

**Technical Report**  
**Flooding in the Great Bay Area, South St. Elizabeth in**  
**Association with Hurricane Emily, July 15 – 16, 2005**



**Water Resources Authority**  
**Hope Gardens**  
**PO BOX 91**  
**Kingston 7**

## INTRODUCTION

### Background

Rainfall associated with Hurricane Emily, which passed the island of Jamaica on July 15 and 16, 2005 caused severe damage to properties and infrastructure in St. Elizabeth including major roads. The stations at Fullerswood and Mountainside received more than 300 % of the normal rainfall for the month of July. This report focuses on the Rockfield-Great Bay-Treasure Beach area and flooding along sections of the Great Pedro Pond (Map 1). The pond is located at the southern end of the Pedro Plains in the Parish of St. Elizabeth northwest of Great Bay and east of Treasure Beach. A number of houses had to

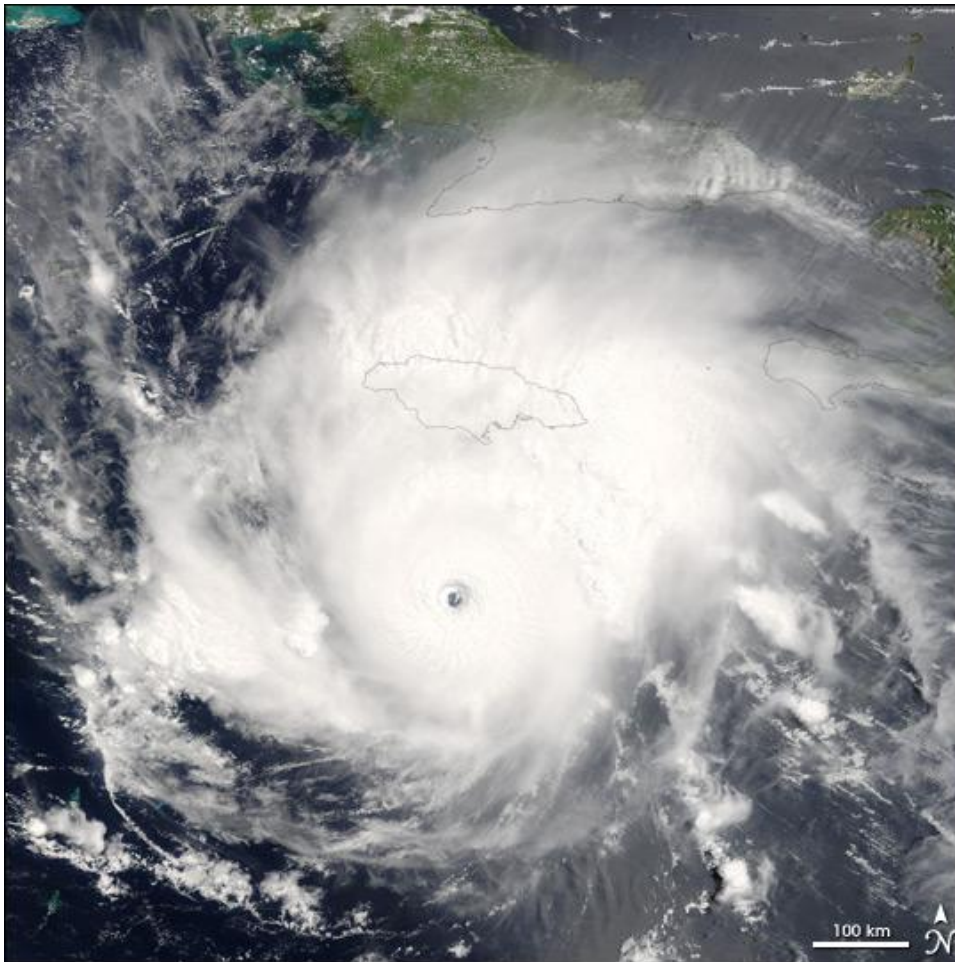


be evacuated as floodwaters entered living areas and caused damage.

Emily is a record-setting storm for many reasons. When it formed on July 11, Emily became the earliest fifth named storm on record. As it moved through the Caribbean, Emily intensified into a powerful Category 4 storm with winds over 250 km/hr (150 mph) and gusts as high as 300 km/hr (184 mph), making it the most powerful storm to form before August. The previous record was set by Hurricane Dennis, which ripped through the Caribbean during the first week of July 2005. Emily's Category 4 status also made 2005 the only year on record to produce two Category 4 storms before the end of July.

Emily is responsible for five deaths through the Caribbean, as well as considerable damage in places as far apart as the Lesser Antilles Islands and Jamaica to Mexico's Yucatan Peninsula. (source: [www. Earthobservatory.nasa.org](http://www.Earthobservatory.nasa.org)) The hurricane's eye was closest to the island of Jamaica at 4 pm on the 16<sup>th</sup> of August when it was about 90-100 miles or 140-150 kilometres southwest of Luana Point in south southwestern St. Elizabeth with highest sustained winds at near 250 kilometres per hour (Figure 1). (source: MetService)

Figure 1: Hurricane Emily's Closest Position to Jamaica (source: [www.earthobservatory.nasa.com](http://www.earthobservatory.nasa.com))



## Objective

The objectives of this report are to:

- 1) Determine the cause of flooding in the Great Bay – Treasure Beach area
- 2) Analyze the magnitude of the rainfall event to determine its frequency of occurrence
- 3) Provide recommendations with the aim to reduce the risk to flooding

## **Physiography**

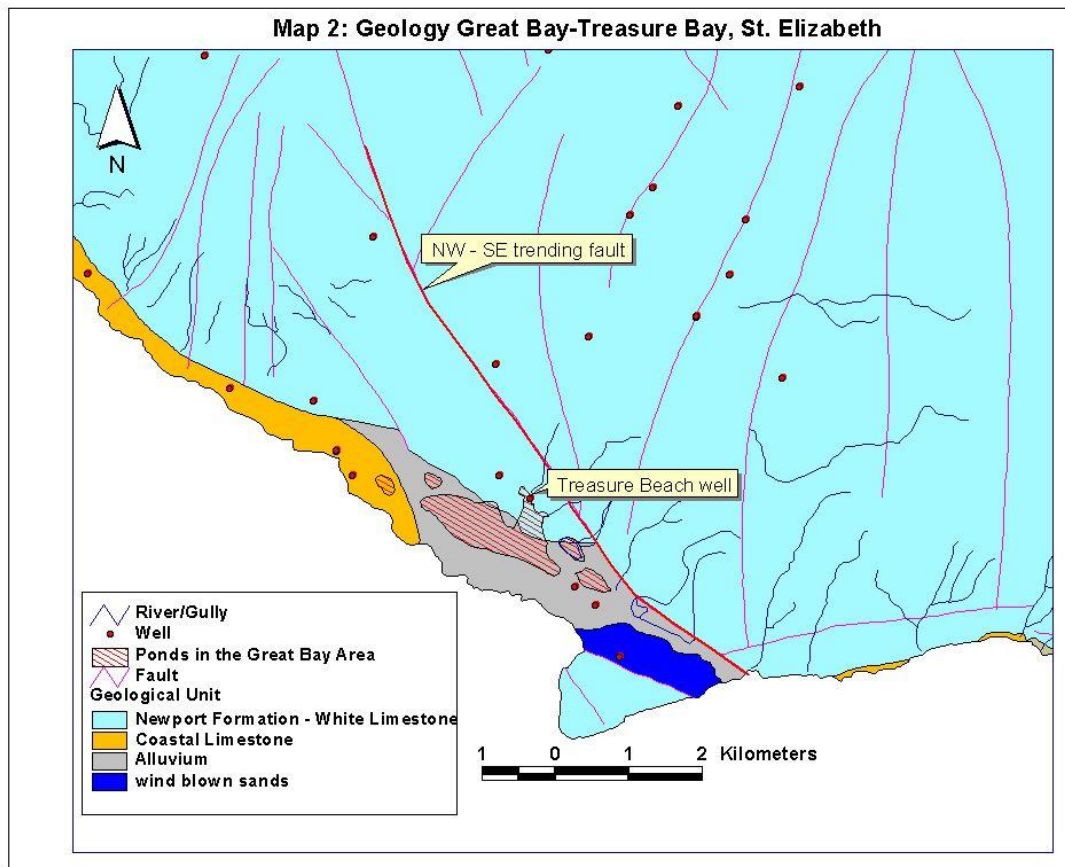
The area under investigation is part of the Pedro Plains, which is a sub area of the Black River Basin. The eastern boundary of the Plains is formed by the imposing escarpment of the Santa Cruz Mountains, and the northern boundary by the swamps of the Lower Morass. The highest ground is in the southeast around Flagaman, at 244 m above mean sea level. Westward the land surface declines towards Treasure Beach Village. South of Flagaman the land falls away towards precipitous cliffs 150 m to 180 m high, overlooking the sea. A westward extension of these hills backs a low-lying coastal area of sand flats and dunes between Great Bay and Treasure Beach Hotel. (Source: UNDP)

## **Drainage**

Southern St. Elizabeth constitutes a part of the Black River Basin, which is drained primarily by the Black River. Tributaries to the Black River exist mainly in the Upper Morass to the north. There are no rivers existing in southern St. Elizabeth because the entire region is underlain by the limestone rocks, which allows the rapid infiltration of water into the ground. Along the steeply sloping south coast below Flagaman are several dry gullies which drain to the sea. The dry gullies to the west of Flagaman drain to depressions in the Great Bay area (Map 1). Surface flows in these gullies only occur during periods of prolonged and heavy rainfall. This water accumulates temporarily in many of the topographic depressions, subsequently infiltrating through the terra rossa soils and clays into the underlying limestone. (Source:UNDP) Along the Great Pedro Pond soils are comprised of Sandy Bank sandy loams with a moderate to rapid infiltration capacity. However, under saturated ground conditions and elevated groundwater levels infiltration is reduced.

## **Hydrogeology**

About 90 % of the Pedro Plains consists of White Limestone the major aquifer along the south coast. As shown in Map 2, the Newport unit of the White Limestone Group is the most abundant in the Pedro Plains and varies from soft chalky to recrystallized limestone. The limestone is extensively fractured ranging from major to minor faults and joints. A major northwest to southeast trending fault is located east of the Great Bay area. The extensive fracturing of the limestone increases the permeability of the formation and significantly controls the groundwater flow. An elevated reef which fringes the coast is overlain by a sandstone terrace in the Frenchman-Great Bay area. In the Great Bay depression, which trends generally parallel to the coastline, four old sand dunes exist. The area has generally been mapped as an alluvial formation. A number of wells have been dug into the alluvial formation. Treasure Beach well dug to a depth of 5.6 m and located at the northern edge of the pond indicates groundwater levels of 4.6 m below ground or approximately 1 m above mean sea level.



## Rainfall

Rainfall data obtained from the National Meteorological Office for some of the rainfall stations in Southern St. Elizabeth and Manchester are presented in Table 1. The data represent rainfall measured over a period of 24 hours only as there are no rainfall intensity gauges in the area. For comparison purposes rainfall associated with Hurricane Charley have been added to this table.

**Table 1: Rainfall Data for Selected Stations in Southern St. Elizabeth**

Station/Location	Hurricane Emily			Hurricane Charley	
	15.07.05	16.07.05	Return Period	11.08.04	Return Period
	mm	mm	years	mm	years
Ft. Charles	101.6			no data	
Fullerswood	0	290	>100	242	>100
Mountainside	330		**	260.6	25
Potsdam	392		**	274.5	*

\* insufficient historical data to determine return period  
 \*\* rain measured as 48 hour rain, return period can not be determined

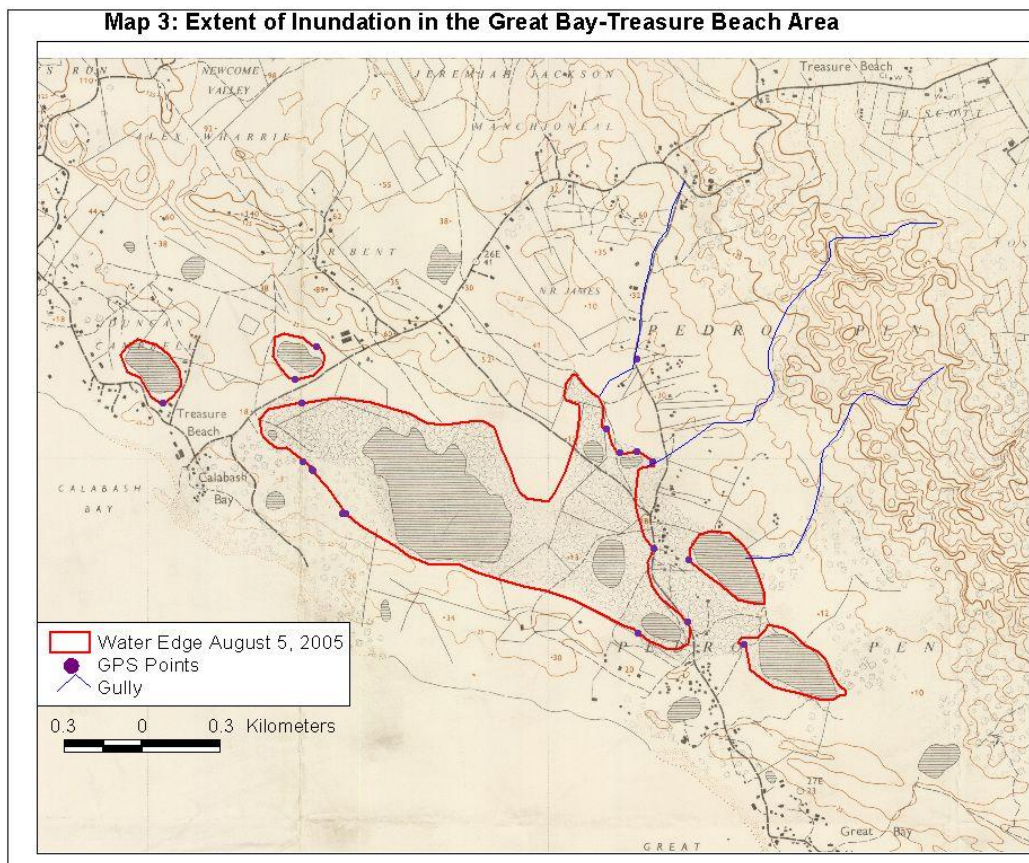
Source: National Meteorological Service

Of the stations captioned in table 1 Fort Charles is the nearest station located 6.5 km northwest of Great Pedro Pond. Fullerswood and Mountainside are located 10.8 km and 16.2 km north of the pond, respectively. Potsdam is located approximately 8.6 km

northeast of the Great Pedro Pond. As shown in table 1, the depth of rainfall recorded in this area during Hurricane Emily appears to be greater than during Hurricane Charley however, the absence of rainfall data for the Fort Charles station makes a final comparison difficult.

## Flooding

The surface area of Great Pedro Pond as of August 5, 2005 was approximately 727,000 m<sup>2</sup> (180 acres) (see Map 3). According to residents the flood levels were lower than those associated with Hurricane Charley on August 11, 2004 and the pond did not overtop the Pedro Plains Police Station to Great Bay road forming one large water body. The normal surface area of the pond under dry weather conditions is approximately 173,000 m<sup>2</sup> (42 acres) based on the 1:12,500 topographic sheet and the IKONOS image. The water levels have fallen by 0.3 m since July 16 and the water edge of the pond has receded by 2 – 5 m within that three-week period.



The lake has now receded to the 5 m contour line. There is no visible surface outflow from the lake. Any losses are confined to evaporation and infiltration to the subsurface.

## **Flood Damage**

Damage is mainly associated with erosion of road surfaces and break aways of concrete gully structures. The road leading from Flagaman to Treasure Beach intersection and then further southward towards the Treasure Beach community has experienced significant erosion particularly along the sides of the road. (see Map 1) The U-drain leading from the Pedro Plains police station towards Great Bay shows heavy silting with marl (possibly from road base) and limestone fragments (possibly from the outcropping limestone rock). The aforementioned U-drain follows the road for approximately 450 m before making a 90° turn to allow water to underpass the road. This sharp turn causes deposition of debris which blocked the drain and caused an overflow. Natural gullies cut through the hinterland and have caused some minor damage along property walls (Mr. Winston Smith's property). Damage to houses could not be ascertained but particularly at the southern and western edge of the Great Pedro Pond two housing units appear to be the ones most affected as water has entered the units. Across the Sandy Bank road a smaller pond fills frequently after heavy rain. There was no damage to houses but large tracts of residential lots were under water. According to residents this pond overflows the Sandy Bank road near the newly constructed Treasure Beach Shopping complex and flows towards the Great Pedro Pond.

## **Intervention Measures**

Constructing buildings along the edge of a water body always carries an inherent risk. Flood proofing measures for individual housing units should have been taken into consideration (such as raising the ground level or building on stilts). The Great Pedro Pond is an enclosed water body without a natural outlet. An intervention measure could be to create an artificial outlet towards the sea to allow for a free outflow. The invert of the outflow should be decided based on plans for development of the area. The site visit revealed lots for sale along the pond edge and roads have already been cut and asphalted and lots were already pegged. The extent of that subdivision could not be ascertained as sections were flooded. With respect to road damage interceptor drains at strategic locations should alleviate the undercutting of roads. The drainage plan needs to take into consideration the numerous small ponds to the East of the Sandy Bank Road which are likely to overflow and form a large water body. A link needs to be established between the small pond located to the west of the Sandy Bank Road and the Great Pedro Pond to allow for an outflow to the east.

## **Conclusion**

Ponding in this area is a regular occurrence during heavy rainfall as the surrounding steep topography allows runoff to move swiftly to topographic depressions. Elevated ground water levels and saturated ground conditions reduce the infiltration rate and as such the reduction in water levels is mainly dependent on evapotranspiration. Based on the Mountainside rainfall station, the return periods of the rainfall events associated with

Hurricane Emily exceed the 25 year level. The return periods however have been determined based on 1950-1985 data series and are due for a revision. The likely outcome of the revision is that the extreme rainfall events are occurring at a higher frequency and as such flooding is expected to occur more frequently.

## **Recommendations**

### **Short Term**

1. Individual home owners need to flood proof housing units. This can be done by raising the floor level and the roof.
2. The drains along the parochial roads to be reconstructed to allow for a controlled runoff.
3. Interceptor drains are to be constructed at locations where runoff crosses parochial roads.
4. The angle where the U-drain joins the culvert below Pedro Plains Police Station needs to be changed to reduce blockage and erosion.
5. It is recommended to use the 6 m contour line derived from the digital surface model created from the IKONOS image and representing the high water mark associated with flooding caused by Hurricane Charley, as the boundary below which no new housing units should be erected

### **Long Term**

1. The pond located to the west of the shopping centre needs to be linked with the Great Pedro Pond and an outlet to the sea needs to be created for the Great Pedro Pond at a location requiring least earth movement.
2. Infrastructural measures are to be in place for conveying water across or below the road surface causing the least damage particularly along the Treasure Beach to Great Bay road.

## **Bibliography**

- A: Groundwater surveys in two Areas of the Interior, Appraisal Report of the Pedro Plains St. Elizabeth, United Nations Development Programme, 1971
- B: Technical Report, Flooding in the Big Woods and Neighbouring Communities in Southern St. Elizabeth due to Hurricane Charley on August 11, 2004 – Water Resources Authority
- C: [www.earthobservatory.nasa.org](http://www.earthobservatory.nasa.org)



**Water Resources Authority**  
**August 28, 2005**

Appendix A



Photo 1  
Natural drain along the Flagaman to Treasure Beach road viewing towards Great Bay.



Photo 2  
Northern edge of Great Pedro Pond at Pedro Plain Police Station to Great Bay road in the vicinity of Mr. Winston Smith's property. Note the burnt grass indicating high water mark and bright spot in foreground indicating flow path.



Photo 3

Image shows section where surface runoff crosses Great Bay parochial road in the vicinity of Mr. Winston Smith's property.



Photo 4

Location where U-drain which carries runoff coming from the Pedro Plains Police Station ends and discharges into a culvert. Note deposition of material within the pasture caused by backwater.

Deposited material



Photo 5  
U-drain blocked with marl preventing free conveyance along Great Bay parochial road



Photo 6  
View towards the Great Pedro Pond from Sandy Bank Road in the vicinity of Treasure Beach Shopping Complex



Photo 7

Extent of flooding along the southern end of the Pond within the newly subdivided section east of Treasure Beach



Photo 8

Temporarily abandoned building at southwestern edge of pond. Note high water mark at walls. Treasure Beach Shopping complex in background.