

November 12, 2002

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CAHA/General

Memorandum

To: Superintendent, Cape Hatteras National Seashore

Through: Chief, Water Resources Division
Chief, Water Operations Branch

From: Larry Martin, Hydrogeologist, Water Operations Branch, WRD

Subject: Hydrology of the Ramp 49 area, Cape Hatteras National Seashore

Summary

Flooding along the interdunal road to Ramp 49 is caused by high water table conditions. The frequency and duration of flooding varies with drought and wet periods and can not be controlled. There is no practical remedy to reduce the frequency and duration of flooding in the interdunal swale. Solutions to the problem will require rerouting the road to follow a higher topographic route or building up the existing roadway to a higher elevation.

Introduction

Ramp 49 provides a route for vehicle access to the beach in the vicinity of Frisco Campground. An interdunal road leaves the pavement at the entrance to the Frisco Campground and traverses to Ramp 49 through a low-lying area on the landward side of the primary dune. The road through the low-lying area is frequently flooded to depths of more than a foot, making the road impassable. This memo addresses the causes of flooding in the interdunal area and identifies alternatives to provide more reliable vehicle access to the beach in this area.

Figure 1 shows the location of the interdunal road, Ramp 49, and other physical features in the area.

Source of water

Virtually all of Hatteras Island is comprised of very permeable, medium-grained sand. Precipitation falling on the island readily infiltrates the sand, causing the water table to

rise. Surface water bodies on the island (ponds, wetlands, ditches) occur where the water table has risen to levels above land surface. In some areas, drainage ditches have been constructed to lower the water table and provide quicker drainage of surface water to the ocean. There are no drainage ditches in the vicinity of Frisco Campground or the interdunal road.

The area contributing groundwater to the interdunal swale is from the center of the island (approximately coinciding with the park boundary north of the campground) southward to the ocean. The east and west boundaries of the area contributing groundwater to the swale are determined by the east-west extent of the flooded interdunal swale area. Figure 2 shows the approximate extent of the area contributing groundwater to the swale. Most of the area contributing groundwater flow to the interdunal swale area is undeveloped NPS land. To the southwest the Frisco airstrip provides a buffer to activities and hydrologic perturbations in the Frisco area. To the north, NPS property extends to the approximate location of the groundwater divide at the center of the island. The only NPS development in the area is the campground, which has no effect on the quantity or direction of groundwater flow. To the east, undeveloped NPS land extends for several miles.

There is no inflow of surface water into the interdunal area in the vicinity of Ramp 49. There are no ditches that would import extra water into the area. There are no land uses or recent land use changes in the surrounding areas that could cause an increase in groundwater flow to the area. Therefore, the cause of increased frequency and duration of flooding on the interdunal road can only be above average precipitation which causes above average water table elevations.

Figure 3 shows monthly precipitation at the Cape Hatteras Weather Service Office. It shows that precipitation was below normal during the latter part of 2000 and most of 2001. This dry period would have allowed the water table to decline to lower than normal levels and caused longer periods during which the road to Ramp 49 would have been dry. This would have contributed to a misperception regarding the amount of time that the road to Ramp 49 is normally flooded. Precipitation was above normal during most of the last half of 2002 and most of 2003. Wetter than normal conditions cause the water table to rise, increasing the duration and frequency of the access road. Thus we have a situation where short-term memory regarding the amount of time that the access road is flooded is distorted by comparing conditions during a drought with conditions during a wetter than normal period.

High water table conditions will persist in the interdunal swale area during periods of above normal precipitation. The interdunal swale is close to the ocean, which is the discharge area for groundwater flowing from the interior parts of the island. The elevation of the water table is fixed at sea level at the shoreline. Essentially, the slope of the water table is hinged at the shoreline so that there is no change in the water table elevation at the shore and the greatest fluctuation occurs in the center of the island. The amount of water table fluctuation and the immediacy of the response of the water table to wet/dry periods decreases closer to the shore. The end result of this process is that during

periods of above average precipitation, high water table elevation near the shoreline will persist for extended periods, for as long as precipitation remains above average. These concepts are shown in Figure 4.

Figure 4 shows approximate water table elevations along a north-south cross-section from the Ramp 49 area to the center of the island. Water table elevations were computed using equation 8.8 in Fetter (2001). Estimates of physical properties, e.g., hydraulic conductivity and recharge rate were taken from a report by Gregory and Morgan (1996) or estimated by scaling measurements from the USGS topographic maps of the area. Data used in the computation of water table elevations were;

Island width = 6000 feet

Recharge rate = 2 mm/day, 1 mm/day, and 0.35 mm/day
for wet, intermediate, and dry conditions

Hydraulic conductivity = 50 feet/day

Salt water density = 1.025 grams/cm³

Figure 4 shows that the interdunal road is likely to be flooded under normal high-to-intermediate water table conditions. During periods when rainfall occurs regularly enough to maintain the water table at high-to-intermediate conditions, the water table may not lower far enough to allow the water table to drop below the level of the road, resulting in long periods of flooding.

Alternatives

The amount of inflow into the groundwater system cannot be controlled or changed. It is a function of the amount of precipitation and infiltration on the island. There are no practical measures that could prevent the rise of the water table during wet periods

Alternatives that would provide more reliable vehicular access to the beach at Ramp 49 include;

1. Draining surface water from the interdunal swale and/or lowering the water table in this area.
2. Raise the level of the roadbed along the existing route.
3. Reroute the road to cross the swale at a higher elevation.

There is no reasonable way to effectively lower the water table in the interdunal area to significantly decrease the duration and frequency of flooding. Attempting to lower the water table would require construction of several large-volume wells and attempting to dewater the area in the vicinity of the interdunal road. However, there is nothing to prevent groundwater from adjacent areas from quickly flowing toward the pumping wells and raising the water table elevation as soon as the pumps were turned off. This alternative would require constant pumping of large volumes of water for extended periods and discharging the water into the ocean or on the beach.

Drainage of surface water is not a practical alternative at this location. Because the elevation of the interdunal swale is only a few feet above sea level, drainage of standing surface water would require construction of culvert-type drains through the primary dune

to discharge on the beach. Such a project would likely require a lot of recurring maintenance. There may be regulatory issues associated with attempting to dewater the wetlands in the interdunal swale area. Attempting to remove a section of the primary dune to create a surface outlet from the swale to the ocean would probably result in topography similar to that presently occurring along the shore south of the lighthouse. In that area, the primary dune was been completely eroded but there remains a gentle topographic rise which allows formation of a shallow impoundment adjacent to the shoreline.

It appears that the only reasonable alternatives for providing more reliable vehicular traffic to the beach in this area is by some combination of rerouting the access road along a topographically higher route or elevating the roadway through the swale. Following the existing route through the swale to the existing ramp would not require disturbing any additional areas, but it would require the most fill to raise the road elevation above the normal high water elevation. The road through the swale might need to be elevated 3-4 feet, or more, above the current elevation. Surveying will be needed to determine the amount of elevation gain that is necessary. Rerouting the road to take a more direct route to the beach from the existing start of the interdunal road at the campground entrance would require less fill because the route through the swale would be shorter. This would require construction of a new beach ramp further west from the existing ramp.

The flooded interdunal swale area extends for quite a distance to the east from the existing interdunal road. It appears that the low elevation swale continues to the west adjacent to the Frisco airstrip. Thus, it appears that there are no alternative routes in the vicinity of Ramp 49 that would allow road passage through the interdunal swale at an elevation above normal high water levels. The only practical alternatives are to raise the elevation of the roadway or accept limiting access to Ramp 49 during wet periods..

If there are any questions regarding this trip report, please call me at (970)-225-3515 to discuss it.

References

Fetter, C.W., 2001, Applied Hydrogeology, 4th Edition, Prentice-Hall publisher, 598 pp.

Gregory, James D, and Amelia S. Morgan, 1996, The Effects of Topography, Rainfall, and Ground-Water Withdrawal on the Water Table Hydroperiod of Buxton Woods Wetlands and Adjacent Uplands, Final report to the USDI National Park Service, Cape Hatteras National Seashore, and the North Carolina Division of Coastal Management, Department of Forestry, North Carolina State University

cc:

CAHA – Harrison, Ebert

SERO – Sherri Fields

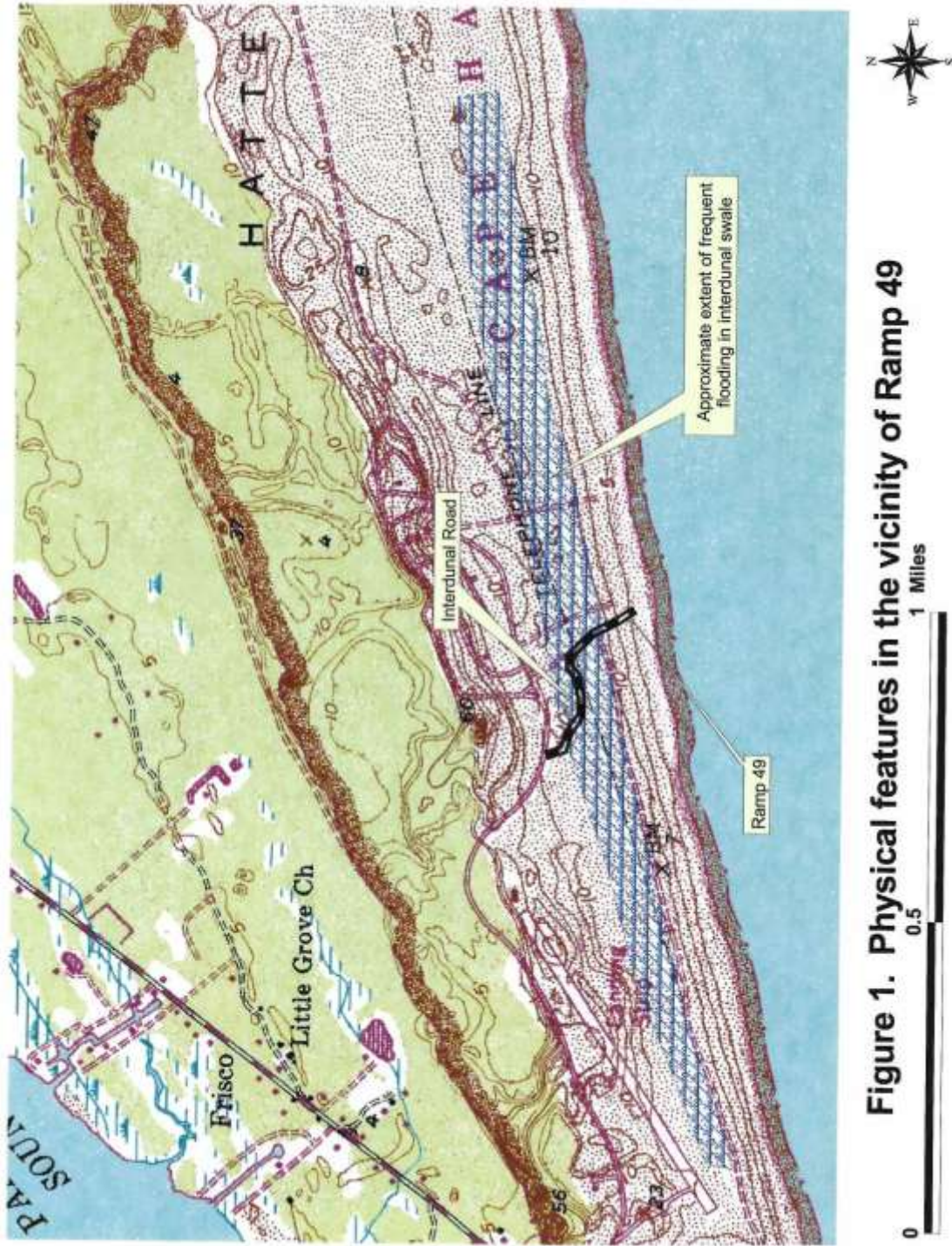


Figure 1. Physical features in the vicinity of Ramp 49

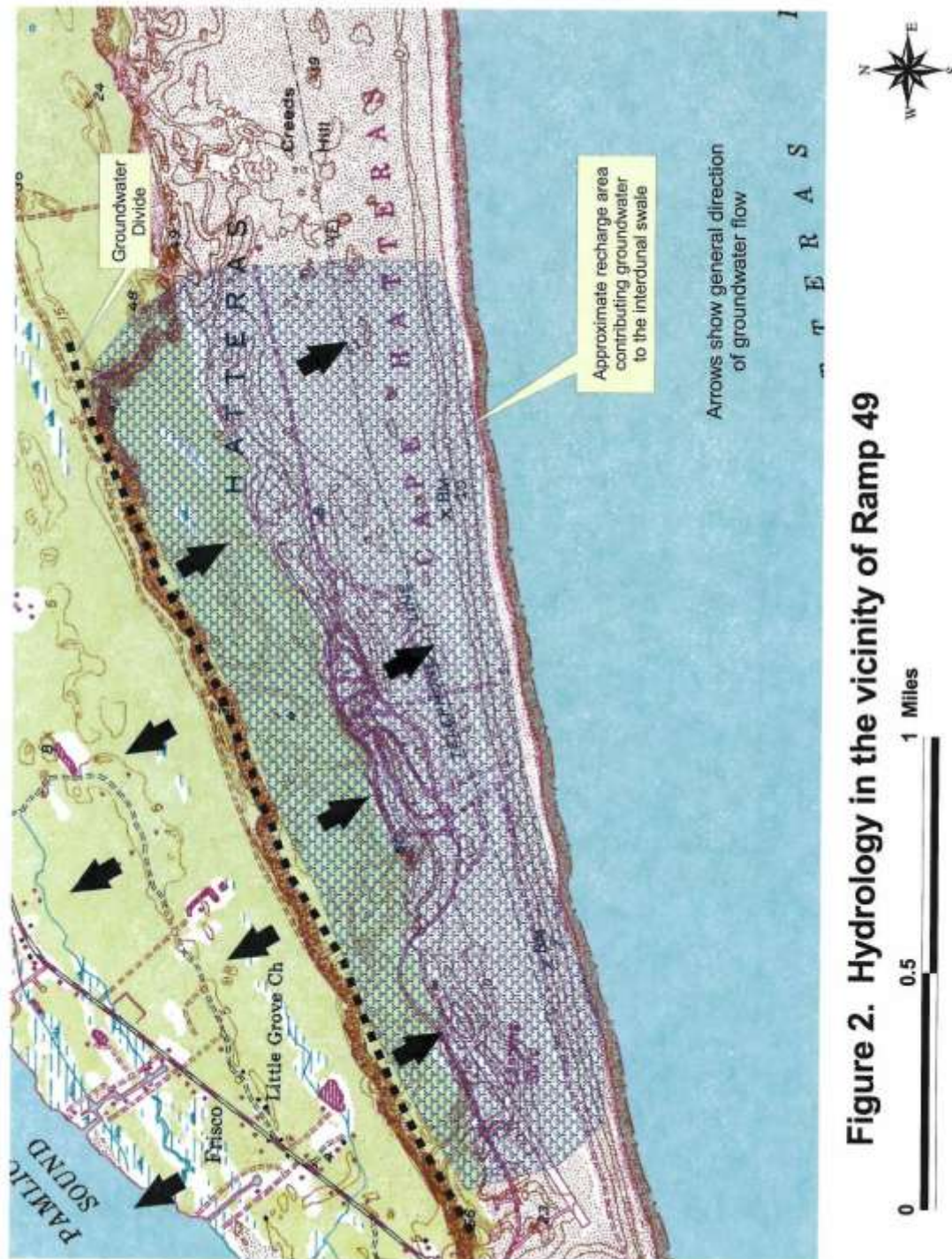


Figure 2. Hydrology in the vicinity of Ramp 49

Cape Hatteras Precipitation

data source = www.dnr.state.sc.us/climate/sercc/climateinfo/historical/historical_nc.html

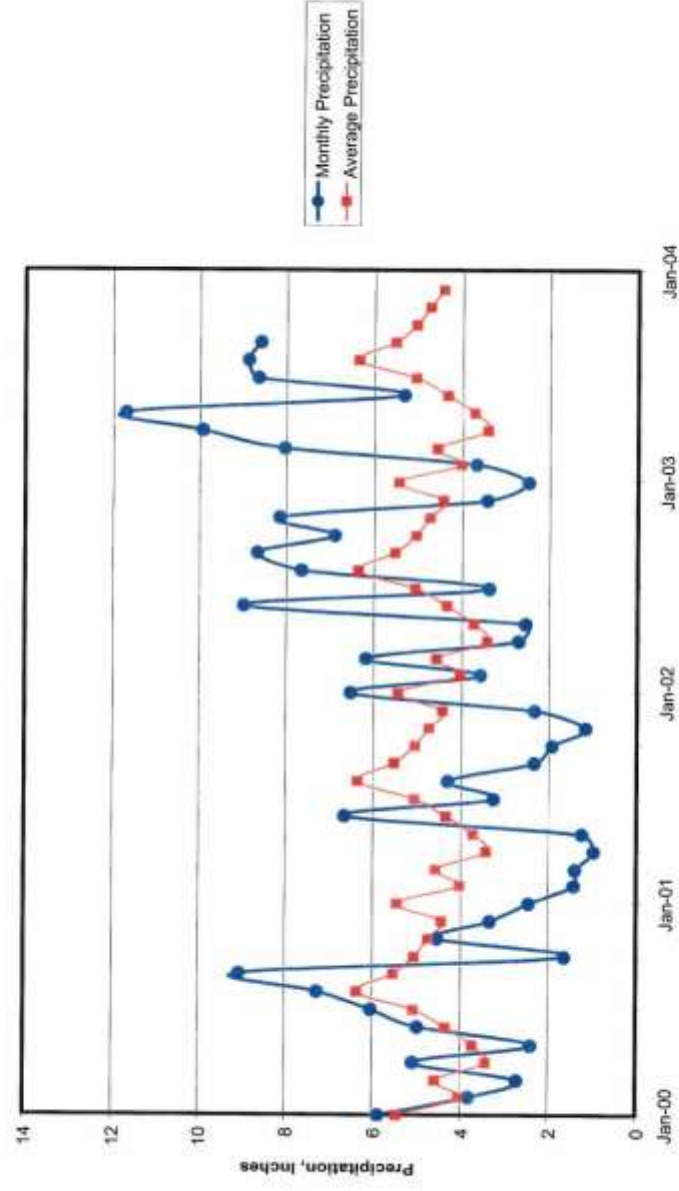


Figure 3. Monthly precipitation at Cape Hatteras

Schematic Cross Section across the southern half of Hatteras Island showing calculated water table elevations for wet, intermediate, and dry conditions

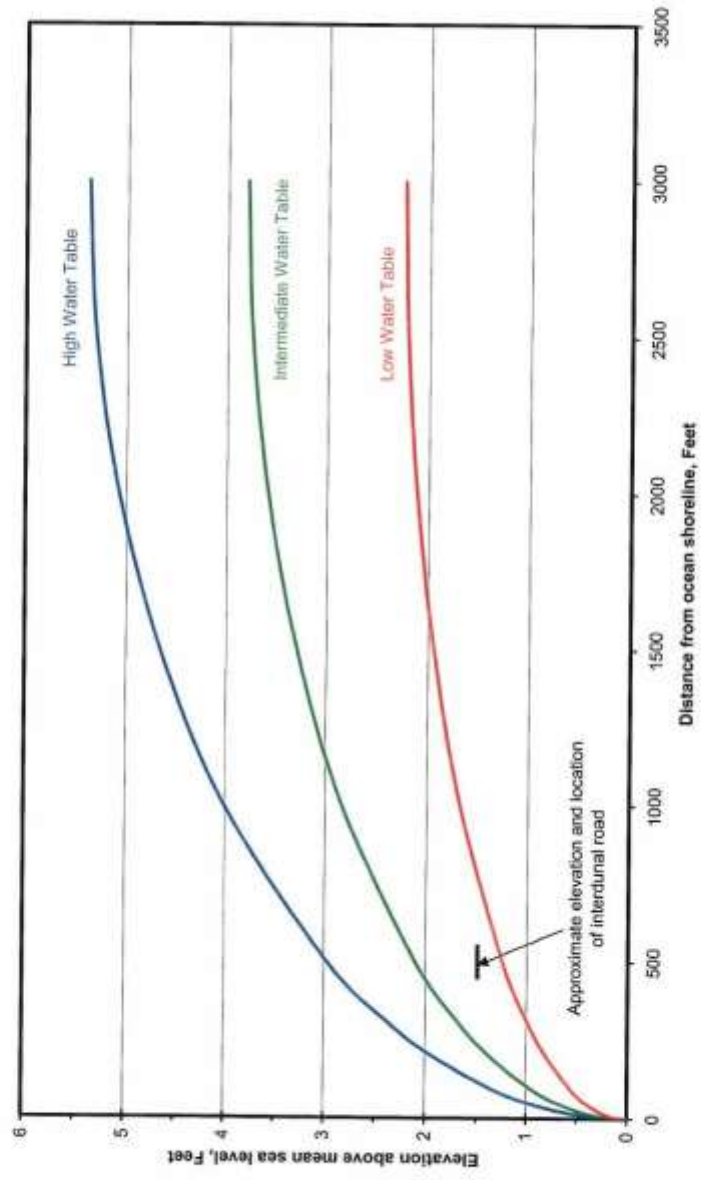


Figure 4. Approximate water table elevations in the vicinity of Ramp 49, Cape Hatteras National Seashore