

# Overview of USGS Programs: Flooding

Observing, Understanding, Predicting and  
Delivering Flood Information

**Andy Ziegler (with slides from Don Cline— AD Water)**

*Director*

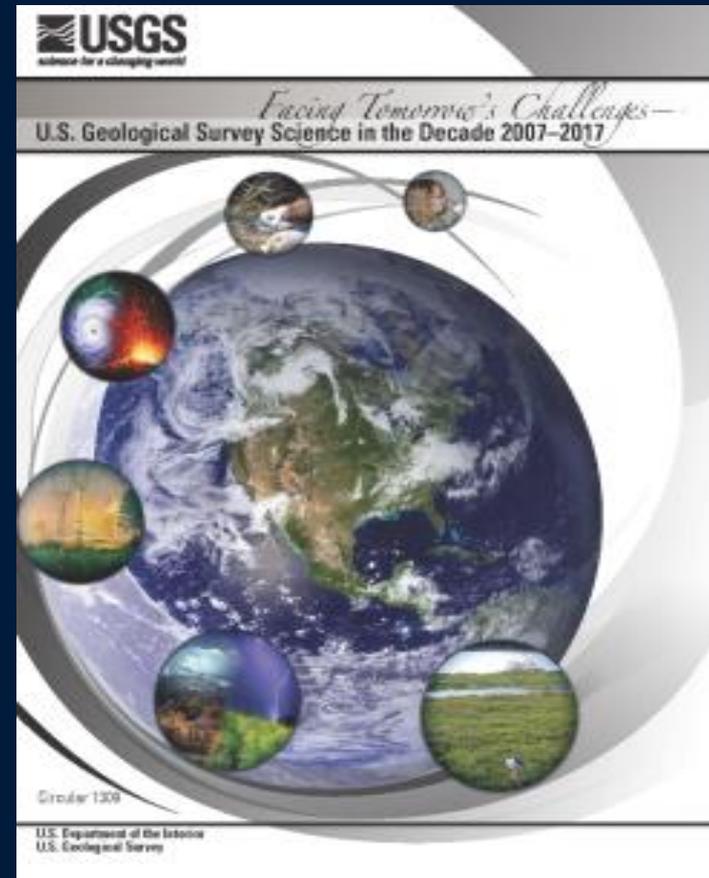
*U.S. Geological Survey, Kansas Water Science Center*



# USGS Strategic Science Themes (Mission Areas)

- Ecosystems
- Climate and Land-Use Change
- Energy and Minerals
- Environmental Health
- Natural Hazards
- Water
- Core Science Systems

28 USGS programs  
managed under the seven  
mission areas.



Circular 1309

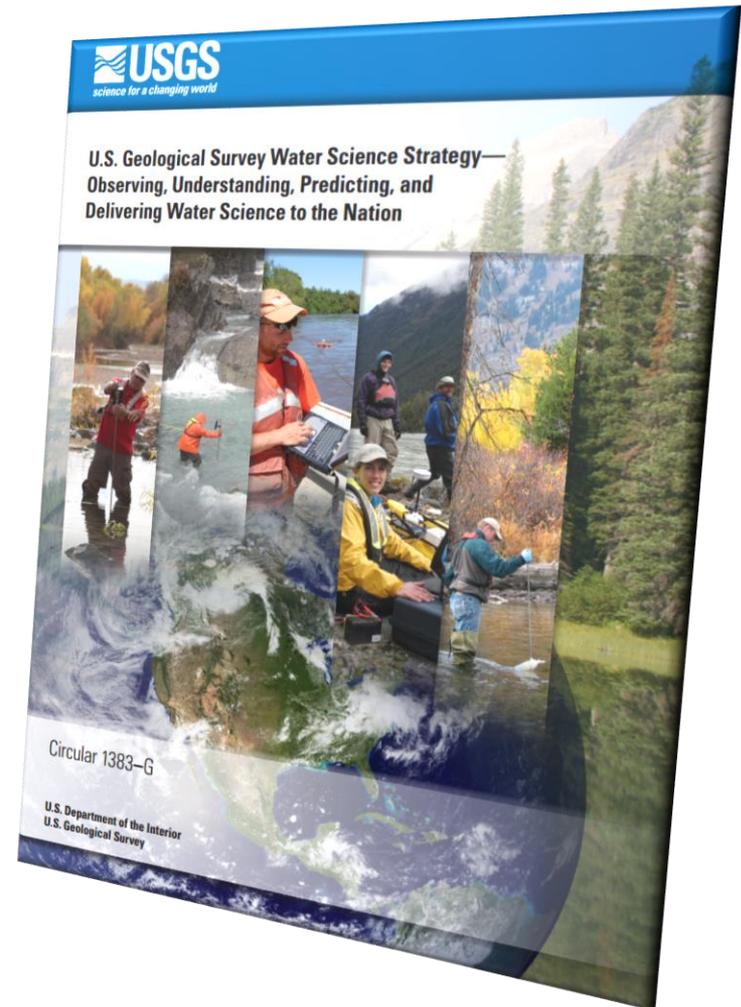
# USGS Water Resources Mission

- Since establishment in 1879, the USGS has been a primary source for scientific data to describe and understand Earth systems and provide assessments to facilitate the management of the nation's resources.
- The USGS is a major national contributor of scientific data, investigations, and information about the nation's waters.
- The beginnings of systematic studies of the water resources of the United States – the antecedents of the USGS Water Resources Mission – are now (2017) 129 years old. Since its conception, the USGS' water mission has remained “to provide reliable, impartial, timely information needed to understand the nation's water resources”.
- With no regulatory or management responsibilities, the USGS water resources mission is recognized as a source of unbiased hydrologic data and scientific information.
- The reputation of the USGS water resources mission is built on high quality data and science, maintained through stringent quality assurance and peer review processes.
- Our collaborative science is possible because of cooperative joint funding agreements that began in Kansas in 1895 with 6 stream gages.

# Observing, Understanding, Predicting, and Delivering Water Science to the Nation

## Water Science Strategy: Five Goals

1. Provide society the information it needs regarding the amount and quality of water in all components of the water cycle at high temporal and spatial resolution, nationwide.
2. Advance understanding of processes that determine water availability.
3. Predict changes in the quantity and quality of water resources in response to changing climate, population, land-use, and management scenarios.
4. Anticipate and respond to water-related emergencies and conflicts.
5. Deliver timely hydrologic data, analyses, and decision-support tools seamlessly across the Nation to support water-resource decisions.



# Water Mission Area: 4 USGS Funding Programs

FY17: \$215M USGS; \$314M Reimbursable (stakeholders)  
33% State/local \$\$ results in National to local scale science!



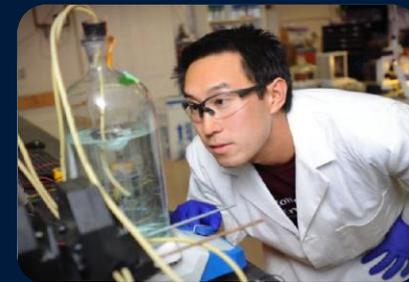
**Groundwater  
and Streamflow  
Information  
Program**  
\$72.7M USGS



**National Water  
Quality  
Program**  
\$90.5M USGS



**Water  
Availability and  
Use Science  
Program**  
\$45M USGS



**Water  
Resources  
Research Act  
Program**  
\$6.5M USGS

**Includes Cooperative Matching Funds (CMF)**

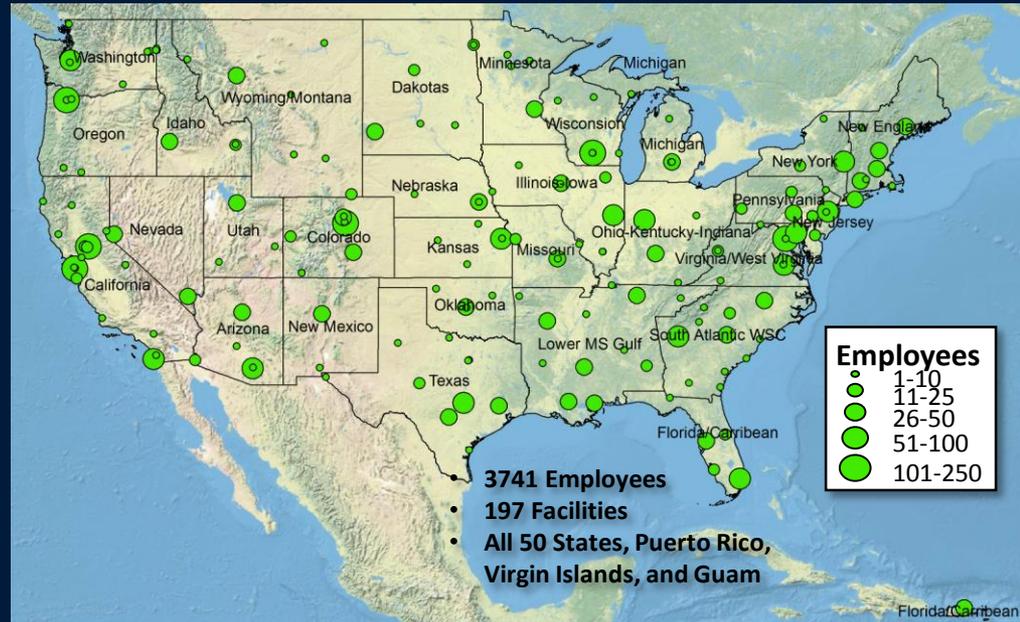
(Requirement for cooperators to match CMF to support State, Tribal,  
& local science needs that also support Federal Programs)

# USGS/Cooperator Programs in Kansas ~\$10M/yr

- **Earthquake Hazards**- Induced seismicity in southern Kansas- (~\$300k)
- **Ecosystems Cooperative Research Unit**- (Manhattan, KS) (~\$300k)
- **Environmental Health**- Organic Geochemistry Research Lab CECs and algal toxins \$800k
- **National Cooperative Geologic Mapping**- KGS (~\$300k)
- **National Geospatial**- USGS National Map Liaison (\$~300k; \$1M+ from NRCS)
- **Water Mission Area**- (USGS Water in Kansas ~\$4M plus grants + \$4M partners)
  - GWSIP (NGWMN- grant to Kansas Geological Survey \$26K; up to \$250k)
  - NWQP
  - WAUSP (Grant to KS DWR \$26k; application in May up to \$250k)
  - Water Resources Research Act (Institutes) about \$100k annually plus

# What Does Water HQ Do?

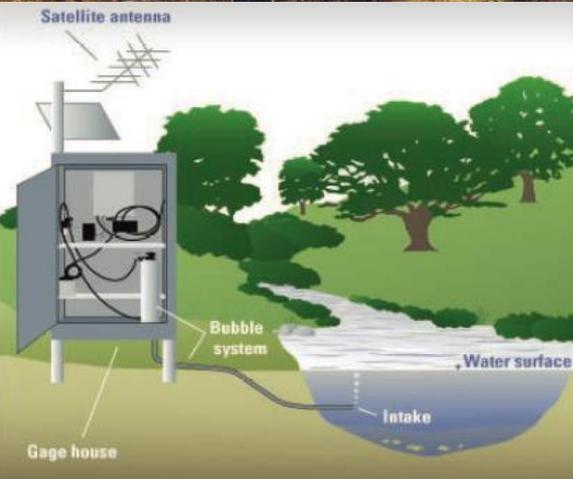
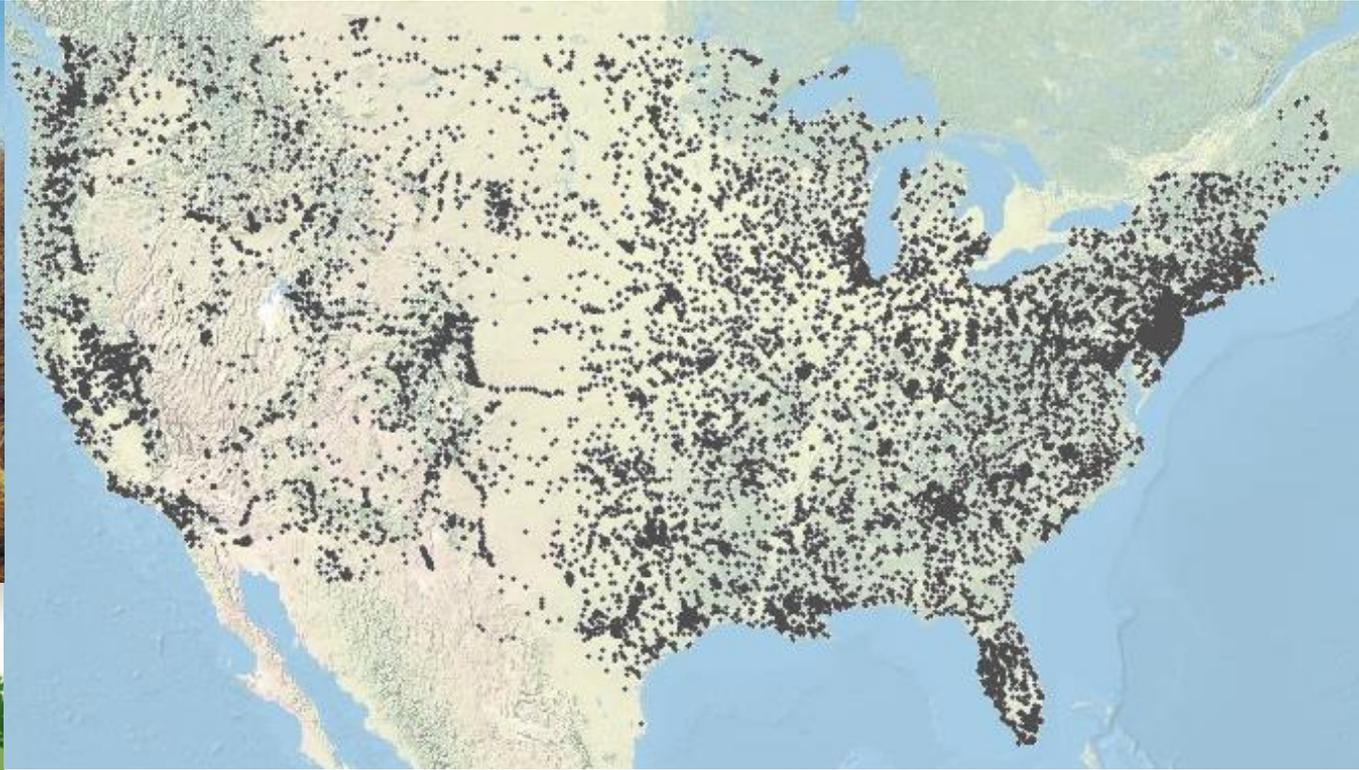
- Science Leadership and Direction (QA)
- Business Operations
- All things IT
- Connection to DOI and the rest of the Executive Branch
- Coordination with other Federal Agencies



## What does a WSC do?

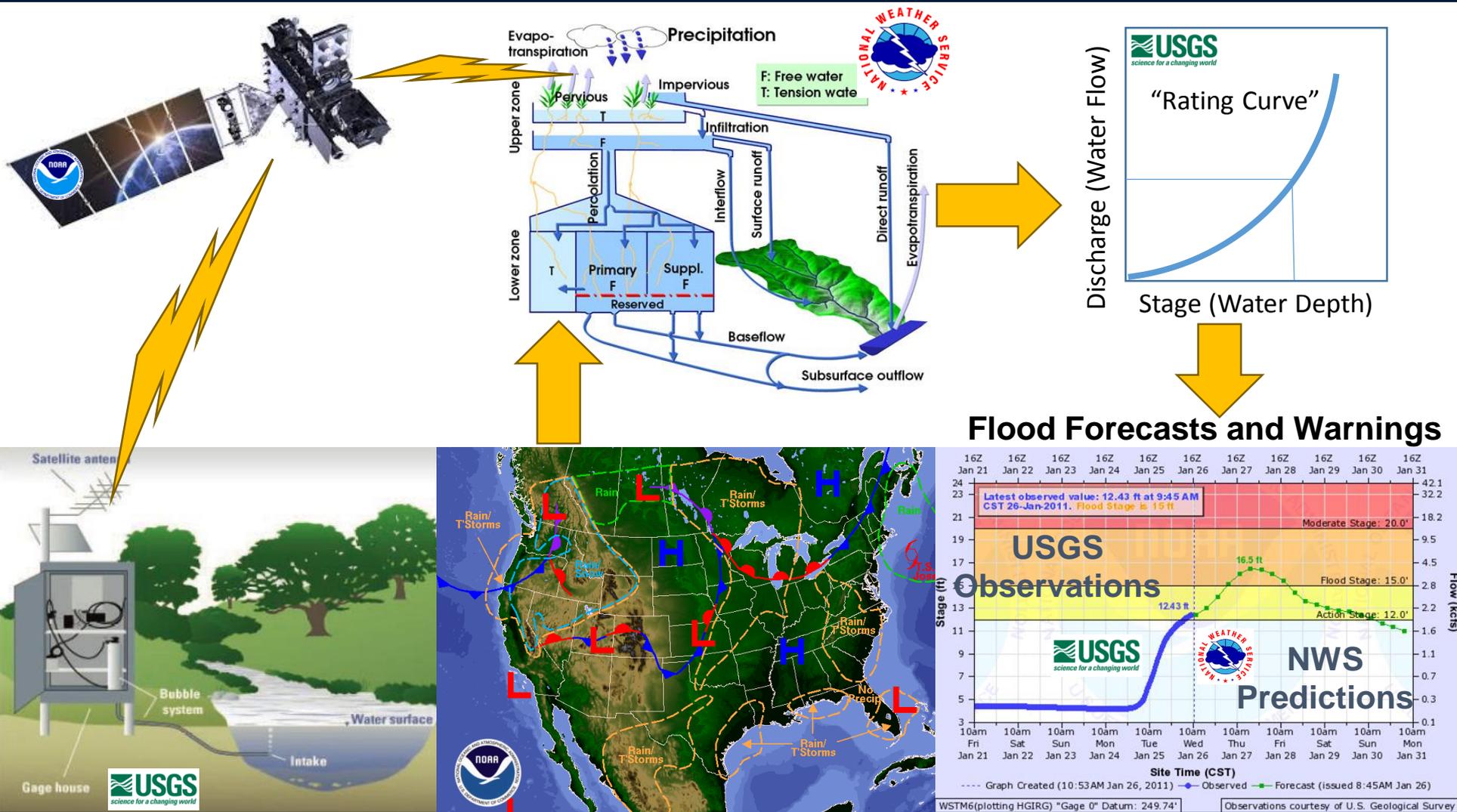
- Provide “bottom-up” science leadership and innovation to meet Federal, State, Tribal, and local stakeholder needs
- Support National data collection, interpretative, and research programs
- Provide input into research and operational needs
- Hire and train future science leaders

# The Nation's Water Observation Backbone

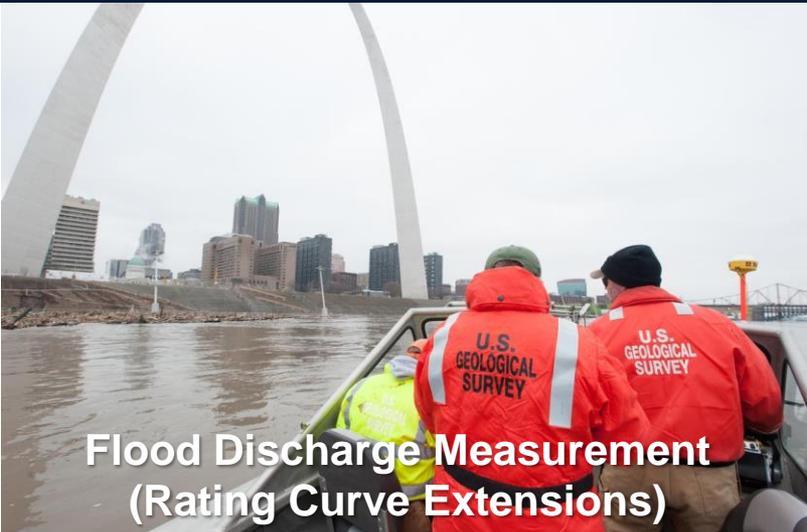


- USGS operates the Nation's largest water observing system with over 8200 real-time streamgages
- Funded by USGS and over 1,000 partners
- Totaling about \$160M in FY17

# USGS and National Weather Service: Partnership to Protect Lives and Property Real-time from the stream to your screen!



# USGS Flood Response



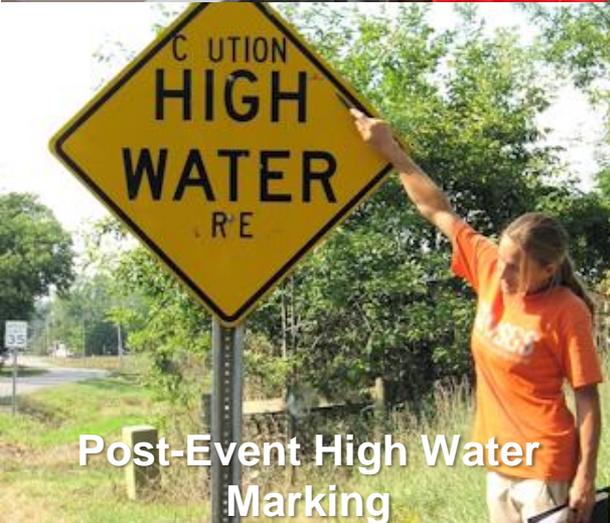
Flood Discharge Measurement  
(Rating Curve Extensions)



High Water Mark  
Surveying



Storm Surge Sensor  
Deployment



Post-Event High Water  
Marking



Flood Discharge Measurement  
(Rating Curve Extension)



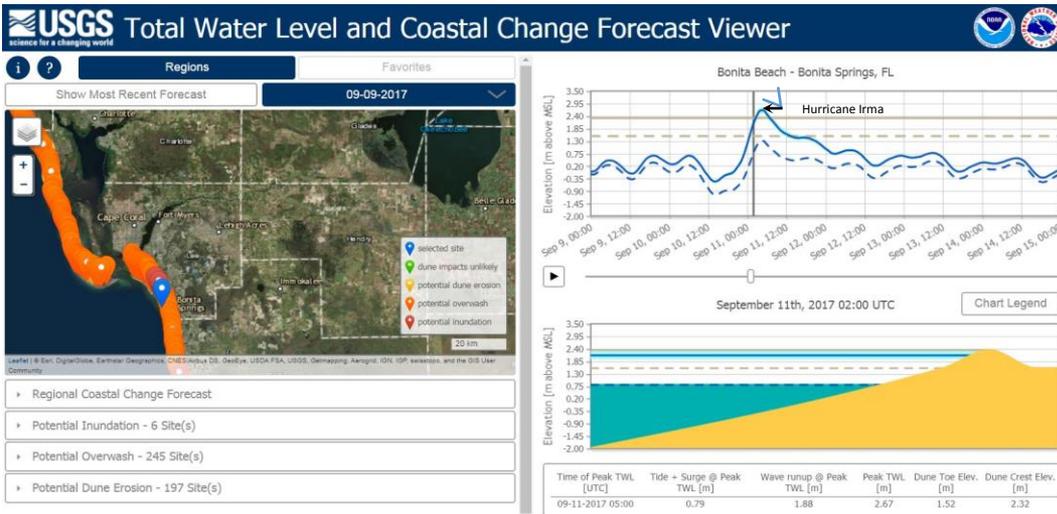
Rapid Deployment Water  
Level Gage Installation

# Coastal Inundation Forecasting

The USGS models the likelihood, magnitude and timing of coastal erosion and inundation by comparing total water levels at the shoreline (including tide, surge, and waves) to the elevations of dunes and berms.

## USGS Coastal Change Hazards Portal

science for a changing world



The map presents the probabilities of coastal erosion (inner band), overwash (middle band), and inundation (outer band) during Hurricane Irma, based on storm conditions from the National Hurricane Center.

# 2017 Hurricane Season

## **Hurricane Harvey (Cat 4): Texas/Louisiana Deployment**

- 16 water-level sensors
- 6 Rapid Deployment Gages
- Additional streamflow measurements to U.S. Army Corps of Engineers to help manage reservoir inflows
- Two FEMA Mission Assignments
  - 1286 High Water Marks flagged and 617 HWM locations surveyed (as of Sept 20)

## **Post-Tropical Storm Jose: CT, RI, MA Deployment**

- 17 water- or wave-level sensors

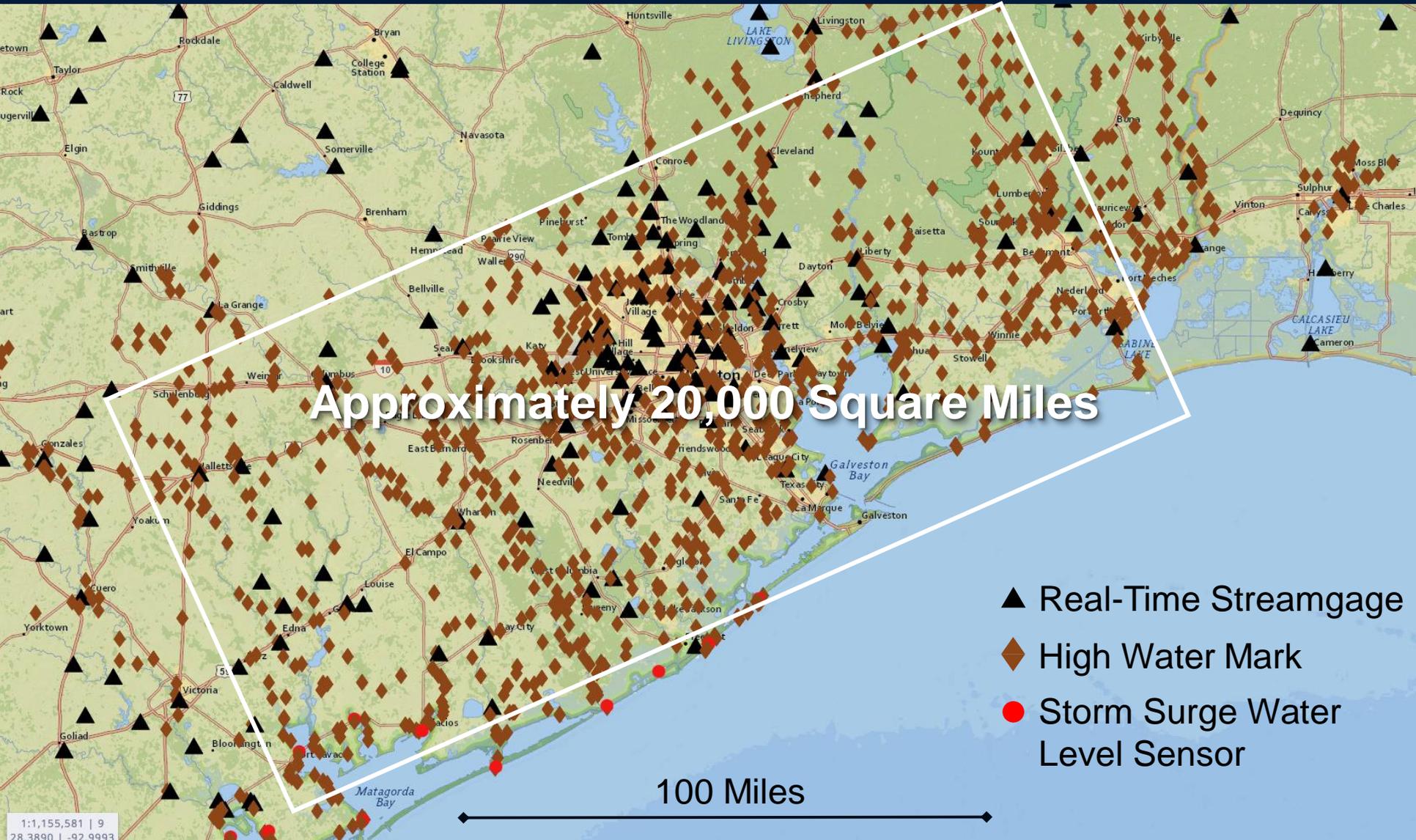
## **Hurricane Irma (Cat 4): Florida – Caribbean Deployment**

- 221 water- or wave-level sensors
- 25 Rapid Deployment Gages
- Four FEMA Mission Assignments
  - 293 High Water Marks flagged and 123 HWM locations surveyed (as of Sept 22)

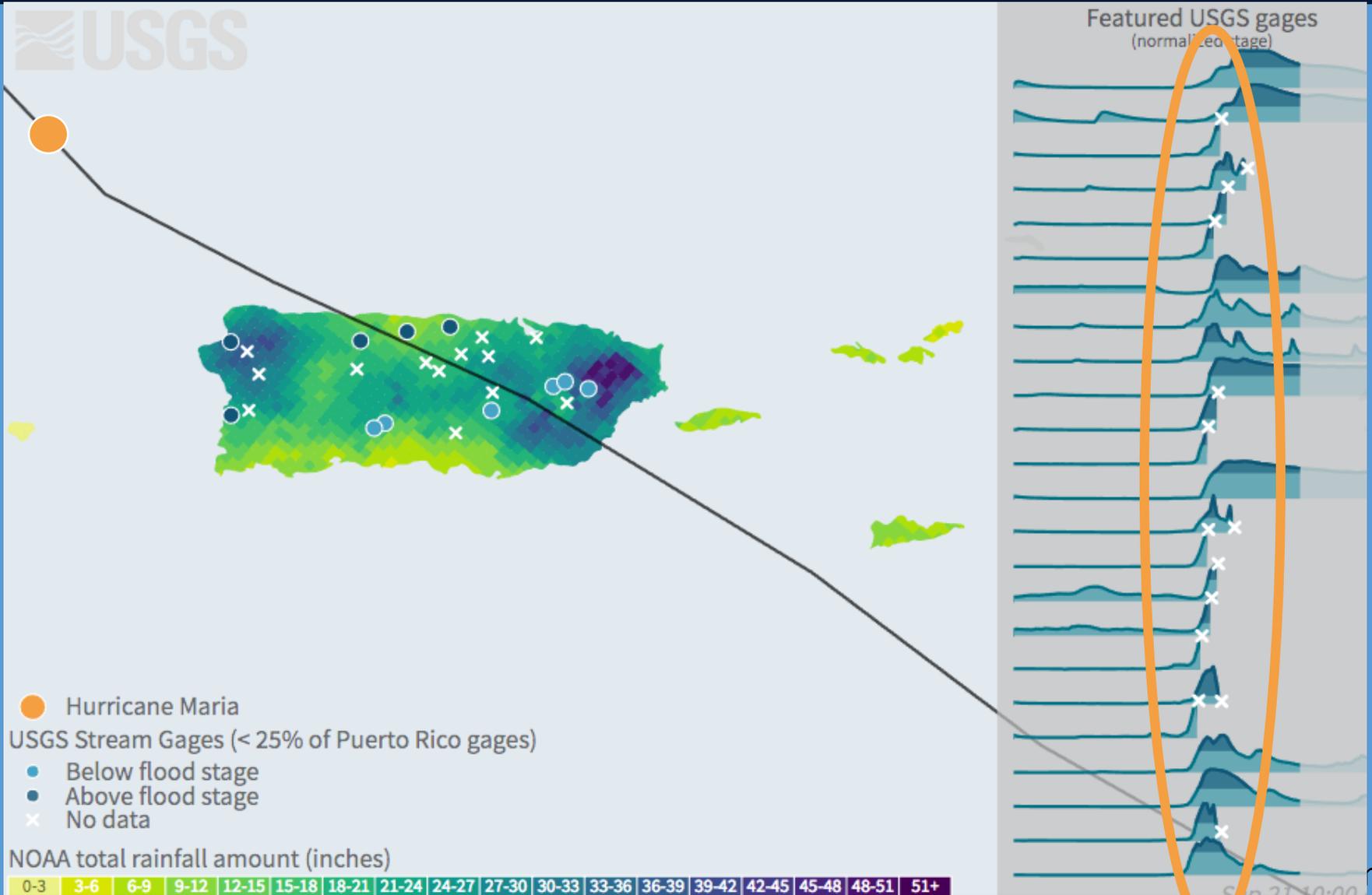
## **Hurricane Maria (Cat 5): Florida – Caribbean Deployment**

- 13 water- or wave-level sensors in Puerto Rico

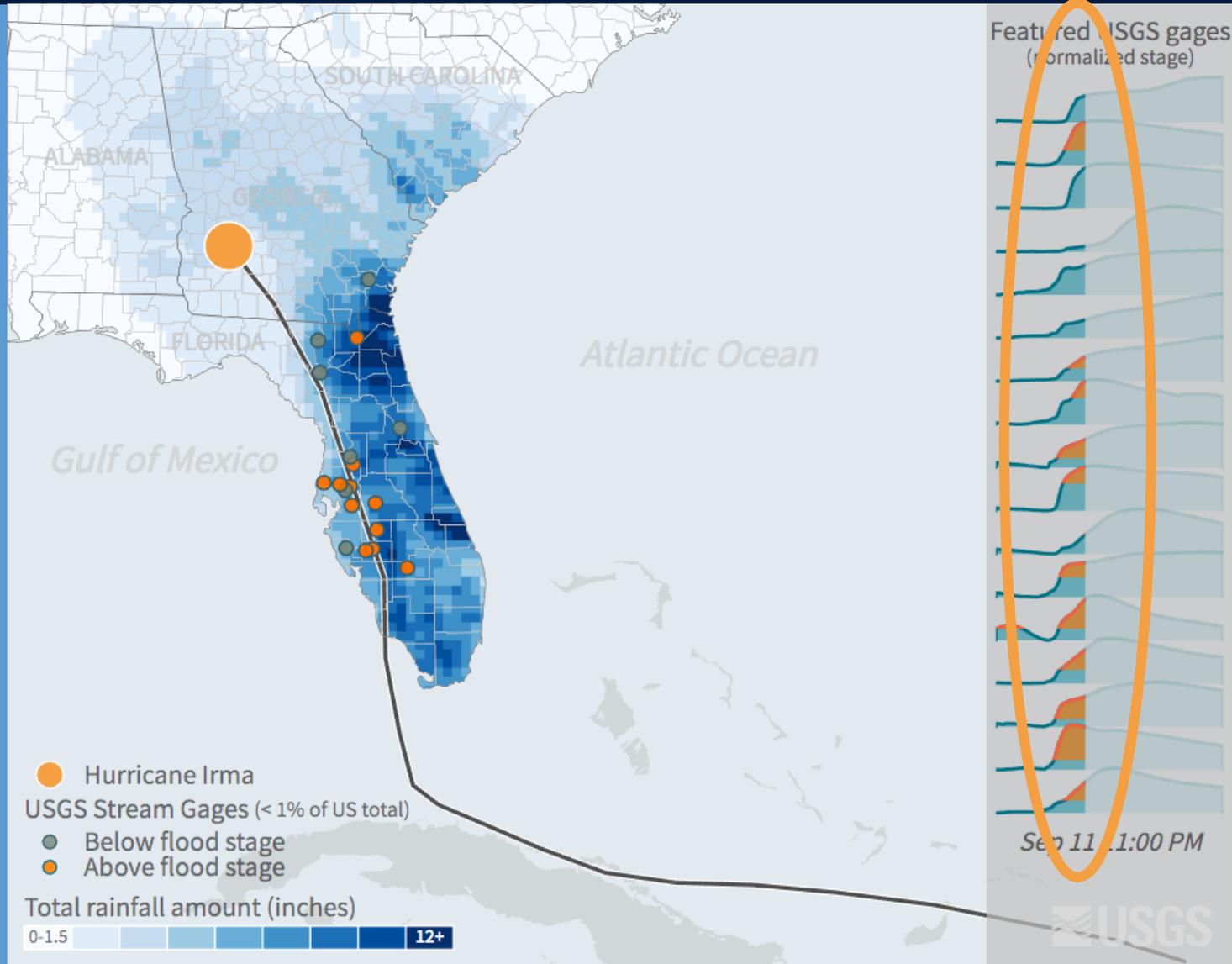
# Hurricane Harvey Deployment



# Hurricane Irma's Water Footprint

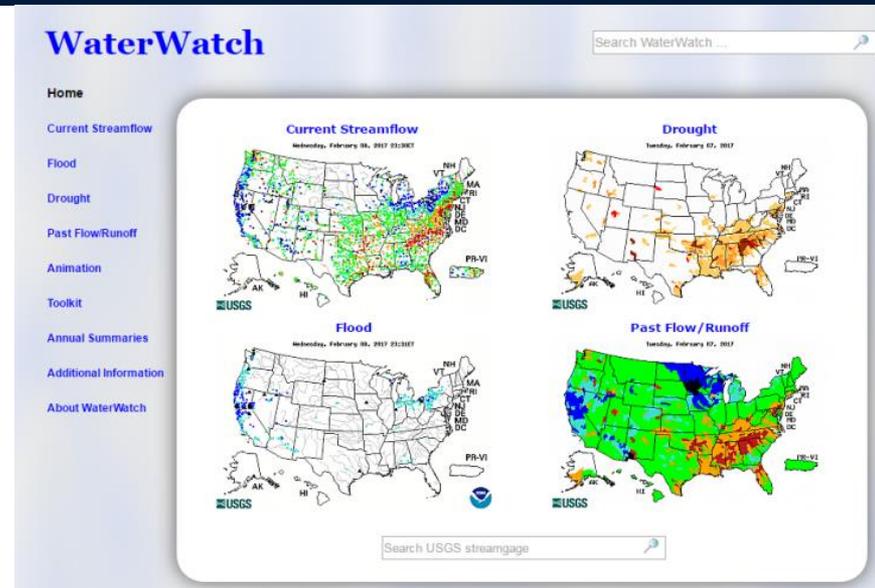


# Hurricane Irma's Water Footprint

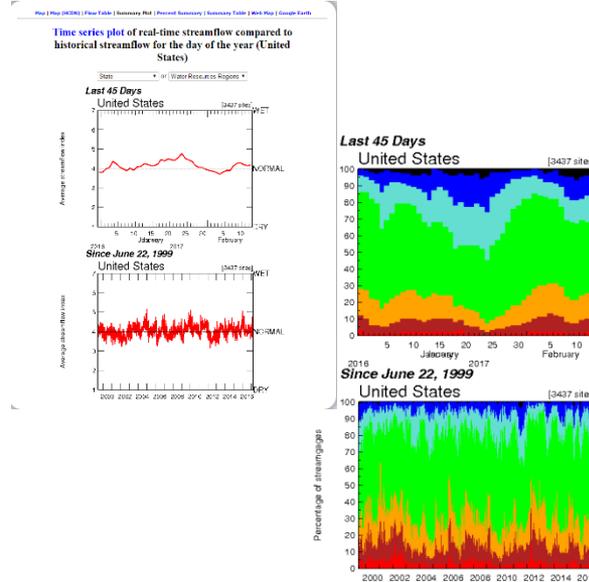
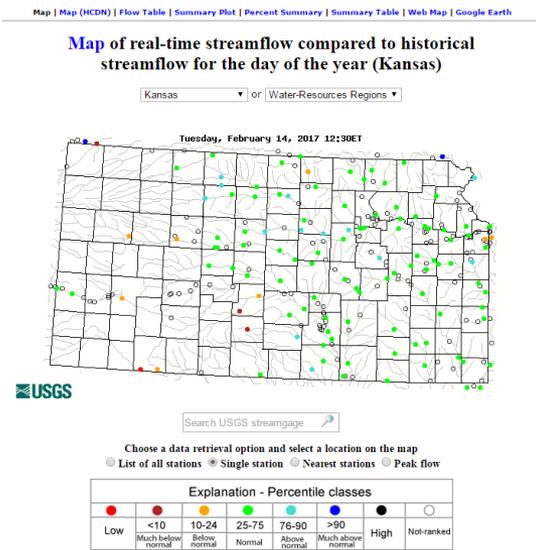


# WaterWatch– Water quantity!

- National site that displays maps, graphs, and tables describing current and historical streamflow
- Has transitioned from maps and graphs to a comprehensive suite of tools
- Features a point-and-click interface to retrieve USGS streamflow data (discharge, stage, precipitation, and water quality) also mobile (add/m/)
- Provides tools to access hydrological drought and flood information, and to analyze hydrological data
- Provides linkages to NWS flood predictions



# Map, Graph and Table



Map | Map (HCDN) | Flow Table | Summary Plot | Percent Summary | Summary Table | Web Map | Google Earth

### Table of real-time streamflow compared to historical streamflow for the day of the year (Kansas)

(How to read this table) (Flip table)

Kansas | Water-Resources Regions

Percentage in class (Driest to wettest)

Date	Time	1	2	3	4	5	6	7	Total stations
20170213	06:45:01	1	2	7	79	11	0	0	106
20170212	06:45:02	1	2	7	79	11	0	0	106
20170211	06:45:02	1	2	6	80	11	0	0	106
20170210	06:45:02	1	3	6	78	12	0	0	101
20170209	06:45:02	1	3	5	79	13	0	0	104
20170208	06:45:02	1	3	5	75	16	0	0	104
20170207	06:45:01	0	3	6	76	15	0	0	104
20170206	06:45:01	0	4	5	72	18	1	0	105
20170205	06:45:02	0	4	5	69	22	1	0	105
20170204	06:45:02	1	2	6	70	22	0	0	105
20170203	06:45:02	1	2	6	68	23	1	0	105
20170202	06:45:02	1	3	5	65	25	2	0	106
20170201	06:45:01	1	2	5	63	25	5	0	104
20170131	12:45:01	1	3	4	62	22	8	0	103
20170130	06:45:02	1	1	4	59	21	14	0	99
20170129	06:45:02	1	1	4	53	24	17	0	99
20170128	06:45:03	1	1	5	45	28	19	0	99
20170127	06:45:02	1	5	40	30	22	0	0	99
20170126	06:45:02	1	1	6	32	38	22	0	104
20170125	06:45:02	1	1	4	27	37	30	0	103
20170124	06:45:02	2	1	5	25	32	36	0	104
20170123	06:45:02	0	2	5	23	34	35	1	98
20170122	06:45:02	1	0	4	28	32	34	2	98
20170121	06:45:03	0	1	5	22	32	39	1	98
20170120	06:45:02	0	2	3	25	28	41	1	96
20170119	06:45:02	0	1	3	18	34	40	3	94
20170118	06:45:01	0	1	4	18	27	41	9	90
20170117	12:45:02	0	0	6	24	21	34	15	85
20170116	17:45:02	0	0	6	35	24	24	10	82
20170115	17:45:02	0	1	7	67	12	11	1	82

...View the complete table

- Streamgages
- HUC shaded
- Static and dynamic maps
- Animations
- Google Earth

- Summary plot
- Various types of hydrographs and charts

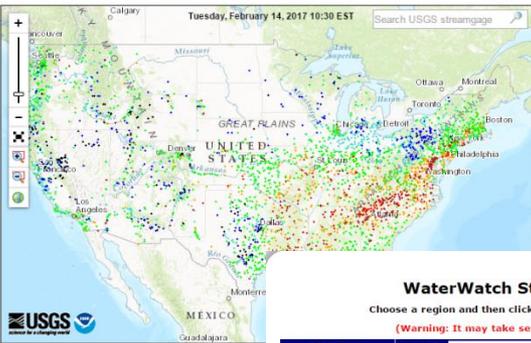
- Recent flows along with historical peak
- Summary for each category
- Flood and high flows

# Dynamic Streamflow Maps

**WaterWatch Streamflow Map**  
Choose a region and then click "GO" to view a regional map  
(Warning: It may take several minutes to process)

Map type Real-Time	Site info: xus	Clear	Multiple regions	Regional map only	GO
Geographic Area	Water Res. Region				

Map of real-time streamflow compared to historical streamflow for the day of the year



Explanation - Percentiles	
Low	<10
	10-24
	25
	More than normal
	Below normal
	No

**WaterWatch Streamflow Map**  
Choose a region and then click "GO" to view a regional map  
(Warning: It may take several minutes to process)

Map type Flood and High Flow	Site info: xus	Clear	Multiple regions	Regional map only	GO
Geographic Area	Water Res. Region				

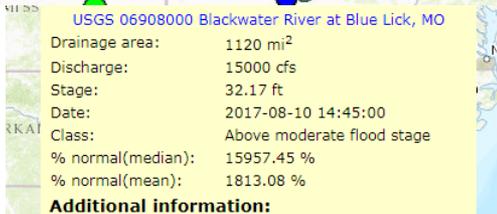
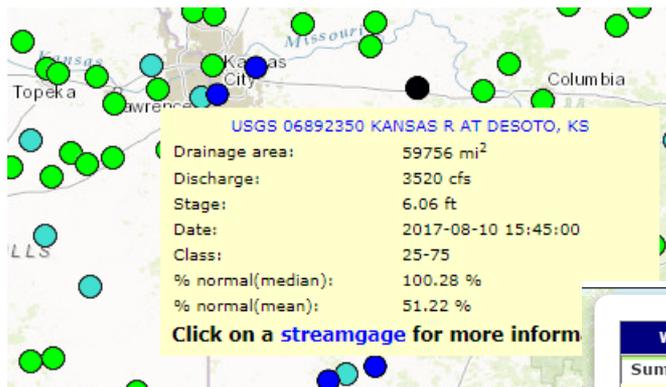
Map of flood and high flow conditions



Explanation - Percentile classes					
<95	95-98	>= 99	Above action stage	Above flood stage	Above moderate flood stage
					Above major flood stage
▲ Streamgage with flood stage    ○ Streamgage without flood stage					

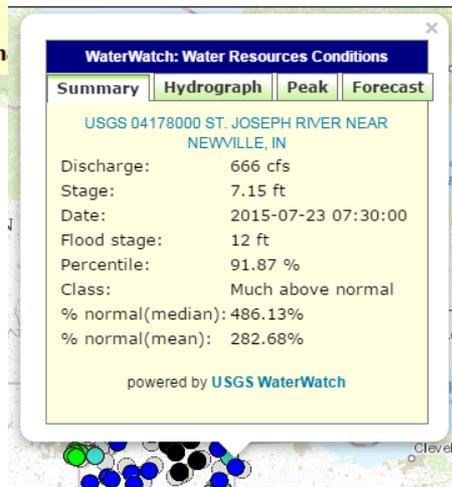
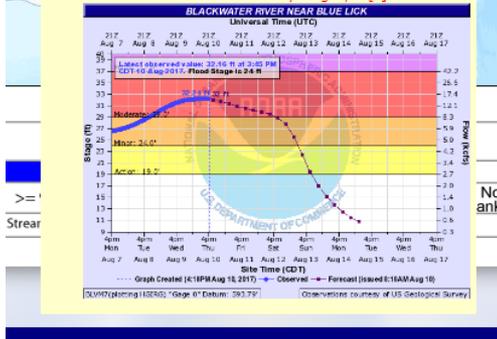
- Access all WaterWatch maps in one place
- Provide dynamic functions such as zooming, panning, zoom box, and full-screen
- Show one or more regions (state and HUC2) or neighboring regions
- Search USGS streamgages
- Seamless maps for real-time, flood, and hourly flow change

# Flow Summary and Hydrographs



#### Additional information:

- Click on a **station** for more summary information
- Go to **USGS** or **AHPS** for streamflow data or river forecast
- [View AHPS River Forecast Hydrograph \[-\]](#)



- Hover over a site to view flow summary
- Click on a site to open tabbed-popup showing summary and hydrographs, and linking to NWISWeb and AHPS (NWIS- USGS National Water Information System); AHPS- Advanced Hydrologic Prediction Service – National Weather Service)
- View flow summary and AHPS river forecast on a flood map by hovering

# Flow Summary and Hydrographs

WaterWatch: Water Resources Conditions

Summary Hydrograph Peak Forecast Rating

USGS 06892350 KANSAS R AT DESOTO, KS

Drainage area:	59756 mi <sup>2</sup>
Discharge:	1060 cfs
Stage:	4.50 ft
Date:	2014-08-25 15:45:00
Flood stage:	26 ft
Percentile:	8.09 %
Class symbol:	<span style="color:red">●</span>
% normal (median):	30.42 %
% normal (mean):	17.66 %
Water temperature:	22.0 °C
	2014-06-09 23:45:00
Specific conductance:	529 µS/cm
	2014-06-09 23:45:00

WaterWatch: Water Resources Conditions

Summary Hydrograph Peak Forecast Rating

Additional Information:

- WaterAlert email and text message alerts
- Subscribe WaterAlert for this site

Tabbed-popup showing summary and hydrographs, and linking to NWISWeb and AHPS

WaterWatch: Water Resources Conditions

Summary Hydrograph Peak Forecast Rating

Additional Information:

- Discharge-based version of this graph
- USGS Peak Streamflow
- Subscribe WaterAlert for this site

WaterWatch: Water Resources Conditions

Summary Hydrograph Peak Forecast Rating

Additional Information:

- Explanation
- Shift-adjusted rating table

WaterWatch: Water Resources Conditions

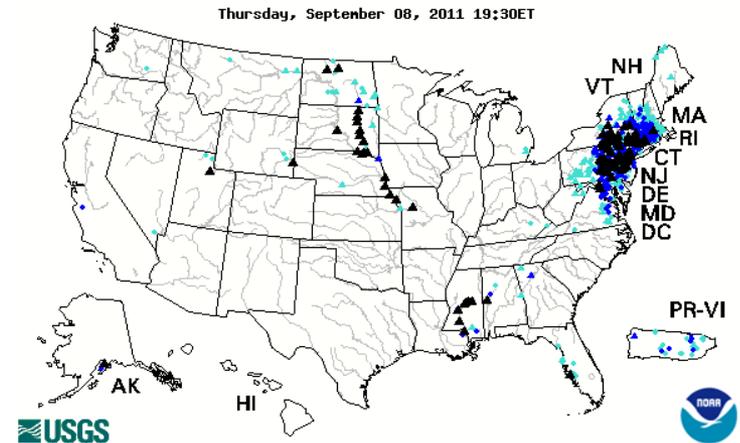
Summary Hydrograph Peak Forecast Rating

Additional Information:

- Explanation
- Shift-adjusted rating table

# Flood Watch

- Map showing flood and high-flow locations
- Table listing locations of flooding sites and monthly flood report
- Tool summarizing recent flood and high-flow conditions by comparison to flood stages, ranking, and recurrence intervals
- Graph comparing recent high flow conditions with historical peaks and flood stages.





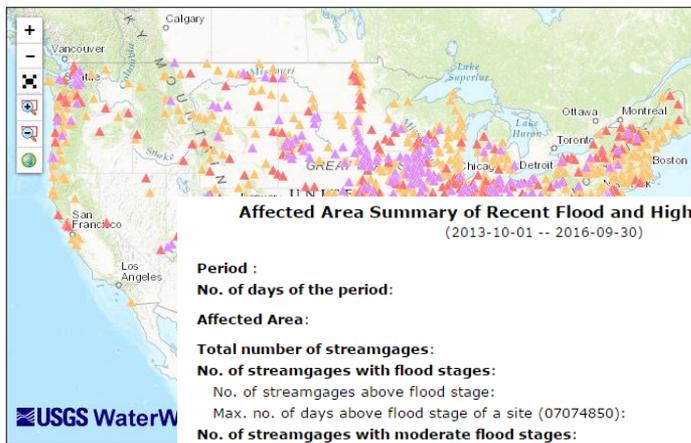
# Flood Table Builder

## Retrieve Summary of Recent Flood and High Flow Conditions

(Warning: These Data are Provisional and May be Prone to Error.)

(Note: Begin Date cannot precede 2006-10-01)

Geographic area:	Water Res. Region:	Refresh
SW (lat,lng): us	NE (lat,lng): us	Box chooser
GO		
Begin Date: 2013-10-01	End Date: 2016-09-30	Output: Map
Flood: Minor	Peak Rank:	No. of years: 20 yr
		Rec. Interval:
Rank 1: <input type="checkbox"/>	Marker size: 10 px	Classify type:
Sort: USGS station number		asc



Affected Area Summary of Recent Flood and High Flow Conditions  
(2013-10-01 -- 2016-09-30)

<b>Period :</b>	2013-10-01 -- 2016-09-30
<b>No. of days of the period:</b>	1096
<b>Affected Area:</b>	SW: 23,-127 NE: 51,-68
<b>Total number of streamgages:</b>	2247
<b>No. of streamgages with flood stages:</b>	2247
No. of streamgages above flood stage:	2247
Max. no. of days above flood stage of a site (07074850):	438
<b>No. of streamgages with moderate flood stages:</b>	2089
No. of streamgages above moderate flood stage:	1173
Max. no. of days above moderate flood stage of a site (08067000):	196
<b>No. of streamgages with major flood stages:</b>	2058
No. of streamgages above major flood stage:	502
Max. no. of days above major flood stage of a site (06181000):	97
<b>No. of streamgages with highest peaks:</b>	189
No. of streamgages with more than 30 year record:	74
No. of streamgages with 20-29 year record:	14
No. of streamgages with less than 20 year record:	101
<b>No. of streamgages with flood frequency information:</b>	1469
No. of streamgages with recurrence interval of 25-50 years:	114
No. of streamgages with recurrence interval of 50-100 years:	48
No. of streamgages with recurrence interval of >100 years:	100

### Explanation

- ▲ USGS streamgages abc
- ▲ USGS streamgages abc
- ▲ USGS streamgages abc
- ▲ USGS streamgages wit
- USGS streamgages wit

References to non-U.S. Department viewing the Leaflet Maps API on th

- Analyze high flow by a region for a period.
- List flood and high flow summary in a table
- Rank flow with historical annual peaks
- Show locations where flood and high flow occur
- Provide regional summary
- Provide annual exceedance probability

# Flood Table Builder (cont.)

## Retrieve Summary of Recent Flood and High Flow Conditions

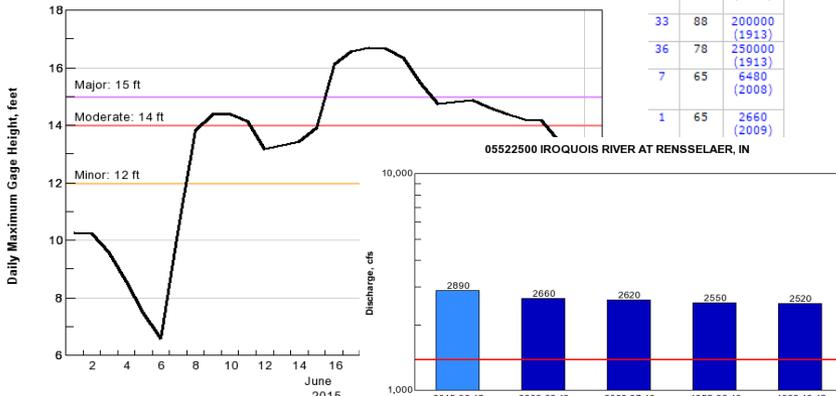
(Warning: These Data are Provisional and May be Prone to Error.)  
(Note: Begin Date cannot precede 2006-10-01)

Geographic area	Water Res. Region	SW (lat,lng):	Box Chooser	Refresh
Indiana		NE (lat,lng):		GO
Begin Date	End Date	Output	<input checked="" type="checkbox"/> Flooding	Sort by: No. of days above flood stage
2015-06-01	2015-07-01	Table	<input checked="" type="checkbox"/> Rank 1	Sort order: <input checked="" type="radio"/> ascend <input type="radio"/> descend

### Summary of Recent Flood and High Flow Conditions

(2015-06-01 -- 2015-07-01)  
[ "...", no data; "<", less than all historical peaks ]

USGS station number	USGS station name	Drain. area [mi <sup>2</sup> ]	NWS flood stage [ft]	No. of days flood above stage	NWS flood stage class	Highest peak from 2015-06-01 to 2015-07-01				Historical Peaks				
						Date	Stage [ft]	Stream flow [ft <sup>3</sup> /s]	Recur. interval [years]	AEP	Rank	No. of years	Max. (year) [ft <sup>3</sup> /s]	
05518000	KANKAKEE RIVER AT SHELBY, IN	1779.00	9	31	▲	2015-06-16	12.9	6040	10-25	4-10	8	91	7650 (1982)	
03335500	WABASH RIVER AT LAFAYETTE, IN	7267.00	11	28	▲	2015-06-19	23.51	69500 (2015)	--	--	19	110	190000 (1913)	
USGS 05522500 IROQUOIS RIVER AT RENSSELAER, IN														
												34	90	230000 (1913)
												33	88	200000 (1913)
												36	78	250000 (1913)
												7	65	6480 (2008)
												1	65	2660 (2009)



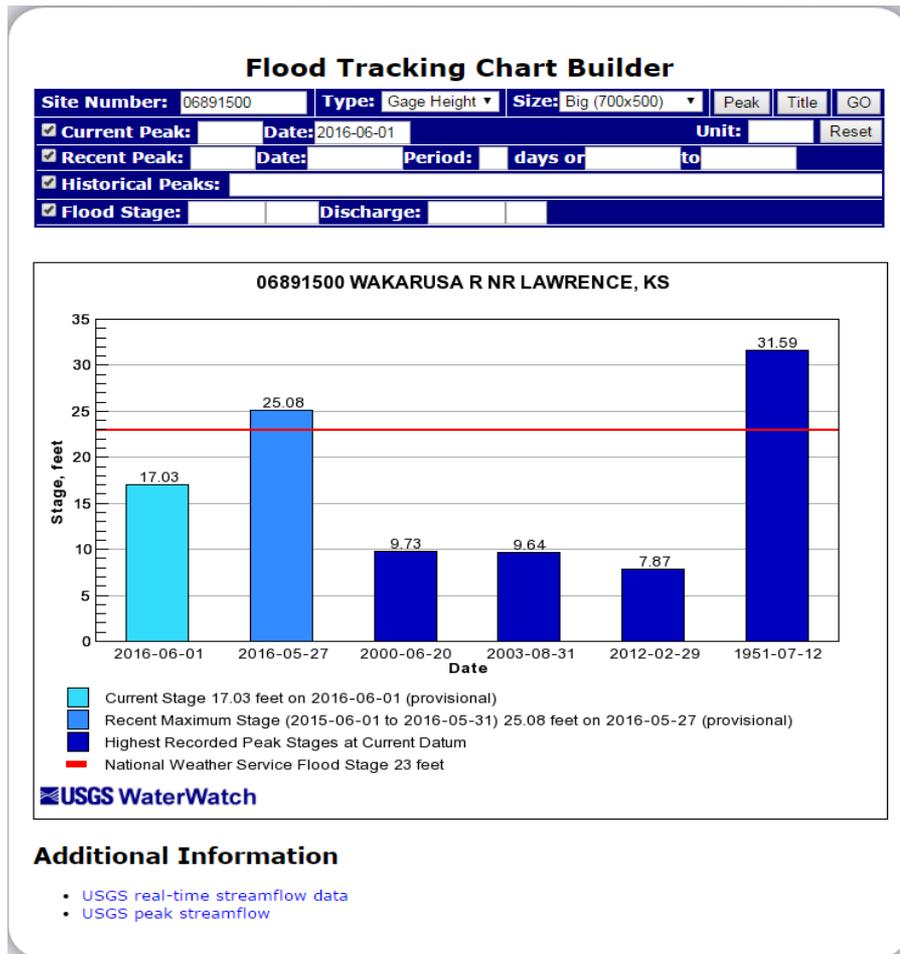
USGS WaterWatch

Maximum Discharge (2015-06-01 to 2015-07-01) 2890 cfs on 2015-06-18 (provisional)  
Highest Recorded Peak Discharges  
Estimated Discharge 1400 cfs from NWS Flood Stage of 12 feet and USGS Rating Curve

USGS WaterWatch

- Highlight flooding or 'record-high' sites
- Link to NWISWeb for more data (flow and peak)
- Plot flows along with flood stages
- Compare with historical peaks with a flood tracking chart
- Share your results using a URL

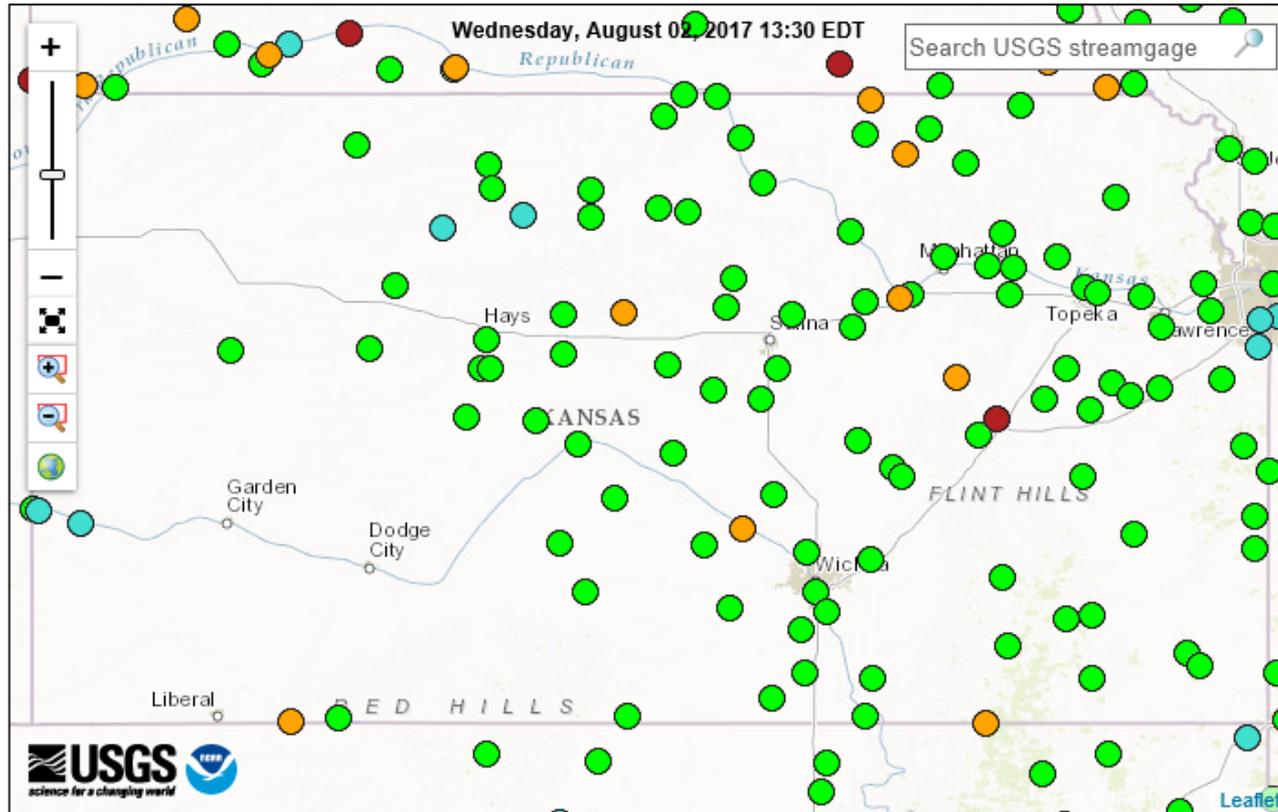
# Flood Tracking Chart



- Chart for all USGS streamgages.
- Easy to select a site from a map.
- Customize chart by applying user specified dates and peak values.
- Customize title and explanation.

# Kansas Streamgaging: A collaboration since 1895 with KWA/KWO (30+ cooperative funding agencies)

Map of real-time streamflow compared to historical streamflow for the day of the year



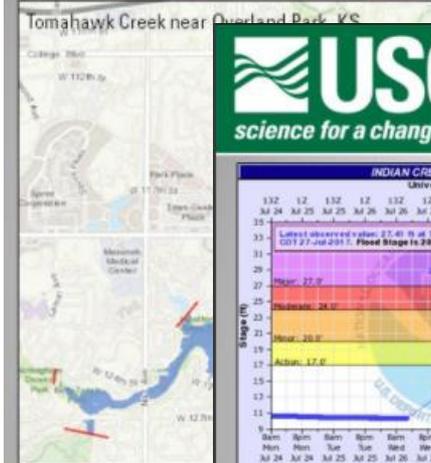
Explanation - Percentile classes

Low	<10	10-24	25-75	76-90	>90	High	Not-ranked
	Much below normal	Below normal	Normal	Above normal	Much above normal		

# Indian Creek flooding on 7/27/17 @USGS\_KS



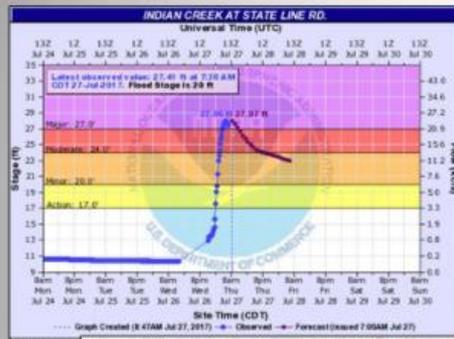
## KC Flooding July 27, 2017



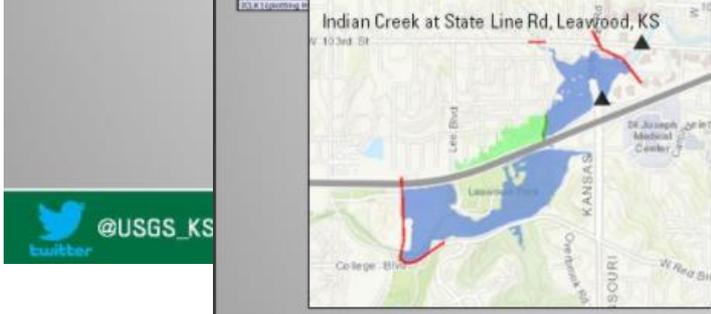
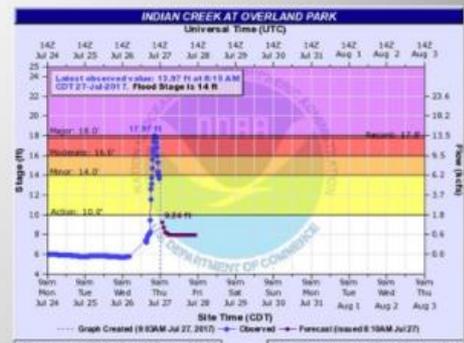
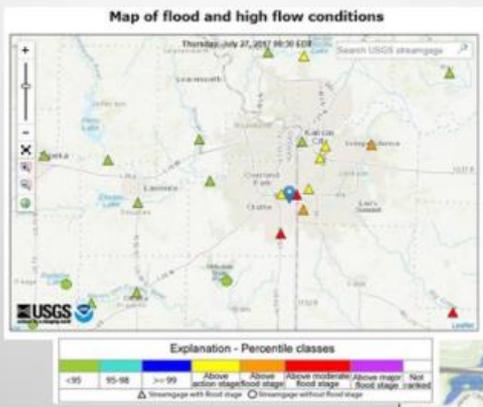
Indian Creek at State Line Rd, Leawood, KS



## KC Flooding Forecast July 27, 2017



For information on flood stages and forecasts at each gage, visit <https://waterwatch.usgs.gov>



@USGS\_KS

@USGS\_KS

<https://water.weather.gov/ahps/>

July 27, 2017



# USGS Flood Inundation Mapping Project

Floods are the leading cause of natural-disaster losses in the United States. More than 75 percent of declared Federal disasters are related to floods, and annual flood losses average almost \$8 billion with over 90 fatalities per year. The USGS Flood Inundation Mapping Project helps communities protect lives and property by providing tools and information to help them understand their local flood risks and make cost-effective mitigation decisions.

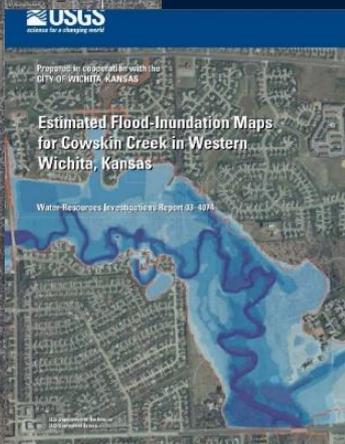
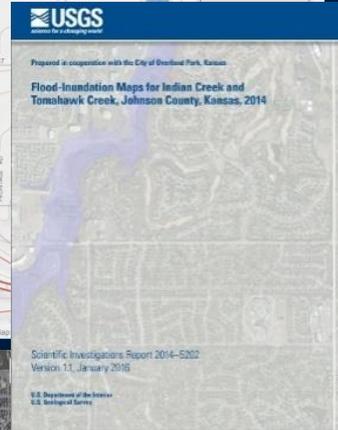
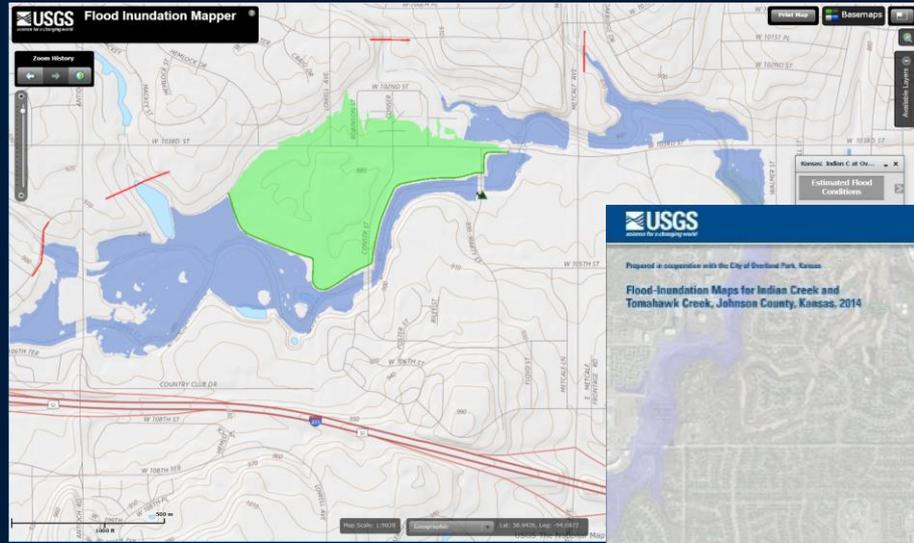
# Flood Inundation Mapping

Completed maps for:

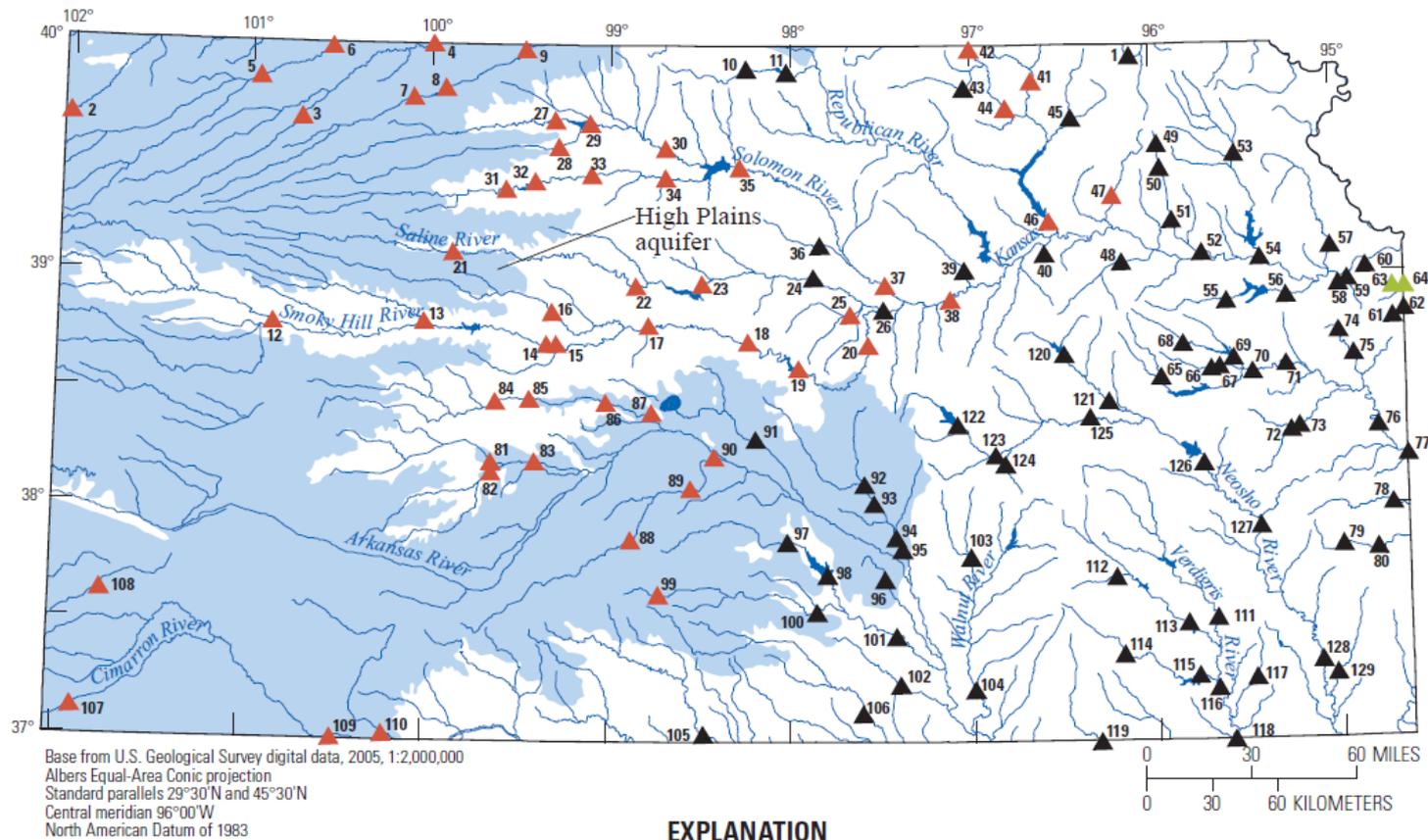
- Johnson County, KS
- Blue River
- Indian Creek
- Tomahawk Creek
- <https://wimcloud.usgs.gov/apps/FIM/FloodInundationMapper.html>

Wichita, KS

- Cowskin Creek
- <https://ks.water.usgs.gov/cowskin-creek>



# Streamflow Alteration (hi flows down in west; up in urban areas)



**Figure 26.** Condition of the average magnitude of flow pulses greater than the 90th percentile metric for 129 streamgages in Kansas.

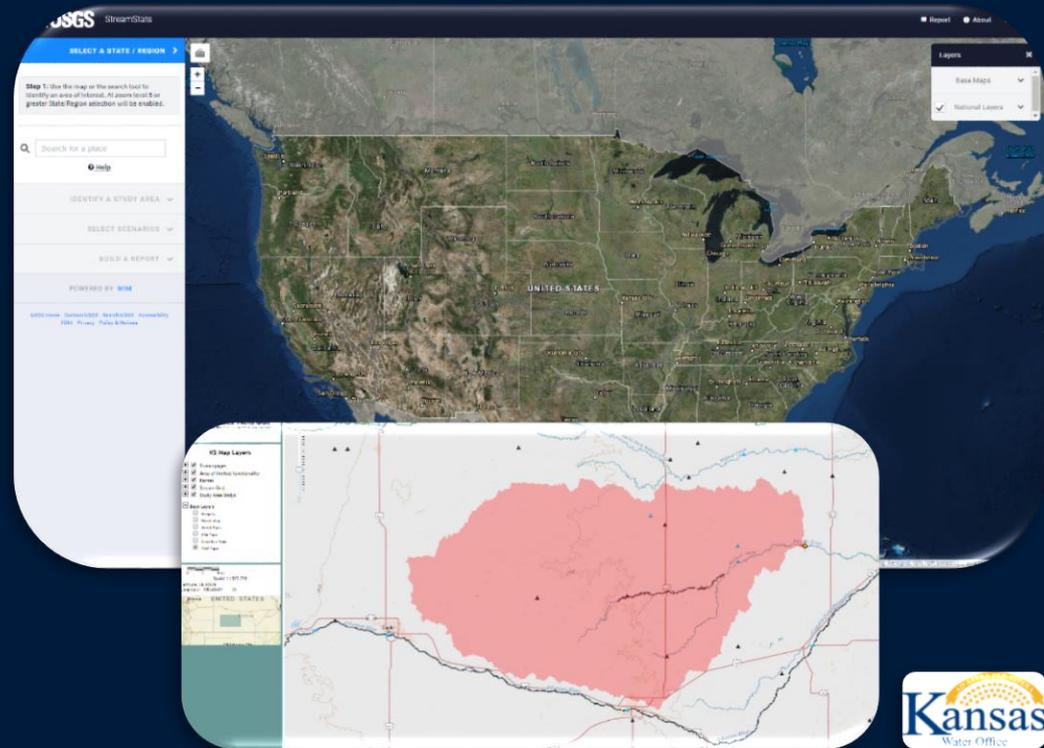
# Questions?

- Check out Presentations, Posters, and USGS Booth!!
- Follow us on Twitter: @USGS\_KS (Real-time water information!)
- Visit our website: <https://ks.water.usgs.gov/>
- For more info– give me or any Kansas USGS employee a call or email!  
Andy Ziegler, (785) 832-3539, [aziegler@usgs.gov](mailto:aziegler@usgs.gov)

end

# FLOOD FREQUENCY CONVERSION TO USGS NATIONAL STREAMSTATS IN 2017

- Used for delineating watersheds and calculating predefined basin characteristics
- Basin characteristics are useful in performing flow statistic calculations for ungaged locations (eg. peak flow recurrence intervals)



<https://streamstats.usgs.gov/ss/>

# Science that Saves:

## Observing, Understanding, Predicting and Delivering Flood Information

**Don Cline**  
*Associate Director for Water Resources  
U.S. Geological Survey*

