

# SUBMARINE GROUNDWATER DISCHARGE IN MANHASSET BAY

Tsvi Pick and Ruth Coffey

Stony Brook University, Stony Brook, NY 11794

[tpick@ic.sunysb.edu](mailto:tpick@ic.sunysb.edu)

## **Introduction:**

Submarine Groundwater Discharge (SGD) carries both freshwater and pollutants, like excess nitrogen into coastal embayments and Long Island Sound. A SGD typology is intended to characterize these sites in term of other, relevant parameters that will allow the extrapolation of limited, available measurements to other sections of the coast.

The USGS has recently measured SGD at selected sites in Manhasset Bay, Port Washington, NY. A SGD typology is intended to characterize these sites in term of other, relevant parameters that will allow the extrapolation of limited, available measurements to other sections of the coast. The underflow can be calculated by Darcy's Law, and the products of hydraulic conductivity, the thickness of the aquifer, and the hydraulic gradient, or water-table, but other relevant characteristics of a regional shoreline would include thickness of the vadose zone, population density, the presence or absence of sewers and shoreline bulkheading. Precipitation, evapotranspiration, etc. would be expected to be uniform over small areas. The simplest GW typology might be based on the underflow for Manhasset Bay. The coastal zone was divided to 100 meters cells. The calculated values of the underflow ranged from -0.018 to -3.03 cm/day

Direct measurements of submarine groundwater discharge were made in using vented benthic chambers on May 20 and October 22, 2008 in the site of Manhasset Bay Yacht Club. In May, a maximum SGD of 32.12 cm/d was recorded 5.5 m from the bulkhead, decreasing to below 7.33 cm/d at a distance of 18.4 m from the bulkhead and below 5.74 cm/day at 23 m from the bulkhead. SGD was inversely correlated with the tide and responded rapidly to precipitation events due to a build up of the water table immediately behind the bulkhead that increases the hydraulic gradient. In October, the highest SGD of 34.3 cm/d was recorded 15 m from the bulkhead. Average SGD 17 m from the bulkhead was 8 cm/d, decreasing to 3 cm/d at 20 m from the bulkhead, and 5 cm/d at 24 m. In setting peizometers, there seemed to be a confining layer at a depth of about 6 m below the seafloor below which the pore water was significantly fresher than that above the confining layer. SGD was most rapid and freshest closest to the pilings which possibly pierce a confining layer and allowed the anomalous inflow of freshwater.

Limitations of groundwater drawdown may be detected before salt water intrusion may occur. On land processes (i.e. human activity) may influence the groundwater typology by blocking recharge zones. Finally, movement and impact of chemicals, such as nitrogen through groundwater flow may be understood better. Findings highlight the need of specific research investigating SGD. Yet, SGD data on Long Island is not sufficient enough. As budgets and human resources are limited, SGD measurement sites are not available on all locations.

This project attempts to overcome the data gap by the use of surrogate data and/or measurements. The ultimate goal is to address the SGD on the location of Manhasset Bay, on the northern shore of Nassau County.

## **Methods:**

**1. Calculation of SGD:** Our investigative approach examines groundwater underflow, or the volume flux of groundwater passing under the shoreline. The underflow can be calculated out from Darcy's Law, and the products of hydraulic conductivity, the thickness of the aquifer, and the hydraulic gradient. But other relevant characteristics of a regional shoreline would include land use, population density, the presence or absence of sewers, and thickness of the vadose zone. Precipitation, evapotranspiration, runoff, infiltration capacity, etc. would be expected to be uniform over small areas.

**2. Groundwater typology used in our project:** The coastal zone of Manhasset Bay was divided to 100 meters cells. GW flow rates due to Darcy's Law, and SGD were calculated for each data point. A directly measured data is existed for one data point. The UTM coordinates for this location are: Zone 18T, 608639 m East, 4521352 m North. Therefore, calculations of the Surrogate data had to be done for all data points.

Although measurements of SGD and nitrogen input were available in only a few of these cells, the greatest SGD in Manhasset Bay would be expected along south-west locations. This result has been confirmed by USGS geophysical measurements.

The coastal zones of these locations were divided to 100 meters cells. Scaling the entire shoreline of Manhasset Bay to the available measurement at one site using the typology yields a total underflow of 44.812 m per day. Results indicated that there is a significant need for more measurement sites in order to determine extraordinary SGD rates.

## **Results.**

The annual precipitation assumed to be 140 cm over Manhasset Bay. This assumption was made by a measurement over Sea Cliff. The hydraulic conductivity is assumed to be 30.48 m/day, with respect to ration between hydraulic gradient and average SGD at the measuring site. The hydraulic gradient was calculated according to distance between 0 and 20 ft contours of the water-table. The thickness of the aquifer was calculated from the difference between the water table and bedrock of the aquifer, and the depth of the vadose zone was calculated according to the difference between the land surface, as obtained at google earth<sup>TM</sup>, and the 20 ft water table. Information on the land use, and population density (per km<sup>2</sup>) was found on official reports and publications of the communities along the shoreline. This information is including for each cell whether or not the described area is sewerred.

## **Discussion:**

The location where SGD was directly measured is on the North-West part of the bay.

The groundwater typology might be based on the underflow for Manhasset Bay. The calculated values of the underflow ranged from -0.018 (north) to -3.03 cm/day (south-east). The highest rates were found to be in the south-east stretch of shoreline, and were detected due to high hydraulic gradient. The average SGD on Manhasset Bay was measured to be -0.3 cm/day, corresponding to a calculated underflow in the 148 typology cells. Extrapolating this correspondence around the shoreline the distribution of average SGD would be expected to range from a maximum of -3.03 cm/day in the south-west to a minimum of -0.018 cm/day in the northern part of the bay.