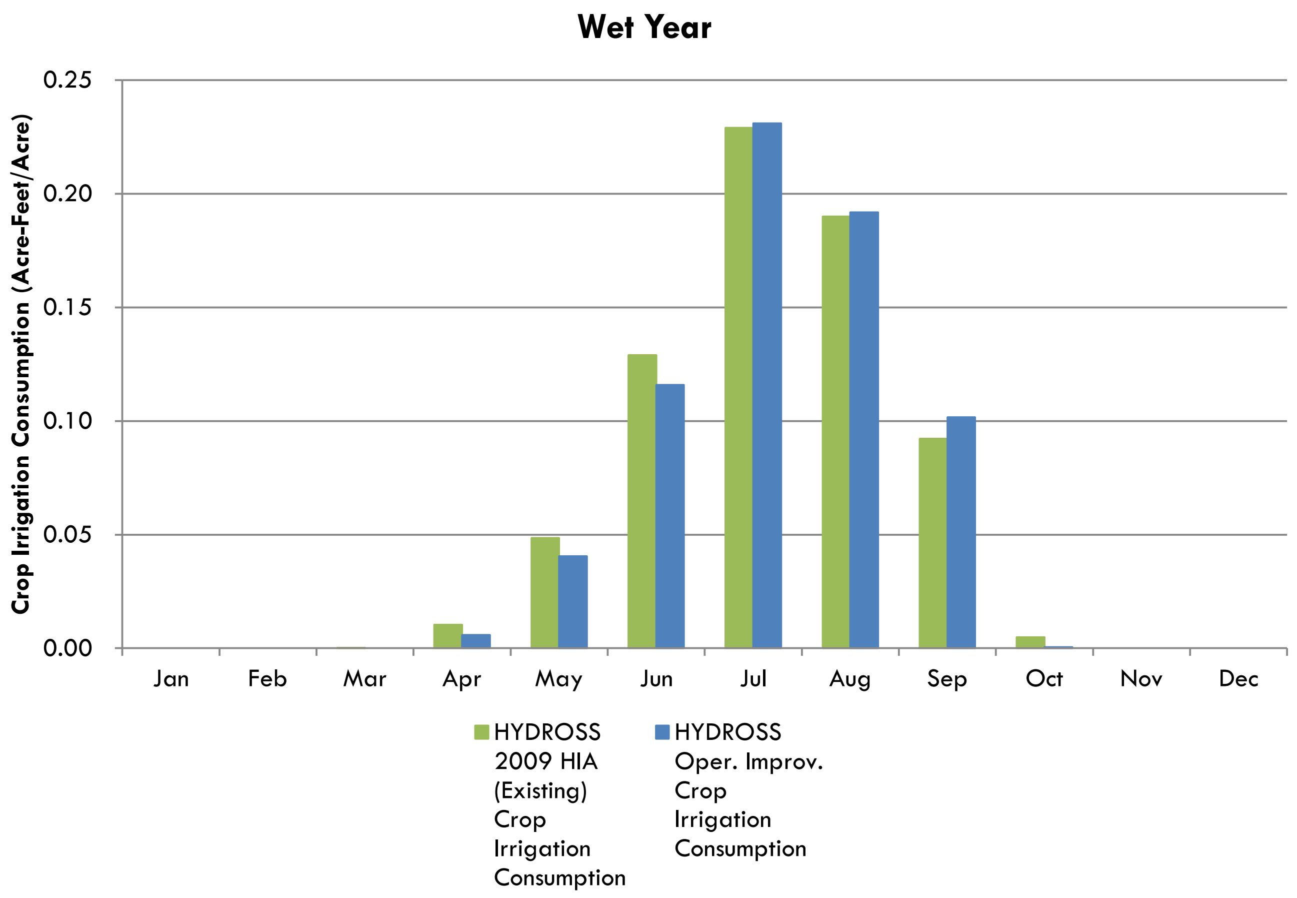
- Assumptions
  - Reduce or eliminate stockwater diversions in off-season months
  - Reduce or eliminate non-crop-based diversions
  - Reduce Tabor Feeder exports to Mission by 15% to enhance North Fork Jocko instream flows
  - Maintain existing levels of Area-wide (Jocko, Mission, and Little Bitterroot) farm turnout deliveries for dry, normal, and wet years, respectively

Operational Improvements

- Assumptions (cont.)
  - Establish Wet, Dry, and Normal years based on April through July natural streamflow, consistent with the anticipated spring/summer forecast period
  - Settlement funding will provide for installation of comprehensive water measurement network, water accounting system, and rehabilitation of key distribution structures to facilitate operational improvements

Total FIIP Crop Irrigation Consumption Mission

67% Sprinkler
33% Flood



Total FIIP Crop Irrigation Consumption Mission

67% Sprinkler
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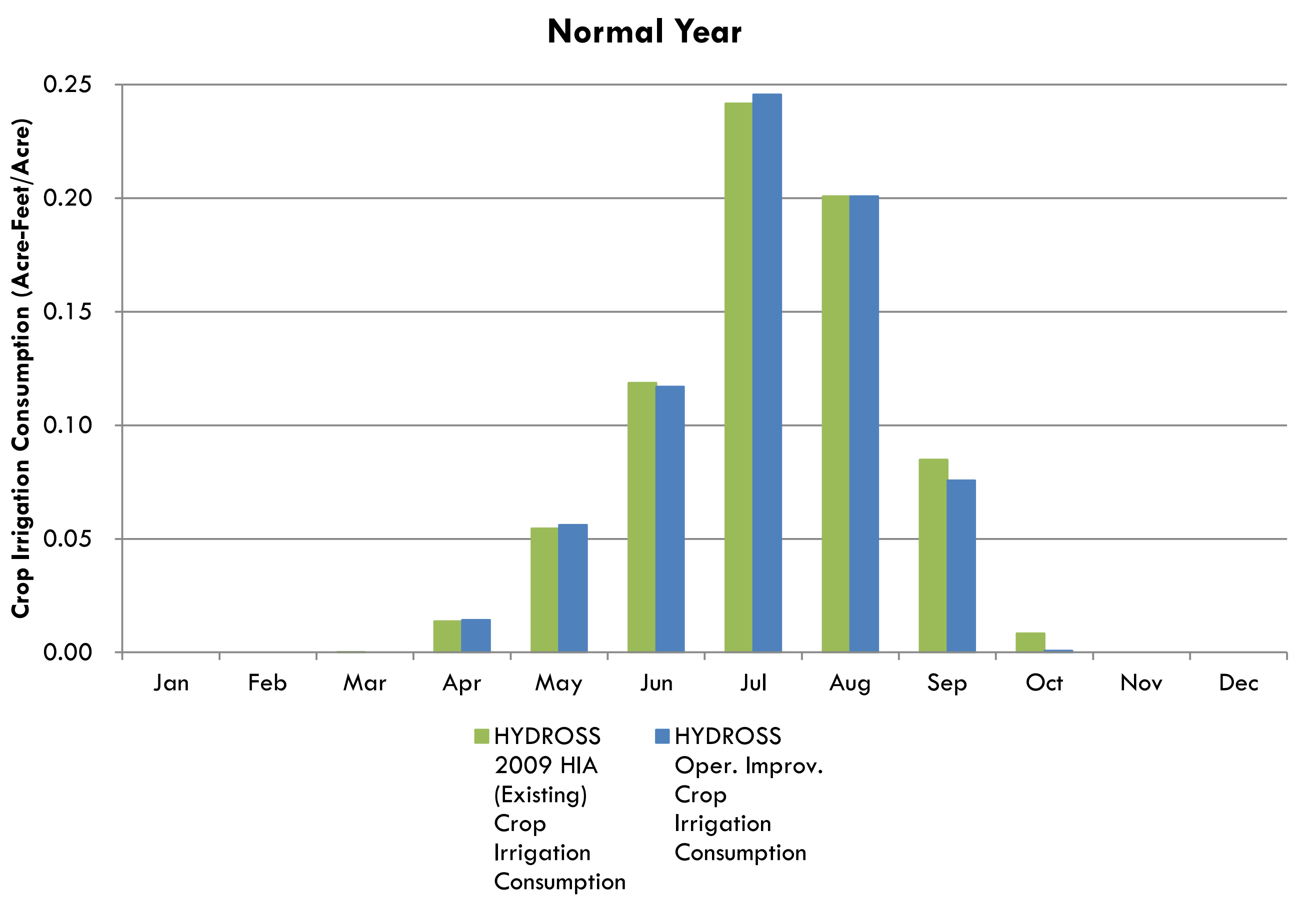
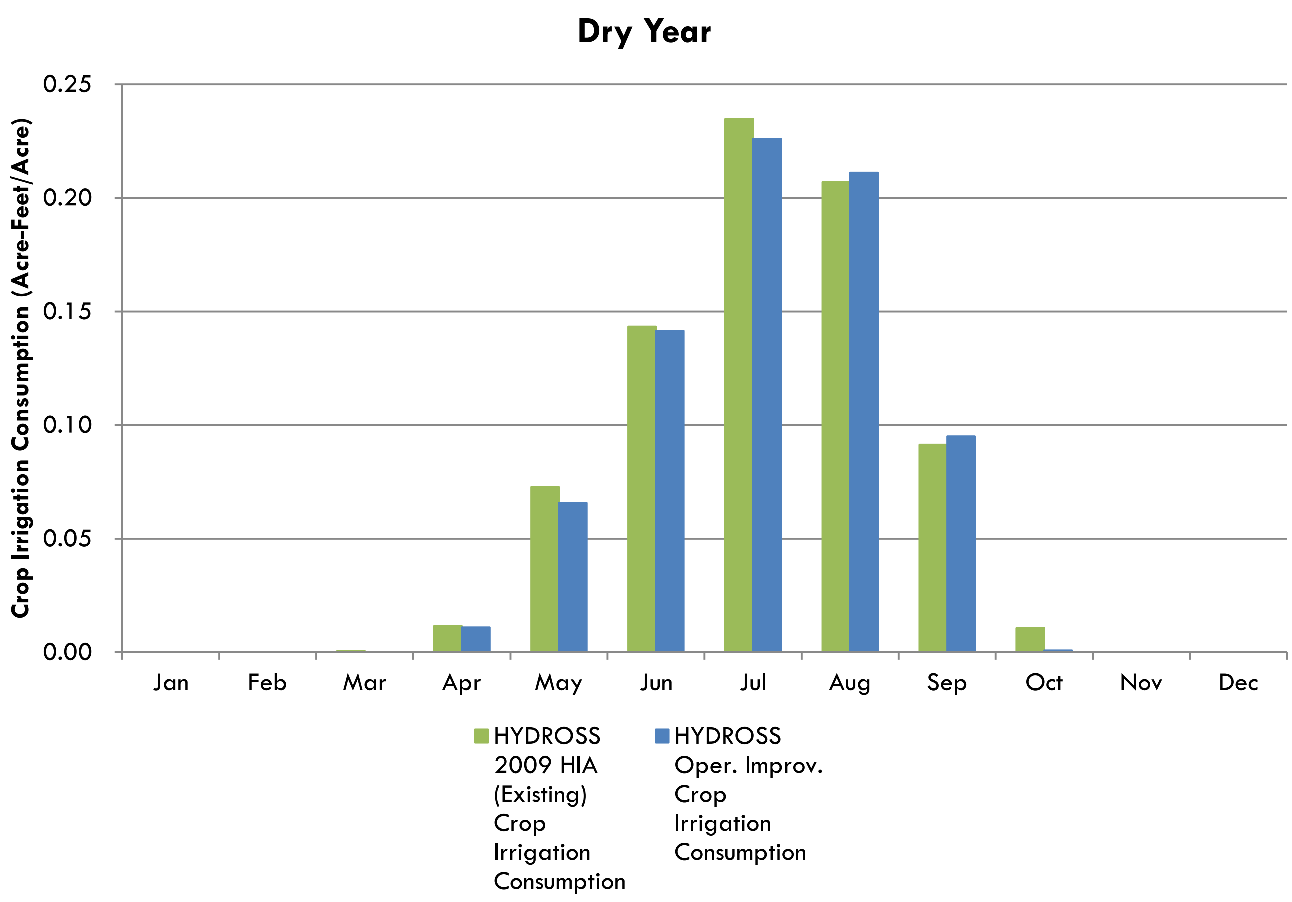


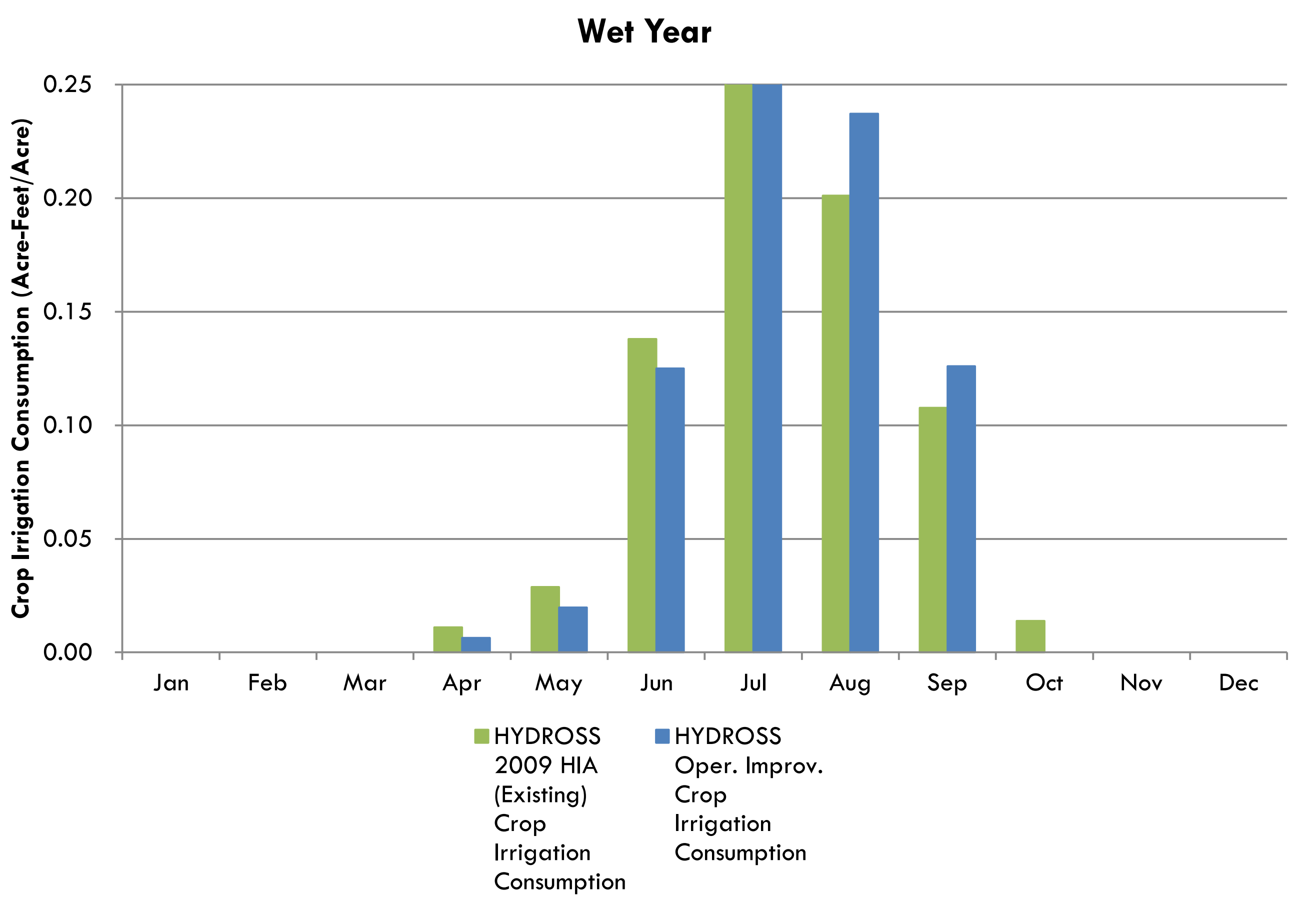
Total FIIP Crop Irrigation Consumption Mission

67% Sprinkler
33% Flood



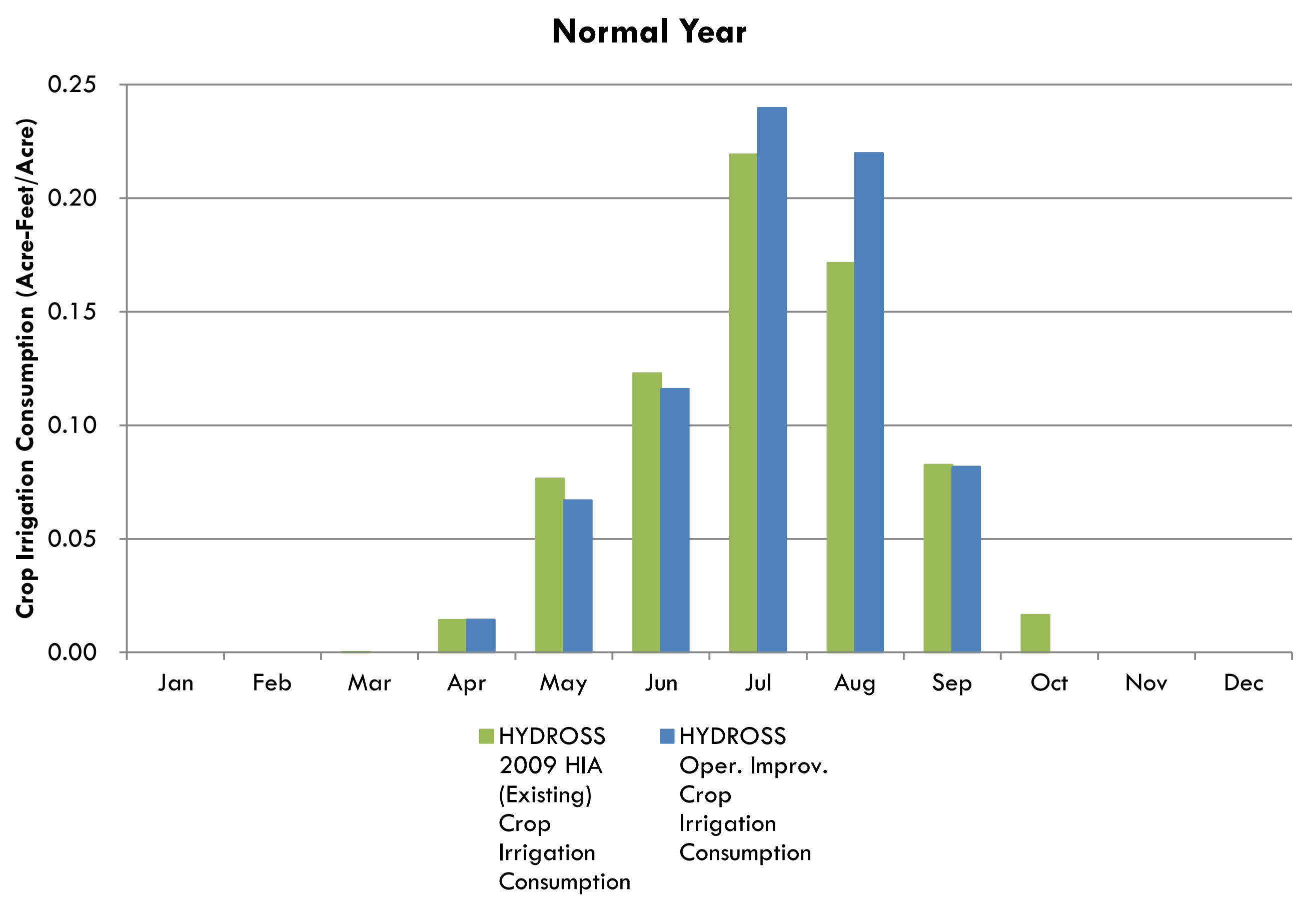
Total FIIP Crop Irrigation Consumption Jocko

58% Sprinkler
42% Flood



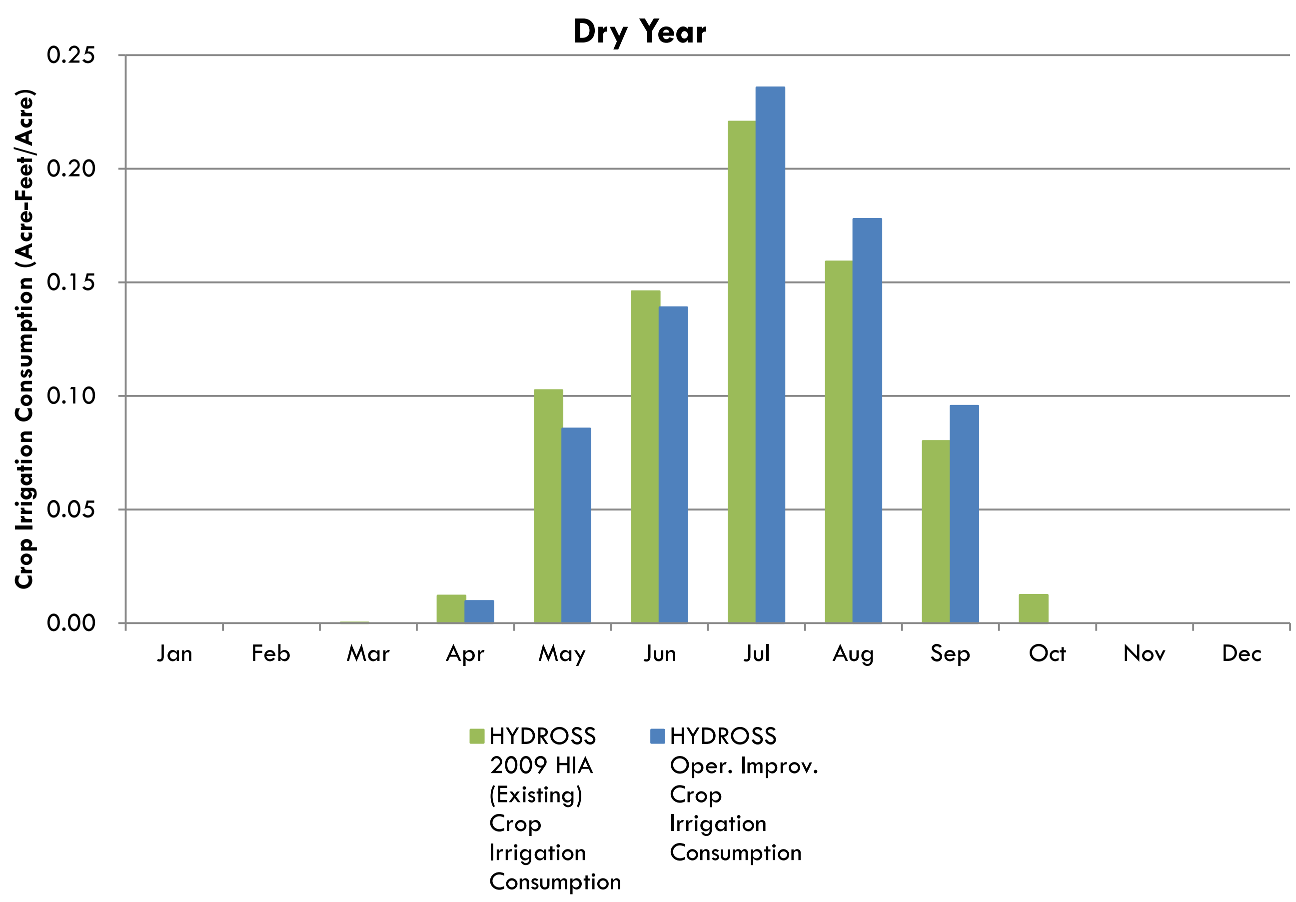
Total FIIP Crop Irrigation Consumption Jocko

58% Sprinkler
42% Flood

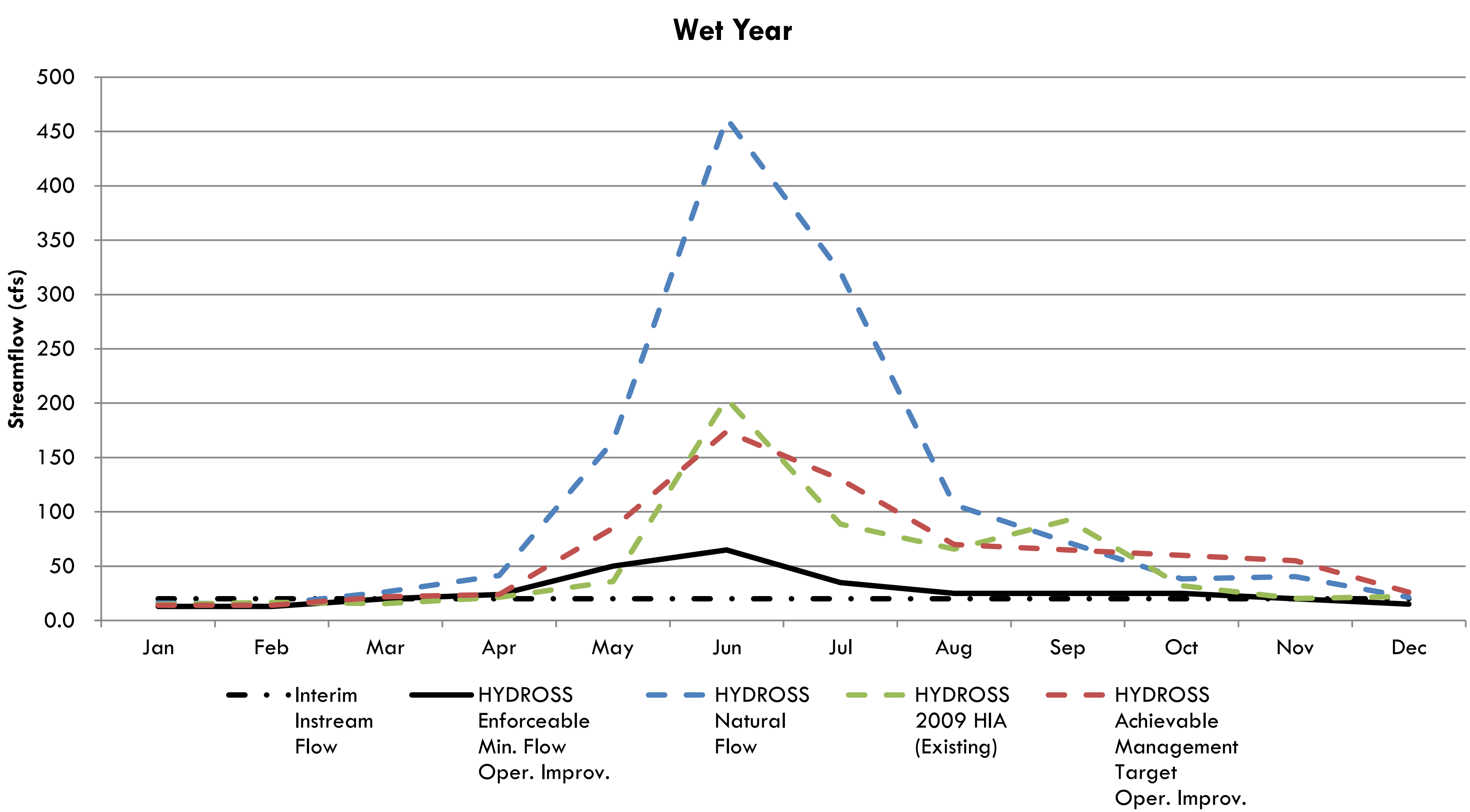


Total FIIP Crop Irrigation Consumption Jocko

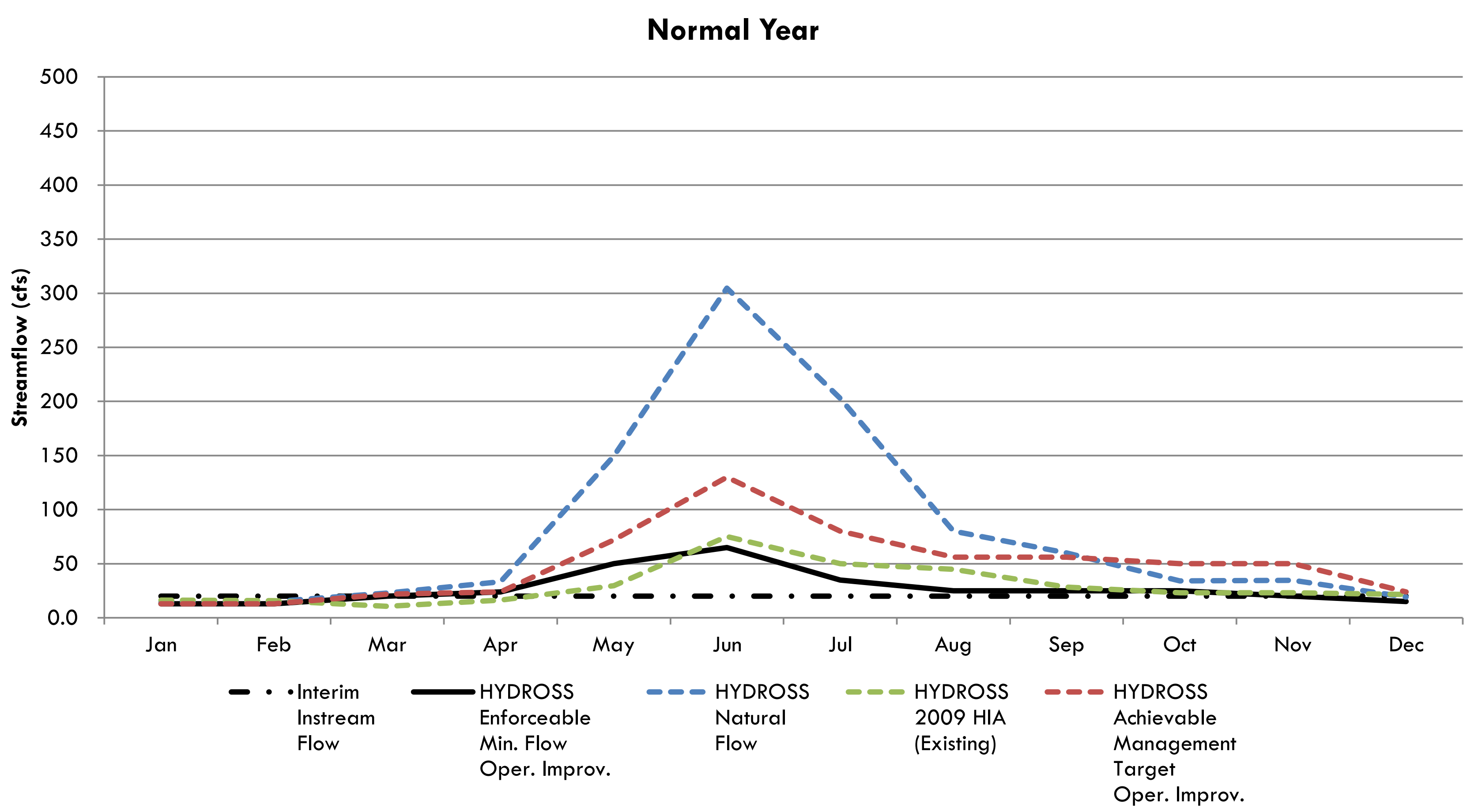
58% Sprinkler
42% Flood



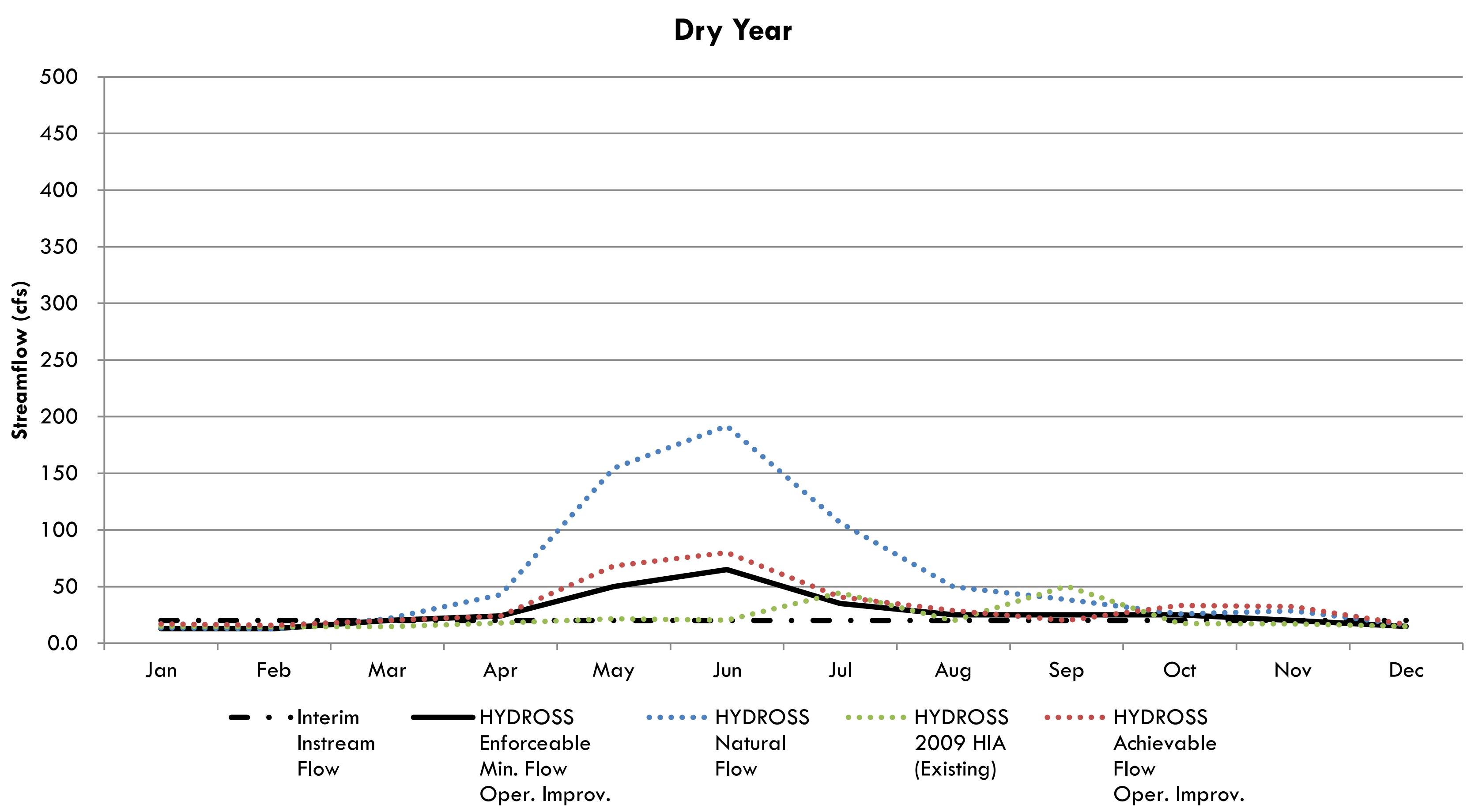
Mission Creek below Mission 6C Lateral



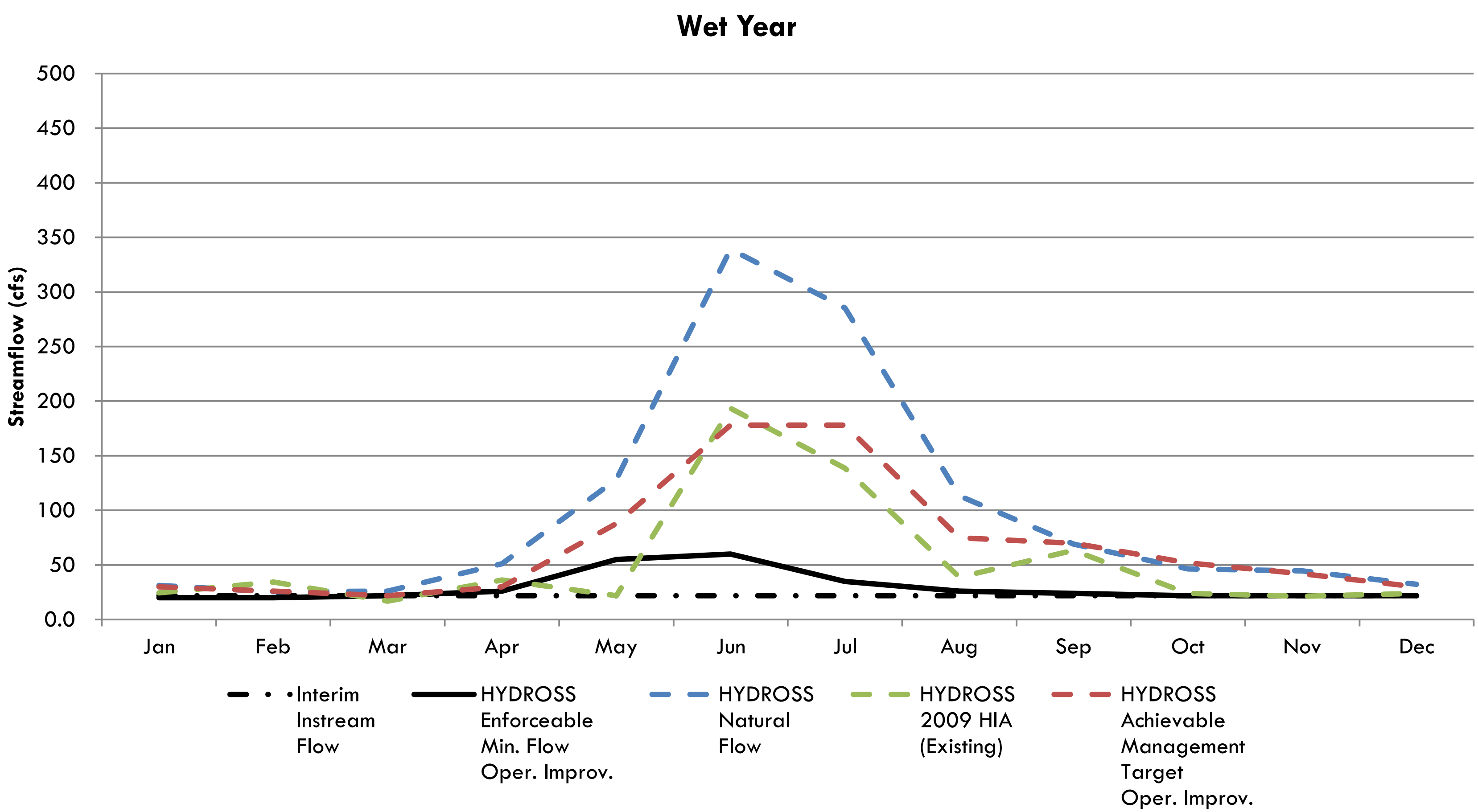
Mission Creek below Mission 6C Lateral



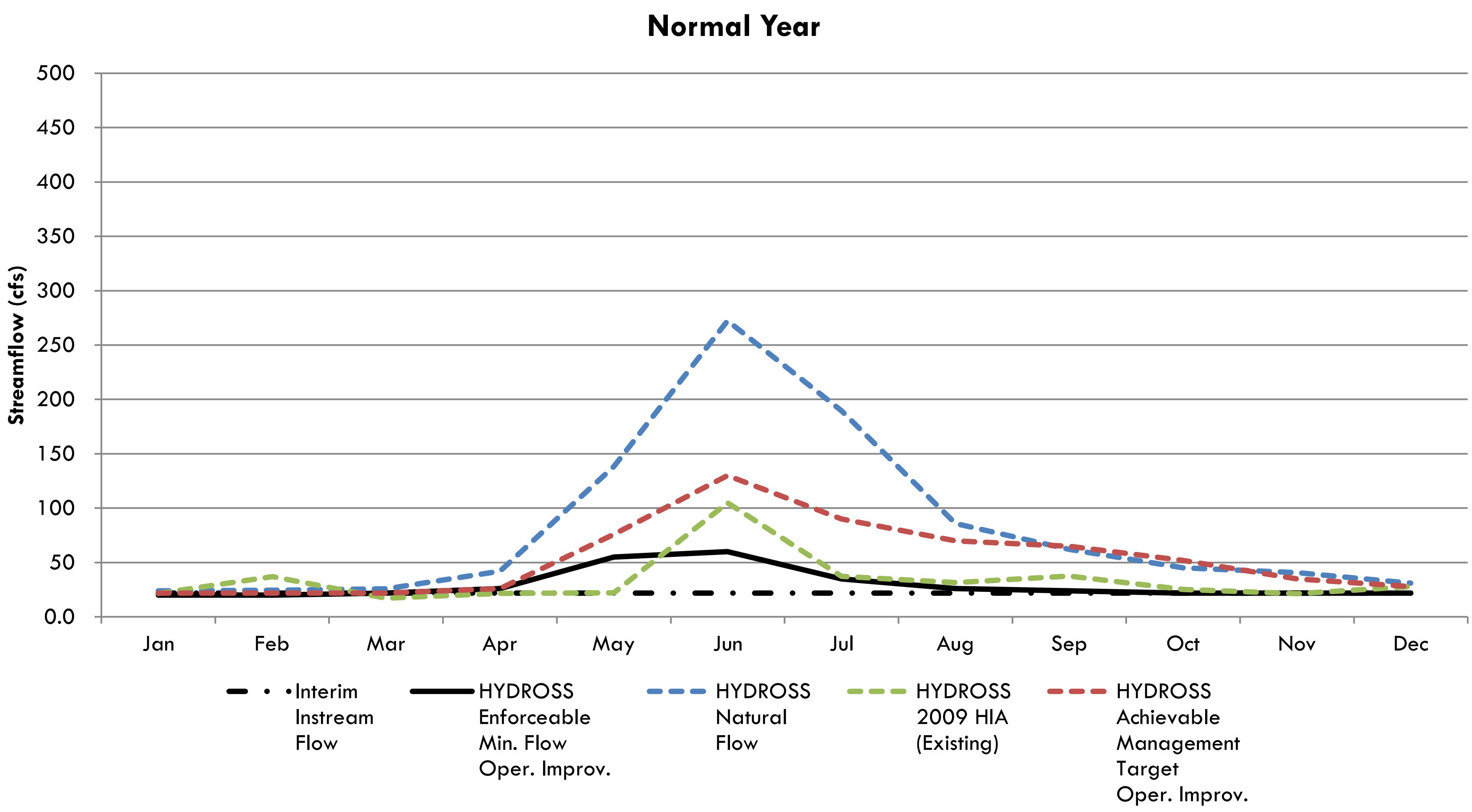
Mission Creek below Mission 6C Lateral



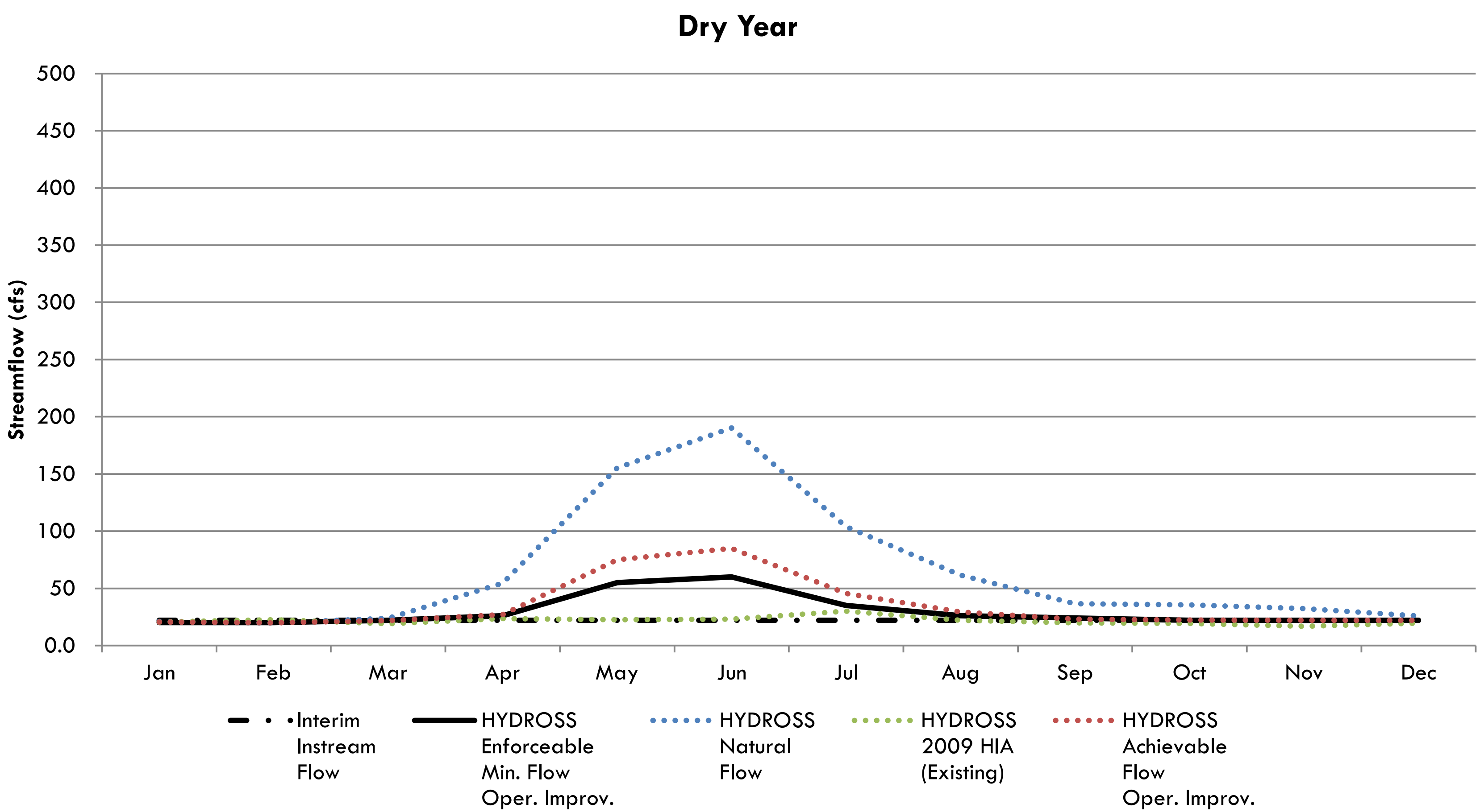
Post Creek below Post F Canal



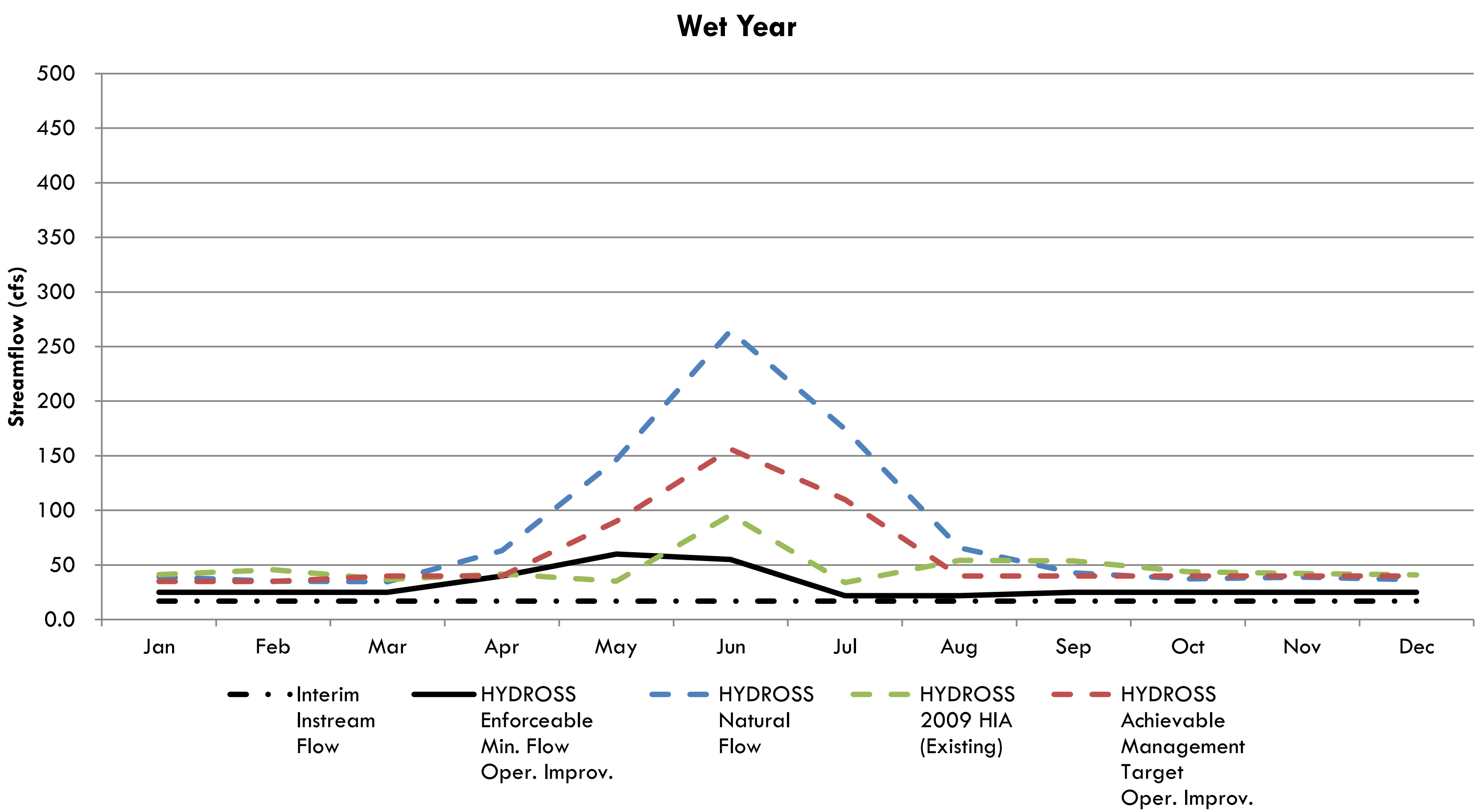
Post Creek below Post F Canal



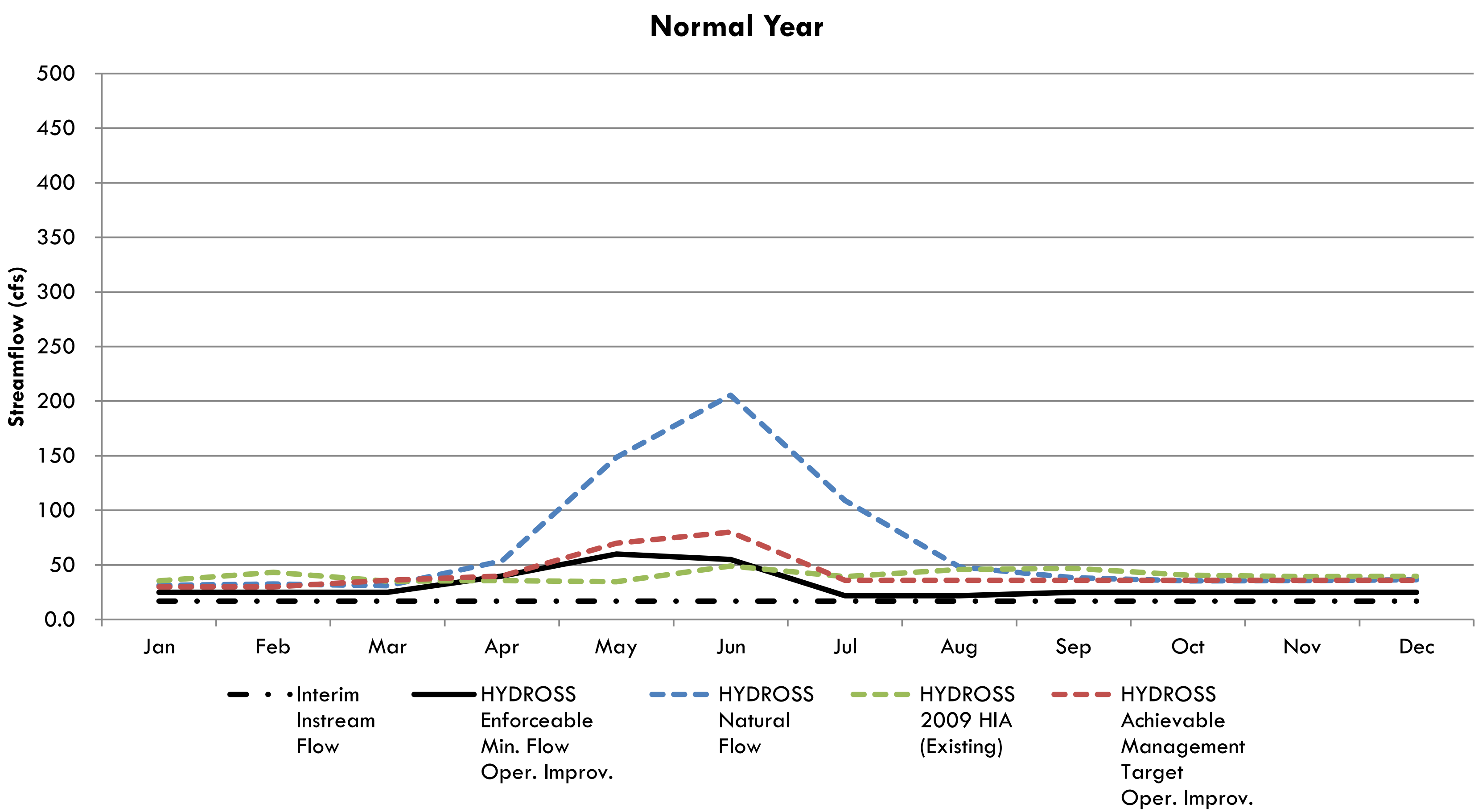
Post Creek below Post F Canal



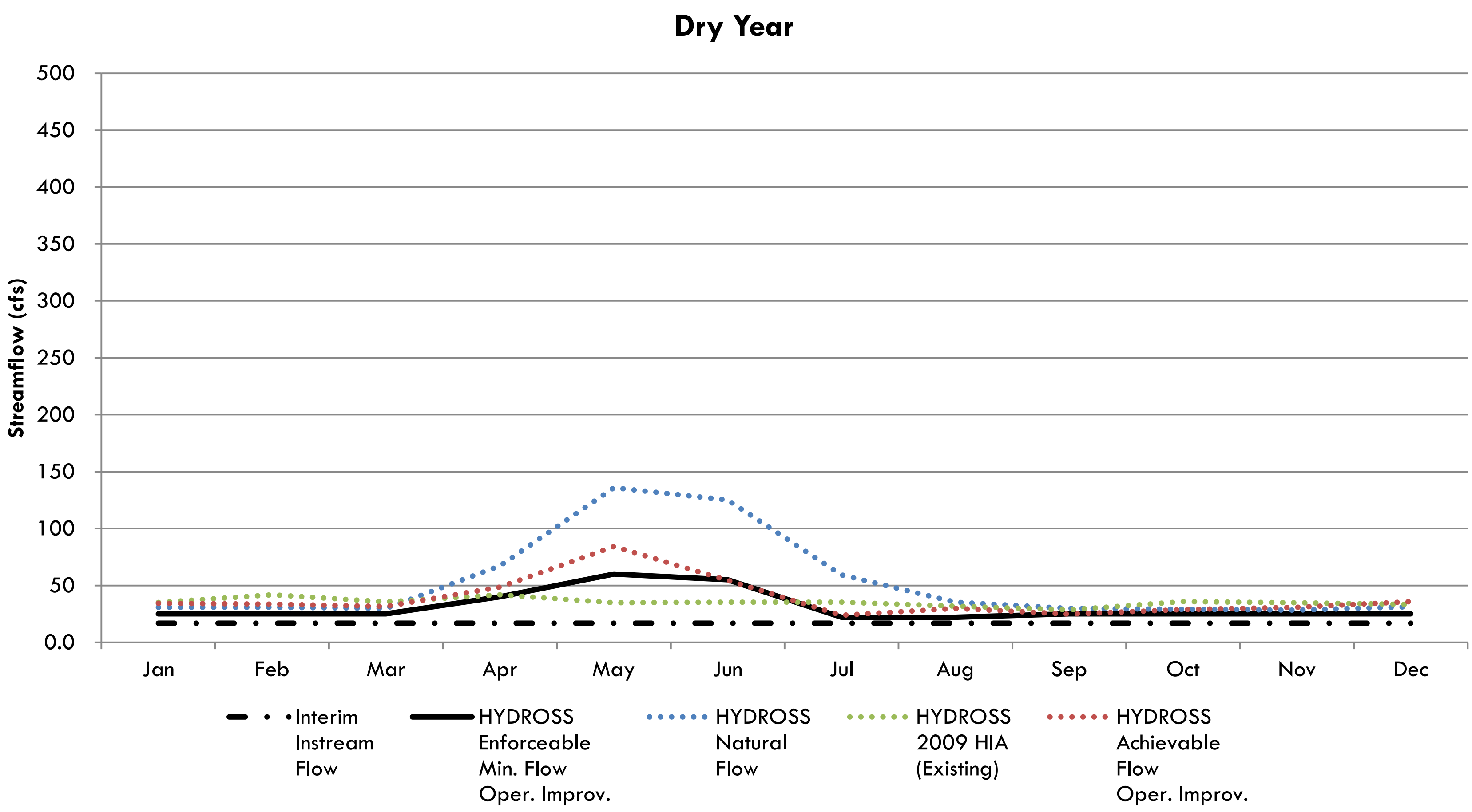
Crow Creek below Crow Pump Canal



Crow Creek below Crow Pump Canal



Crow Creek below Crow Pump Canal



Basis of Water Allocation

1. Provide Adequate Water Supply to Match Existing Crop Irrigation Consumption

2. Identify Potential Water Conservation Improvements to Project Water Distribution Operations

3. Determine the remaining streamflow available for Minimum Instream Flows (MEFs) and Target Instream Flows (TIFs) after implementing Project Improvements

TECHNICAL BASIS FOR PROPOSED FLATHEAD INDIAN IRRIGATION PROJECT WATER USE AGREEMENT
JUNE 12, 2014 - HELENA

Table 1 – Precipitation at the St. Ignatius AgriMet Station (in Inches) 1983 through 2002 in comparison to 2012

Year	May	June	July	August	September	Season	July-September	Dryness Ranking (Jul-Sep)
1983	2.43	3.86	3.42	1.02	1.38	12.11	5.82	19
1984	1.56	1.95	0.31	1.23	1.32	6.37	2.86	9
1985	2.08	0.74	0.07	3.54	3.62	10.05	7.23	21
1986	2.49	3.25	0.98	0.96	3.15	10.83	5.09	15
1987	2.24	1.79	3.54	1.54	0.51	9.62	5.59	18
1988	4.15	0.87	0.59	0.28	1.09	6.98	1.96	5
1989	2.03	1.47	1.38	2.80	2.38	10.06	6.56	20
1990	3.13	1.66	1.69	1.49	0.07	8.04	3.25	10
1991	1.90	3.89	0.46	0.98	0.68	7.91	2.12	7
1992	0.59	2.11	1.91	1.46	1.74	7.81	5.11	16
1993	1.14	2.57	3.00	1.61	0.87	9.19	5.48	17
1994	1.88	1.94	0.28	0.10	0.40	4.60	0.78	1
1995	2.08	2.62	1.21	1.38	1.48	8.77	4.07	13
1996	2.89	1.59	0.59	0.13	1.24	6.44	1.96	4
1997	2.38	2.64	1.89	1.16	1.05	9.12	4.10	14
1998	3.63	3.88	2.41	0.27	0.66	10.85	3.34	11
1999	1.21	1.70	0.48	0.85	0.38	4.62	1.71	3
2000	2.46	0.40	1.18	0.14	2.71	6.89	4.03	12
2001	0.32	4.44	1.74	0.05	0.30	6.85	2.09	6
2002	2.93	3.49	0.88	0.61	0.96	8.87	2.45	8
2012	2.53	3.34	0.70*	0.01	0.00	6.58	0.80*	2

Table 2 – July through September Net Irrigation Requirement for Pasture Grass at St. Ignatius AgriMet Station from Dowl HKM Crop Water Requirements work

Year	Irrigation Consumptive Index	Jul – Sep Evapotranspiration (Inches)	Jul-Sep Effective Precipitation (Inches)	Jul-Sep Full-Supply Net Irrigation Requirement (Inches)
1983	19	10.56	5.82	4.74
1984	9	11.54	2.87	8.67
1985	17	11.12	5.41	5.71
1986	13	10.72	3.84	6.87
1987	15	11.42	5.59	5.84
1988	4	11.83	1.96	9.87
1989	18	11.39	6.56	4.83
1990	10	11.82	3.18	8.64
1991	2	12.37	2.12	10.25
1992	16	10.92	5.11	5.81
1993	20	9.63	5.48	4.15
1994	1	12.99	0.68	12.31
1995	12	11.07	4.07	7.00
1996	5	11.62	1.88	9.74
1997	14	10.87	4.10	6.76
1998	7	12.30	3.34	8.96
1999	6	11.41	1.71	9.70
2000	11	11.69	3.51	8.18
2001	3	12.22	2.04	10.18
2002	8	11.36	2.45	8.91
Avg.	4 Wettest	10.68	5.82	4.86
Avg.	12 Typical	11.40	3.47	7.92
Avg.	4 Driest	12.35	1.70	10.65

Map 1 – Irrigated Lands within the Mission B and C/6C Canal Service Areas - Laskody parcel shown for reference

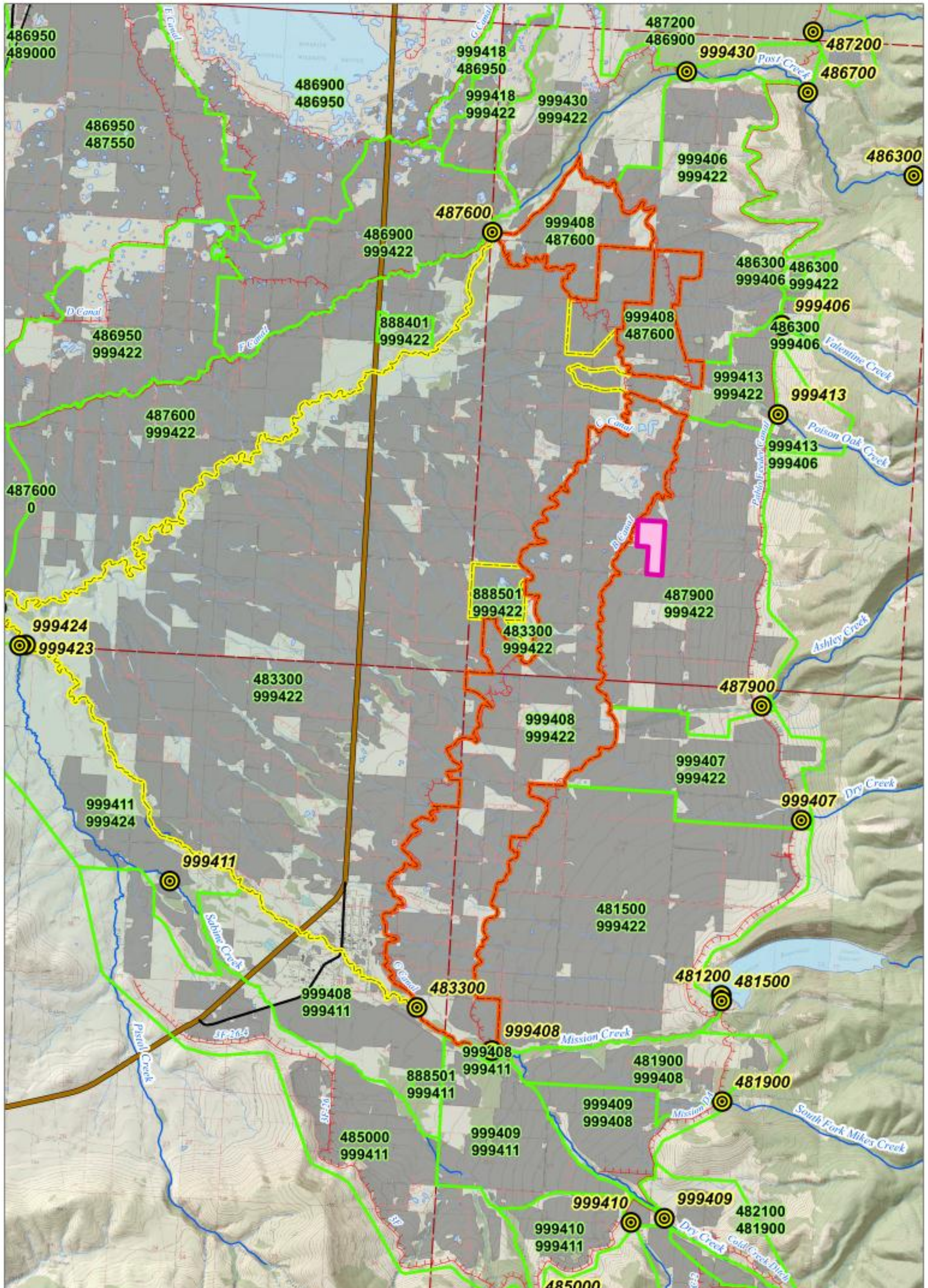
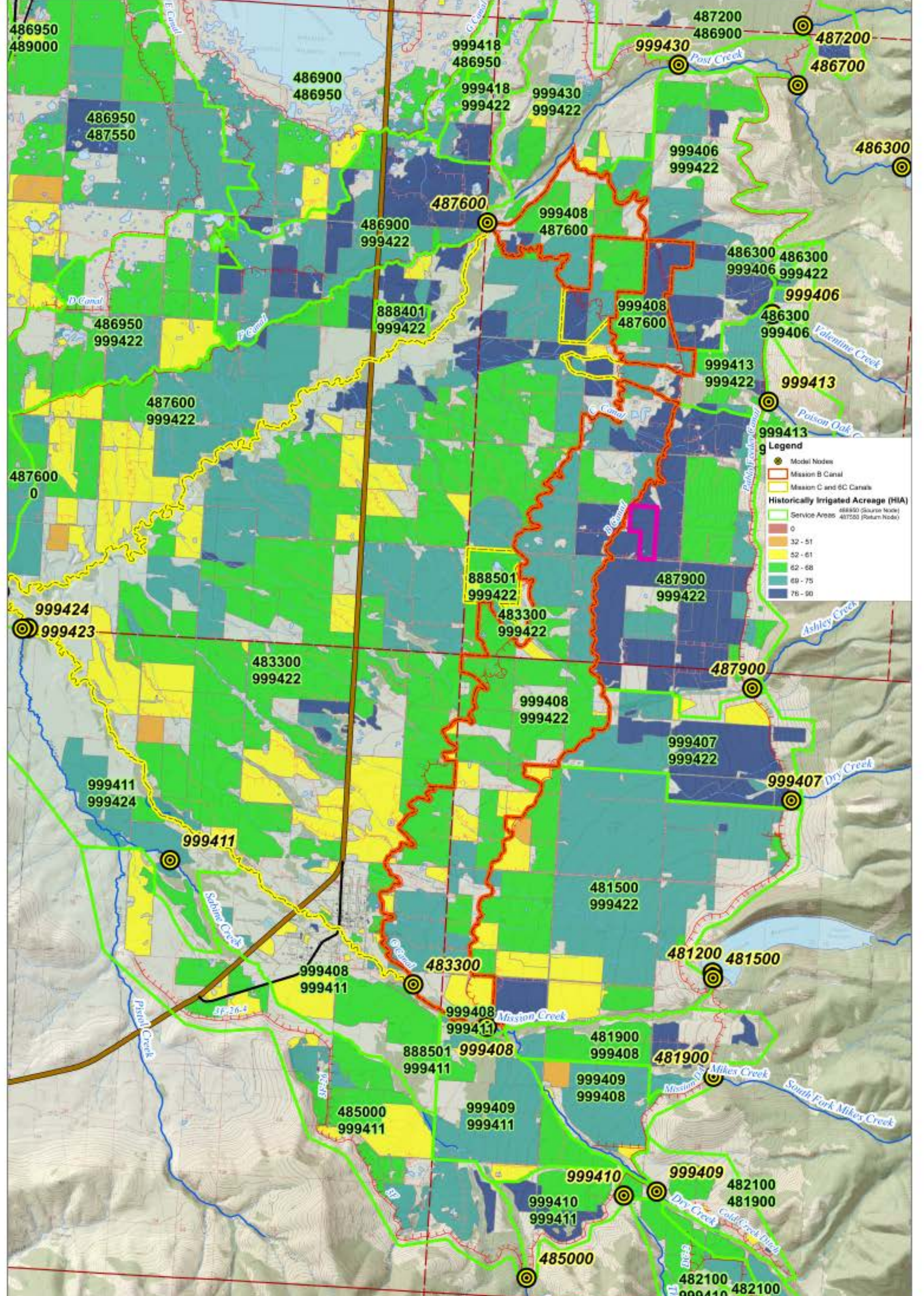


Table 4 – Water Budget for the Mission B and Mission C/6C Canal Service Areas

Stream Diversion	Recorded Apr–Oct Stream Headworks Diversion (Ac-Ft)	Recorded Jul–Sep Stream Headworks Diversion (Ac-Ft)	Irrigated Acres	Recorded Stream Headworks Diversion for Apr–Oct (Ac-Ft/Acre)	Recorded Stream Headworks Diversion for Jul–Sep (Ac-Ft/Ac)	Modeled Farm-Turnout for Jul–Sep (Ac-Ft/Ac)	Modeled CIC for Jul–Sep (Ac-Ft/Ac)	METRIC CIC for Jul–Sep (Ac-Ft/Ac)
Mission B Canal near Headworks (4827.10) Recorded 1992-2002]	3,637	2,799	3,214	1.13	0.87	0.80	0.50	0.56
Mission C Canal (4829.10) & Mission 6C Canal (4831.50) near Headworks [Recorded 1992-2002]	9,102	7,111	7,540	1.21	0.94	0.80	0.47	0.53

*Mission B modeled application efficiency was 59% for July and 64% for August and September (weighted average based on surface irrigation acreage at 45%/50% and sprinkler irrigation at 75%/80%). Mission C modeled application efficiency was 56% for July and 61% for August and September (weighted average based on surface irrigation at 45%/50% and sprinkler irrigation at 75%/80%).

Map 2 – Irrigated Lands by METRIC Factor (Percent of Maximum) within the Irrigation Service Areas in the vicinity of the Laskody parcel



CSKT Water Measurement Program – Surface Water

- 1982 – present
- Cooperator with USGS through period
- Cost-share USGS gages on Reservation
- Frequent training classes with USGS, most recent March 2014 – ADCP class

- 1992 – upgraded sites to continuous recorders
- July 2014 – start to transition to new electronics and real-time monitoring 26 stream/canal sites

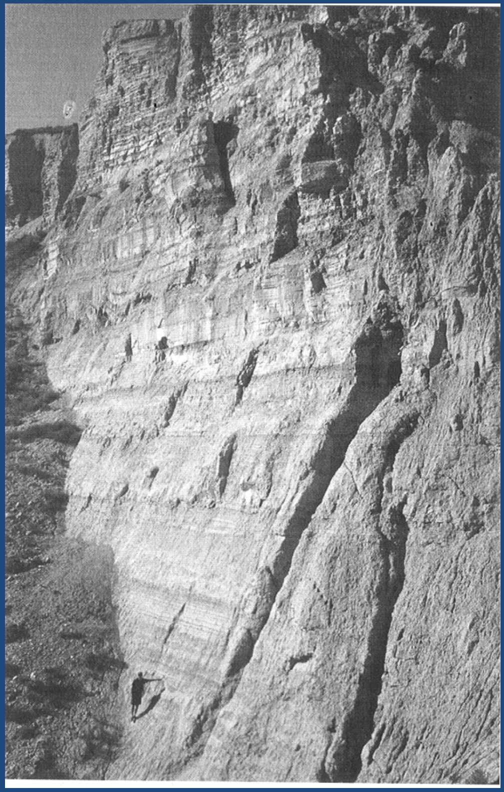
- At peak – maintained 85 continuous recorder sites, including 45 canal headworks
- Currently - maintain ~ 60 sites, including several canal sites
- Compliance monitoring at 28 instream flow sites
- Combined hydrographer staff have well over 100 years of experience
- Employed retired USGS hydrographer full-time for 8 year period

CSKT Water Measurement Program – Surface Water Data Management

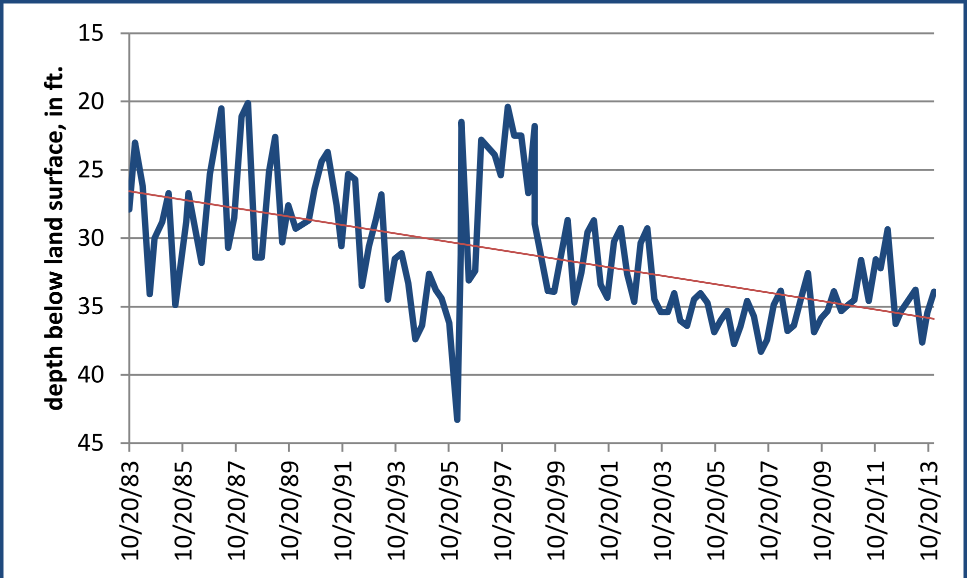
- Each station file includes station description and annual station analysis summary
- Each water year data are prepared by hydrographers
- QC of each record by Supervisory Hydrographer
- Final QC of each record by Hydrologist
- Data maintained in relational database, recently upgraded and re-programmed in MySQL
- Over 300 station files in database
- All original field notes archived
- Each rating table for each station preserved

CSKT Water Measurement Program – Ground Water

- Monitoring network starting 1982
- Data reported to USGS then MBMG – currently maintained in GWIC
- Well network has gone from ~ 75 wells to ~ 40 wells
- Additional work – contract sampling for MBMG during mid-1990's for MBMG groundwater Assessment Atlas 2
- Numerous stream and canal seepage runs
- Calibrated basin-scale groundwater flow models for primary alluvial basins



View of Lake Missoula silts – confining layer on Reservation



Well in Little Bitterroot Lonepine aquifer

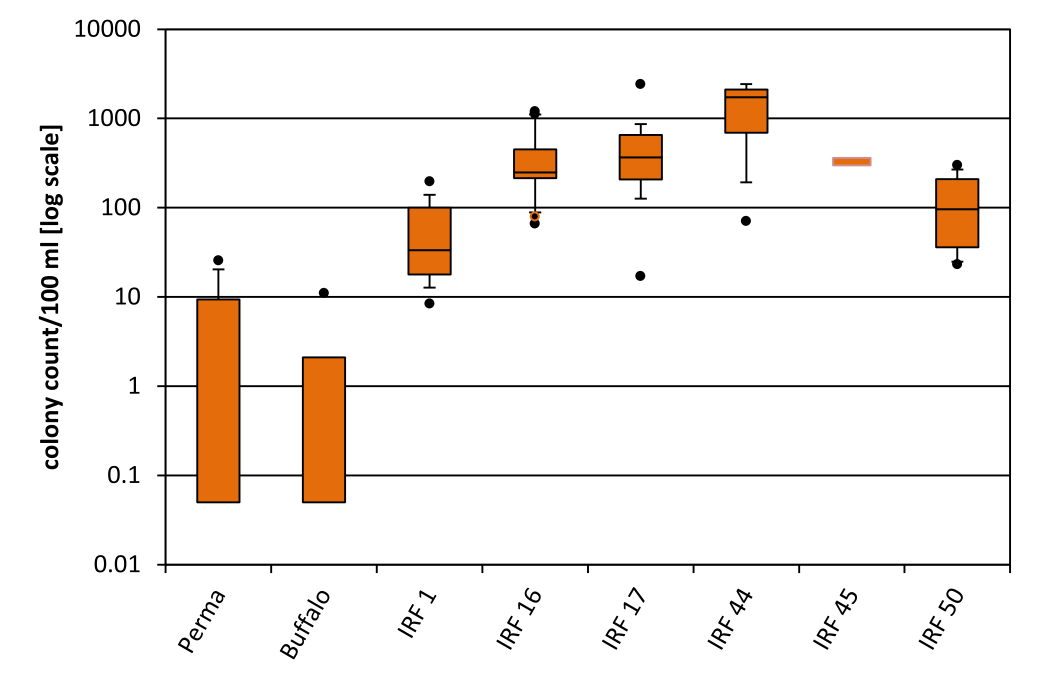
CSKT Water Measurement Program – Snowpack

- CSKT one of largest State-wide cooperators with NRCS
- Work done at no-cost to NRCS
- Field crew are snow survey certified by NRCS
- Winter sampling from Marias Pass to Stuart Peak near Missoula; Swan Range to Marion Area

Moss Peak Snotel site

CSKT Water Measurement Program – Water Quality

- Tribes have "Treatment as a State" from EPA
- Have maintained water quality monitoring program for over 15 years
- 1998-2012 Rotating Basin Assessments – each documented in stand-alone reports submitted to EPA
- Most recent study – Flathead River Corridor Assessment

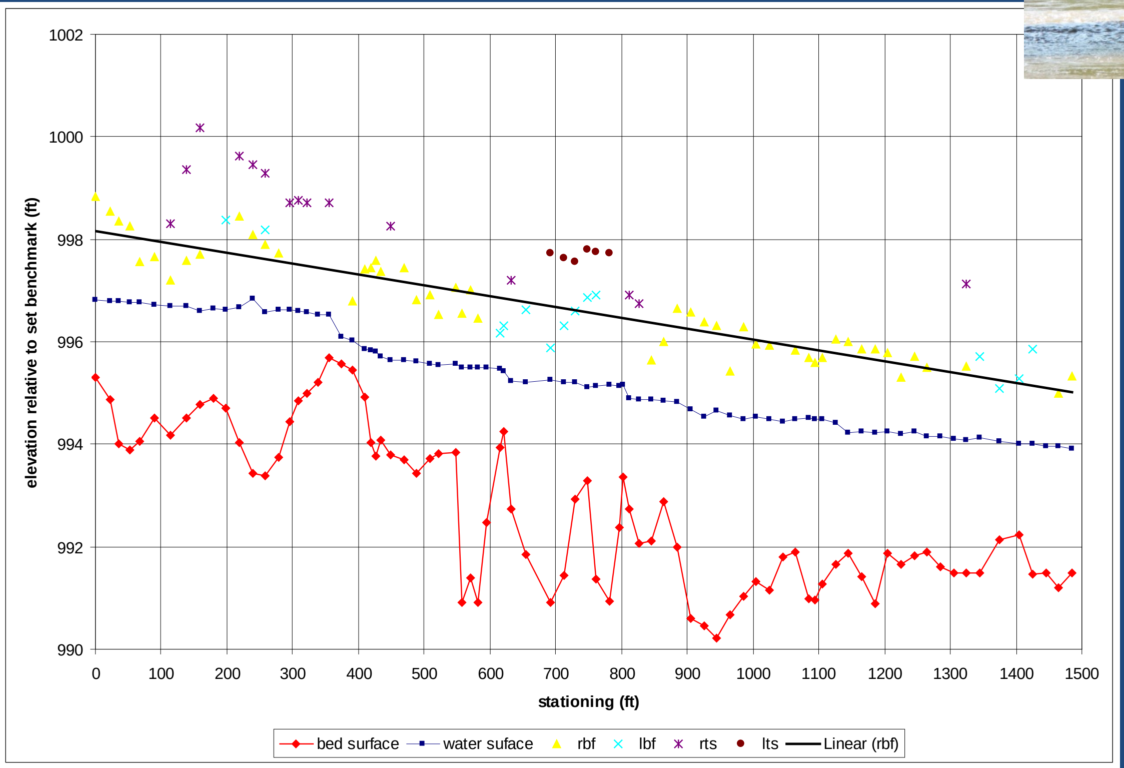


Box plot showing E. Coli contributions to Flathead River from irrigation return flows

CSKT Water Measurement Program – Miscellaneous

- Reservoir monitoring for CSKT Safety of Dams Program
- Pesticides and Emerging Contaminants Sampling
- Geomorphic monitoring, sediment transport

Bridge crane sampling Big Horn River for Emerging Contaminants



Longitudinal profile lower Mission Creek – restoration design inputs

FIIP Water Use Agreement

Caveat – We refer to the Water Use Agreement throughout presentation since this document contains the elements of the FIIP Water Use Right and the FIIP instream flows. However, …

Negotiation Process for Water Use Agreement

- Parties – CSKT, FJBC, federal counterparts
- Negotiations built from momentum in the Agreement for Transfer of the FIIP from BIA to local control under Cooperative Management Entity (CME)
- Negotiations on WUA started in 2008, accelerated in early 2010 and culminated in 2013
- First draft of a Water Use Agreement produced in January, 2012

Sample of Public Outreach

- May 31, 2012 – FJBC approved release of draft WUA and document was made available online
- June 21, June 27, August 20, Sept 4, Sept 5, Oct 3, Oct 24 2012 – public meetings to present on WUA and address questions (some meetings other Compact topics also addressed)
- January 8, 9 2013 formal negotiating session lead to final version of WUA
- February 4, 5 2013 FJBC public meetings on WUA
- March 2013 CSKT maintains kiosk in capitol to answer questions on Compact and WUA

FIIP Water Use Agreement – Project Background and Conditions

FIIP Water Use Agreement – Project Background and Conditions

Geography

- Topography – topography varies over 400 feet in some irrigated service areas
- Soil textures vary widely
- Climate – precipitation and climate vary

Physical Infrastructure

- ~ 1,100 miles of open earthen ditches
- ~ 10,000 irrigation structures
- 16 irrigation reservoirs
- Water supply can vary widely based on snowpack / spring rains

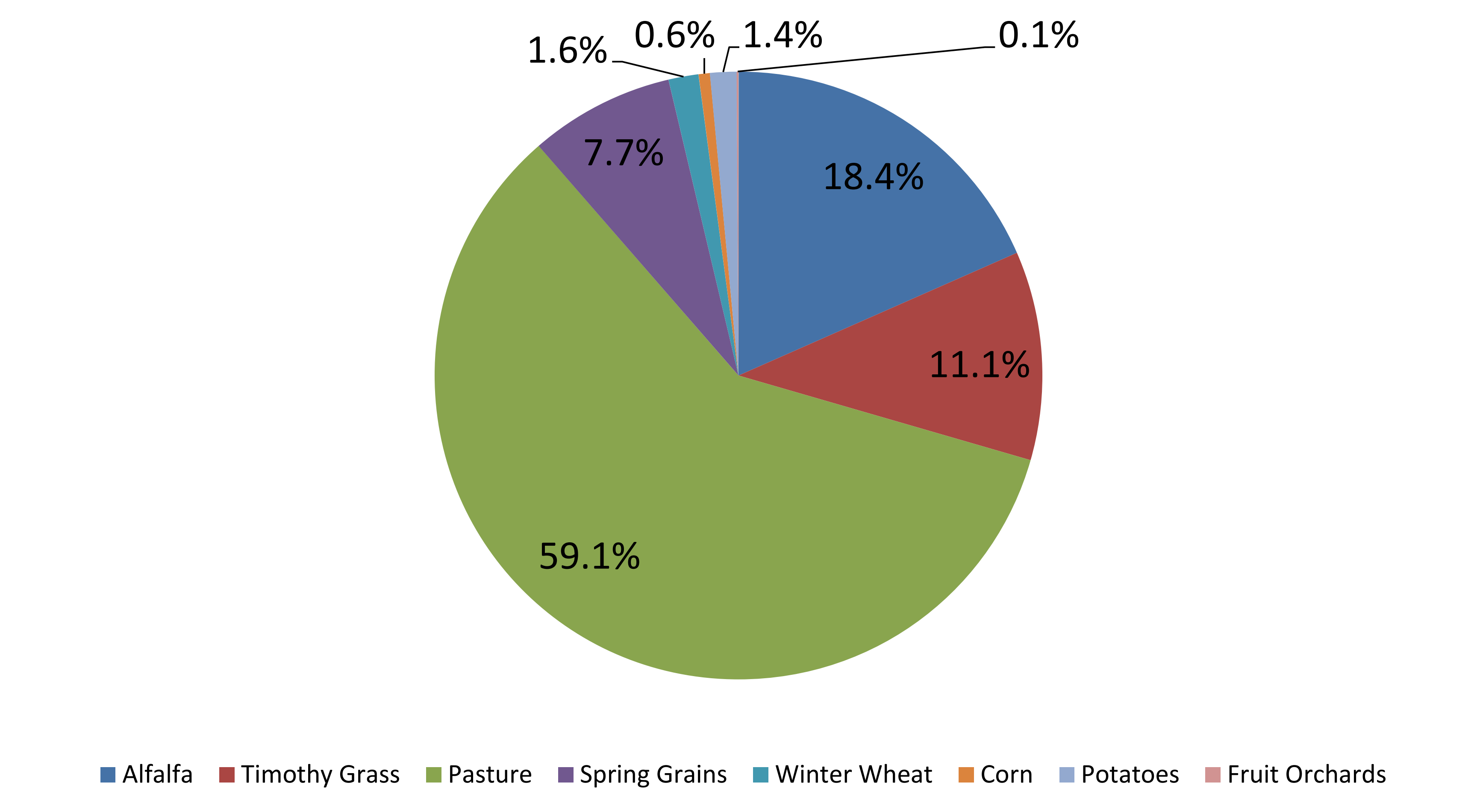
Administrative

FIIP staff track / administer water to 5,025 tracts of land
40 % of tracts < 10 acres
80% of tracts < 40 acres
99% of tracts < 100 acres

- ~ 150 lawn and garden service contracts

FIIP Water Use Agreement – Project Background and Conditions

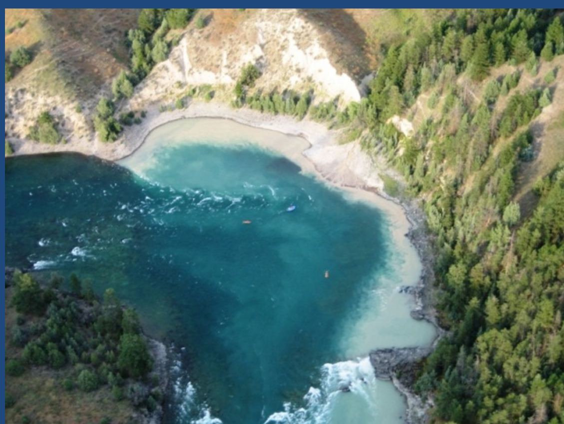
Historic Cropping Patterns



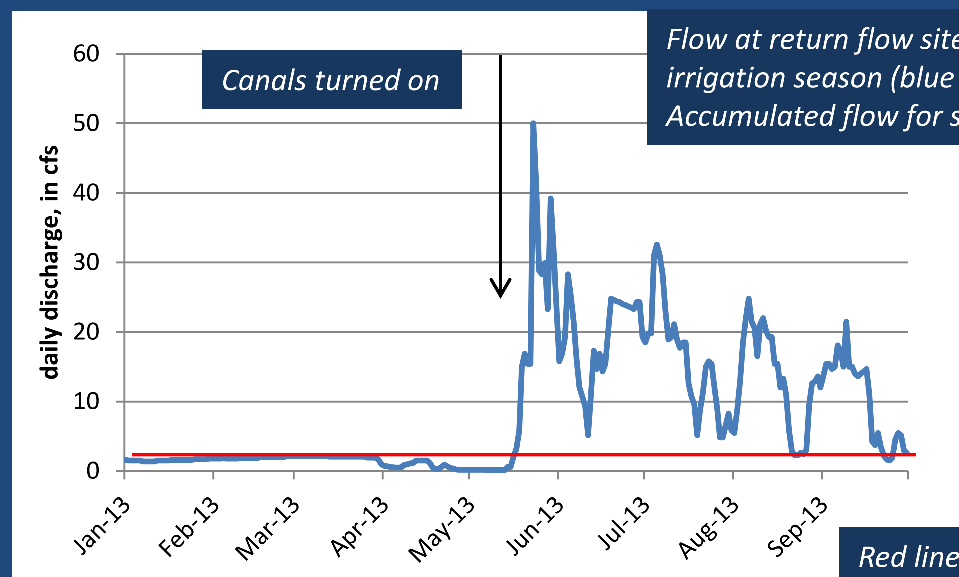
FIIP Water Use Agreement – Project Background and Conditions

Environmental Compliance

- **FIIP operating under a ESA Biological Opinion for Bull Trout**
- **Irrigation Return Flow Management / Water Quality Compliance**



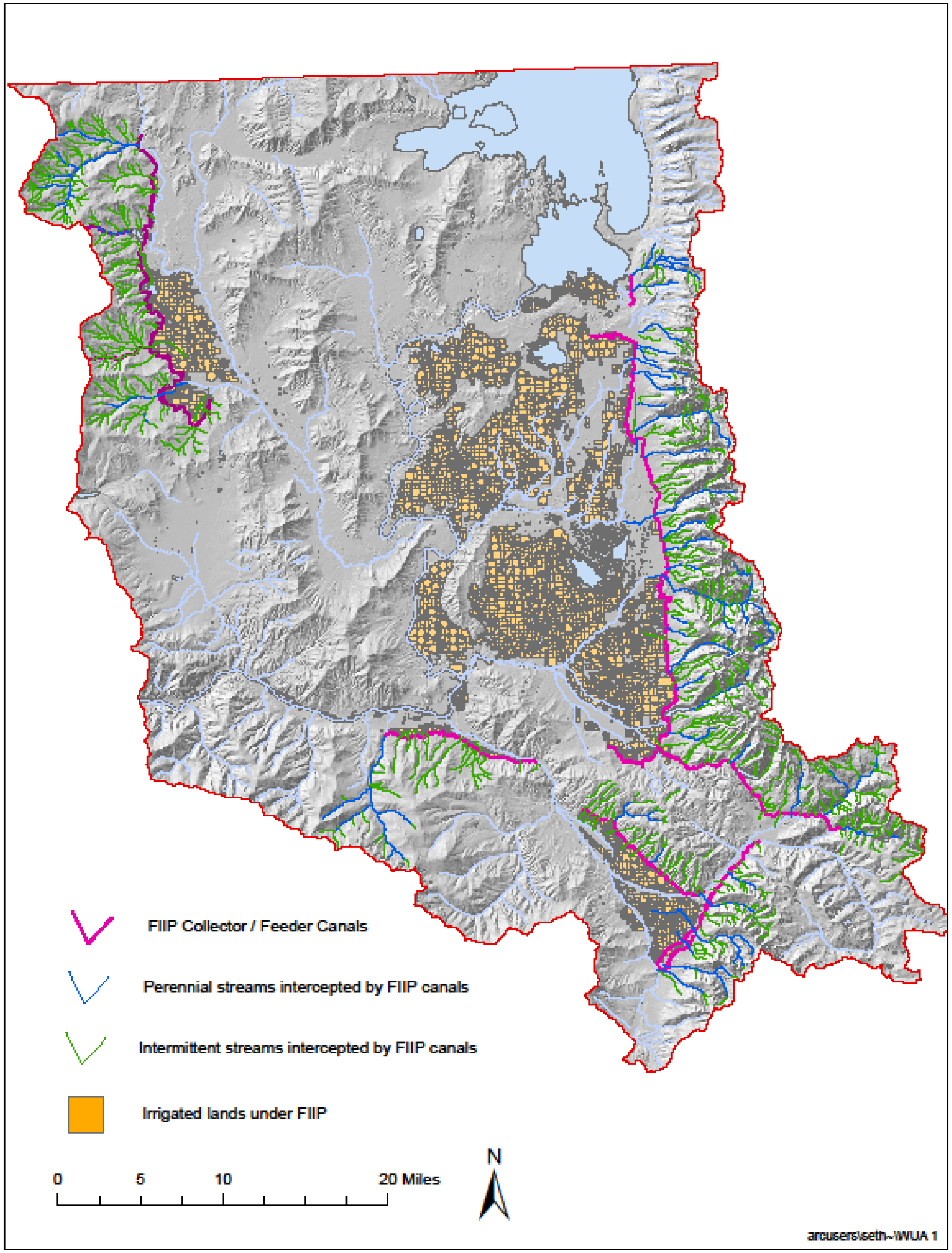
Return flow event to Flathead River July, 2012, boats for scale



Flow at return flow site for 2013 irrigation season (blue line)
Accumulated flow for season = 4,250 af

Red line BIOP upper level of allowable return flow discharge at site

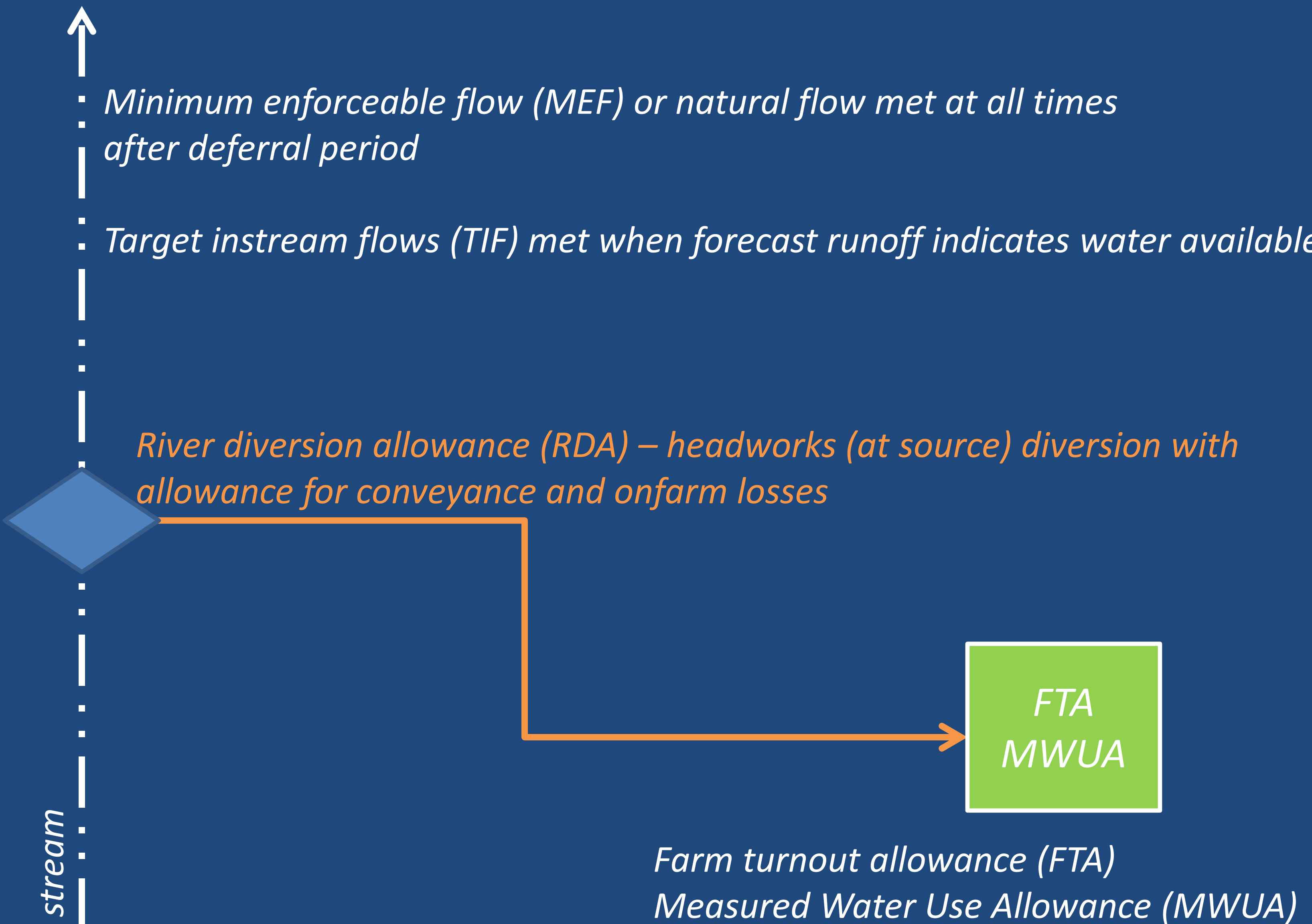
Return flow event to Flathead River August, 2013



FIIP Water Use Agreement - Project Background and Conditions *Water Supply*

- Lack of single primary water supply
- Lack of carry-over storage capacity for Mission and Jocko areas
- Primary distribution canals intercept numerous streams for source of supply
- Trans-basin diversions from Clearwater and Little Thompson drainages
- Trans-basin diversions throughout interior of project
- Reliance on Flathead Pumps – lift ~ 300 feet

FIIP Water Use Agreement - Structure of Water Right and Allocation



FIIP Water Use Agreement - Deferral Process

Implementation of new instream flows and farm turnout allowances is geographically prioritized to focus settlement resources – Mission, Jocko, Little Bitterroot

Instream Flow Deferral Process

Interim instream flows in-force until new instream flow levels applied

MEF / TIF can be deferred up to 5 years after operational improvements

MEF / TIF can be deferred up to 7 years after rehab and betterment

Irrigation Water Deferral Process

Quota and Extra Duty System in-force until farm turnout allowance applied

FTA applied after onfarm measurement and operational improvements and rehab and betterment, but not deferred greater than the 5 and 7 years noted above

Measured Water Use Allowance applicable after FTA and efficiency audit

Deferral Process and water saved through improvements implemented through adaptive management process allowing for technical process with Tribes, FJBC, Project Operator staff

FIIP Water Use Agreement - Adaptive Management and Water Management Coordination

- Adaptive Management
  - Flexibility for adaptation to specific water availability conditions;
  - Ability to re-examine instream flow and farm turnout allocations through irrigation season;
  - Procedure to define saved water from operational improvements and rehabilitation and betterment
- Target Instream Flows not met every year, based on forecast and realized water
- Allocation numbers- MEF, TIF, FTA re-evaluated after a period of data collection
- Consistency and Integration between Water Supply Management and monetary settlement resources