**Safe Harbor**

**Description:**
Why should we care about Harbors? Roughly 90% of the world's goods are transported by sea. The port of NY/NJ is the third busiest port in the U.S. and the 18th in the World. Without our ports, life as we know it would not exist, however they are often overlooked.

As trade volume increases, so does the size of ships.

When European explorers first visited the New York Harbor, they found an estuary with a natural depth of 17 feet. As colonies became established and trade flourished, shipping channels were needed to allow for bigger ships. By 1880, the main ship channel was dredged to a depth of 24 feet and by 1891 to a depth of 30 feet. In 1914 the Ambrose Channel became the main entrance to the port of New York and had a depth of 40 feet and 2,000 feet wide (ship design changes/technological advancements allowed for wider ships). During World War II the main channel was dredged to 45 feet deep to accommodate larger ships up to Panamax size (Panamax is a term referring to the largest size ship which can transit through the Panama Canal).

<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Tonnage: 52,500 DWT</td>
<td>Tonnage: 120,000 DWT</td>
</tr>
<tr>
<td>Length: 950 ft</td>
<td>Length: 1,201 ft</td>
</tr>
<tr>
<td>Beam: 106 ft</td>
<td>Beam: 161 ft</td>
</tr>
<tr>
<td>Height: 190 ft</td>
<td>Height: 190 ft</td>
</tr>
<tr>
<td>Draft: 39.5 ft</td>
<td>Draft: 50 ft</td>
</tr>
<tr>
<td>Capacity: 5,000 TEU</td>
<td>Capacity: 13,000 TEU</td>
</tr>
</tbody>
</table>

Eventually even the Panama Canal was not big enough. In 2016, an expanded Panama Canal opened to allow for significantly larger ships (see above). Also in 2016, the U.S. Army Corps of Engineers completed a $2.1 billion dredging project, deepening NY Harbor channels to 50 feet (15 m) in order to accommodate Post-Panamax container vessels, which can pass through the widened Panama Canal as well as the Suez Canal.

Do you note any potential issues for NY harbor not being safe for large vessel navigation?

**Subject:**
Physical Science or Physics

"This material is based upon work funded by the U.S. Department of Homeland Security under Cooperative Agreement No. 2014-ST-061-ML0001. “The views and conclusions contained in this document are those of the authors and should not be interpreted as necessarily representing the official policies, either expressed or implied, of the U.S. Department of Homeland Security."
Assumptions of Prior Knowledge:
- objects in motion have a direction and speed that can be changed;
- principles of buoyancy;
- basic knowledge of tides;
- map locations can be determined using a system of coordinates in latitude and longitude;
- how to read map coordinates and plot points using latitude and longitude; and
- how to use a semicircular or a circular protractor to determine direction in degrees on a map.

Part 1 – Guiding a ship into harbor

Objectives:
Students will
- Assess the general specifications of a ship;
- Assess the general specifications of a harbor;
- Determine if the ship would have low, medium or high probability of navigating the harbor; and
- Consider environmental factors on the safety of ship navigation.

Materials:
- Access to real time NY/NJ Harbor data
- Copies of the Worksheet
- Pen or pencil
- 1 ruler
- 1 calculator (optional)

Classroom Implementation

Time required: one 45 minute class

1) The draft of a ship's hull is the vertical distance between the waterline and the bottom of the hull (keel). Draft determines the minimum depth of water a ship or boat can safely navigate.

Under-keel clearance (UKC) is the term used for the distance between the lowest point on the ship's keel (or hull) and the highest point on the channel bottom beneath the ship.

UKC is equal to the minimum total water depth at the location of the ship minus the maximum dynamic draft of the ship.

The dynamic draft is the distance from the water's surface to the lowest point on the ship's keel while the ship is in motion.

Each of these components has several elements.

There are a number of ways that a ship's master can effectively manage the UKC of the ship:
(1) actions which affect the ship's dynamic draft (changing the speed)
(2) planning actions to ensure there will be sufficient water level for safe passage along the route.
Both are dependent on having the necessary real-time and forecast environmental information and supporting analyses of the ship's motion in varying situations. A ship’s master can always increase UKC by slowing the ship. This action will have economic repercussions (e.g., arriving later at the pier), so it is vital to have the necessary information to determine exactly how much to slow down to avoid grounding (or to stay within the port's minimum UKC guidelines – 3 feet in Ambrose Channel, the main approach to the NY Harbor, and 2 feet in most other NY Harbor channels).

In order for the ship's master to be able to accurately manage the ship's UKC, the following information is required:

- the ship's **static draft** (static draft is the draft of the ship when it is not moving impacted by cargo and water density) and **dynamic draft** (a ship in motion sits lower in the water – Bernoulli effect – which can be dramatic in shallow water, (maximum draft for NY Harbor is 48.5 feet);
- **charted depths** and underwater hazards;
- **water levels** (real-time and forecast out to 24 hours into the future, as well as tide predictions and the total water depth consists of the charted depth plus the water level above the chart datum);
- **channel-specific ship-specific formulas for dynamic draft** (based on ship speed, static draft, and water depth);
- **water temperature** (in the summer the water is warmer therefore less dense, so there is an expansion of the water column and a small but significant increase in water level);
- **currents** (variety of causes including river discharge);
- **water density**; and
- **waves**, swell, and/or seiching
- **ship speed**


**OOCL Berlin** (2013)
Tonnage: 144,143 DWT
Length: 1,202 ft
Beam: 158 ft
Draft: 50.85 ft
Capacity: 13,208 TEU

Determine if the ship would have low, medium or high probability of navigating the harbor today.

**Channel depth** – 50 feet


**Tides** – (https://tidesandcurrents.noaa.gov/map/index.html)
Currents -  
(http://hudson.dl.stevens-tech.edu/maritimeforecast/maincontrol.shtml)  
(https://tidesandcurrents.noaa.gov/map/index.html)  
(http://oceansmap.maracoos.org/#)

Wind –  
(http://hudson.dl.stevens-tech.edu/maritimeforecast/maincontrol.shtml)  
(https://tidesandcurrents.noaa.gov/map/index.html)  
(http://oceansmap.maracoos.org/#)

Water Temperature –  
(http://hudson.dl.stevens-tech.edu/maritimeforecast/maincontrol.shtml)  
(http://oceansmap.maracoos.org/#)

Salinity –  
(http://hudson.dl.stevens-tech.edu/maritimeforecast/maincontrol.shtml)  
(http://oceansmap.maracoos.org/#)

Ship speed – top speed 11 knots

Waves –  
(http://hudson.dl.stevens-tech.edu/maritimeforecast/maincontrol.shtml)  
(http://oceansmap.maracoos.org/#)

Area Buoys  
National Data Buoy Center (https://www.ndbc.noaa.gov/obs.shtml)  Stations SDHN4, ROBN4, BATN6

NOAA Marine Forecasts (https://www.nws.noaa.gov/om/marine/zone/east/phimz.htm)

Resources  
Current Ship Traffic in NY/NJ Harbor  

Modern Under-Keel Clearance Management  
https://journals.lib.unb.ca/index.php/ihr/article/download/22959/26656

Harbor Safety, Operations and Navigation for the Port of New York and New Jersey  

Sandy Hook Pilots Association  
https://www.sandyhookpilots.com/

Houston Pilot Video  
https://youtu.be/ZHKo88AfJqE

Become a Boat Captain  
https://study.com/articles/Become_a_Boat_Captain_Step-by-Step_Career_Guide.html

Become a Deckhand  
http://tugboatjobs.org/merchant-marine/#.XIRNE4hKhpY