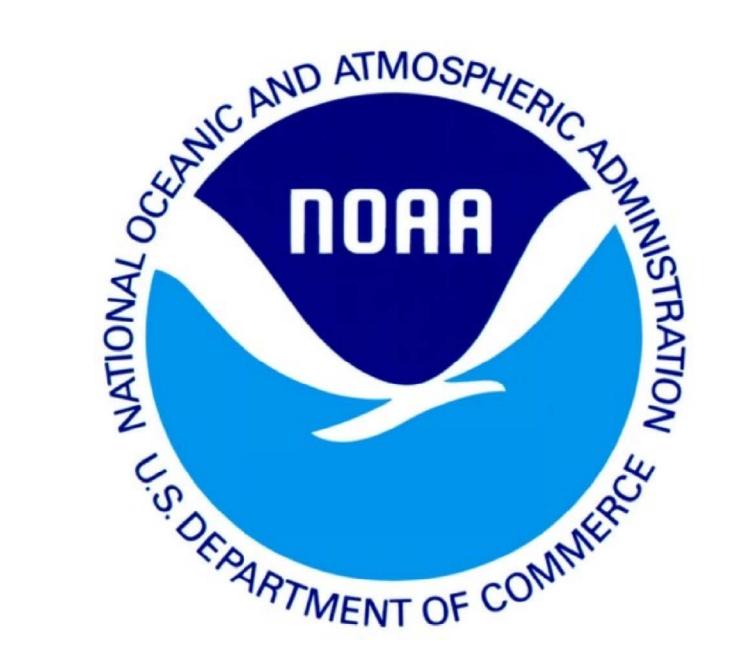




CATALOGING ALL AVAILABLE STORM SURGE MEASUREMENTS FOR THE STATE OF NORTH CAROLINA: THE NATIONAL STORM SURGE DATABASE





Katie McDowell* and Rob Young, Program for the Study of Developed Shorelines, Western Carolina University, Cullowhee, NC 28723, kmcdowell@wcu.edu

PROJECT DESCRIPTION

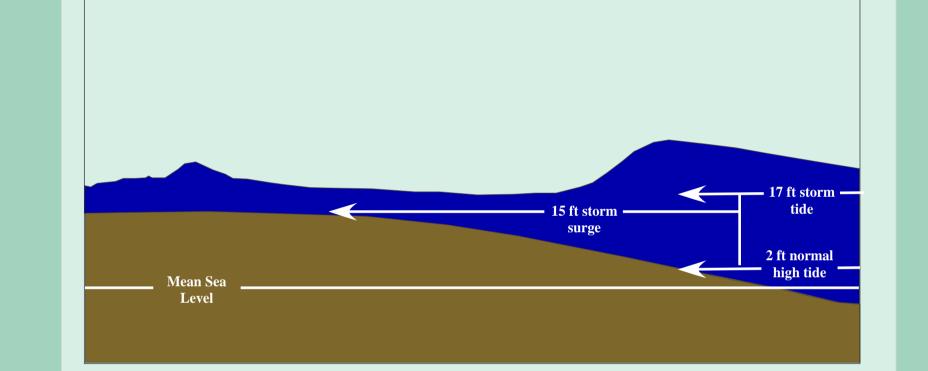
The Program for the Study of Developed Shorelines (PSDS) at Western Carolina University (WCU) is using relational tools and geographic information systems (GIS) to build a national storm surge database, beginning with a North Carolina prototype. This project will provide one central location for coastal scientists and engineers to access storm surge and high water mark data (HWM).

This queriable database is being built in Microsoft Access and ArcGIS at WCU, but will ultimately be maintained and archived at NOAA's National Climatic Data Center (NCDC). Storm surge data are being obtained from multiple sources including federal agencies, state agencies, academic studies, and the private sector.

SIGNIFICANCE

During a hurricane, storm surge is often the greatest factor contributing to loss of life and property along the coast. Therefore, predicting the height of storm surge for an approaching storm is vital for coastal communities.

Predicting a value for storm surge has proven to be extremely difficult, due to the numerous factors that can contribute to the overall rise in water level. One setback for these predictions is the lack of one central location to access past storm surge measurements. Prior to this project, most water level data has been stored within storm specific reports and documents.



What is Storm Surge?

Storm Surge is an abnormal rise of water generated by a storm, over and above the predicted astronomical tides; storm surge is produced by water being pushed toward the shore by the force of the winds moving cyclonically around the storm.

-NOAA National Hurricane Center

DATABASE FIELDS

Numerous different types of measurements are part of the database, including hurricane tracks, characteristics and water level data.

Much of the hurricane track and characteristic data was imported directly from NOAA's IBTrACS (International Best Track Archive for Climate Stewardship) Database. Several of the characteristics were calculated internally using existing data in combination with ArcGIS

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| Reference Tables | * | + | 793 | Isabel HW | 'M | 3 | 3.5 | | NAVD | 35.328611 | -75.508056 | Dare | 0 | NC | Avon ESP Associates | О | 0 2003 |
| Linked Photograph Tables | * | + | 794 | Isabel HW | 'M | 7 | 5.0 | | NAVD | 35.288889 | -75.515556 | Dare | 0 | NC | Avon ESP Associates | О | 0 2003 |
| HurricanePhotos | | + | 795 | Isabel HW | 'M | 3 | 4.2 | | NAVD | 35.344167 | -75.504167 | Dare | 0 | NC | Avon ESP Associates | 0 | 0 2003 |
| ■ WaterMarkPhotos | | + | 796 | Isabel HW | 'M | 7 | 12.8 | | NAVD | 36.034167 | -75.668333 | Dare | 0 | NC | Kill Devil Hills ESP Associates | 0 | 0 2003 |
| IBTrACS | * | + | 797 | Isabel HW | 'M | 7 | 16.2 | | NAVD | 36.046667 | -75.676667 | Dare | 0 | NC | Kill Devil Hills ESP Associates | О | 0 2003 |
| qry_Updating TrackPoints | * | + | 798 | Isabel HW | 'M | 7 | 9.0 | | NAVD | 36.057222 | -75.686111 | Dare | 0 | NC | Kitty Hawk ESP Associates | О | 0 2003 |
| qry_InProgress | * | + | 799 | Isabel HW | 'M | 3 | 2.3 | | NAVD | 35.908611 | -75.668889 | Dare | 0 | NC | Manteo ESP Associates | О | 0 2003 |
| qry_Max/Min/LF | * | + | 800 | Isabel HW | 'M | 3 | 1.9 | | NAVD | 35.919722 | -75.660556 | Dare | 0 | NC | Manteo ESP Associates | 0 | 0 2003 |
| qry_UpdatingHurricaneLF | * | + | 801 | Isabel HW | M | 7 | 12.3 | | NAVD | 35.867222 | -75.573056 | Dare | 0 | NC | Nags Head ESP Associates | О | 0 2003 |
| qry_CalcTrackStraight | * | + | 802 | Isabel HW | M | 7 | 3.0 | | NAVD | 35.700000 | -75.742222 | Dare | 0 | NC | Stumpy Point ESP Associates | О | 0 2003 |
| qry_CalcTrackSpeed | * | + | 803 | Isabel HW | M | 7 | 4.2 | | NAVD | 35.690000 | -75.736667 | Dare | 0 | NC | Stumpy Point ESP Associates | О | 0 2003 |
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| qry_SEGSA Fun Facts | × | + | 805 | Isabel HW | 'M | 7 | 5.1 | | NAVD | 35.073611 | -77.148611 | Craven | 0 | NC | River Bend ESP Associates | 0 | 0 2003 |
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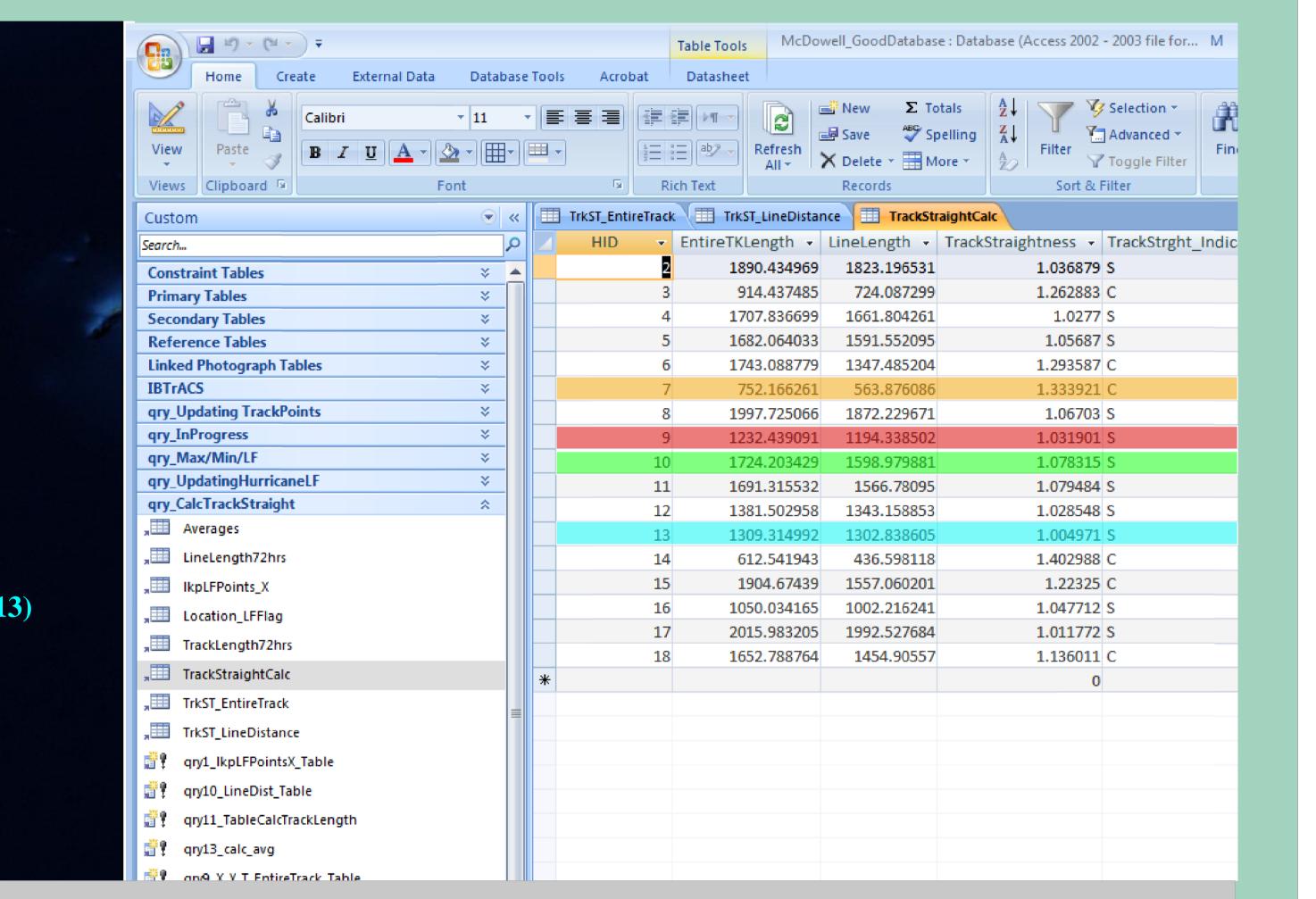
Water Level Characteristics

- Measurement Type (storm surge, HWM, storm tide)
- Elevation of Water Level
- Latitude/Longitude
- Collector
- Reported Quality
- Vertical Datum County/State

Reference

Hurricane Landfall Characteristics

- State/City
- Time
- Winds
- Pressure
- Diameter
- Imported directly from IBTrACS
- database
- Track Speed • Storm Impact Angle
- Track Straightness Nearshore Slope
- Calculated by PSDS using data from IBTrACS and ArcGIS



Above: Track straightness calculation performed internally at PSDS using data from IBTrACS. Track straightness was determined for the 72 hours prior to landfall using hurricane track points in ArcGIS and Access. The thicker bold lines represent the actual 72 hour tracks and the thinner lines represent the straight line distance between the first and last point. The number in parentheses after each hurricane name correlates to the HID in the access database (above right).

Possible Database Uses

- Understanding the factors that lead to higher storm surge
- More accurate storm surge prediction
- Storm surge model verification and calibration
- Locating surge data gaps
- Understanding the role of barrier islands/wetlands as storm buffers



Above: All of the water mark data points for the North Carolina storm surge prototype. Many of the 1300+ marks overlap at this scale.

Far Left: Example query for all the measurements over 10 feet in elevation on Wrightsville Beach, NC. The white numbers represent the actual measurement elevation (ft).

NCData

Elev (ft)

0.6 - 3.0

3.1 - 6.0

6.1 - 9.0

Left: Example query for the storm tracks and water mark measurements for two hurricanes, Isabel (2003) and Fran (1996).

NC DATABASE FUN FACTS

Hazel (1954) Brunswick 18

Top ten HWM measurements:

| Brunswick | 17.6 |
|-------------|--|
| Brunswick | 16 |
| Brunswick | 16 |
| Dare | 16.2 |
| New Hanover | 15.4 |
| New Hanover | 15.3 |
| New Hanover | 15.2 |
| New Hanover | 15.1 |
| | Brunswick Brunswick Dare New Hanover New Hanover New Hanover |

*Hurricane Name (year), County, Mark Elevation (ft)

Largest storm diameter *Isabel (2003) :* 400 nmile *since 2000

Lowest pressure: *Gloria (1985)* : 920 mb *Isabel (2003)*: 915 mb

**Fun Facts are based on 16 hurricanes from 1954-2008

Hurricane with the straightest track (72 hrs prior to landfall) Isabel (2003)

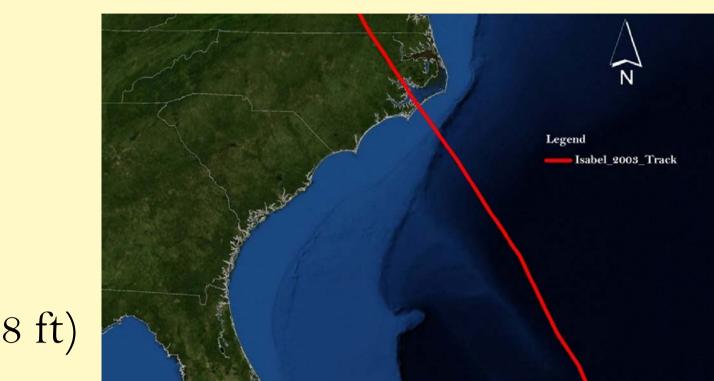
Most Dangerous NC Counties

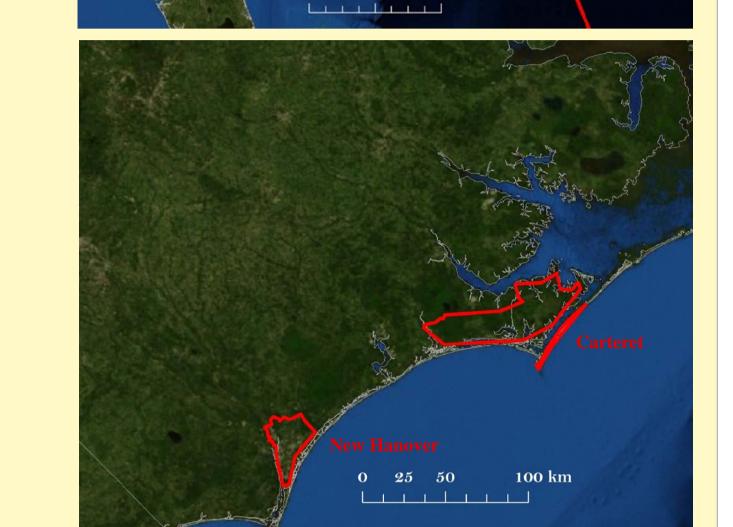
Counties most frequently hit by high storm surge (>8 ft) New Hanover: 5/16 hurricanes

Hurricanes with fastest/slowest approach speed (12 hrs prior to landfall) *Hazel (1954)* : 49 km/hr *Diana (1984)* : 8 km/hr

Highest wind speed Donna (1960): 140 knots/160 mph Isabel (2003): 145 knots/167 mph *10-min sustained gusts

Hurricane with the most perpendicular angle of landfall Isabel (2003): 87°





Top: Hurricane Isabel (2003) storm track. Isabel had both the straightes 72 hour storm track as well the mos perpendicular angle of landfall

Below: Most dangerous counties (most frequently experiencing storm surge >8 ft) in NC, Carteret and New

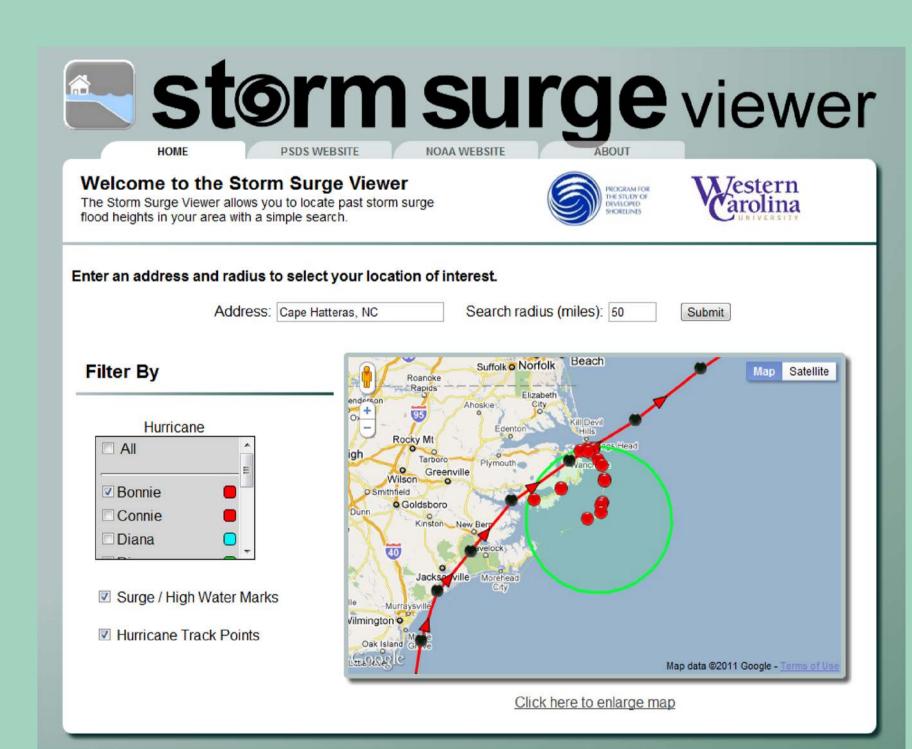
CURRENT & FUTURE WORK

Additional data

The database has recently been updated to include the states of South Carolina and Florida. This brings the number of hurricanes in the database to 26, with over 1700 water marks.

storm surge viewer

One of the most important features utilizing the database is the user-interactive web site, the storm surge viewer. This site uses a Google Maps interface to search, filter and view storm surge and hurricane path data using a simple location

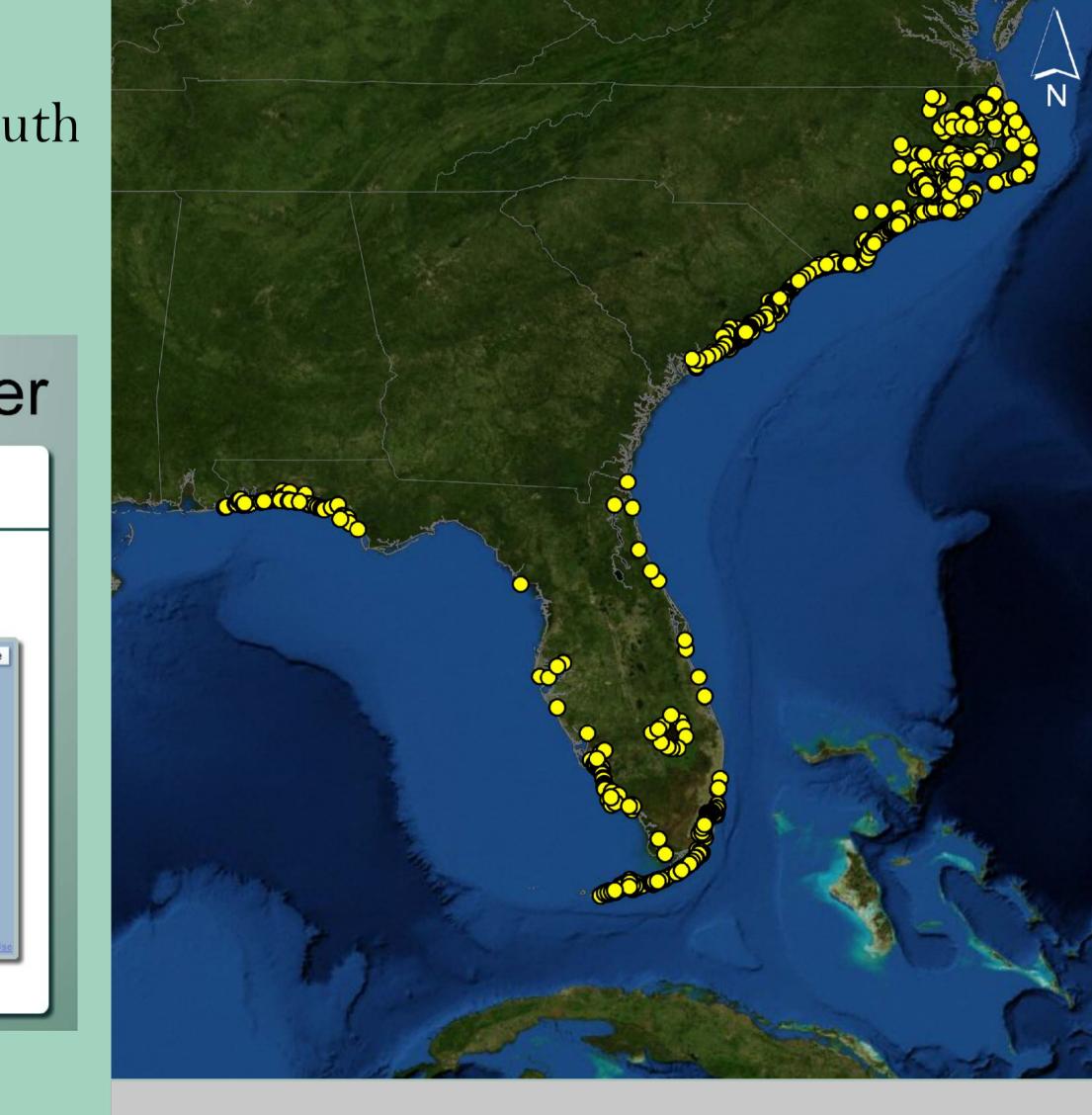


Hertford
Hurricane Name: Bonnie
Meas. Elevation: 5.2 ft
Meas. Type: HWM
County: Dare
Hurricane Year: 1998

Click here to enlarge map

The example above shows a search for Cape Hatteras, NC, and a radius of 50 miles. All data found within that radius can be viewed by hurricane name. One, multiple, or all of the hurricanes with pertinent data can be viewed simultaneously. In this case, Hurricane Bonnie (1998) was selected and the results for surge/high water marks and hurricane track points are displayed.

Each surge/high water mark data point has metadata that can be viewed by clicking on the icon. The example to the right shows a HWM from Bonnie (1998) in Dare County, with an elevation of 5.2 ft.



Above: All 1700+ water mark and storm surge measurements currently in the database.

ACKNOWLEDGMENTS

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