Matilija Dam Ecosystem Restoration Project

2D Hydraulic Modeling & Sediment Transport

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Stillwater Sciences

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Existing Conditions Hydraulic Modeling in SRH-2D

• Digital terrain model from 2018 USGS LiDAR
  • Added updated topography adjacent to Robles Diversion based on 2019 LiDAR showing recent sediment removal
• 14 tributary inputs
• Channel roughness coverages based on landcover classification
• General model calibration and validation based on 1D HEC-RAS results and comparison to FEMA floodplain
• Existing conditions hydraulic modeling results presented at April 2021 meeting
Slide 3

2D Sediment Transport Modeling within four Focus Reaches

<table>
<thead>
<tr>
<th>Focus Reach Name</th>
<th>Location</th>
<th>HEC-RAS Stations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Robles Diversion Dam</td>
<td>From Live Oak Acres to upstream of Robles Diversion Dam</td>
<td>10.13 to 15.05</td>
</tr>
<tr>
<td>Santa Ana Bridge</td>
<td>From San Antonio Creek Confluence to Santa Ana Bridge</td>
<td>8.05 to 9.23</td>
</tr>
<tr>
<td>Casita Vista Road</td>
<td>Adjacent to Casita Vista Road</td>
<td>5.97 to 6.63</td>
</tr>
<tr>
<td>Ventura Water Purification Plant (VWPP)</td>
<td>Adjacent to Ventura Water Purification Plant (VWPP)</td>
<td>4.83 to 5.49</td>
</tr>
</tbody>
</table>

- Initial approach was to create separate SRH-2D models for each reach
- Adapted approach created one coarse SRH-2D model that encompassed all four focus reaches (Stations 4.83 to 15.05)
2D Sediment Transport Modeling Approach

- Integration between DREAM-2 sediment transport model results and SRH-2D
  - Hydrology
  - Sediment supply grain size distributions
  - Sediment volumes & transport timing
Hydrology

- Comparison of initial SRH-2D and DREAM-2 hydrology
Hydrology

- Hydrograph extended based on initial SRH-2D runs showing much slower sediment transport rates than DREAM-2

- Simulation includes four recurrences of three large 1969 storms

- Simulation objective: Move dam removal peak sediment pulse through entire study reach
Dam Removal Sediment Supply

• ~1.4 million CY coarse sediment flushes in three storms based on DREAM-2 Run 2b

• For time series sediment input SRH-2D could not be run through standard SMS modeling platform
Background Sediment Supply

- Based on average annual sediment supply rates for WY 1950 to 2017
- Used for existing conditions SRH-2D model
- NF Matilija and San Antonio Creeks only
- Preliminary results show minimal bed changes in focus reaches under existing conditions

<table>
<thead>
<tr>
<th>Tributary Description</th>
<th>Average annual background sediment supply rate (yd³/yr)</th>
<th>Total sediment supply volume over 68-year time period (yd³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NF Matilija Creek</td>
<td>3,730</td>
<td>253,640</td>
</tr>
<tr>
<td>San Antonio Creek</td>
<td>6,210</td>
<td>422,280</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tributary Description</th>
<th>2-4 mm</th>
<th>4-8 mm</th>
<th>8-16 mm</th>
<th>16-32 mm</th>
<th>32-64 mm</th>
<th>64-128 mm</th>
<th>128-256 mm</th>
<th>256-512 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>NF Matilija Creek</td>
<td>11.5%</td>
<td>14.9%</td>
<td>16.8%</td>
<td>20.0%</td>
<td>20.0%</td>
<td>12.0%</td>
<td>3.3%</td>
<td>1.5%</td>
</tr>
<tr>
<td>San Antonio Creek</td>
<td>15.0%</td>
<td>20.0%</td>
<td>20.0%</td>
<td>20.0%</td>
<td>17.0%</td>
<td>6.0%</td>
<td>1.0%</td>
<td>1.0%</td>
</tr>
</tbody>
</table>
SRH-2D Sediment Transport and Hydraulic Modeling Approach

- Fixed channel bed
- Two scenarios at Robles:
  1) Existing Conditions
  2) Failure of Crib Wall
SRH-2D Dam Removal Sediment Deposition Trends

- Total volume of deposition within each focus reach after each annual storm series

<table>
<thead>
<tr>
<th>Reach Name</th>
<th>HEC-RAS Stations</th>
<th>t=336 hr</th>
<th>t=744 hr</th>
<th>t=1,152 hr</th>
<th>t=1,560 hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Robles Diversion Dam</td>
<td>10.13 to 15.05</td>
<td>1,120,000</td>
<td>680,000</td>
<td>553,000</td>
<td>507,000</td>
</tr>
<tr>
<td>Santa Ana Bridge</td>
<td>8.05 to 9.23</td>
<td>113,000</td>
<td>148,000</td>
<td>120,000</td>
<td>107,000</td>
</tr>
<tr>
<td>Casita Vista Road</td>
<td>5.97 to 6.63</td>
<td>16,000</td>
<td>24,000</td>
<td>20,000</td>
<td>19,000</td>
</tr>
<tr>
<td>VWPP</td>
<td>4.83 to 5.49</td>
<td>12,000</td>
<td>11,000</td>
<td>5,000</td>
<td>5,000</td>
</tr>
</tbody>
</table>
VENTURA RIVER, CALIFORNIA
SRH-2D Sedimentation at T = 552 hrs
Robles Diversion Dam Reach - 1

LEGEND
- Adjacent tile
- SRH-2D Tributary Inlet
- Point of Interest (labeled with distance downstream from Matilija Dam)
- HEC-RAS cross section - focus reaches
- Future (Dam Removal) sedimentation deposition depth (ft) during 100-year storm event at T = 552 hrs from SRH-2D

Focus reach area
Future (Dam Removal) 100-year floodplain at T = 552 hrs from SRH-2D

DATA SOURCES
- Proposed Sedimentation: Stillwater Sciences 2021
- Imagery: NAIP 2020
- Roads, cities, streams, and waterbodies: ESRI 2016

SCALE & NORTH ARROW
1:7,000

Stillwater Sciences

HEC-RAS cross section - focus reaches
Future (Dam Removal) 100-year floodplain at T = 552 hrs from SRH-2D

Adjacent tile
VENTURA RIVER, CALIFORNIA
SRH-2D Sedimentation at T = 552 hrs
Robles Diversion Dam Reach - 2

DATA SOURCES
Proposed Sedimentation: Stillwater Sciences 2021
Imagery: NAIP 2020
Roads, cities, streams, and waterbodies: ESRI 2016

SCALE & NORTH ARROW
1:7,000

LEGEND
Adjacent tile
SRH-2D Tributary Inlet
Point of Interest (labeled with distance downstream from Matilija Dam)
Focus reach area
HEC-RAS cross section - focus reaches
Future (Dam Removal) 100-year floodplain at T = 552 hrs from SRH-2D
Future (Dam Removal) sedimentation deposition depth (ft) during 100-year storm event at T = 552 hrs from SRH-2D

> 6.47 ft
5.45 ft - 6.47 ft
4.42 ft - 5.45 ft
3.39 ft - 4.42 ft
2.36 ft - 3.39 ft
1 ft - 2.36 ft

Ojai
Ventura
Saticoy
Lake
Casitas
Lake
Matilija

HEC-RAS cross section - focus reaches
Future (Dam Removal) 100-year floodplain at T = 552 hrs from SRH-2D
Future (Dam Removal) sedimentation deposition depth (ft) during 100-year storm event at T = 552 hrs from SRH-2D
VENTURA RIVER, CALIFORNIA
SRH-2D Sedimentation at T = 552 hrs
Robles Diversion Dam Reach - 3

LEGEND
- Adjacent tile
- SRH-2D Tributary Inlet
- Point of Interest (labeled with distance downstream from Matilija Dam)
- HEC-RAS cross section - focus reaches
- Focus reach area
- Future (Dam Removal) 100-year floodplain at T = 552 hrs from SRH-2D
- Future (Dam Removal) sedimentation deposition depth (ft) during 100-year storm event at T = 552 hrs from SRH-2D

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- Roads, cities, streams, and waterbodies: ESRI 2016

SCALE & NORTH ARROW
VENTURA RIVER, CALIFORNIA
SRH-2D Sedimentation at T = 552 hrs
Robles Diversion Dam Reach - 3

HEC-RAS cross section - focus reaches
Focus reach area
Future (Dam Removal) 100-year floodplain at T = 552 hrs from SRH-2D
Future (Dam Removal) sedimentation deposition depth (ft) during 100-year storm event at T = 552 hrs from SRH-2D

Adjacent tile
SRH-2D Tributary Inlet
Point of Interest (labeled with distance downstream from Matilija Dam)

1:7,000
VENTURA RIVER, CALIFORNIA
SRH-2D Sedimentation at T = 552 hrs Robles Diversion Dam Reach - 3

DATA SOURCES
Proposed Sedimentation: Stillwater Sciences 2021
Imagery: NAIP 2020
Roads, cities, streams, and waterbodies: ESRI 2016

LEGEND
- Point of Interest (labeled with distance downstream from Matilija Dam)
- SRH-2D Tributary Inlet
- HEC-RAS cross section - focus reaches

Future (Dam Removal) 100-year floodplain at T = 552 hrs from SRH-2D
Future (Dam Removal) sedimentation deposition depth (ft) during 100-year storm event at T = 552 hrs from SRH-2D

SCALE & NORTH ARROW
1:7,000

HEC-RAS cross section - focus reaches

Stillwater Sciences
VENTURA RIVER, CALIFORNIA
SRH-2D Sedimentation at T = 552 hrs
Castle Vista Road Reach

LEGEND
- Adjacent tile
- SRH-2D Tributary Inlet
- Point of Interest (labeled with distance downstream from Matilija Dam)
- HEC-RAS cross section - focus reaches
- Future (Dam Removal) cross section - focus reaches
- Focus reach area
- Future (Dam Removal) 100-year floodplain at T = 552 hrs from SRH-2D
- Future (Dam Removal) sedimentation deposition depth (ft) during 100-year storm event at T = 552 hrs from SRH-2D
  - > 6.47 ft
  - 5.45 ft - 6.47 ft
  - 4.42 ft - 5.45 ft
  - 3.39 ft - 4.42 ft
  - 2.36 ft - 3.39 ft
  - 1 ft - 2.36 ft

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SCALE & NORTH ARROW

MAP LOCATION
VENTURA RIVER, CALIFORNIA
SRH-2D Sedimentation at T = 552 hrs VWPP Reach

LEGEND

DATA SOURCES
Proposed Sedimentation: Stillwater Sciences 2021
Imagery: NAIP 2020
Roads, cities, streams, and waterbodies: ESRI 2016

SCALE & NORTH ARROW
1:7,000

VENTURA RIVER, CALIFORNIA
SRH-2D Sedimentation at T = 552 hrs VWPP Reach

LEGEND

- Adjacent tile
- SRH-2D Tributary Inlet
- Point of Interest (labeled with distance downstream from Matilija Dam)
- Focus reach area
- HEC-RAS cross section - focus reaches
- Future (Dam Removal) 100-year floodplain at T = 552 hrs from SRH-2D
- Future (Dam Removal) sedimentation deposition depth (ft) during 100-year storm event at T = 552 hrs from SRH-2D

- > 6.47 ft
- 5.45 ft - 6.47 ft
- 4.42 ft - 5.45 ft
- 3.39 ft - 4.42 ft
- 2.36 ft - 3.39 ft
- 1 ft - 2.36 ft
- Adjacent tile
- SRH-2D Tributary Inlet
- Point of Interest (labeled with distance downstream from Matilija Dam)
- Focus reach area
- HEC-RAS cross section - focus reaches
- Future (Dam Removal) 100-year floodplain at T = 552 hrs from SRH-2D
- Future (Dam Removal) sedimentation deposition depth (ft) during 100-year storm event at T = 552 hrs from SRH-2D

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HEC-RAS cross section - focus reaches
Focus reach area
Future (Dam Removal) 100-year floodplain at T = 552 hrs from SRH-2D
Future (Dam Removal) sedimentation deposition depth (ft) during 100-year storm event at T = 552 hrs from SRH-2D

Ojai
Ventura
Saticoy
Lake
Casitas
Matilija
Lake
6
7
4
2
8
3
5
1
£¤
UV
126
Without coordinates, it is not possible to accurately interpret the text or the map. Please provide the necessary coordinates to proceed with the analysis.
Ventura River, California
SRH-2D inundation at T = 552 hrs
Casitas Vista Road Reach

Legend
- Adjacent
- SRH-2D Tributary Inlet Point of Interest (labeled with distance downstream from Matilija Dam)
- HEC-RAS cross section - focus reaches
- Focus reach area
- FEMA 100-year floodplain extent
- Current 100-year floodplain from SRH-2D
- Future (Dam Removal) 100-year floodplain at T = 552 hrs from SRH-2D

Data Sources
- Proposed Inundation: Stillwater Sciences 2021
- Existing Inundation: Stillwater Sciences 2021
- FEMA 100-year FP: FEMA NFHL
- Imagery: NAIP 2020
- Roads, cities, streams, and waterbodies: ESRI 2016

Scale & North Arrow
1:7,000
VENTURA RIVER, CALIFORNIA
SRH-2D Velocity at T = 552 hrs
Robles Diversion Dam Reach - 1

DATA SOURCES
Proposed Velocity: Stillwater Sciences 2021
Imagery: NAIP 2020
Roads, cities, streams, and waterbodies: ESRI 2016

LEGEND
- Adjacent
- SRH-2D Tributary Inlet
- Point of Interest (labeled with
  distance downstream from Matilija Dam)
- HEC-RAS cross section - focus reaches
- Focus reach area

Future (Dam Removal) 100-year discharge velocity at T = 552 hrs from SRH-2D
1 fps 10 fps 25 fps
VENTURA RIVER, CALIFORNIA
SRH-2D Velocity at T = 552 hrs
Robles Diversion Dam Reach - 4
DATA SOURCES
Proposed Velocity: Stillwater Sciences 2021
Imagery: NAIP 2020
Roads, cities, streams, and waterbodies: ESRI 2016
LEGEND
Adjacent
SRH-2D Tributary Inlet
Point of Interest (labeled with distance downstream from Matilija Dam)
HEC-RAS cross section - focus reaches
Focus reach area
Future (Dam Removal) 100-year discharge velocity at T = 552 hrs from SRH-2D
1 fps 13 fps 25 fps
SCALE & NORTH ARROW
1:7,000
MAP LOCATION
Page 4 of 8
VENTURA RIVER, CALIFORNIA
SRH-2D Velocity at T = 552 hrs
Robles Diversion Dam Reach - 5

Legend:
- Adjacent
- SRH-2D Tributary Inlet Point of Interest (labeled with distance downstream from Matilija Dam)
- HEC-RAS cross section - focus reaches
- Focus reach area

Future (Dam Removal) 100-year discharge velocity at T = 552 hrs from SRH-2D
1 ft/s 2 ft/s 3 ft/s 4 ft/s 5 ft/s 6 ft/s 7 ft/s 8 ft/s 9 ft/s 10 ft/s

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SCALE & NORTH ARROW
0 100 200 300 400 500 600 700 800 900 1000 Feet
0 50 100 150 200 250 300 350 400 450 Meters

Map Location Page 5 of 8
VENTURA RIVER, CALIFORNIA
SRH-2D Velocity at T = 552 hrs
Santa Ana Bridge Reach

LEGEND

- Adjacent
- SRH-2D Tributary Inlet
- Point of Interest (labeled with distance downstream from Matilija Dam)
- HEC-RAS cross section - focus reaches

Focus reach area

Future (Dam Removal) 100-year discharge velocity at T = 552 hrs from SRH-2D

1 ft/s
13 ft/s
25 ft/s

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SCALE & NORTH ARROW

身边

MAP LOCATION
Comparison of Sediment Deposition predicted by DREAM-2, SRH-1D and SRH-2D

<table>
<thead>
<tr>
<th>HEC-RAS River Station (mi)</th>
<th>Focus Reach Name</th>
<th>DREAM-2 Future Conditions Predicted Change in Bed Elevation (ft)</th>
<th>SRH-1D Future Conditions Predicted Change in Bed Elevation (ft)</th>
<th>SRH-2D Future Conditions Predicted Change in Bed Elevation (ft)</th>
<th>Difference in Predicted Change in Bed Elevation (ft) between DREAM-2 and SRH-1D</th>
<th>Difference in Predicted Change in Bed Elevation (ft) between DREAM-2 and SRH-2D</th>
<th>Difference in Predicted Change in Bed Elevation (ft) between SRH-1D and SRH-2D</th>
</tr>
</thead>
<tbody>
<tr>
<td>15.0568 to 14.0152</td>
<td>Upstream of Robles</td>
<td>3.9</td>
<td>5.1</td>
<td>4.1</td>
<td>-1.2</td>
<td>-0.2</td>
<td>1.0</td>
</tr>
<tr>
<td>14.0152 to 13.3523</td>
<td>Meiners Oaks Levee</td>
<td>1.3</td>
<td>2.9</td>
<td>2.4</td>
<td>-1.6</td>
<td>-1.2</td>
<td>0.4</td>
</tr>
<tr>
<td>13.3523 to 11.1181</td>
<td>DS Meiners Oaks to Baldwin Rd Bridge</td>
<td>1.6</td>
<td>0.6</td>
<td>1.8</td>
<td>1.0</td>
<td>-0.2</td>
<td>-1.2</td>
</tr>
<tr>
<td>11.1181 to 10.1326</td>
<td>Baldwin Rd Bridge to US of Live Oak Acres Levee</td>
<td>1.7</td>
<td>0.7</td>
<td>0.4</td>
<td>1.0</td>
<td>1.3</td>
<td>0.2</td>
</tr>
<tr>
<td>9.2297 to 8.0492</td>
<td>Downstream of San Ana Focus Reach</td>
<td>0.7</td>
<td>0.0</td>
<td>1.0</td>
<td>0.7</td>
<td>-0.2</td>
<td>-0.9</td>
</tr>
<tr>
<td>6.6288 to 5.9723</td>
<td>Casita Vista</td>
<td>1.5</td>
<td>2.4</td>
<td>0.3</td>
<td>-0.9</td>
<td>1.2</td>
<td>2.1</td>
</tr>
<tr>
<td>5.4924 to 4.8295</td>
<td>VWPP</td>
<td>1.1</td>
<td>-1.3</td>
<td>0.3</td>
<td>2.4</td>
<td>0.8</td>
<td>-1.6</td>
</tr>
</tbody>
</table>

- Results from three modeling approaches are consistent
- Important to remember that model results are not absolute and have significant uncertainty based on modeling approach and variations in hydrologic conditions
Next Steps

- Detailed SRH-2D Sediment Transport and Hydraulic Modeling for reach upstream of Robles and three levee reaches (October/November 2021)

- Assess 2\textsuperscript{nd} hydrologic scenario (DREAM-2 run 2e) for reach upstream from Robles (October/November 2021)

- Final SRH-2D Model Revisions & Reporting (December 2021/January 2022)
Questions?