
Comments on High Water Marks of the Congaree River

15 February 2001

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High Water Mark Information:

1. Carolina-Eastman:

Carolina-Eastman maintained high water mark information on a facility drawing from April 1964 to October 1976. The information is summarized in Table 1 below.

Table 1 - Carolina-Eastman High Water Mark Information									
Date	Flow Rate @ Gage 2169500	Location Number							
		1	2	3	4	5	6	7	8
09/27/67 ¹	14100	125.5	125.5	124.8	122.6	122.6	122.4	122.4	122.6
01/22/69	30600	118.9	118.6	118.3	117.6	117.5	117.3	117.3	NA
06/14/68 ²	48000	122.1	122.1	121.6	120.0	119.7	119.8	119.6	119.5
05/17/71	49000	NA	NA	122.0	NA	119.4	118.8	NA	120.3
01/11/72	57000	NA	NA	122.5	NA	120.5	119.7	NA	121.3
06/23/72	58100	NA	NA	123.6	NA	121.1	120.3	NA	121.6
03/19/73	58100	NA	NA	123.7	NA	NA	NA	NA	NA
12/17/72	58300	NA	NA	123.5	NA	NA	NA	NA	NA
01/17/68	58700	123.5	123.2	122.4	120.7	120.4	120.6	120.4	120.6
03/05/71	76000	124.8	121.9	123.8	120.4	121.8	122.2	122.7	NA
02/04/73	78900	NA	NA	124.8	NA	NA	NA	NA	NA
04/03/73	88400	NA	124.9	124.5	122.5	122.4	122.0	122.0	NA
04/20/69	89400	124.8	124.8	124.5	122.4	122.3	121.1	120.8	121.1
03/17/75	120000	126.1	126.0	126.5	123.6	123.6	123.2	123.2	123.1
04/10/64	126000	126.0	NA	NA	122.0	121.5	NA	121.1	NA
10/11/76	150000	127.6	127.0	NA	124.7	124.5	NA	124.4	124.2

See Figure 2-Locations of High Water Marks at Carolina-Eastman for measurement point locations. The following table extracts just the 1976 flood information for the Carolina-Eastman Facility:

¹ USGS records indicate peak flow occurred on 13 September 1967.

² USGS records indicate peak flow occurred on 10 June 1968.

Table 2 - Carolina-Eastman Information for the 1976 Flood								
C-E Location Number	1	2	3 ³	4	5	6	7	8
River Station (ft)	217770	215700	212950	207550	207000	203600	203300	202800
High Water Elevation (ft)	127.6	127.0	-	124.7	124.5	-	124.4	124.2
Interpolated Value (ft)	-	-	126.2	-	-	124.4	-	-

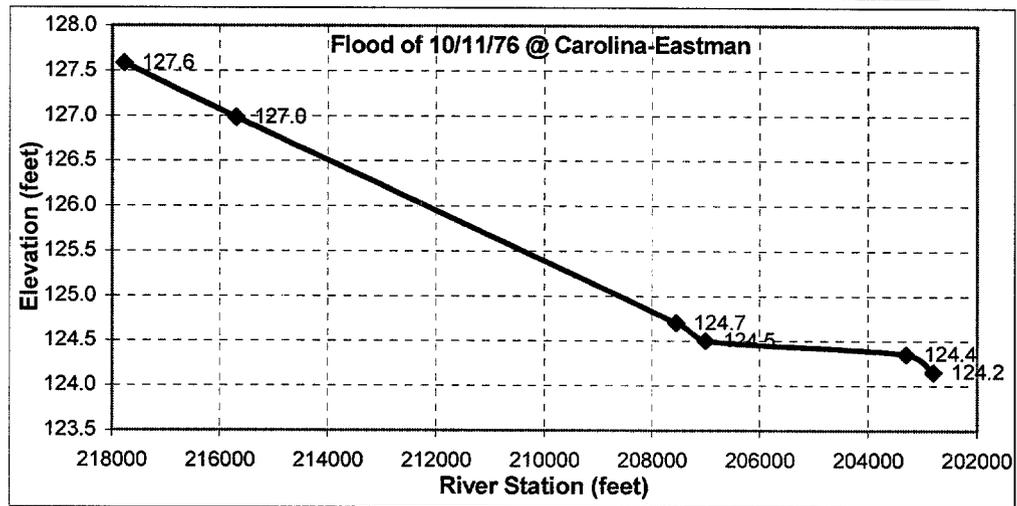


Figure 1- Carolina-Eastman 1976 Flood High Water Marks

During the 1976 flood information was not collected for Carolina-Eastman locations number 3 and 6. A notable point is that location 3 equals the downstream limit of the HEC-2 study (station 212950). The information along the site appears to be consistent based on the profile in Figure 1, so it is reasonable to interpolate the values for locations 3 and 6. The result of interpolation indicates that the HEC-2 starting water surface elevation is 126.2. See Figure 2 for a map of Carolina-Eastman with a portion of high water marks indicated.

³ Equals the end of the HEC-2 study = Station 212950, but no reading was taken for the 1976 flood.

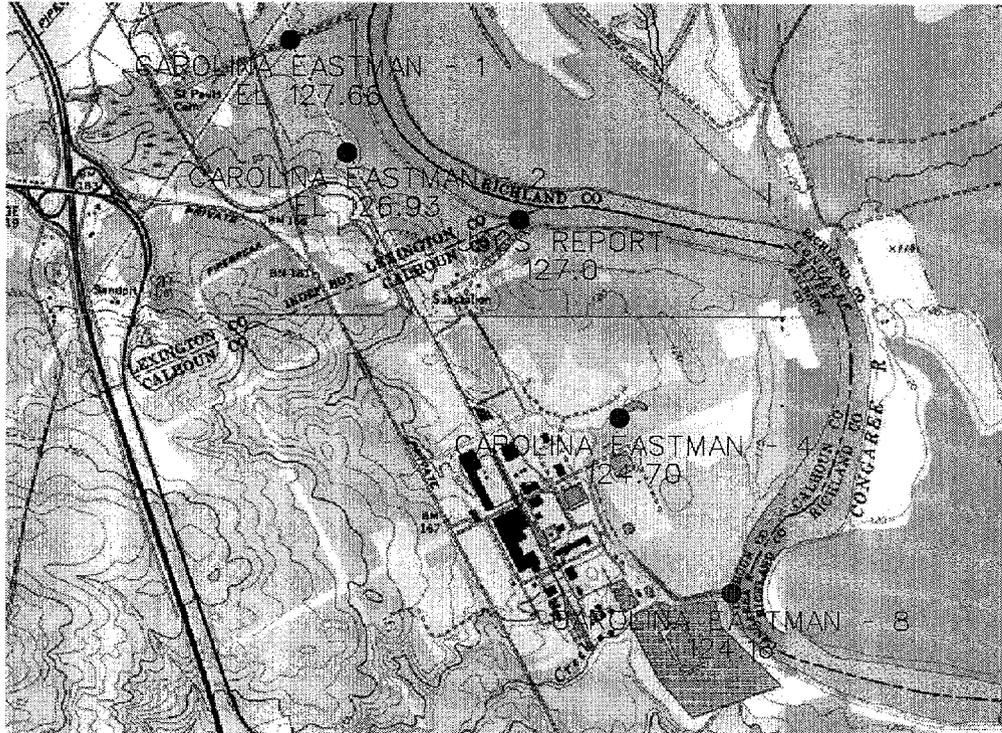


Figure 2-Locations of High Water Marks at Carolina-Eastman

2. FEMA Report:

The FEMA report titled "Appeal Resolution for Congaree River in Richland and Lexington Counties, South Carolina" indicates that the following information was used for model calibration concerning the 1976 flood.

Table 3 - FEMA Used High Water Marks

Location No.	Location	HEC-2 Cross Section	Observed Elevation ft. NGVD	
			High	Low
8	Columbia gage 2169500	266750	142.72	142.72
1	River Bluff Estates- right channel bank	254500	139.6	138.0
2	Cayce Wastewater treatment plant-	246700	135.4	135.4

Table 3 - FEMA Used High Water Marks

Location No.	Location	HEC-2 Cross Section	Observed Elevation ft. NGVD	
			High	Low
	right channel bank			
3	Old State Road bridge. Congaree Creek-right over bank	245800	133.4	133.2
4	Left Channel bank where I-77 crosses now	242440	134.2	134.0
5	Old State Road-right over bank.	241500	130.6	130.5
6	Old state road - right over bank	239370	130.8	130.2
7	Power line -right over bank	215700/226700	129.7	129.7
9	Lexington County line - down stream study limit	212950	127.0	127.0

Note that the FEMA location 7 corresponds to HEC-2 station 215700. These high water mark locations based on FEMA's description were placed on the USGS 7.5 minute quadrangle map and overlaid with the HEC-2 cross sections. The quadrangle map indicates that location 7 was incorrectly labeled as station 215700 and should have been station 226700. Note Figure 3-Profile of High Water Marks where a sudden drop occurs between stations 215700 and 212950 that indicates that an error has occurred in high water mark placement. Also note the undulation in the profile between stations 246700 and 239370. High water marks at stations 245800, 241500, and 239370 occur along Old State Road and occur greater than 1000' away from the Congaree River. The HEC-2 model doesn't account for changing water surface elevation along a wide floodplain cross section, therefore the high water marks in FEMA locations 3, 5 & 6 are not valid for HEC-2 calibration. These high water marks are valid for the RMA-2 model (2-D).

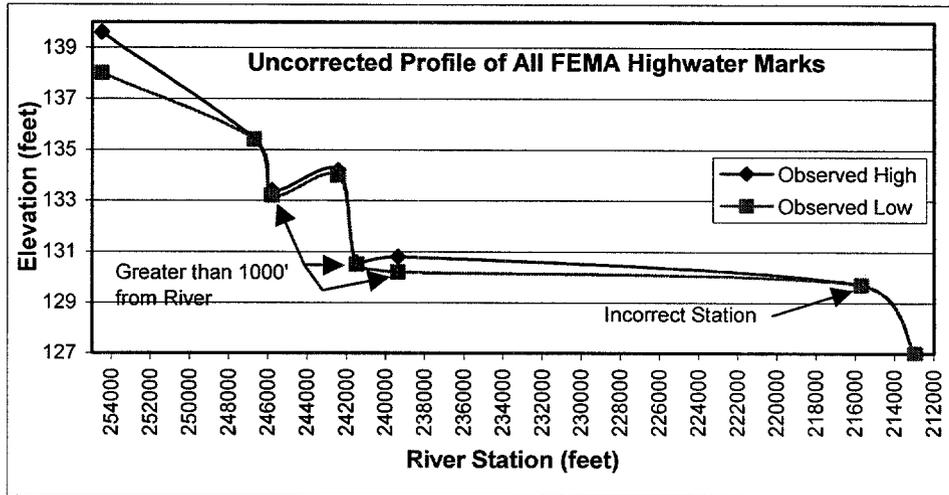


Figure 3-Profile of High Water Marks

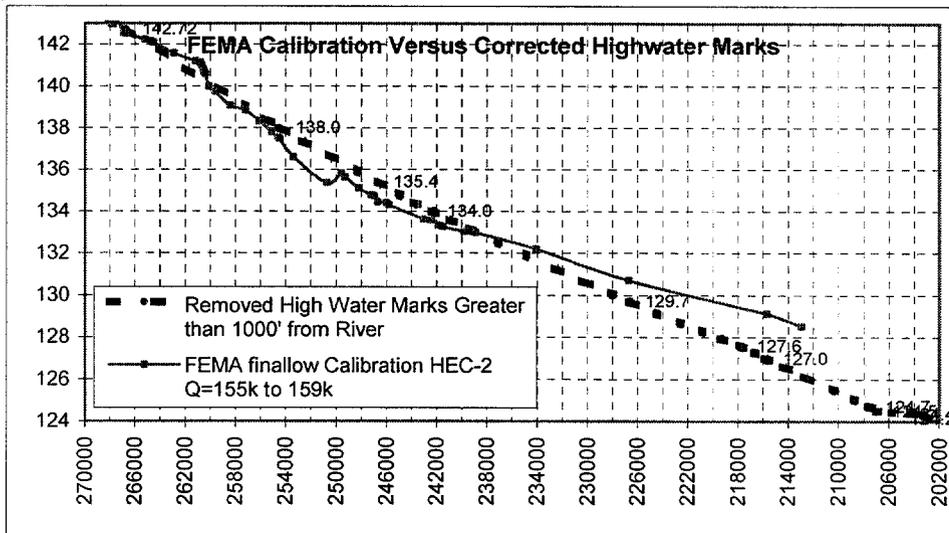


Figure 4 - FEMA Calibration Finallow Versus Corrected High Water Marks on 1976 Flood

Note that the FEMA HEC-2 model calibrates fairly well in the upper reach, but the HEC-2 calculated flood elevation is over stated south of Gills Creek (lower reach). The difference at the end of the HEC-2 study limit (Station

212950) is 128.5 minus 126.2 equals 2.3 feet (above high water marks). The HEC-2 model with the levee in calibrates to high water marks. On the other hand FEMA's HEC-2 calibration model finalhgh.dat (levee-out) under estimates every high water mark along the Congaree River (except the starting water surface elevation).

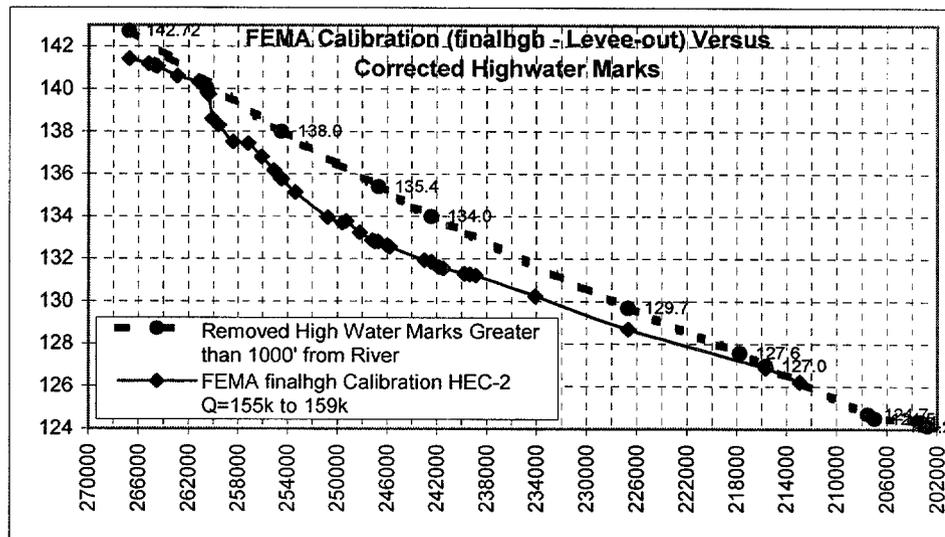


Figure 5 - FEMA Calibration Finalhgh Versus Corrected High Water Marks on 1976 Flood
 In other words the HEC-2 file that takes the levee out does not match high water marks and is there not calibrated. The use of a calibration HEC-2 model that removes the levee is not valid. Removal of the levee from a calibration model violates FEMA 37-5.A. (page 5-1) that requires:

Models should match known high water marks within 0.5 foot. The SC should not calibrate to data that results in roughness coefficients out of the realm of observed data.

FEMA justifies using a non-calibrate model on page 24 of the Appeal Resolution document by stating that the levee is overtopped at flows equal

to 200,000 cfs, but FEMA did not provide any HEC-2 file documentation. Based on FEMA's latest published Base Flood Elevation for Lexington County there was *no* place where the levee was overtopped along the Congaree River. FEMA's overtopping justification is not valid.

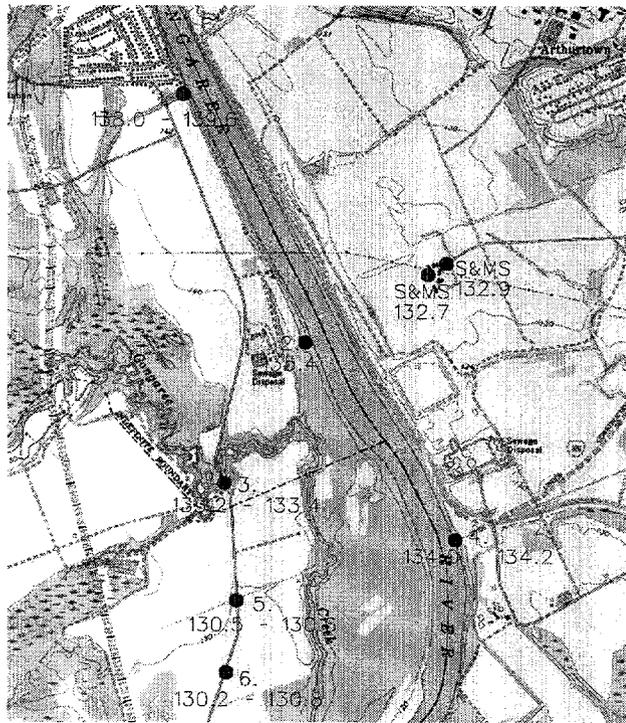


Figure 6 - Location of High Water Marks

3. Heathwood Hall:

Photos taken of the 1976 flood were obtained from Mr. Burwell Manning indicating high water marks at Heathwood Hall School. Figure 7 - 1976 Photograph of High Water Mark at Entrance Sign was taken at the main entrance sign and indicates a high water mark elevation of 132.9'. Figure 9 - 1976 Photograph of High Water Mark on Building indicates a high water mark elevation of 132.7'.

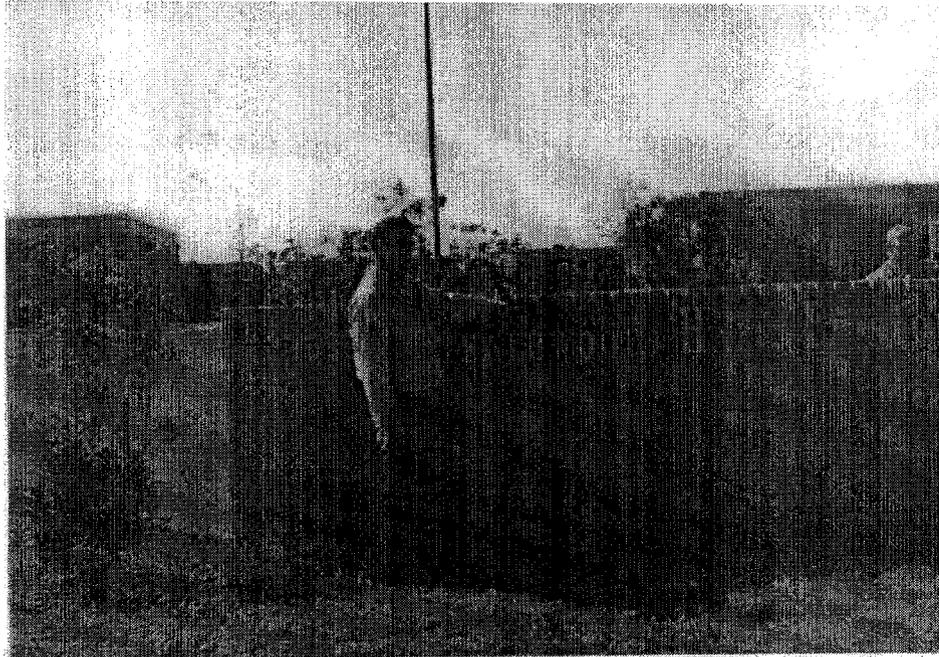


Figure 7 - 1976 Photograph of High Water Mark at Entrance Sign

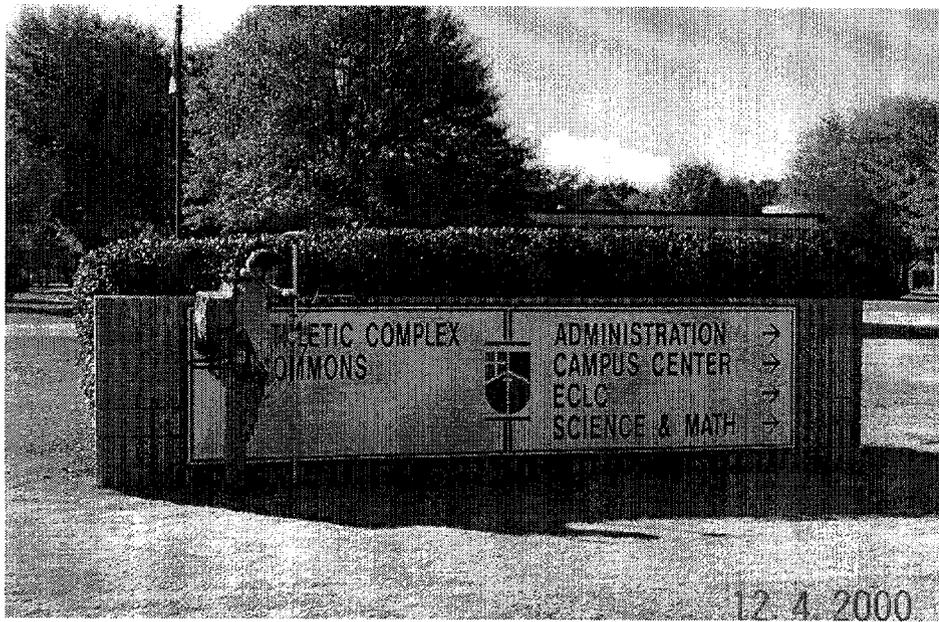


Figure 8 - December 2000 Photograph of Survey Indicating Elevation 132.9'

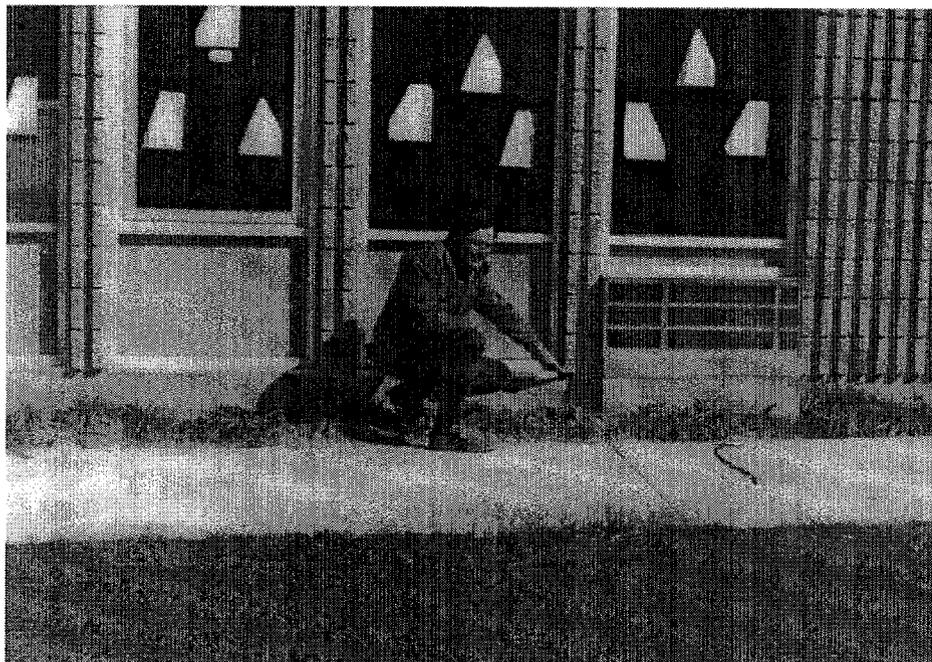


Figure 9 - 1976 Photograph of High Water Mark on Building

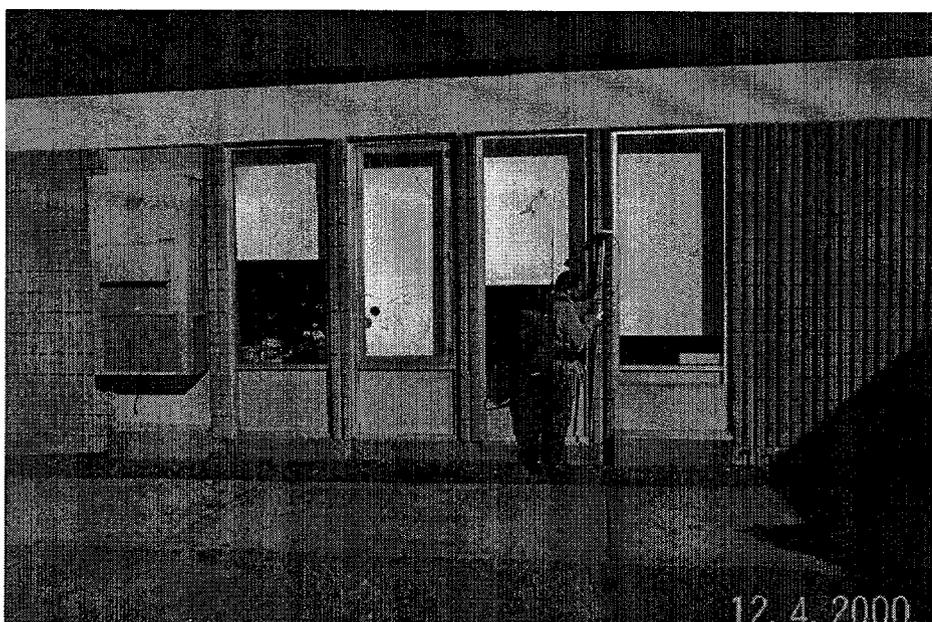


Figure 10 - December 2000 Photograph of Survey Indicating Elevation 132.7'

The high water marks at Heathwood Hall School varied from 132.7 to 132.9. The FEMA high water mark location 2 at the Lexington County Wastewater Treatment Plant was 135.4. Note that these are located at almost the same exact river station. If the levee were missing, then these high water mark elevations would have been nearly identical from one side of the river to the other.

Table 4 – Heathwood Hall School and Lexington Co. Wastewater Treatment Plant High Water Mark Elevation Comparison	
Location	Elevation (feet)
Lexington WWT – FEMA location 2	135.4
Heathwood Hall School	132.7
Difference	2.7

Even though the levee was breached during the 1976 flood the levee influenced flood elevations. A head difference of 2.7 feet occurred across the levee. This is consistent with FEMA’s RMA-2 model, but not consistent with FEMA’s Richland County HEC-2 model.

Conclusion:

1. Carolina-Eastman:

- A high water mark was not read at Carolina-Eastman location 3 for the 1976 flood.
- Carolina-Eastman high water marks appear to be consistent/reasonable.
- Interpolation between high water marks is reasonable to obtain an estimated water surface elevation of 126.2 for the end of the HEC-2 study (Carolina-Eastman location 3).

2. FEMA Report:

- Correct FEMA high water mark location 7 from station 215700 to 226700.
- High water marks in FEMA locations 3, 5 & 6 are not valid for HEC-2 calibration since they are greater than 1000' from the river.
- The corrected high water mark profile appears to be more reasonable than the FEMA undulating profile.
- FEMA's calibration model overstates the flood elevation by 2.3 feet at the end of the HEC-2 study.

3. Heathwood Hall:

- Recently surveyed high water marks indicate an elevation of 132.7 to 132.9 at Heathwood Hall School.
- When comparing 1976 high water marks of the Lexington WWT Facility of 135.4 to the Richland County Heathwood Hall School of 132.7 to 132.9 a 2.7' head differential occurred across the levee breach.