

Challenges in Site Investigations, Design, Remedy Implementation, and Monitoring in Shorelines with Shallow Bedrock

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Canada

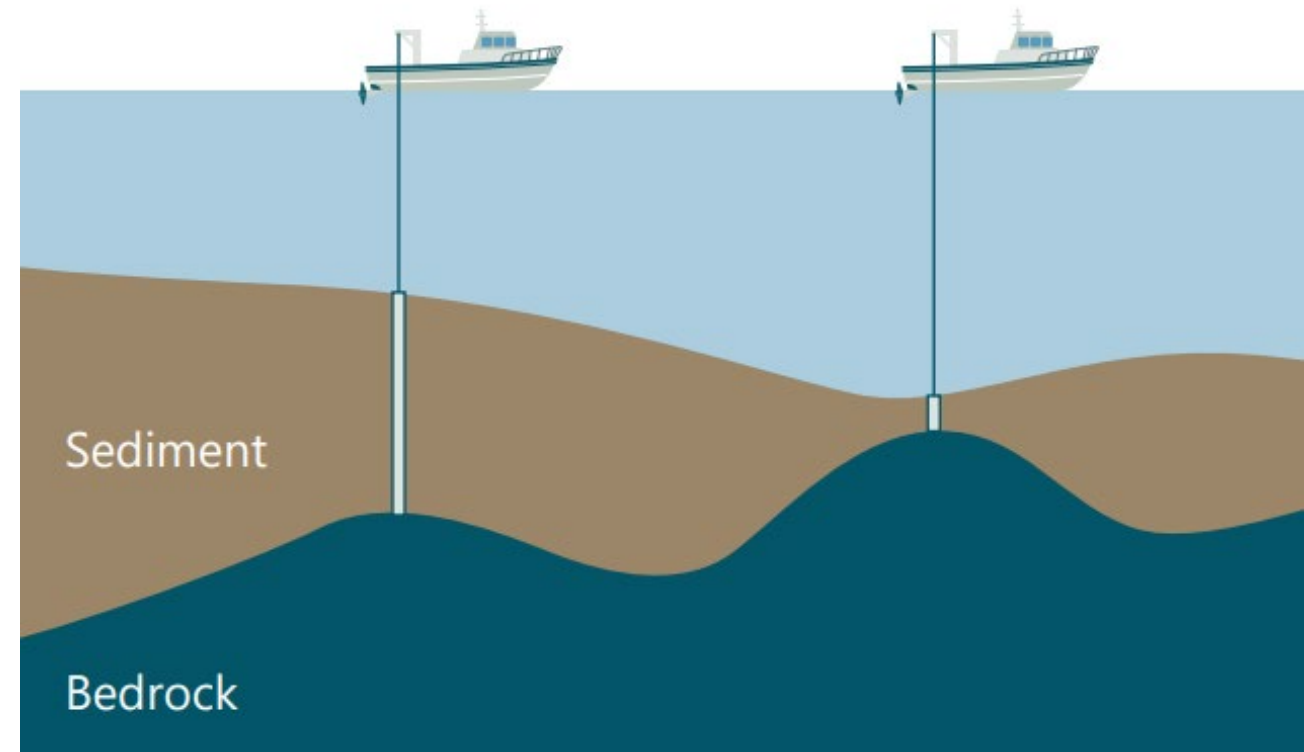




How does shallow bedrock impact your ability to conduct sediment remediation?

Challenge for Investigations

- Need to investigate bedrock vertical and lateral extent for use in design
- Limits the ability to get adequate recovery during sediment sampling
- Heterogeneity in surface makes it difficult to composite multiple attempts



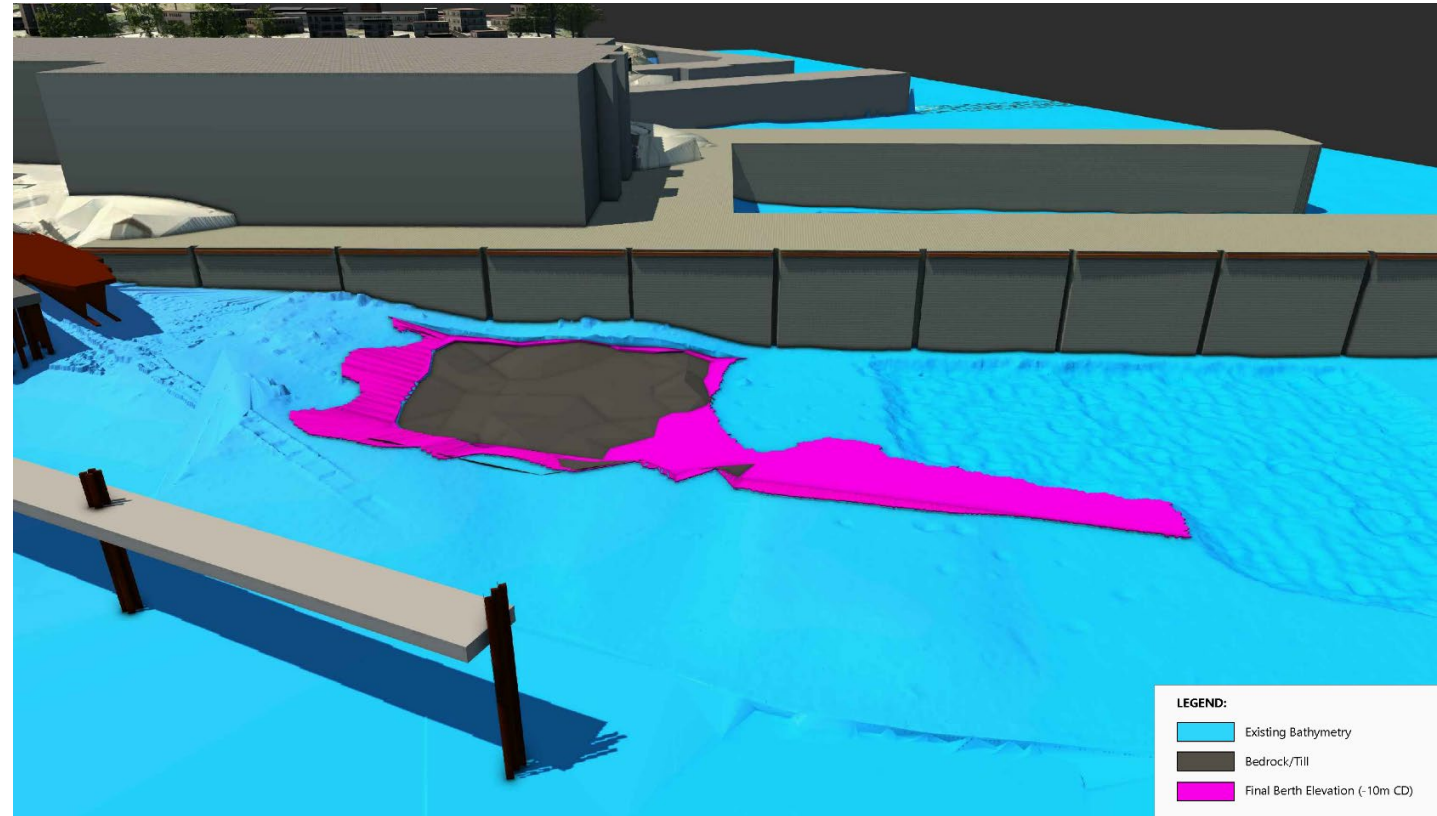
Solutions for Investigations

- Complete a reconnaissance at low tide or with a diver prior to identifying sample locations
- Allow field teams to adapt based on conditions
- Use jet probing and core refusal depths for determining depth of sediment overlying bedrock



Design Challenges

- Development of a simulated bedrock surface
 - To share or not to share with contractor
- Preparation of specifications to minimize claims based on change in volumes



Design Solutions

- Variable conditions clauses in specifications to limit change of conditions claims
- Variation in Estimated Quantities Clause approaches
 - Start with a reduced value (e.g., no payable overdredge included in estimated quantity)
 - Track closely during implementation
 - Have on-ramp areas to bolster volumes

Construction Challenges

- Bedrock and dredge residuals
 - Both generated residuals and missed inventory potential
 - Difficult to remove
 - Material placement may not be an option
- Bedrock blasting may be required for berth deepening
 - Complicates remediation if all contaminated material not removed



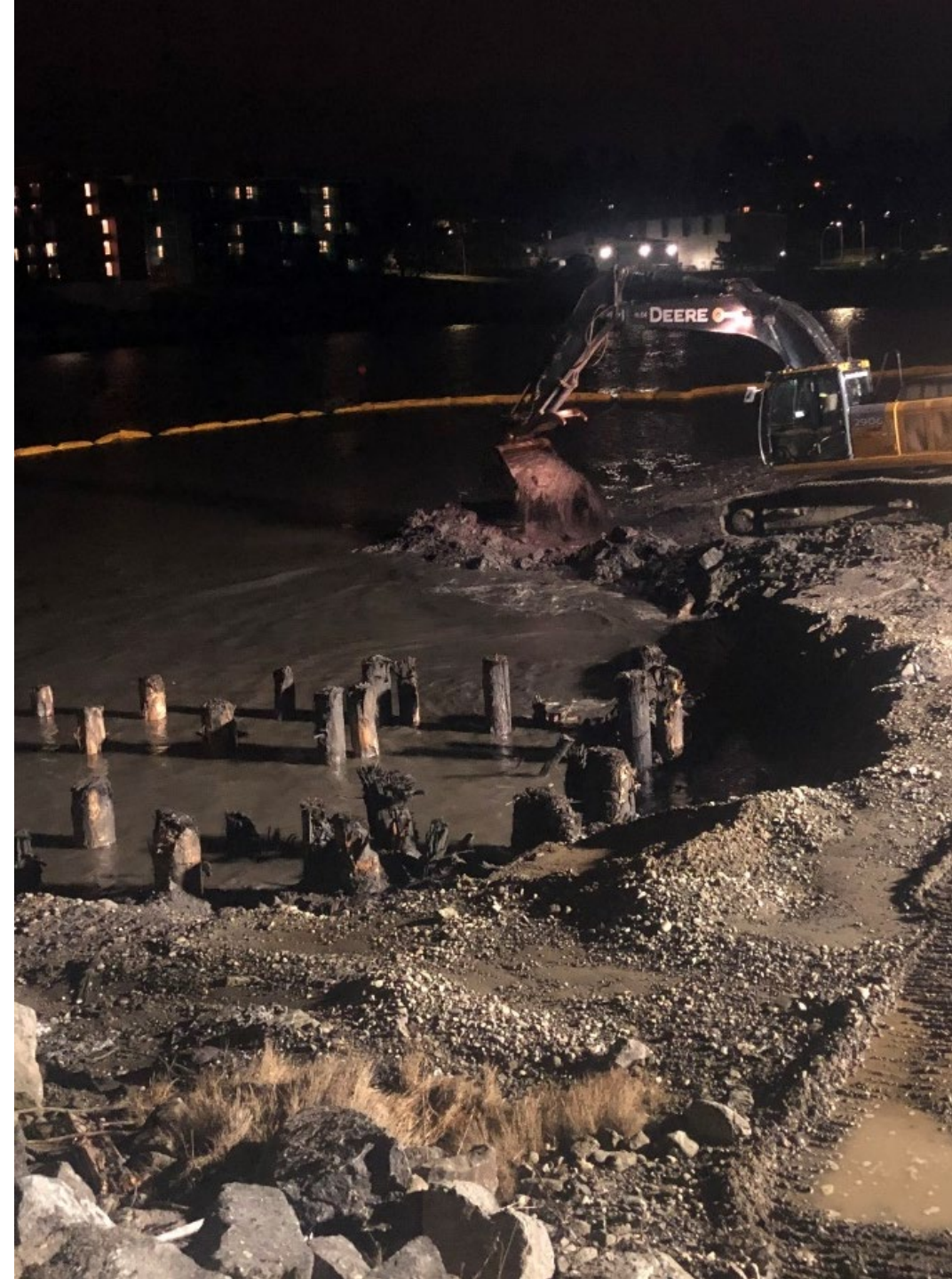
Construction Solutions

- Equipment choices
 - Excavators in the intertidal areas
 - Consideration for hydraulic dredge pass to address residuals (balance of cost versus effectiveness)
- Consider requiring an additional dredge pass
- Be prepared for additional residuals management strategies



Construction Solutions

- Adaptive management
 - Cap layers may not fit in shallower cuts
 - Adjustment of cap materials and layer thicknesses
 - Look to alternative technologies for containment



Postconstruction Monitoring

- Is there any sediment left to monitor?
- Allow field team to adapt to conditions
- Repeatability challenges for multiple years of sampling
- Consider alternative methods
 - Bathymetry
 - Diver grabs
 - Porewater



Lessons Learned

- Investigations helped but only provided partial information
 - Consider multiple investigation technologies in design
- Dredge volumes have potential to be lower than estimated
 - Develop risk management approach early in planning phase
- Adaptive management during construction will be necessary
 - Modifications to required dredge elevations and grades
 - Changes to material placement requirements
- Monitoring didn't always allow for first-choice locations, but ultimately, postconstruction conditions could be verified

Summary

- Plan for bedrock investigations early in project
- Notify contractor of expected conditions and limit liability associated with potential claims
- Include cost contingency for potential bedrock encounter
- Be ready to apply adaptive management approaches during construction