Advancing CVFED Sacramento River Basin HEC-RAS 1D Model to Integrated 1D-2D Models for Improved Flood Risk and Ecosystem Management

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Presentation Overview

- Background and Purpose
- Current Hydraulic Models
- Integrated HEC-RAS 1D-2D System Models
- Model Applications
Background and Purpose
Sacramento Valley Flood System

- State Plan of Flood Control (SPFC)
- Network of multi-purpose reservoirs, levees, flood relief structures, weirs and bypass systems
- Floodwaters diverted to bypasses through weirs
- Bypasses provide ecosystem for wildlife
- Floodplains comprise of urban, rural and agricultural land use types
DWR’s Role in Advancing H&H Tools

- Support flood risk and ecosystem management programs and projects
- Improve quality and accuracy of flood hazard data and mapping
- Provide best available tools to local communities
- Enable testing of flood risk management alternatives
Current Hydraulic Models
CVFED HEC-RAS 1D System Model

• Comprehensive river hydraulics model

• Includes
  – Sacramento, Feather and American Rivers and their tributaries
  – Levees, bypasses, weirs and riverine hydraulic structures
  – Floodplains as storage areas

• Built using CVFED LiDAR and bathymetry survey data
CVFED HEC-RAS 1D System Model

Key strengths

- Hydraulic channel routing of reservoir releases
- Calibrated to historical flood records
- High degree of confidence in simulated results
- Optimized to run for a wide range of flow conditions

Major Applications

- CVFPP 2017 Update
  - Incorporated CVHS hydrology
  - Flow and stage frequency curves for flood risk analysis
  - Channel capacity analysis
CVFED HEC-RAS 1D System Model

Limitations

- Simplified representation of Floodplains (1D)
- Simplified representation of complex confluence areas
  - Fremont Weir confluence
- Simplified representation of hydraulics in the bypasses
  - Wide cross sections
  - Average water surface elevations
Integrated HEC-RAS 1D-2D System Models
Integrated HEC-RAS 1D-2D System Models

- USACE’s HEC-RAS 5.0 modeling software
- Integrated 1D-2D hydraulic models
  - 1D Channels
    - 120 reaches (total length: 729 mi)
    - 6,096 cross sections
    - 3,493 lateral structures
    - 298 bridges and culverts
    - 24 inline structures
  - 2D Mesh
    - 445 mi² area representing bypass systems
    - 2,170 mi² area representing SPFC floodplains
    - 3,615 miles of breaklines
    - 95 floodplain hydraulic structures
Suite of Integrated 1D-2D System Models

- Bypass Model
- Upper Sac West
- Upper Sac East
- Natomas/Mid Sac
- Feather River West
- Feather River East
- Lower Sac West
- Lower Sac East
What are Integrated HEC-RAS 1D-2D Models?

1. H&H Analysis
2. Floodplain Mapping

1D Channels for River Streams

1D Lateral Structures for Levees & Weirs

2D Mesh for Floodplains

Volume transfer between 1D and 2D elements (Levee Overtopping or Breaching)

2D Hydraulic Routing

Floodplain Maps for 2D Areas and 1D channels
What is Included in the Models?

- High-resolution floodplain mapping results: Depth, Elevation, Velocity, Shear Stress, Arrival Time, Duration and Hazards

- Urban: 200 feet cells
  Non-Urban: 400 feet cells
  Breaklines: 3 feet or higher
  Floodplain Bridges and Culverts

- USGS NLCD 2011 30-meter Resolution land use raster grid

- CVFED Program LiDAR, Bathymetry, and USGS DEM
Detailed Topographic Data
High Resolution Outputs

Sub-grid Mapping

Flow Paths (Particle tracking)
How do the Models Perform?

• Compared to Records of Observed Floods
How do the Models Perform?

• Compared to Records of Observed Floods

1997 Flood Records
How do the Models Perform?

• Compared to Other Models
Model Applications
Flood Risk Management Analysis

- Dynamic Levee Breach Analysis and Floodplain Mapping
- Flood Impacts Assessment
- Datasets for Flood Damage and Life Loss Estimates
Flood Risk Management Analysis
Emergency Response Planning

• Evacuation Route Planning
SFHA Maps for FEMA NFIP

• Special Flood Hazard Area (SFHA) Maps

Flood Hazard Zones
- 1% Annual Chance Flood Hazard
- Regulatory Floodway
- Special Floodway
- Area of Undetermined Flood Hazard
- 0.2% Annual Chance Flood Hazard
- Future Conditions 1% Annual Chance Flood Hazard
- Area with Reduced Risk Due to Levee
Ecosystem Management Analysis

- Ecosystem Restoration Impacts Assessment
- Habitat Increase and Suitability Evaluation
Coupled Flood Forecasting

- Overland Flow Runoff Simulation
- Direct Precipitation Input to 2D Model (No infiltration)
- Couple with Hydrologic Model for Forecasted Streamflow
Questions?