

## Action Item 13

Consider Approval of Additional  
Expenditure to Right-on-Q  
Hydrogeology for Technical Support  
for the Carmel River Basin  
Hydrologic Model

August 19, 2019, Regular Board Meeting  
Staff contact: Thomas Christensen and Jon Lear

# Request for Additional Expenditure for CRBHM

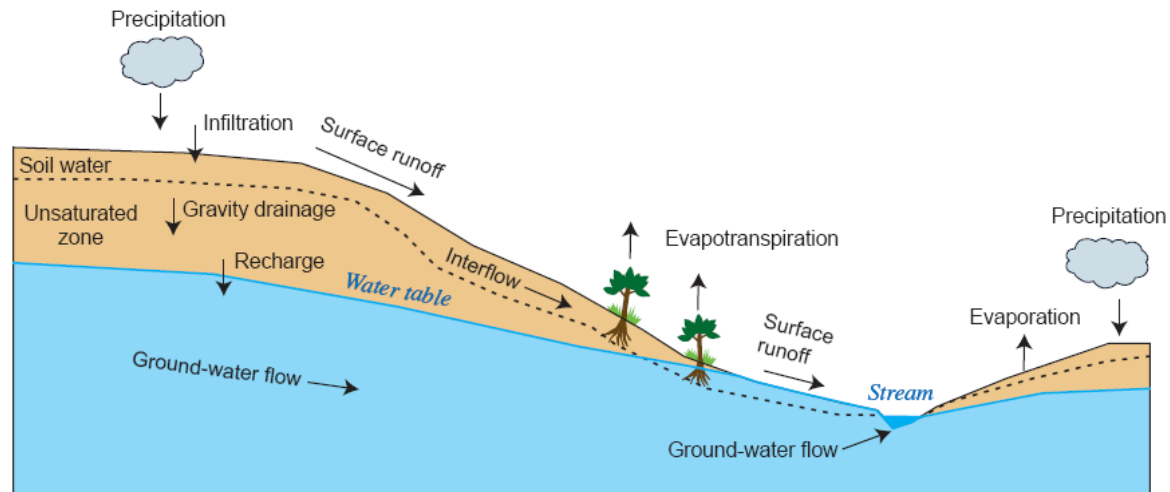
- Original Contract was for \$58,000
- Requesting additional \$15,000 for Right on Q Hydrogeology
  - For development of Matlab scripts that process model output
  - For carrying out sensitivity analysis of various model parameters

# CRBHM Team

- Jonathan Lear – MPWMD
- Thomas Christensen – MPWMD
- Richard Niswonger – USGS
- Mike Hutnak – Right on Q Hydrogeology
- Justin Huntington – Huntington Hydrologic

# Carmel River Basin Hydrologic Model (CRBHM)

- GSFLOW is basin scale integrated model that uses the Precipitation Runoff Modeling System (PRMS) for surface water and the Modular Groundwater Flow Model (MODFLOW) for groundwater



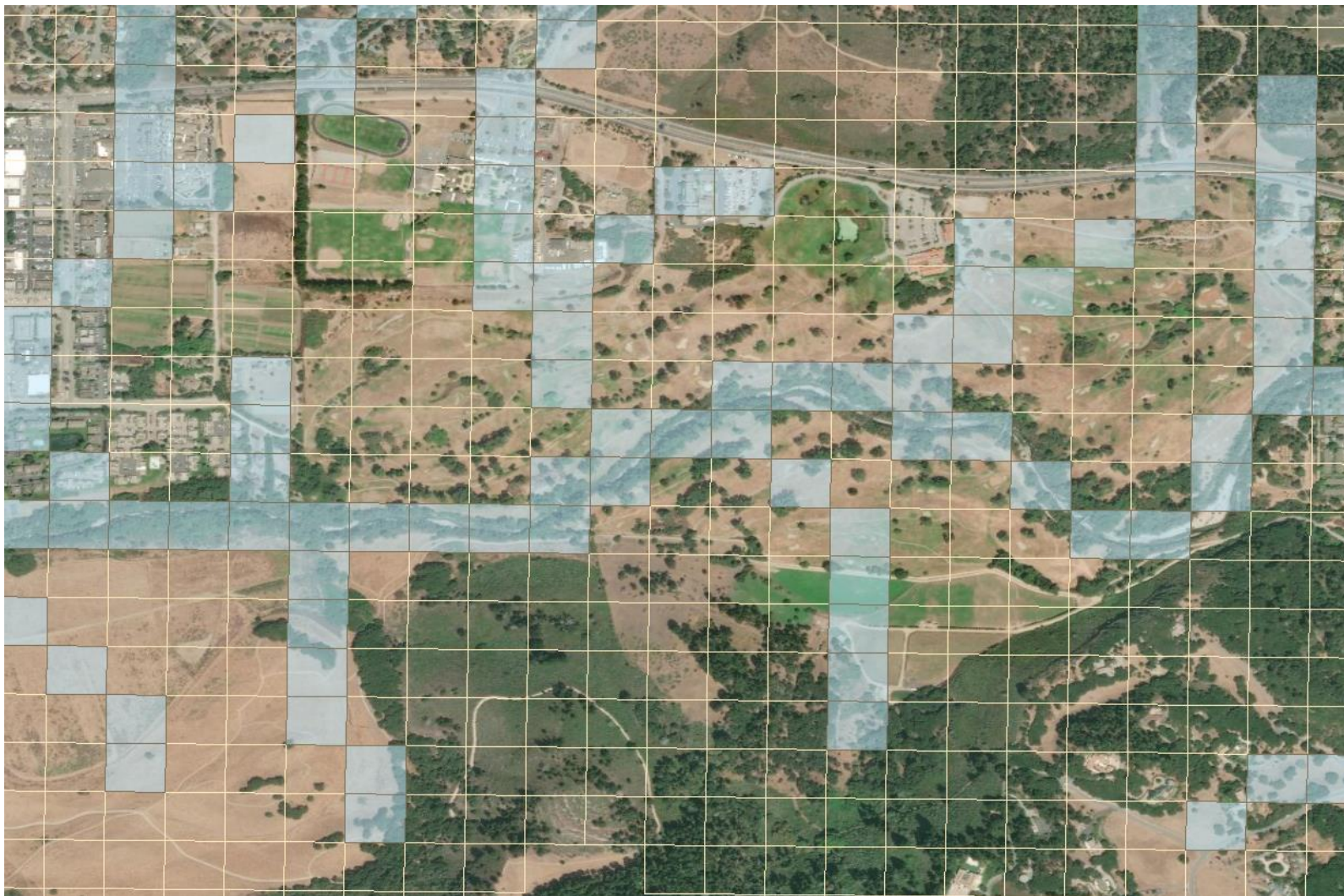


# CRBHM Model Grid





# CRBHM Model Grid





# Data Sets

- Modeling period – WY 1992 to WY 2015
- Data sets
  - Rainfall – San Clemente Rainfall (Daily)
  - Temperature – Carmel Valley Village COOP and Hastings COOP Daily High and Low
  - Evapotranspiration/Vegetation - LANDFIRE
  - Streamflow – USGS and MPWMD stream gage records
  - Pumping – Cal-Am Muni, Private Metered, and Private Water Systems
  - Groundwater Levels – MPWMD and Cal-Am Networks
  - Geology – USGS Geology
  - Soils – SSURGO soils data
  - Channel Geometry – FEMA (2009)
  - Aquifer Parameters – Pumping and aquifer testing

# What will the CRBHM be used for? Los Padres Alternatives Study

Determine the effects of the following on flows and aquatic habitat in the Carmel River Basin


- CDO compliant pumping
- CDO compliant pumping and removal of Los Padres Dam
- CDO compliant pumping and expansion of storage capacity on Los Padres Reservoir (Dredge and Raise)

Estimate the historic dry back of the Carmel River prior to development






# Los Padres Alternatives Scenarios

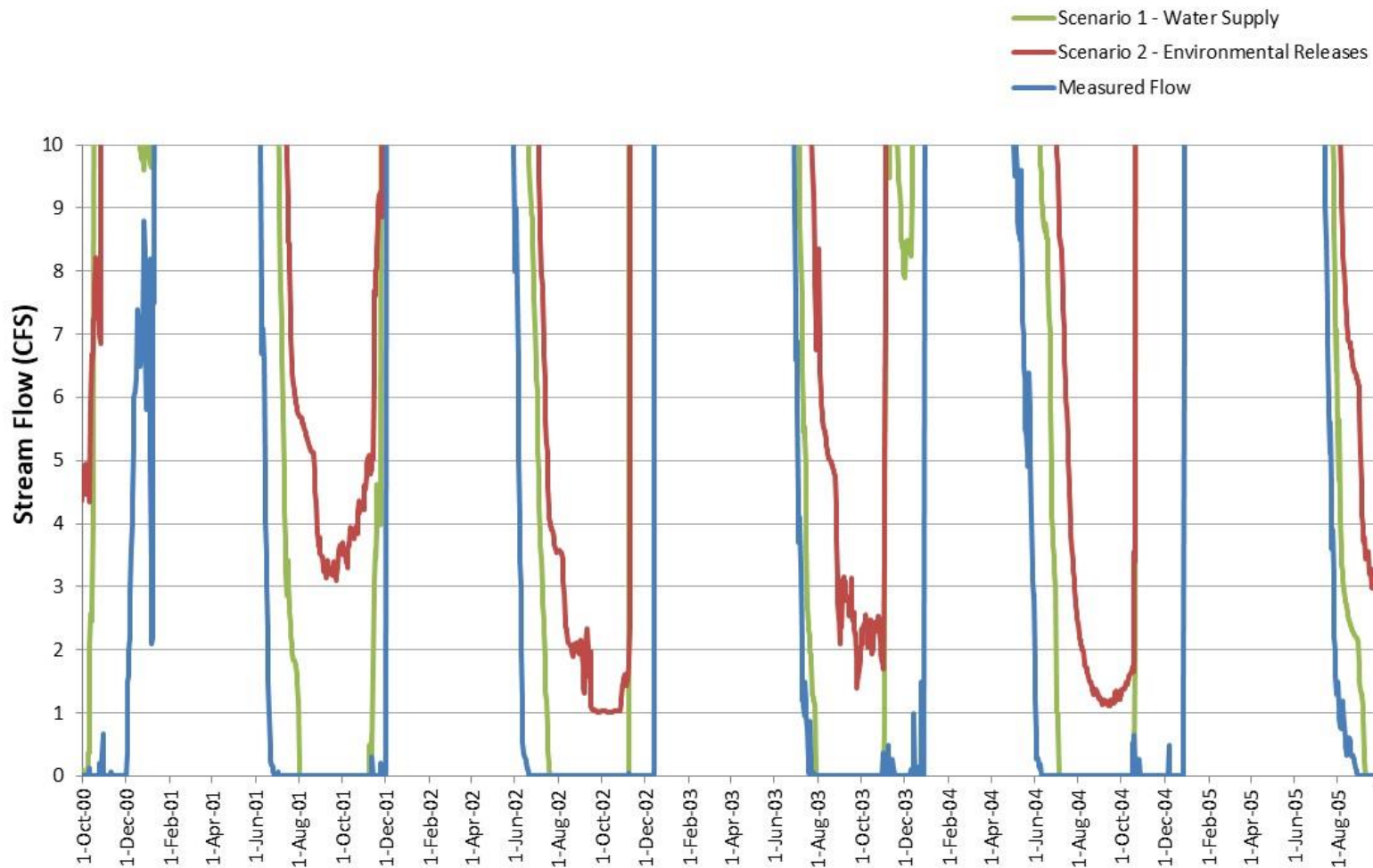
- 
- Historic Calibrated (observed vs simulated)
  - Current Los Padres Operations, CDO compliant pumping and ASR operations
  - Remove Los Padres, CDO compliant pumping, and ASR operations
  - Dredge Los Padres with rubber dam, CDO compliant pumping, and ASR operations
  - Remove Los Padres and raise river bed with no pumping (requested by NOAA)

# Future Uses of the CRBHM

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- A vertical photograph of a river with white water rapids, surrounded by green trees and rocks.
- The CRBHM is a tool that can be used for many scenarios when it comes to making changes in pumping rates, location of pumping, and diversion of streamflow in the Carmel River Basin
  - Planned future use in the following areas:
    - Future water rights applications (20808B)
    - State Board Hearings
    - Future operations
    - Impact of climate change on water supply



# Example of Data from CRBHM (Streamflow Highway 1)





# Raw model output for a stream gage

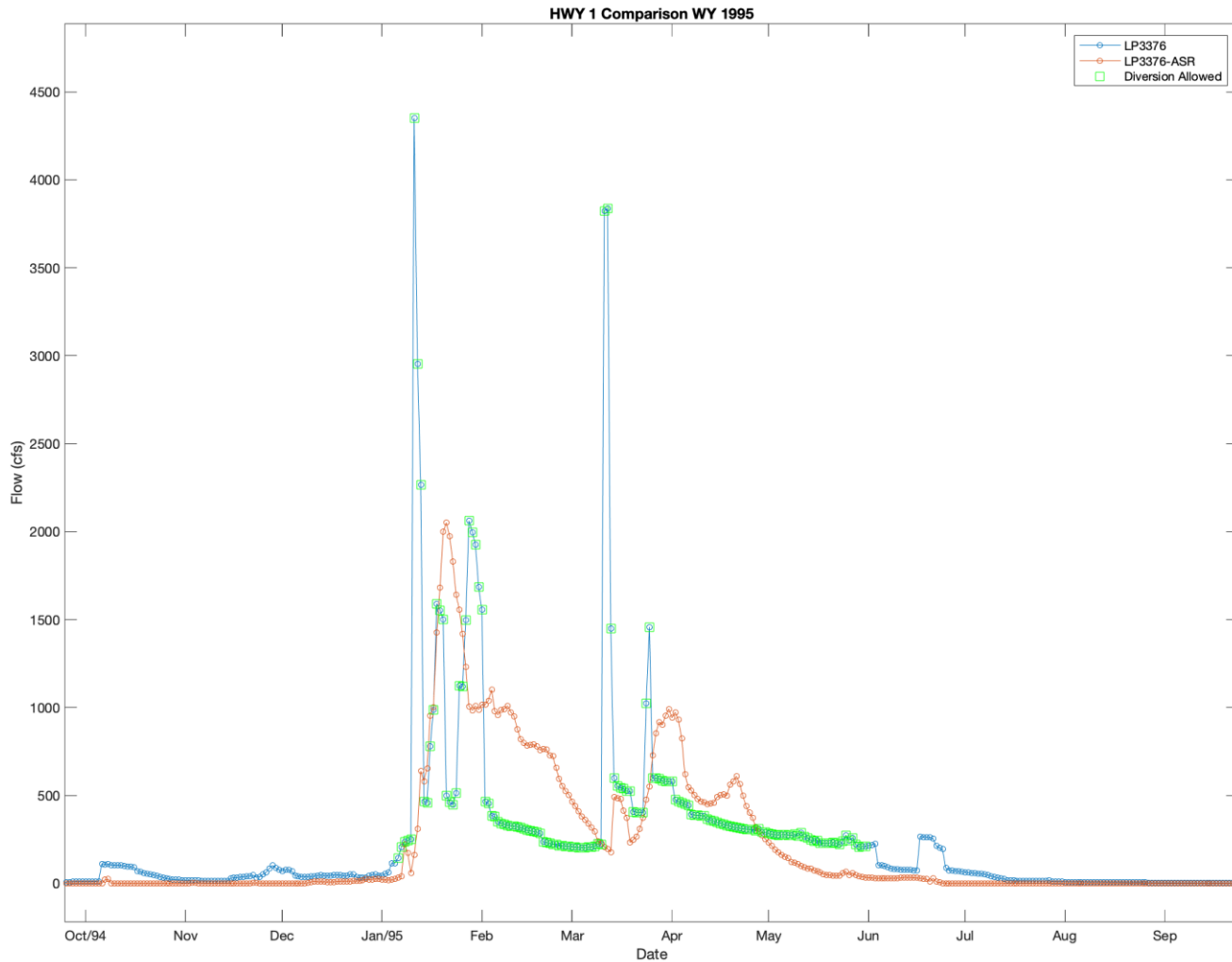
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"GAGE No. 29: K,I,J Coord. = 1, 54, 104; STREAM SEGMENT = 229; REACH = 2 "												
"DATA: Time	Stage	Flow	Depth	Width	Midpt-Flow	Precip.	ET	SFR-Runoff	UZF-Runoff	Conductanc		
1.000000E+00	3.2838596E+01	5.0245780E+07	3.1985958E+00	5.3872746E+01	5.0246032E+07	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	5.6511455E		
2.000000E+00	3.0480537E+01	6.2595381E+05	8.4053749E-01	1.9358027E+01	6.2597100E+05	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	2.0306191E		
3.000000E+00	3.0414370E+01	4.8334878E+05	7.7437013E-01	1.7055641E+01	4.8336447E+05	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	1.7891034E		
4.000000E+00	3.0410988E+01	4.7659753E+05	7.7098924E-01	1.6940777E+01	4.7663466E+05	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00	1.7770543E		
5.000000E+00	3.0393738E+01	4.4595228E+05	7.5373840E-01	1.6358959E+01	4.4599653E+05	0.000000E+00	0.000000E+00	2.3846278E+00	0.000000E+00	1.7160227E		
6.000000E+00	3.0385366E+01	4.2850988E+05	7.4536633E-01	1.6079185E+01	4.2854859E+05	0.000000E+00	0.000000E+00	1.4276660E+01	0.000000E+00	1.6866752E		
7.000000E+00	3.0448528E+01	5.5377681E+05	8.0852872E-01	1.8231413E+01	5.5383694E+05	0.000000E+00	0.000000E+00	2.8889898E+01	0.000000E+00	1.9124395E		
8.000000E+00	3.0399265E+01	4.5421750E+05	7.5926584E-01	1.6544601E+01	4.5425500E+05	0.000000E+00	0.000000E+00	5.9500403E+00	0.000000E+00	1.7354963E		
9.000000E+00	3.0370104E+01	4.0145669E+05	7.3010522E-01	1.5573595E+01	4.0148653E+05	0.000000E+00	0.000000E+00	1.0768556E+01	0.000000E+00	1.6336396E		
1.000000E+01	3.0337961E+01	3.4832141E+05	6.9796187E-01	1.4527486E+01	3.4835012E+05	0.000000E+00	0.000000E+00	5.6055708E+00	0.000000E+00	1.5239049E		
1.100000E+01	3.0480347E+01	6.2542075E+05	8.4034735E-01	1.9351265E+01	6.2552362E+05	0.000000E+00	0.000000E+00	4.9599690E+00	0.000000E+00	2.0299098E		
1.200000E+01	3.0312962E+01	3.1049500E+05	6.7296177E-01	1.3731736E+01	3.1050488E+05	0.000000E+00	0.000000E+00	4.4146166E+00	0.000000E+00	1.4404323E		
1.300000E+01	3.0295527E+01	2.8581222E+05	6.5552765E-01	1.3186227E+01	2.8584044E+05	0.000000E+00	0.000000E+00	3.9498458E+00	0.000000E+00	1.3832094E		
1.400000E+01	3.0283134E+01	2.6910834E+05	6.4313549E-01	1.2803239E+01	2.6914666E+05	0.000000E+00	0.000000E+00	3.5505888E+00	0.000000E+00	1.3430347E		
1.500000E+01	3.0277103E+01	2.6122297E+05	6.3710481E-01	1.2618301E+01	2.6126691E+05	0.000000E+00	0.000000E+00	3.2051446E+00	0.000000E+00	1.3236351E		
1.600000E+01	3.0269306E+01	2.5126888E+05	6.2930626E-01	1.2380561E+01	2.5131359E+05	0.000000E+00	0.000000E+00	2.9043150E+00	0.000000E+00	1.2986965E		
1.700000E+01	3.0257668E+01	2.3689283E+05	6.1766750E-01	1.2028723E+01	2.3693612E+05	0.000000E+00	0.000000E+00	2.6407883E+00	0.000000E+00	1.2617894E		
1.800000E+01	3.0351929E+01	3.7083094E+05	7.1192968E-01	1.4978919E+01	3.7091556E+05	0.000000E+00	0.000000E+00	2.4086928E+00	0.000000E+00	1.5712593E		
1.900000E+01	3.0324850E+01	3.2811650E+05	6.8485063E-01	1.4108188E+01	3.2817216E+05	0.000000E+00	0.000000E+00	2.2032695E+00	0.000000E+00	1.4799213E		
2.000000E+01	3.0331886E+01	3.3886328E+05	6.9188672E-01	1.4332664E+01	3.3892162E+05	0.000000E+00	0.000000E+00	2.0206285E+00	0.000000E+00	1.5034684E		
2.100000E+01	3.0231413E+01	2.0892773E+05	5.9141332E-01	1.1248301E+01	2.0894689E+05	0.000000E+00	0.000000E+00	1.8575643E+00	0.000000E+00	1.1799247E		
2.200000E+01	3.0238913E+01	2.1495602E+05	5.9891331E-01	1.1469357E+01	2.1499273E+05	0.000000E+00	0.000000E+00	1.7114171E+00	0.000000E+00	1.2031132E		
2.300000E+01	3.0249096E+01	2.2664184E+05	6.0909706E-01	1.1771936E+01	2.2668738E+05	0.000000E+00	0.000000E+00	1.5799646E+00	0.000000E+00	1.2348530E		
2.400000E+01	3.0219013E+01	1.9411655E+05	5.7901448E-01	1.1002383E+01	1.9415153E+05	0.000000E+00	0.000000E+00	1.4613379E+00	0.000000E+00	1.1541284E		
2.500000E+01	3.0268902E+01	2.5080730E+05	6.2890315E-01	1.2368315E+01	2.5086220E+05	0.000000E+00	0.000000E+00	3.9340847E+00	0.000000E+00	1.2974120E		
2.600000E+01	3.0302544E+01	2.9573972E+05	6.6254354E-01	1.3404815E+01	2.9579219E+05	0.000000E+00	0.000000E+00	1.6579729E+01	0.000000E+00	1.4061389E		
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2.800000E+01	3.0366941E+01	3.9477981E+05	7.2694266E-01	1.5469535E+01	3.9480331E+05	0.000000E+00	0.000000E+00	7.9228625E+00	0.000000E+00	1.6227239E		
2.900000E+01	3.0287802E+01	2.7544356E+05	6.4780235E-01	1.2947005E+01	2.7544478E+05	0.000000E+00	0.000000E+00	1.2597376E+01	0.000000E+00	1.3581155E		
3.000000E+01	3.0297281E+01	2.8814622E+05	6.5728199E-01	1.3240767E+01	2.8817084E+05	0.000000E+00	0.000000E+00	7.0376487E+00	0.000000E+00	1.3889305E		
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# Scripts can take raw output and create plots




# Challenges to the Los Padres Alternatives Analysis Process

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- When you build a hydrologic model you want consensus among the stakeholders
    - All model results will be presented to the Technical Review Committee (TRC) including MPWMD, NOAA, CDFW, AECOM, and Cal-Am
    - Requested sensitivity analysis will help build consensus on the TRC
    - Once results are deemed reasonable, flow records will be used by Normandeau to assess habitat quality for steelhead at different locations
    - Report preparation summarizing results by AECOM



# Sensitivity Analysis

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- Tasks associated with the Sensitivity Analysis include:
    - Testing the sensitivity of hydraulic parameters related to the stream bed and underlying aquifer to modeled flows in the Carmel River
    - This will show how sensitive the model is to measured and assumed properties of the streambed and aquifer
    - And shows which model inputs are the most important

# Questions and Comments

