1D/2D Modeling for Steep Urban Watersheds
Grand Terrace

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Agenda

- Project Description (Private & Public)
- Study Goals
- Formulation of Design Criteria
- Existing Condition Model Development
- Model Verifications
- Alternatives
- Results & Lessons Learned
Project Description
(Focus Areas – Flood Control 2 Locations)

Van Buren/Michigan

Pico/Michigan
Project Description

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Pico/Michigan
Project Description
(Previous Studies-Traditional “Steady-State” Models)
Watershed Description

- City developed along the foothills in San Bernardino County
- Steep Streets (2-7%)
- Offsite flow from adjacent mountains
- Drainage conveyed primarily in streets
- 1.4 Square Miles
Drainage conveyed primarily in streets

- Very little Storm Drain
- 12 to 16-inch Curbs
- Not much flooding in upper watershed
- Silt/Sediment dropout in lower watershed
Run Analysis that accounts for bifurcation and “hazard”

Evaluate Flood Control Measures to improve conditions at 2 major intersections.

Work with the City to develop feasible alternatives
Hazard

- (Flow Velocity) x (Flow Depth)
- Hazard Greater than 6.0 = Problem
  - 12” Curbs
  - Velocity > 6 fps
- Work with City to Incorporate into Criteria
Hydrology

- Offsite (Hillside) Hydrology
  - San Bernardino County Methods
  - NOAA 14 Rainfall Data
  - Unit Hydrograph Method
Hydrology

Urban Area Hydrology
- Distributed Rainfall Method
- NOAA Atlas 14 Data
- SBC Loss Rate Calculations
  - Deducted from rainfall
- Grid Size = 10’x10’
**DEVELOPMENT OF EXISTING CONDITIONS MODEL**

- Develop Surface from LiDAR Data
- Input 1D Elements from As-Builts and Breaklines with Field Verification
- First Round of Model Runs to “Scrub” Model of Erroneous Sumps and Bifurcation Points
  - Coordinate w/ City
  - Historical Flooding
- Sensitive Process (Domino)
FLOW REGIME CHECKS

- Supercritical and Transitional Flow Concerns
- Critical Locations: Breakouts and Intersections
- Surface Velocities and 2D Results crosschecked with Flo2D
  - XPSTORM assumes no tailwater or backwater effects in supercritical regime
  - Flo2D can force flows Subcritical
EXISTING CONDITIONS 100-YEAR STORM EVENT
EXISTING CONDITIONS 100-YEAR MAX DEPTH
EXISTING CONDITIONS 100-YEAR BREAK OUTS
Surface Improvements

- Pico St.
- Mt. Vernon
- Van Buren
- Pico St.
ONLY FIX BREAKOUTS (CITY)
COMPARE: EXISTING CONDITIONS 100-YEAR MAX DEPTH

Legend
- Offsite Hydrograph Locations
- Existing Storm Drain
- Tributary Area
- Max Depth (ft)
  - 0.25 - 0.5
  - 0.5 - 1
  - 1 - 2
  - 2 - 3
  - 3 - 4
  - >4

City of Grand Terrace
Max Flood Depth - Existing Condition
100 Year - 24 Hour Storm
Exhibit 1
FIX BREAKOUTS: HAZARD (Vel x Depth)
EXISTING HAZARD (Vel x Depth)
ALTERNATIVE 1 – FLOOD MITIGATION

- 1191 LF 30" RCP
- 1557 LF 36" RCP
- 2784 LF 54" RCP
- 765 LF 48" RCP
- 467 LF 48" RCP
- 275 LF 42" RCP
- 425 LF
- 37 LF 24" RCP
- 349 LF 18" RCP
- 293 LF 18" RCP
- 1506 LF
- 217 LF
- 364 LF
ALTERNATIVE 2 – FLOOD & HAZARD MITIGATION

- 1192 LF 48" RCP
- 917 LF 36" RCP
- 1557 LF 54" RCP
- 2232 LF 66" RCP
- 765 LF 48" RCP
- 1293 LF 54" RCP
- 102 LF 48" RCP
- 216 LF 24" RCP
- 415 LF 18" RCP
- 37 LF 24" RCP
- 217 LF
- 425 LF
- 462 LF
- 364 LF
- 1137 LF 42" RCP
- 1506 LF
ALTERNATIVE 2 – FLOOD & HAZARD MITIGATION

Max Depth (ft)

- 0.25 - 0.5
- 0.5 - 1
- 1 - 2
- 2 - 3
- 3 - 4
- >4

Grand Terrace
ALTERNATIVE 2 – FLOOD & HAZARD MITIGATION

Legend

- Offsite Hydrograph
- Tributary Area
- Hazard (VxD)
  - 0.1 - 2
  - 2 - 4
  - 4 - 6
  - 6 - 8
  - >8

Results and Discussion

- Two Main Alternatives:
  1. Mitigate flooding
  2. Mitigate flooding & acceptable hazard
- Balancing act between using street for capacity and hazard in steep watersheds
- Surface Velocities at critical locations checked and collaborated using separate models (Supercritical & Transitional)
  - At locations near intersections and Breakouts
Lessons Learned
(Steep Urban Models)

- Allow for additional field reconnaissance time while developing the Existing Conditions Model
- Check model velocities and Froude Numbers at critical locations
- Work with agency (up front) to develop feasible criteria that deals with Hazard