Two-Dimensional SRH-2D Modeling to Identify and Evaluate Habitat Enhancement and Flood Hazard Reduction Actions on a Reach of the Yakima River

Client: Kittitas County Flood Control Zone District
- Two projects: Schaake Levee (USBR) and Hansen Pits Reach (Kittitas County FCZD)
- Site Overview Including Existing Flood & Erosion Facilities
- Channel Migration and Avulsion Potential
- Identify Existing Flood Hazards
- Impacts / Benefits of Existing Flood & Erosion Facilities
- Flood & Erosion Hazard Reduction Opportunities
- Habitat Opportunities
- USBR Two-dimensional Modeling using SRH-2D and extended by WSE for Hansen study very beneficial
Develop focused strategy of viable alternatives for integrated floodplain management ("Floodplains by Design"), to preserve and/or enhance floodplain function along 7 miles of Yakima River near Ellensburg, WA.

USBR (Schaake levee) and Kittitas County (Hansen Pits, etc.) both primarily focused on left/east bank levees:

- Setting back existing levees will help reconnect cutoff side-channels and encourage channel migration
- Decreased flood depths reduce flood hazard and stress along existing revetments
- Increased channel/floodplain interaction and overall river habitat
- Right bank levees to remain, for now, but 2D model results show benefit of modifications to these levees and should be considered in the future
EXISTING FLOOD AND EROSION PROTECTION FACILITIES & ACTIVE BANK EROSION

YAKIMA RIVER
SRH-2D MODELING
CHANNEL MIGRATION

PLANFORM CHANGES
1942 TO 2013

YAKIMA RIVER
SRH-2D MODELING
AVULSION HAZARDS

REMNANT CHANNELS IDENTIFIED BY DEPTH

(YSIDE CHANNEL HABITAT POTENTIAL)

YAKIMA RIVER
SRH-2D MODELING
HUMAN INFLUENCES

1954 AERIAL SHOWING 1940S CORPS FLOOD CONTROL PROJECT

YAKIMA RIVER
SRH-2D MODELING
USBR Project
(Schaake Levee Reach)

Primarily focused upon channel and floodplain rehabilitation through levee setback and side channel re-creation

YAKIMA RIVER
SRH-2D MODELING
SRH-2D Model Velocity Predictions with Proposed Levee Setback

**Proposed Levee Alignment**

**Proposed Modifications**

**Q = 25,000 cfs**

**Velocity - ft/s**

- Red: 13 - 16 ft/s
- Orange: 10 - 13 ft/s
- Brown: 8 - 10 ft/s
- Yellow: 6 - 8 ft/s
- Light Green: 4 - 6 ft/s
- Medium Green: 3 - 4 ft/s
- Green: 2 - 3 ft/s
- Light Green: 1 - 2 ft/s
- Dark Green: 1 ft/s
- Green: 0 - 1 ft/s

**YAKIMA RIVER**

SRH-2D MODELING
SRH-2D Model
Shear Stress Predictions along Lower Side Channels

YAKIMA RIVER
SRH-2D MODELING
PHASE I: Assess Existing Conditions and Identify Alternatives:

- Improve and/or Maintain Flood Protection to Humans and Infrastructure (roads, buildings, farm land)
- Reduce Risk of Bank Erosion and Avulsion Potential (including at former gravel extraction site)
- Enhance Habitat and Restoration (subconsultant Herrera)
- Engage Multiple Agency and Private Stakeholders as Partners
- Use Defensible Tools that Easily Convey to Stakeholders and Public → Extend USBR Two-dimensional SRH-2D modeling

PHASE II: Select and Implement Preferred Alternative(s) and Corridor Plan (future).
Bed Elevation:

100-yr Velocity:

YAKIMA RIVER
SRH-2D MODELING
<table>
<thead>
<tr>
<th></th>
<th>Original USBR Model:</th>
<th>Modified WSE Model:</th>
<th>RIVER:</th>
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<tbody>
<tr>
<td>TOTAL:</td>
<td></td>
<td>TOTAL:</td>
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</tr>
<tr>
<td></td>
<td>330,111 nodes</td>
<td>77,527 nodes</td>
<td>Channel width=</td>
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<tr>
<td></td>
<td>383,006 elements (≈10 foot channel)</td>
<td>142,342 elements (≈25 foot channel)</td>
<td>150-225 feet</td>
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<tr>
<td></td>
<td>2,150 acres</td>
<td>2,900 acres</td>
<td>Floodplain width=</td>
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<tr>
<td></td>
<td>≈4 miles long</td>
<td>≈7 miles long</td>
<td>1 mile or greater</td>
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</table>

YAKIMA RIVER
SRH-2D MODELING
USBR MODIFIED DEEP & FAST FLOOD HAZARD CURVE FOR CHILDREN (USBR 1988)
HAZARDS

100-YEAR FLOOD

YAKIMA RIVER
SRH-2D MODELING
WATER DEPTH CHANGES CAUSED BY JEFFRIES LEVEE ALONE ASSUMING NO HANSEN PITS LEVEE AND DOWNSTREAM PRIVATE BERM

100-YEAR FLOOD

YAKIMA RIVER
SRH-2D MODELING
WATER DEPTH CHANGES CAUSED BY JEFFRIES LEVEE ALONG WITH THE HANSEN PITS LEVEE AND DOWNSTREAM PRIVATE BERM

100-YEAR FLOOD

YAKIMA RIVER
SRH-2D MODELING
WATER DEPTH CHANGES CAUSED ONLY BY HANSEN PITS LEVEE & DOWNSTREAM PRIVATE BERM

100-YEAR FLOOD

YAKIMA RIVER
SRH-2D MODELING
VELOCITY CHANGES CAUSED BY JEFFRIES LEVEE ALONE ASSUMING NO HANSEN PITS LEVEE AND DOWNSTREAM PRIVATE BERM

100-YEAR FLOOD

YAKIMA RIVER
SRH-2D MODELING
VELOCITY CHANGES CAUSED BY JEFFRIES LEVEE ALONG WITH THE HANSEN PITS LEVEE AND DOWNSTREAM PRIVATE BERM

100-YEAR FLOOD

YAKIMA RIVER SRH-2D MODELING
VELOCITY CHANGES CAUSED ONLY BY HANSEN PITS LEVEE & DOWNSTREAM PRIVATE BERM

100-YEAR FLOOD

YAKIMA RIVER
SRH-2D MODELING
Flood Observations and Bank Erosion and Avulsion Potential Confirmed by Model Results:

- Velocities and depths
- Corps flood control project (Jeffries Levee)

Benefits and Unintended Impacts of Flood Control Levees and Berms:

- Upstream Jeffries project protects right floodplain by deflecting flow to downstream left floodplain, resulting in increased depths and velocities
- Hansen Pits levee and downstream berm offset Jeffries impacts and provide flood hazard benefit, but further confine the flow

Flood and Erosion Reduction at Hansen Pits Needs to Consider Modifications to Upstream Levee:

- Improved angle of attack to reduce bank erosion
- Setback of each levee/berm

Geomorphic and Habitat Impact of Levee Confinement
Consider modifications to the Jeffries Levee that would reduce impacts to the Hansen Pits Levee and Private Berm.

**PRIORITY 2:** Hansen Pits Levee Repairs or Relocation

**PRIORITY 4:** Private Berm Modifications

**PRIORITY 3:** Bank Erosion and Channel Avulsion Counter Measures

**PRIORITY 5:** Concrete Rubble and LWJ Jam Modifications

**PRIORITY 1:** Ringer Loop Road Erosion

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**Flood & Erosion Hazard Reduction Opportunities & Priorities**

**ADDITIONAL MEASURES:**

- PREPARE FOR THE NEXT BIG FLOOD
- LIMIT DEVELOPMENT
- FLOOD PROOFING
- EVACUATION PLAN
- CRITTER PADS
- ETC.

**YAKIMA RIVER**

**SRH-2D MODELING**
Low Flow Fish Runs:
- Base flow for typical habitat conditions
- September – February low flow period (1000 cfs)
- May – August higher flow period (3000 cfs)
- “flip-flop” due to upstream reservoir storage in upper watershed and summer releases for irrigation

SRH-2D Modeling of Existing Conditions:
- Identify key edge habitat and side-channel habitat
- Less than 3 ft deep and under 1.5 fps requirement for juvenile salmonid refuge

Propose Habitat Project Opportunities:
- Based upon site reconnaissance, habitat evaluation, 2D model results, and stakeholder input
- Future 2D modeling of specific alternatives, due to modified geometry (e.g. opening cut off side channel inlet), roughness (LWD protection), etc.
Low (Fish) Flow Depth Plots

YAKIMA RIVER
SRH-2D MODELING

1000 cfs: 3000 cfs:

0 ft – 3 ft
Low (Fish) Flow Velocity Plots

YAKIMA RIVER
SRH-2D MODELING

1000 cfs: 3000 cfs:

0 fps – 1.5 fps
Identified Habitat Opportunities (proposed alternatives)

YAKIMA RIVER
SRH-2D MODELING
Benefits of SRH-2D Modeling:

- Ease of use, SMS for pre- and post-processing
- Very stable robust model, handles dry beds & wetting/drying
- Gives realistic & defensible results to characterize existing conditions & to formulate alternatives
- Results easy to understand by public/stakeholders

Specifically to Yakima project:

- Used to identify flood hazard areas (e.g. deep/fast)
- Used to identify erosion/avulsion hazards & future problem areas (e.g. high velocities)
- Simulated low flow events to help Habitat team identify sites for proposed edge habitat and side channel restoration
- Will be used to test specific alternatives for flood & erosion hazard protection, combined with proposed Schaake setback