OS42A-08 Hydrodynamic Measurements and Analysis in a Microtidal River-Harbor System

Thomas Chisholm¹ Adrienne Nemura² Mark Kosakowski ³
chisholm@ebs.ogi.edu anemura@limno.com mlk@oceansurveys.com

1 EBS Dept., Oregon Health and Science University, 20000 NW Walker Rd, Beaverton, OR 97006 United States
2 Limno-Tech, Inc. 501 Avis Drive Ann Arbor, MI 48108, United States
3 Ocean Surveys, Inc. 91 Sheffield Street Old Saybrook, CT 06475 United States

Seiche
The U. S. Army Corps of Engineers reports that the Cuyahoga River has a L=9.4 km long channel dredged to a depth of D=7 m. Upstream of the dredged channel the river’s depth returns to its natural depth of about 1m. The quarter waves oscillation frequency of the river is easily calculated using f=(gD)^{1/4}L=0.00221 Hz corresponding to a period of 70 minutes. Causes for this difference could include the channel shoaling to less than project depth and portions of the river below river mile zero contributing to the seiche. Note the strong seiche action at station 3, which all but disappears at station 4.

Forcing
The site, being a freshwater lacustrine environment, has neither salinity differences nor noticeable astronomical tides. Forcing parameters therefore include primarily wind and river discharge. Plots of wind velocity in the onshore-offshore and longshore directions show differences. The onshore-offshore direction shows the daily cycle of sea breezes. The longshore direction shows the prevailing southwesterly wind that varies as meteorological systems pass through the area. Daily river discharge shows a gradual decreasing trend as summer progresses. However, higher flow events, presumably caused by thunder storms, interrupt this pattern.

Supporting data included winds and Cuyahoga River discharge. The National Weather Service collects meteorological data at Burke Lakefront Airport, which lies adjacent to the harbor immediately northeast of the mouth of the Cuyahoga. The USGS collects daily average discharge at site 04208504 Cuyahoga River at LTV Steel Cleveland, OH.

Temperature
Temperature measurement instruments at the three levels provide a view of water column processes. Plots below present data from station 3, the river mouth. The record shows a typically warm well mixed water column with periodic intrusions of colder water accompanied by greater top to bottom variation. Also notable are occasional inversions where slightly warmer water occurs at the bottom temperature probe. To further investigate this the ratio of surface temperature to bottom temperature is plotted with forcing functions. It appears that sustained winds in the along shore direction drive cold water intrusions. High discharge events promote mixing of the water column. The inversions appear to frequently occur after high discharge events. It is possible that suspended sediment in the Cuyahoga River water provides necessary negative buoyancy to drive warmer river water under colder lake water.