Presentation Outline

• Geomorphic Assessment Draft Report
• Review of High Risk Sites
Geomorphic Assessment

• Objectives
  – Overview and context for the Lower American River, particularly for ESP Report
  – Future channel adjustments, as they may alter high risk sites for bank and levee erosion
Approach

• The morphology of a river is affected by the following independent factors:
  – Floodplain and Valley Geology
  – Sediment Supply
  – Discharges
  – Tributary Inflows
  – Downstream Controls

• Generally qualitative understanding
Approach

• Step 1: Understand historical changes and response of the LAR
• Step 2: Predict future behavior from:
  – Trends in morphology
  – Future hydrology and sediment transport studies
  – Behavior of other rivers in similar situations
Geomorphology Outline

- Independent Factors
- Response of LAR
- Reach-based discussion of
  - Present morphology
  - Future morphology, with focus on erosion issues
Floodplain and Valley Geology

- Overview
- Erosion Resistant Sediments (Fugro)
- Bank Stratigraphy (URS)
Geology Overview

Figure 2 - Block diagram showing the general association of major landforms and soils along the lower American River. Characteristic soil series indicated on landform surface; geologic unit identified below surface: M = Modesto Formation, R = Riverbank Formation, F.O. = Fair Oaks Formation, A.S. = Arroyo Seco Gravel, Lag. = Laguna Formation, Mehr. = Mehrten Formation.
Figure 6 – Generalized structure sections across the American River at Fair Oaks (A-A') and downstream near the Rancho Cordova District (B-B'). American River terraces designated by Roman numerals; subsurface contacts along section B-B' based on well log control as indicated e.g., 9/6 - 33D1, 8/6 - 4L1 etc.
Figure 3-1. Generalized, composite stratigraphic section of the Lower American River.
Erosion Resistant Units

- Reconnaissance and detailed field mapping (Fugro)
- Upper Unit (Paradise Bend; RM 7.2?)
- Lower Unit (Fair Oaks formation)
- Fairman thesis
Distribution of Lower Unit

- No Exposures downstream of RM 6.6
- In bed from RM 6.6 to about RM 10
- In bed and bank upstream of RM 10
- Laterally extensive and very thick
- Treat as inerodible
URS Section 21 (RM 9.4 - Watt)
Historical Changes

- Independent factors: Hydrology, sediment supply, downstream control
- Direct Impacts: Gold dredging, gravel mining, revetment, etc
# Hydrology and Sediment Supply

<table>
<thead>
<tr>
<th>Period</th>
<th>Hydrology</th>
<th>Sediment Supply</th>
<th>Sacramento R</th>
</tr>
</thead>
<tbody>
<tr>
<td>1850 to 1905 (Hydraulic Gold Mining Period)</td>
<td>natural</td>
<td>Greatly accelerated</td>
<td>Bed elevated about 10 feet (?)</td>
</tr>
<tr>
<td>1905 to 1955 (Post Hydraulic Mining)</td>
<td>Natural; MAF about 60,000 cfs</td>
<td>Accelerated</td>
<td>Returning to present elevation</td>
</tr>
<tr>
<td>1955 to 2018(?) Folsom Dam Operation</td>
<td>Folsom Dam releases; reduced MAF of 30,000 cfs</td>
<td>None from upstream; erosion along upper and lower AR</td>
<td>Present elevation</td>
</tr>
<tr>
<td>2018 to future</td>
<td>Modified Folsom Dam; reduced MAF, greater 10-year release</td>
<td>As above; declining transport rates</td>
<td>Possibly higher (?)</td>
</tr>
</tbody>
</table>
Fair Oaks Gage Annual Maxima

Annual Peak Streamflow at Fair Oaks

Discharge (cfs)

Folsom Dam completed

Profile Response

LOWER AMERICAN RIVER
Thalweg Profiles

ELEVATION (m-NGVD)

RIVER MILE
Profile Adjustment Summary

- Mining Debris deposited to RM 13; mostly eroded by 1950’s
- RM 12 to RM 6: shallow bed slope over Fair Oaks formation
- RM 12 to RM 14: steeper bed slope; knickpoint (?)
Channel Morphology/Shifting

- Descriptions/Geologic evidence
- Comparison of Channel Alignments on maps (Fairman 2007)
- Comparison of Bank top positions on air photos (Ayres 2010: NHC 2012)
Descriptions/Surficial Geology

- 1862 Flood
- Chute cutoffs, erosion RM 12 to 16
- Channel fill and chute cutoff RM 9 to 9.6
- Fill at mouth; channel shifting
Channel Alignments

- Fairman Thesis
- Channel centerline
- 1865, 1900 and 1937 Alignments
- Only three active sites; near Nimbus, RM 12 to 15; RM 6 or so
Channel Alignments (RM 11 to 15)
1965 Flood (RM 14 to 15)
Historical Bank Lines

• Ayres Analysis of air photos
• Issues discussed last September
• Overlays for changes in channel width; bank erosion; shifting
Historical Bank Lines


LEGEND

- 1957
- 1964
- 1998
- 1972
- 2010

Note: Bankline information from 1957 to 1998 was prepared by Ayres Associates (2004)
Channel Shifting Summary

- 1862 Shifting
- Post 1865: active shifting upstream limb of Paradise Bend; RM 12 to 16
- Post 1900: shifting near RM 6
- Post 1955: no significant bank top erosion downstream of RM 10 or so
- Floodplain and channel gravel mining
Current and Future Morphology

- Reach division and description
- Future hydrology and sediment transport
- Bed erosion and deposition
## LAR Reach Description

<table>
<thead>
<tr>
<th>#</th>
<th>RM</th>
<th>Bed</th>
<th>Banks</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>LAR 1</td>
<td>0 to 3</td>
<td>sandy</td>
<td>Sandy silty</td>
<td>backwatered</td>
</tr>
<tr>
<td>LAR 2</td>
<td>3 to 6.6</td>
<td>gravel</td>
<td>Sandy silty; some cobbles</td>
<td>Sinuous gravel deposition reach</td>
</tr>
<tr>
<td>LAR 3</td>
<td>6.6 to 8.6</td>
<td>Gravel over Fair Oaks</td>
<td>Thin layer of Modesto cobbles overlain by sandy silty</td>
<td>Straight reach widened by gravel mining</td>
</tr>
<tr>
<td>LAR 4</td>
<td>8.6 to 11.5</td>
<td>Gravel over Fair Oaks</td>
<td>Fair Oaks, thick Modesto cobbles, sandy silty</td>
<td>Straight reach widened by gravel mining</td>
</tr>
<tr>
<td>LAR 5</td>
<td>11.5 to 14</td>
<td>Gravel over Fair Oaks</td>
<td>Fair Oaks, thick Modesto cobbles, sandy silty</td>
<td>Bar complex with active shifting; floodplain mining</td>
</tr>
</tbody>
</table>
Future Sediment Transport

- Updated version of Ayres HEC-6T Model
- Predicts sediment transport and changes in bed elevations for given water and sediment inflows and downstream boundary
- Water Inflows
- Sediment Inflows
- Downstream boundary
Model Caveats

• Model does not simulate:
  – Local scour
  – Local deposition
  – Bank erosion
  – Adjustments in channel width
  – Lateral channel shifting
Model Development

- Hydraulic and sediment calculations
- Based on 84 cross sections
- Total length is 22 miles
- WSE Calibrated to 1997 Flood HWM
- Sediment transport calculated from hydraulics and bed material gradations
- Transport formula selected by testing against 1997 to 2006 bed changes
Sediment Model Operation

- **Purpose** – impacts of Folsom Dam Spillway
- **Base and Project Hydrology**
- **1930 to 2002 inflows (73 years)**
- **Started with 2006 bed geometry (2079)**
Bed and Hard Surface Profile

American River

WY 1930-2002

- Initial (2006 bathymetry)
- Section-average hard surface
- Assumed hard surface
- Existing hydrology final
- Project hydrology final

Invert elevation (ft NAVD88)

River Mile (RM)

Laursen-Copeland transport function
Sediment Transport Results

• Current Operating Regime
  – 1.6 million yd$^3$ eroded
  – 1.3 million yd$^3$ deposited
  – 0.2 million yd$^3$ outflow to Sacramento River
  – Net bed elevation increase about 1.4 feet in LAR leveed reach
  – Likely conservative
Future Gravel Deposits

American River

WY 1930-2002

Laursen-Copeland transport function

Total bed material deposition (cubic yards)

Existing hydrology

Project hydrology

River Mile (RM)
Reach LAR 1
Reach LAR 4
Reach LAR 5

BANK TYPE
- rock
- cement
- cobble
- natural
- concrete rubble

2015 MBK Erosion Sites

Fair Oaks Blvd
Arden Way
McClaren Dr
Folsom Blvd
Coloma Rd

water resource specialists
Summary

• Paradise Bend potential cutoff
• RM 6.2 vicinity Bar growth; erosion
• RM 7.2 vicinity Right bank erosion
• RM 11 to 13 channel shifting