Overview of Presentation

**Background**

**Motivations**

**What Is Currently Provided?**
- USGS Provisional Inundation Map
- DuPage County Flood Forecasting Simulations

**What Are We Working on Now?**
- Inundation Maps
- Peak Flood Depth Maps
- Dynamic Flood Inundation Maps

**Where Are We Going?**
- Animated Flood Inundation Maps and Features

**Applications and Users**

**Contributors**

**Summary**

**Questions**
Background

**DuPage County, Illinois**

- Suburbs of Chicago
- Nearly 1 million residents
- Highly impervious
- Terrain is relatively flat
- Watersheds: Des Plaines River, DuPage River (East and West Branches), Fox River, and Salt Creek
Background

Stormwater Management in DuPage County

- Countywide program established in 1989
- Guided by the Stormwater Management Planning Committee and Plan
- Enforce the Countywide Stormwater Management and Floodplain Ordinance
- Flood control facilities have a floodwater capacity of nearly 6 billion gallons
- FY17 operating budget $7.1 million

Stormwater Department Programs

- Flood Control Operations and Maintenance
- Floodplain Mapping
- Regulatory Services
- Water Quality
- Watershed Management

http://www.dupageco.org/swm/
Background

Flood Control Facilities

- DuPage County owns and operates 16 flood control facilities
- Includes reservoirs, pump stations, and dams
- 6 facilities are mechanically-operated by staff, remaining are gravity-operated
- Floodwater capacity of nearly 6 billion gallons

Flood Operations

- Flood forecasting simulations
- Remote operation using rain and stream gages with real time video
DuPage County Flood Control Facilities

Fawell Dam – West Branch DuPage River
Naperville
1.6 billion gallons

Elmhurst Quarry – Salt Creek
Elmhurst
2.7 billion gallons
Motivations

Recent Heavy Precipitation and Flooding Events

- September 12-15, 2008
- July 22-24, 2010
- April 17-18, 2013
- October 13-14, 2017
Motivations

Can we predict when and where a river will cause flooding? Yes!

**Flood Forecasting**
Simulate future stream levels using hydrologic and hydraulic models with observed stream gage levels and predicted precipitation as input.

**Flood Inundation Maps**
A map that depicts the portion of land which will be covered by flood waters. Translates observed stream gage levels and simulated results into a 2-D map.

*A river overtopping a road*
Motivations

Translate Water Elevations into Inundation Maps

• Current condition inundation map based on current stream gage levels

• Future conditions inundation maps linked to flood forecasting simulations based on the predicted rainfall

*Hydrograph: a graph showing the river elevation or flow versus time at a specific point in a river.*
Currently Provided

U.S. Geological Survey (USGS) Provisional Inundation Map

- Salt Creek at Wood Dale
- Limited area near stream gage
- Library of static maps based upon stream gage levels
- User must determine forecasted level
- https://il.water.usgs.gov/ifhp/dupage/
Currently Provided

Flood Forecast Simulations

- Supports operations of flood control facilities
- Observed stream gage heights modeled with forecast precipitation
- Only Salt Creek and West Branch DuPage River are currently modeled
- East Branch DuPage River to be added in 2019
- Updated every Monday, Wednesday, and Friday; updated every 6 hours during an event
Currently Provided

Hydrologic and Hydraulic Modeling

- Simulations utilize Hydrologic Simulation Program – FORTRAN (HSPF) for the hydrology and Full Equations (FEQ) for the hydraulics.
Currently Provided

Simulation System – Multiple Scenarios

• Various upstream boundary conditions
  o Observed stream gages
  o Entire upstream watershed modeled
• Observed precipitation from rain gages
  o With Quantitative Precipitation Forecast (QPF) for forecast precipitation
  o With manually entered data for forecast precipitation
• Observed precipitation from NEXRAD cells
  o With QPF for forecast precipitation
  o With manually entered data for forecast precipitation
Currently Provided

Multiple Scenarios (continued)

Gage Inputs from USGS and DuPage County

- Precipitation (5- or 15-minute converted to hourly)
- Stream stage
- Stream discharge
Currently Provided

Multiple Scenarios (continued)

Scenario using MPE Data

NEXRAD cells converted to hypothetical gages

Salt Creek HSPF/FEQ
4 hypothetical gages

West Branch HSPF/FEQ
11 hypothetical gages

NWS Multisensor Precipitation Estimates (MPE) Data

MPE
(1-hour total)

- Radar data
- Gage corrected
- 4x4 kilometer grid

Salt Creek – 36 cells

West Branch – 35 cells
Currently Provided

Multiple Scenarios (continued)

Precipitation Forecasts

• Simulations include 72-hour precipitation forecast

• Simulations use QPF: 6-hourly data distributed into 1-hourly values for modeling

• Simulations use Warrenville (WRNI2) and Western Springs (WSPI2) grid points for the West Branch DuPage River and Salt Creek, respectively

• Simulation system allows forecast precipitation values and distribution to be input manually
Currently Provided

Available on our Website

- Includes brief forecast discussion
- 24-hour and 72-hour precipitation forecast
- Facility operation information
  http://ec.dupageco.org/dec/stormwater/watershed/index.html
Currently Provided

Output Hydrographs

Salt Creek
- Irving Park Road (used to predict operation of Wood Dale-Itasca Reservoir)
- Harger Road (used to predict operation of Elmhurst Quarry)
- Prairie Path

West Branch DuPage River
- Near West Chicago
- Near Warrenville
- Fawell Dam (used to predict operation of Fawell Dam)
- Near Naperville
What Are We Working on Now?

Real Time Flood Inundation Maps

- Current condition inundation map based on current stream gage levels
- Future conditions inundation maps linked to flood forecasting simulations based on the predicted rainfall
- Peak conditions map (flood extents and depths)

Process:
- Requires integration of flood forecast system with mapping program
- Utilizing Full Equations (FEQ) modeling output with HEC-RAS Mapper to create maps
- May be updated with each forecast update (currently 6 hour intervals)
What Are We Working on Now?

Process to Create Inundation Maps

- Digital Elevation Model derived from LiDAR (2014)
  - Resolution: 1.5 feet grid
- Clean up, extend, and edit cross-sections
What Are We Working on Now?

Process to Create Inundation Maps

- Extract 2-dimensional cross-sections from the Digital Elevation Model
- Add channel inverts for low flows
- Set parameters required by HEC-RAS model
What Are We Working on Now?

FEQ Output Converted into HEC-RAS Format
What Are We Working on Now?

HEC-RAS Model Input

- Build geometry
- Copy FEQ output into Steady Flow, including internal changes in Water Surfaces
What Are We Working on Now?

**HEC-RAS Mapper**
- Forcing FEQ output into Mapper
- Not actual hydraulic model
What Are We Working on Now?

**Flood Simulations**
- Spring 2019 – Add East Branch DuPage River

**Inundation Maps**
- Fall 2018 – Salt Creek and West Branch DuPage River
- Fall 2019 – East Branch DuPage River
What Are We Working on Now?

Peak Flood Depth Maps

• Static map by watershed

• Peaks of all hydrographs at various times combined

• Flood depths computed from water surface elevations subtracted from Digital Elevation Model

• Conveys severity of extents and depths of flooding for disaster response and recovery

Proof of concept – not actual event
What Are We Working on Now?

Real Time Flood Inundation Maps

• Dynamic maps at each 6-hour time-step from the current condition through the 72-hour forecast
• By watershed – not limited area around gages
• Each flood forecast and set of inundation maps are unique depending on:
  o the current river levels,
  o how much rain falls, and
  o where the rain falls
West Branch DuPage River and Winfield Creek – Current Condition

Proof of concept – not actual event
West Branch DuPage River and Winfield Creek – +6 Hour Condition

Proof of concept – not actual event
West Branch DuPage River and Winfield Creek – +12 Hour Condition

Proof of concept – not actual event
What Are We Working on Now?

Dynamic Flood Inundation Maps

- Web based maps
- Zoom in / out
- By forecast time periods (6-hour time steps)
Where Are We Going?

Real Time Animated Flood Inundation Maps and Features

• Animated maps and features from the current condition through the 72-hour forecast

• Work in progress – may require detailed HEC-RAS models (hydraulic structures)

• No timeline established to complete this portion
Where Are We Going?

Animated Maps

- Animation of flood depths showing flood forecast at hourly time steps over 72 hours in future

*Modeling to be utilized for internal demonstration purposes only.*
Where Are We Going?

Animated Features

- Animated cross-sectional view showing the water surface elevation at a particular road crossing

*Modeling to be utilized for internal demonstration purposes only.*
Where Are We Going?

Animated Features

• Animated hydrographs

Modeling to be utilized for internal demonstration purposes only.
Where Are We Going?

Animated Features

• Animated flood profile

Modeling to be utilized for internal demonstration purposes only.
Applications and Users

Applications

- Flood control operations
- Resource allocation and placement
- Evacuations
- Road closures
- Emergency vehicle routing
- Credit for Community Rating System (CRS) program
- Damages documentation for disaster assistance

Users

- DuPage County Stormwater Department
- DuPage County Office of Emergency Management
- DuPage County DU-COMM
- Public Works Departments
- Transportation Departments
- First responders (fire, police)
- Critical facilities (i.e., hospitals)
- Municipalities
- Businesses and residents
Contributors

**U.S. Geological Survey (USGS)**
*USGS Central Midwest Water Science Center in Urbana, Illinois*
- Flood forecasting simulations
- Mapping
- Animations

**U.S. Army Corps of Engineers Chicago District**
- Conversion of FEQ output into HEC-RAS compatible format
- HEC-RAS Mapper
- Animated maps and features examples

**DUPage County**
**Stormwater Management**
Summary

Flood Inundation Maps

- Translate observed and simulated water surface elevations onto maps
- Maps provide more information than hydrograph plots
- Dynamic and animated maps
- Zoom to any point in the watershed
- Web based maps support decision-making for multiple users
Questions / Contact Information

Questions?

Contact Information

Kristina Murphy, CFM
Civil Engineer
Kristina.Murphy@dupageco.org
(630) 407-6821

Jessica Spurlock, P.E., CFM
Project Engineer
Jessica.Spurlock@dupageco.org
(630) 407-6714