

HYDROLOGY REPORT

Naples Bay Bridge – Route 302, Naples, BR #2047

General Information and Scope

This study is prepared to furnish hydrologic information from various water regulating agencies; on the waterway crossing over the Chutes River of the Naples Bay Bridge. The best and most reliable information will be used in the hydraulic evaluation of the existing and proposed bridge openings. The Naples Bay Bridge carries Route 302 over the junction of Long Lake and Brandy Pond in the town of Naples, and it is located 0.1 miles west of Route 35 on highway 302. The existing natural waterway opening is approximately 110 ft wide along the centerline of the bridge. The flow direction is southerly from Long Lake to Brandy Pond through the Chutes River. The current navigational channel is limited to 30 feet of width due to the following obstructions:

- 1- A 32 feet wide concrete turn table platform of the existing swing bridge.
- 2- An 11 feet wide fender and pier protection system adjacent to platform.
- 3- Sloping embankments of approximately 18 feet wide on each side.

The scope of this study is to determine the flood flows, which are used to perform a detailed hydraulic analysis of the waterway underneath the bridge. The hydrologic information and data presented herewith are obtained from three different sources:

- 1- Flood Emergency Management Agency (FEMA)
- 2- United States Geological Survey (USGS)
- 3- The Maine DOT Hydrology Department.

Flood Emergency Management Agency (FEMA)

FEMA has conducted studies on the probability of flooding of Long Lake, and Brandy Pond for flood insurance purposes. It has issued flood maps for the 100 and 500 year flood events with peak stage elevations of 274.0 ft, and 275.2 ft (NGVD) respectively. Since the bridge opening links the water bodies, and no dams, weirs, spillways, and man made obstructions exist, the water stages in the vicinity of the bridge are expected to be the same as that of the lakes.

They also completed a flood study for the Naples Bay Long Lake and Brandy Pond areas, and produced a flood map for the town of Naples with the following data:

Type of flow	Flow(cfs)	Stage(ft)
Design Discharge (Q50)	10,000cfs	274.0
Check Discharge (Q100)	11,500cfs	274.4
Scour Discharge (Q500)	15,200cfs	275.1
Ordinary High Water (Q 10)	6,300 cfs	273.2

United States Geological Survey

The USGS, which only maintains gage stations at river basins and streams in Maine, does not have any data for water stage and flow for the area in question. However, it offers a linear regression method for computing flows. The computation process is largely based on watershed areas and influence of wetlands. With an estimated watershed area of 82 sq-miles including 60% of wetlands, the flows were computed for Long Lake and Brandy Pond, and are as follows:

	Q ₁₀ (cfs)	Q ₅₀ (cfs)	Q ₁₀₀ (cfs)	Q ₅₀₀ (cfs)
1999 USGS Full Regression Equation	6744	10140	11718	15704

Maine DOT Hydraulic Department

The flows obtained from the various institutions were suspected to be too high, and a preliminary hydraulic check has indicated that the existing channel upstream and downstream of the bridge is incapable of passing the above flood flows without overtopping the bridge. For that reason, the Maine DOT Chief Hydrologist Charles Hebson was engaged to determine reasonable flows for the hydraulic analysis. He determined that other hydraulic factors has to be taken into consideration, and that the flows in the channel has to be reduced in order to meet actual records of water stage elevations in the range of 267' to 271'. After full investigation and study, new flood flows were determined and furnished by the chief hydrologist as follows:

	Q10(cfs)	Q50(cfs)	Q100(cfs)	Q500(cfs)
Maine DOT Results	970	1175	1246	1355

Maine DOT Flow Determination

The Maine DOT flows were determined by taking FEMA 100 year flood flows for the Songo River; located downstream of the bridge, and combining flows with water surface elevations over the dam at the Songo River. A weir coefficient was obtained and used to estimate other flood flows from corresponding water surface elevations data by FEMA. It was concluded that the obtained flows match well to USGS estimates; after the model was calibrated for upstream wetlands storage amounts.

Results Comparison

As expected, the Maine DOT flows were found to be much lower than flows determined by other institutions. Based on the chief hydrologist point of view, the data furnished by the USGS, FEMA, and NFIP is based on the full flow of the Long Lake water body, which does not take into consideration the water storage volume available upstream of the bridge. That storage volume will have to be deducted from the full flow to arrive at correct flows passing through the channel. A quick check of the DOT flows confirmed that the water stage at the 50 year flood did not exceed 270'; which agreed with historical stage elevations observed over long periods not exceeding 271'. Moreover, the institutions flows were estimates at best, since they were not obtained from actual gauge data in the vicinity of the bridge.

Design Flows

Based on the above, the Maine DOT refined flood flows were adopted for design as follows:

Q1.1(cfs)	Q ₁₀ (cfs)	Q ₅₀ (cfs)	Q ₁₀₀ (cfs)	Q ₅₀₀ (cfs)
600	970	1175	1246	1355

Flood Plain Information

The information on flood plains and the possibility of flooding is available from the National Flood Insurance Program. Its Flood map produced for the Naples Bay; Long Lake area shows the 100 and 500 year flood limits. The 100 yr flood limits are considered to be moderate with slight overflow of embankments occurring upstream and downstream of the bridge. However, at the bridge location, Excessive overflow is noted on the west side, and moderate overflow at the east side. The 500 yr flood map shows further overflow at the west side of the bridge, with no additional overflow at the east side. It can thus be concluded that the west side directly downstream of the bridge is susceptible to flooding. This may be due to the necking action produced by the small bridge opening in comparison to the large water bodies directly upstream and downstream. Thus, depending on the results of the hydraulic analysis, it may be recommended to remove existing obstructions and utilize the full width of the bridge waterway in passing flood flows.

Conclusion

Based on the above studies, the existing channel under the bridge may or may not be satisfactory in containing and directing flood flows. However, this important information must be substantiated by hydraulic analysis using peak discharges of both the 50, and 100 year flood events. Also, historical information from nearby residents on whether there was ever any water on the bridge can be most helpful in determining flood flow conditions of the channel. We have sent for information from local residents, but we have not received a response yet.

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The drainage basin characteristics were provided by the Maine Department of Transportation Office of Environment-Hydrology Section. No other flow data is available such as gage data, and reports from local residents. Therefore the hydrology data was used as provided as follows:

Summary

Drainage area = 82 square miles
Ordinary High Water ($Q_{1.1}$) = 600 cfs
10 year Flood (Q_{10}) = 970 cfs
Design Discharge (Q_{50}) = 1175 cfs
Check Discharge (Q_{100}) = 1246 cfs
Scour Check Discharge (Q_{500}) = 1355 cfs

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