Upper Llagas Creek Flood Protection Project – How Flood Protection, Geomorphological Science, Habitat Enhancement, and Long-term Maintenance are Integrated to Create a Successful Project

Floodplain Management Association Annual Conference

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Valley Water and Woodard & Curran

Valley Water
- Serves 2 million residents in Santa Clara County
- Wholesale water supply
- Groundwater recharge
- Flood protection and stream stewardship

Woodard & Curran
- Nationwide firm with over 1,000 employees
- Watershed, flood protection, and stormwater services among many others
- Planning, design, construction, operations
Project Overview

- ~14 miles of flood protection improvements
- Flood protection for
  - 1,100 residences, 500 businesses
  - 1,300 acres of agricultural land
# Project Overview

## 1% Flow Summary

<table>
<thead>
<tr>
<th>Location</th>
<th>Pre-Project</th>
<th>Post-Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hillwood Lane (Upper Project Reach)</td>
<td>290 cfs</td>
<td>640 cfs</td>
</tr>
<tr>
<td>Highway 101 (Mid Project Reach)</td>
<td>5,590 cfs</td>
<td>5,780 cfs</td>
</tr>
<tr>
<td>Buena Vista Avenue (Lower Project Reach)</td>
<td>12,070 cfs</td>
<td>12,570 cfs</td>
</tr>
</tbody>
</table>

## Representative Channel Dimensions

<table>
<thead>
<tr>
<th>Location</th>
<th>Pre-Project</th>
<th>Post-Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hillwood Lane (Upper Project Reach)</td>
<td>15’ x 2’</td>
<td>50’ x 8’</td>
</tr>
<tr>
<td>Highway 101 (Mid Project Reach)</td>
<td>100’ x 10’</td>
<td>120’ x 13’</td>
</tr>
<tr>
<td>Buena Vista Avenue (Lower Project Reach)</td>
<td>80’ x 12’</td>
<td>140’ x 12’</td>
</tr>
</tbody>
</table>
Upper Llagas Creek Project History

**Major Floods**
- 1955
- 1958
- 1962
- 1963
- 1969
- 1982
- 1986
- 1996
- 1997
- 1998
- 2002
- 2008
- 2009
- 2011
- 2017

**Project Milestones**
- 1969 – NRCS authorized to start work and completes initial design
- 1973 – Lower Llagas Creek construction starts
- 1994 – Lower Llagas Creek construction ends
- 1995 – Updated hydraulic analysis for Upper Llagas Creek
- 1999 – Project transferred to USACE
- 2010 – Project Hydraulic Analysis Final Report by USACE
- 2010 – Valley Water assumes responsibility for design, environmental documentation, and permitting for Project
- 2019 – Groundbreaking for Phase 1 of construction

What happened to make this project a success?
Project Success Factors

- Motivated Project Proponent
- Project Purpose clearly identified – Provide 100-year flood protection to urban reaches of the creek; Avoid downstream induced flooding
- Project Objectives clearly identified
  - Improve public safety
  - Minimize footprint
  - Horizontally and vertically stable channel
  - Preserve and enhance desirable habitat
  - Provide maintenance access and minimize maintenance requirements

Early identification allowed discipline integration in the design from the outset of the Project.
Project Approach – Integrated Design

- Integrated Design
- H&H / Flood Protection
- Habitat
- Geomorphology
- Long-term Maintenance
- Project Design
Geomorphology

- **Goal** – Anticipate the natural creek geometry to incorporate into the Project design

- **Tools/Techniques**
  - Documentation, historic aerial photo, and profile review
  - Sediment transport measurements
  - Comparable reach review
  - SAM modeling

- **Approaches**
  - Bankfull channel recommendations
  - Natural meander
  - Grade control structures
  - Sediment banks
Geomorphology – Natural Meander

- Anticipating natural form of creek prevents property damage and unneeded maintenance

Early Bank Relaxation Sketch

Aerial Photography Analysis
Geomorphology – Sediment Banks

- Allow storage of sediment for future release in supply-limited system
- Low maintenance area; also reduces need for downstream maintenance
Habitat

- **Goal** – Preserve and enhance where possible native vegetation and habitats

- **Tools/Techniques**
  - Vegetation surveys
  - Soil characterization surveys
  - Topsoil surveys

- **Approaches**
  - Instream complexities
  - Native seeding & invasive removal
  - Limit excavation to one bank
  - Bedload harvesting
  - Topsoil management
  - Site transformation
Established native vegetation is preferred over new native vegetation

- Provides high value habitat
- Stabilizes soil
- Requires less maintenance
- More efficient at conveying flows
Habitat – Site Transformation

- Thinking outside the box can yield project benefits such as on-site mitigation, greater flow capacity, and spoils sites
Flood Protection

- **Goal** – Provide 1% flood protection in urban reaches and avoid induced flooding elsewhere

- **Tools/Techniques**
  - Hydrology review of prior work
  - HEC-RAS & FLO-2D modeling
  - Coordination with disciplines

- **Approaches**
  - ‘Evolved’ channel expansion
  - High flow bypass
Hydraulic modeling from the outset accounted for bankfull channels, sediment deposition, and roughness corresponding to little/no vegetation maintenance

- Iterative process as discipline information developed

Engineered slopes are accessible and reuse existing topsoil

Bench allows bankfull channel meander, flood conveyance, and mitigation opportunity

Bankfull design for stable channels

Preserved bank and vegetation
Flood Protection – ‘Evolved’ Channel Expansion
Flood Protection – High Flow Bypass

- Sometimes avoiding instream work is the best solution

- Minimal disruption to
  - Riparian environment
  - Local development
  - Stream functions and benefits
Flood Protection – High Flow Bypass

Typical Section: Double Box Culvert
- Double Box Culvert
- Low flow pipeline
- Channel transition
- Tunnel portals

Typical Section: Horseshoe Tunnel
- Weir diversion structure
Closing Thoughts

- Project owner’s values and objectives will drive the design
- Engage discipline experts early in the process
  - Project success may be measured by ability to achieve objectives other than flood protection
  - Shoe-horning considerations into the design reduces their value
- Balance long-term maintenance and permitting requirements with additional project footprint costs
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