



Plenary Session 3
Making it Work
Flood Mitigation Best Practices and Success Stories



Roger D. Lindsey, P.E., CFM
Practice Leader - Stormwater and Floodplain
Management

Metro Nashville Water Services



May 2010, Nashville

*Photo: The
Tennessean*



May 2010, Nashville
I-24

Photo: WKRN



May 2010, Nashville
Downtown

*Photo: Larry McCormack, The
Tennessean*



May 2010, Nashville

Opryland Hotel and Opry Mills Mall

*Photo: Samuel M. Simpkins, The
Tennessean*



May 2010, Nashville
Opryland Hotel



May 2010, Nashville
Titans Stadium

Wonkblog • Analysis

Houston is experiencing its third ‘500-year’ flood in 3 years. How is that possible?

By **Christopher Ingraham** August 29, 2017 [✉ Email the author](#)



This drone video taken Aug. 27 shows the historic flooding in Houston caused by Hurricane Harvey. (ahmed.gul/Instagram)

[U.S.](#)

Historic Maryland Town Hit by a Second Devastating Flood Since 2016

National Guardsman reported missing in Ellicott City; some businesses not sure they can recover again



Ellicott City Hit by Second '1000-Year Flood' Since 2016

The second flash flood in two years hit Ellicott City, Md., on Sunday, sweeping away cars and covering streets in mud. Photo: Getty

Capital Weather Gang

Cedar Rapids, Iowa, braces for second biggest river flood on record

By **Jason Samenow** September 26, 2016 [Email the author](#)

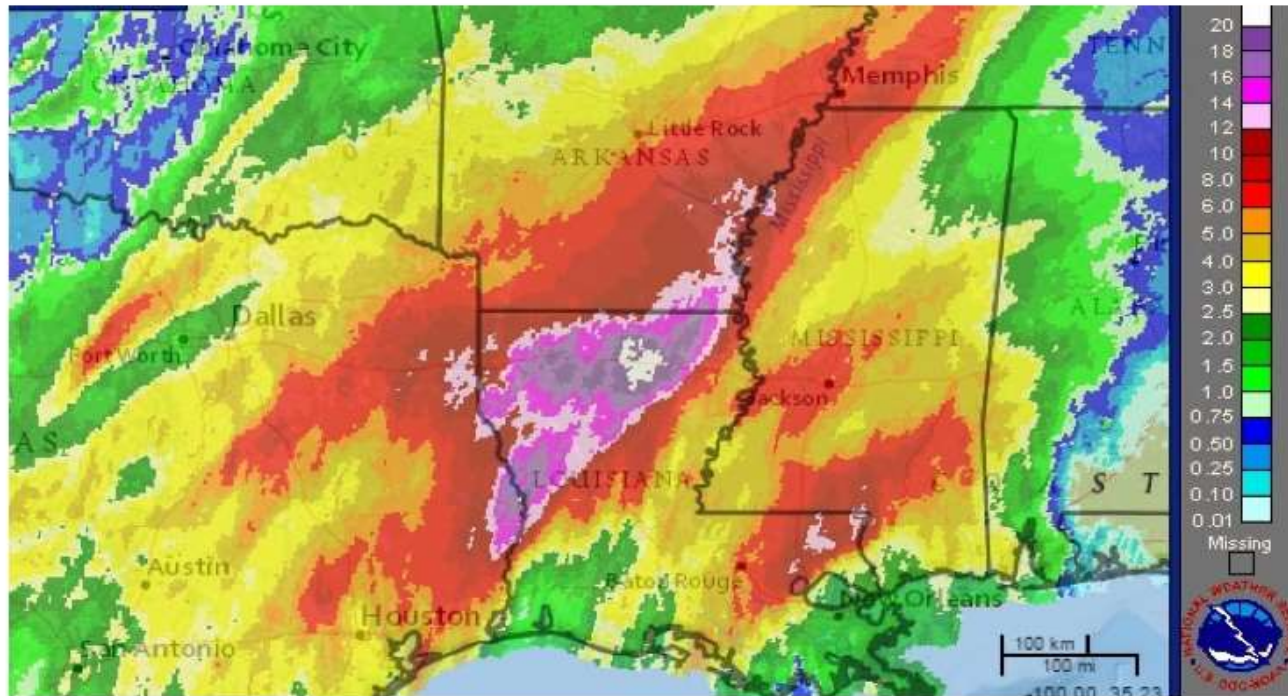


Jason Mann, of Cedar Rapids, Iowa, loads sandbags onto a truck in the New Bohemia District, on Sept. 23. (David Scrivner/Iowa City Press-Citizen via AP)

Capital Weather Gang

State of emergency in Louisiana, as atmospheric river unloads disastrous rains

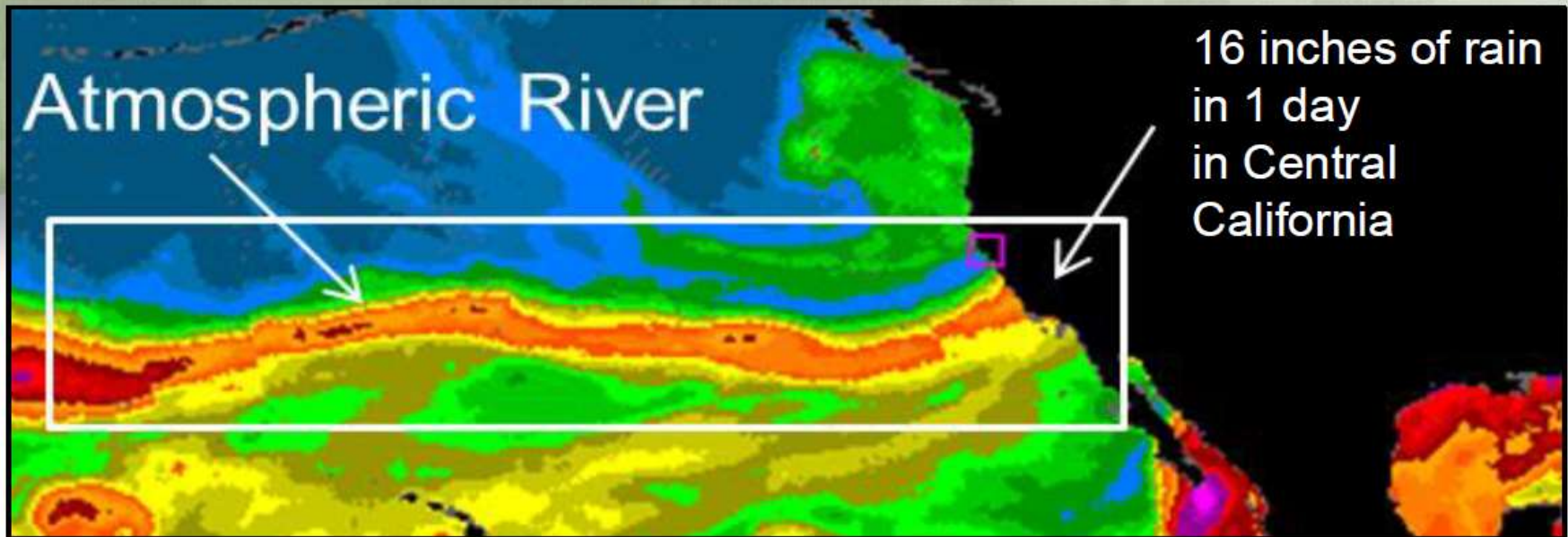
By **Jason Samenow** March 11, 2016 [Email the author](#)



Doppler estimated rainfall over the last four days in South Central U.S. (NWS)

Up to two feet of rain have fallen in Louisiana and three people have died, as historic flood event swamps parts of the South and Gulf Coast states.

Atmospheric Rivers



- A narrow “conveyor belt” of water vapor extending from thousands of miles out at sea, carrying, on average, ~10 Mississippi Rivers
- Generally provide 35-50% of annual rainfall across California

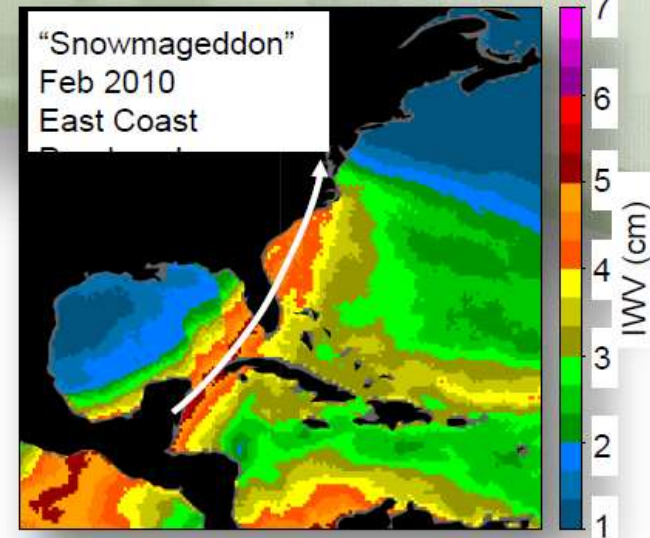
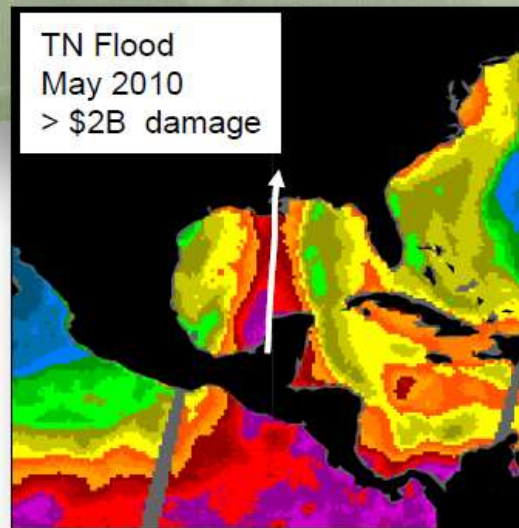
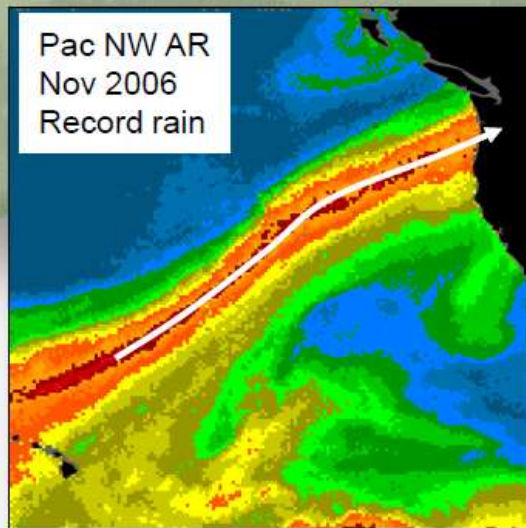
Dettinger et al., *Atmospheric Rivers, “Floods and the Water Resources of California.”* *Water*, 2011



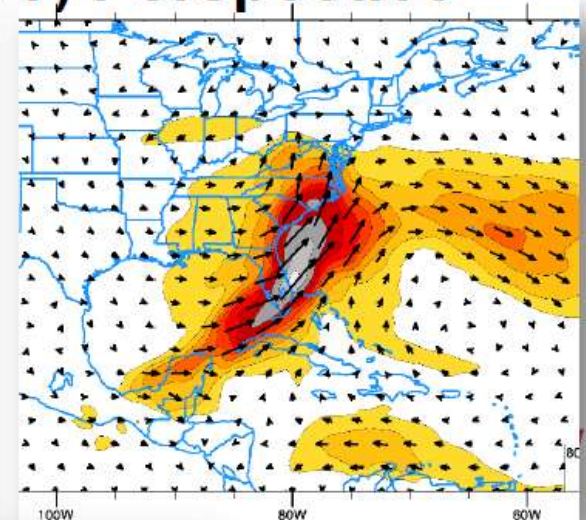
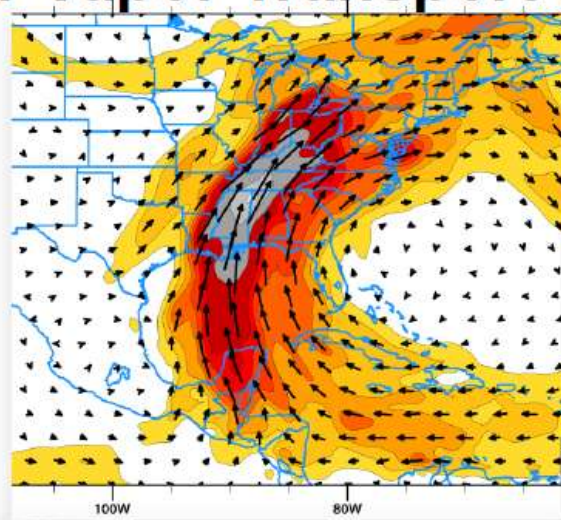
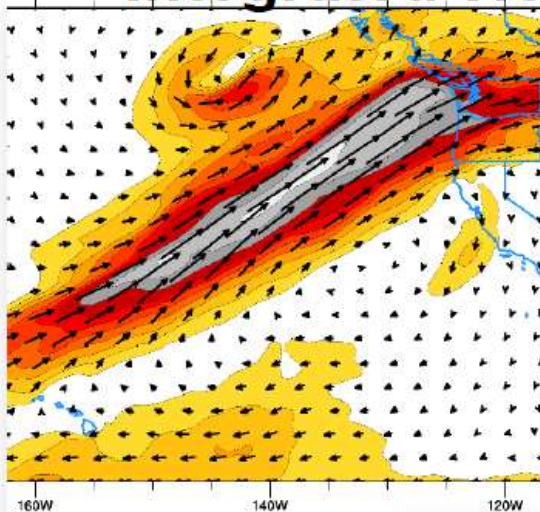
ERDC

Atmospheric Rivers: Not just a West Coast Issue

Integrated Water Vapor (IWV) Perspective



Integrated Water Vapor Transport (IVT) Perspective



BUILDING STRONG®



for a safer, better world

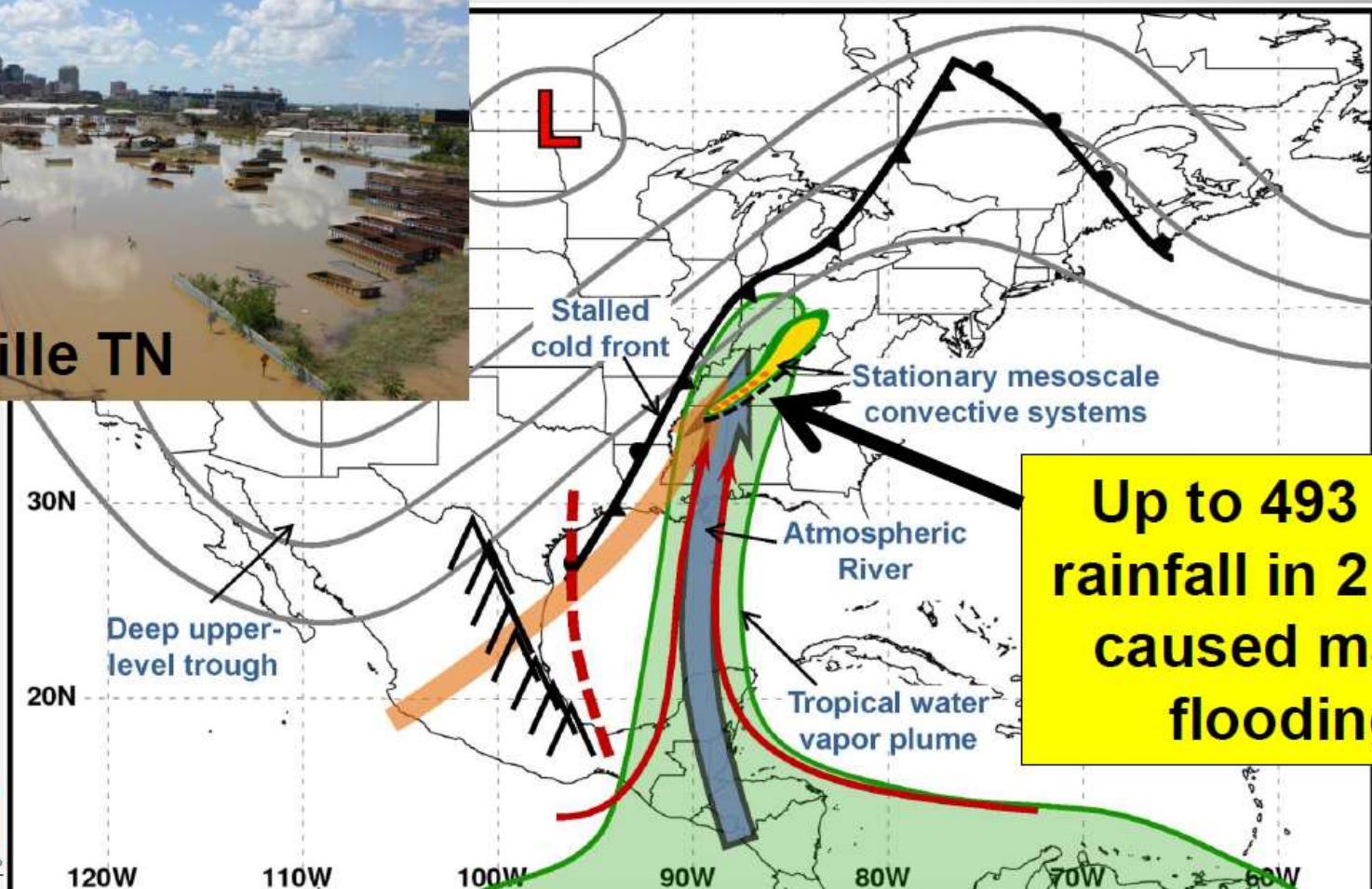
Slide courtesy Marty Ralph

Physical Processes Associated with Heavy Flooding Rainfall in Nashville, Tennessee, and Vicinity during 1–2 May 2010: The Role of an Atmospheric River and Mesoscale Convective Systems

Ben Moore, Paul Neiman, Marty Ralph, Faye Barthold
Monthly Weather Review (2012)



Nashville TN



**Up to 493 mm
rainfall in 2 days
caused major
flooding**



BUILDING STRONG®

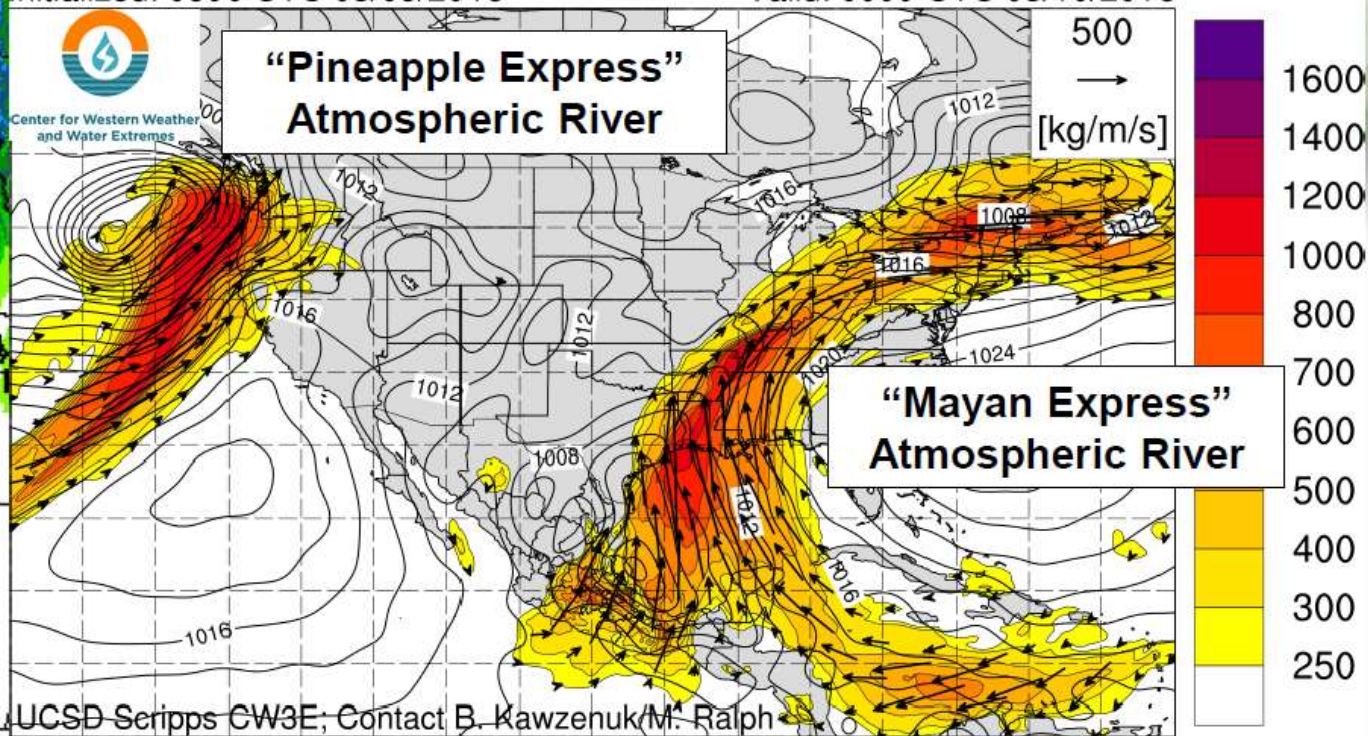


innovative solutions for a safer, better world

Atmospheric rivers and current extreme precipitation events in the Southeast & West Coast

F. M. Ralph (CW3E at Scripps Institution of Oceanography)

NCEP GFS IVT (kg/m/s; shaded), IVT Vector, and SLP (hPa; contours)
Initialized: 0600 UTC 03/09/2016 Valid: 0000 UTC 03/10/2016



DAY 1-3 OPF
VALID 12Z WED MAR 09 2016
THRU 12Z SAT MAR 12 2016
ISSUED: 0835Z WED MAR 09 2016
FORECASTER: WPC/WPC
NOAA/NWS/NCEP/WPC



Extreme Events in 2016



WATER & WASTEWATER



May 2
K.R. Harrington
WTP Floods



- Emergency procurement procedures allow on the spot bids & awards
- 270 flood-related purchase orders issued in May
- \$13 million in flood-related procurement in May

May 4
Recovery Begins



- Four 2500 hp pumps repaired
- Electrical circuits replaced
- Clear well structure assessed
- Disinfection & Water Quality Testing
- Repair of solids building walls
- Dry out records

June 1 (One month later)

K.R. Harrington

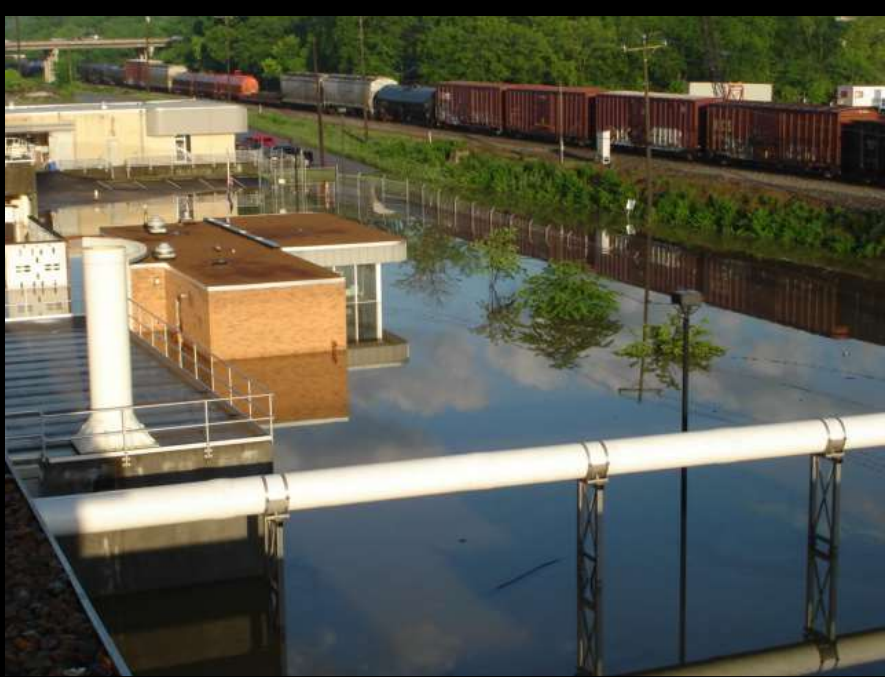
WTP Online



- Relocate generators, switch gear
- Add 5th generator = increase capacity to 90mgd
- Raise clear well vents
- Seal wall penetrations
- Elevate chemical feed system



Mitigation
K.R. Harrington
WTP

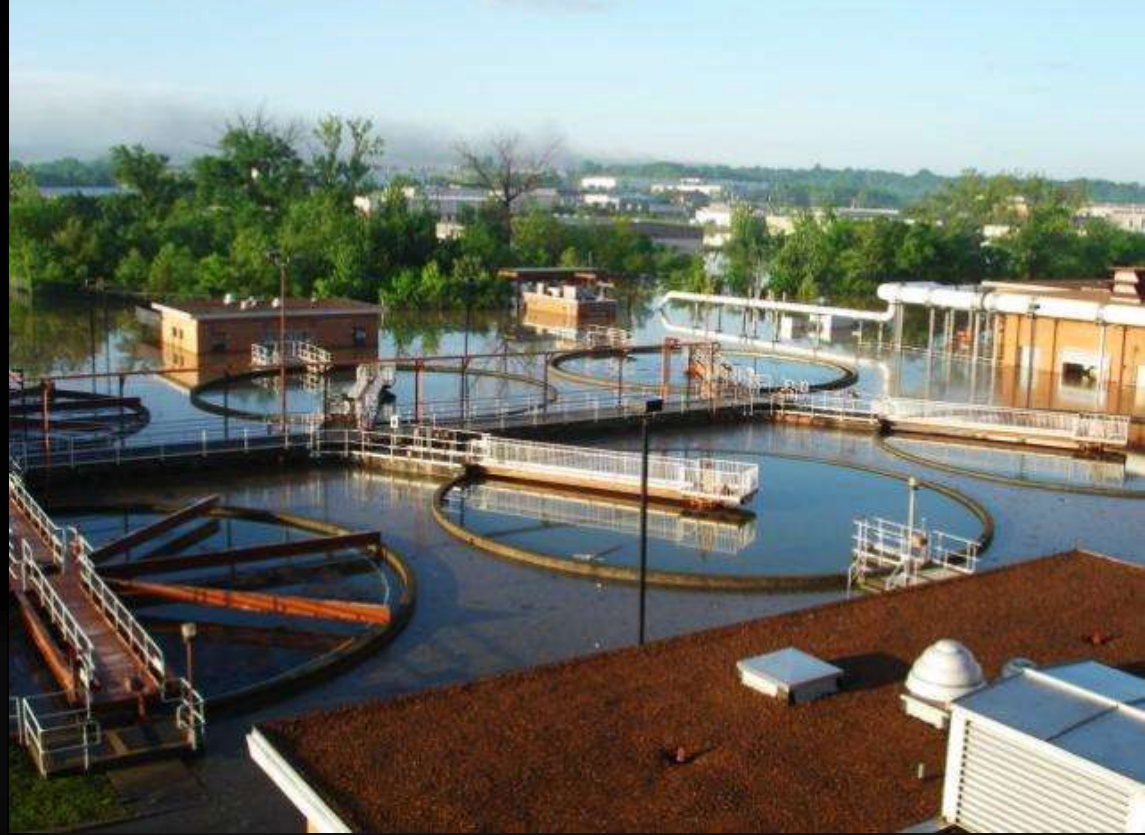


← 2010 High Water Mark

975 High Water Mark →



May 2
*Dry Creek WWTP
Floods*



Recovery

- Last violation: July 2010
- Repair/replace telephones
- Timeline: Winter 2012

Mitigation

- Wall around plant
- Storm drain closures

Mitigation and Recovery

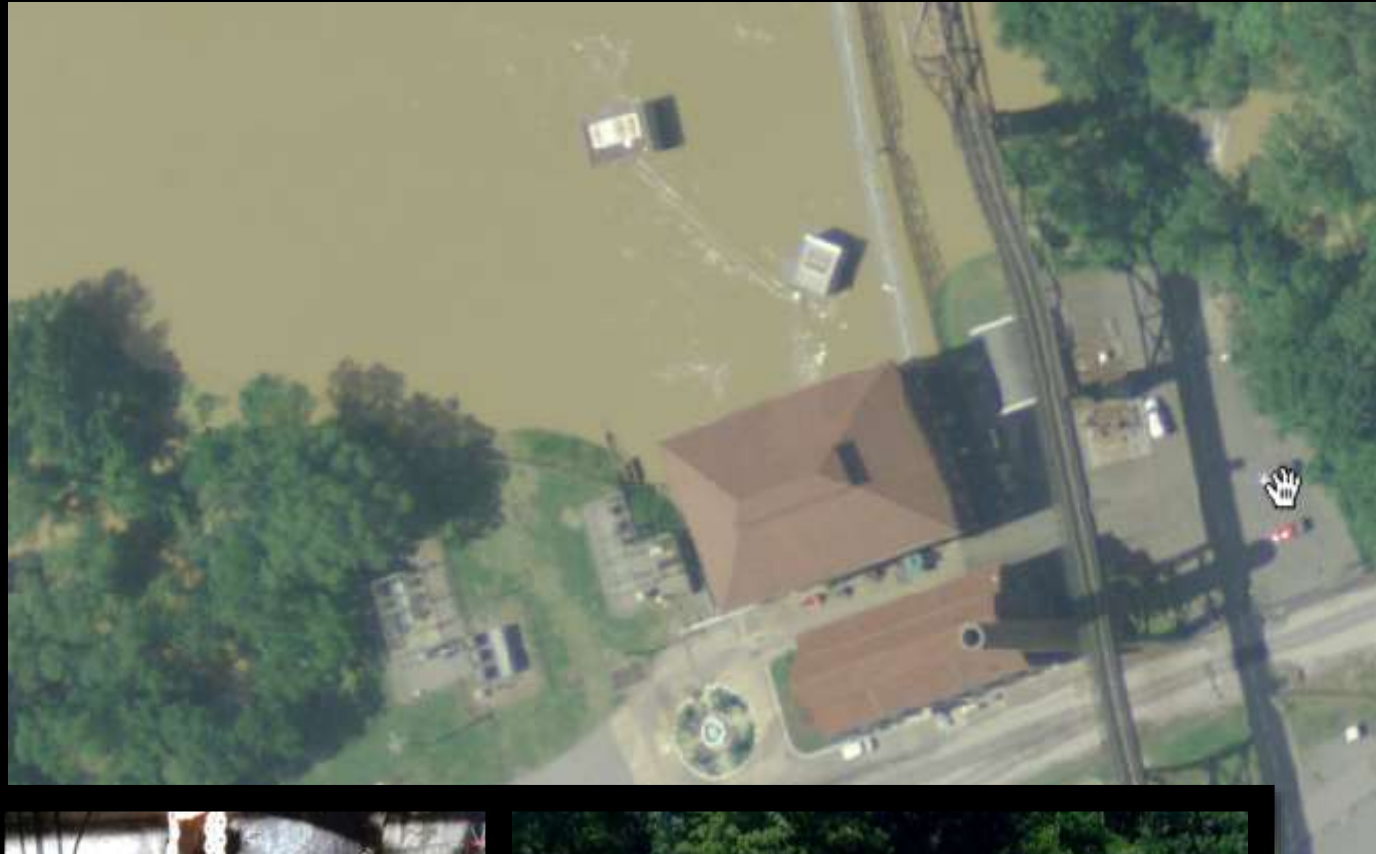
Dry Creek WWTP



12:27
p.m.



9:56 p.m.



3pm - Latest Crest
Projection: 52.5' at 8 p.m.
Flood stage: 40.0'

May 3
*Protecting
Omohundro WTP*

Recovery

- Online: September 2010
- Work on critical process areas:
 - electrical system
 - thickening process
 - digester control system
 - heat drying process
- Additional repairs:
 - repair fixed digester cover
 - replace digester membrane covers
 - minor electrical work



Mitigation

- Elevate electrical substations

Mitigation and Recovery

Biosolids Facility



39 Water-related emergency repairs in
May

- 22 water mains
- 10 water service lines
- 7 fire hydrants

System Services Priority
*Locate and Repair
Leaks*



THE COMMUNITY



Substantially Damaged
Elevated and Renovated



Substantially Damaged
Elevated and Renovated



Substantially Damaged

Lot cleared, new home constructed



Substantially Damaged
Elevated and Renovated



Substantially Damaged

Elevated and Renovated





Substantially Damaged
*New Structure built to NFIP Standards
(one-ft. freeboard)*

Sources of funds:

- HMGP Funds
- Local Dollars
- USACE Basin Planning

Home Buyouts






SW 8 Blackman Road Blackman Court

-  Grass
-  Parcel Boundaries
-  Water Bodies
-  Streams and Rivers

Total Parcel Area: 188,615 Sq. Feet
Total Area To Be Mowed: 62,660 Sq. Feet

Total Parcel Acres: 4.33
Total Acres To Be Mowed: 1.44

120
 Feet
1 inch = 106 feet

Map Updated on 3/12/2018

BLACKMAN ROAD COMMUNITY GARDEN



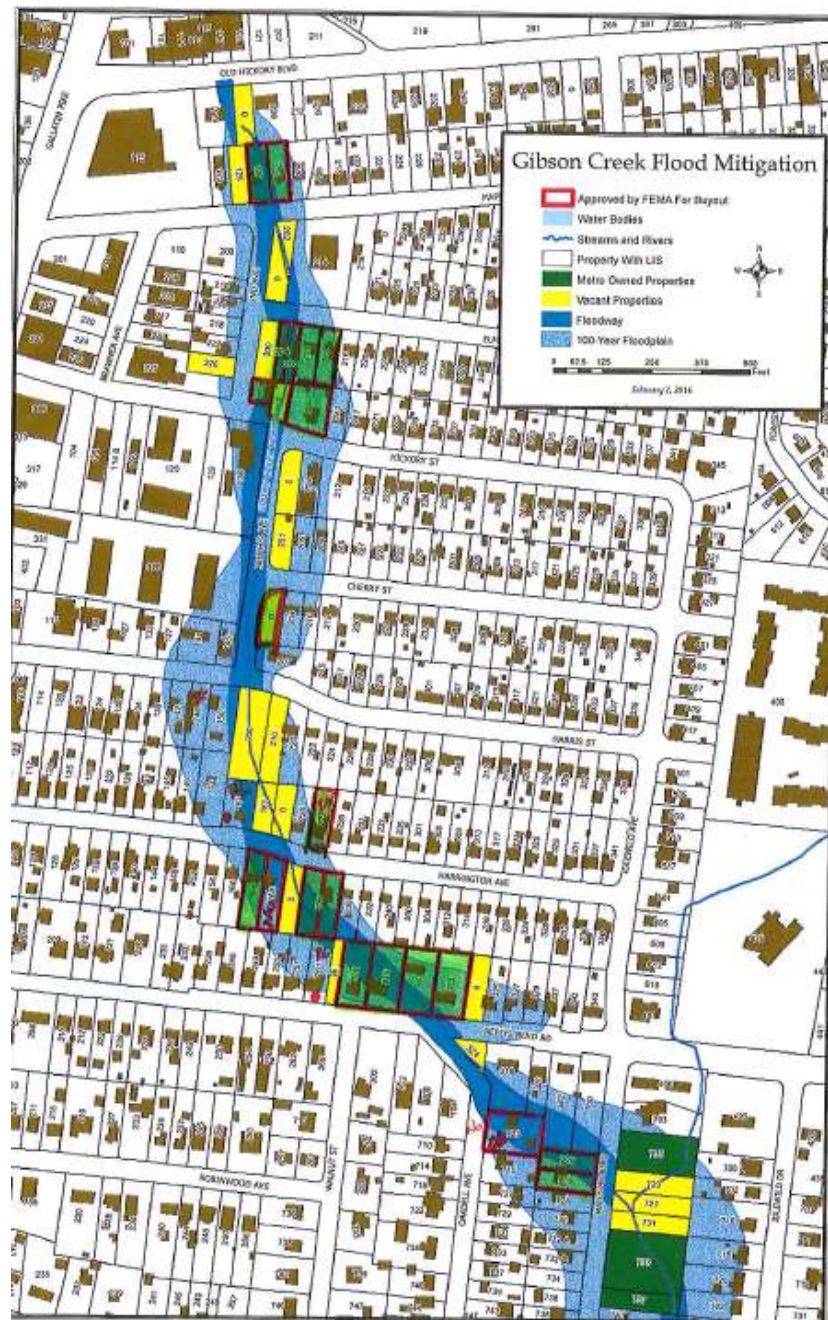


Total Parcel Area: 253,885 Sq. Feet
 Total Area To Be Mowed: 163,500 Sq. Feet
 Total Parcel Acres: 5.83
 Total Acres To Be Mowed: 3.75

(SW 1)
 EWINGDALE DRIVE
 GWYNNWOOD DRIVE

March 2013

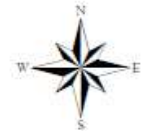
-  Grass
-  Parcel Boundaries
-  Water Bodies
-  Streams & Rivers



Nashville Flood Preparedness
Metro Nashville
Davidson County, TN
FIS Study Limits

Legend

-  Phase 2 (Complete)
-  Phase 3 (Complete)
-  Phase 4A (Complete)
-  Phase 4AA (Complete)
-  Phase 4B (Complete)
-  Phase 4C (Complete)
-  Phase 4D (Complete)

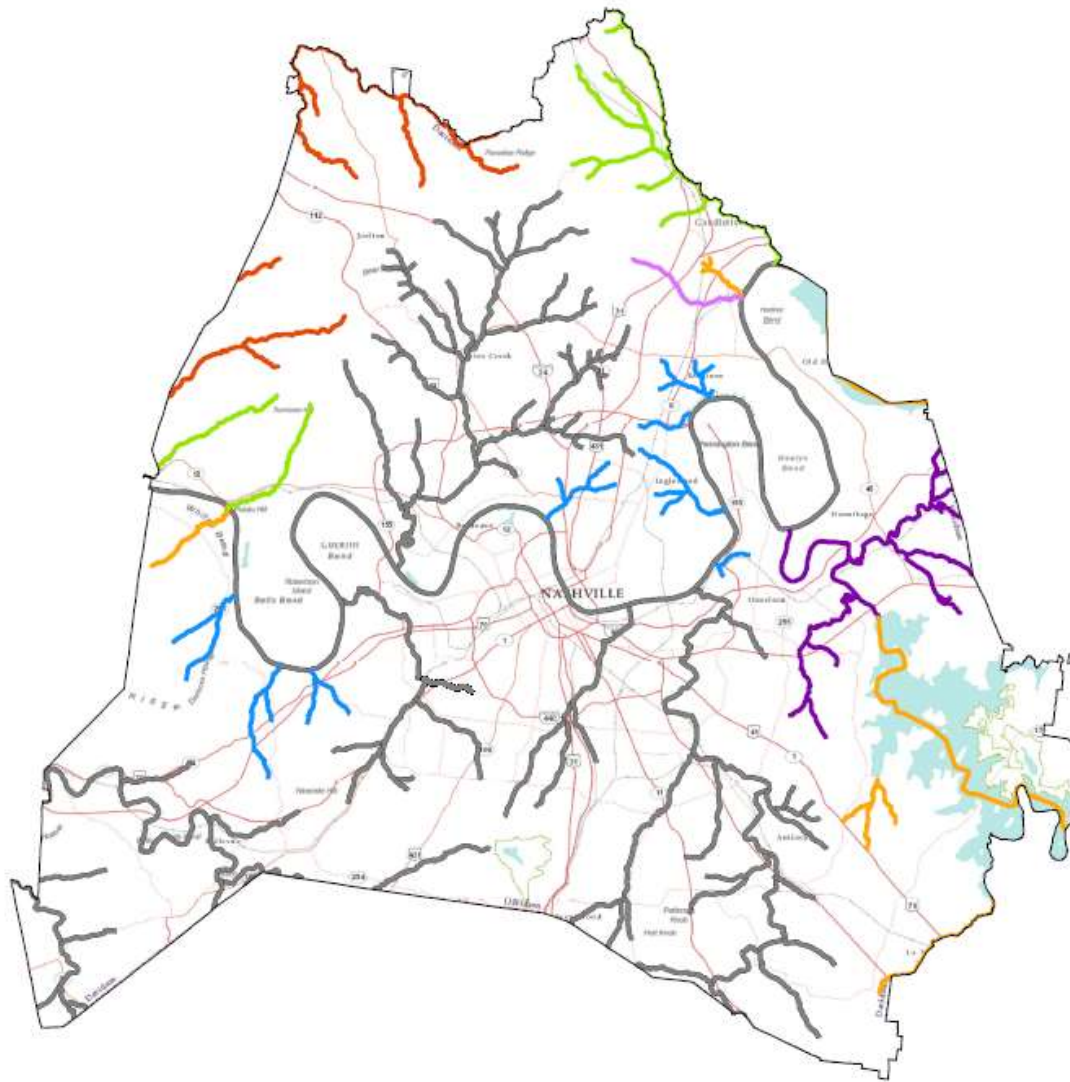


0 1.5 3 6 Miles

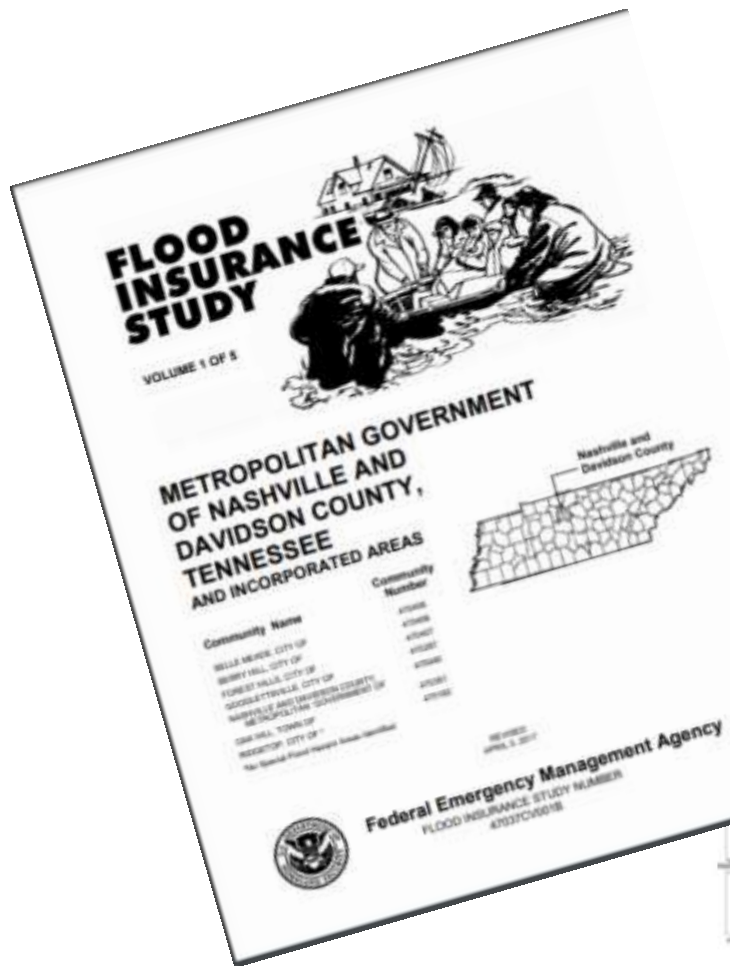


**US Army Corps
of Engineers®**
Nashville District

Updated: August 30, 2016



All New H&H....county-wide!!





NASHVILLE SAFE & NERVE

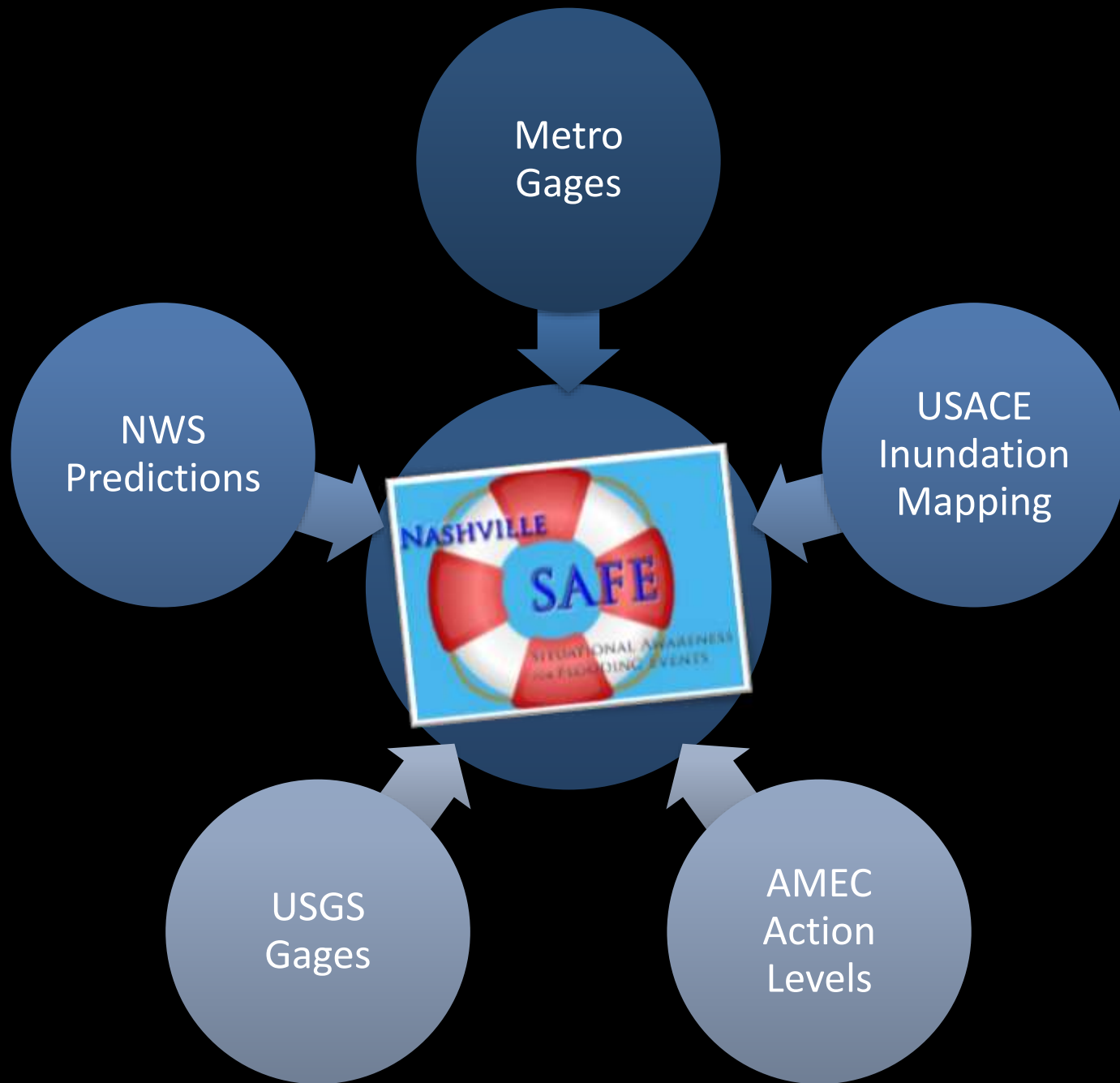


Improve
d
Coordina
tion

Trained
Person
nel

More &
Better
Data

Service Assessment Recommendations



NASHVILLE

SAFE

SITUATIONAL AWARENESS
FOR FLOODING EVENTS

- ☒ Current Readings
- ☐ NWS Highest Predicted
- ☐ User Set Predicted

Additional Layers

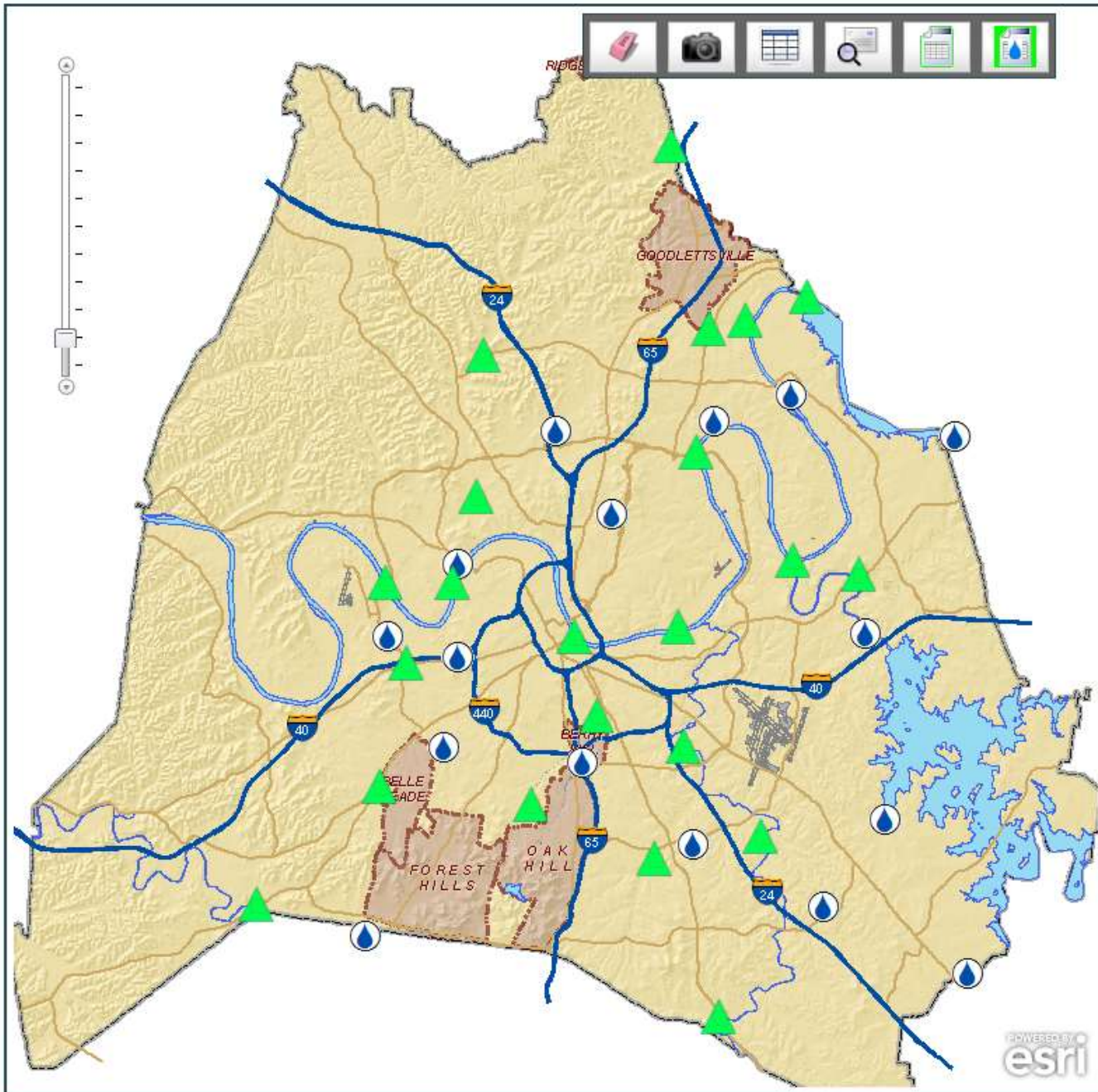
Select Additional Layers

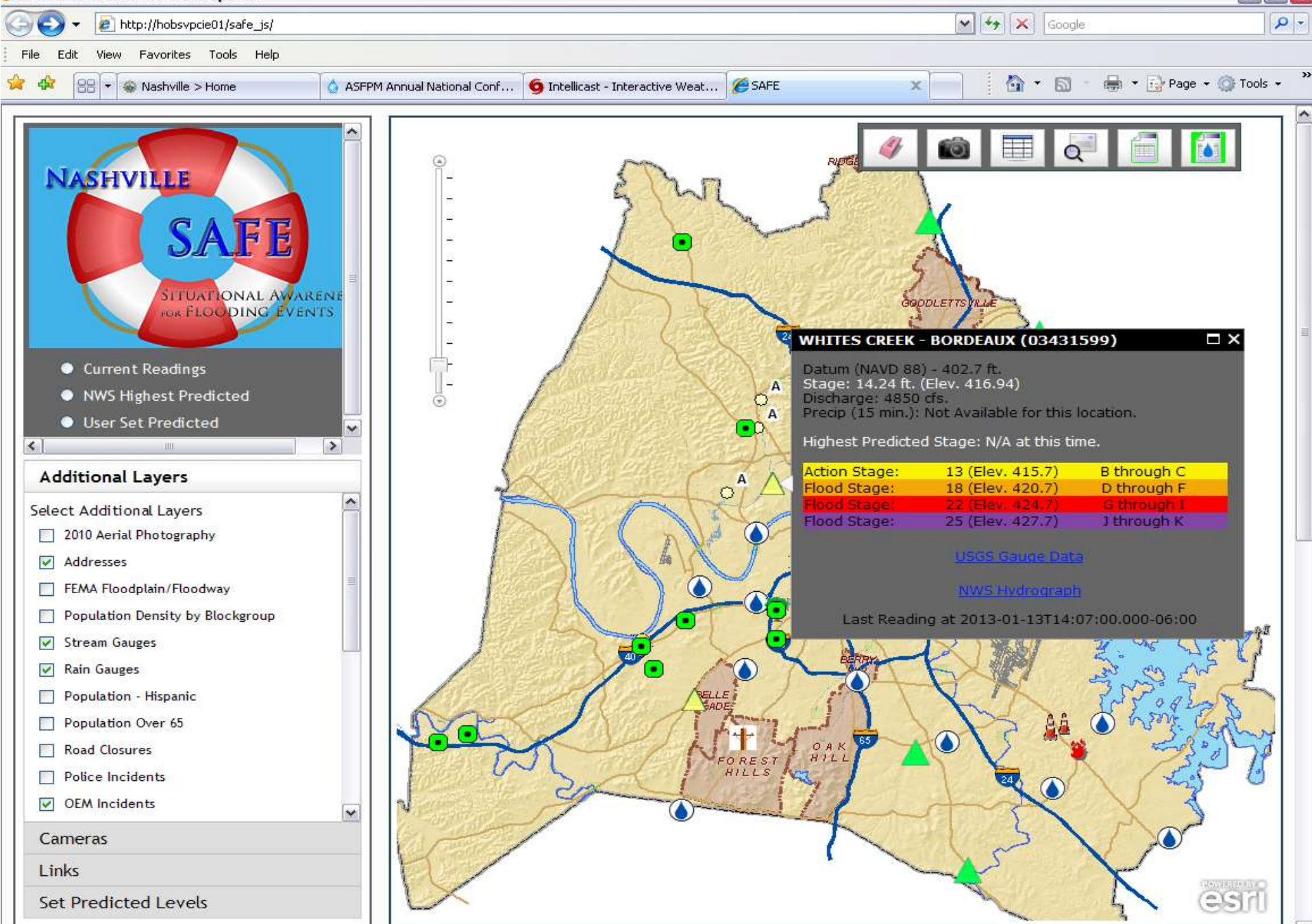
- ☐ 2010 Aerial Photography
- ☒ Addresses
- ☐ FEMA Floodplain/Floodway
- ☐ Population Density by Blockgroup
- ☒ Stream Gauges
- ☒ Rain Gauges
- ☐ Population - Hispanic
- ☐ Population Over 65
- ☐ Road Closures
- ☐ Police Incidents
- ☒ OEM Incidents

Cameras

Links

Set Predicted Levels





WHITES CREEK - BORDEAUX (03431599)



Datum (NAVD 88) - 402.7 ft.

Stage: 5.96 ft. (Elev. 408.66)

Discharge: 180 cfs.

Precip (15 min.): Not Available for this location.

Highest Predicted Stage: N/A at this time.

Action Stage:	13 (Elev. 415.7)	B through C
Flood Stage:	18 (Elev. 420.7)	D through F
Flood Stage:	22 (Elev. 424.7)	G through I
Flood Stage:	25 (Elev. 427.7)	J through K

[USGS Gauge Data](#)

[NWS Hydrograph](#)

Last Reading at 2013-01-15T16:30:00.000-06:00

SAFE - Windows Internet Explorer

http://hobsvpcie01/safe_js/

File Edit View Favorites Tools Help

Nashville > Home ASFPM Annual National Conf... Intellicast - Interactive Weat... SAFE

● Current Readings

● NWS Highest Predicted

● User Set Predicted

Additional Layers

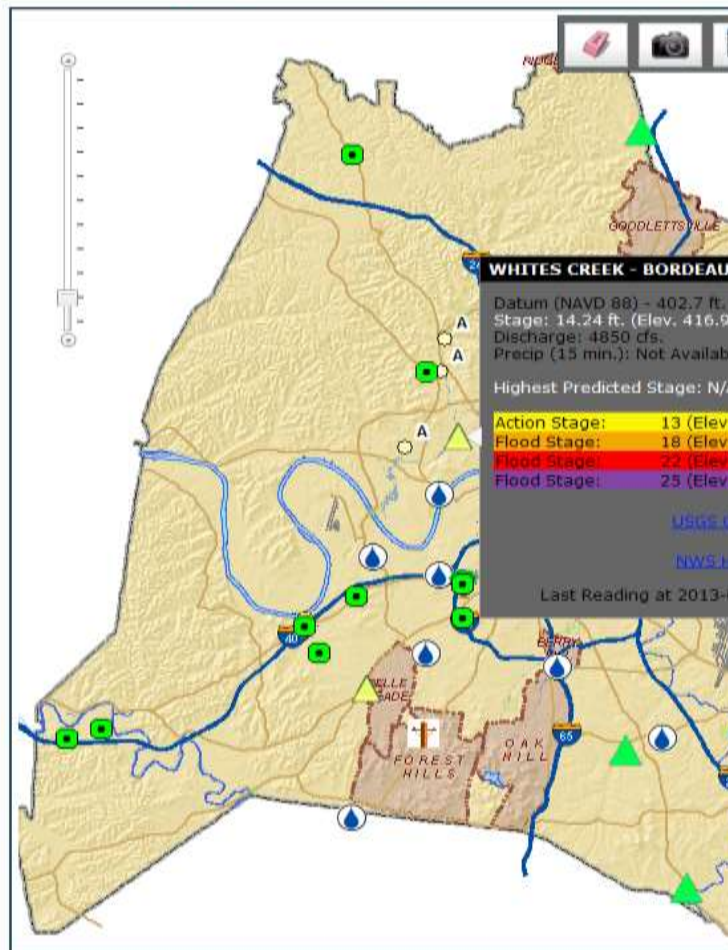
Select Additional Layers

- ☐ 2010 Aerial Photography
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Cameras

Links

Set Predicted Levels



USGS Real-Time Water Data for USGS 03431000 MILL CREEK NEAR ANTIOCH, TN

PROVISIONAL DATA SUBJECT TO REVISION

Available data for this site: Time-series Real-time data GO

This site is operated in cooperation with

U.S. Army Corps of Engineers, Nashville District

This station managed by the Nashville Field Office.

Available Parameters

☐ All 3 Available Parameters for this site

☒ 00060 Discharge

☒ 00065 Gage height

☐ 00045 Precipitation

Output format

☒ Graph

☐ Graph w/ stats

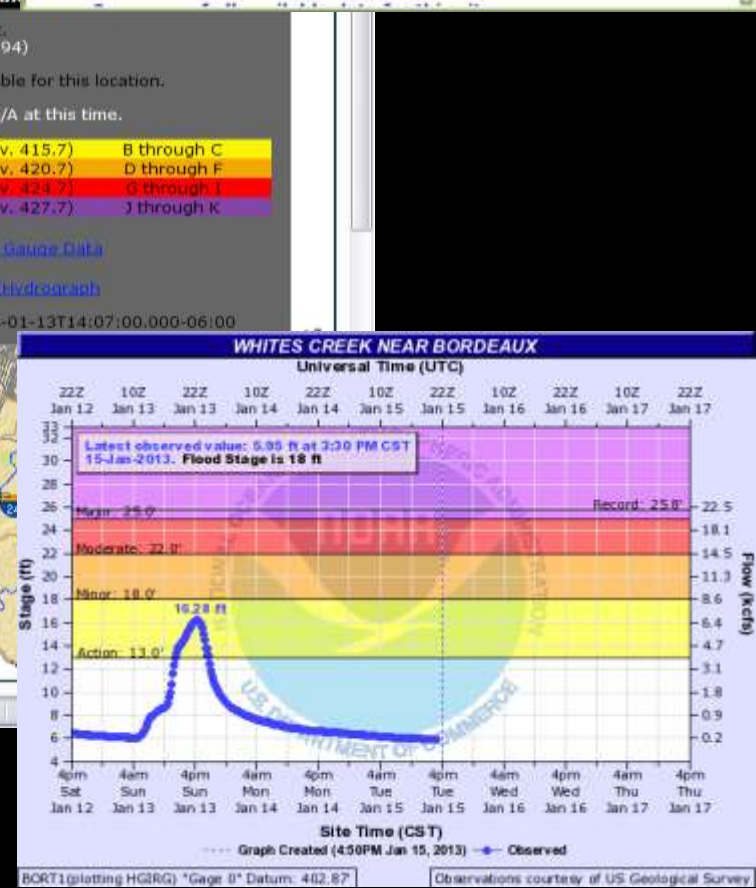
☐ Graph w/o stats

☐ Table

☐ Tab-separated

Days

7 (1-120) GO

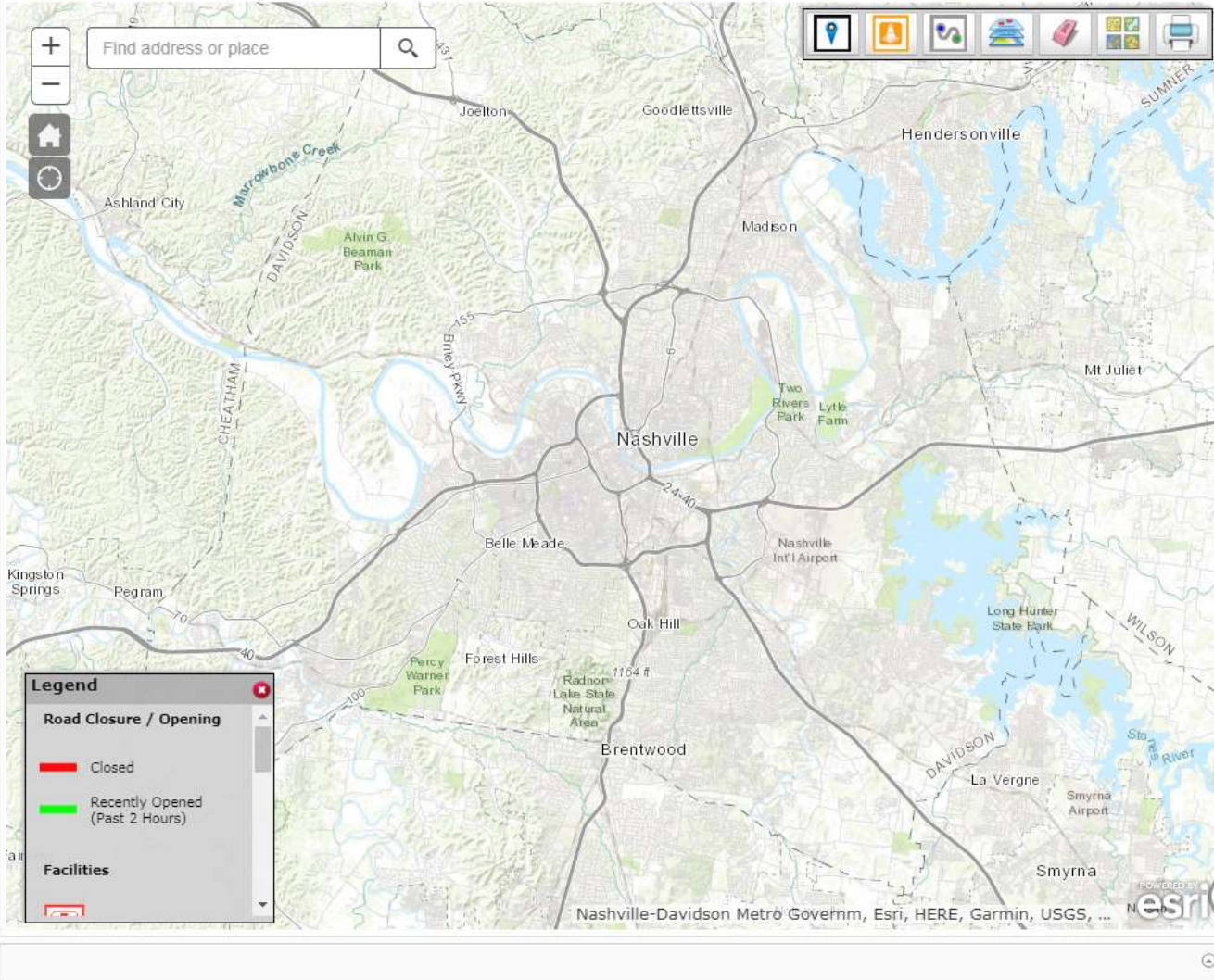




ter is currently NOT activated. OEM is monitoring

 Evacuation Areas

-  Shelters
-  Disaster Information Centers
-  Disaster Recovery Centers
-  Food Distribution Centers
-  Clothing Distribution Centers
-  Water Distribution Centers



NERVE

Presentations at this Conference:

Real-Time Flood Forecasting in Nashville
TN using HEC-RTS, Brantley Thames, PE

Tearing Down Homes to Build
Community Resilience – An Evaluation
of the Benefits of the Nashville Home
Buyout Program,
Janey Camp, PhD, PE, CFM

Additional Research

Questions??

Roger D. Lindsey, P.E., CFM

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Management*

Metro Nashville Water Services

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