Prediction and Mitigation of Scour and Scour Damage to Vermont Bridges

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Tropical Storm Irene: Extreme flooding damage to Bridges

Over 300 Vermont bridges were damaged in the 2011 Tropical Storm Irene and many experienced significant scour. Damage included scour, flanking, debris blockage, and superstructure damage. Successfully mitigating bridge scour in future flooding events requires reliable estimates of scour potential, and design methods and maintenance to minimize damage potential.

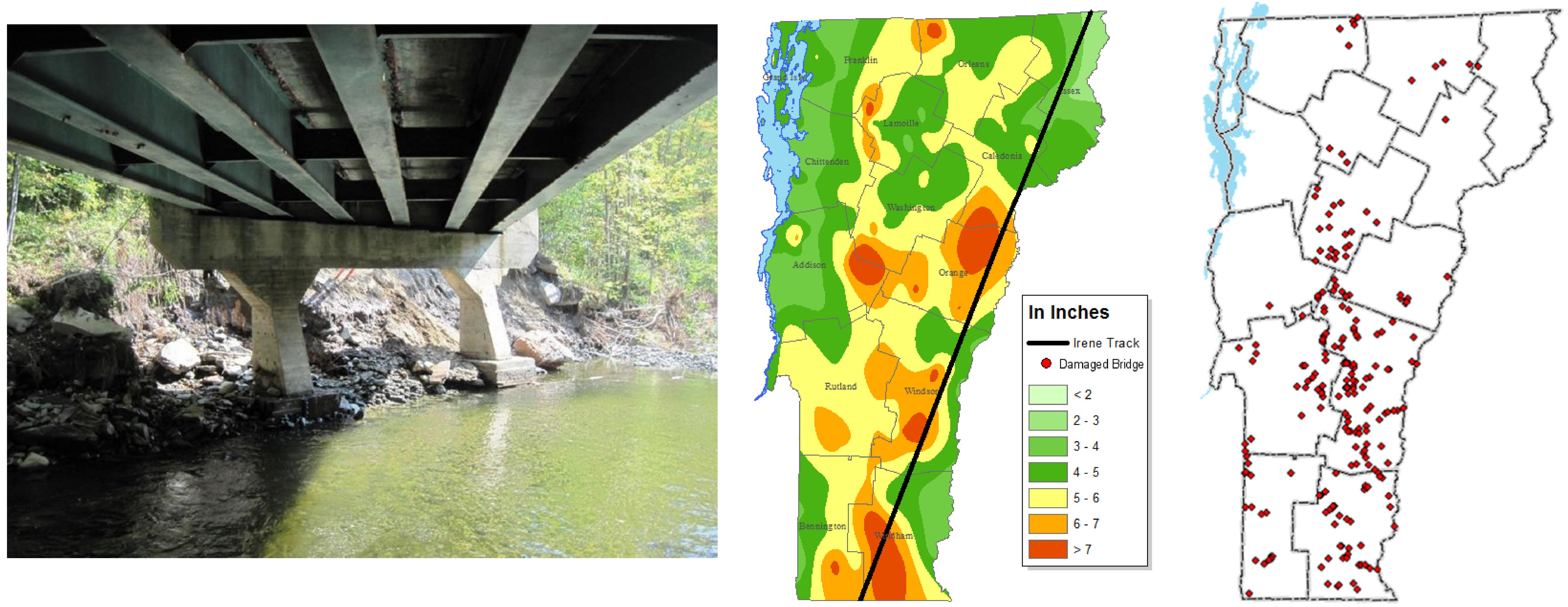


Figure 1. Bridge Scour, and Damaged Bridges in Vermont

Bridge Database Analysis: Feature Damage Correlation

A georeferenced database was created to combine bridge inspection, stream geomorphic data, watershed analysis, and damage reports. Stream power was computed at all bridge locations. The collected data was then analyzed for key features that correlate to damage. Key features include:

- Stream Power, including specific and storm scaled versions
- Geomorphic parameters like incision, entrenchment, W/D ratios
- Channel and waterway adequacy ratings

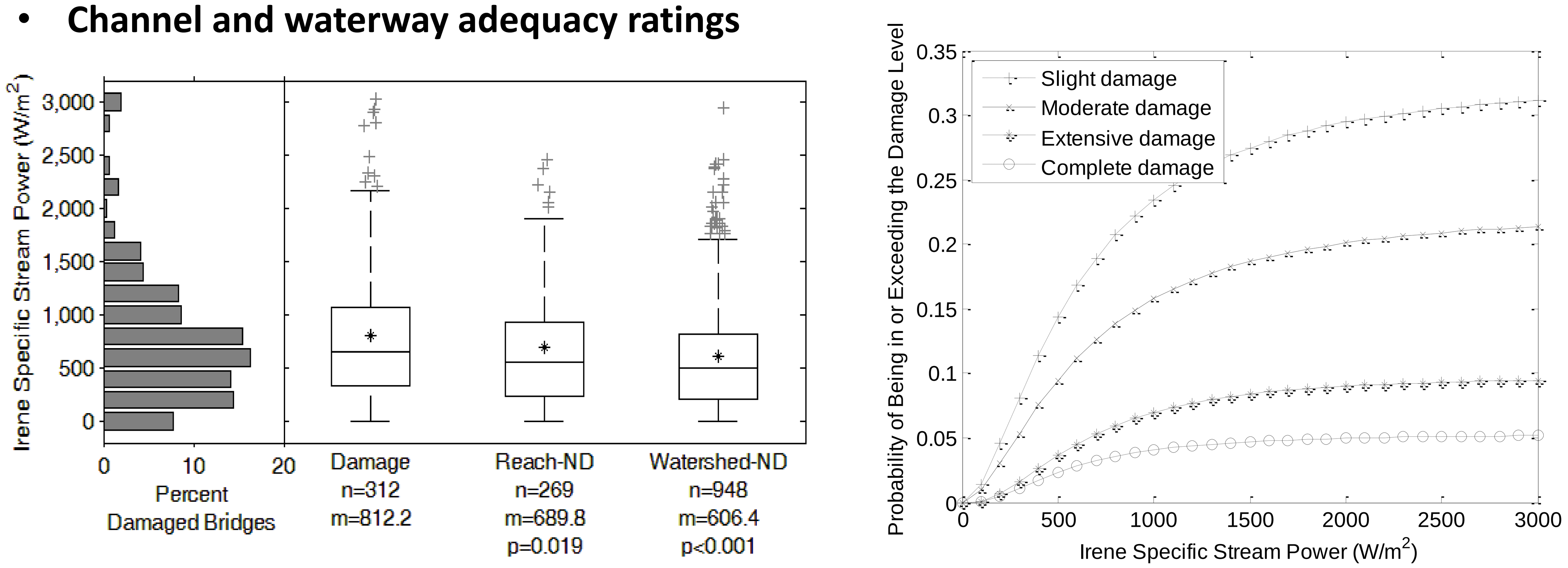


Figure 2. Irene Specific Stream Power ANOVA, and Empirical Fragility Curves

Hydraulic Modeling: Optimization and Alternative Design

An optimization scheme was programmed and wrapped around HEC-RAS to determine key areas where floodplain encroachment can affect bridge scour. Evolutionary computation was used to simulate stream alterations, rapidly solving for the best remediation locations to reduce scour potential.

Alternative embankment designs were tested in HEC-RAS as initial assessment of their feasibility. Targeting erosion of the approaches (as an intentional "fuse") reduces the hydraulic stress as the foundations, increasing flow area, reducing scour potential, upstream flooding, and repair costs.

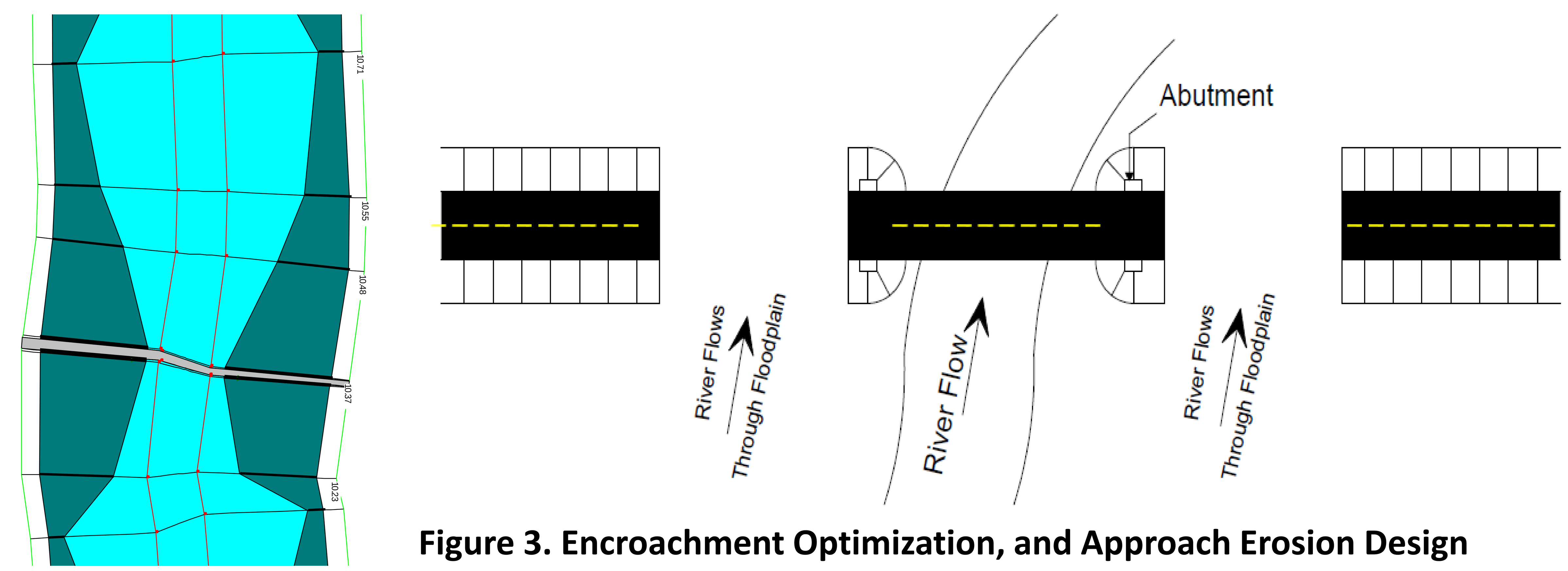
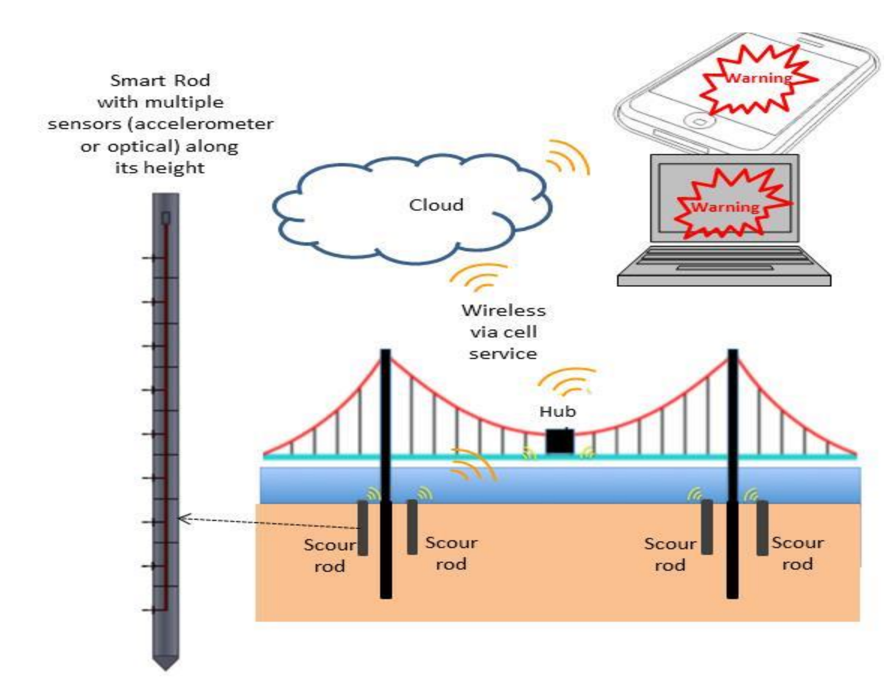


Figure 3. Encroachment Optimization, and Approach Erosion Design

Optical Scour Sensor

A prototype optical scour sensor capable of detecting scour and deposition was designed and fabricated. This innovative low-cost sensing method had numerous advantages over conventional techniques, and was successful in prototype testing.



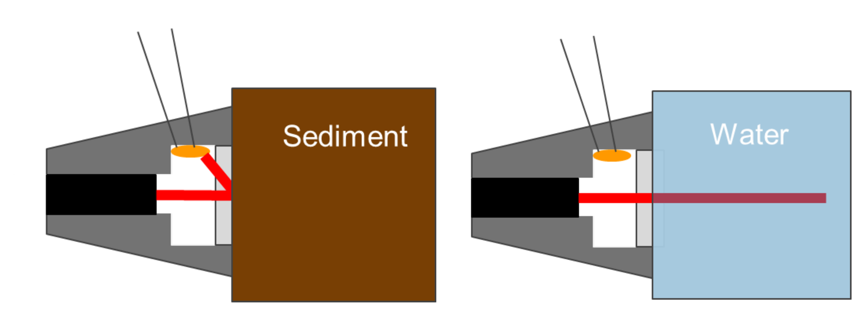


Figure 4. Scour Sensor Development

Acknowledgments

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References

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