

Santa Ana River Wasteload Allocation Model Update

March 6, 2019



3/6/2019



Overview

- **Responses to WEI Technical Questions**
- **Responses to Risk Sciences Questions**
- **Responses to WEI Policy Questions**

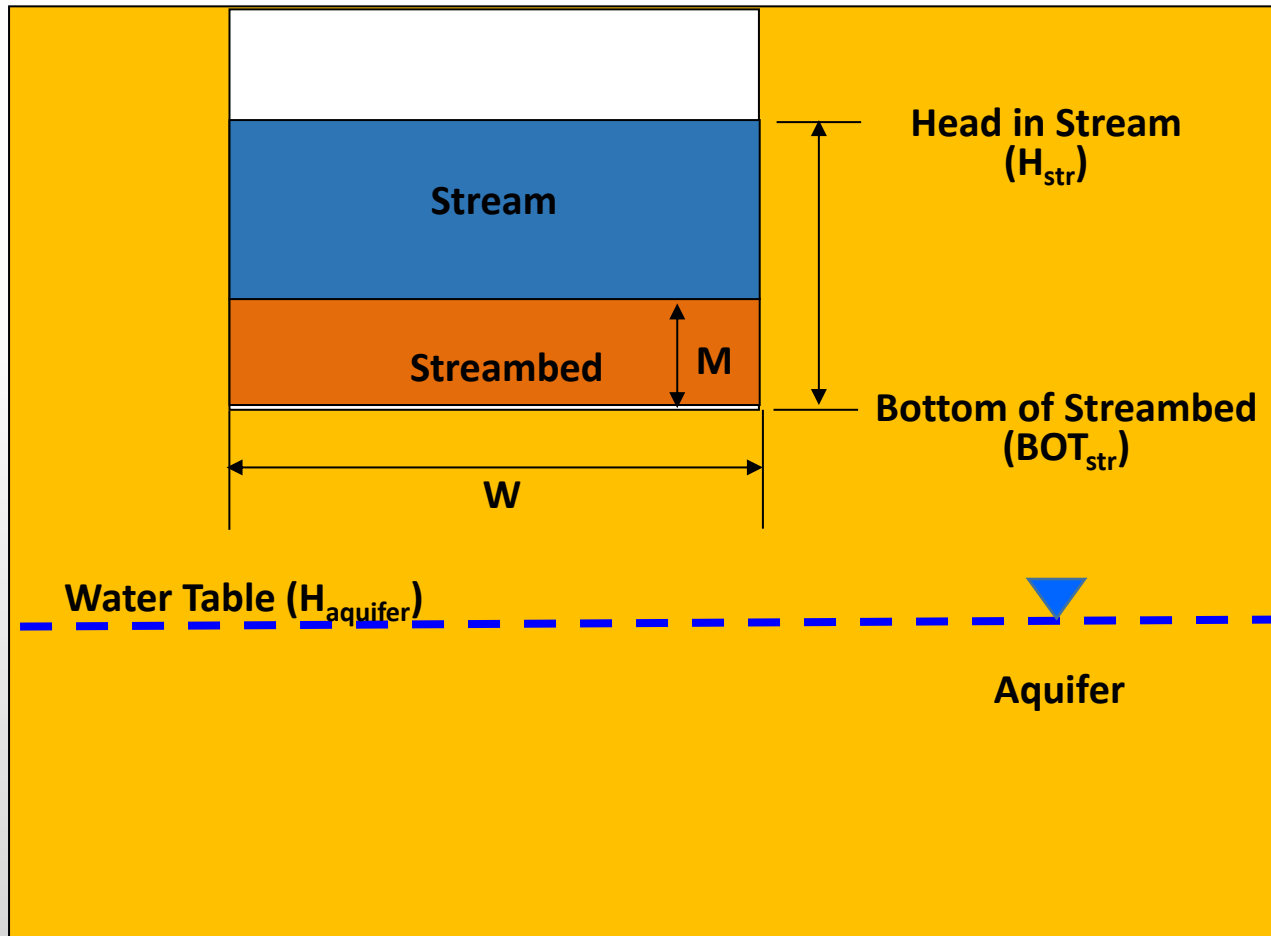
Overview

- **Responses to WEI Technical Questions**
- Responses to Risk Sciences Questions
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Responses to WEI Technical Question No. 1

Comment	GEOSCIENCE Response
1. What does the real world look like? E.G. Characterize how surface water discharge and streambed infiltration vary along the axis of the Riverside-A GMZ for (1) wet weather conditions and (2) dry weather conditions.	Streambed percolation occurs upstream of the discharge point for the RIX Facility. Farther downstream, above MWD Crossing, there is a transition from a losing stream (where percolation occurs) to a gaining stream (where rising water occurs). This transition zone is dependent on groundwater elevations in the vicinity of the River, which changes based on hydrologic conditions. The amount of rising water is therefore also dependent on hydrology (i.e., wet vs. dry).

Surface Water and Groundwater Interaction



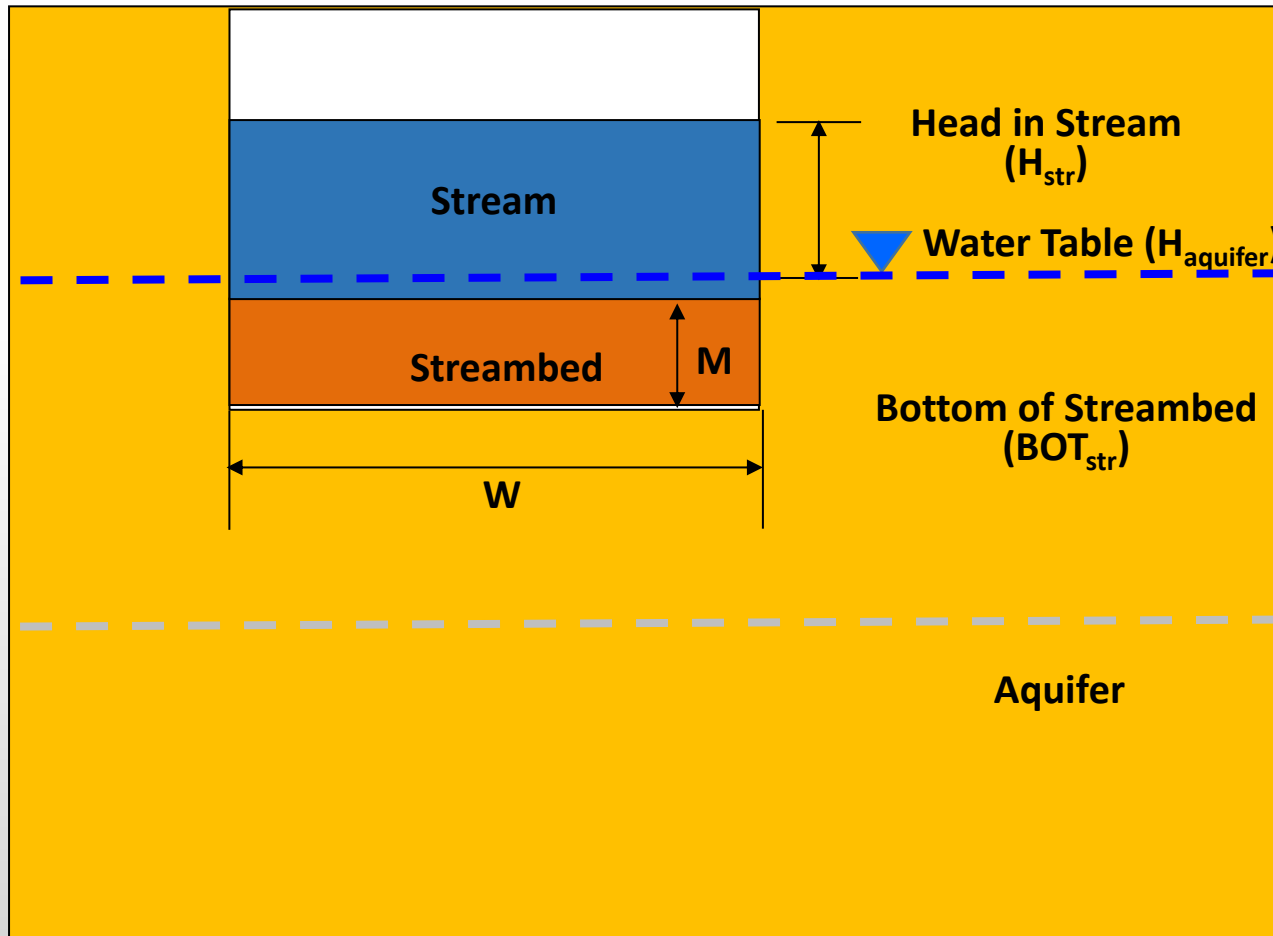
(1) Water Table Below Bottom of Streambed

$$BOT_{str} > H_{aquifer}$$

$$\text{Streambed Percolation} = C_{str} (H_{str} - BOT_{str})$$

$$\text{Note: } C_{str} = K_{str} \times W \times L / M$$

Surface Water and Groundwater Interaction (cont.)



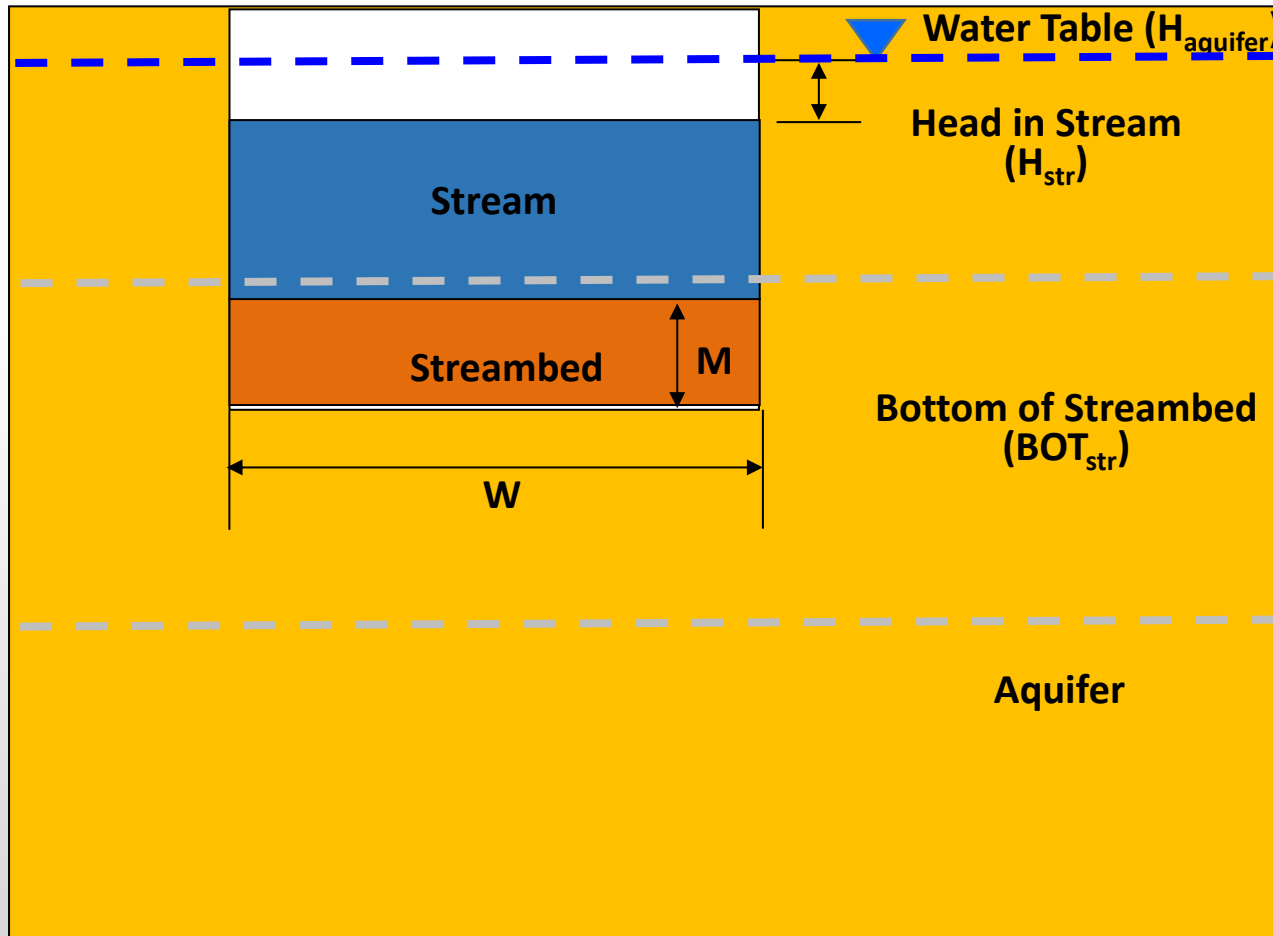
(2) Water Table Above Bottom of Streambed but Below Head in Stream

$$H_{str} > H_{aquifer} > BOT_{str}$$

$$\text{Streambed Percolation} = C_{str} (H_{str} - H_{aquifer})$$

$$\text{Note: } C_{str} = K_{str} \times W \times L / M$$

Surface Water and Groundwater Interaction (cont.)



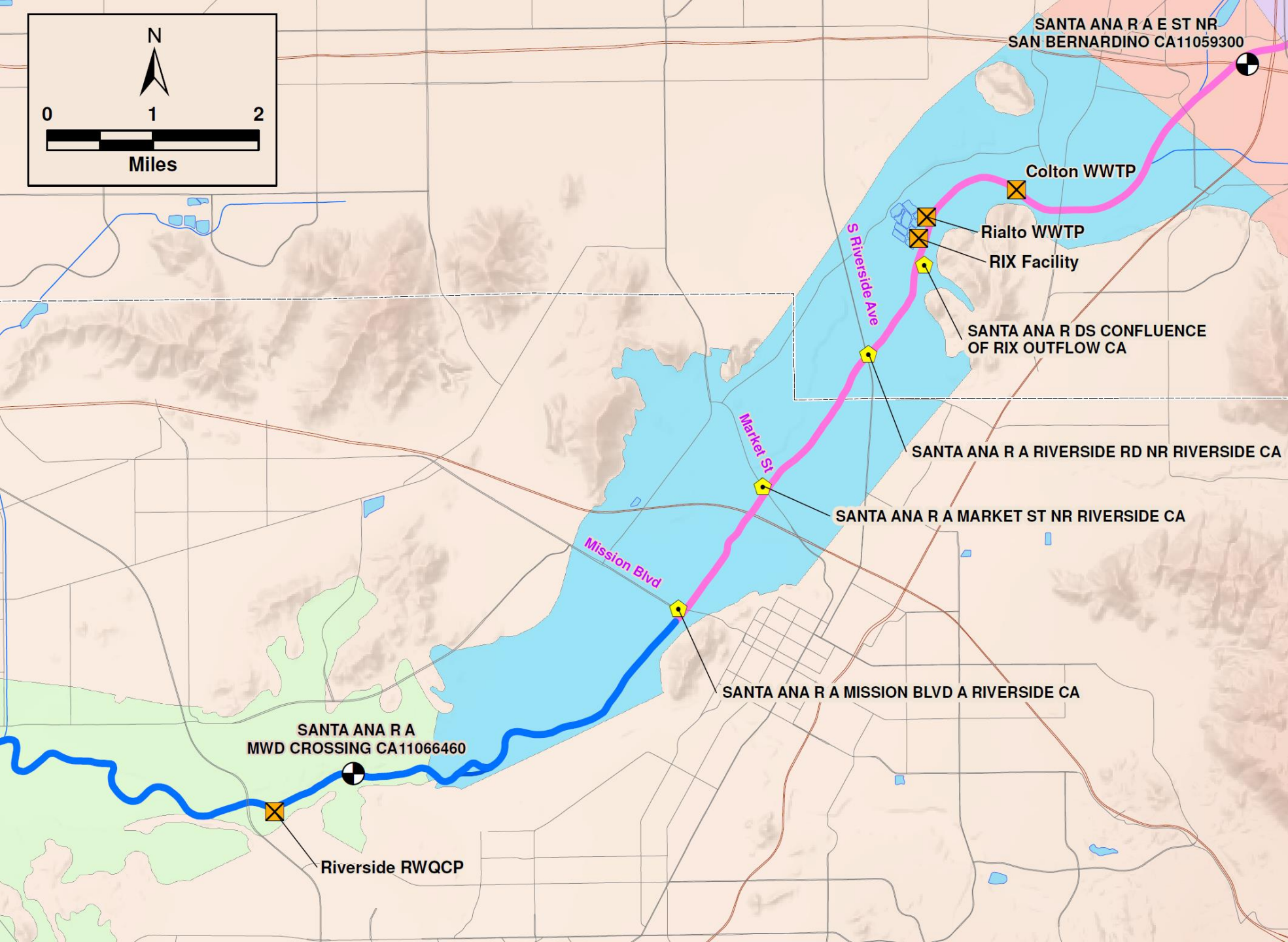
(3) Water Table Above Stream Head

$$H_{\text{aquifer}} > H_{\text{str}}$$

Groundwater from Aquifer Systems to Stream = $C_{\text{str}} (H_{\text{aquifer}} - H_{\text{str}})$

Note: $C_{\text{str}} = K_{\text{str}} \times W \times L / M$

Locations of USGS Streamflow Measurements



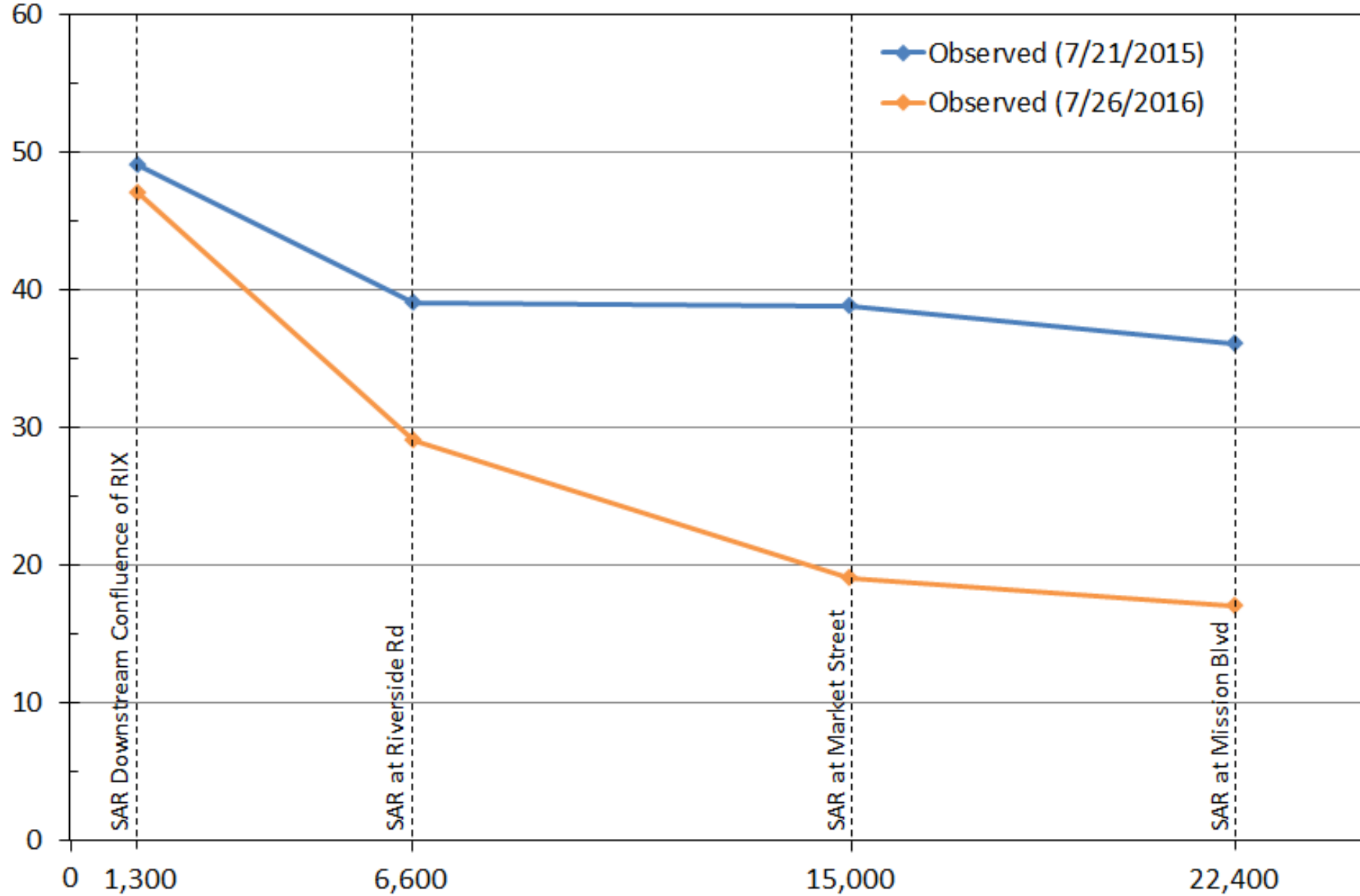
SAR Streamflow in Riverside A GMZ

July 2015 and July 2016

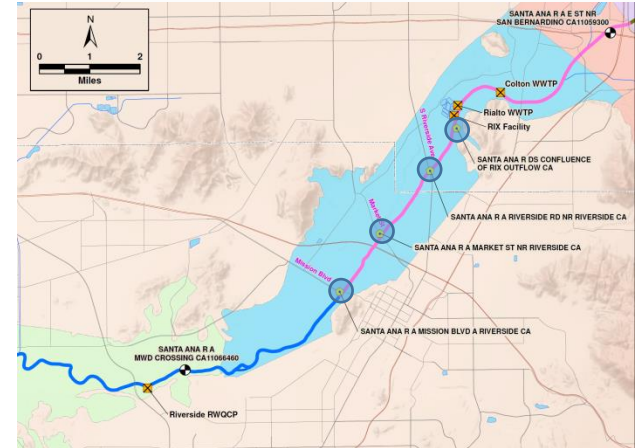
NE

SW

Streamflow, cfs



Distance from RIX, ft



SAR Streamflow in Riverside A GMZ

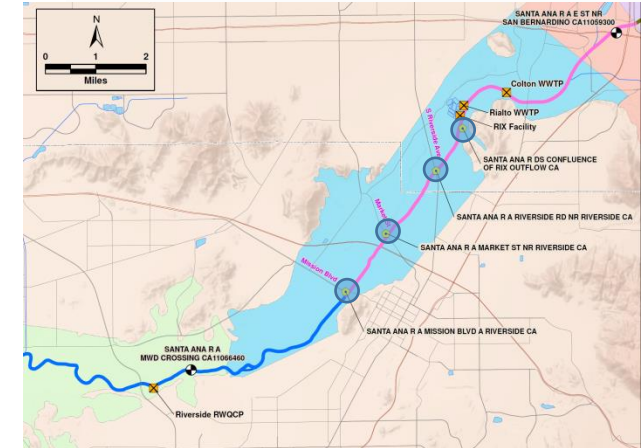
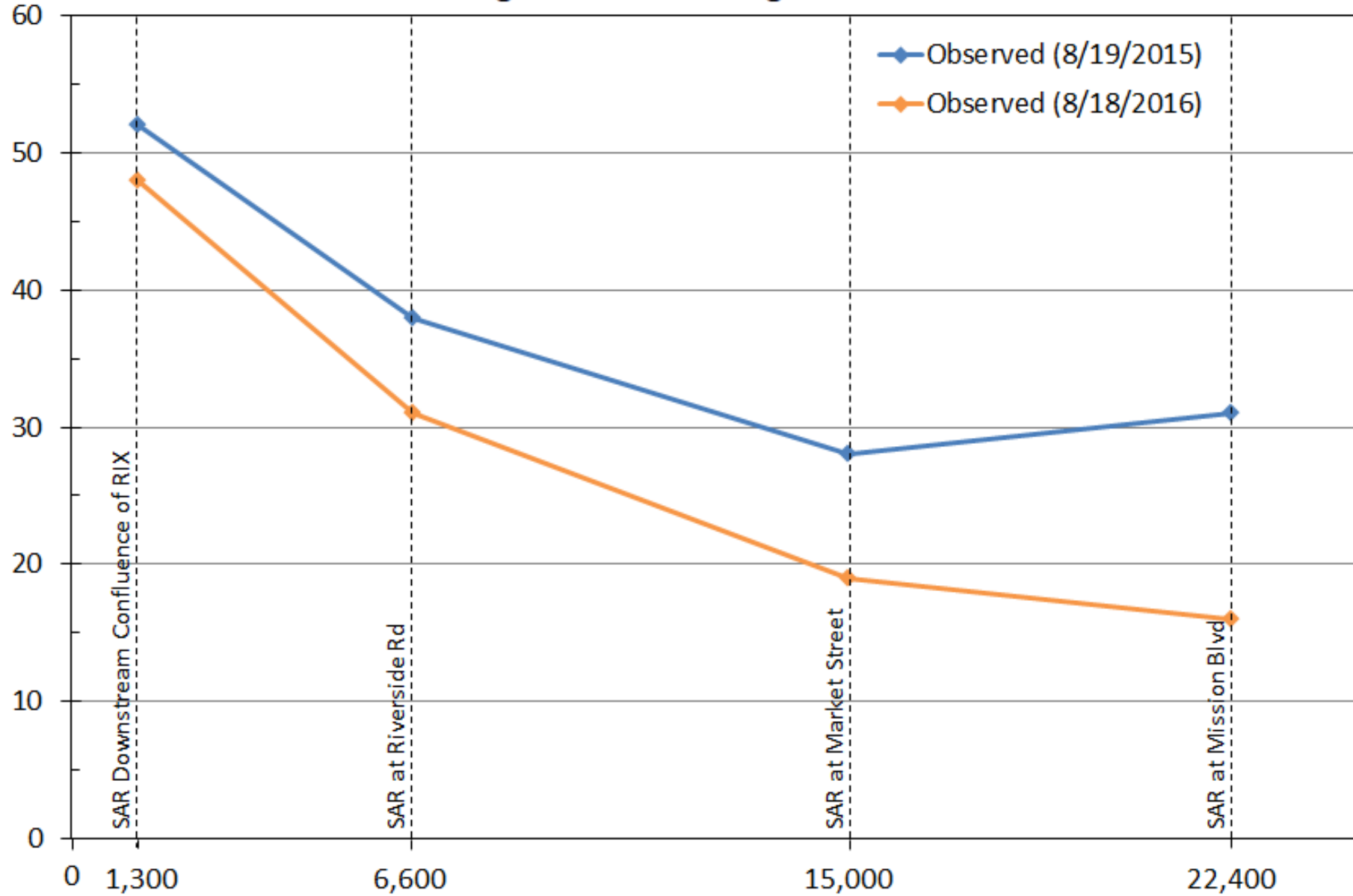
August 2015 and August 2016

NE

SW

Streamflow, cfs

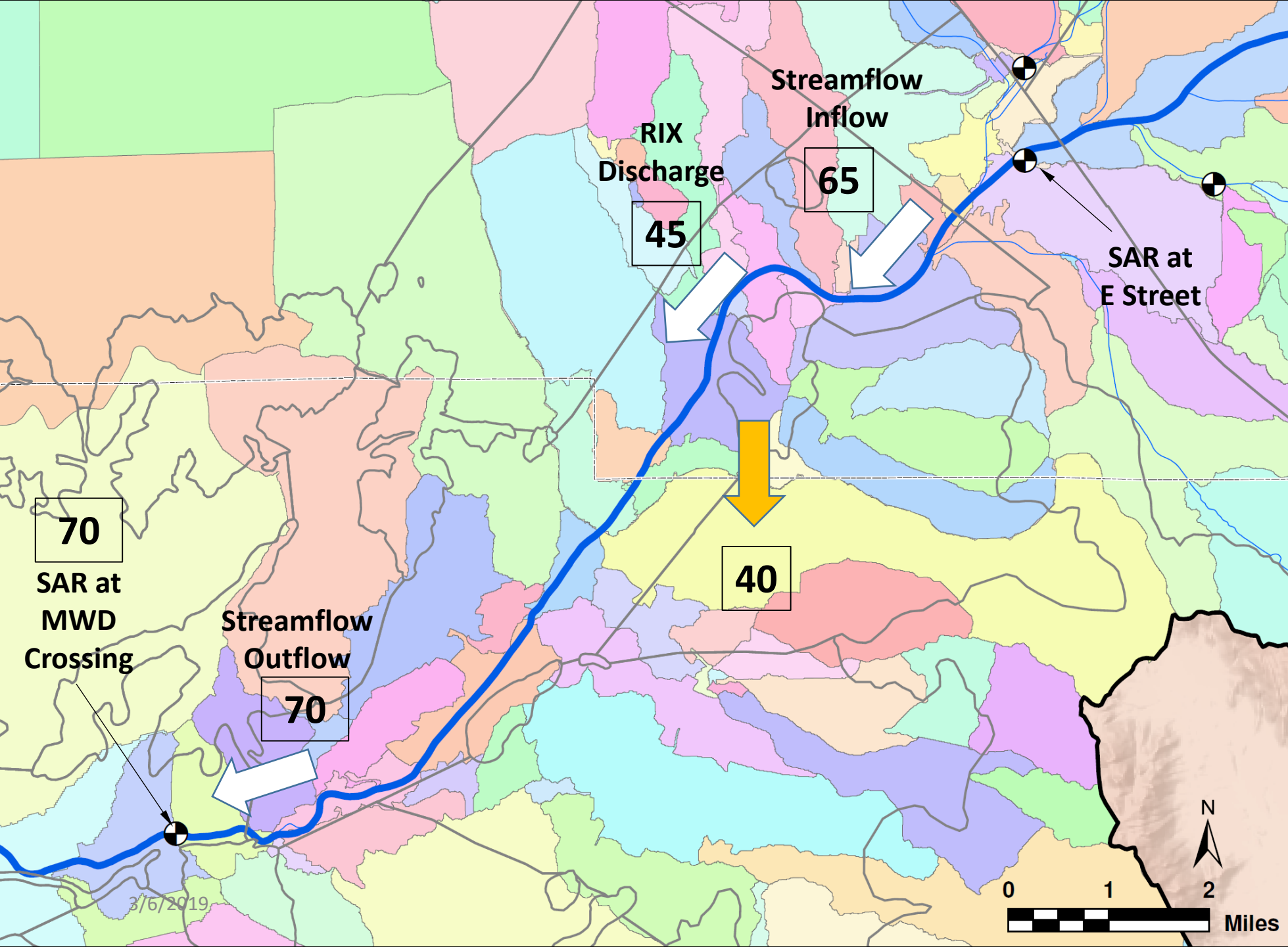
Distance from RIX, ft



Responses to WEI Technical Question No. 2

Comment	GEOSCIENCE Response
<p>2. How does each version of the WLAM represent the real world in Riverside A?</p>	<p>HSPF and other watershed models are limited in the fact that they are not able to simulate the interaction between groundwater and surface water. Percolation is calculated based on the flow in the river and the assigned streambed parameters. In reality, streambed percolation is dependent on groundwater level elevations; higher groundwater levels will cause a reduction in streambed percolation while the reversal of gradients (i.e., rising water) will effectively cause there to be no percolation.</p> <p>In order to account for rising water, the 2017 WLAM HSPF assumes zero percolation in the gaining reach (i.e., Reach 3 above MWD Crossing) and factors in assumed rising water during post-processing by adjusting model-calculated percolation upstream. Because the transition zone between the gaining and losing stream segments varies seasonally and annually, this approach relies on the overall average percolation for Reach 3 and 4 above MWD Crossing.</p>

Rising Water Approach 2017 WLAM HSPF



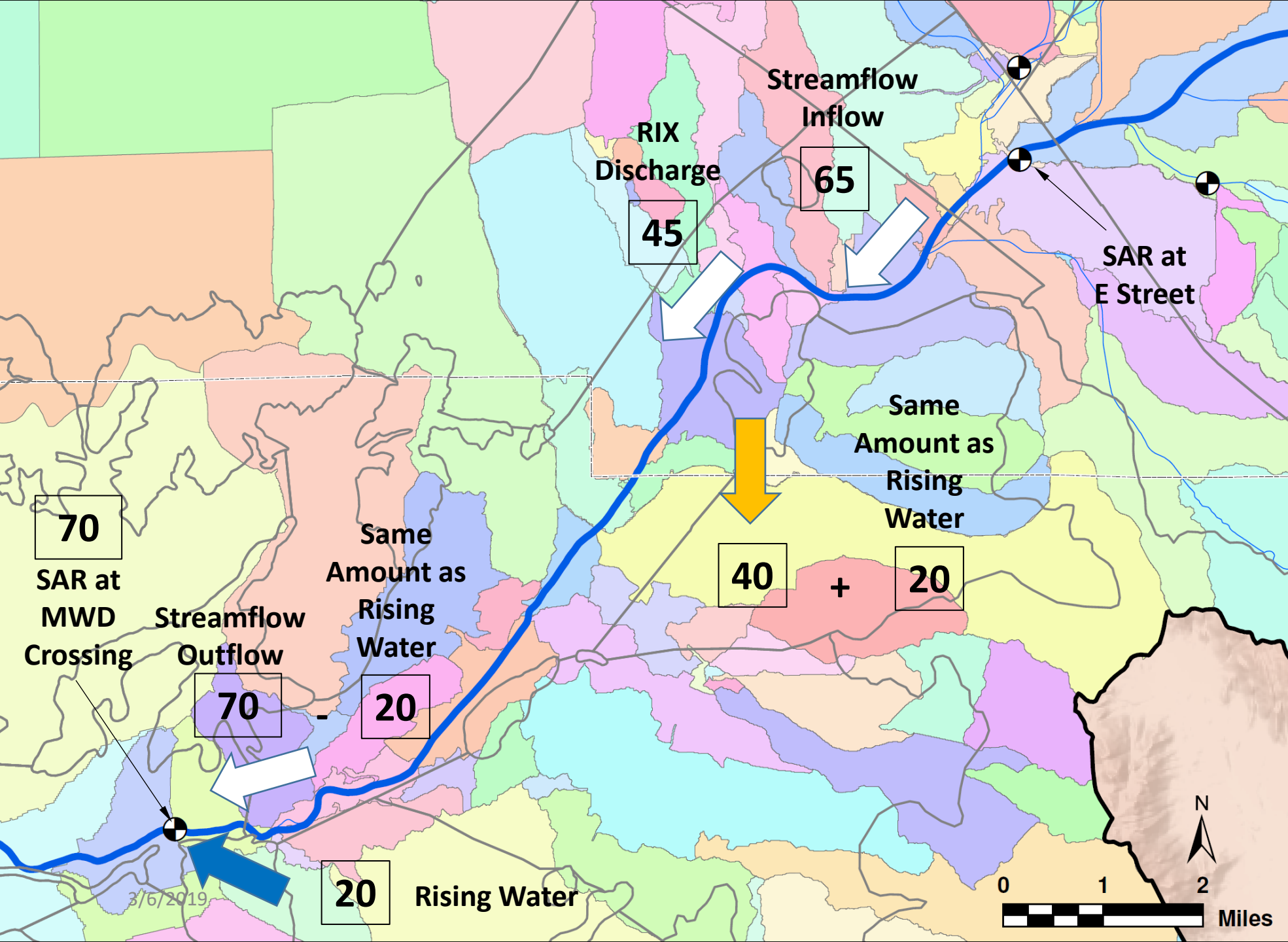
HSPF Model Run:

- Streambed percolation is calculated by the model for Reach 4.
- No Percolation is assumed to occur in Reach 3 due to rising water.
- Model was calibrated so model-calculated flow at MWD Crossing matched observed flow from the MWD gage.

Rising Water Approach 2017 WLAM HSPF (Cont.)

HSPF Post-Processing:

- The amount of rising water was determined from the existing groundwater flow model.
- Since this rising water is contributing to the model-calculated flow at MWD Crossing, additional percolation of the same amount must be added upstream to equilibrate the water balance.



Responses to WEI Technical Question No. 3

Comment	GEOSCIENCE Response
3. What are the hydrologic (flow/recharge) implications of the two model conceptualizations?	Hydrologically, the assumptions used by the 2008 WLAM and 2017 WLAM HSPF have the same implications. Both models are calibrated to the MWD gage. Model-calculated percolation in Reach 3 and 4 is therefore dependent on the assumed volume of rising water. For example, if the assumed rising water volumes are the same, the model-calculated percolation should be similar.

Responses to WEI Technical Question No. 4

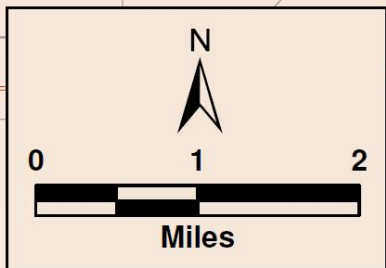
Comment	GEOSCIENCE Response
4. What are the associated implications for the water quality of surface water flow and recharge?	Since both models are calibrated to observed data at MWD Crossing, the water quality of the streamflow and groundwater recharge is dependent on the assumed concentration of rising water. For example, if the concentration (mass) of rising water is the same, the concentration of recharging streamflow should be similar.

Overview

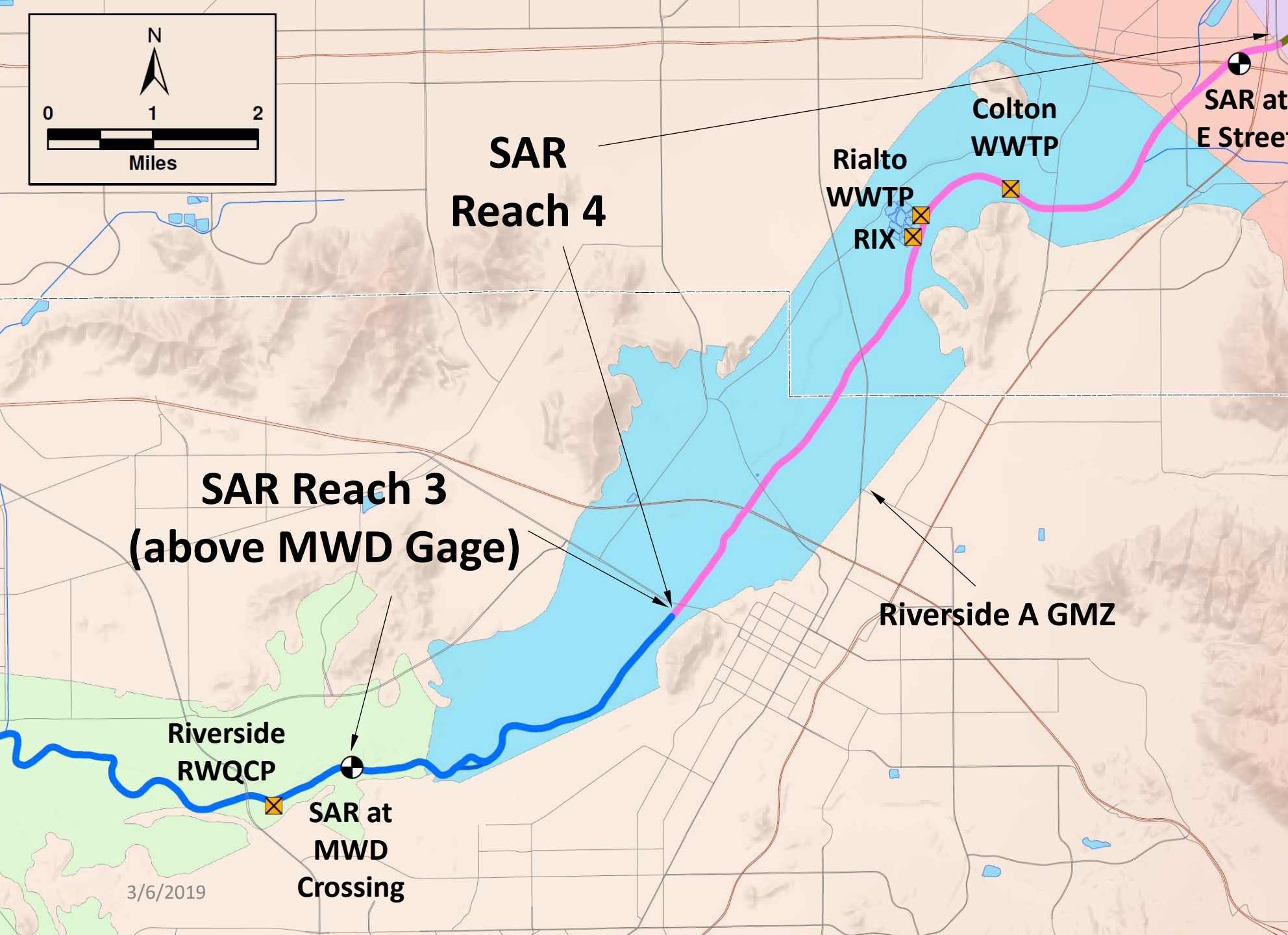
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Responses to Risk Sciences Question No. 1

Comment	GEOSCIENCE Response
<p>1. What initial assumptions did the models make with respect to the permeability of streambed sediments in the upper half of Reach 3 (above the MWD gage)? How were these assumptions changed during the calibration process? Do the final calibrated values still align with our existing knowledge about the sediment characteristics in this area of the river?</p>	<p>The streambed conductivity of Reach 3 was assumed to be zero since SAR Reach 3 above the MWD gage is a gaining reach and receives rising water (if rising water is occurring, percolation is effectively zero).</p> <p>This assumption was not changed during the model calibration process.</p> <p>This assumption for streambed sediment conductivity is not consistent with the sediment characteristics in this area. However, this assumption was chosen to overcome one of the limitations of watershed models, which are unable to simulate the interaction between streamflow and groundwater. Rising water volumes were determined outside of the watershed model based on results from the existing groundwater model and incorporated into the post-processing phase of the surface water calculations above the MWD gage.</p>



Riverside A GMZ and SAR Reaches 3 and 4



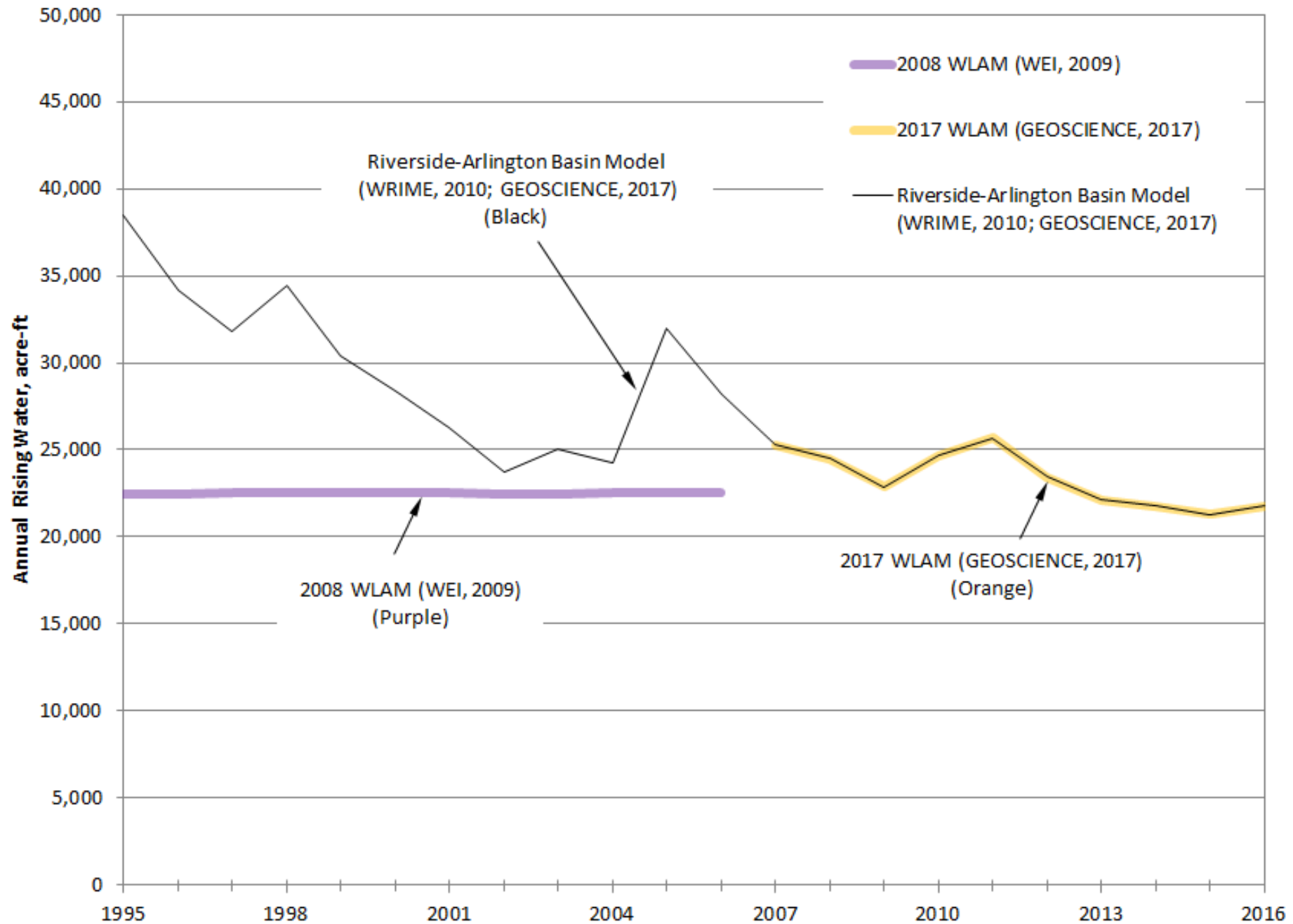
Responses to Risk Sciences Question No. 2

Comment	GEOSCIENCE Response
2. How much of the RIX and Rialto discharge is estimated to recharge in the upper half of Reach 3? (To keep this simple, let's focus only on dry weather baseflow conditions in August)	No percolation is assumed to occur in SAR Reach 3 above the MWD gage since this is the location where rising water is expected to occur.

Responses to Risk Sciences Question No. 3

Comment	GEOSCIENCE Response
3. How was the amount of rising groundwater that occurs in upper half of Reach 3 estimated?	The amount of rising groundwater was estimated based on the results from the Riverside-Arlington Groundwater Model. These rising water values vary monthly based on the corresponding hydrological conditions and model-calculated groundwater levels.

Annual Riverside Narrows Rising Water



Responses to Risk Sciences Question No. 4

Comment	GEOSCIENCE Response
4. How was the average TDS and TIN concentration of that same rising groundwater estimated	The TDS and TIN values from the existing WLAM were used initially and adjusted during model calibration until model-calculated water quality matched observed water quality at the MWD gage.

Responses to Risk Sciences Question No. 5

Comment	GEOSCIENCE Response
<p>5. Is there any way to know, with high confidence, what is happening in the upper half of Reach 3 without taking intermediate flow measurements at the Riverside Ave., Market St. and Mission Ave. bridges (above where we believe the rising groundwater starts to influence surface flows?)</p>	<p>In-field measurements of streamflow at different locations along the reach would yield the best estimate of where rising water is occurring and to what degree.</p> <p>The USGS has limited observations from the following gaging stations downstream of RIX:</p> <ul style="list-style-type: none">• SAR at Riverside Rd. near Riverside CA• SAR at Market St. near Riverside CA• SAR at Mission Blvd. at Riverside CA <p>Flow measurements from these stations can indicate generally where the river transitions from a losing stream to a gaining stream.</p>

Responses to Risk Sciences Question No. 6

Comment	GEOSCIENCE Response
6. Can we use a tool similar to Piper Diagrams to help sort out the relative flow contributions from RIX/Rialto vs. rising groundwater at the MWD gage?	A Piper Diagram analysis may yield qualitative information (e.g., if mixing is occurring and relative mixing of sources), but there are too many other variables to generate high confidence quantitative estimates of source contribution.

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Responses to WEI Policy Question No. 1

Comment	GEOSCIENCE Response
<p>1. Do the hydrologic and water quality implications of the model conceptualizations have the potential to impact the policy interpretations and outcomes?</p>	<p>Conceptually, both models achieve the same effect.</p> <p>While the amount and quality of rising water is unknown, model calibration to the MWD streamflow gage affords some level of confidence for the historical period.</p> <p>However, the rising water assumptions (i.e., flow and concentration) used for the predictive period have the potential to impact policy interpretations.</p>

Responses to WEI Policy Question No. 2

Comment	GEOSCIENCE Response
<p>2. Are the potential impacts significant enough to warrant further review/update/testing of the model conceptualization?</p>	<p>The main source of uncertainty in this area comes from the assumed volume and water quality of rising water upstream of MWD Crossing, since these assumptions drive the amount of model-calculated percolation. Furthermore, there is no way to know how rising water will change under future conditions unless we have a higher confidence in the temporal distribution of rising water concentrations and volume in response to changes in hydrology. This uncertainty can only be improved by using long-term measurements of flow and water quality from multiple upgradient streamflow gages.</p>