



Screening-Level Analysis:

# Influence on Spokane River Flows of Hypothetical Pumping Relocation Scenarios

*Using the City/SAJB Groundwater Flow Model*

*Prepared for*

Spokane Aquifer Joint Board

*Prepared by*

John Porcello, LHG - GSI Water Solutions

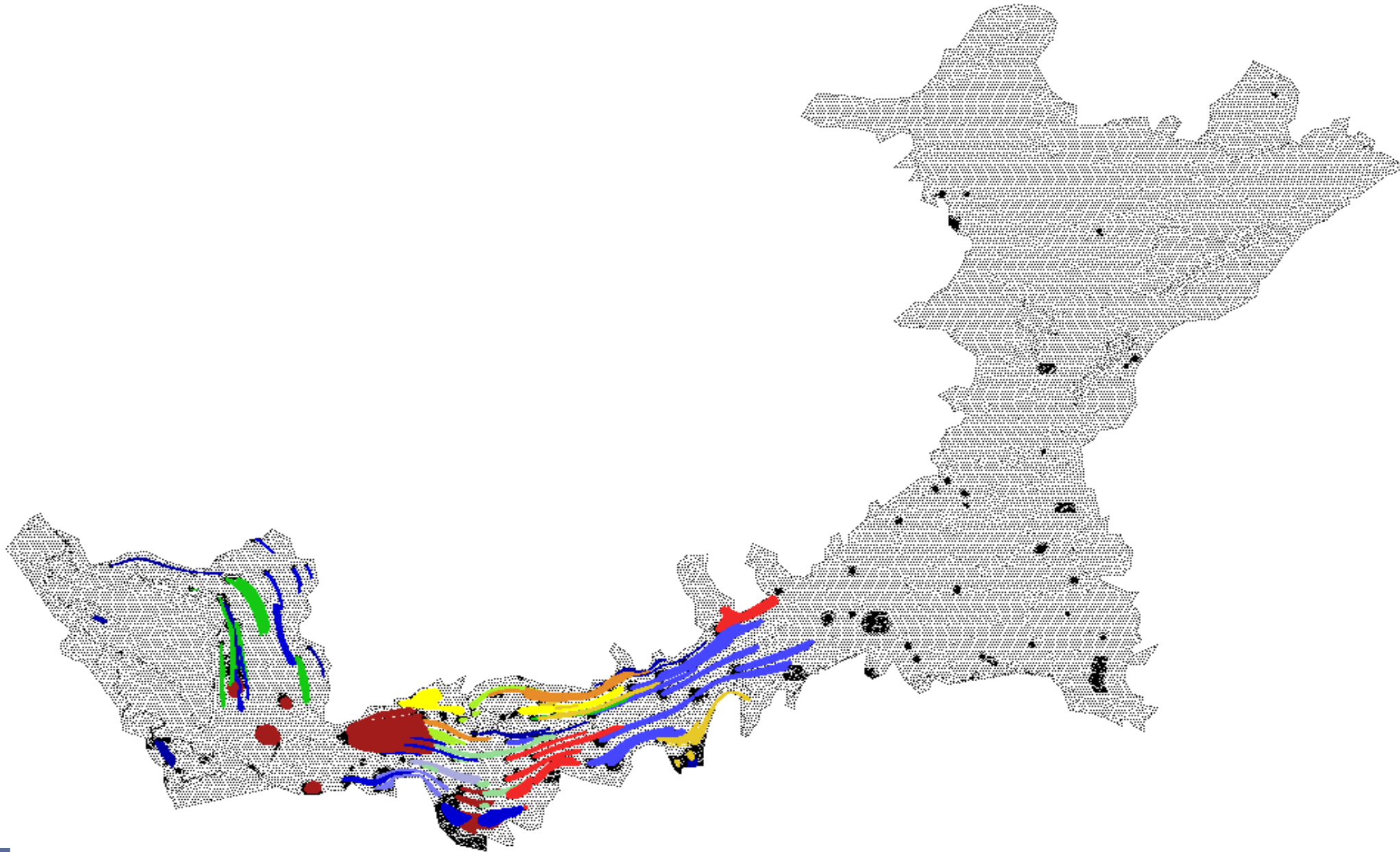
April 24, 2014

# SAJB Pumping Relocation Analysis

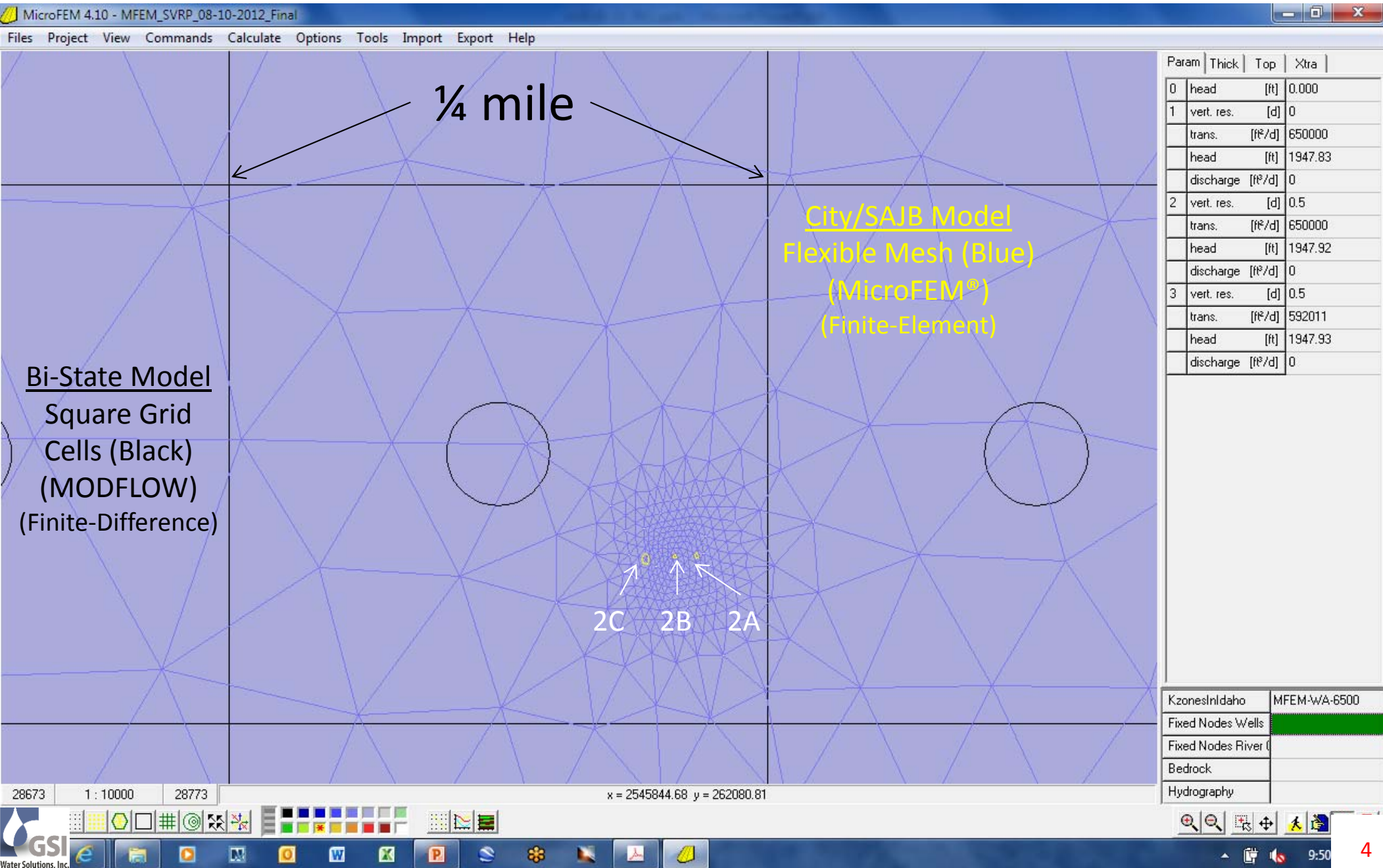
## Study Objectives

1. How much does groundwater pumping by SAJB members currently affect flows in the Spokane River
  - Individually and collectively
  - Focus on peak-season (June through August)
2. How much benefit to river flows could arise if summer pumping is shifted to wells farther from the river?
  - Magnitude and timing
  - Move pumping – not wells
3. How do the changes arising from relocation compare with the proposed in-stream flow standards?

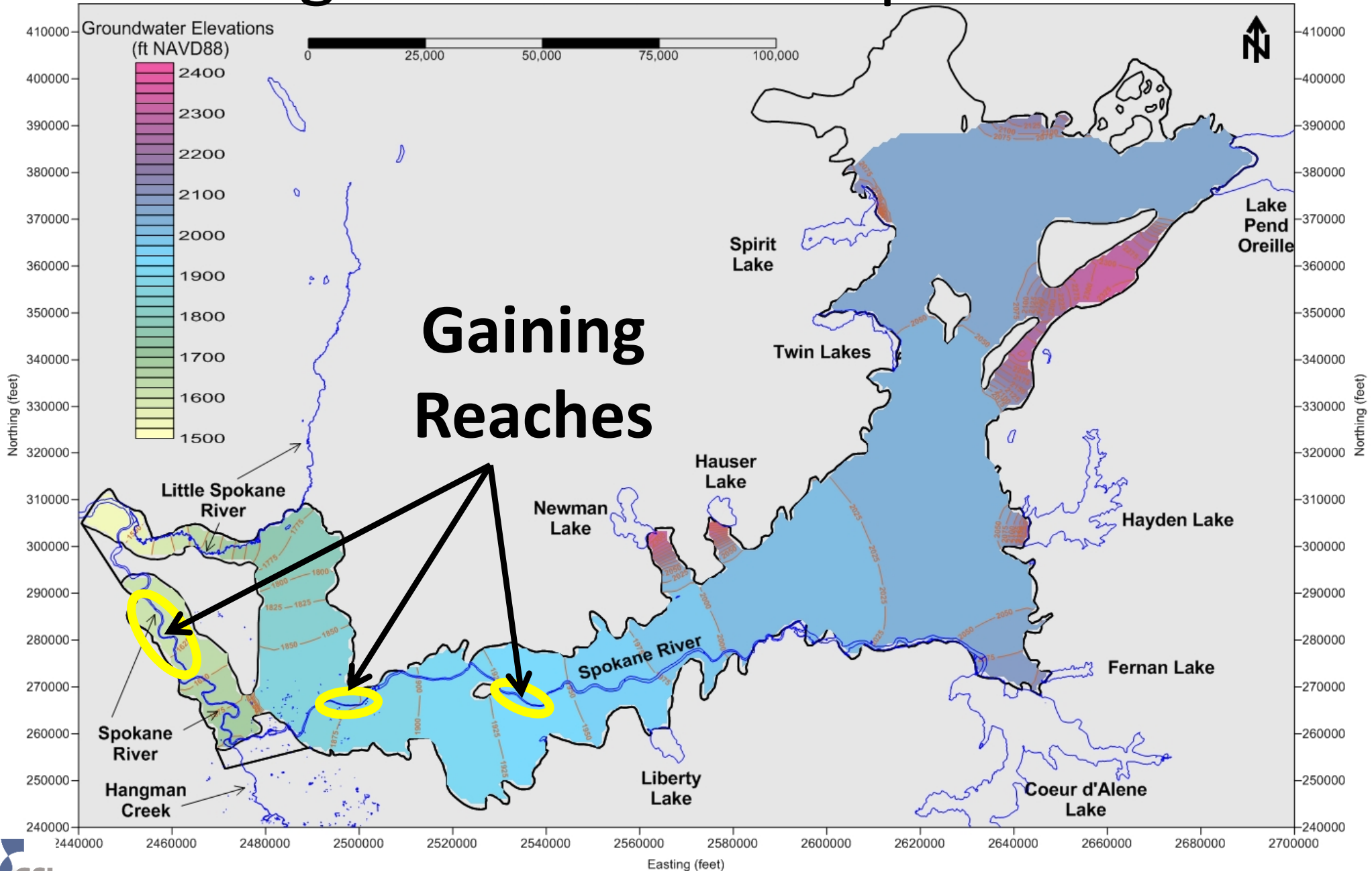
# Groundwater Model Grid (Black) and Special Wellhead Protection Areas (Colored)



# City/SAJB and Bi-State Model Grids at CID-2



# Groundwater Elevations and Gaining Reaches of the Spokane River



# Simulated Spokane River / Aquifer Exchanges (Average Annual Conditions)

Simulated Annual Average Groundwater Exchanges (cfs) with the Spokane River in the City/SAJB 2012 Regional Model		Gaging Station		Exchange (cfs)
		Upstream	Downstream	
Coeur d'Alene Lake to Sullivan Road	-307	Lake CDA Bed Seepage		-41
		Lake CDA	Stateline	-128
		Stateline	BAR	-63
Sullivan Road to Plantes Ferry	198	BAR	SUL	-75
		<b>SUL</b>	<b>KAI</b>	<b>130</b>
		KAI	ETR	57
Plantes Ferry to Upriver Dam Forebay	-13	ETR	PLF	11
		PLF	ARG	-6
		ARG	UDF	-7
Upriver Dam Tailway to Greene Street Bridge	241	<b>UDT</b>	<b>GRE</b>	<b>241</b>
Greene Street Bridge to Monroe Street Bridge	16	GRE	MIS	-1
		MIS	SIR	15
		SIR	MST	2
Western Arm of Aquifer (Below Monroe Street Bridge)	24	MST	USGS Gage	-28
		USGS Gage	TJM	-93
		TJM	BAP	-10
		<b>BAP</b>	<b>7ML</b>	<b>140</b>
		7ML	9DF	15

Negative values indicate losing river reach.

Positive values indicate gaining river reach.

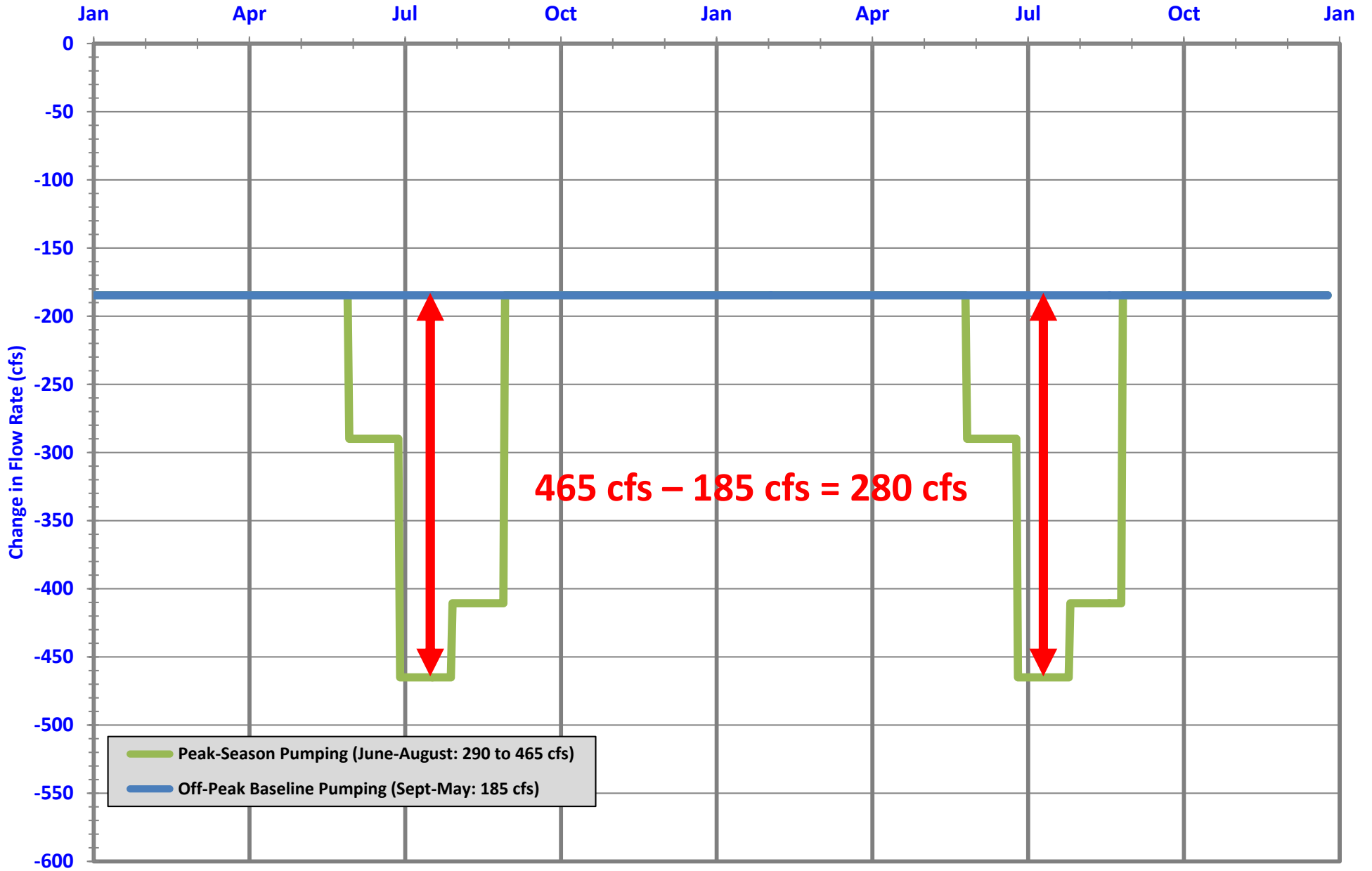
# SAJB Pumping Relocation Analysis

## Study Approach

### 1. Establish baseline

- Present-day effects on river from all SAJB members
- The portion of summer pumping rates (June-August) that are in excess of the year-round average rate
  - Examine effect of pumping at higher than year-round avg.

# 2013 Total Pumping - All SAJB Members



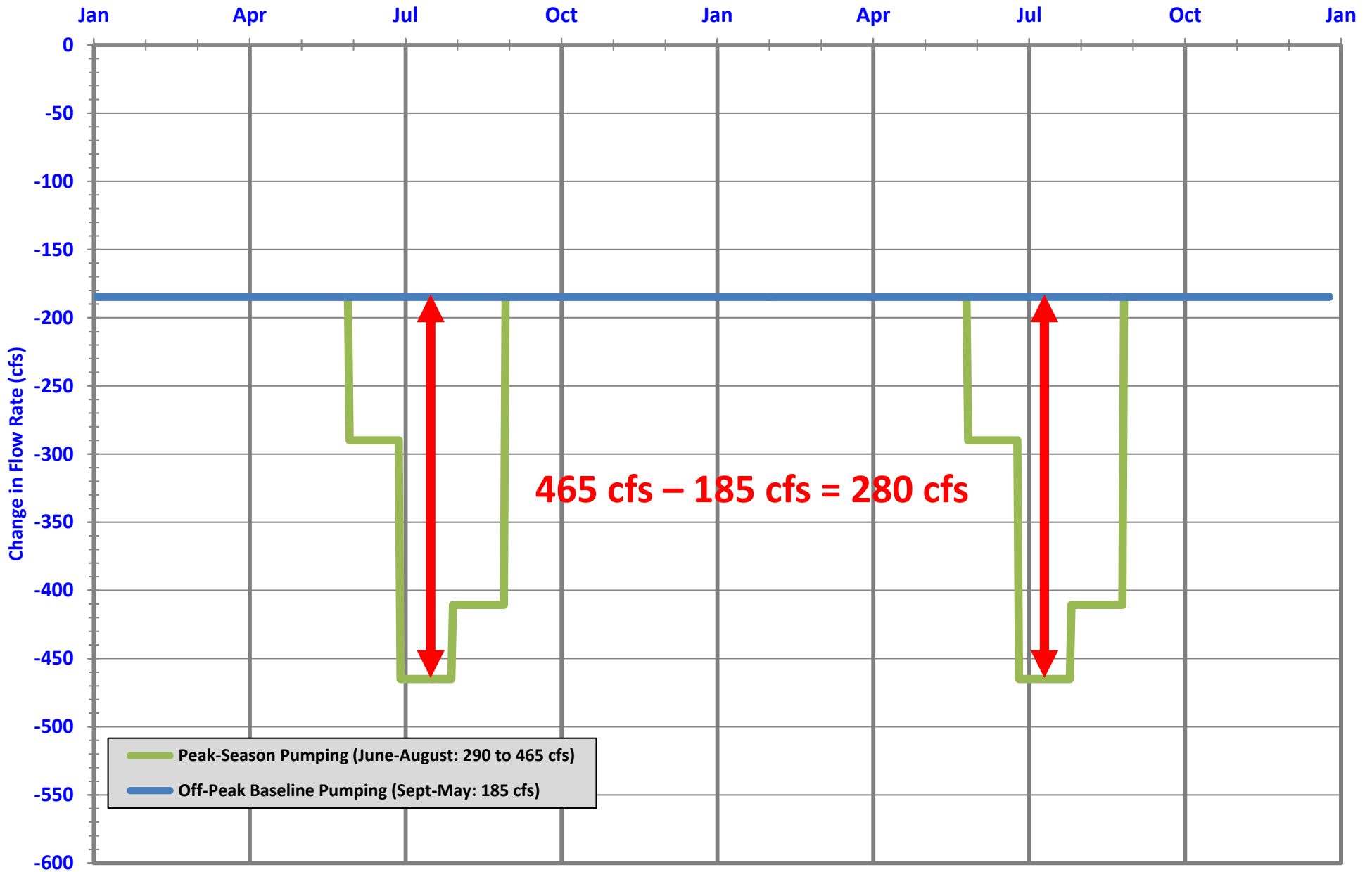


# SAJB Pumping Relocation Analysis

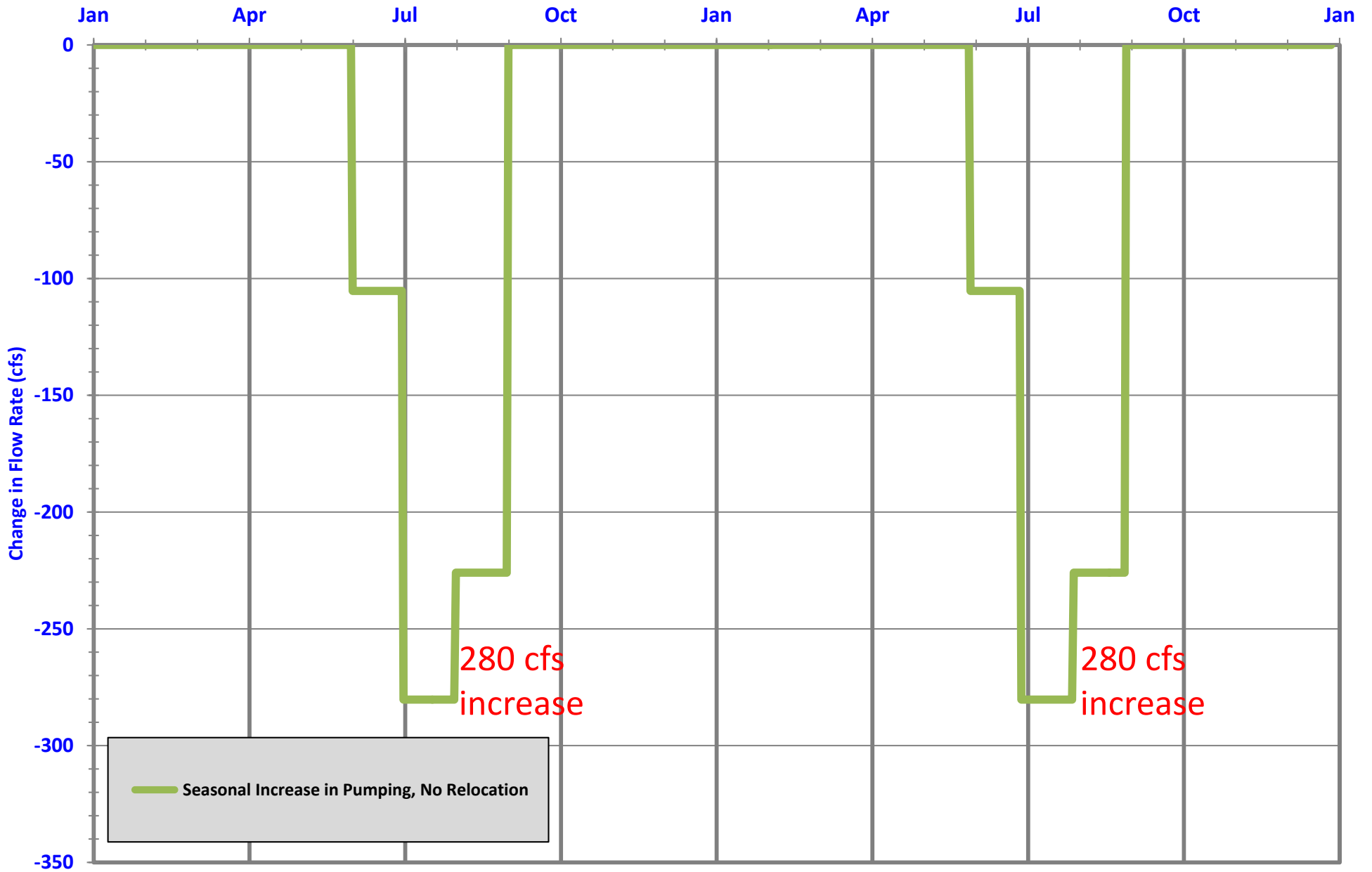
## Study Approach

1. Establish baseline
  - Present-day effects on river from all SAJB members
  - The portion of summer pumping rates (June-August) that are in excess of the year-round average rate
    - Examine effect of pumping at higher than year-round avg.
2. Identify members with relocation ideas
  - CID, IWD, MEWCO, PPID, Vera, WD3
3. Define pumping volumes to move
  - Percentages for those not sure how much
4. Many model runs! Lots of spreadsheets!
  - Test aquifer parameters that control timing

# 2013 Total Pumping - All SAJB Members



# 2013 Seasonal Increase in Pumping - All SAJB Members

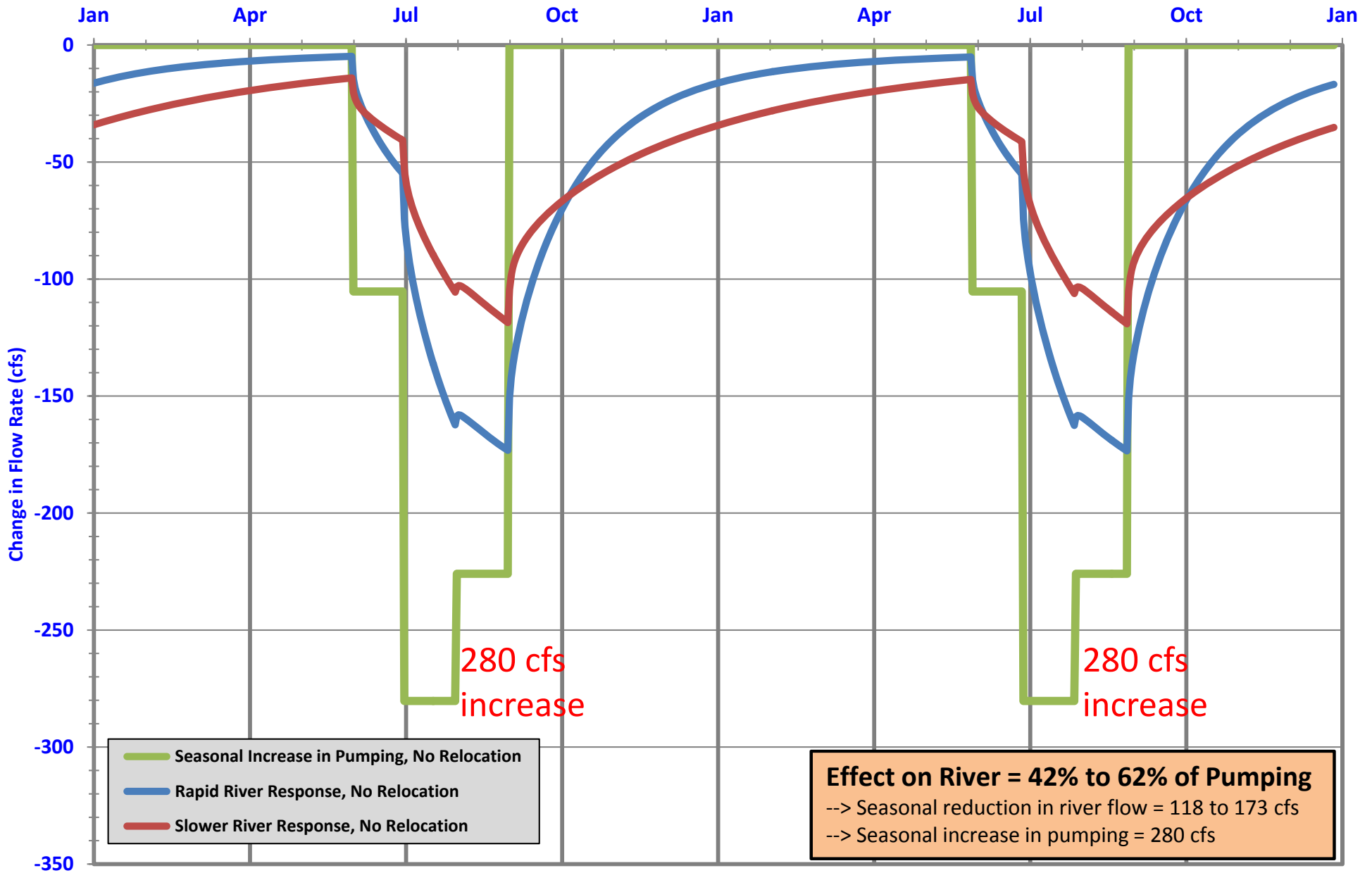


— Seasonal Increase in Pumping, No Relocation

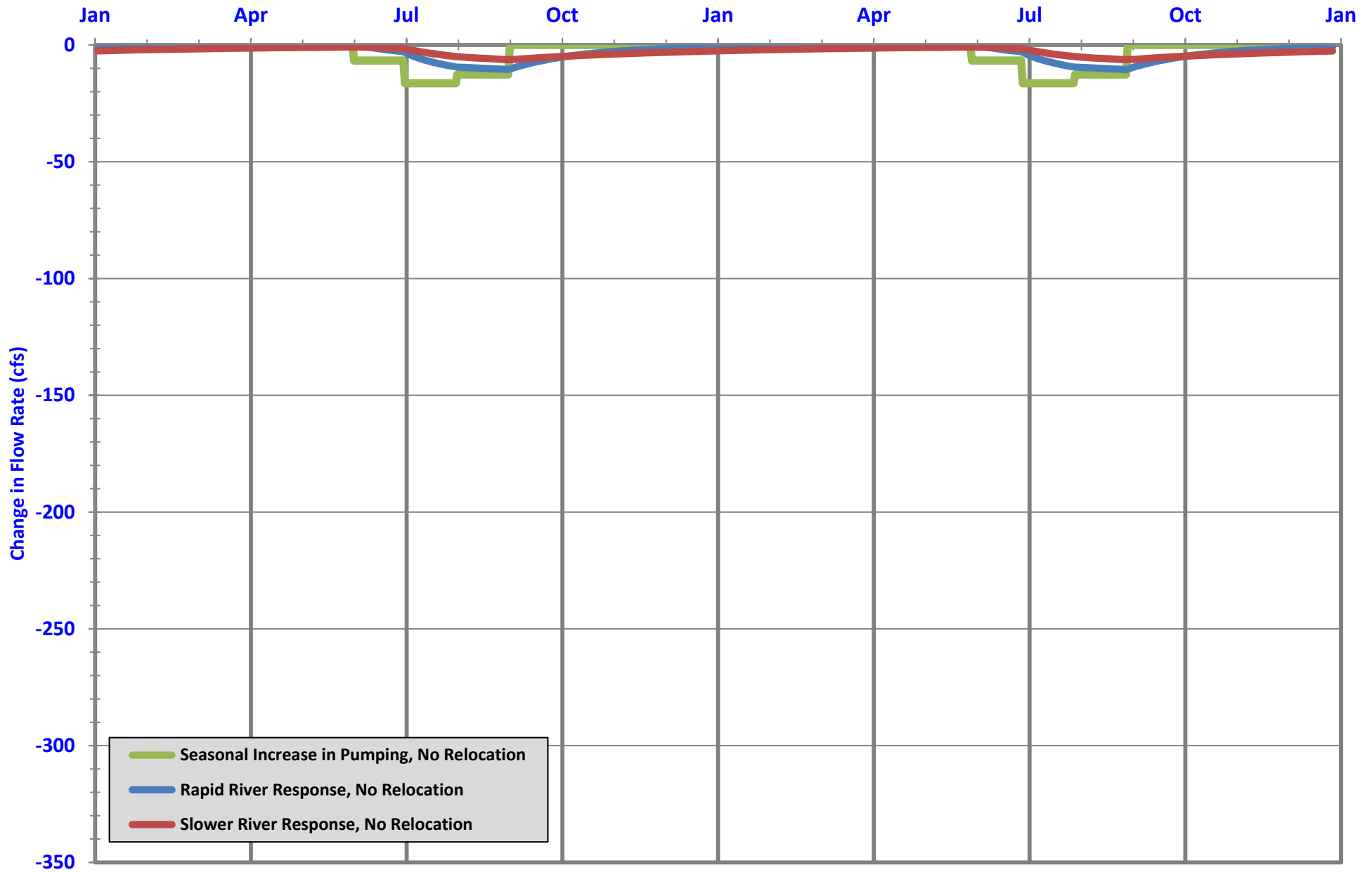
280 cfs  
increase

280 cfs  
increase

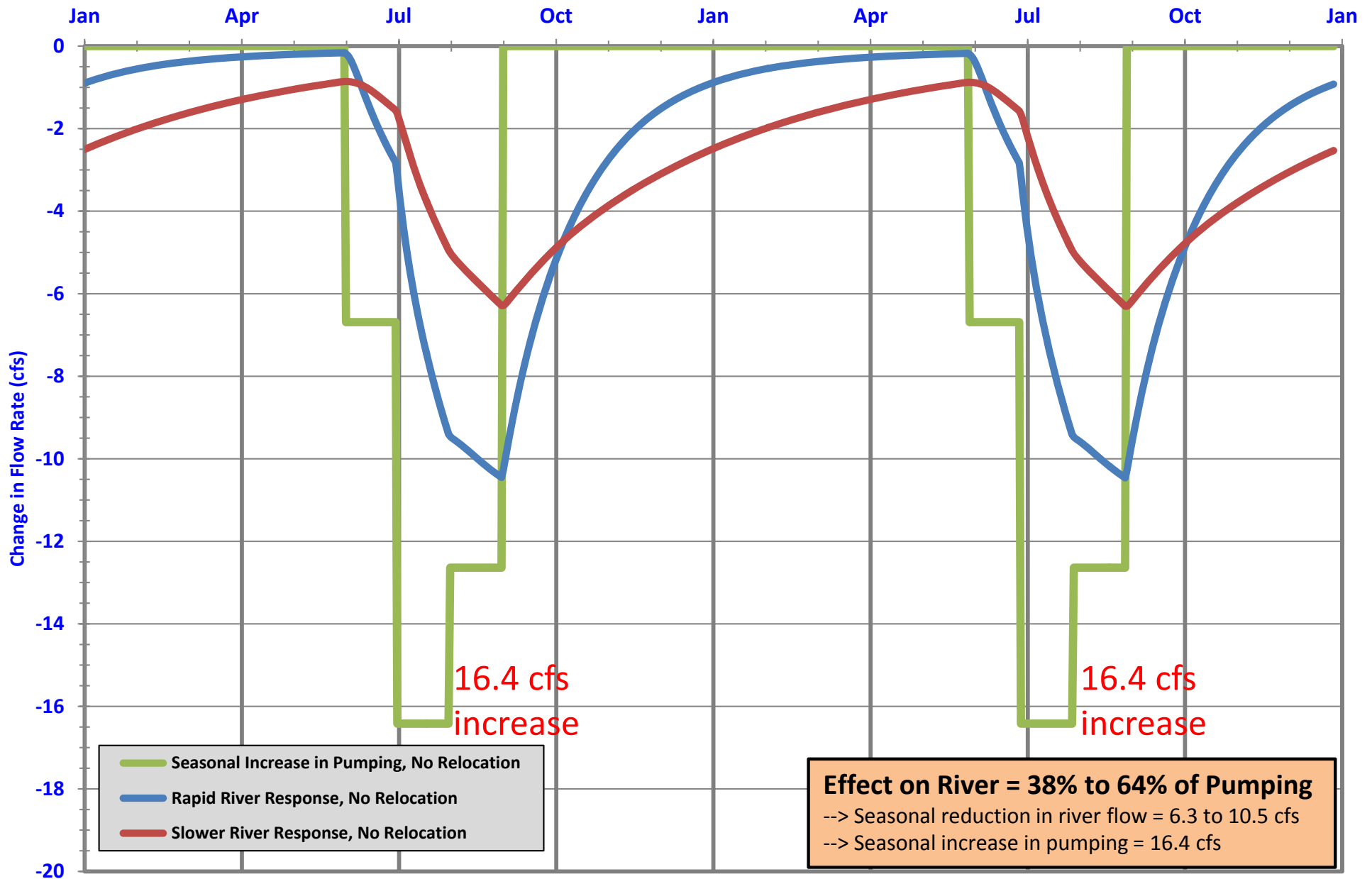
# Spokane River Modeled Response to Seasonal Increase in Pumping - All SAJB Members



# Spokane River Modeled Response to Seasonal Increase in Pumping - Vera



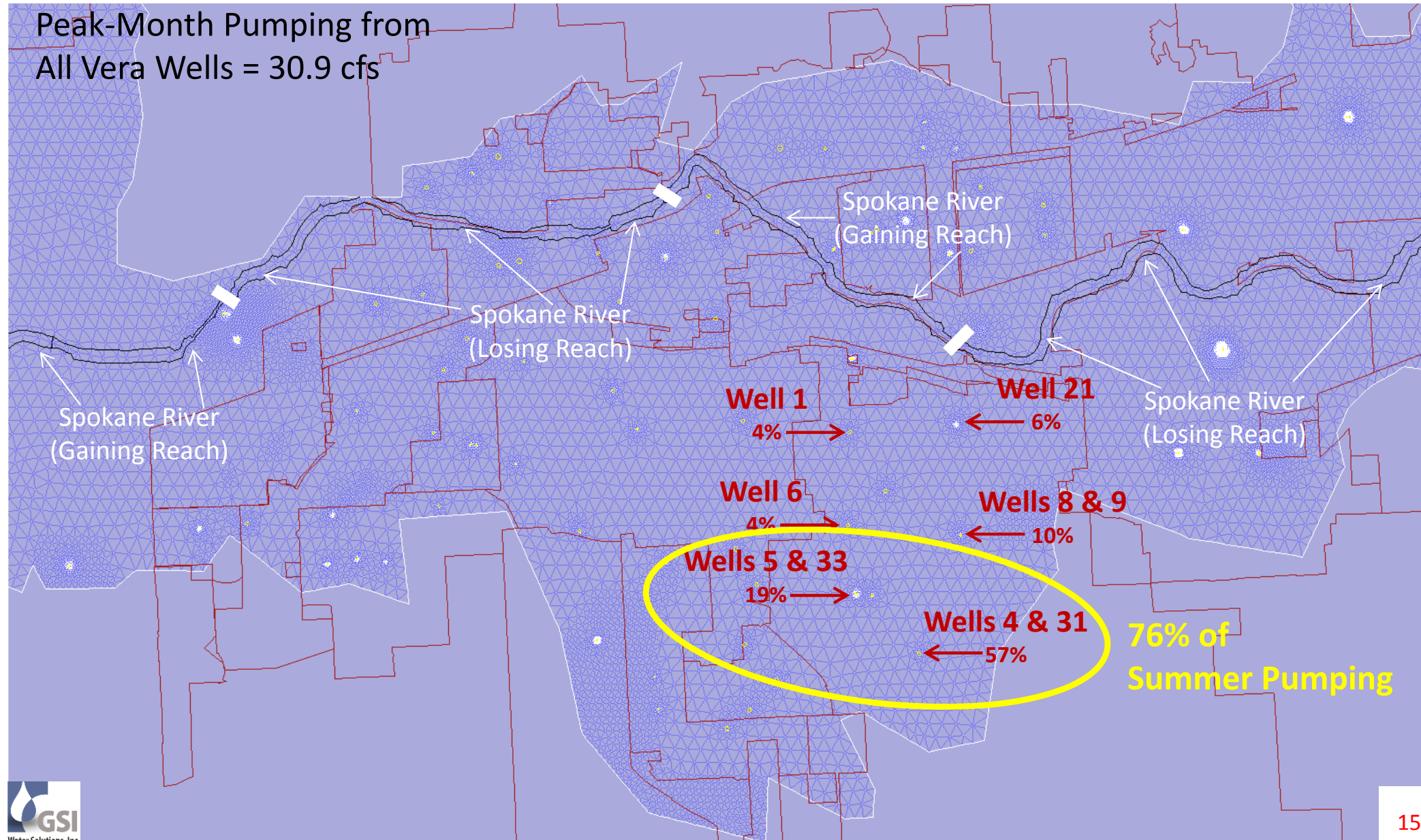
# Spokane River Modeled Response to Seasonal Increase in Pumping - Vera



# Vera Water & Power (No Relocation)

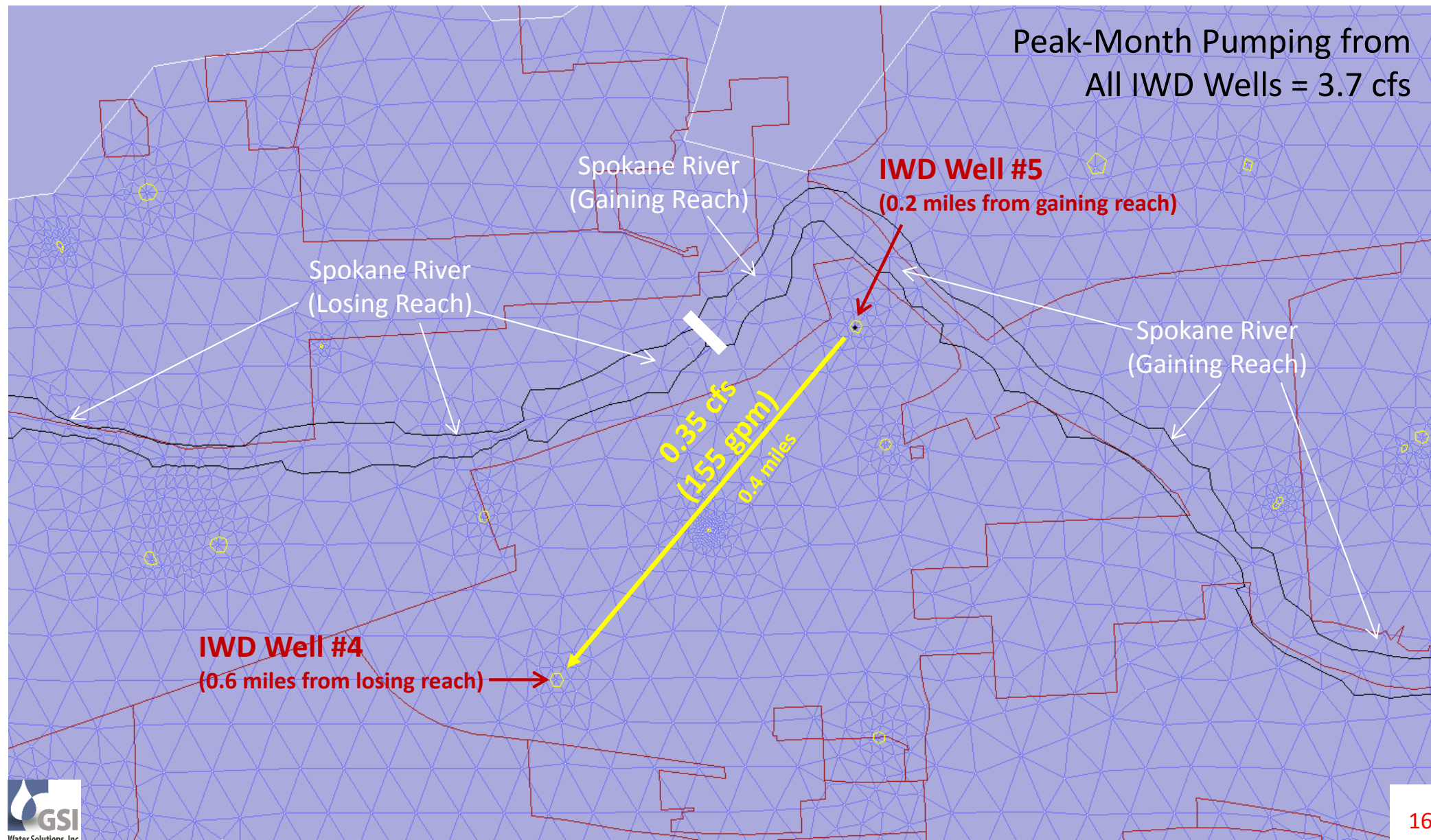
## (Distribution Of Summer Pumping Already Optimal)

Peak-Month Pumping from  
All Vera Wells = 30.9 cfs



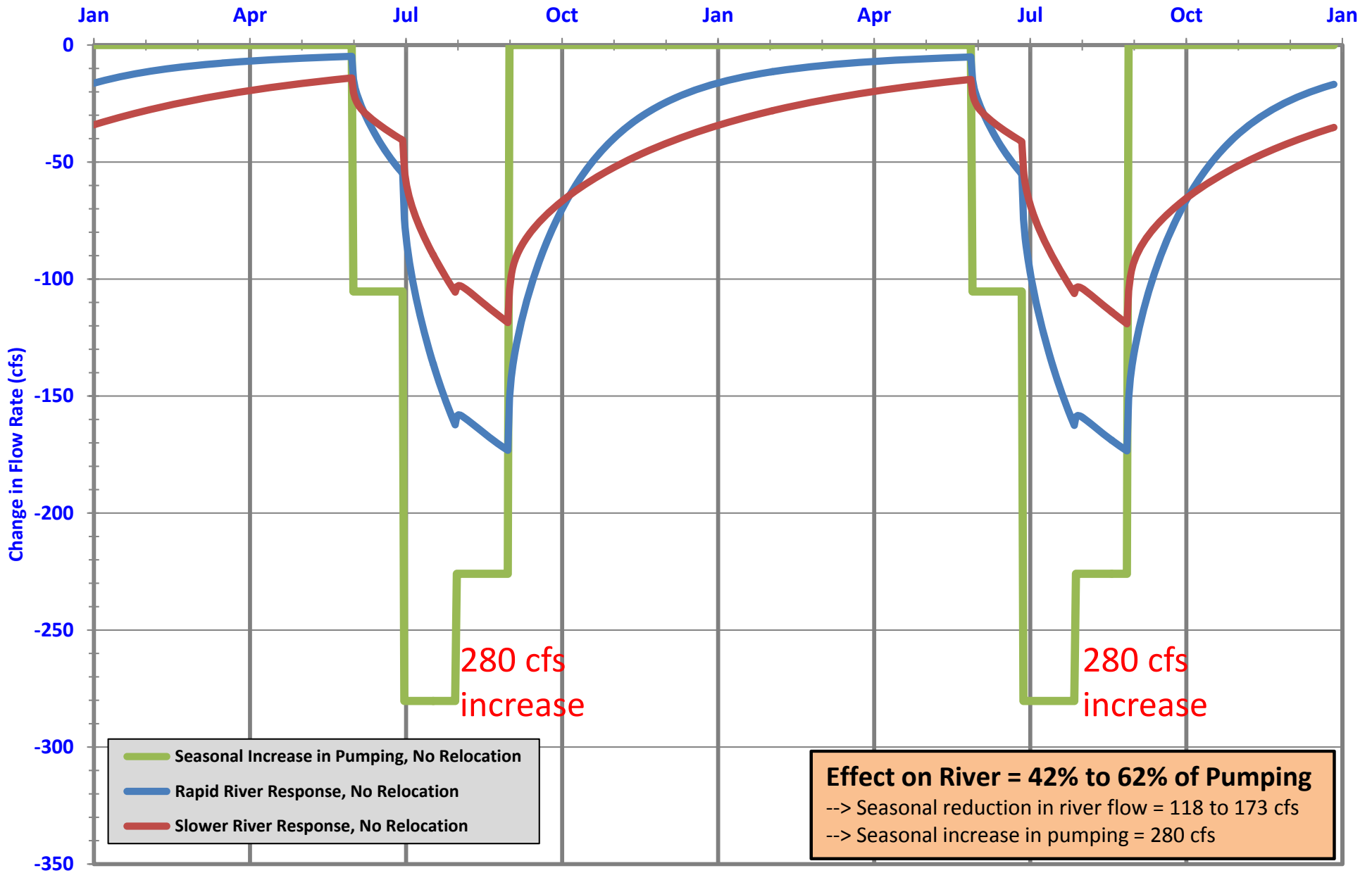
# Irvin Water District

(Move From Cement Well 5 To Montgomery Well 4)  
(Move Up To 0.35 cfs = 10% Of Peak Pumping)

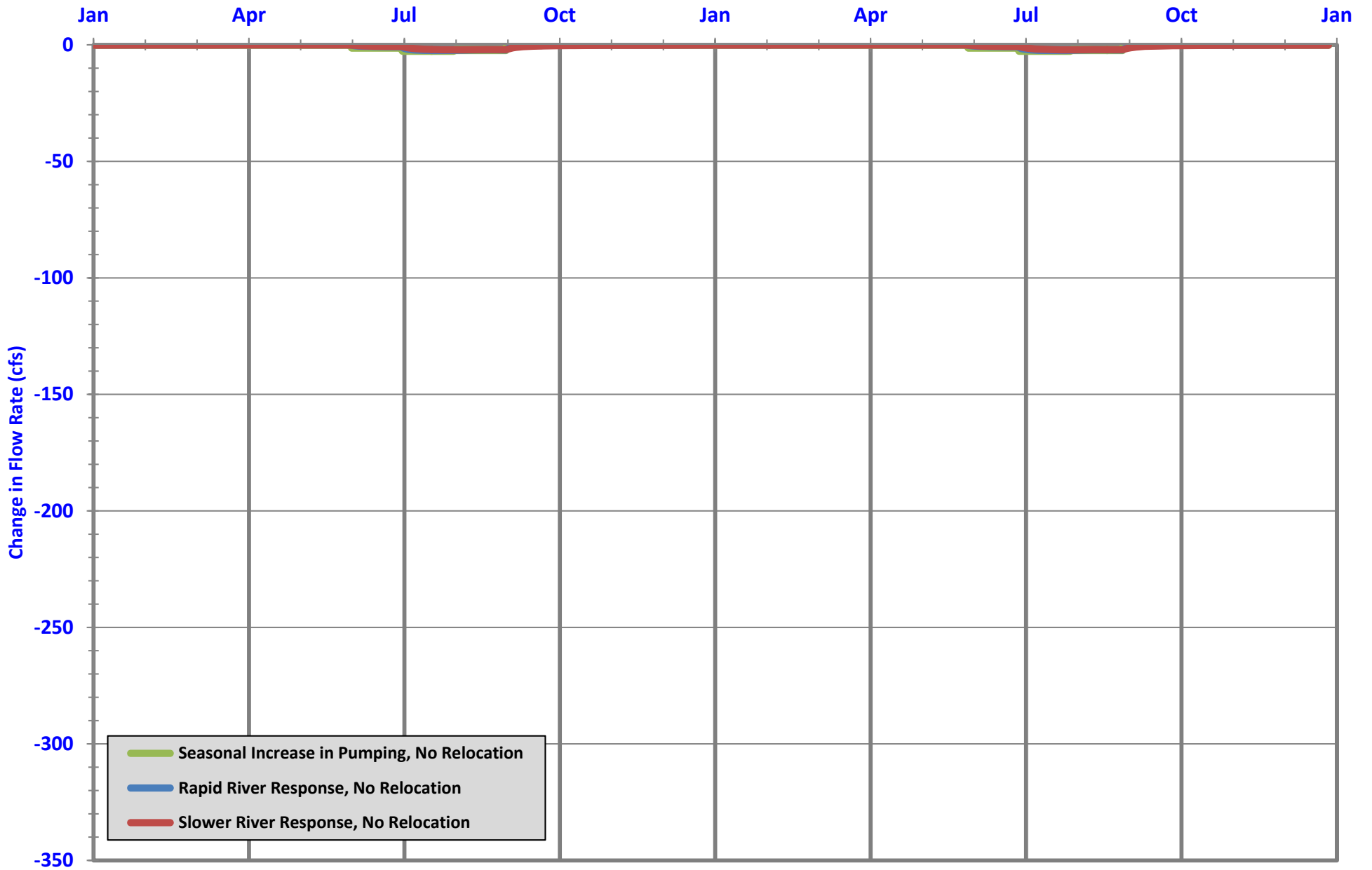




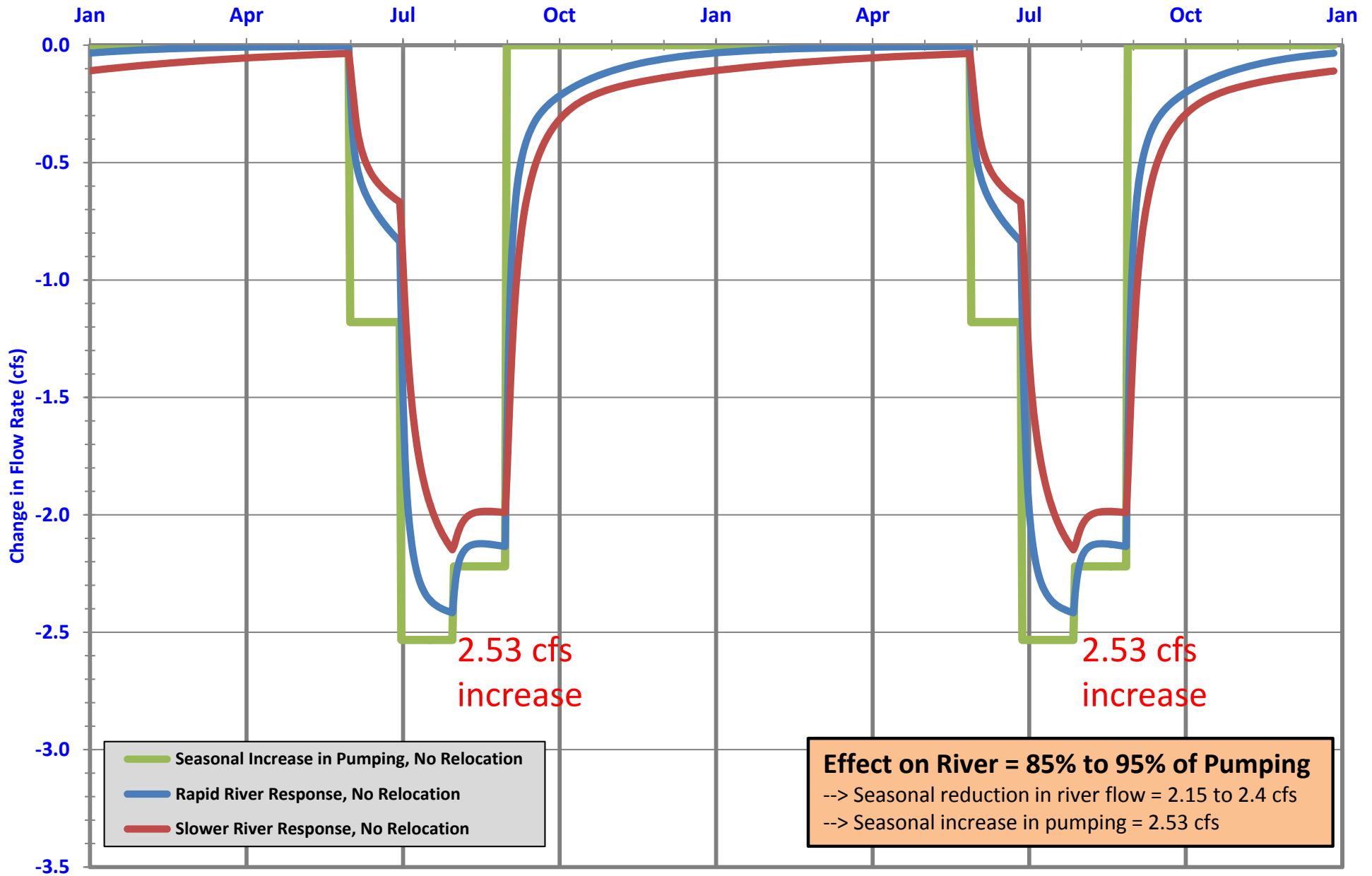
# Spokane River Modeled Response to Seasonal Increase in Pumping - All SAJB Members



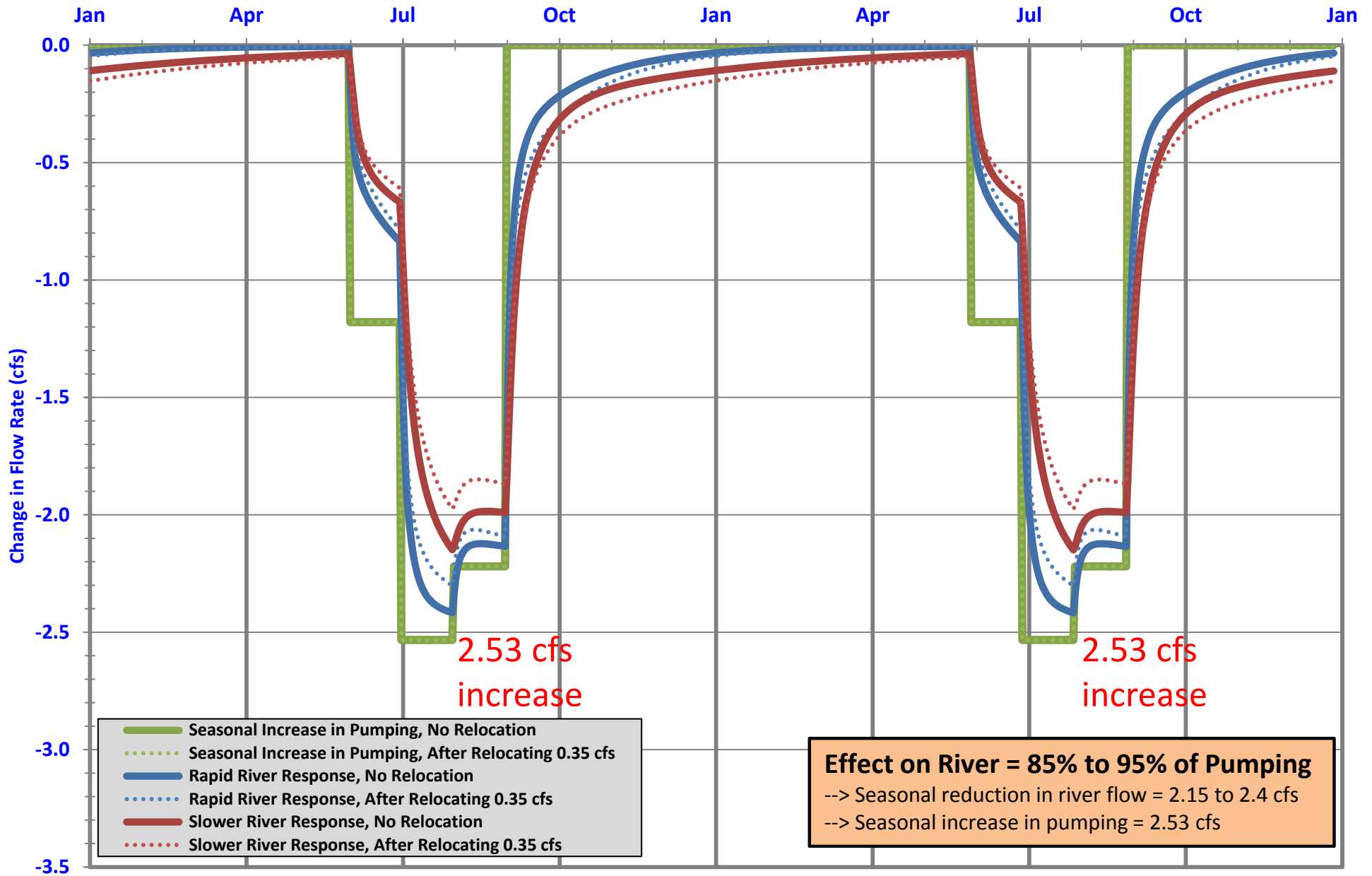
# Spokane River Modeled Response to Seasonal Increase in Pumping - IWD



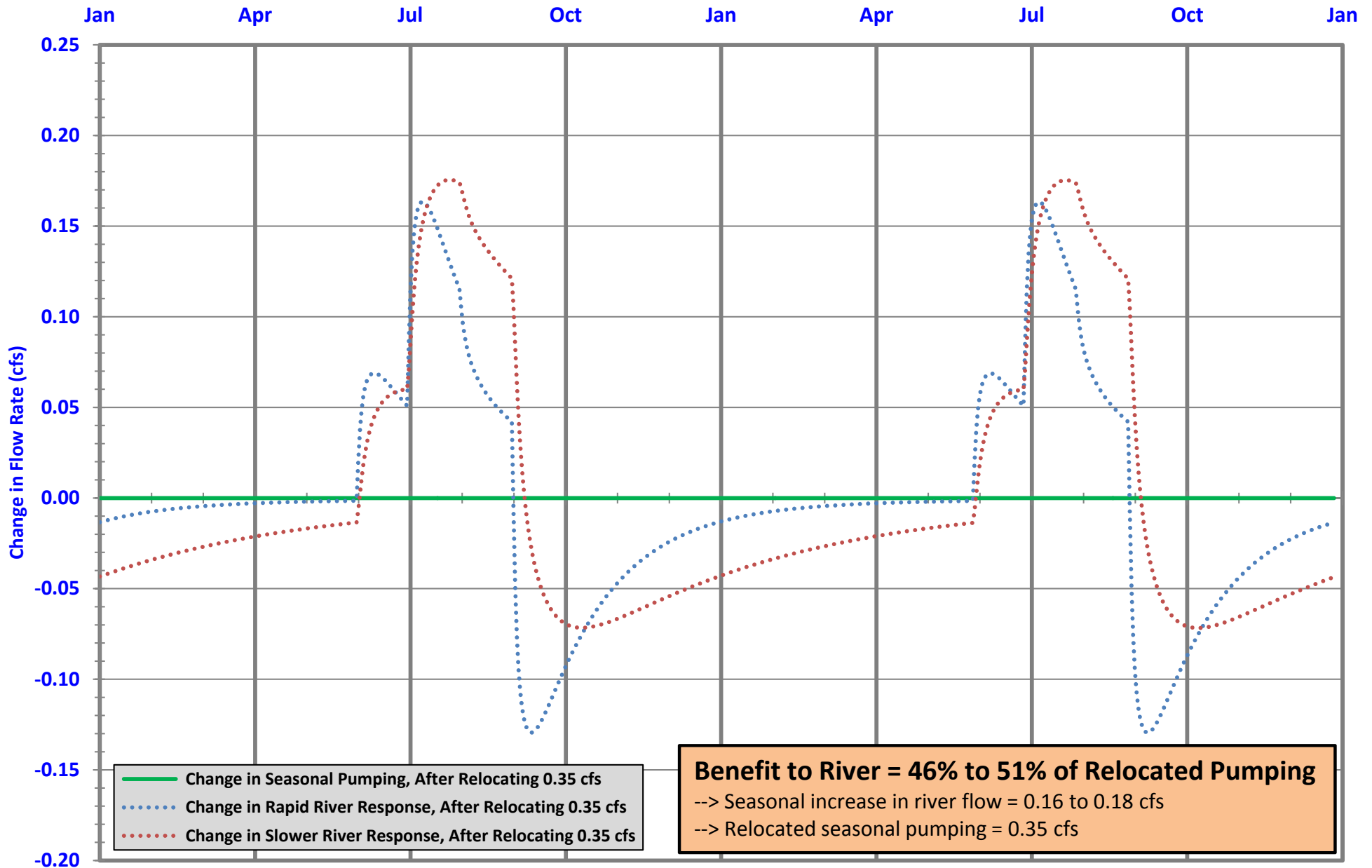
# Spokane River Modeled Response to Seasonal Increase in Pumping - IWD



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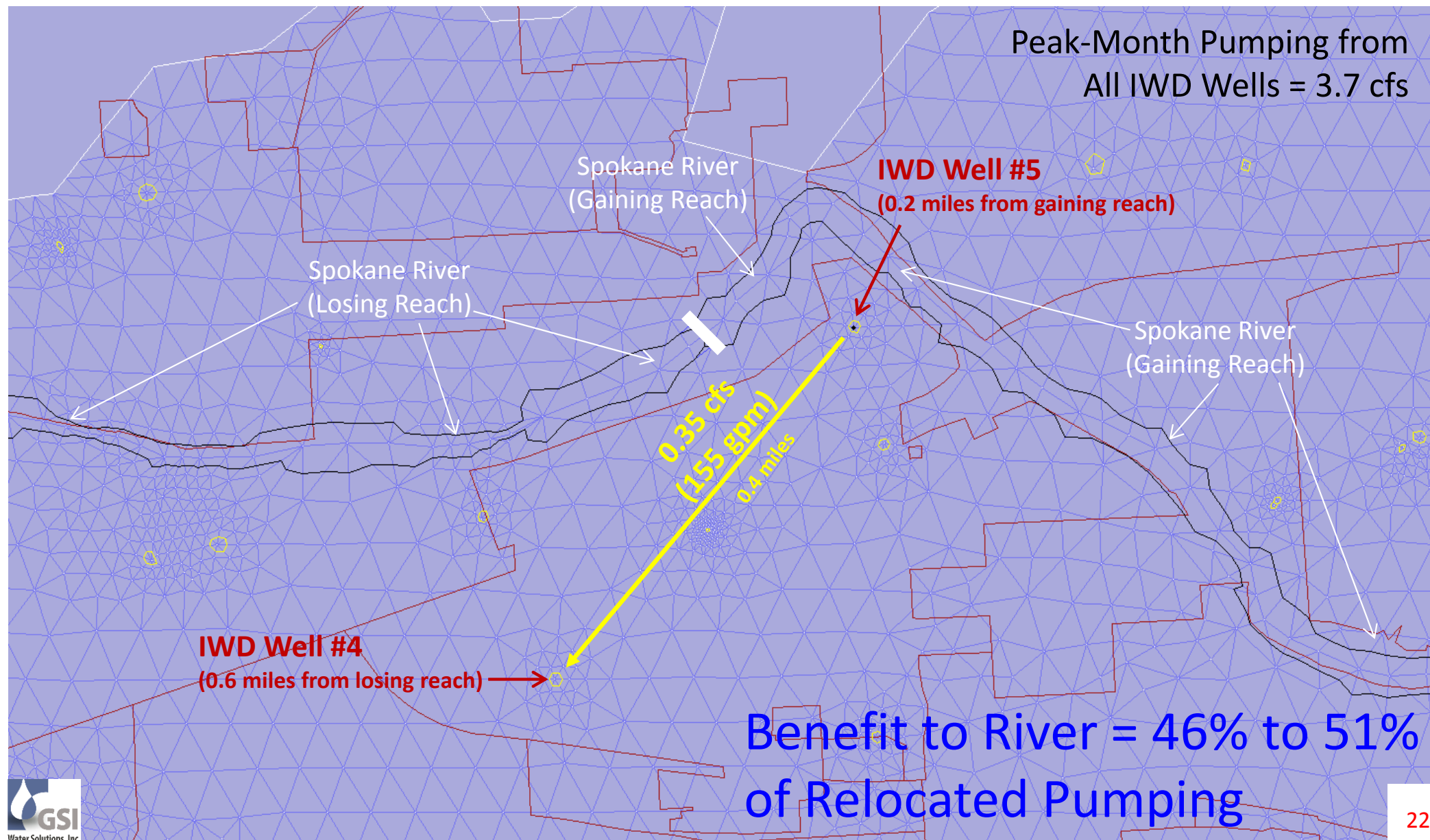
## Change in Spokane River Modeled Response to Seasonal Pumping Relocation - IWD



**Moving Pumping Away from Well Adjacent to Gaining Reach = Notable Benefit to River**

# Irvin Water District

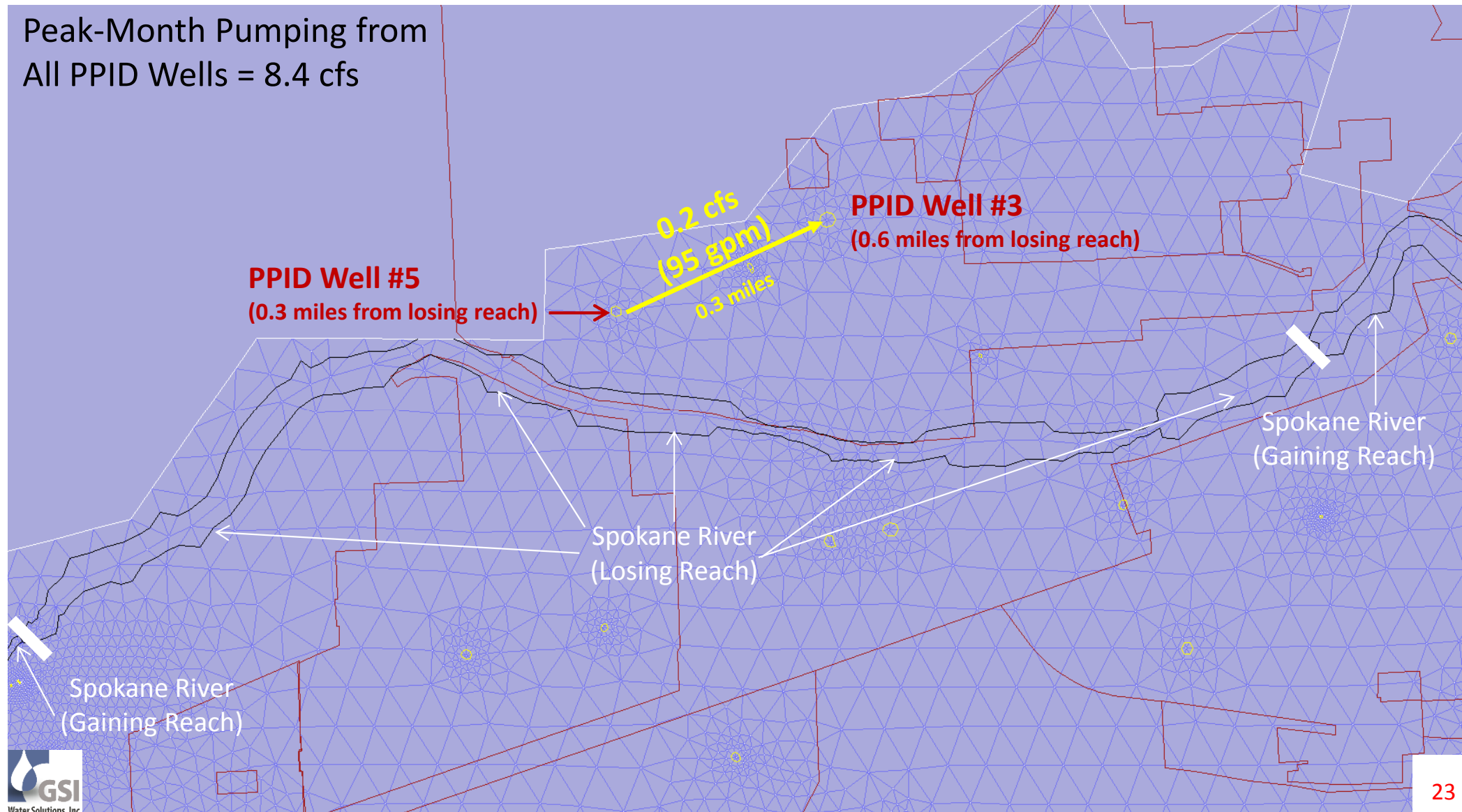
(Move From Cement Well 5 To Montgomery Well 4)  
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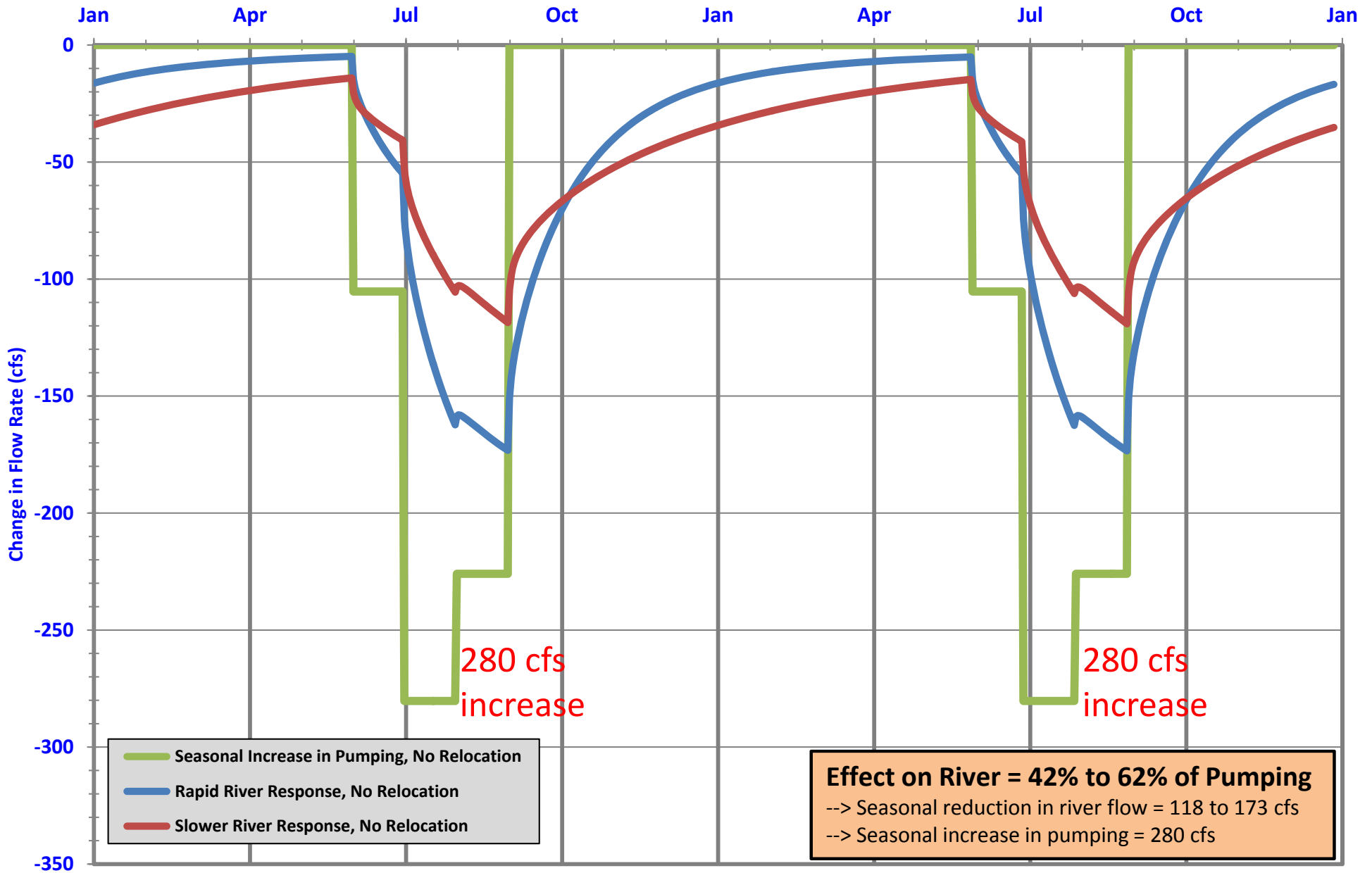
# Pasadena Park Irrigation District

(Move From Well 5 To Well 3)

(Move Up To 0.2 cfs = 2.3% of Well 5 Peak Pumping)

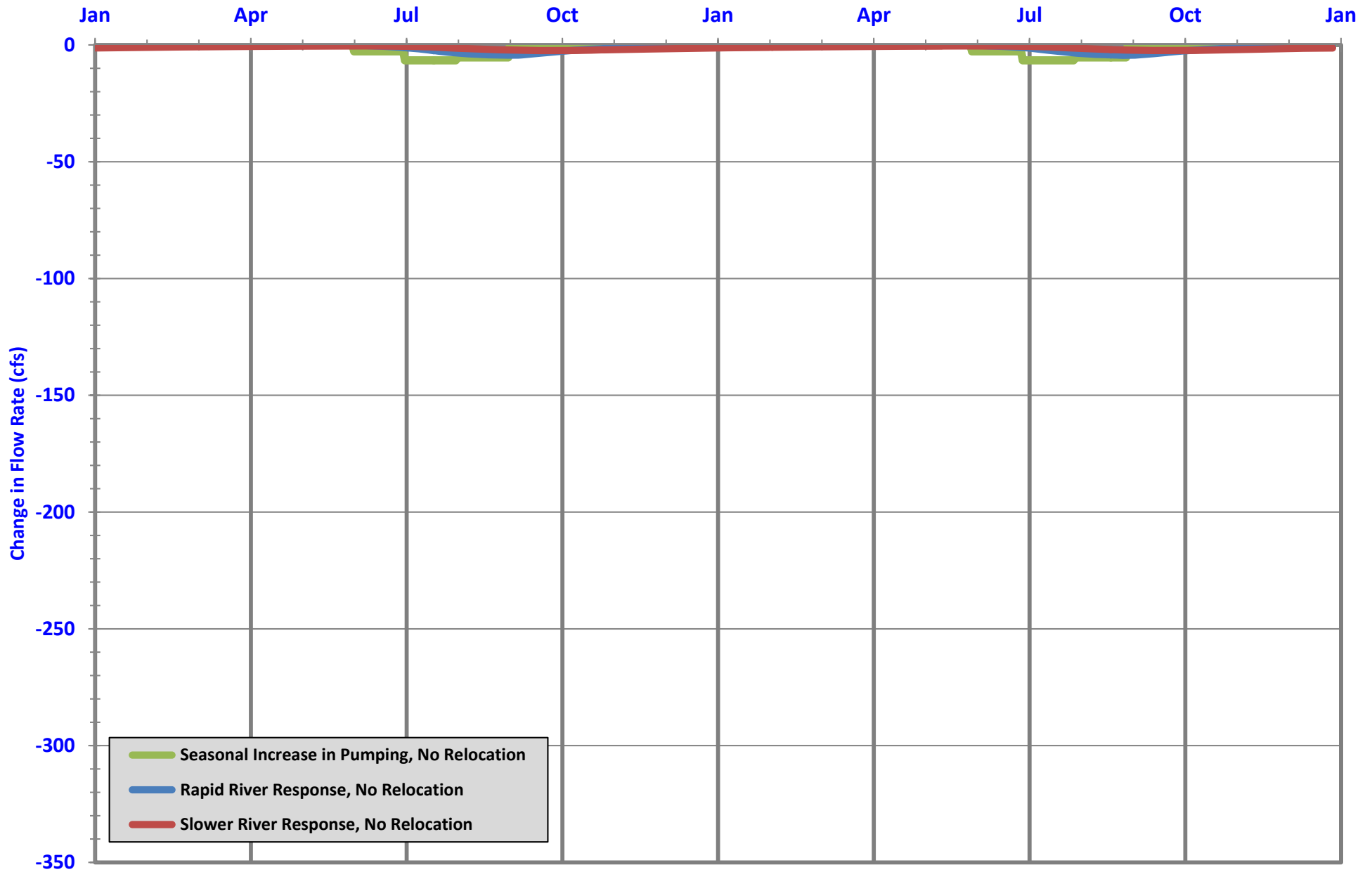


# Spokane River Modeled Response to Seasonal Increase in Pumping - All SAJB Members

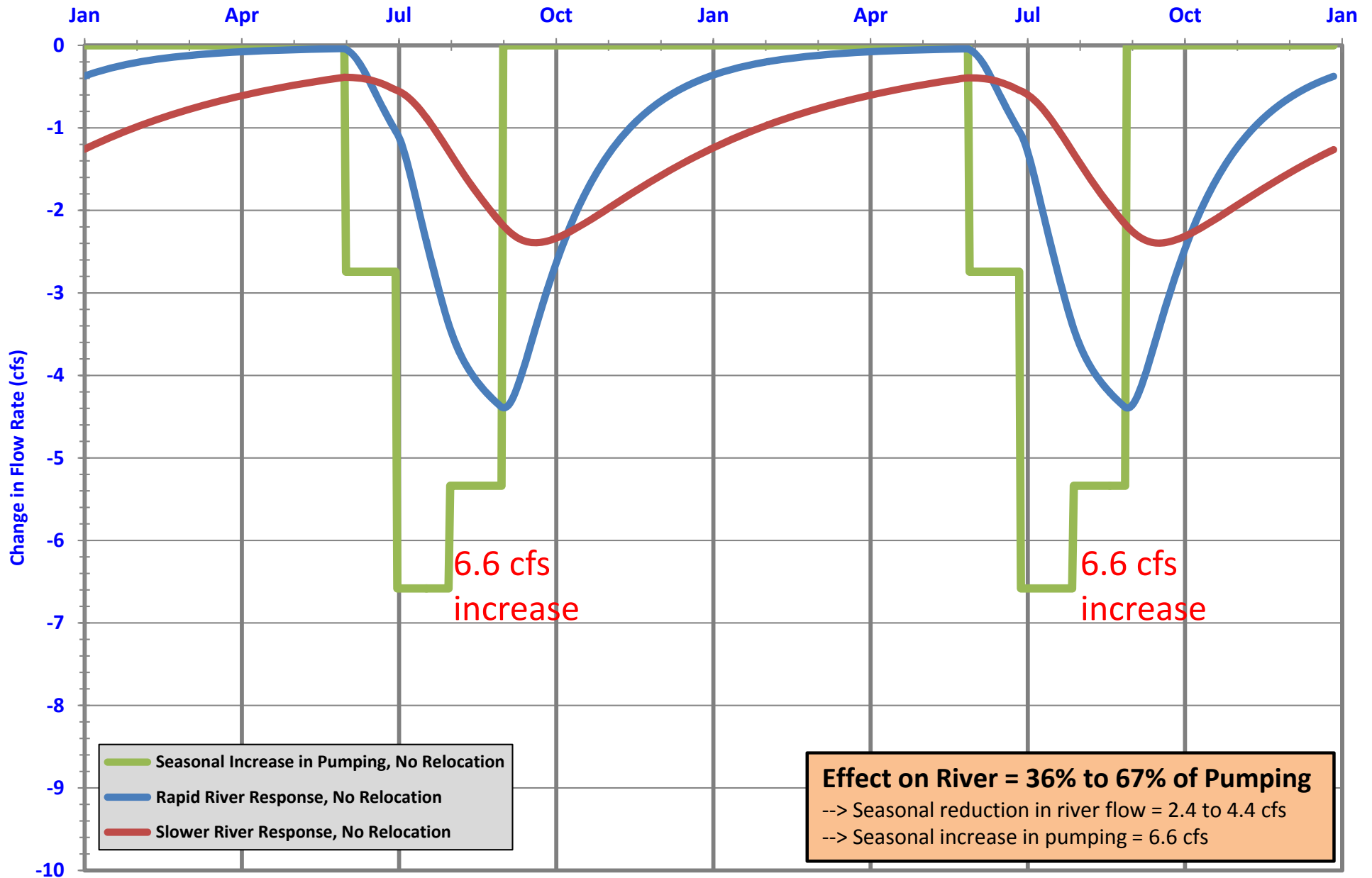




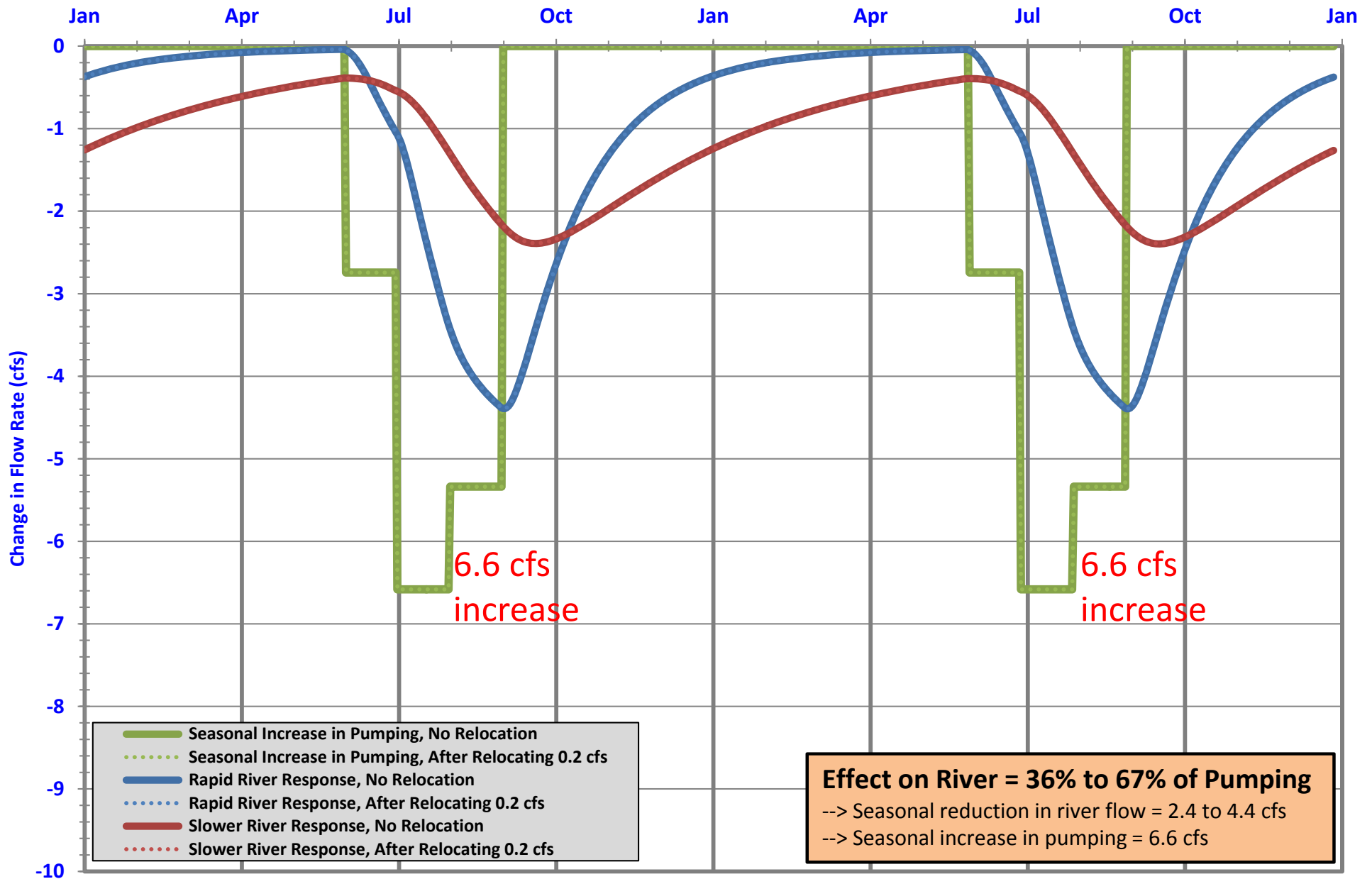
# Spokane River Modeled Response to Seasonal Increase in Pumping - PPID



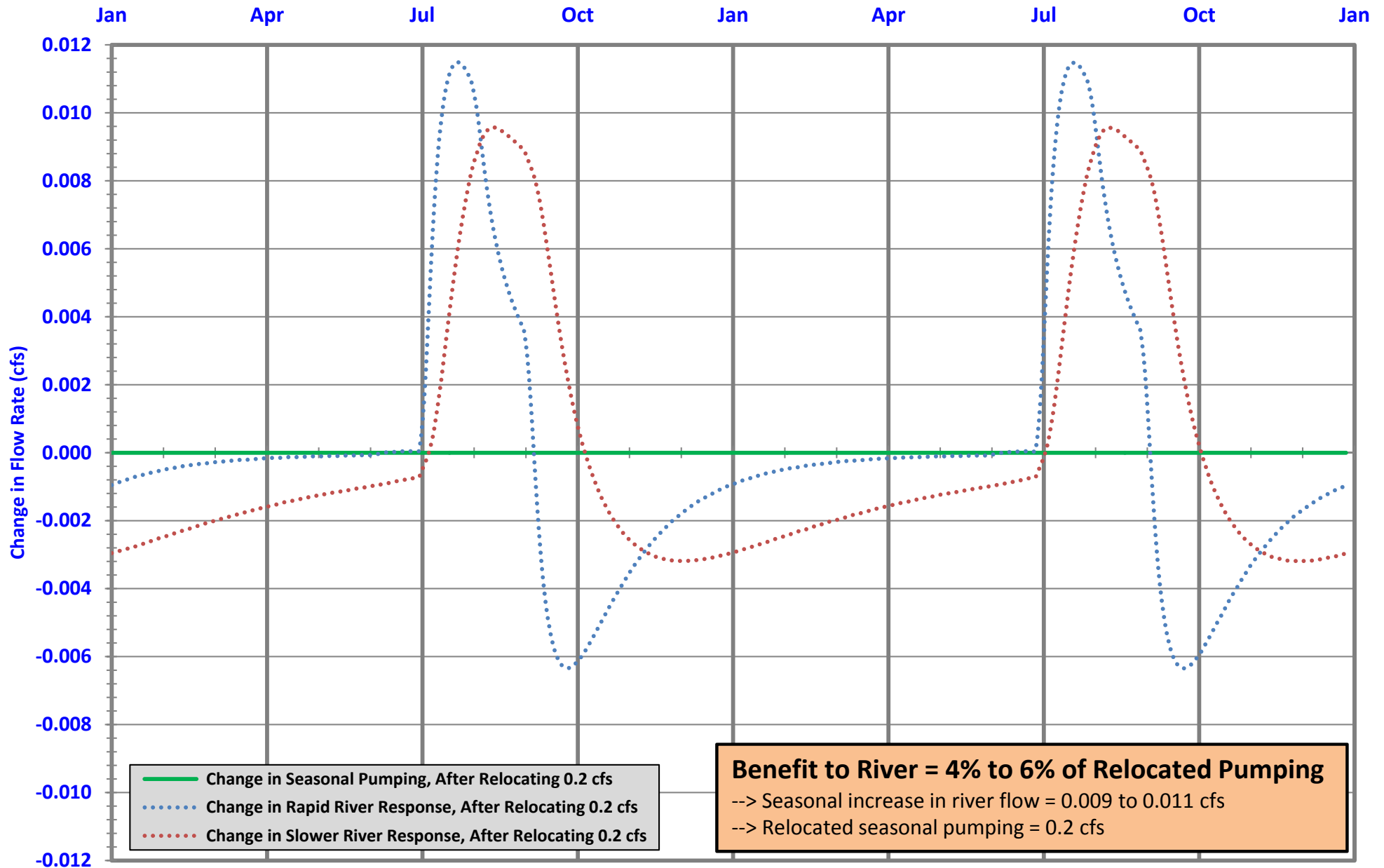
# Spokane River Modeled Response to Seasonal Increase in Pumping - PPID



# Spokane River Modeled Response to Seasonal Increase in Pumping - PPID



## Change in Spokane River Modeled Response to Seasonal Pumping Relocation - PPID

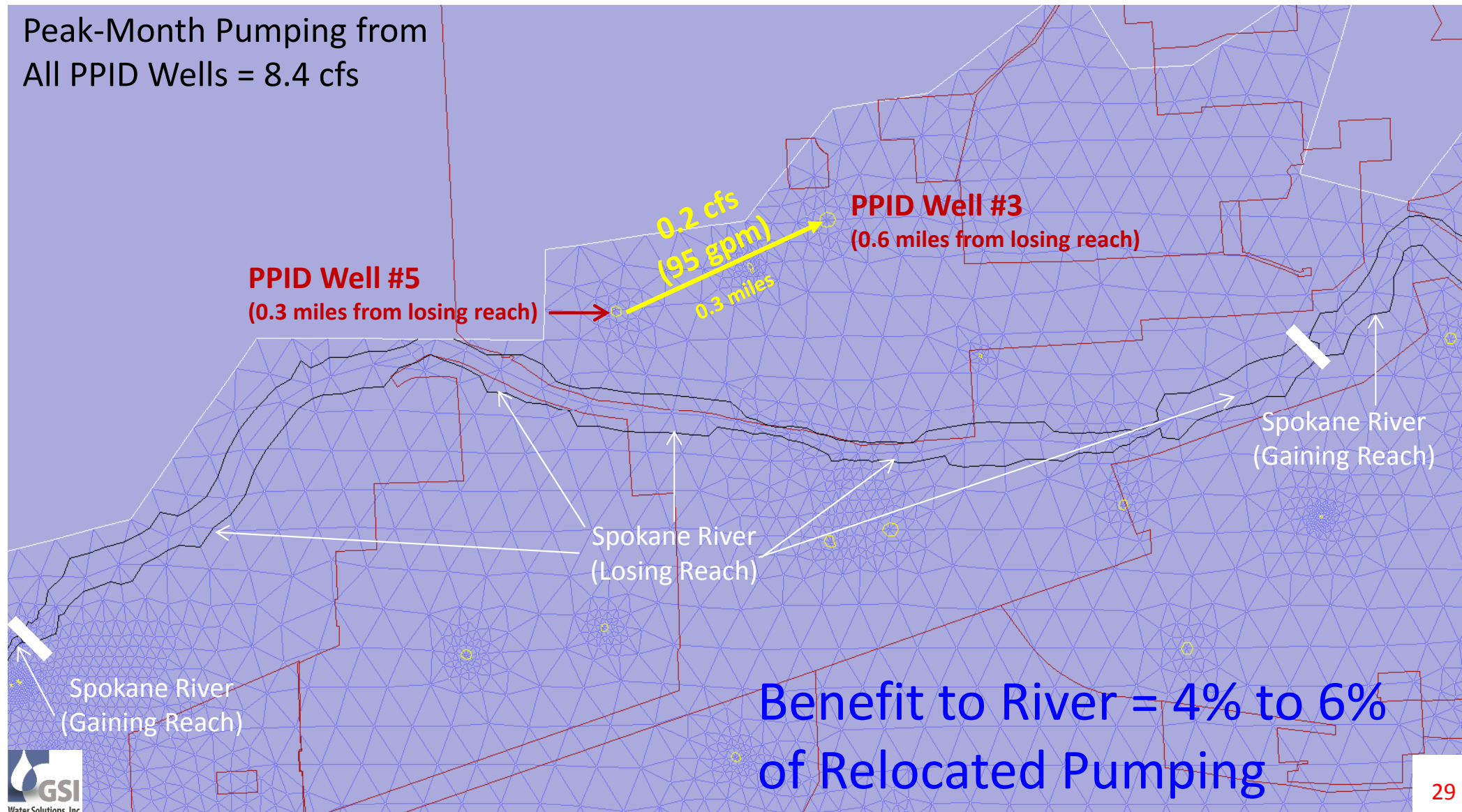


**Near a Losing Reach + Moving Pumping a Small Distance = Minimal Benefit to River**

# Pasadena Park Irrigation District

(Move From Well 5 To Well 3)

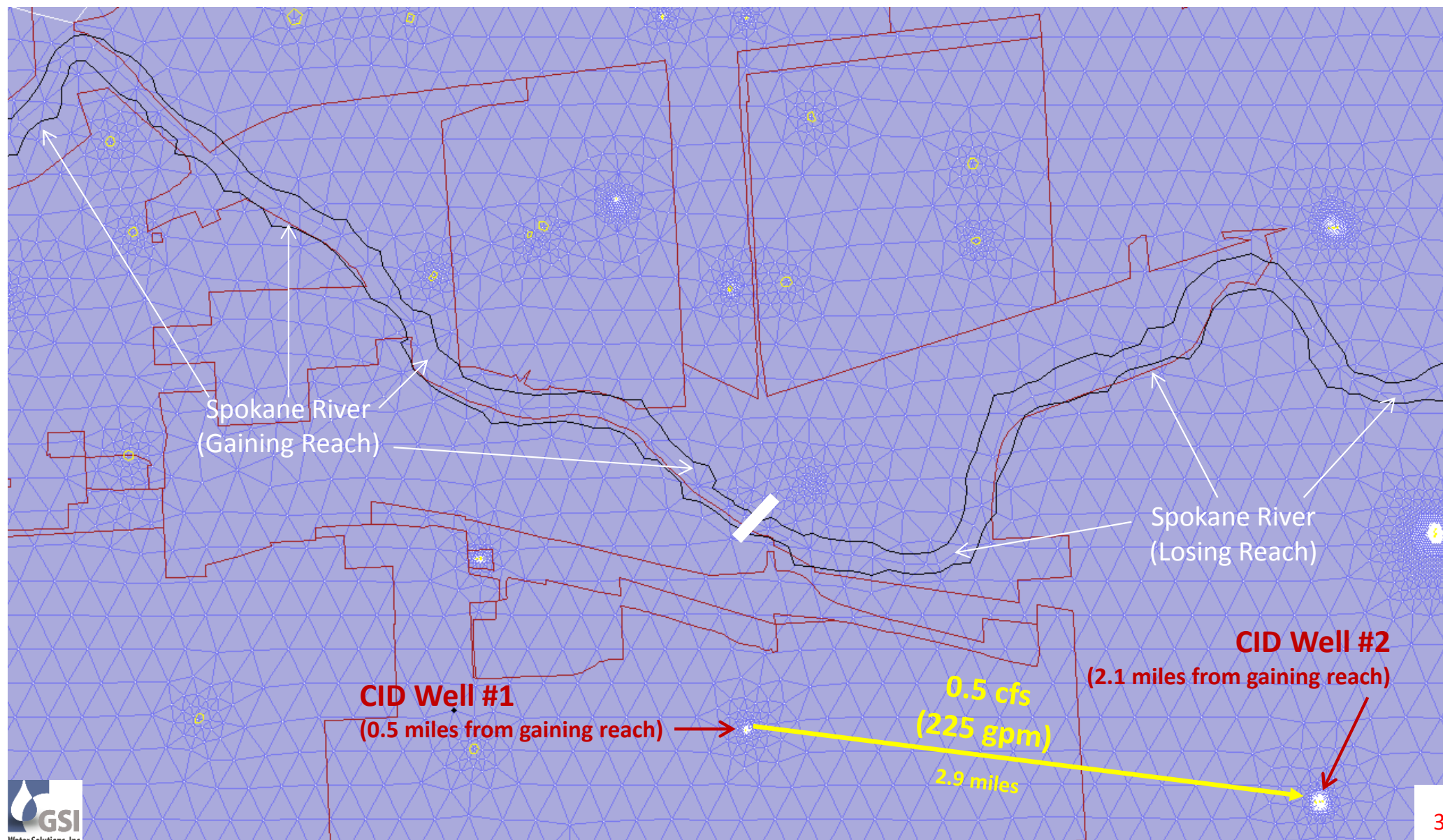
(Move Up To 0.2 cfs = 2.3% of Well 5 Peak Pumping)



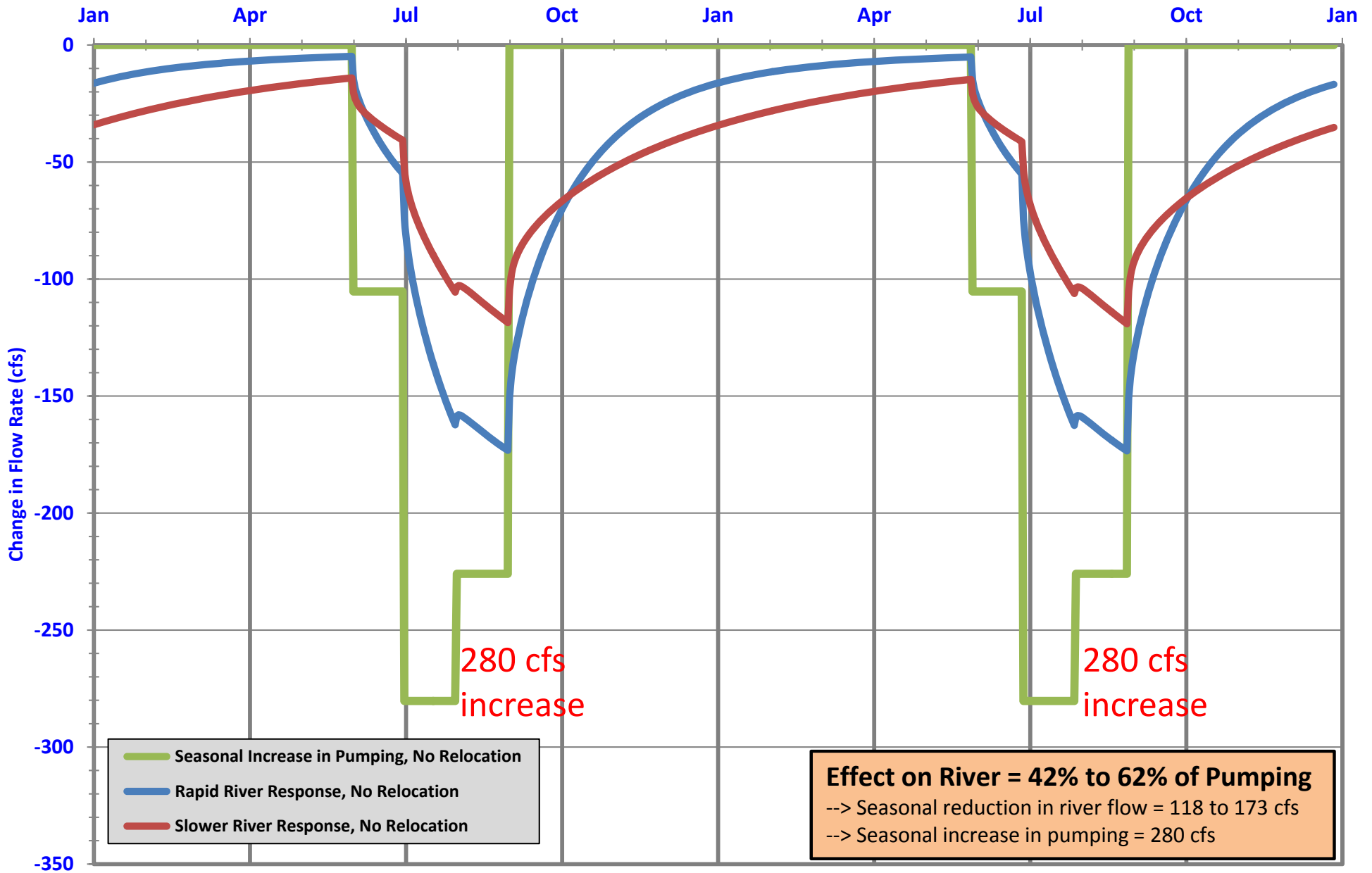
# Consolidated Irrigation District

(Move From Well 1 To Well 2)

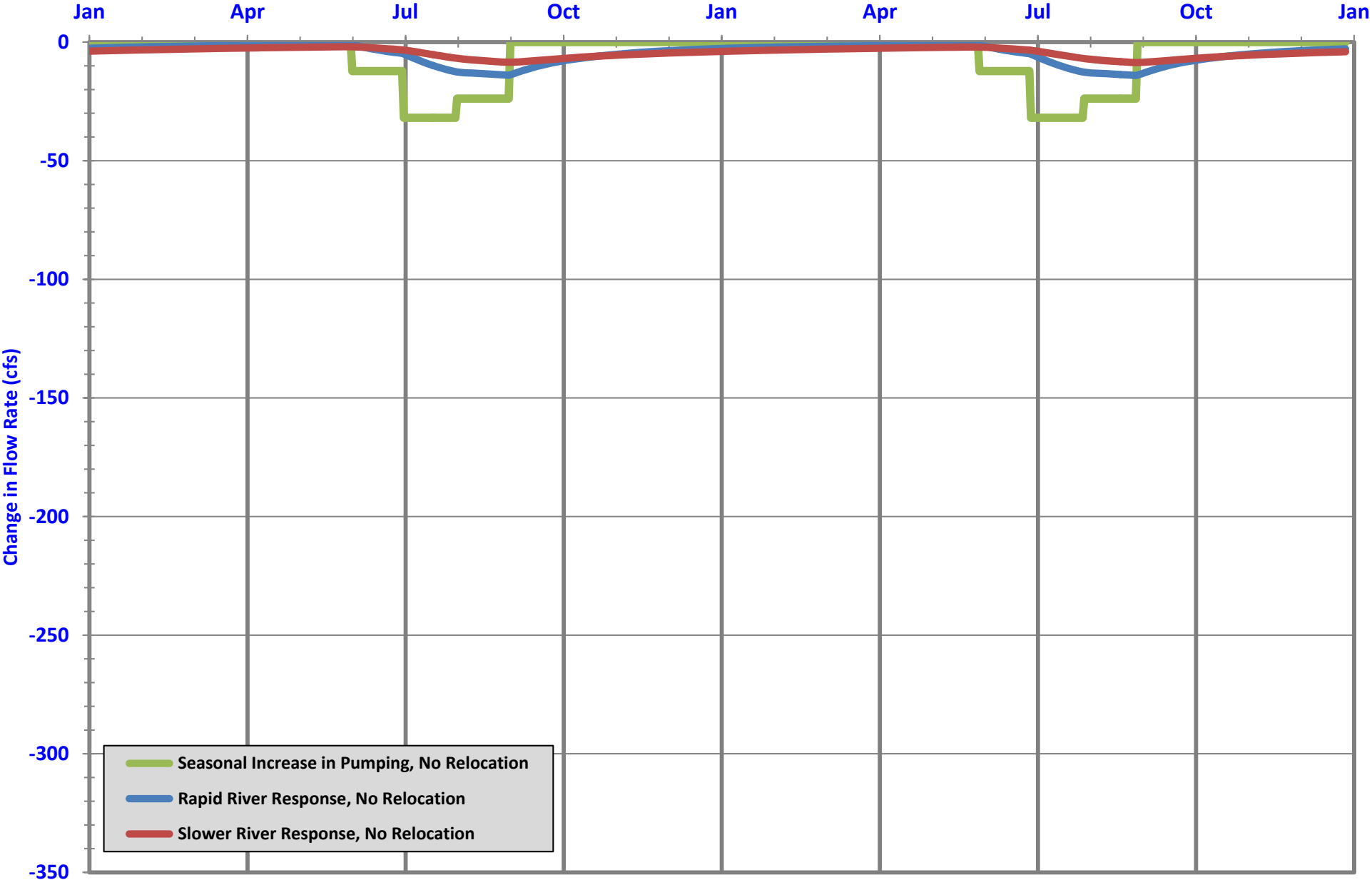
(Move 0.5 cfs = 10% Of May Pumping at Well 1)



# Spokane River Modeled Response to Seasonal Increase in Pumping - All SAJB Members

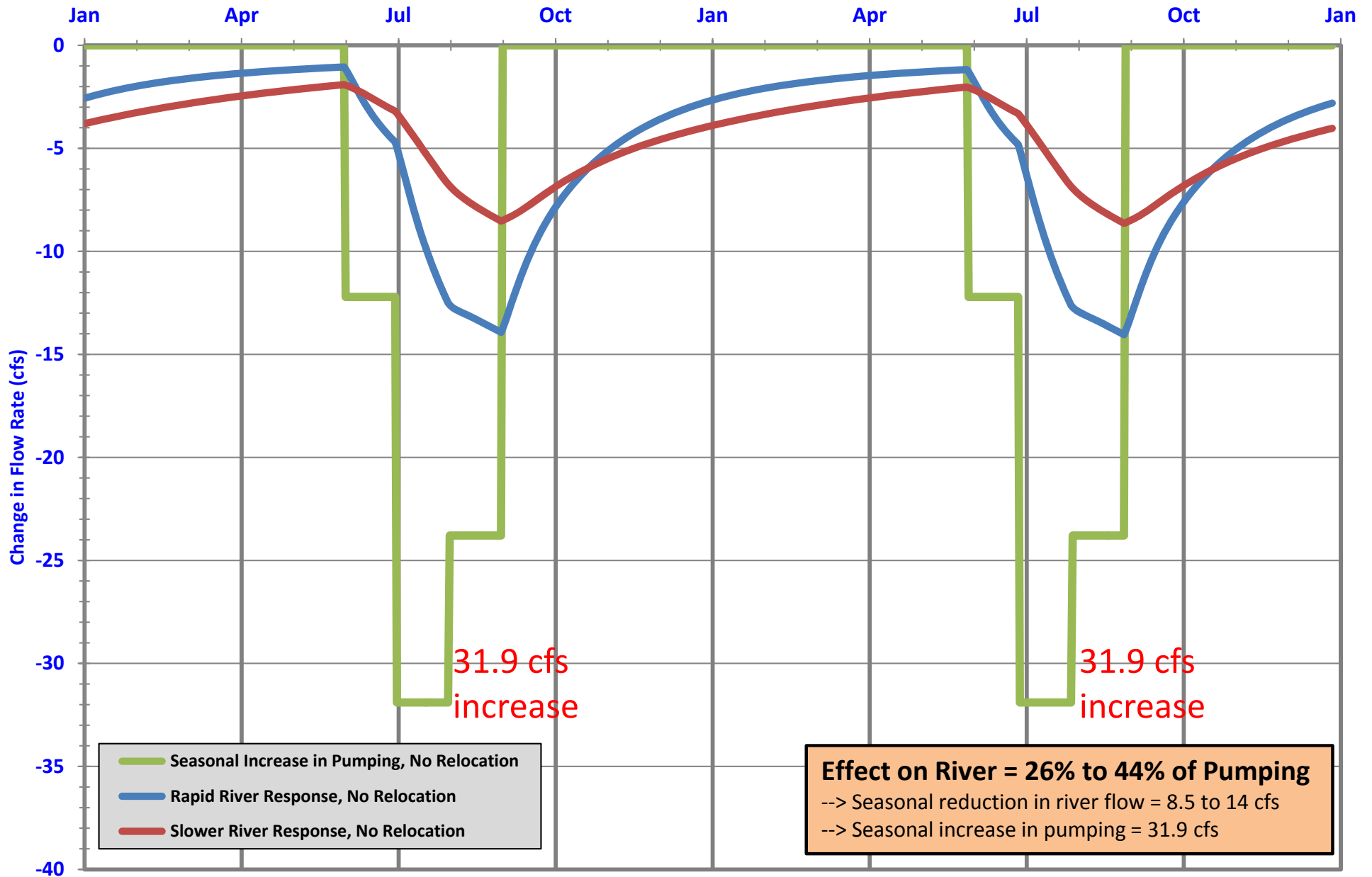


# Spokane River Modeled Response to Seasonal Increase in Pumping - CID

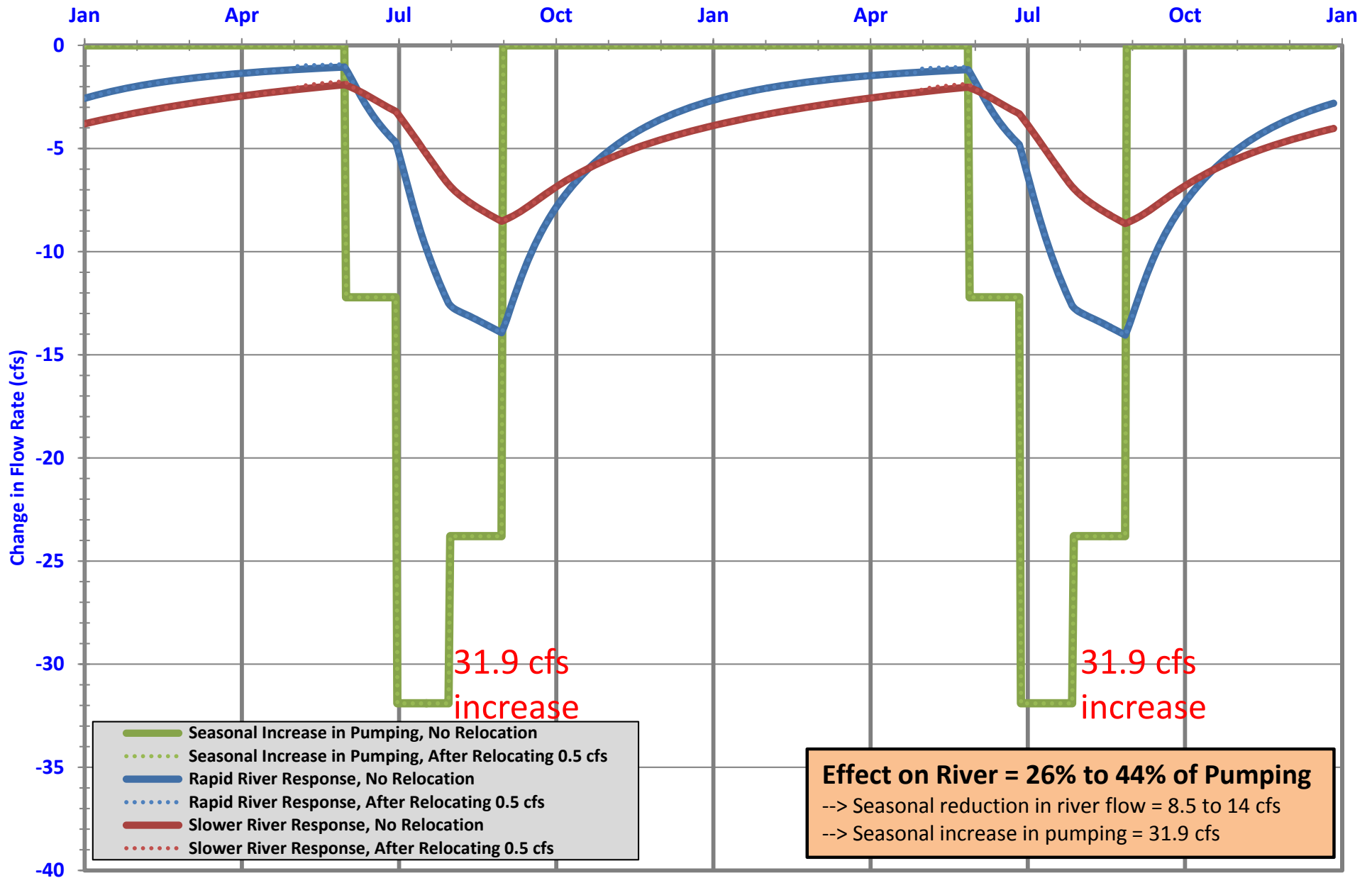




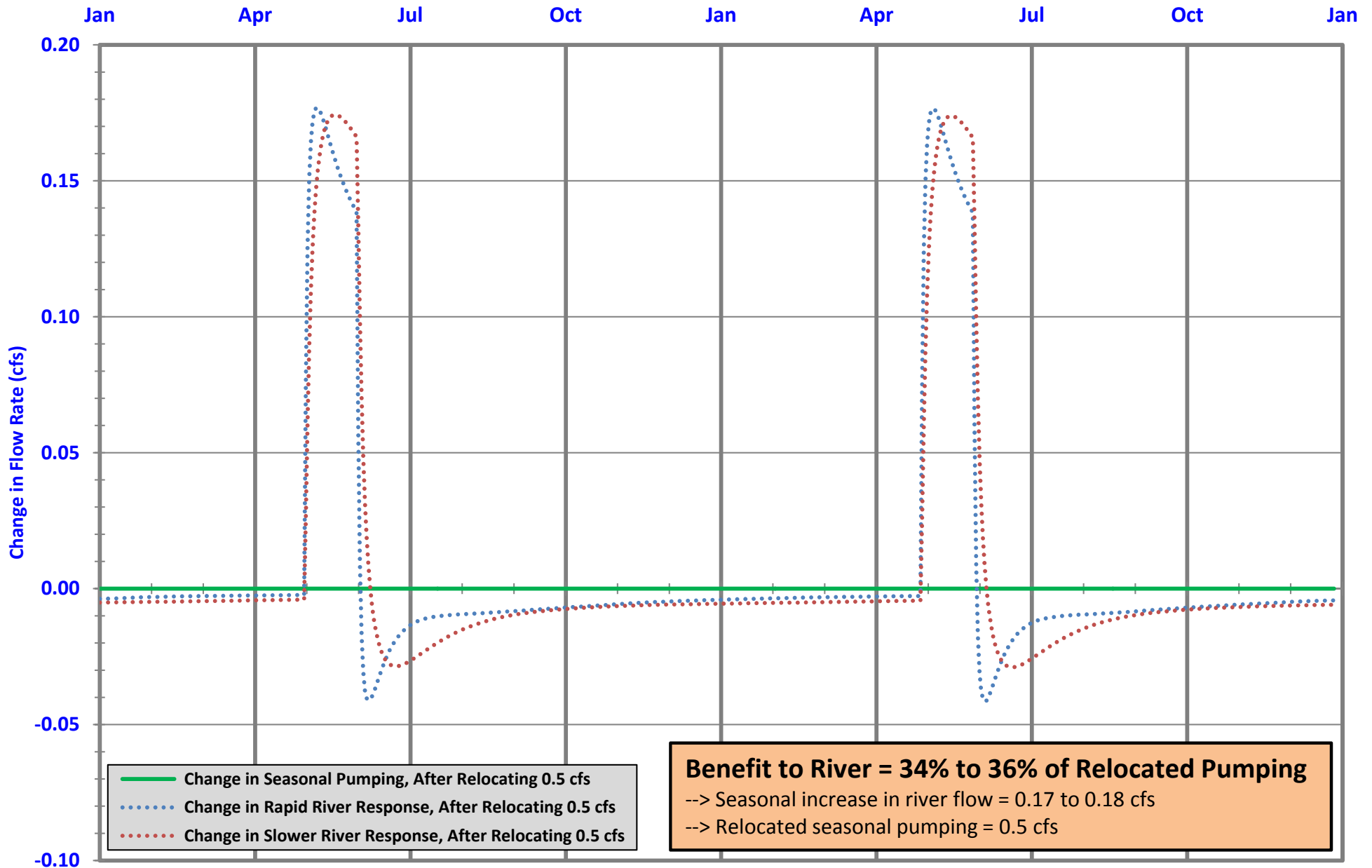
# Spokane River Modeled Response to Seasonal Increase in Pumping - CID



# Spokane River Modeled Response to Seasonal Increase in Pumping - CID



## Change in Spokane River Modeled Response to Seasonal Pumping Relocation - CID

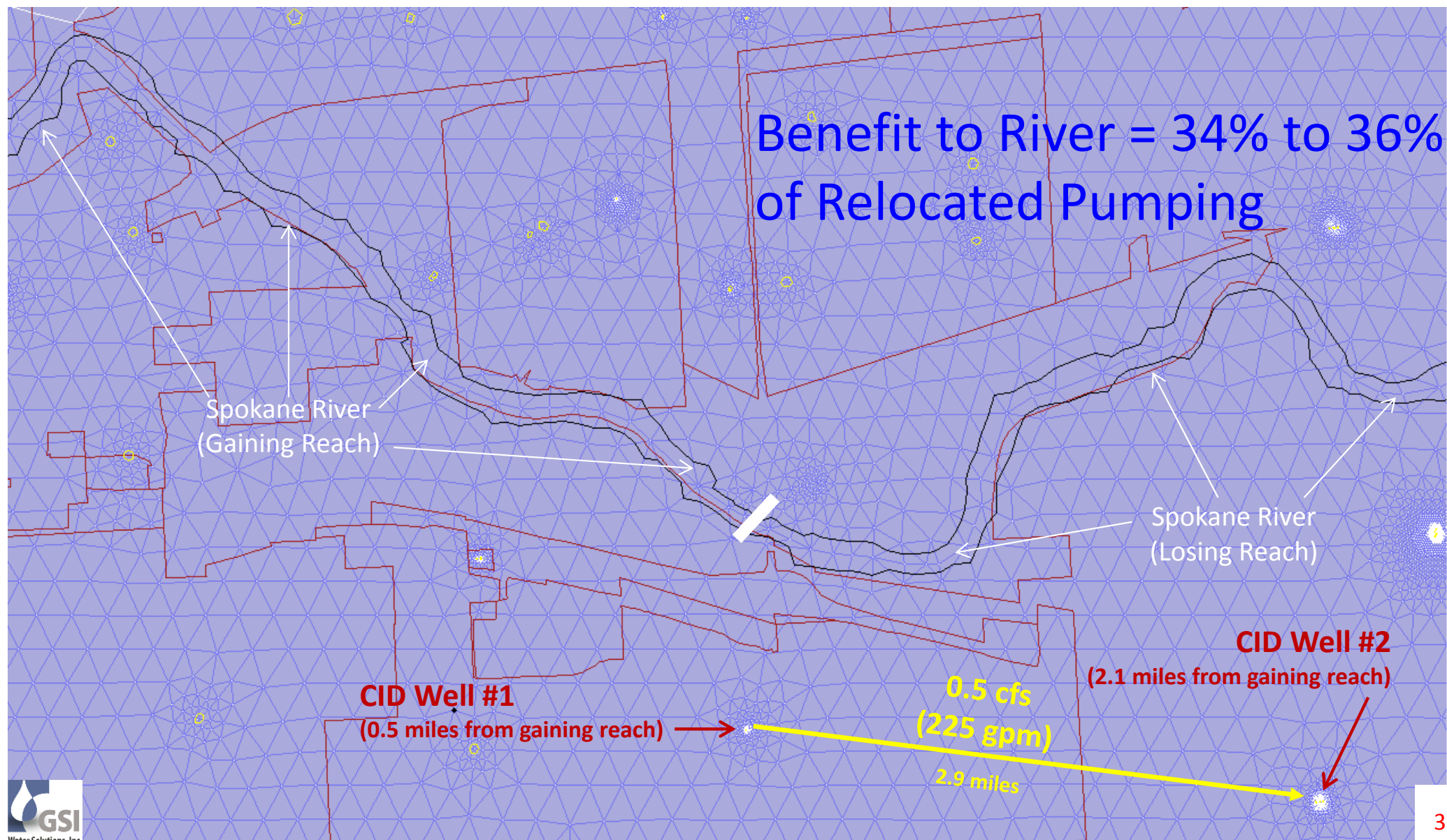


**Moving Pumping Away from Well Adjacent to Gaining Reach = Notable Benefit to River**

# Consolidated Irrigation District

(Move From Well 1 To Well 2)

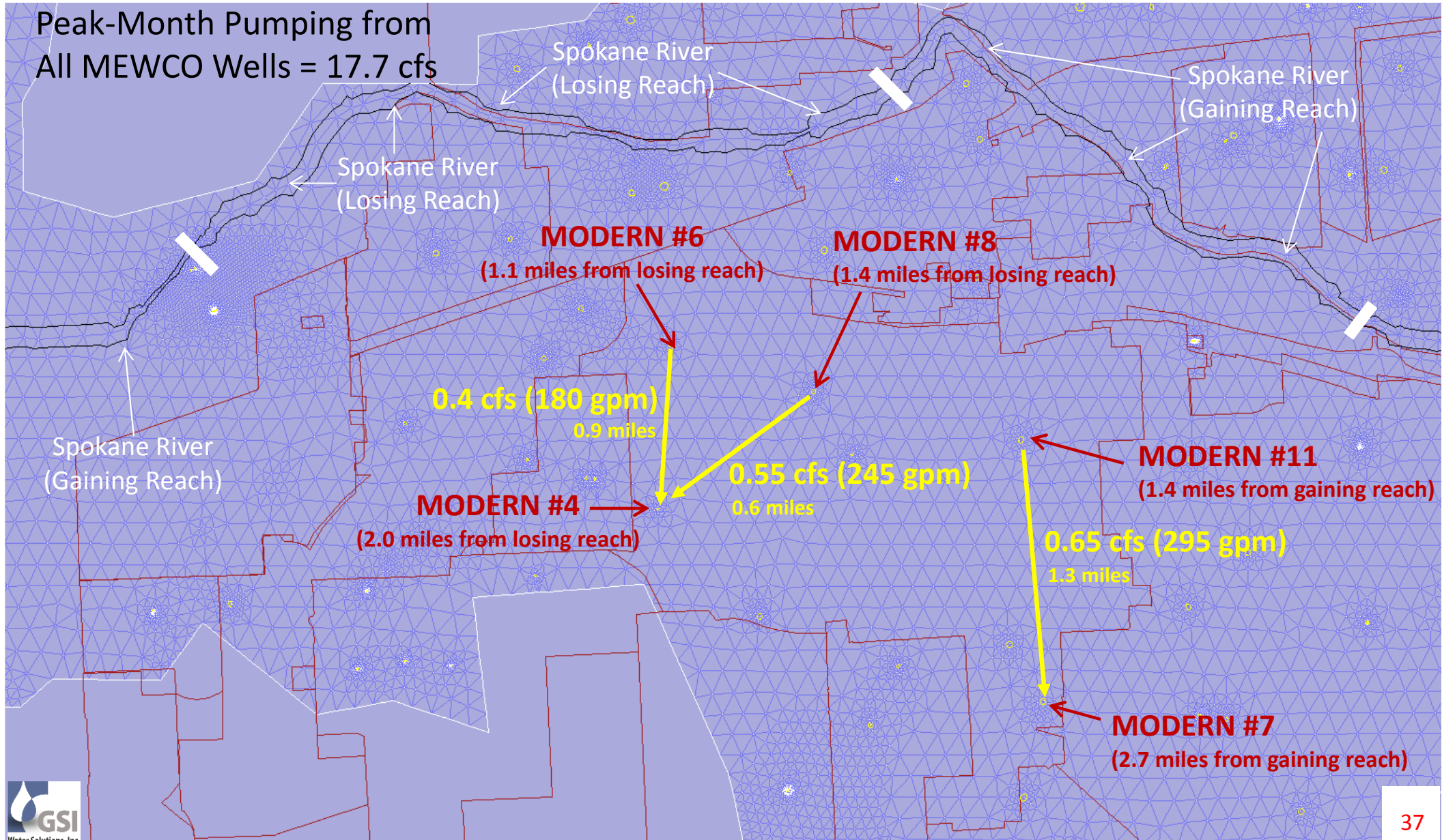
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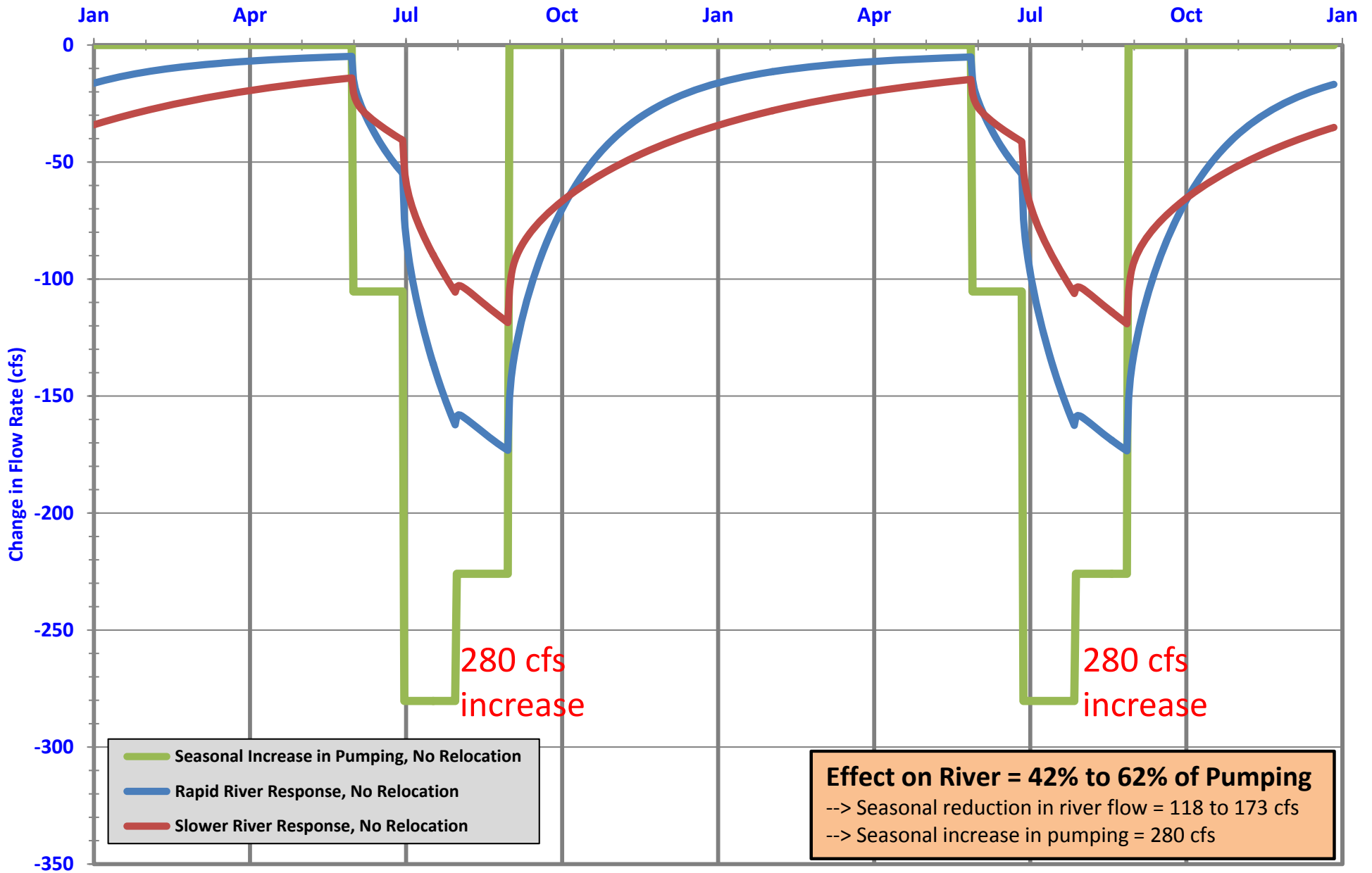
# Modern Electric Water Company

(Move From Wells 6, 8, & 11 To Wells 4 & 7)

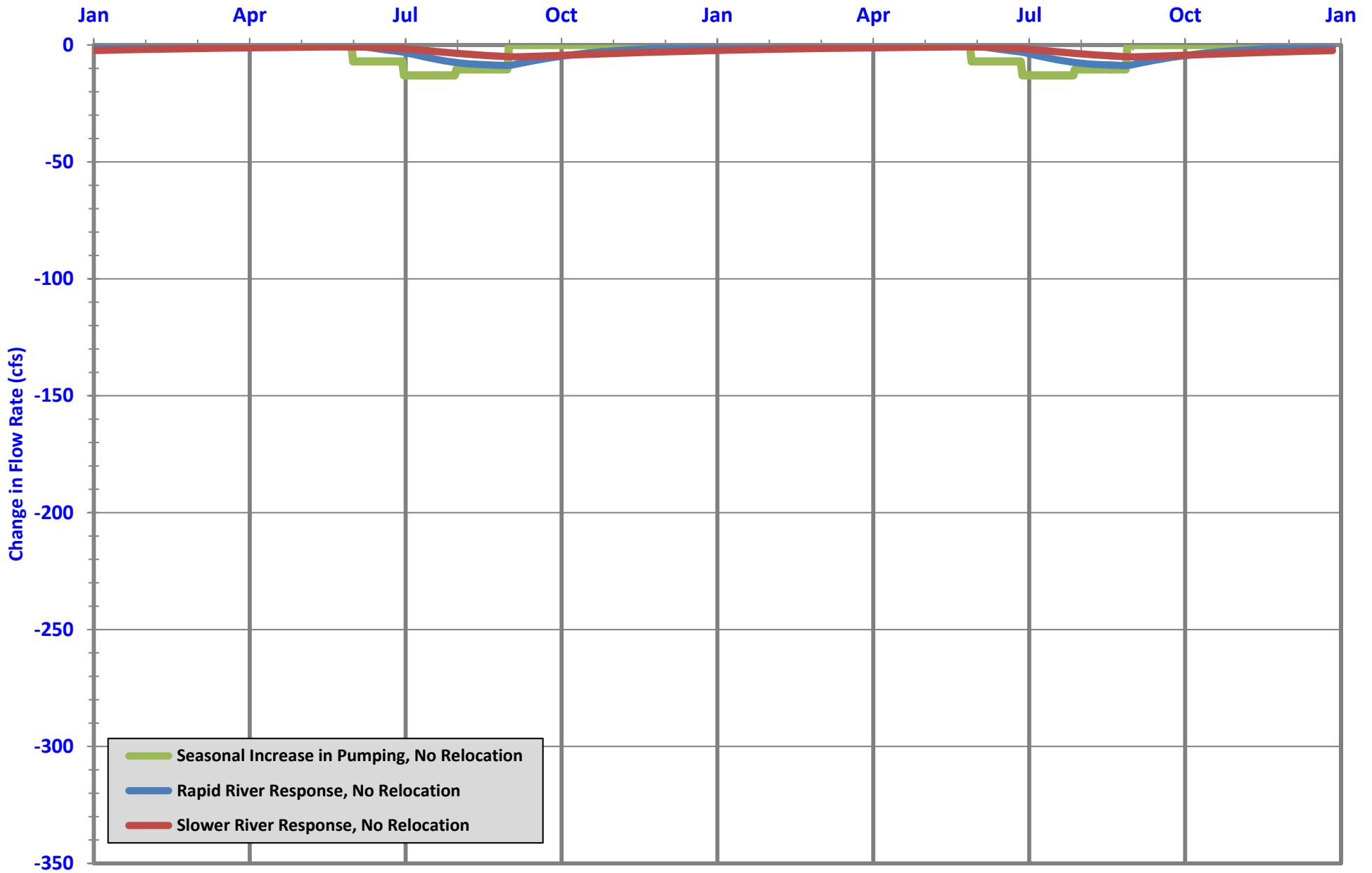
(Move Up To 1.6 cfs = 9% Of Peak Pumping)



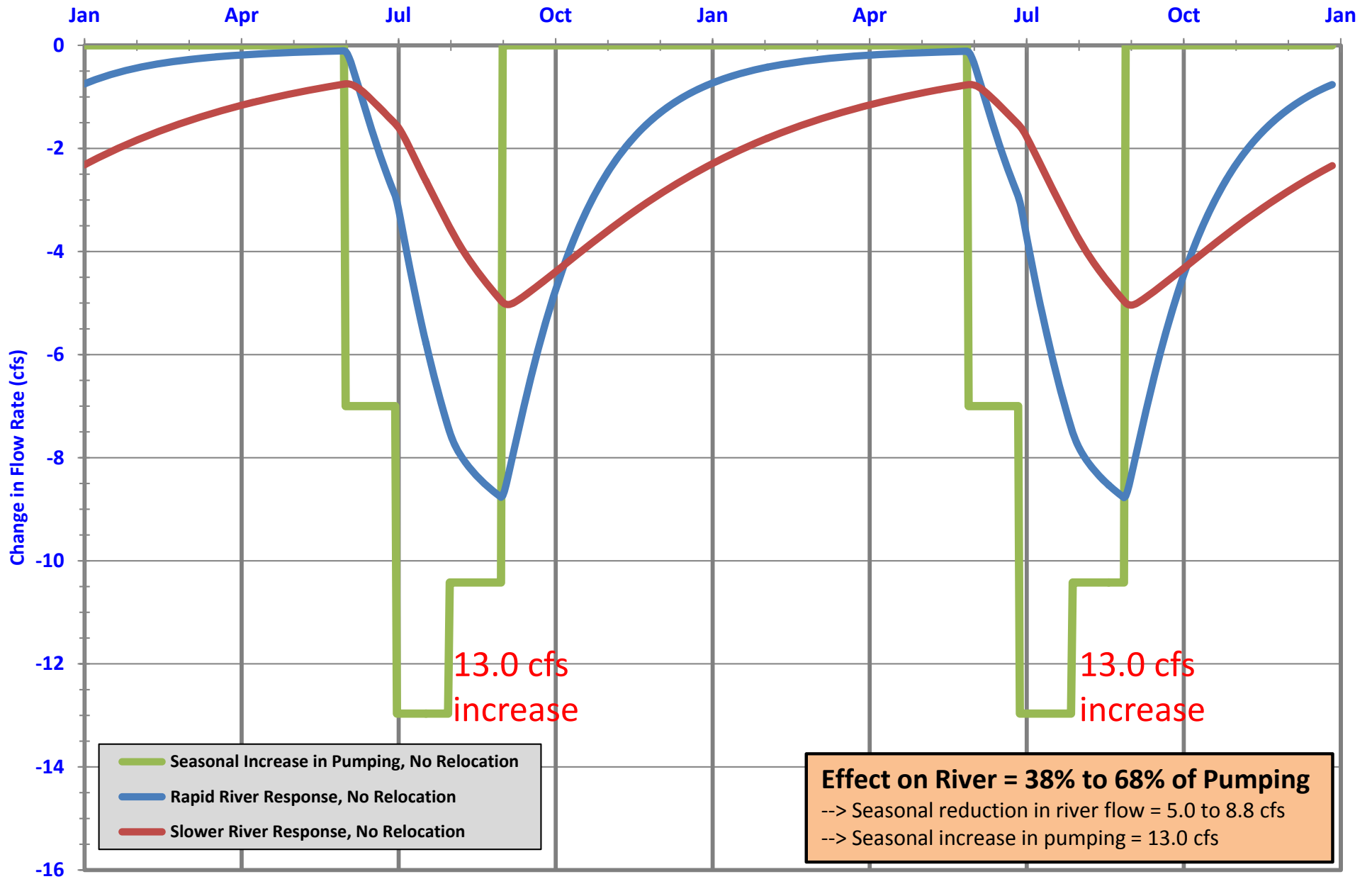
# Spokane River Modeled Response to Seasonal Increase in Pumping - All SAJB Members



# Spokane River Modeled Response to Seasonal Increase in Pumping - MEWCO

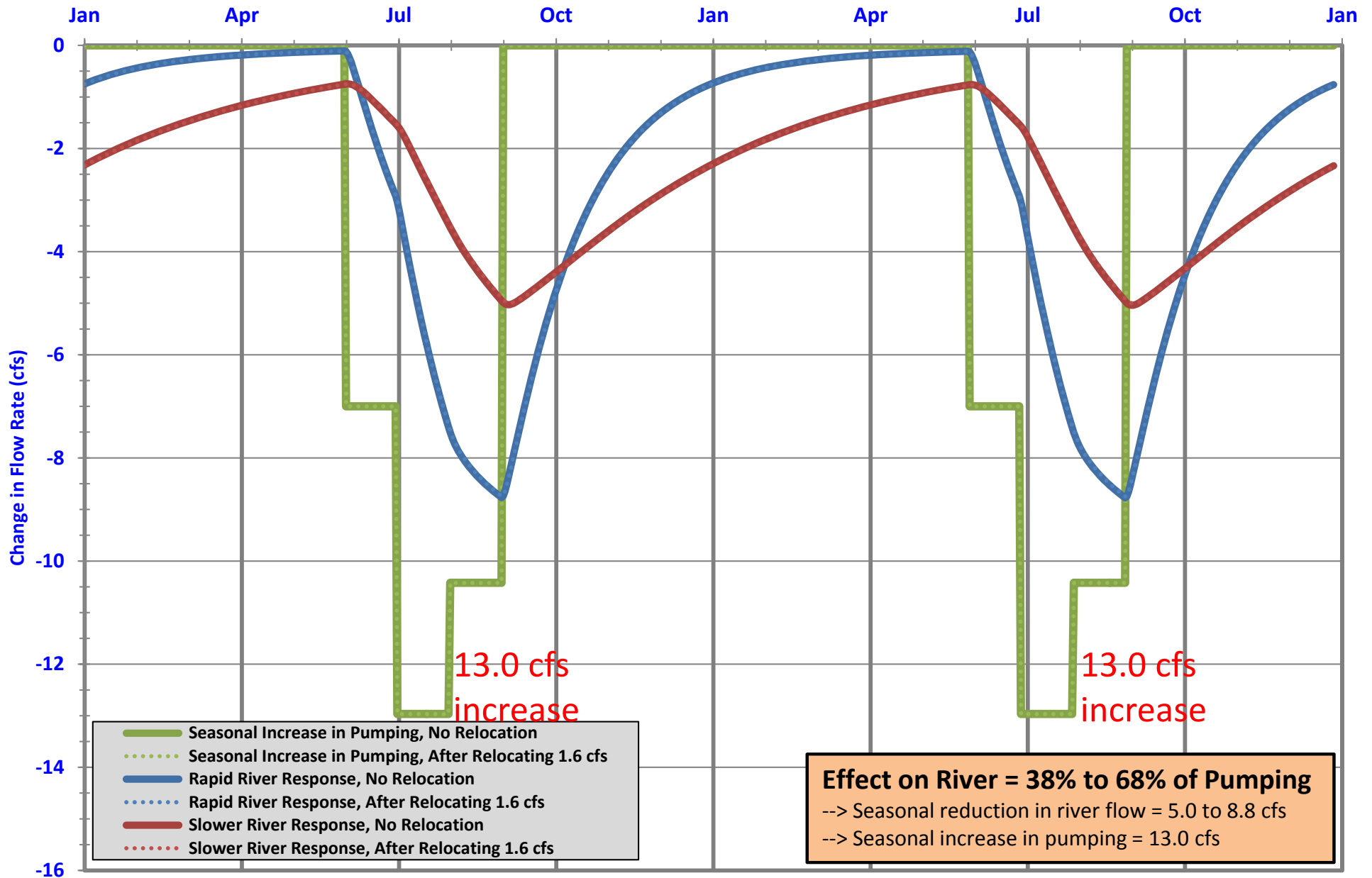


# Spokane River Modeled Response to Seasonal Increase in Pumping - MEWCO



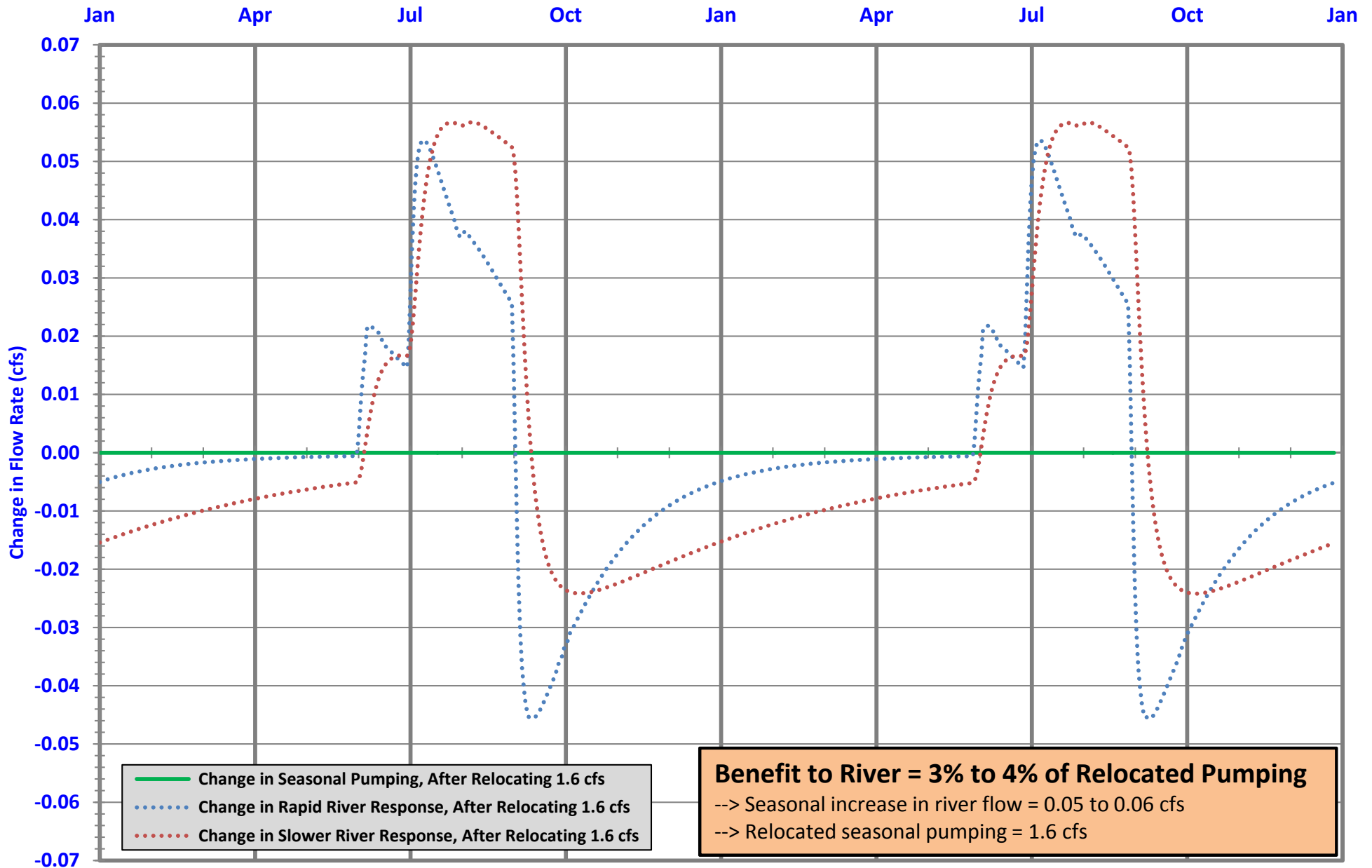


# Spokane River Modeled Response to Seasonal Increase in Pumping - MEWCO



**Effect on River = 38% to 68% of Pumping**  
 --> Seasonal reduction in river flow = 5.0 to 8.8 cfs  
 --> Seasonal increase in pumping = 13.0 cfs

# Change in Spokane River Modeled Response to Seasonal Pumping Relocation - MEWCO

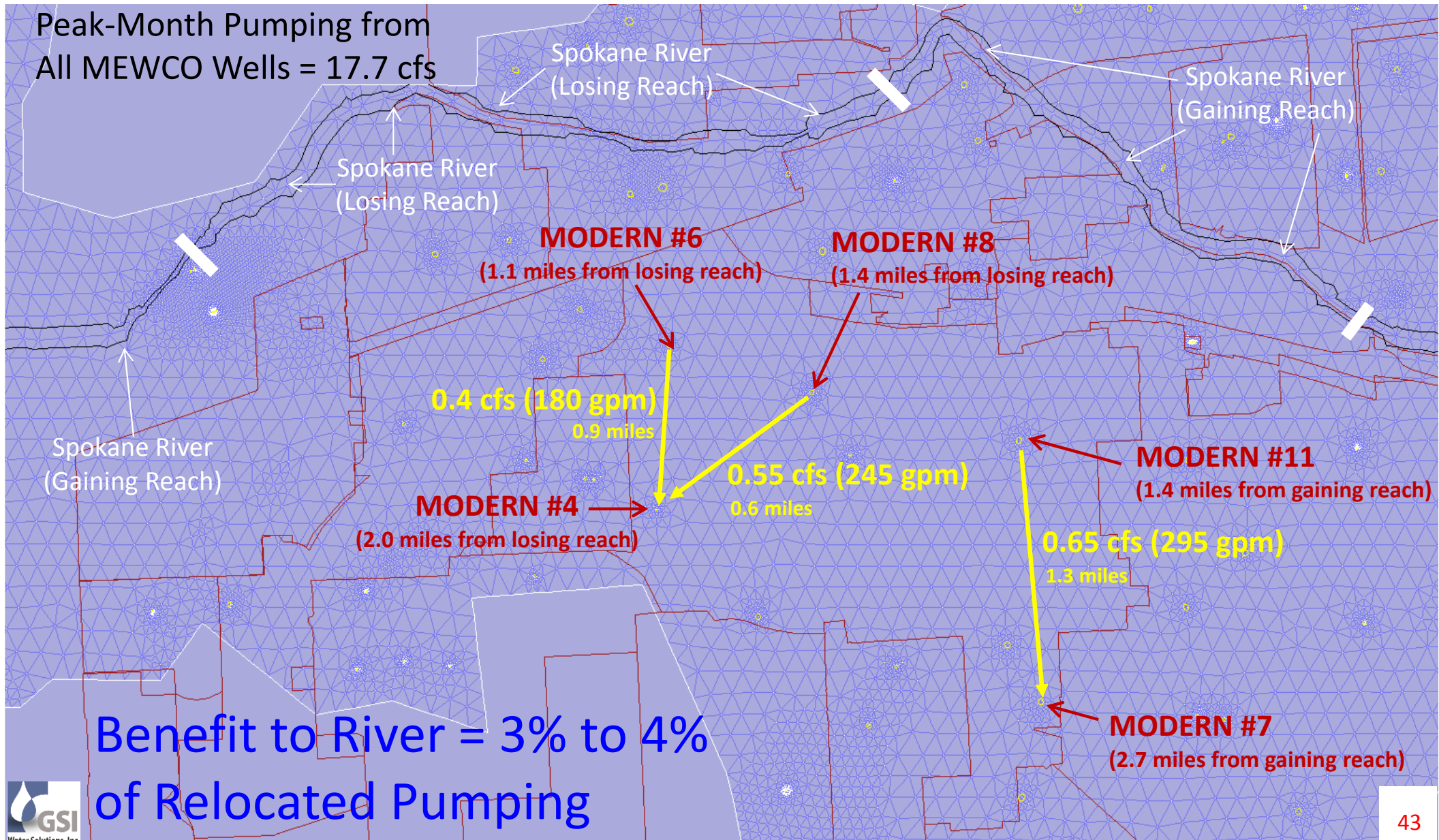


**Near a Losing Reach + Moving Pumping Only Modest Distances = Minimal Benefit to River**

# Modern Electric Water Company

(Move From Wells 6, 8, & 11 To Wells 4 & 7)

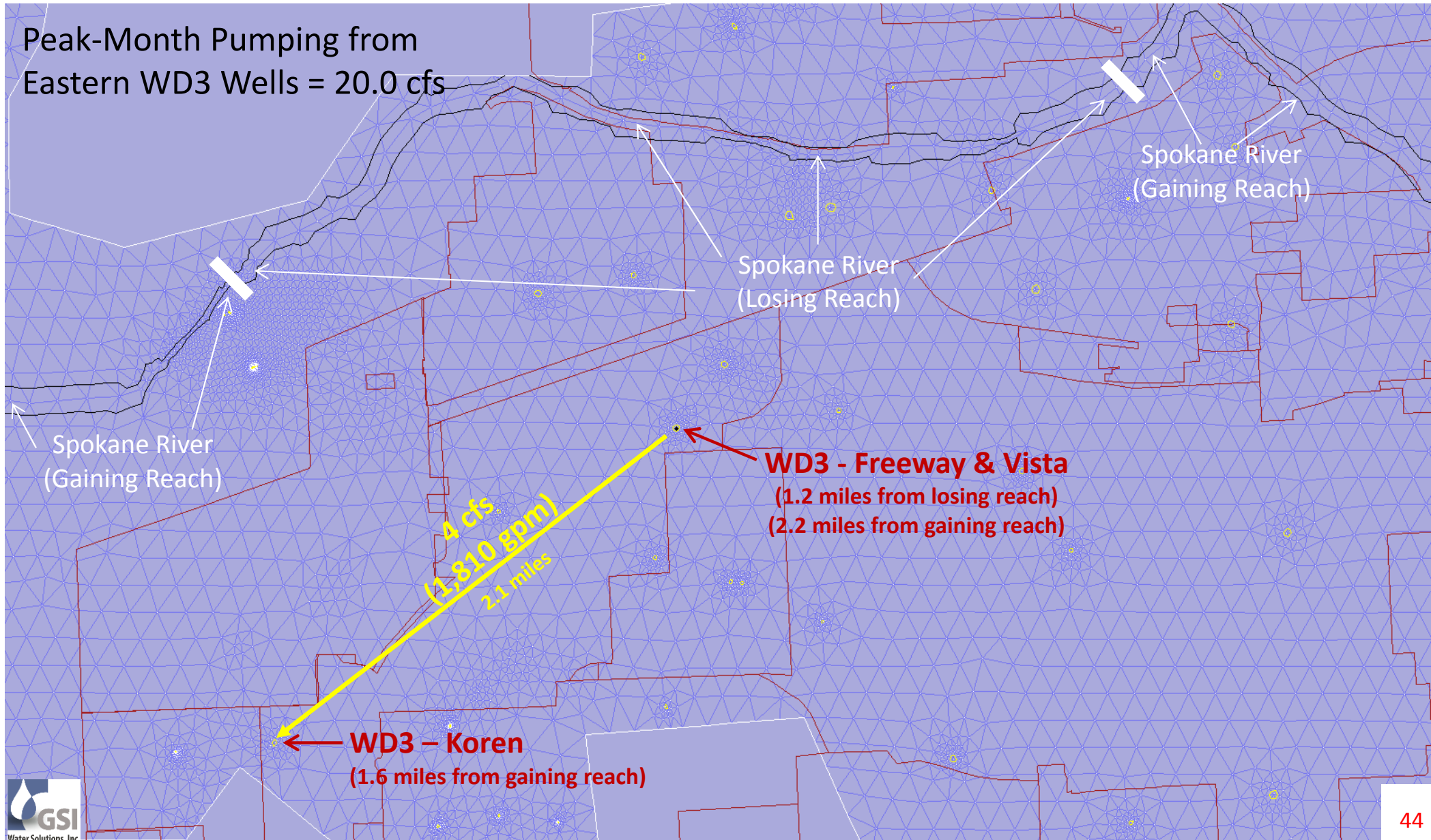
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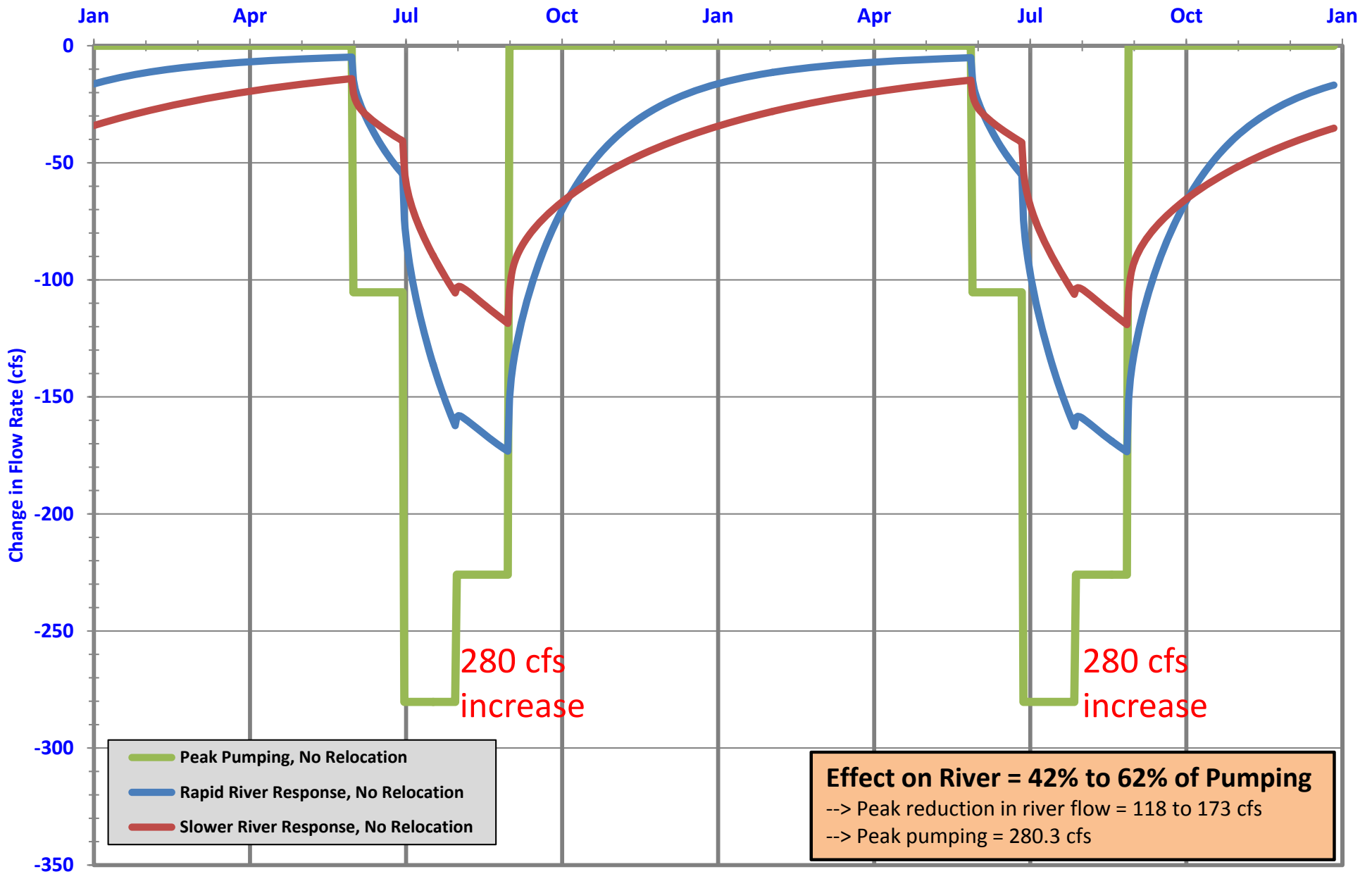
# Spokane County Water District 3

(Move From Freeway & Vista To Koren)

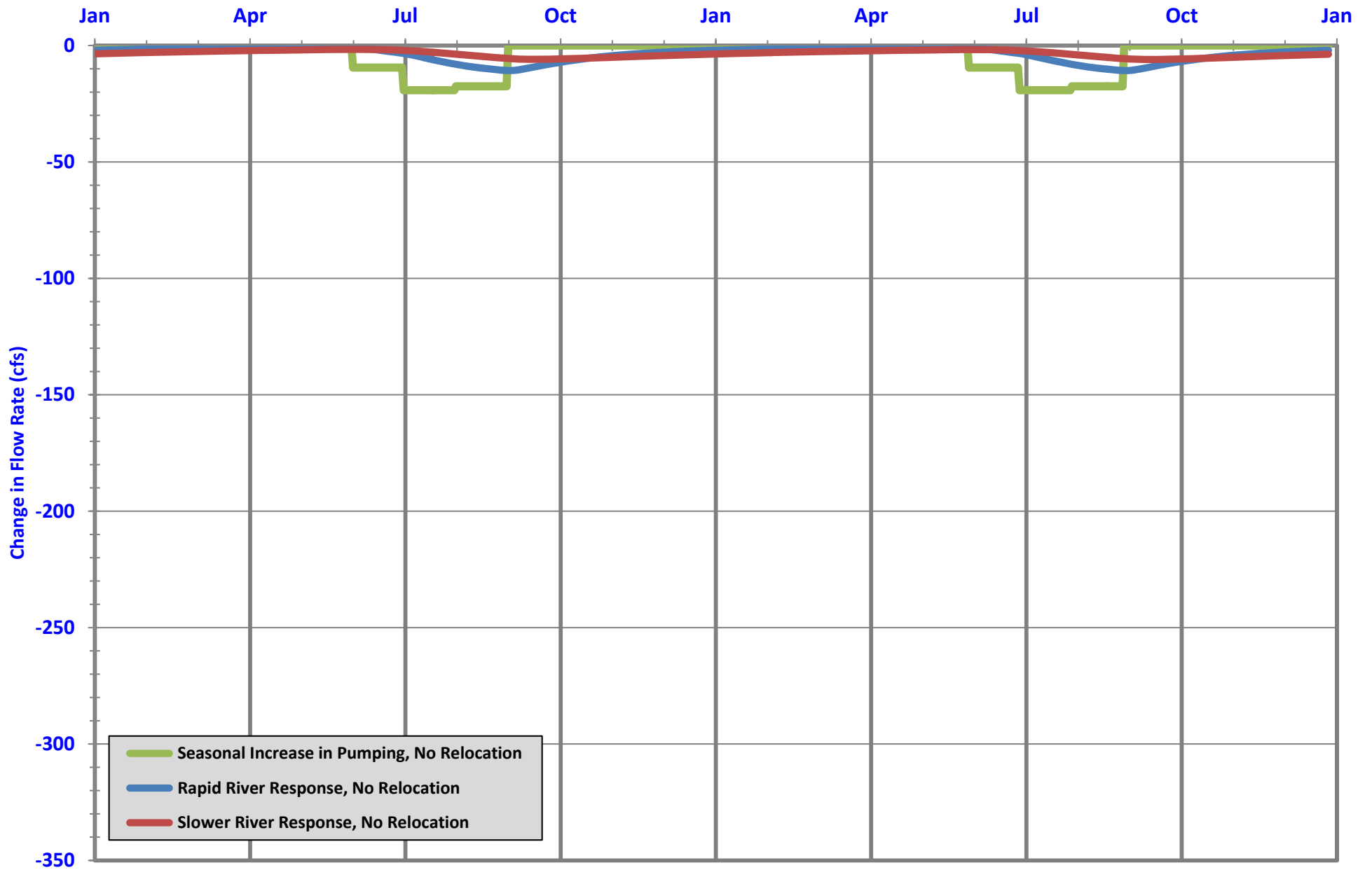
(Move Up To 4.0 cfs = 20% Of Eastern System Peak)



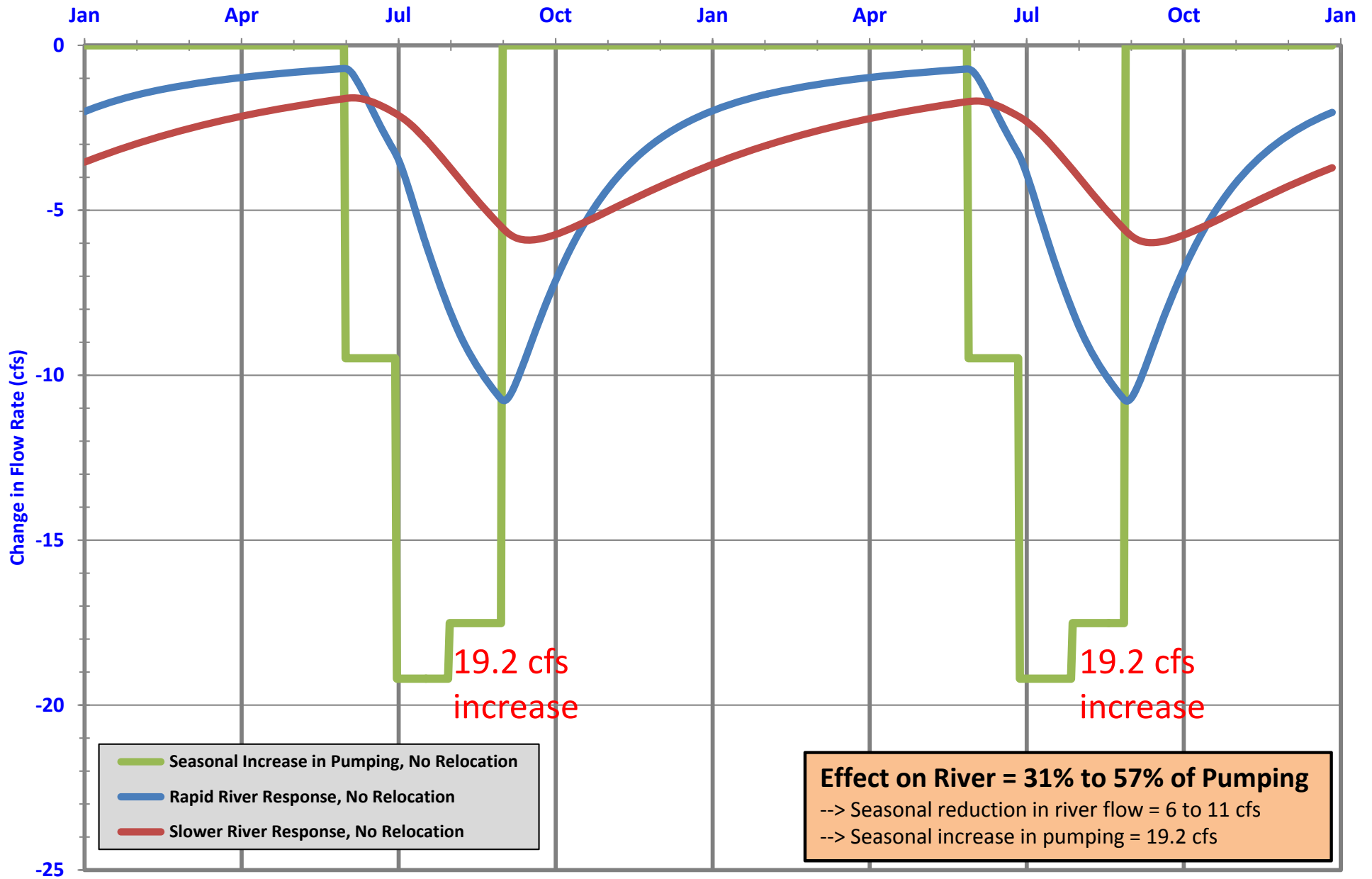
# Spokane River Modeled Response to Peak-Season Pumping - All SAJB Members



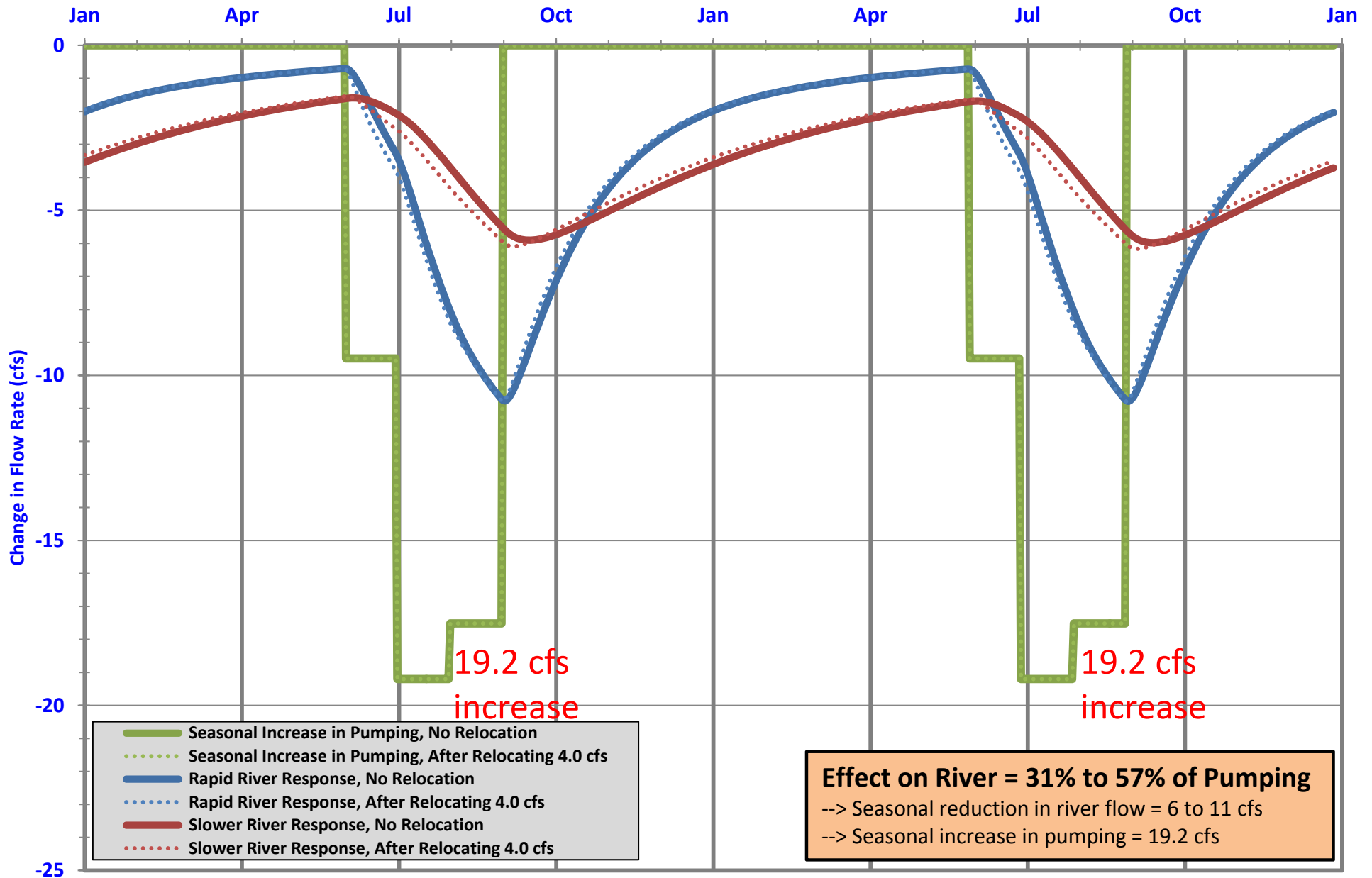
# Spokane River Modeled Response to Seasonal Increase in Pumping - WD3



# Spokane River Modeled Response to Seasonal Increase in Pumping - WD3

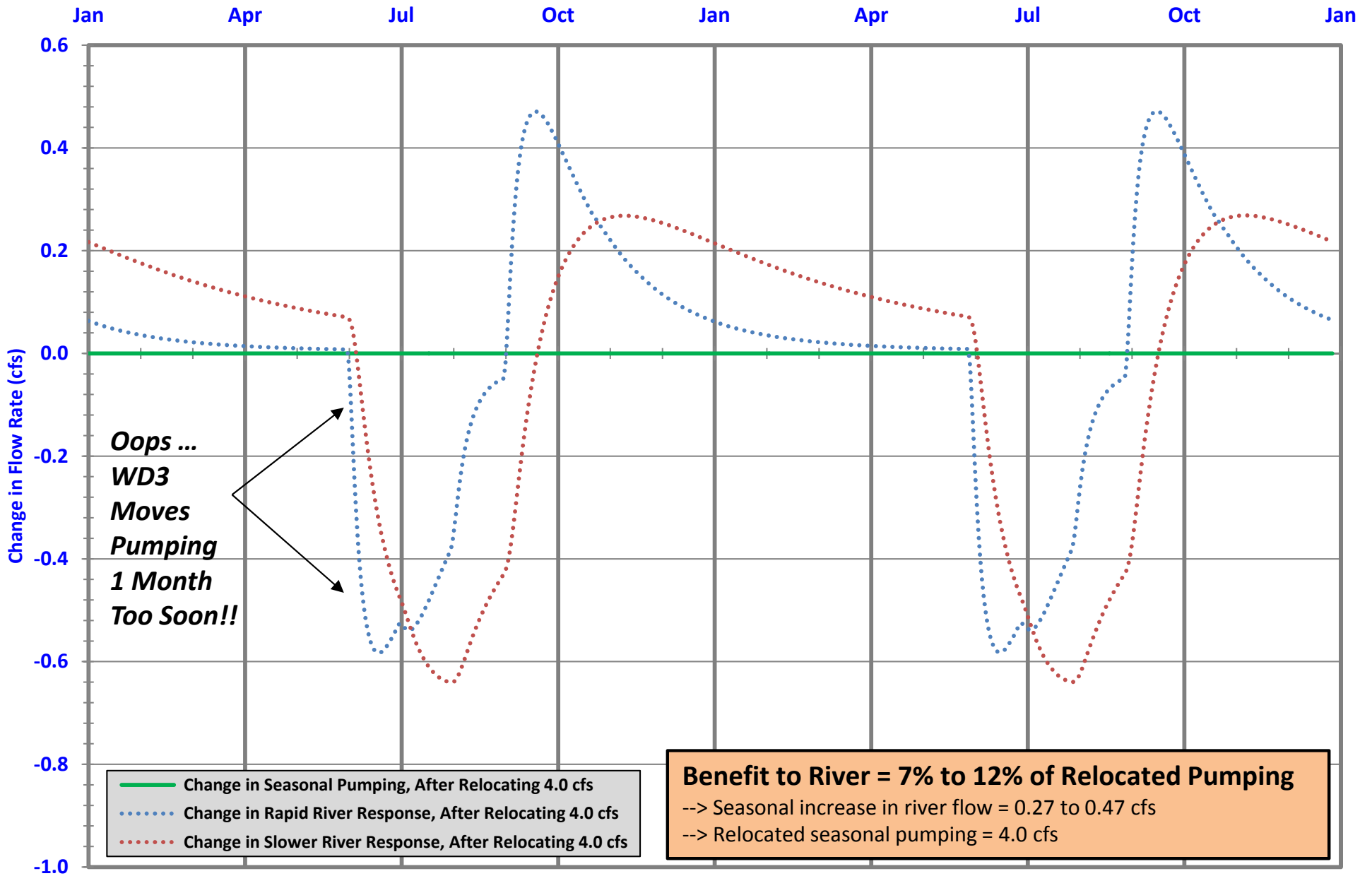


# Spokane River Modeled Response to Seasonal Increase in Pumping - WD3

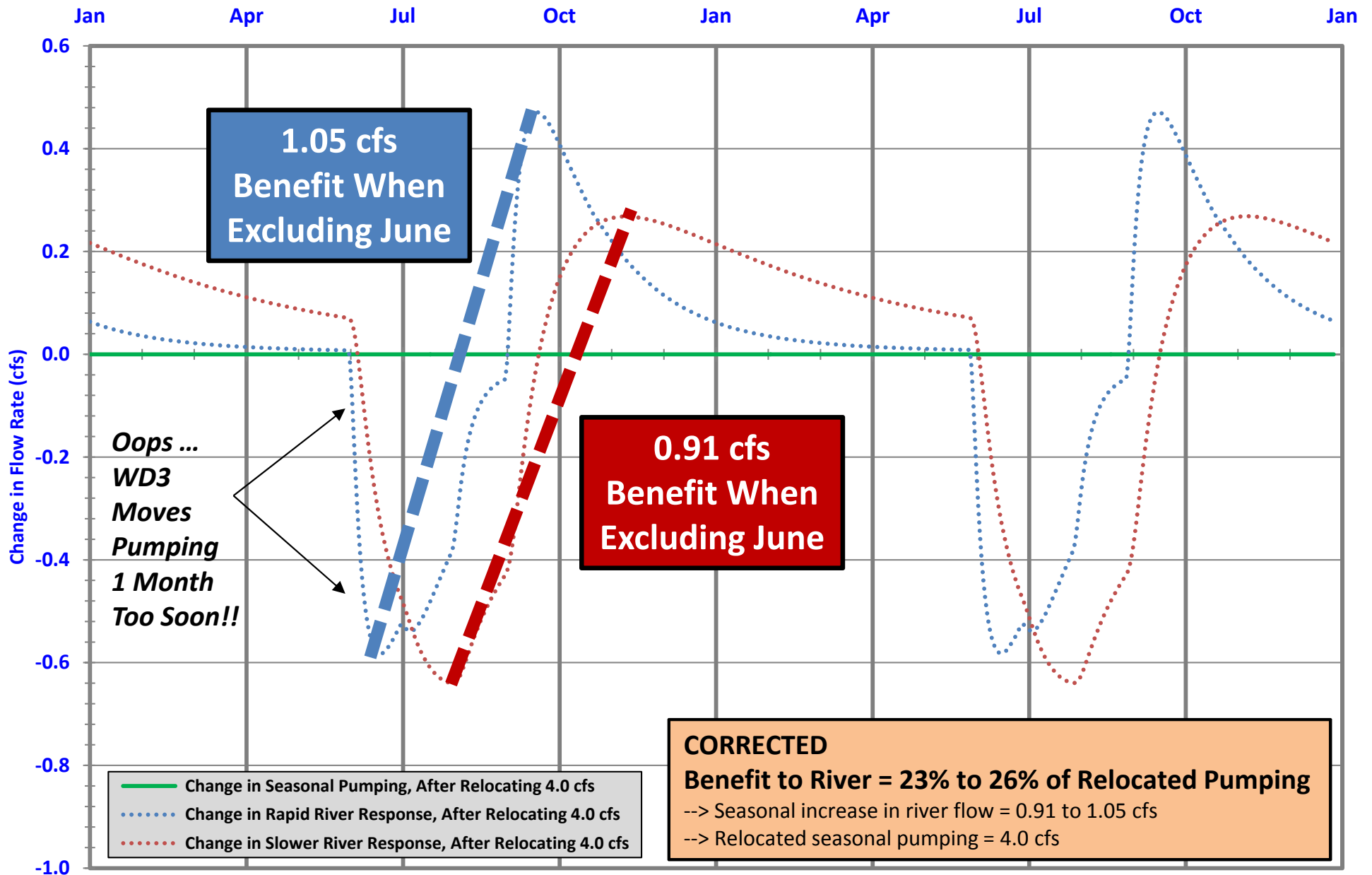




# Change in Spokane River Modeled Response to Seasonal Pumping Relocation - WD3



## Change in Spokane River Modeled Response to Seasonal Pumping Relocation - WD3

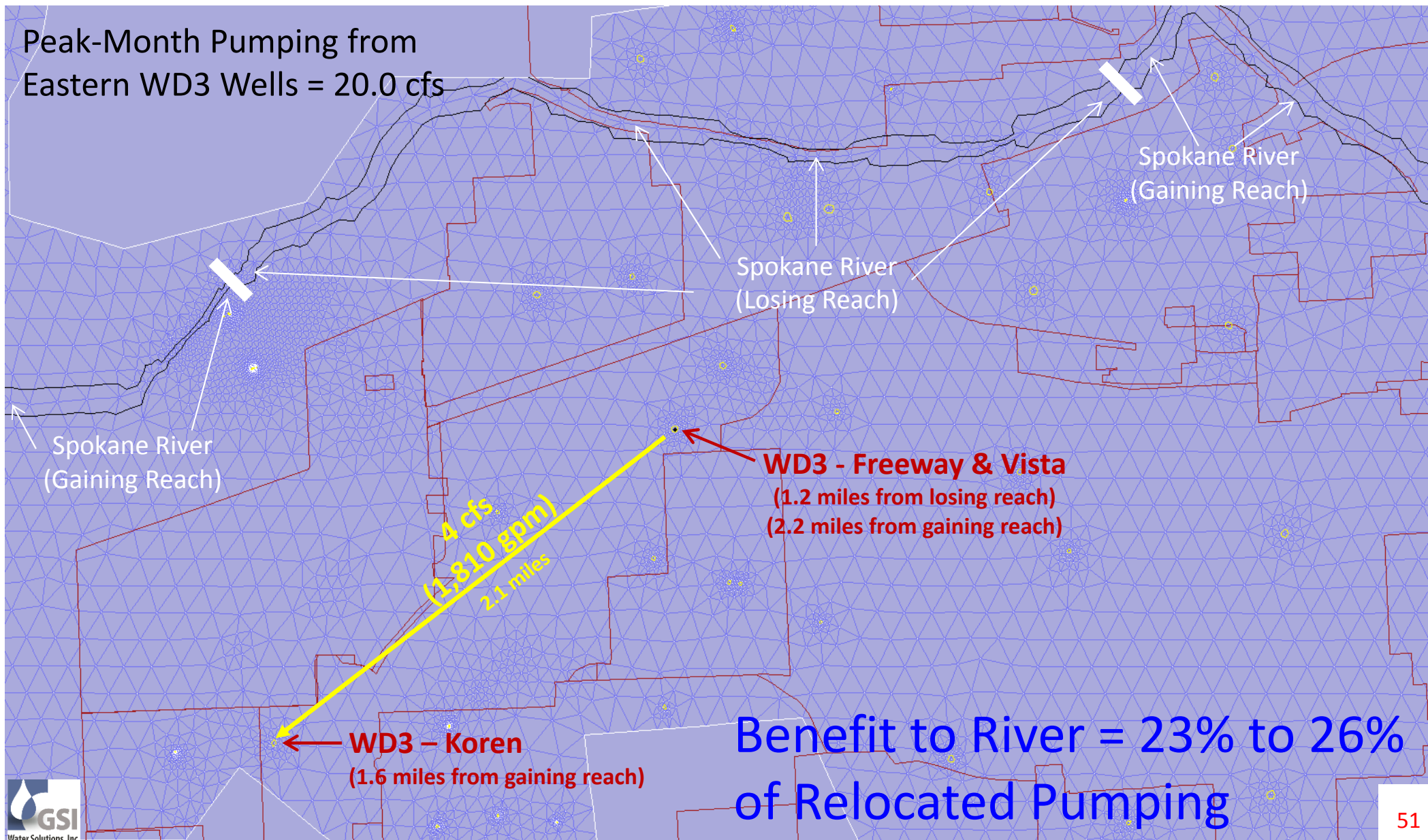


1. Temporary increases in pumping near river offset benefits of relocation at other times.
2. Relocating farther from river but closer to gaining reach can reduce benefits of relocation.

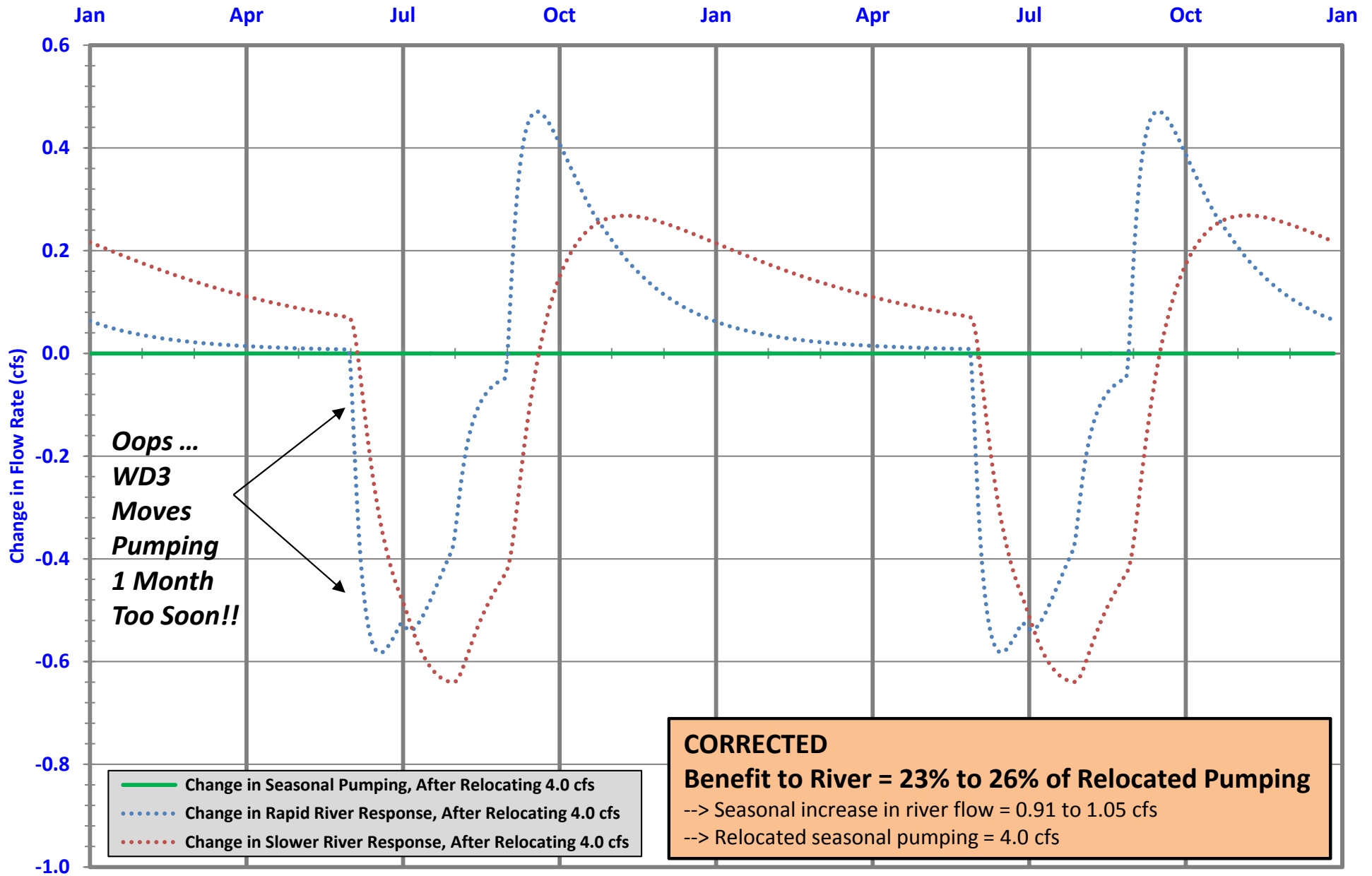
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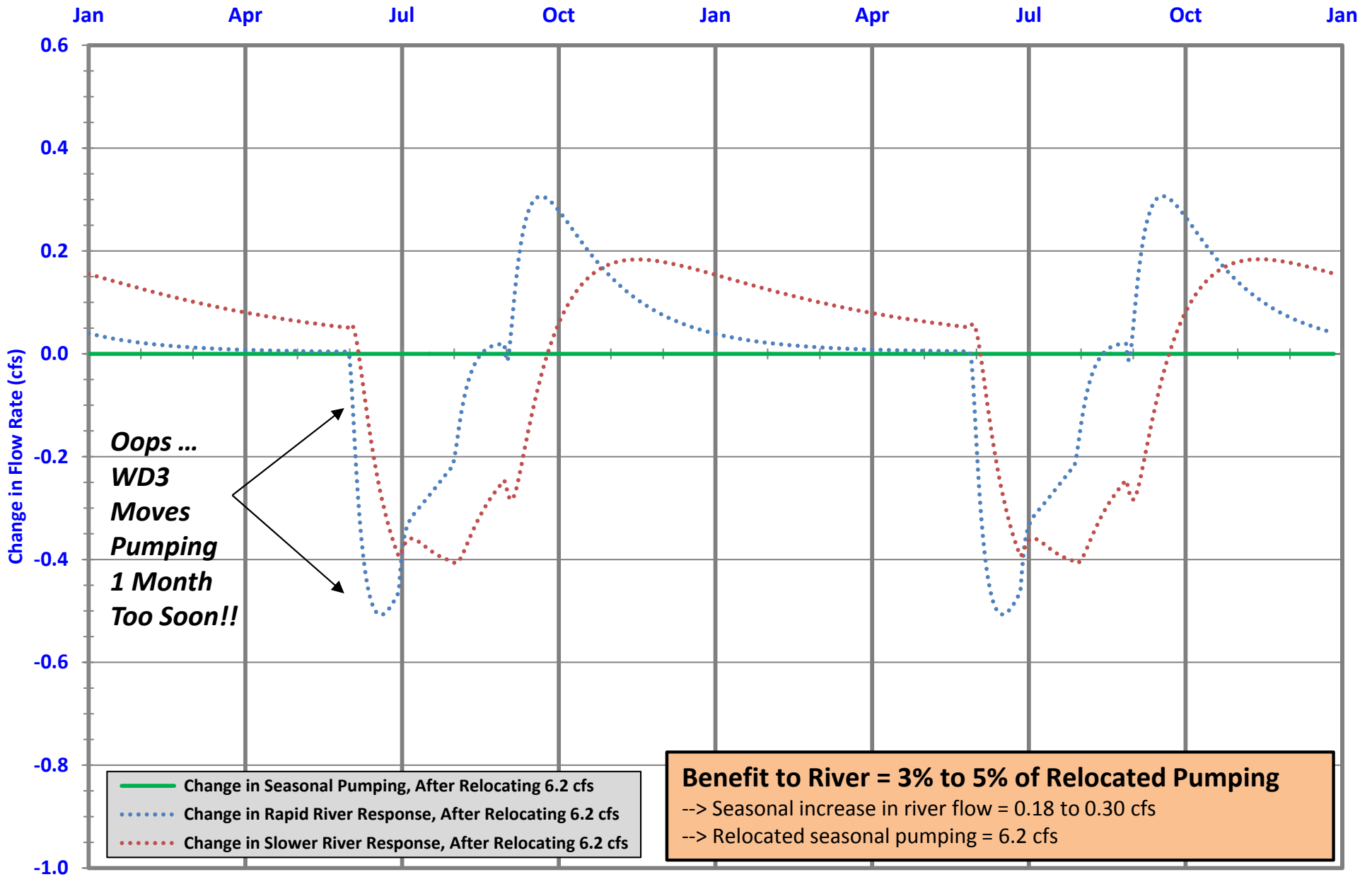
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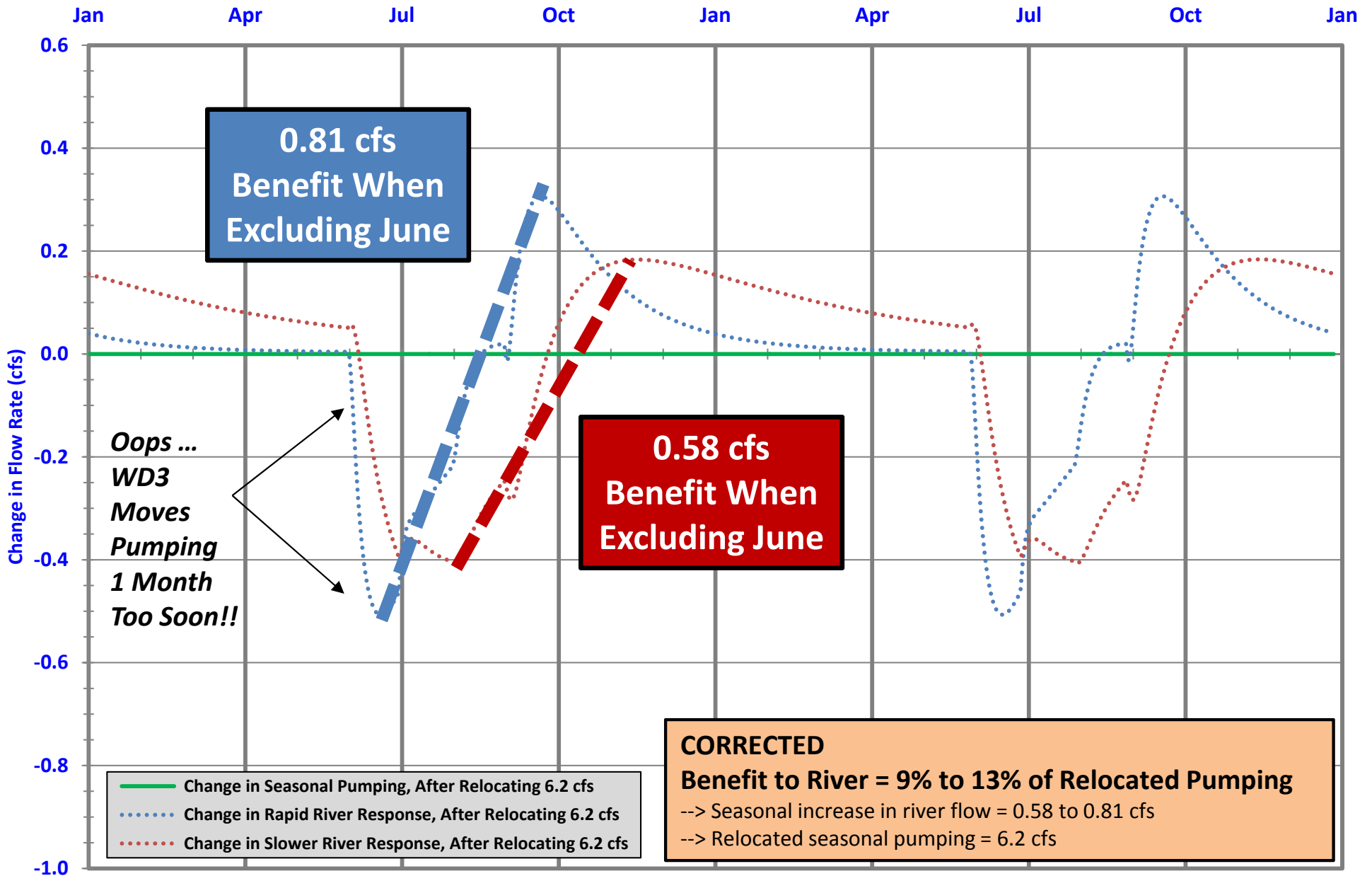
# Change in Spokane River Modeled Response to Seasonal Pumping Relocation - WD3



## Change in Spokane River Modeled Response to Seasonal Pumping Relocation CID + IWD + MEWCO + PPID + WD3



Change in Spokane River Modeled Response to Seasonal Pumping Relocation  
 CID + IWD + MEWCO + PPID + WD3



# SAJB Pumping Relocation Analysis

## Study Conclusions

1. How much does groundwater pumping by SAJB members currently affect flows in the Spokane River
  - Individually and collectively
  - Focus on peak-season (June through August)

# Current Conditions- Sorted by Purveyor

SAJB Member	SAJB Groundwater Pumping (cfs)			Effect of Peak-Season Pumping on River		
	Average	Peak Month	Peak Month minus Average	River Flow Reduction (cfs)	Reduction as % of Pumping	
					Min to Max	Average
<b>MUNICIPAL PROVIDERS</b>						
Carnhope Irr. Dist.	0.76	1.76	0.99	0.5 to 0.8	50% to 81%	65%
Consolidated Irr. Dist.	15.74	47.63	31.90	8.6 to 14.1	27% to 44%	36%
City of Spokane	93.04	213.99	120.95	63 to 84	52% to 69%	61%
East Spokane Water Dist.	2.31	5.31	3.00	1.3 to 2.1	43% to 70%	57%
Hutchinson Irr. Dist.	3.12	7.17	4.05	1.5 to 2.7	37% to 67%	52%
Irvin Water Dist.	1.17	3.71	2.53	2.1 to 2.4	83% to 95%	89%
Liberty Lake Sewer & Water Dist.	3.89	8.95	5.06	1.0 to 1.8	20% to 36%	28%
City of Millwood	8.20	17.18	8.98	3.2 to 6.0	36% to 67%	51%
Moab Irr. Dist.	1.43	3.30	1.86	0.2 to 0.4	11% to 21%	16%
Model Irr. Dist.	3.37	7.76	4.38	1.4 to 2.8	32% to 64%	48%
Modern Electric Water Co.	4.72	17.68	12.97	5.0 to 8.8	39% to 68%	53%
North Spokane Irr. Dist.	1.16	2.67	1.51	0.3 to 0.6	20% to 40%	30%
Orchard Irr. Dist.	4.36	10.04	5.67	2.3 to 3.9	41% to 69%	55%
Pasadena Park Irr. Dist.	1.83	8.41	6.58	2.4 to 4.4	36% to 67%	52%
Spokane Co. Water Dist. 3	8.47	27.67	19.20	6.0 to 10.8	31% to 56%	44%
Trentwood Irr. Dist.	3.09	7.11	4.02	2.2 to 2.9	55% to 72%	63%
Vera Water & Power	6.06	22.48	16.42	6.3 to 10.5	38% to 64%	51%
Whitworth Water Dist.	7.31	16.81	9.50	1.4 to 2.1	15% to 22%	18%
<b>Total (municipal providers)</b>	<b>170.05</b>	<b>429.64</b>	<b>259.59</b>	<b>108.7 to 161.1</b>	<b>42% to 62%</b>	<b>52%</b>
<b>OTHER MEMBERS</b>						
<b>Total (others)</b>	<b>15.92</b>	<b>36.63</b>	<b>20.70</b>	<b>10.4 to 12.3</b>	<b>50% to 59%</b>	<b>55%</b>
<b>GRAND TOTAL</b>	<b>185.97</b>	<b>466.26</b>	<b>280.29</b>	<b>119.1 to 173.4</b>	<b>42% to 62%</b>	<b>52%</b>



# Current Conditions – Sorted by Effect

SAJB Member	SAJB Groundwater Pumping (cfs)			Effect of Peak-Season Pumping on River		
	Average	Peak Month	Peak Month minus Average	River Flow Reduction (cfs)	Reduction as % of Pumping	
					Min to Max	Average
<b>MUNICIPAL PROVIDERS</b>						
Irvin Water Dist.	1.17	3.71	2.53	2.1 to 2.4	83% to 95%	89%
Carnhope Irr. Dist.	0.76	1.76	0.99	0.5 to 0.8	50% to 81%	65%
Trentwood Irr. Dist.	3.09	7.11	4.02	2.2 to 2.9	55% to 72%	63%
City of Spokane	93.04	213.99	120.95	63 to 84	52% to 69%	61%
East Spokane Water Dist.	2.31	5.31	3.00	1.3 to 2.1	43% to 70%	57%
Orchard Irr. Dist.	4.36	10.04	5.67	2.3 to 3.9	41% to 69%	55%
Modern Electric Water Co.	4.72	17.68	12.97	5.0 to 8.8	39% to 68%	53%
Hutchinson Irr. Dist.	3.12	7.17	4.05	1.5 to 2.7	37% to 67%	52%
Pasadena Park Irr. Dist.	1.83	8.41	6.58	2.4 to 4.4	36% to 67%	52%
City of Millwood	8.20	17.18	8.98	3.2 to 6.0	36% to 67%	51%
Vera Water & Power	6.06	22.48	16.42	6.3 to 10.5	38% to 64%	51%
Model Irr. Dist.	3.37	7.76	4.38	1.4 to 2.8	32% to 64%	48%
Spokane Co. Water Dist. 3	8.47	27.67	19.20	6.0 to 10.8	31% to 56%	44%
Consolidated Irr. Dist.	15.74	47.63	31.90	8.6 to 14.1	27% to 44%	36%
North Spokane Irr. Dist.	1.16	2.67	1.51	0.3 to 0.6	20% to 40%	30%
Liberty Lake Sewer & Water Dist.	3.89	8.95	5.06	1.0 to 1.8	20% to 36%	28%
Whitworth Water Dist.	7.31	16.81	9.50	1.4 to 2.1	15% to 22%	18%
Moab Irr. Dist.	1.43	3.30	1.86	0.2 to 0.4	11% to 21%	16%
<b>Total (municipal providers)</b>	<b>170.05</b>	<b>429.64</b>	<b>259.59</b>	<b>108.7 to 161.1</b>	<b>42% to 62%</b>	<b>52%</b>
<b>OTHER MEMBERS</b>						
<b>Total (others)</b>	<b>15.92</b>	<b>36.63</b>	<b>20.70</b>	<b>10.4 to 12.3</b>	<b>50% to 59%</b>	<b>55%</b>
<b>GRAND TOTAL</b>	<b>185.97</b>	<b>466.26</b>	<b>280.29</b>	<b>119.1 to 173.4</b>	<b>42% to 62%</b>	<b>52%</b>

# SAJB Pumping Relocation Analysis

## Study Conclusions

2. How much benefit to river flows could arise if summer pumping is shifted to wells farther from the river?

→ Magnitude and timing; and moving pumping (not wells)

SAJB Member	Peak Influence on River	Benefit Relative to Pumping
	Min cfs to Max cfs	Min to Max
CID	<i>Assume zero June-August</i>	34% to 36%
MEWCO	0.05 to 0.06	3% to 4%
Irvin	0.16 to 0.18	46% to 51%
PPID	0.009 to 0.012	4% to 6%
WD3	0.58 to 0.81	23% to 26%
<b>Total Influence</b>	<b>0.80 to 1.06</b>	<b>9% to 13%</b>

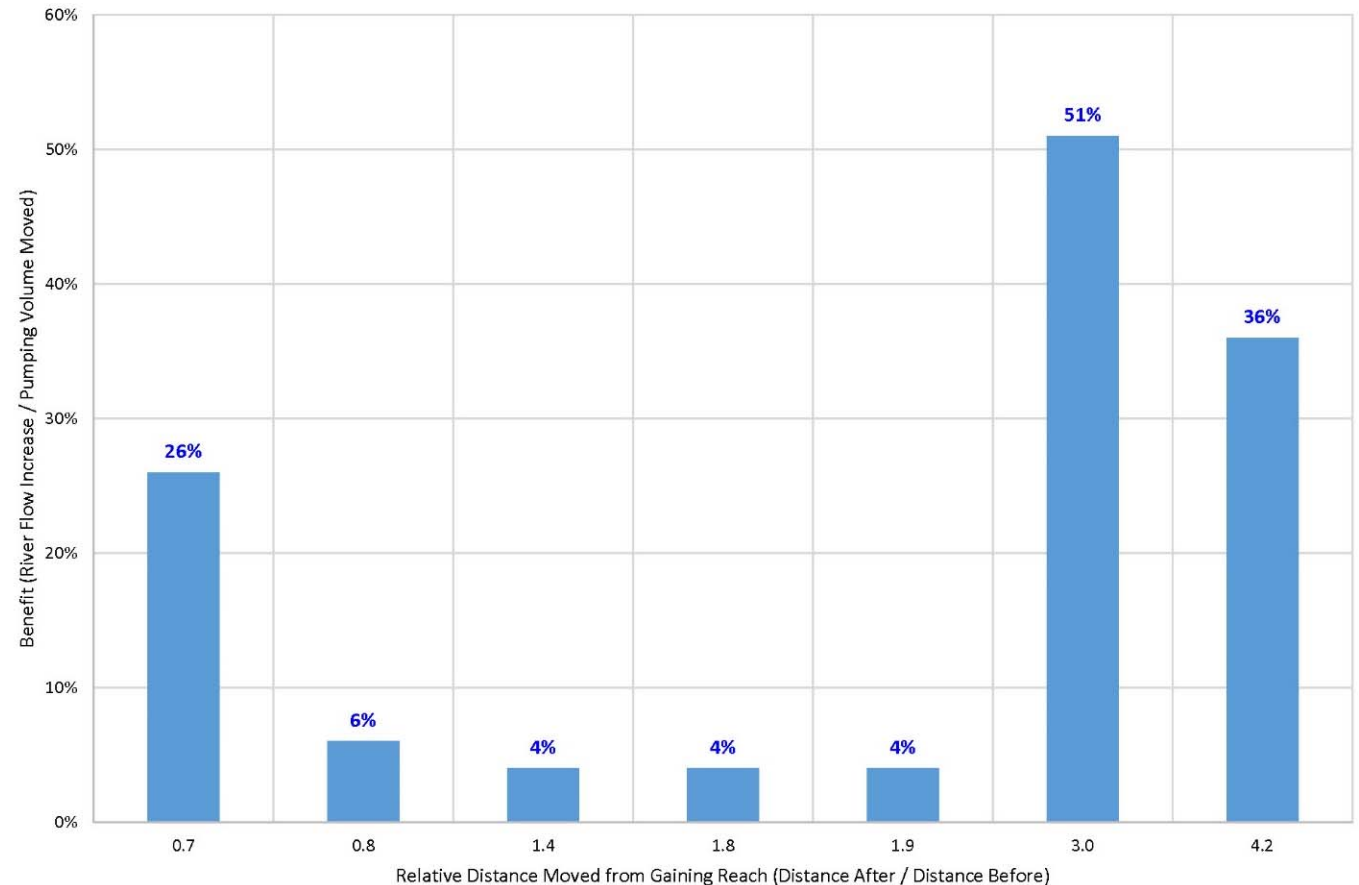
Values are heavily dependent on:

1. Amount of pumping being moved (the tabulated results are for moving 6.2 cfs)
2. The distance that pumping is being moved away from gaining reaches

# Potential Benefits to River

SAJB Member	Distance (miles) from Gaining Reaches			Benefit Relative to Pumping Min to Max
	Before	After	After/Before	
WD3	2.2	1.6	0.7	23% to 26%
PPID	2.0	1.5	0.8	4% to 6%
MEWCO	1.4	2.0	1.4	3% to 4%
	1.1	2.0	1.8	
	1.4	2.7	1.9	
Irvin	0.2	0.6	3.0	46% to 51%
CID	0.5	2.1	4.2	34% to 36%
<b>Total Influence</b>				<b>9% to 13%</b>

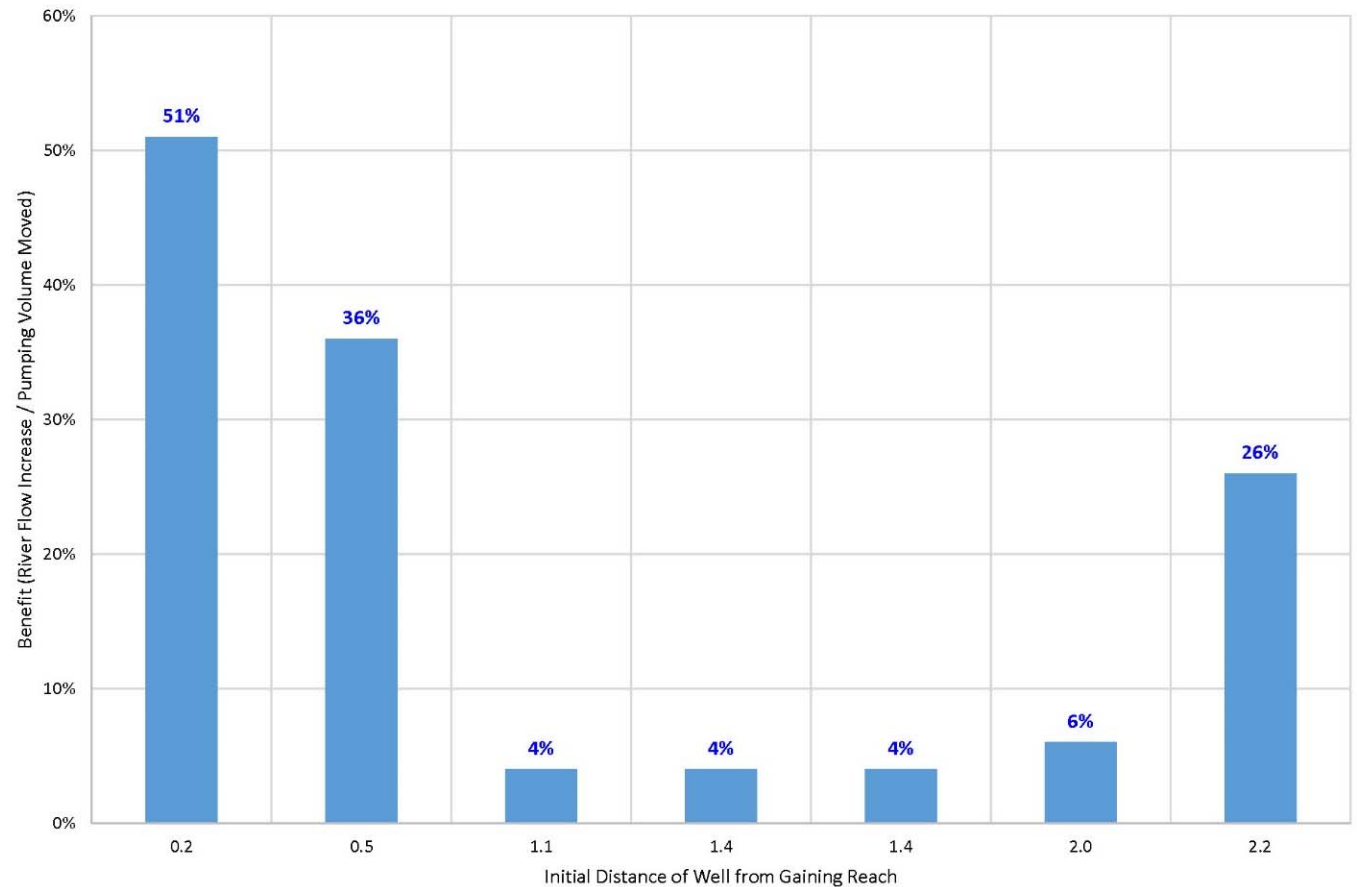
Benefit to River as a Function of  
Relative Distance that Pumping is Moved Away from Gaining Reaches



# Potential Benefits to River

SAJB Member	Distance (miles) from Gaining Reaches			Benefit Relative to Pumping
	Before	After	After/Before	Min to Max
Irvin	0.2	0.6	3.0	46% to 51%
CID	0.5	2.1	4.2	34% to 36%
MEWCO	1.1	2.0	1.8	3% to 4%
	1.4	2.0	1.4	
	1.4	2.7	1.9	
PPID	2.0	1.5	0.8	4% to 6%
WD3	2.2	1.6	0.7	23% to 26%
<b>Total Influence</b>				<b>9% to 13%</b>

Benefit to River as a Function of Initial Distance of Wells from Gaining Reaches



# SAJB Pumping Relocation Analysis

## Study Conclusions

3. How do the changes arising from relocation compare with the proposed instream flow standards?

### Proposed Instream Flow Standard:

- June 15 – Sept 30: 850 cfs
- August historical flows = 525 to 700 cfs  
(90% exceedance probability)
- Deficit = 150 to 325 cfs

# Published Exceedance Curves for Flows in the Spokane River

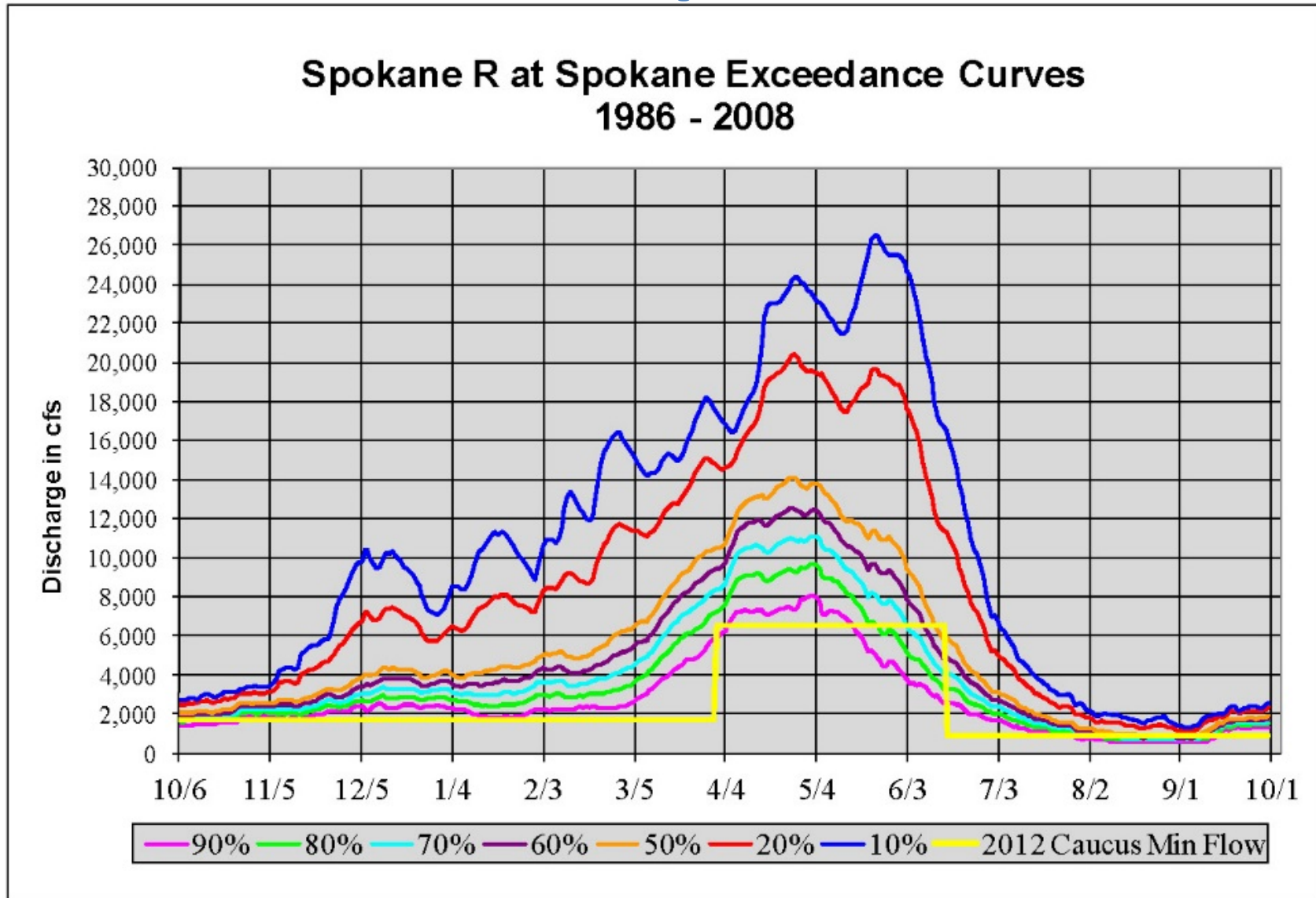
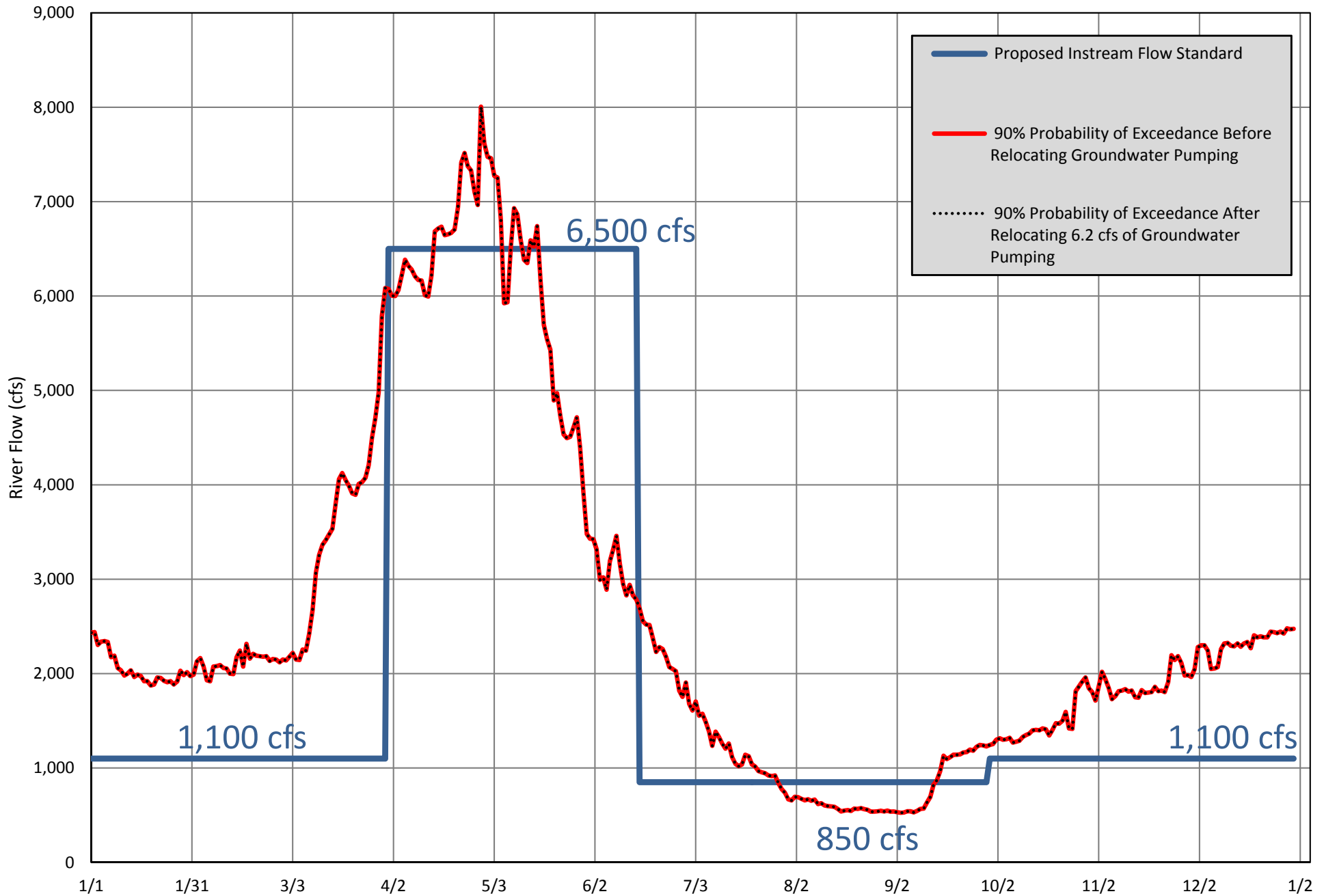
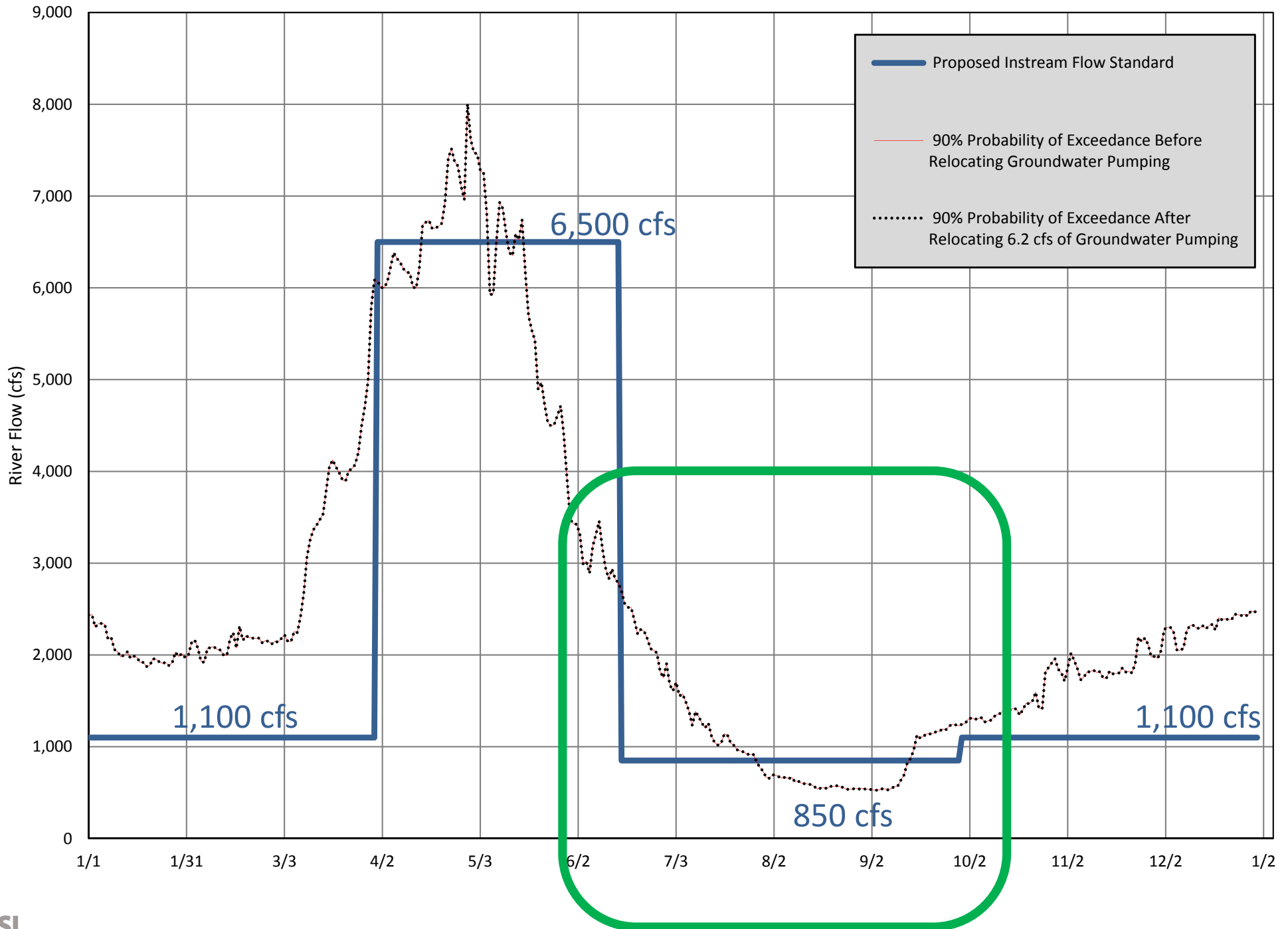


Figure 4. Exceedance hydrographs and recommended instream flows at USGS gauge 12422500 (Spokane River at Spokane). Source: 2012 Instream Flow Recommendations for the Spokane River (Hal Beecher, WDFW, May 31, 2012)

90% Exceedance Hydrograph for Spokane R. 1986-2008 (USGS gage 12422500)

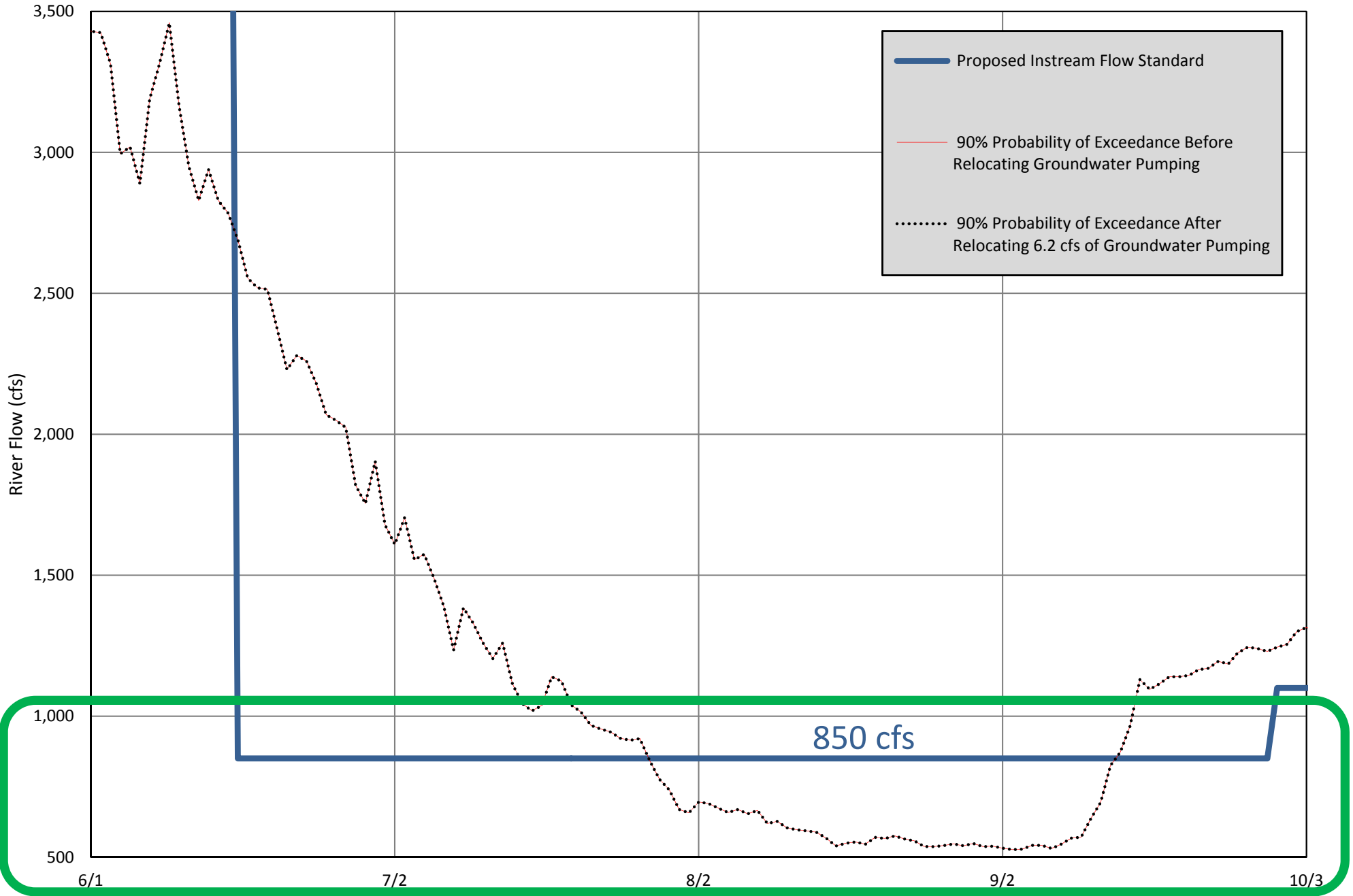


90% Exceedance Hydrograph for Spokane R. 1986-2008 (USGS gage 12422500)

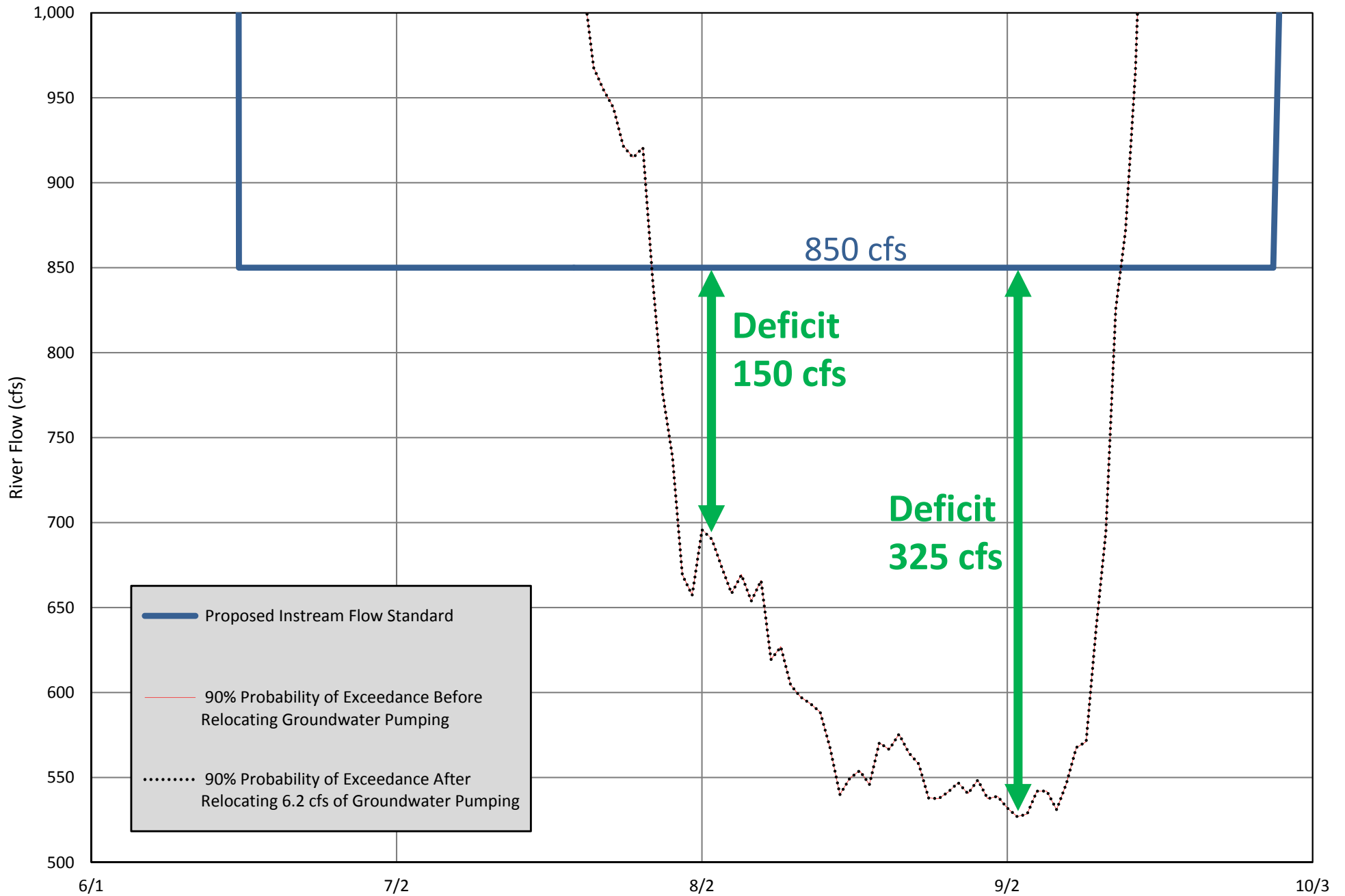




90% Exceedance Hydrograph for Spokane R. 1986-2008 (USGS gage 12422500)



90% Exceedance Hydrograph for Spokane R. 1986-2008 (USGS gage 12422500)



— Proposed Instream Flow Standard  
— 90% Probability of Exceedance Before Relocating Groundwater Pumping  
..... 90% Probability of Exceedance After Relocating 6.2 cfs of Groundwater Pumping

# SAJB Pumping Relocation Analysis

## Study Conclusions

3. How do the changes arising from relocation compare with the proposed in-stream flow standards?

### Proposed Instream Flow Standard:

- June 15 – Sept 30: 850 cfs
- August historical flows = 525 to 700 cfs  
(90% exceedance probability)
- Deficit = 150 to 325 cfs

### Relocation Scenarios Examined:

- Move 6.2 cfs for 3 months
- Effect on river is 0.8 to 1.1 cfs
  - Nominally 0.25% to 0.75% of the 150 to 325 cfs deficit in flow



# Discussion, Questions

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