United States Antarctic Program

Palmer Pier Above Waterline Structural Survey

RPSC & NSF

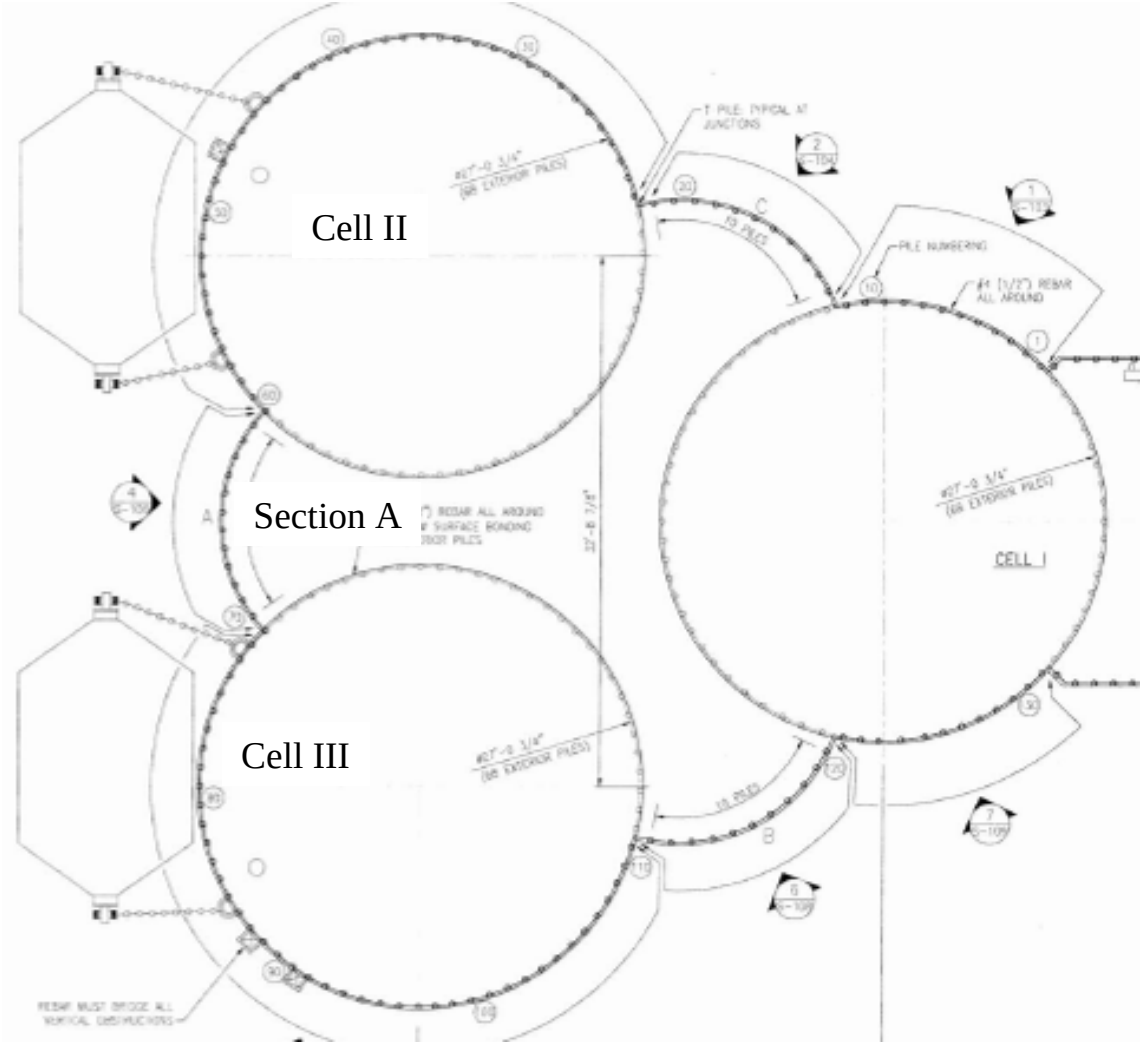
2/10/2009

Raytheon
Polar Services

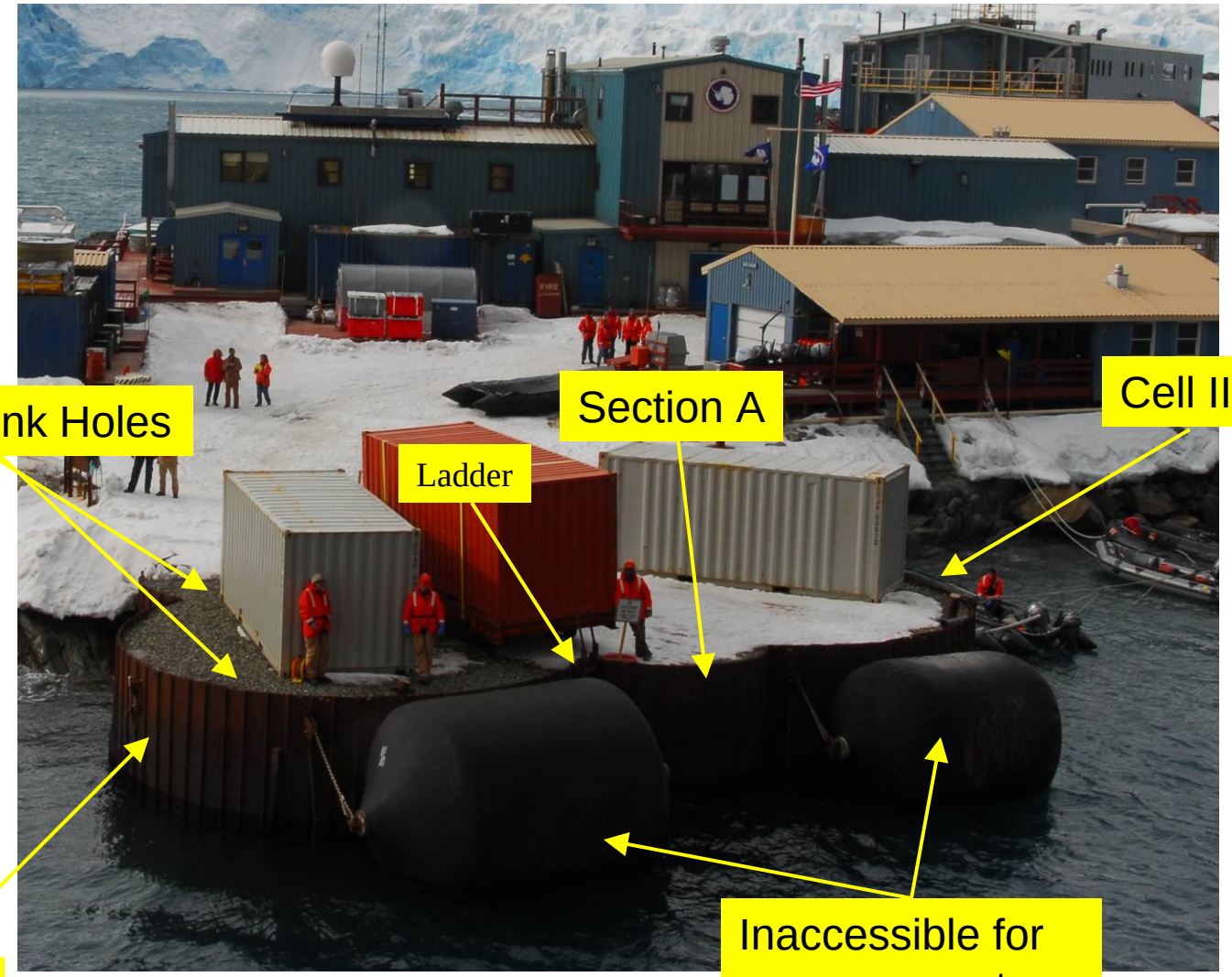
Overview

- Pier thickness measurements
  - Thickness measurements were taken with NIST calibrated ultrasonic metal thickness meter over regular interval along pier above the low tide line
- Pier condition/Photos
- Survey Summary (above and below water)
- Results
- Key Observations
- Recommendations

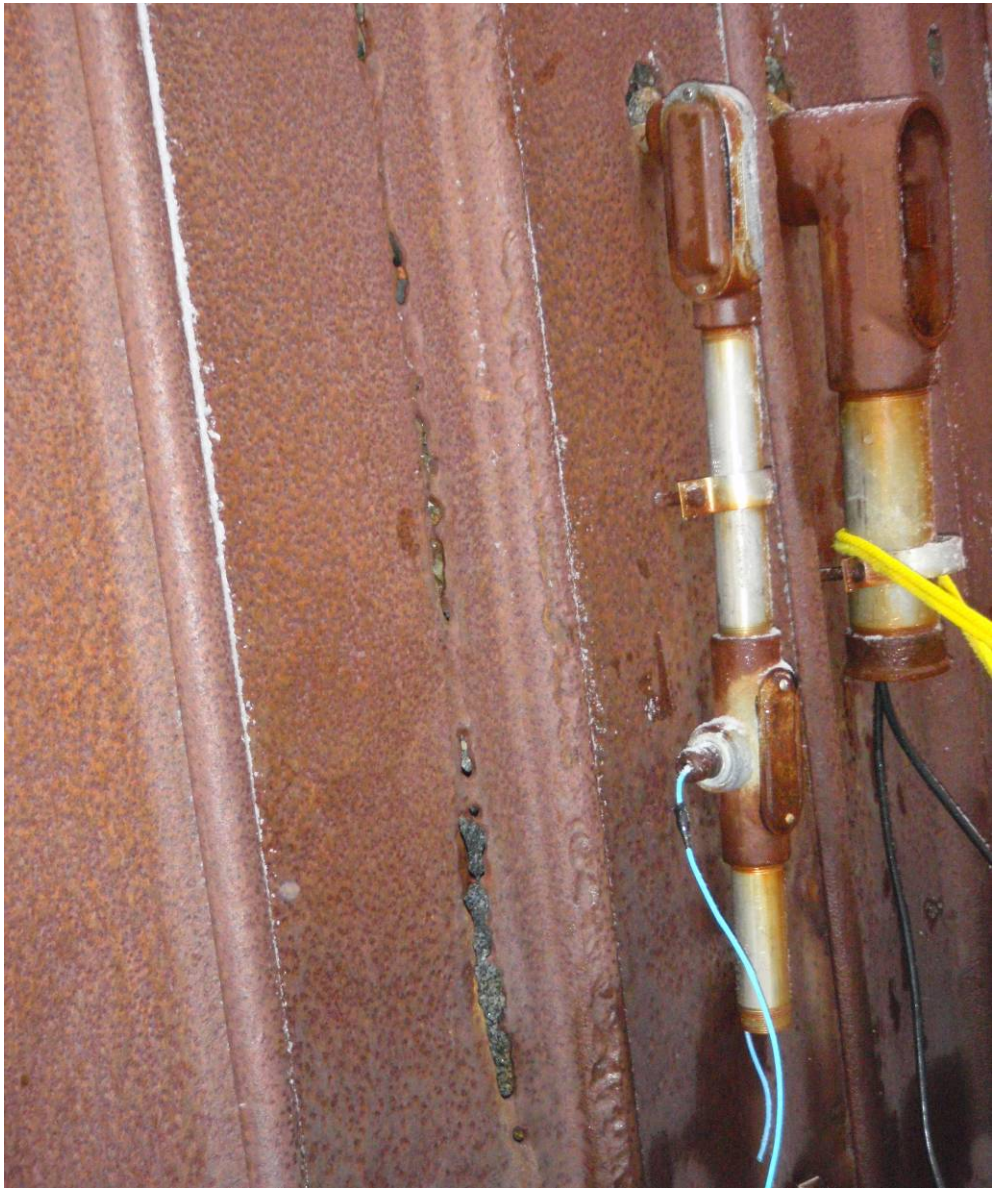
Pier Plan



Areas Surveyed



Tears in Piles



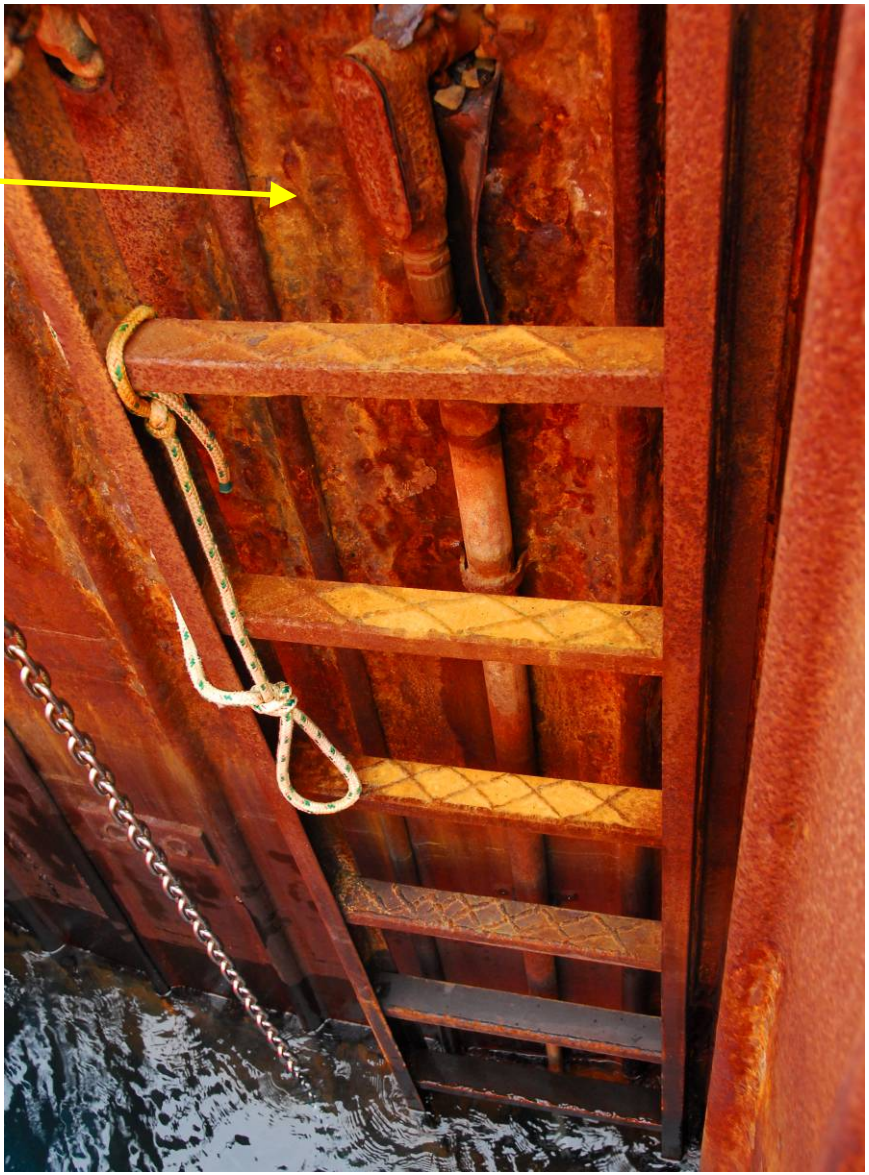
Weakened Piles

Corrosion

Corrosion and Holes

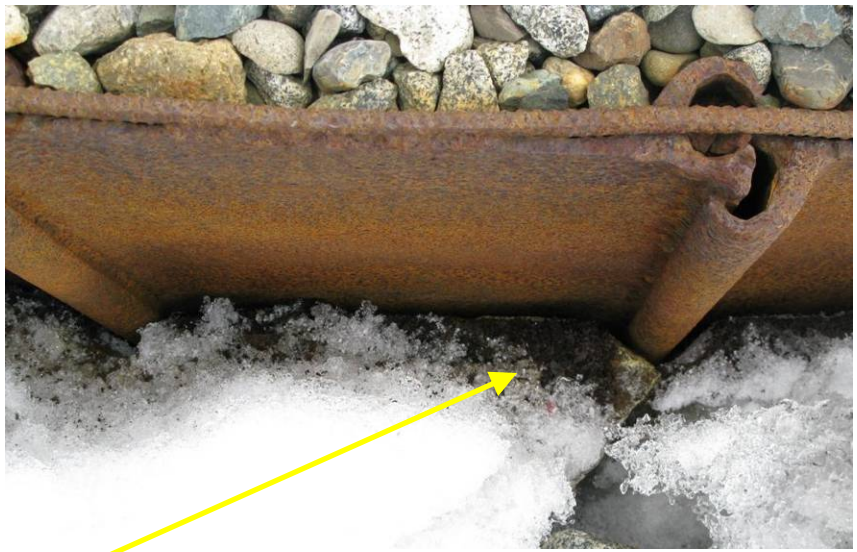
More Corrosion

0.1” thick in places



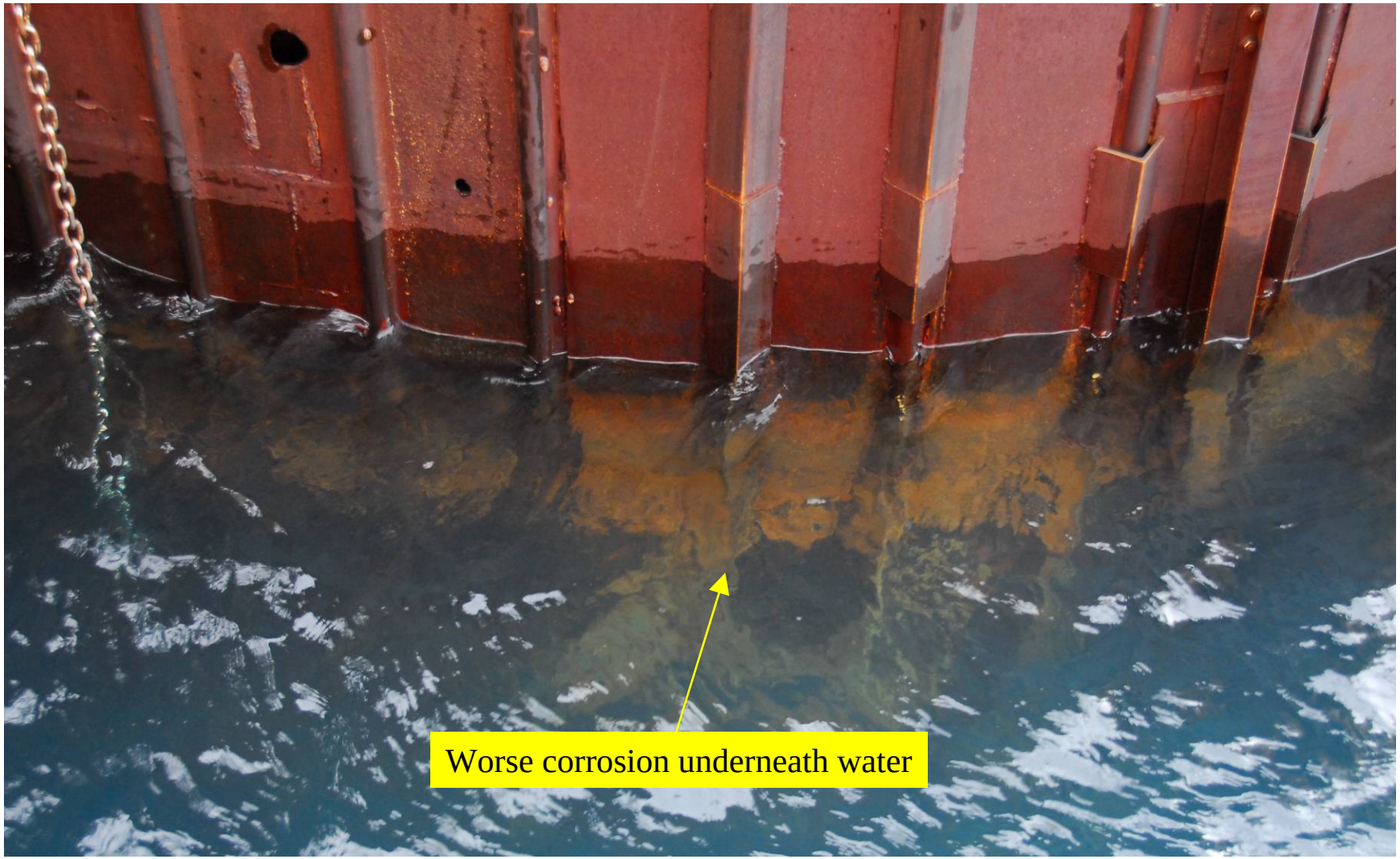
Growing Holes

Flaking



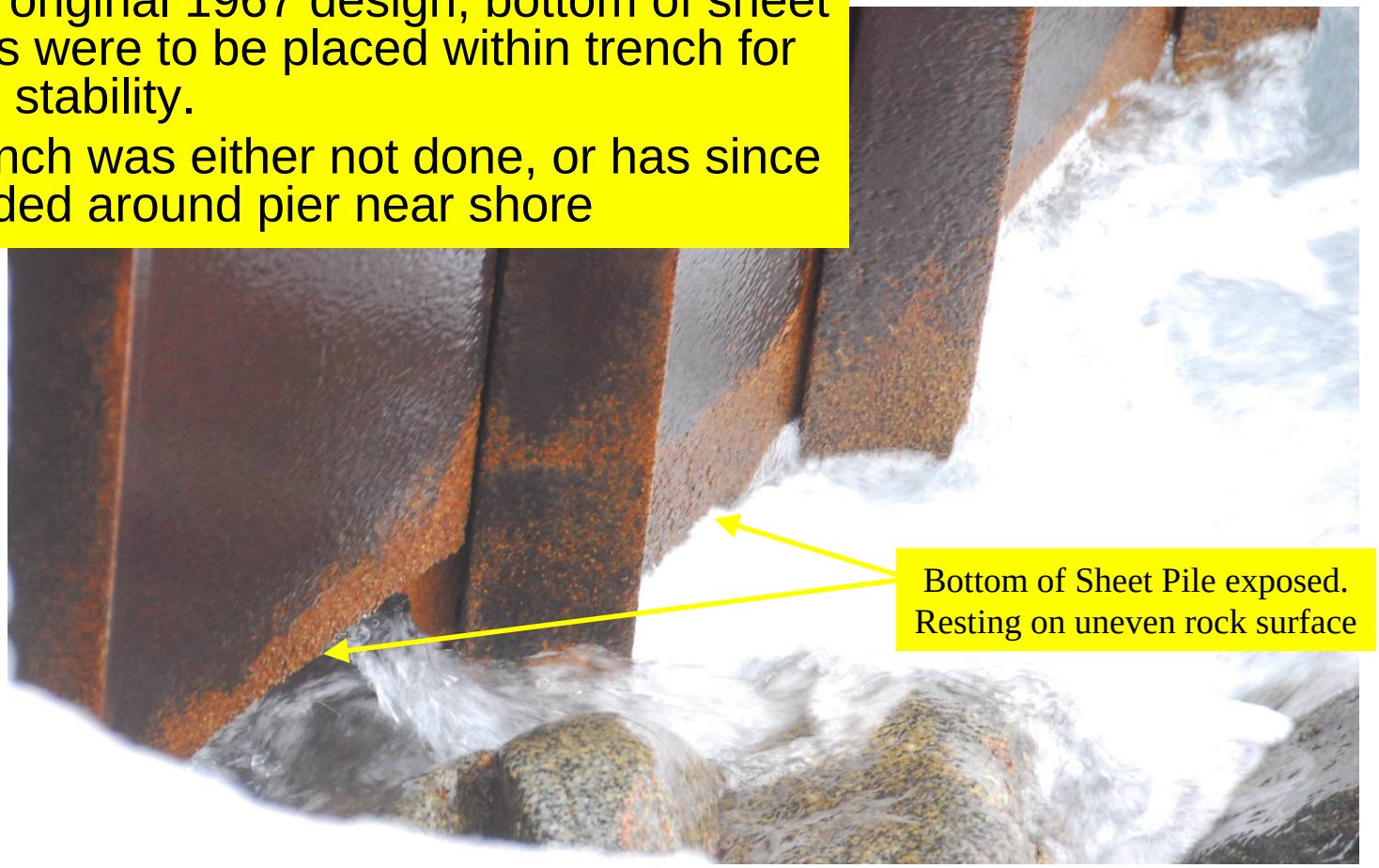
Flaking of Sheet Piles. (Enough flaking to show on top of seasonal snows)

Underwater Corrosion



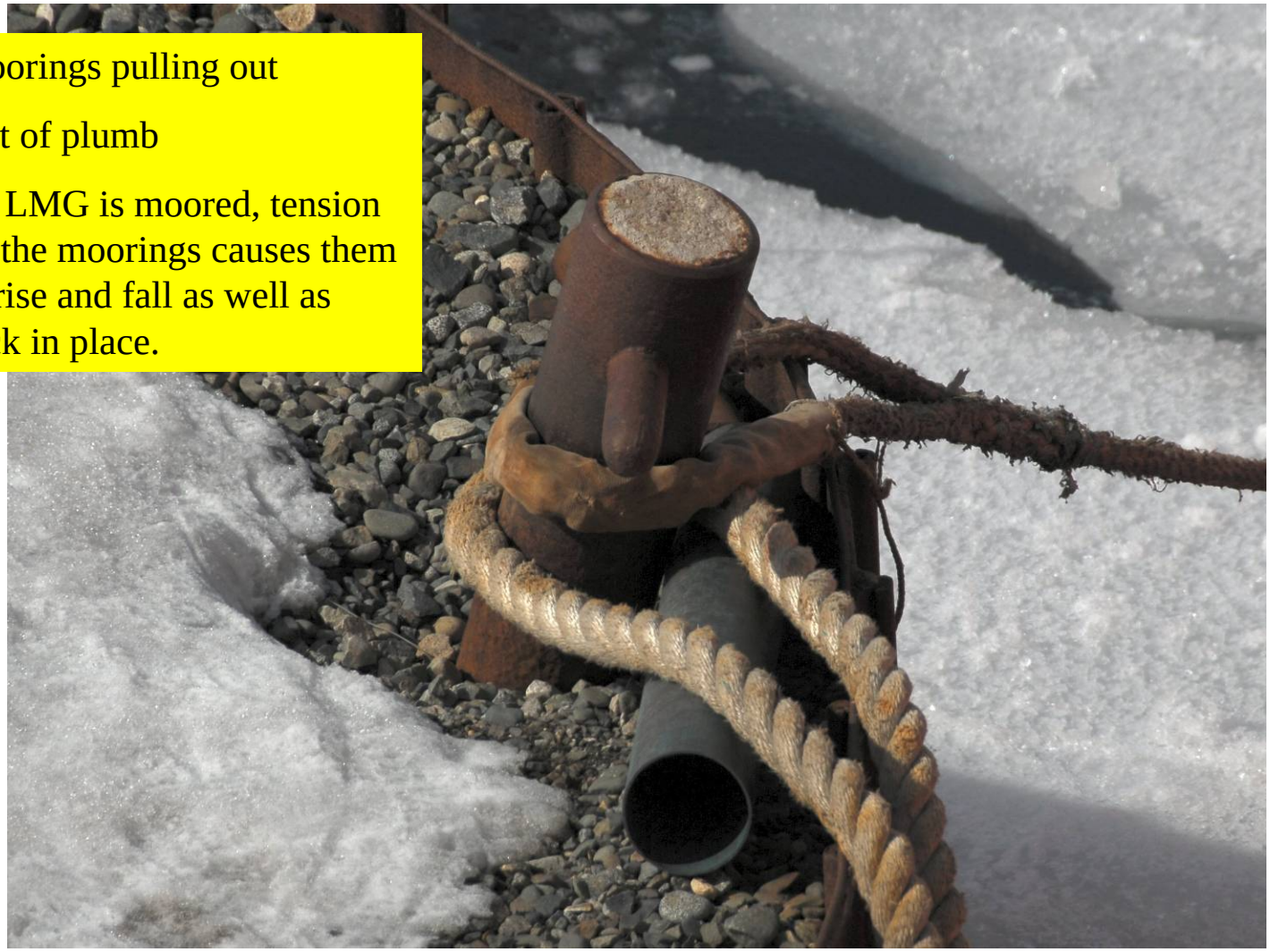
Pier Foundation

- Per original 1967 design, bottom of sheet piles were to be placed within trench for pier stability.
- Trench was either not done, or has since eroded around pier near shore



Unsecure Moorings

1. Moorings pulling out
2. Out of plumb
3. As LMG is moored, tension on the moorings causes them to rise and fall as well as rock in place.



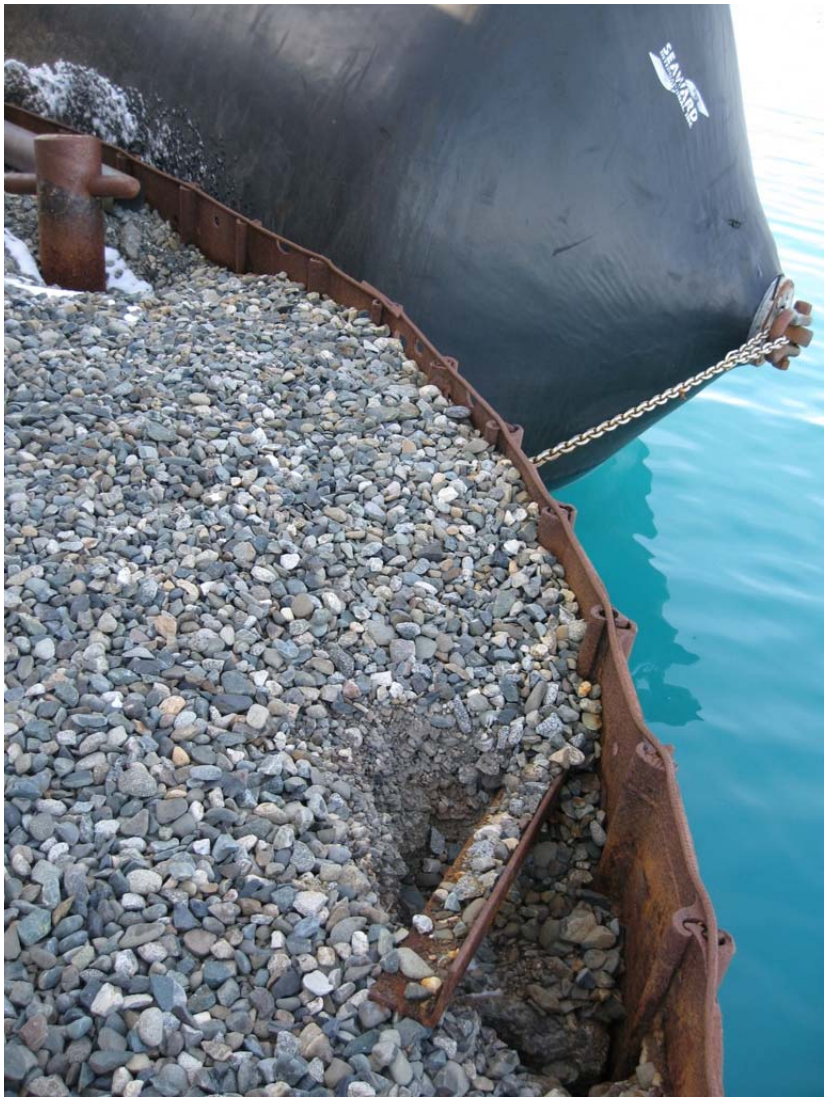
Unsecure Moorings

Sink Hole

Largest Sink Hole to date appeared as LMG left Palmer 10/24/2008

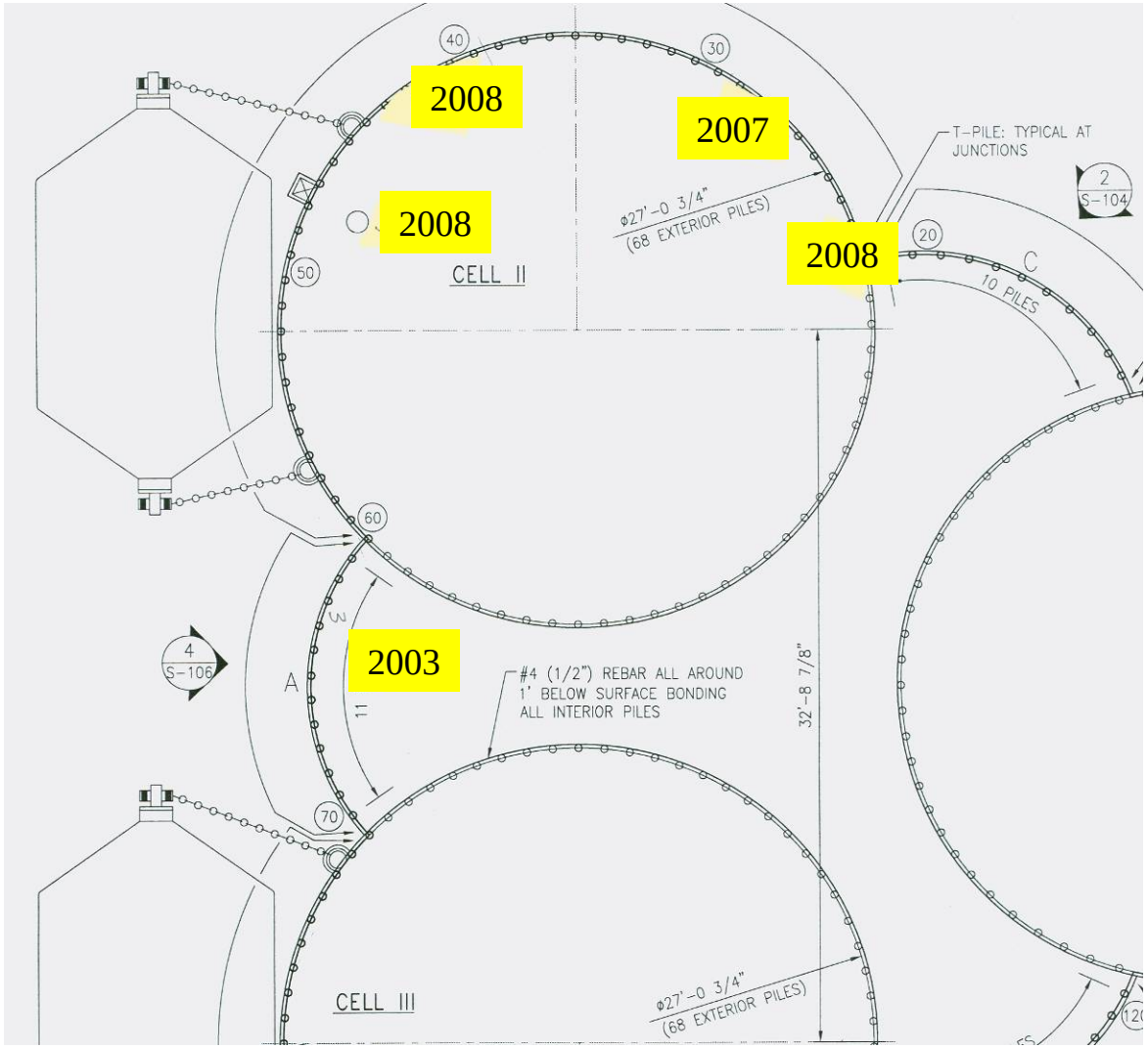
- 14” in diameter with undercut edges
- 6 feet deep

Sink Holes

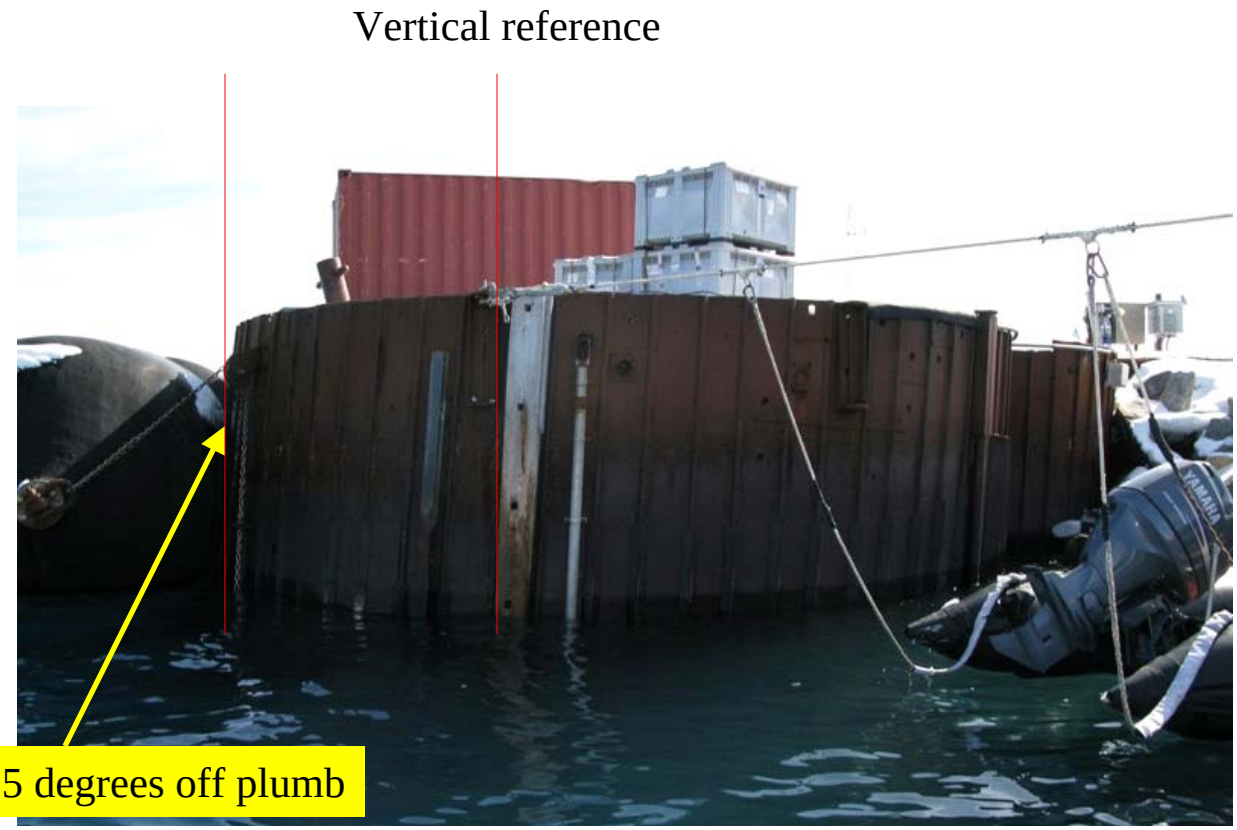


New Sink Hole
11/4/2008

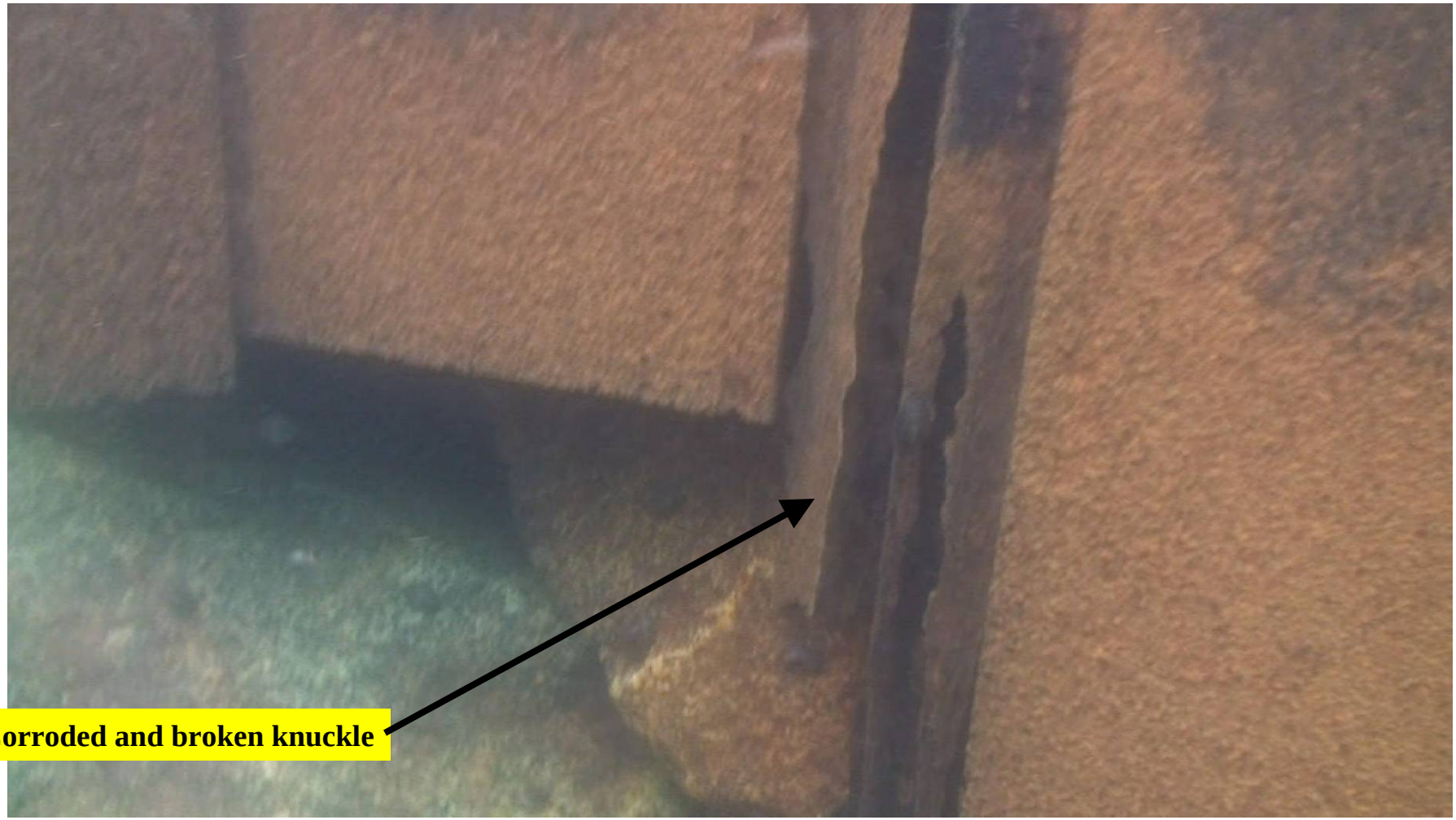
Sink Hole Locations



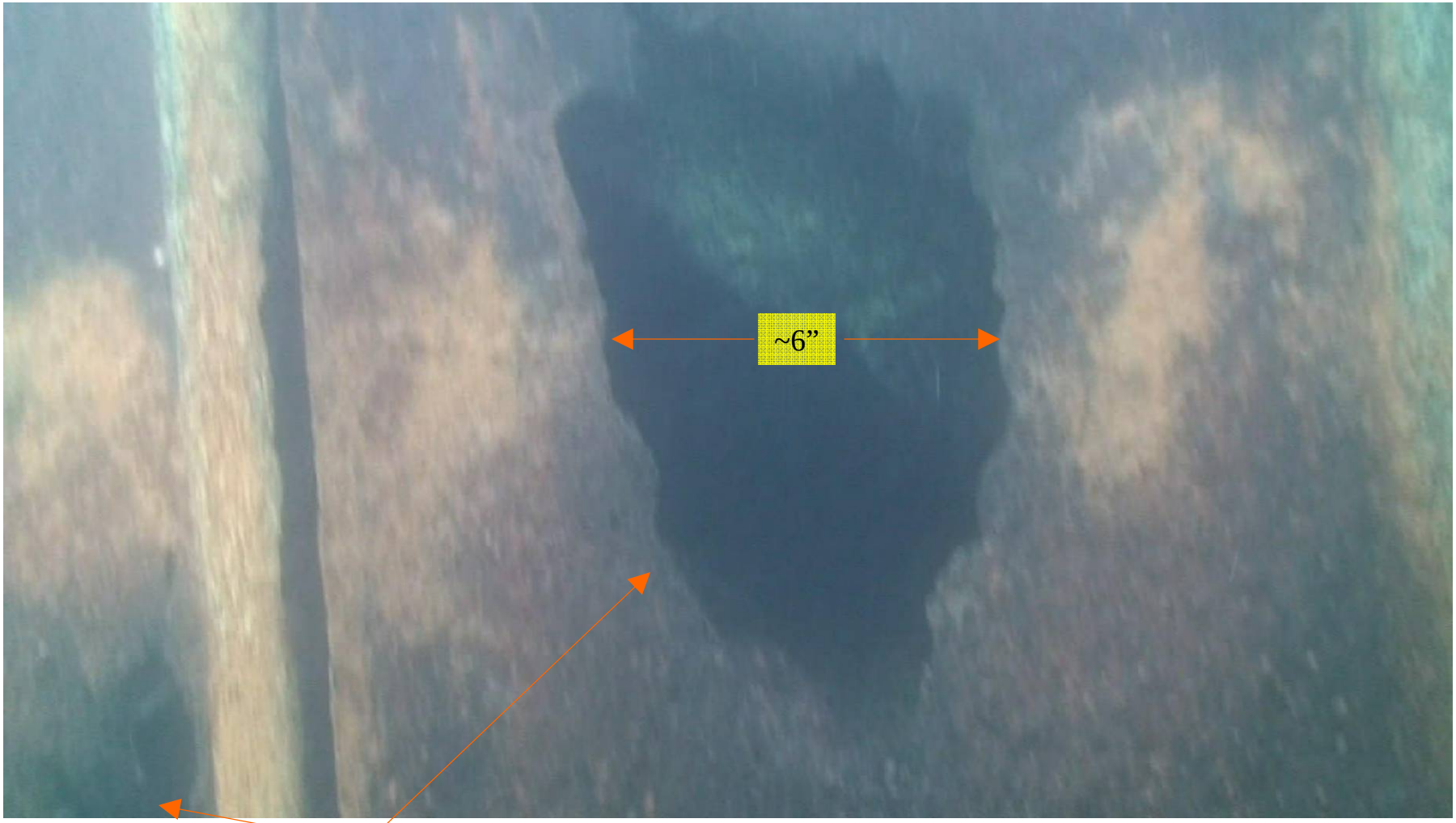
Pier Lean



Pier Bottom



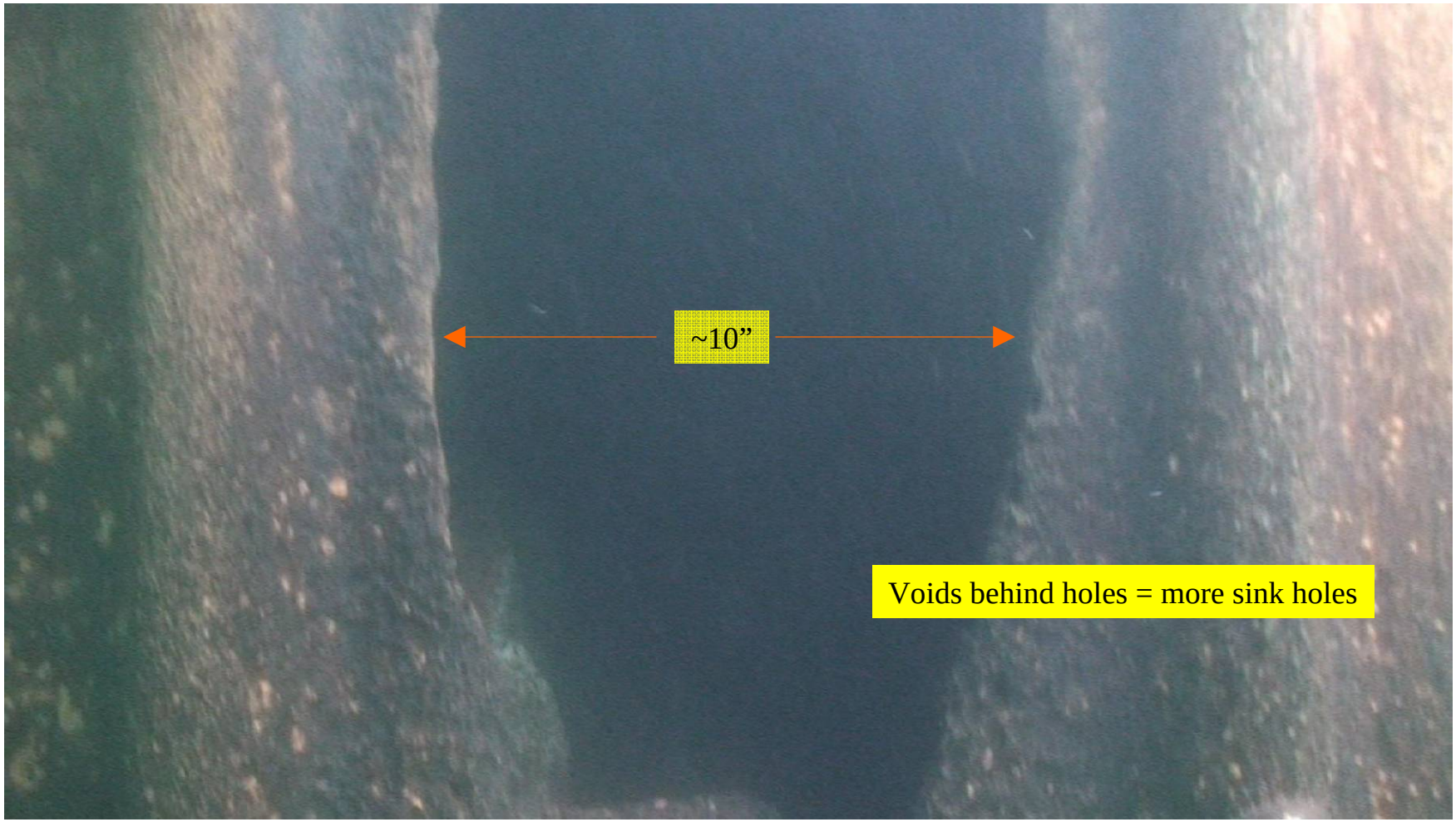
Hole in Pier



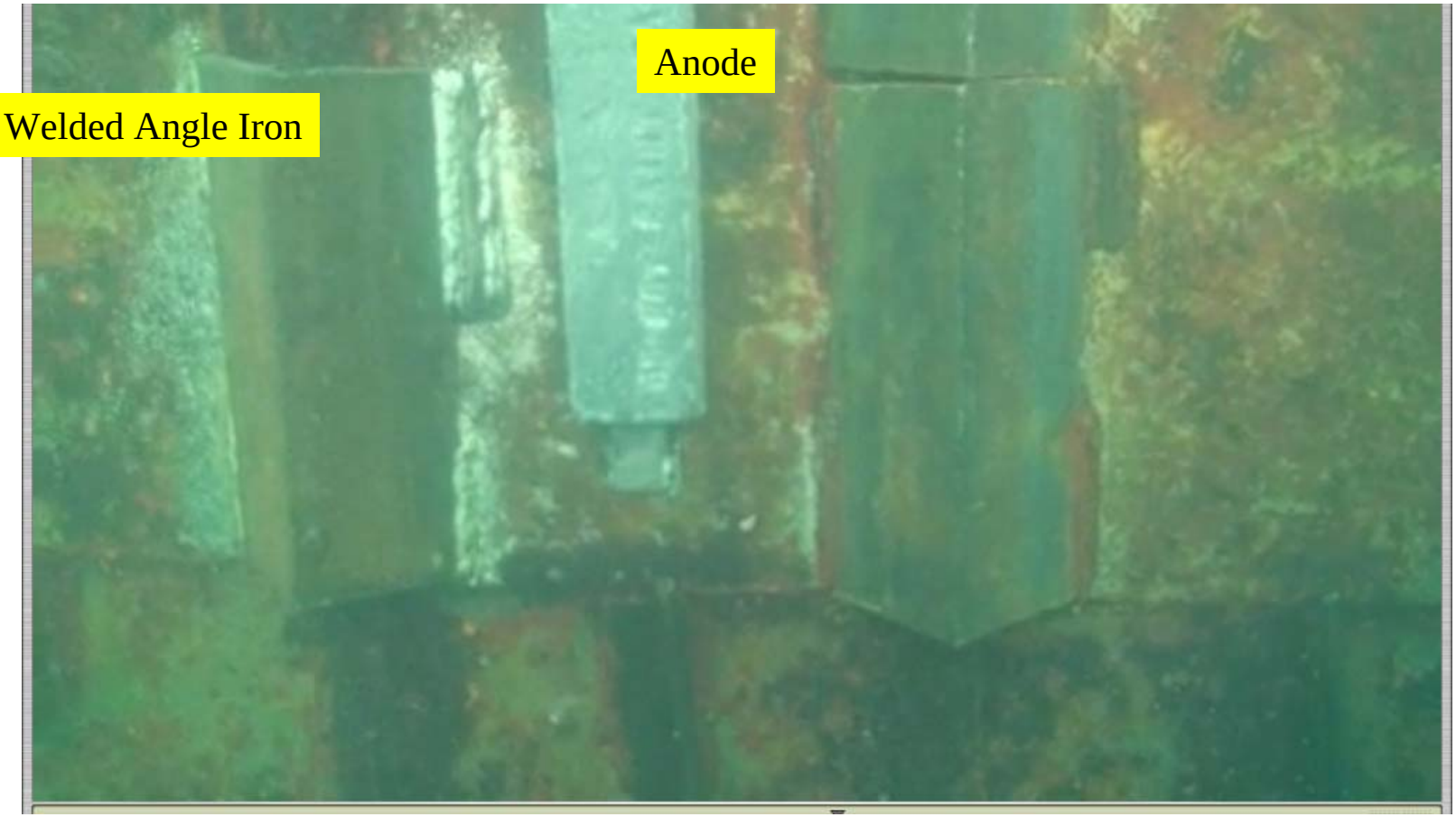
Holes and Thin Areas

Cobbled Area

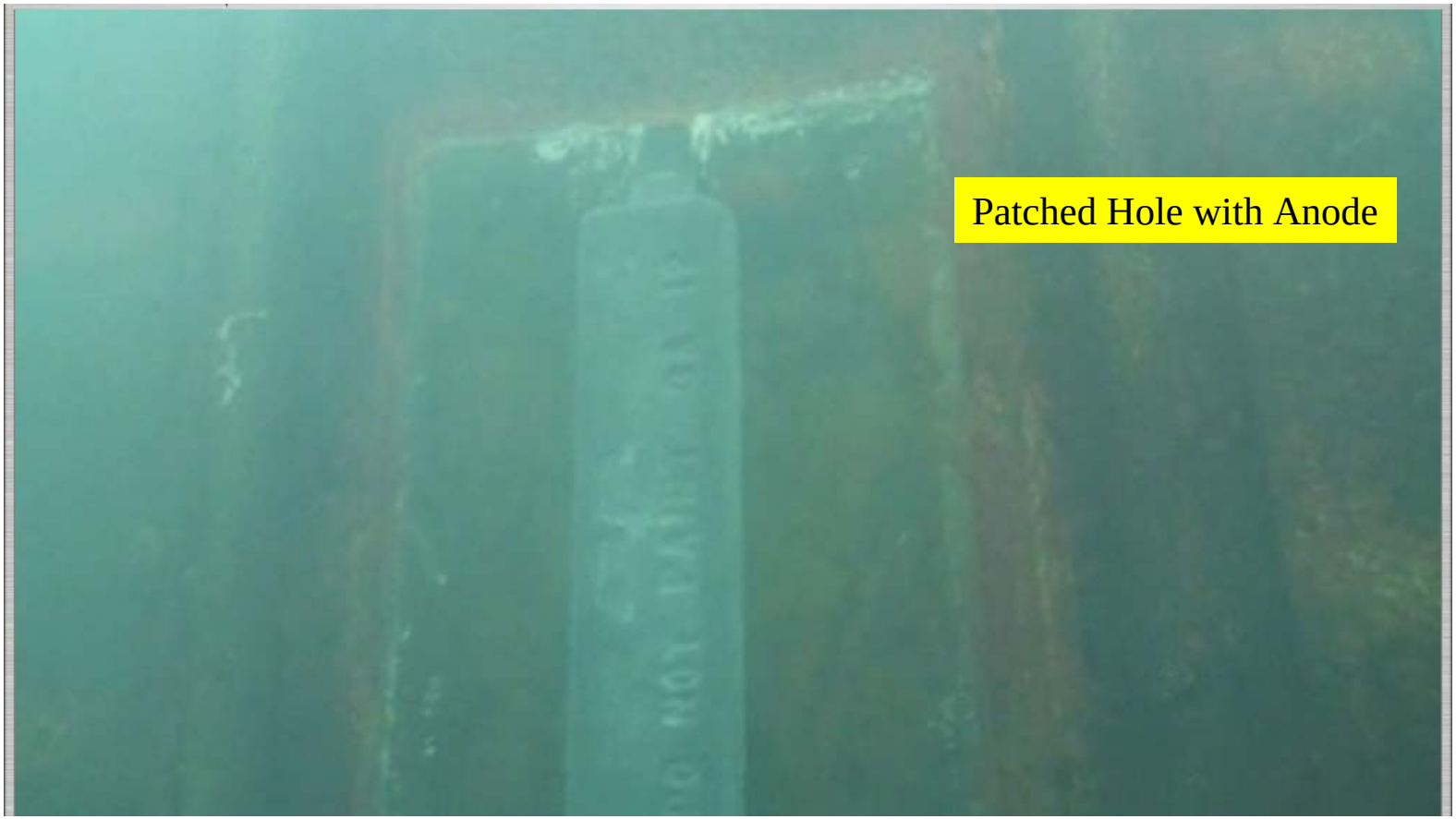
Large Hole



Joint Repair



Hole Repair



Hole Repair

New Patches beginning to corrode

Hole and Joint Repair

Repair of Hole and failing joint

Above Water Measurements

Average Reductions in Pier Thickness (original sheet pile thickness: 0.375")

	Above Water Measurements		Measurements Between High and Low Tide		Measurements Above High Tide Line	
	Average Thickness (in.)	% Reduction	Average Thickness (in.)	% Reduction	Average Thickness (in.)	% Reduction
Cell II	0.284	24%	0.262	30%	0.303	19%
Cell III	0.310	17%	0.299	20%	N/A	N/A
Section A	0.295	21%	0.272	27%	0.308	18%
Complete Pier	0.296	**21%**	0.278	**26%**	0.306	**19%**

Underwater Measurements

Average Reductions in Pier Thickness (original sheet pile thickness: 0.375")

	All Measurements Taken (Above and Below Water)		Underwater Measurements		Underwater Measurements Minus Repaired Sections	
	Average Thickness (in.)	% Reduction	Average Thickness (in.)	% Reduction	Average Thickness (in.)	% Reduction
Cell II	0.341	9%	0.372	1%	0.357	5%
Cell III	0.376	0%	0.382	-2%	N/A	N/A
Section A	0.349	7%	0.385	-3%	N/A	N/A
Complete Pier	0.355	**5%**	0.380	**-1%**	N/A	**N/A**

Negative indicates an increase in thickness (most likely inaccurate)
We had to use a different probe for the underwater measurements

Results

- 5% overall reduction in sheet pile thickness
- 26% reduction in sheet pile thickness between low and high tide
- 1% increase in sheet pile thickness below water (high probability of inaccurate measurements)
- Severe corrosion mostly concentrated between tide lines
- Local minimums of 0.1” in spots of worst corrosion but still absent of holes

Observations

- Many holes due to corrosion present in piles throughout
  - Cell II has seen the most corrosion
- Walls along mooring edge of pier 5 degrees out of plumb
  - Tilted toward Station, most likely as a result of the ship's pressure on the pier
- Large sink holes forming over Cell II and Section A of pier
- Large holes in Pier above and below water ~10 inches
  - Wave action may contribute to loss of fill behind these holes creating voids
- Areas of significant corrosion resulting in uneven surface (unable to measure thickness with ultrasonic sensor)

Divers' Comments

- Underwater probe's sensor area too large for accurate readings (unable to get solid interface with pier surface in areas of heavy corrosion)
- Underwater probe measured adequate thickness regularly in areas of obvious corrosion and reduced thickness (i.e. inaccurate underwater measurements)

Repairs

- Divers identified 17 areas needing immediate attention
- 6 of these areas were repaired
- 11 areas remain
- Data from survey indicated 21 areas of severe corrosion (holes/weak areas needing repair)
- 15 of these areas were repaired
- Installed zinc anodes for corrosion protection
- The remaining 6 areas to be repaired next season

Recommendations

- Further measurements should be taken with new probe during next year's inspection
- Additional areas of corrosion need to be repaired
- Mooring procedure has been changed to reduce pressure against pier
- Use pier for two years with annual inspection program