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Early Detection of Bridge Scour

MAPPING AND REAL-TIME VISUALIZATION OF SCOUR USING HYPACK SOFTWARE.

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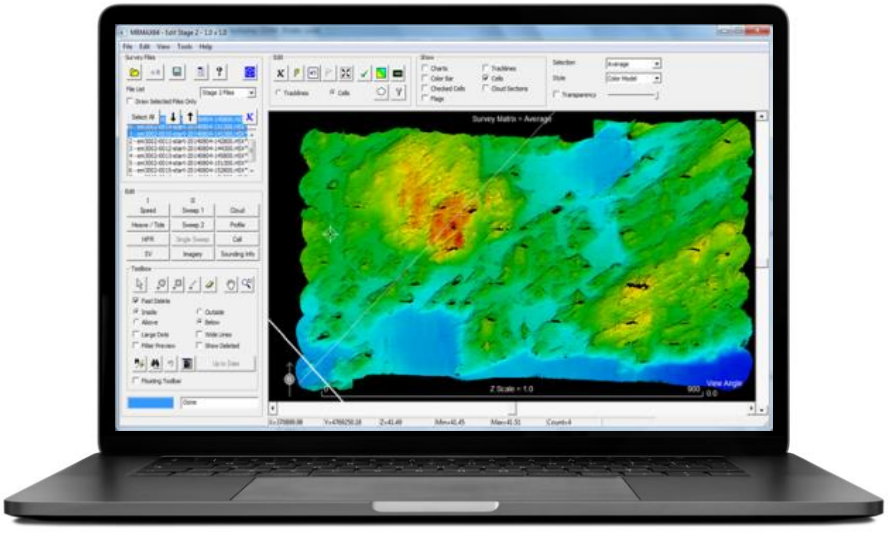
High precision acquisition and processing of georeferenced data collected from:

- Echosounders
- Sidescan Sonars
- Multibeam Systems
- LiDAR Surveys
- Environmental Sensors



GIS environment allows for data analysis and planning for remediation work.

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Underwater Inspection

Early Detection of Bridge Scour

Mapping and real-time visualization of scour using HYPACK software. Early detection of potential infrastructure issues allows for remediation before failure.

Let's start by answering three questions:

1. Why it is needed?
2. How it can be done?
3. What should we look for in the data?

Bridge Piles & Support

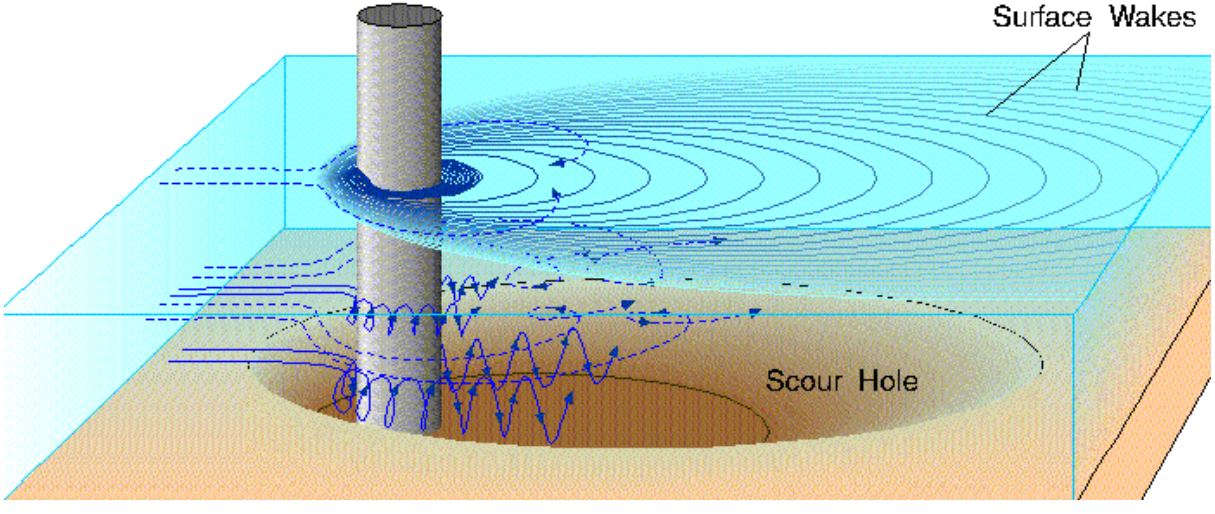
What You Don't See is the Problem

Bridge piling can be made with steel supports of concrete footings supported by riprap.

What is a Bridge Scour

The removal of sediment around a bridge abutment/pier caused by swiftly moving water, creating a hole that can compromise the integrity of the structure.

In the United States, bridge scour is estimated at **60%** of all bridge failures.



Schoharie Creek Bridge Disaster

In 1987, a 400-foot section of the New York State Thruway collapsed into the rain-swollen Schoharie Creek, 40 miles northwest of Albany, killing ten people.

Learn More via The History Channel:
https://www.youtube.com/watch?v=nwm0seFZXvM

Bridge Collapse, April 5, 1987

Bonner Bridge, NC

A new bridge is being built to replace the Bonner Bridge but won't be done until 2018.

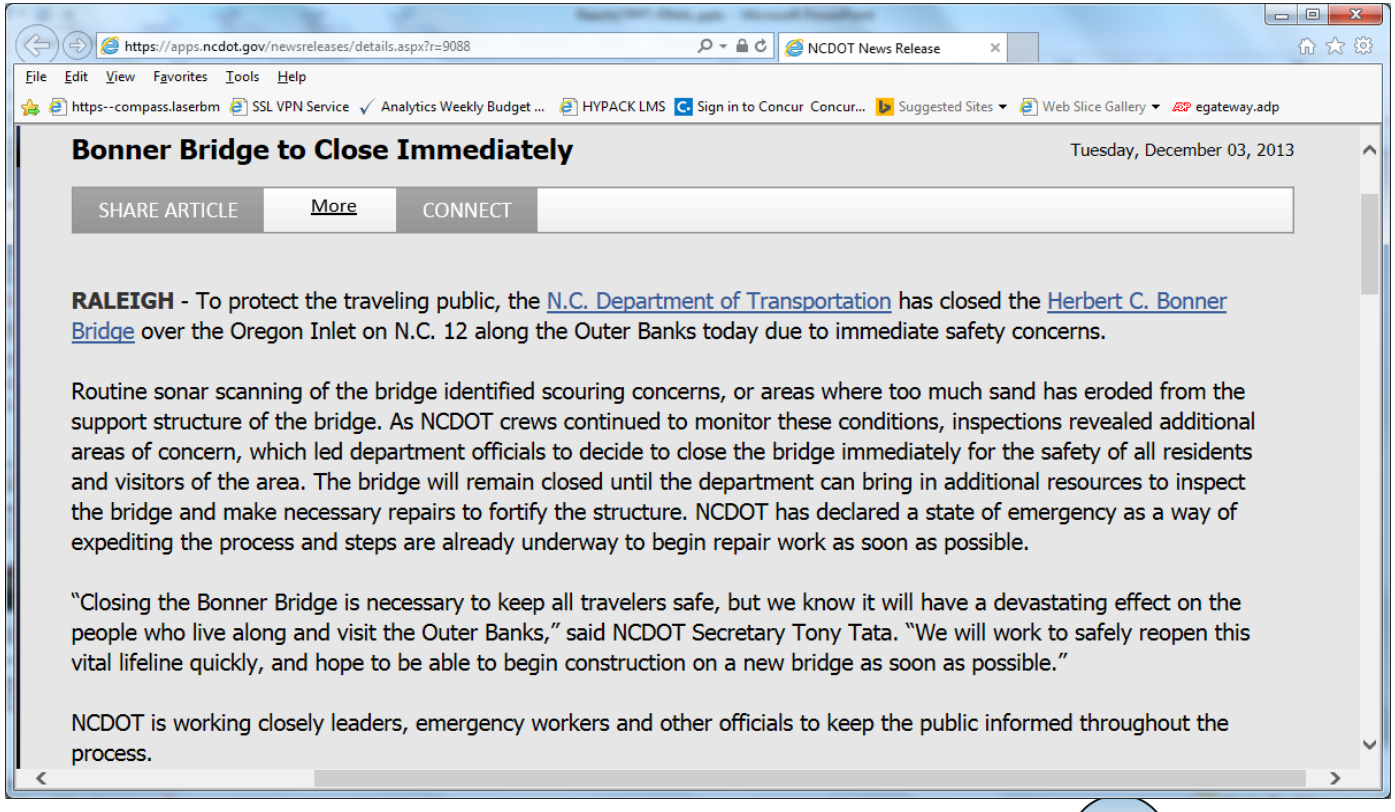
Continuous monitoring of the Bonner Bridge piles are now done monthly for degradation of support.

NCDOT uses the sonar information for bridge closure if there is unsafe conditions.

Immediate Response to Sonar Work

Survey inspections, followed by data processing for any potential faults, allows the highway department to issue an immediate warning. In this case, the bridge was closed before any potential collapse

Immediate remediation occurred to fill in any scour holes and build up enough material to prevent any potential collapse.



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NCDOT News Release

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Bonner Bridge to Close Immediately

Tuesday, December 03, 2013

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RALEIGH - To protect the traveling public, the N.C. Department of Transportation has closed the Herbert C. Bonner Bridge over the Oregon Inlet on N.C. 12 along the Outer Banks today due to immediate safety concerns.

Routine sonar scanning of the bridge identified scouring concerns, or areas where too much sand has eroded from the support structure of the bridge. As NCDOT crews continued to monitor these conditions, inspections revealed additional areas of concern, which led department officials to decide to close the bridge immediately for the safety of all residents and visitors of the area. The bridge will remain closed until the department can bring in additional resources to inspect the bridge and make necessary repairs to fortify the structure. NCDOT has declared a state of emergency as a way of expediting the process and steps are already underway to begin repair work as soon as possible.

"Closing the Bonner Bridge is necessary to keep all travelers safe, but we know it will have a devastating effect on the people who live along and visit the Outer Banks," said NCDOT Secretary Tony Tata. "We will work to safely reopen this vital lifeline quickly, and hope to be able to begin construction on a new bridge as soon as possible."

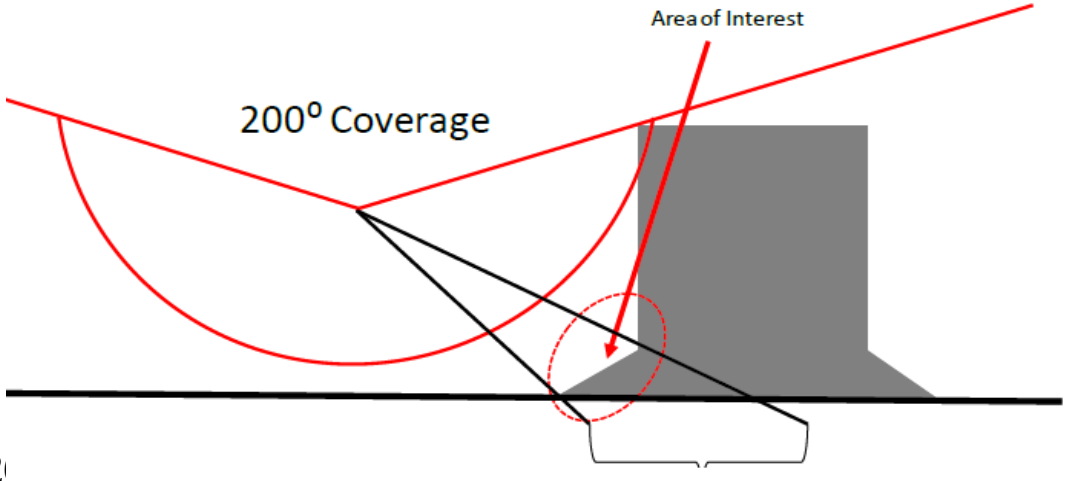
NCDOT is working closely leaders, emergency workers and other officials to keep the public informed throughout the process.

Using Sonar to Detect Potential Scour

Different types of sonar can be used for surveying:

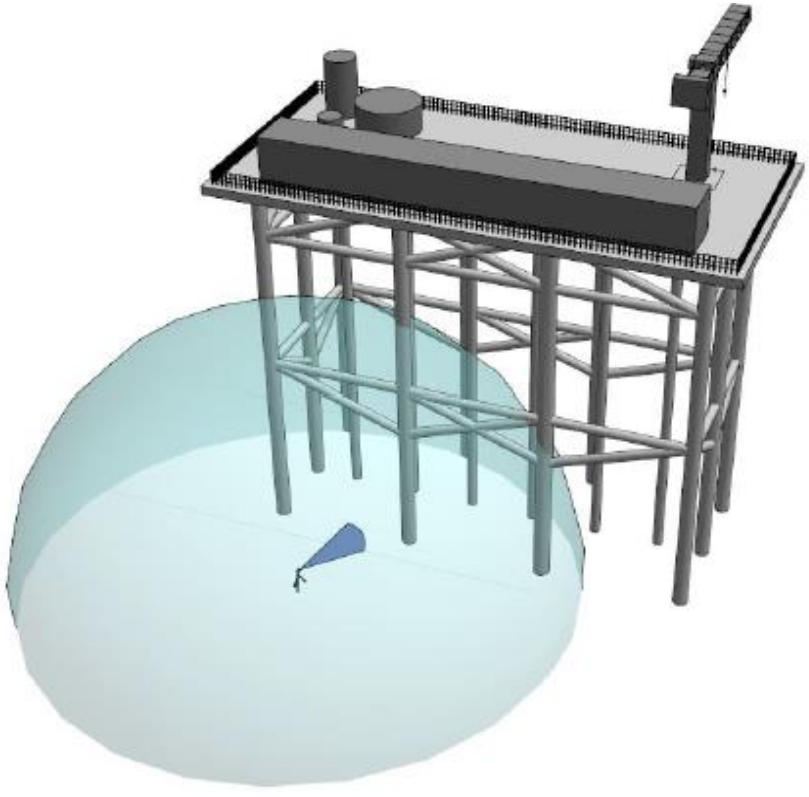
1. Fixed mount, SCANNING sonar
   EX: BlueView5000, Tritech, Blueview

2. Vessel mounted system for sidescan and bathymetry
   EX: Edgetech 6205, Klein 3500, PingDSP



Scanning Sonar

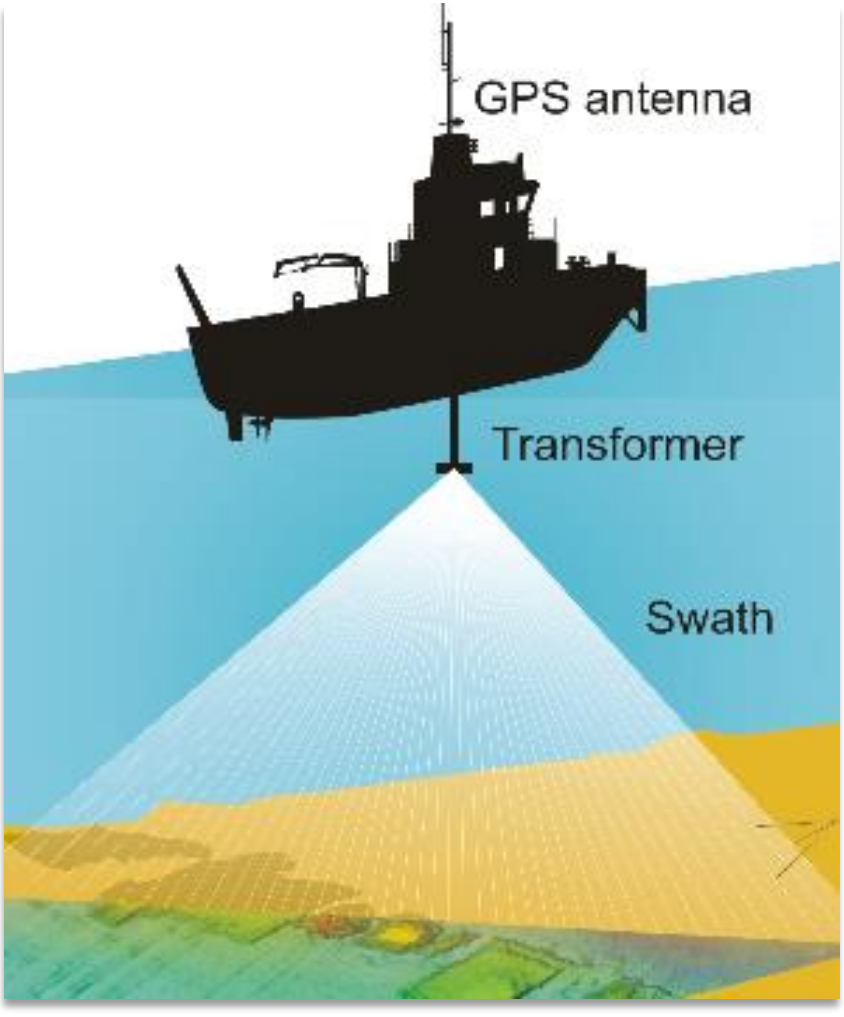
Fixed on seabed, the sonar can scan out vertical or horizontal. System is moved to next section when completed.



Vessel Mounted Sonar

Combined with precise positioning, underwater features can be mapped to decimeter.

Running at a speed of 4kts, large survey areas are mapped in minimal time.



Vessel Mounted Sonar

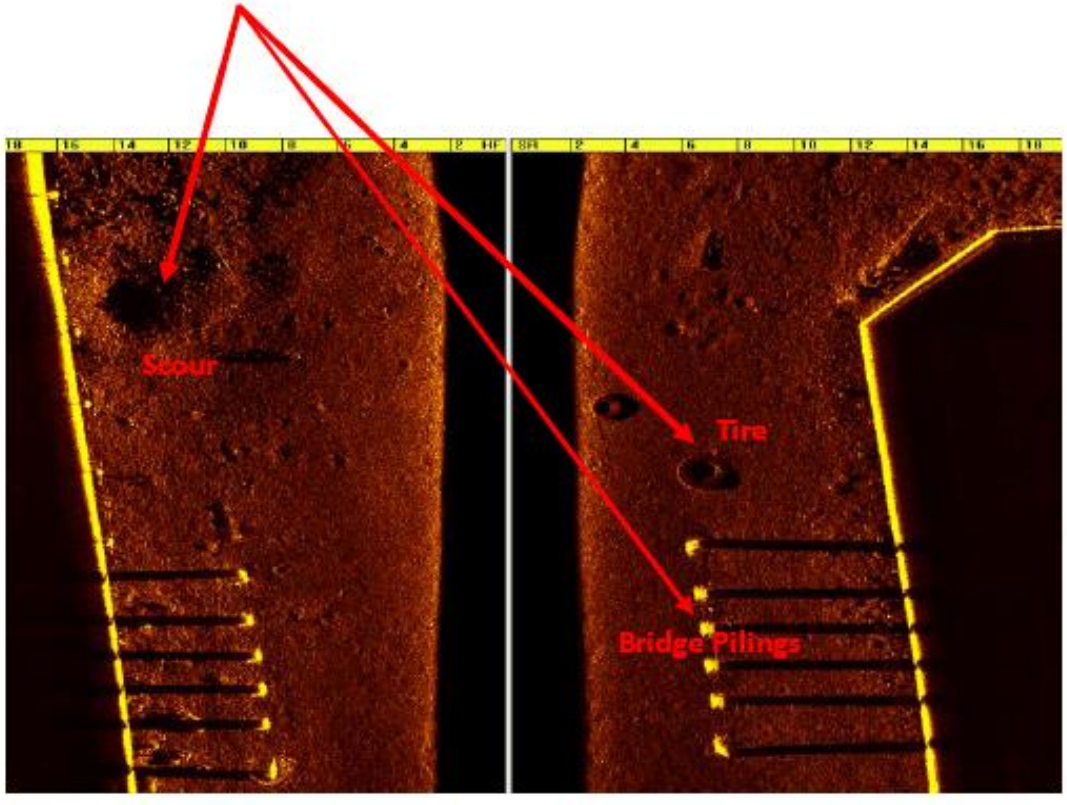
Case Study: Bonner Bridge in North Carolina

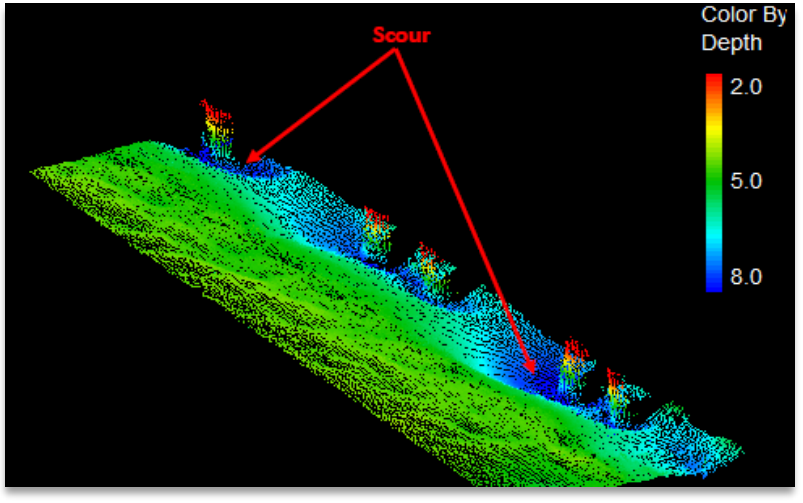
- Spans over 1000 meters over Oregon Inlet
- Survey on east and west side
- Survey speed 4 kts (2 m/s)
- Each side can be completed in under 10 minutes.
- With the new construction of a bridge taking place, the old one is continually monitored for potential closure. Since 2014, it has not been closed.

Bridge Piles, Debris, and Scour

Data Analysis: Bathymetry and sidescan output

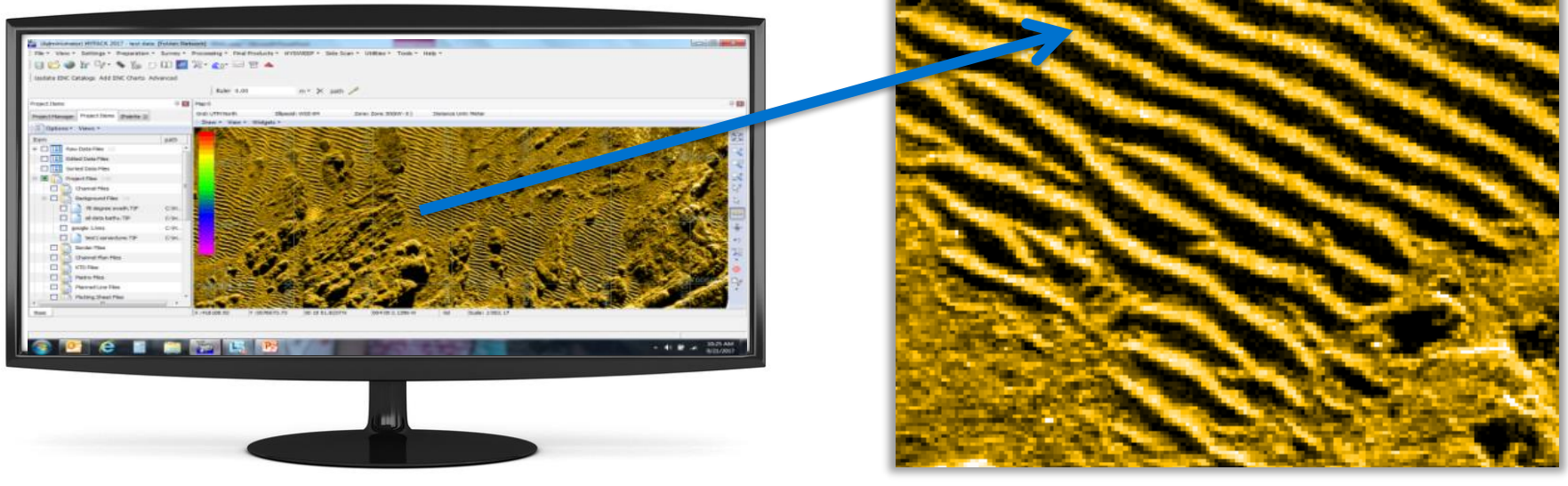
Scour on sidescan will present itself as a dark image (no shadow); on bathymetry, can color code the depths for the “deep” pocket





Seabed Detection

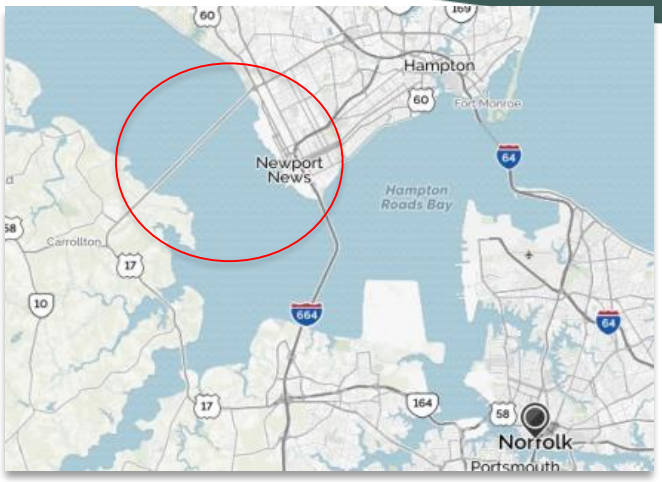
Sidescan detection can resolve rocks of less than 25cm and is useful for scanning bridge foundations for riprap.

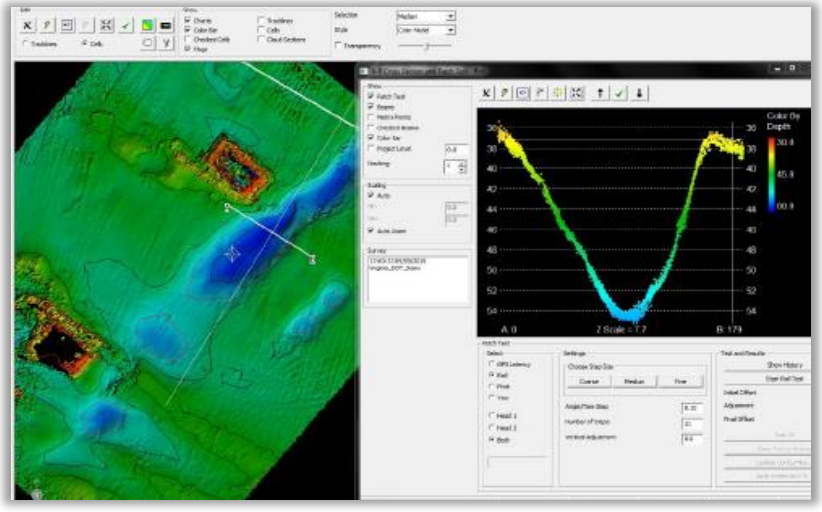


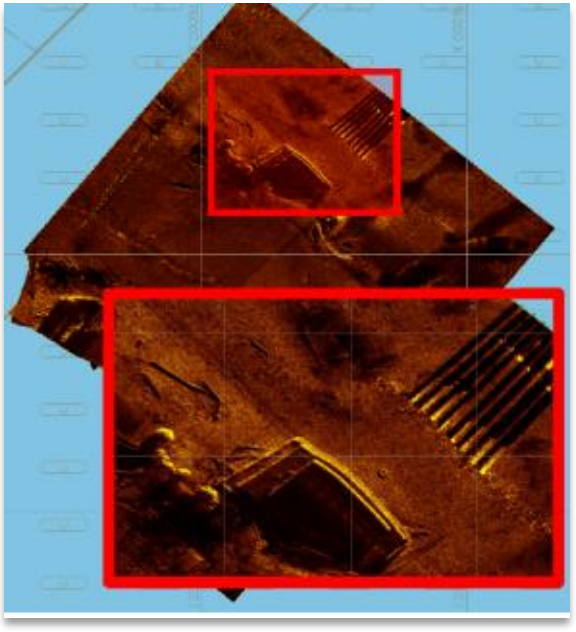
James River Bridge, Virginia

- Spanning the James River in VA, the original bridge in 1928 was the longest bridge over water 4.5 miles.

- On a recent survey, one scour hole more than 6m (20 feet) deep was observed.

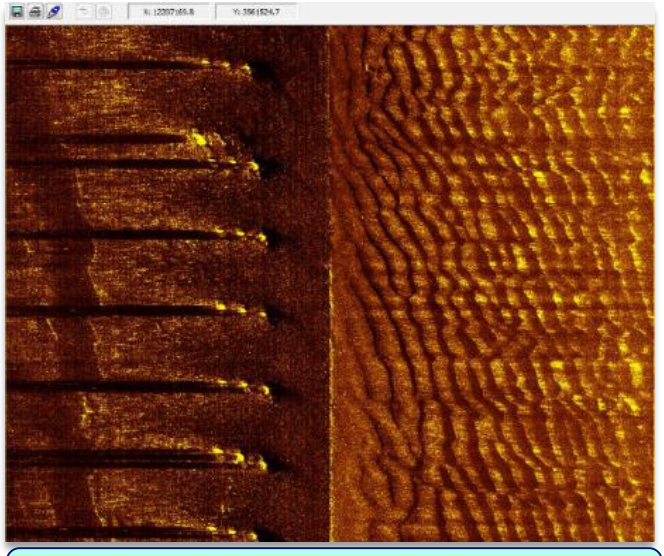




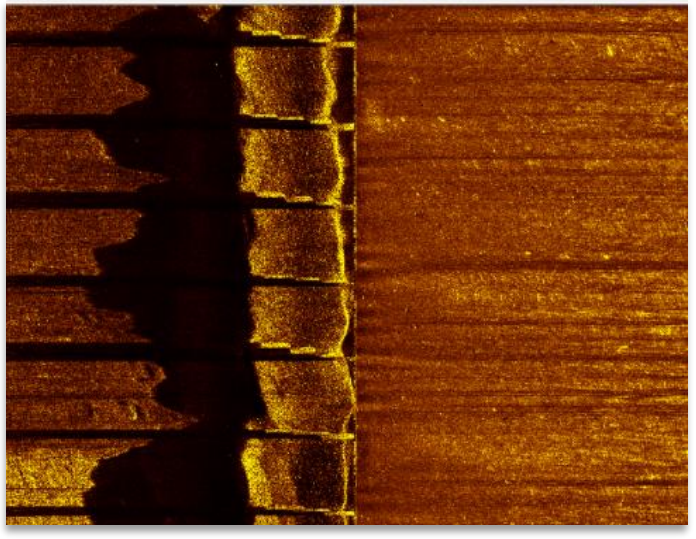


Using Sidescan to Monitor Riprap

- Using Riprap will protect the bridge footings. High currents and flood waters can move these rocks.
- Sidescan collection allows for the observation of the material during construction and inspection surveys.



Bridge piles with no protection



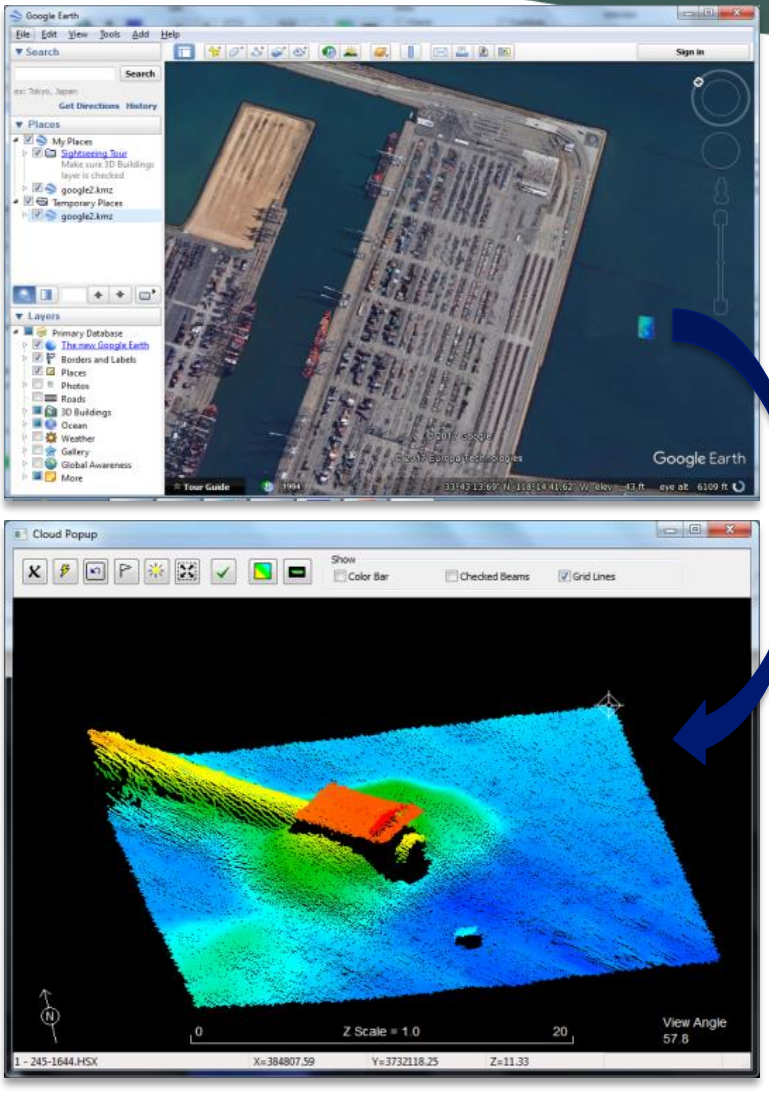
Bridge piles surrounded by protective material

How else can we use Sonar? - Underwater Inspection

City of Long Beach, CA sewer outfall 400 meters offshore.

- 12 meters water at exit
- Pipe diameter 2.5m

Survey to ensure no free span or damage



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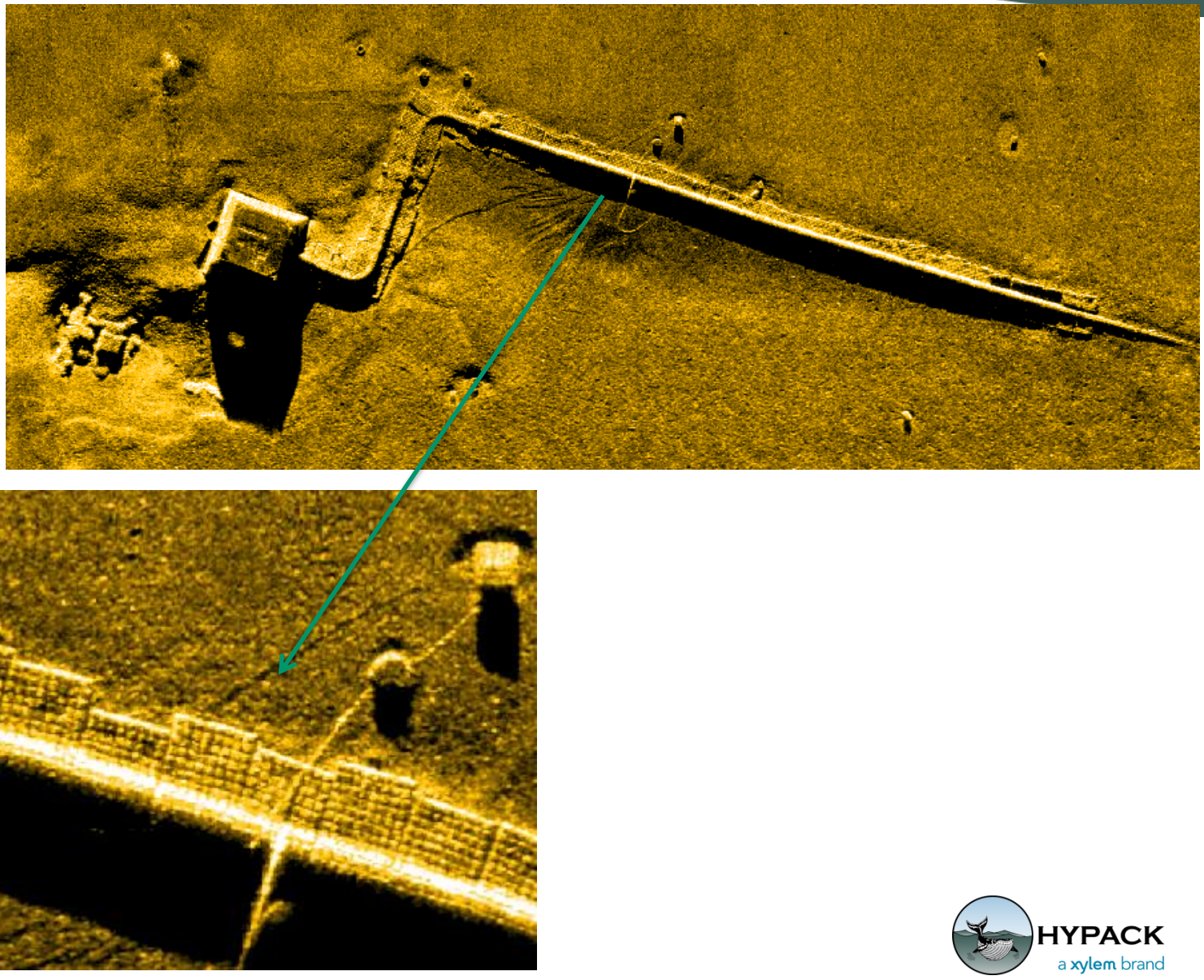
Sonar inspection examples

1 meter pipe, protected by a matting.

Sonar inspection can detail any potential faults



Using Sonar Technology for Monitoring Infrastructure

Vessel of opportunities allow the sonar and equipment to be easily installed.

Software for acquisition (line planning, repeatability/condition survey) will aid for real time decisions.

Processing multiple data sets (sonar, bathy) or multiple surveys (comparison over time)

Any infrastructure (underwater) can be mapped and observed for possible failure