

**Optimizing Hydraulic Cleaning Techniques  
for Oiled Coarse Sediment Beaches**

**Meso-scale Field Trials  
Final Report**

**Prepared for:**

**Emergencies Science Division  
Environment Canada  
Edmonton, Alberta**

**Prepared by:**

**Beak Consultants Inc.  
Kirkland, Washington**

**June 1999  
Beak Project No. 22326**

**For further information about this project, please contact:**

Gerald M. Erickson  
Gary S. Mauseth  
Polaris Applied Sciences  
12509 130th Lane NE  
Kirkland, WA 98034-7713  
(425) 823-4841  
(425 823-3805 (fax)

Sandra Blenkinsopp  
Gary Sergy  
Emergencies Science Division  
Environment Canada  
Room 200, 4999 - 98th Avenue  
Edmonton, Alberta T6B 2X3  
Canada  
(780) 951-8600  
(780) 495-2615 (fax)

**Cover:** Lizzie Cove on Hunter Island, BC; site of cobble donor beach used in project. Cover Art by Stacey Poulson, Photo by G. Erickson, Canadian Hydrographic Service Nautical Chart No. 3785 (Namu Harbour to Dryad Point).

## TABLE OF CONTENTS

|  |    |
|--|----|
| <b>EXECUTIVE SUMMARY</b>                           | x  |
| <b>1.0 INTRODUCTION</b>                            | 1  |
| <b>2.0 PROJECT OBJECTIVES AND STATUS</b>           | 2  |
| 2.1 Project Status                                 | 2  |
| 2.2 Summary of Laboratory/Pilot Scale Study        | 3  |
| 2.2.1 Laboratory/Pilot Scale Study objectives      | 3  |
| 2.2.2 Findings of the Laboratory/Pilot Scale Study | 4  |
| 2.3 Meso-scale Field Trials study objectives       | 5  |
| <b>3.0 METHODS</b>                                 | 6  |
| 3.1 Donor beach, substrate, and key species        | 6  |
| 3.2 Laboratory facilities and equipment            | 7  |
| 3.3 Wash apparatus                                 | 8  |
| 3.4 Treatment temperature and pressure measurement | 8  |
| 3.5 Oil loading and removal                        | 8  |
| 3.6 Treatments and parameter levels                | 10 |
| 3.7 Controls                                       | 11 |
| 3.8 Biological observations                        | 11 |
| 3.9 Ambient water temperature monitoring           | 12 |
| 3.10 Data analysis and statistical methods         | 12 |
| <b>4.0 RESULTS</b>                                 | 16 |
| 4.1 Temperature and pressure measurements          | 16 |

|            |  |           |
|------------|--|-----------|
| 4.2        | Biological observations  | 17        |
| 4.2.1      | Treatment effects on <i>Fucus spp.</i> mortality, immediately (48 to 72 hours) post-treatment                | 19        |
| 4.2.2      | Treatment effects on <i>Fucus spp.</i> mortality, one year post-treatment                                    | 21        |
| 4.2.3      | Treatment effects on <i>Balanus glandula</i> (> 3 mm) mortality, immediately (48 to 72 hours) post-treatment | 24        |
| 4.2.4      | Treatment effects on <i>Balanus glandula</i> (> 3 mm) mortality, one year post-treatment                     | 27        |
| 4.2.5      | Treatment effects on <i>Balanus glandula</i> spat (< 3 mm) abundance, one year post-treatment                | 30        |
| 4.2.6      | Treatment effects on mortality in other species, immediately (48 to 72 hours) and one year post-treatment    | 33        |
| 4.3        | Ambient water temperature monitoring   | 35        |
| <b>5.0</b> | <b>DISCUSSION</b>  | <b>36</b> |
| 5.1        | Treatment effects on <i>Fucus spp.</i> mortality   | 36        |
| 5.2        | Treatment effects on <i>Balanus glandula</i> (> 3 mm) mortality  | 39        |
| 5.3        | Treatment effects on <i>Balanus glandula</i> spat (< 3 mm) abundance, one year post-treatment                | 41        |
| 5.4        | Treatment effects on mortality in other species, immediately and one year post-treatment                     | 43        |
| 5.5        | Comparison of Meso-scale Field Trials findings with other studies  | 44        |
| 5.5.1      | NOAA studies   | 44        |
| 5.5.2      | CEDRE studies  | 46        |
| <b>6.0</b> | <b>CONCLUSIONS</b>   | <b>50</b> |
| <b>7.0</b> | <b>REFERENCES</b>  | <b>53</b> |

## ACKNOWLEDGEMENTS

The Meso-scale Field Trials phase of the Hydraulic Cleaning project was jointly funded by the Emergencies Science Division of Environment Canada, the Panel for Energy Research and Development, the Minerals Management Service of the United States Department of the Interior, the Alaska Department of Environmental Conservation (ADEC), Imperial Oil, Ltd., and NOAA Hazardous Materials Response and Assessment Division (HAZMAT) under Environment Canada Contracts No. KM643-4-0244/01-XSG and KE501-8-0169/001/EDM.

The authors would especially like to thank John Bolton of the Heiltsuk Band Fisheries Department, and the staff of the Heiltsuk Band Fish Plant for their assistance and cooperation. They would also like to thank Steve Sainas and the staff of the Pacific Canadian Fisheries Cannery, and Bryan Clerx. In addition, the authors would like to thank Steve Brocco, Andrew Martin, Cathy McNair, John Rithaler, Jimmy Spencer, Leo Rebele, Daryl Fyall, Julie Carpenter, and Niki Verzuh for their long hours and dedication.

## LIST OF TABLES

- Table 1. Summary of the composition of Bunker C fuel oil used in the project treatments.
- Table 2. Distances from spray nozzle to substratum for selected treatment pressure levels.
- Table 3. Substrate level temperature and pressure sensor measurements for target treatment levels.

## LIST OF FIGURES

- Figure 1. Project sites in vicinity of Bella Bella, BC.
- Figure 2. Cobble donor beach in Lizzie Cove.
- Figure 3. Cobble donor beach in Lizzie Cove on Hunter Island, BC in 1997.
- Figure 4. Close-up of natural cobble on Lizzie Cove donor beach.
- Figure 5. Treated cobble groups deployed on Lizzie Cove donor beach one year post-treatment.
- Figure 6. Experimental drainage scheme at Pacific Canadian Fisheries Cannery, Shearwater, BC.
- Figure 7. 1997 experimental set-up at Pacific Canadian Fisheries Cannery in Shearwater, BC.
- Figure 8. 1997 experimental set-up at Pacific Canadian Fisheries Cannery in Shearwater, BC.
- Figure 9. Landa Model PDHW4-2000H Hot Water Pressure Washer used to supply water to wash apparatus at selected water temperatures and pressures.
- Figure 10. Cobble test boxes being held in seawater berms at Heiltsuk Band Fish Plant on McLoughlin Bay, south of Waglisla, BC in 1998.
- Figure 11. Scientists and technicians conducting one year post-treatment biological observations at Heiltsuk Band Fish Plant in 1998.
- Figure 12. Oiled cobbles in test box being prepared for pressure washing treatment in wash apparatus in 1997.
- Figure 13. Close-up of oiled cobbles in test box in 1997.
- Figure 14. Scientist and technician conducting immediate (48 to 72 hours) post-treatment biological observations on oiled cobbles in 1997.
- Figure 15. Close-up of Cobble No. 82 showing residual weathered oil one year post-treatment in 1998.

- Figure 16. Comparisons of 48 hour post-treatment mortality versus water pressure for *Fucus spp.*
- Figure 17. Comparisons of 48 hour post-treatment mortality versus water temperature for *Fucus spp.*
- Figure 18. Comparisons between control groups for *Fucus spp.* mortality data.
- Figure 19. Comparisons of *Fucus spp.* mortality data between years and to control groups.
- Figure 20. Close-up of Cobbles 241-244 one year post-treatment.
- Figure 21. Close-up of Cobbles 265-268 one year post-treatment.
- Figure 22. Comparisons of one year post-treatment mortality versus water pressure for *Fucus spp.*
- Figure 23. Comparisons of one year post-treatment mortality versus water temperature for *Fucus spp.*
- Figure 24. Comparisons of 48 hour post-treatment mortality versus water pressure for *Balanus glandula* (> 3 mm).
- Figure 25. Comparisons of 48 hour post-treatment mortality versus water temperature for *Balanus glandula* (> 3 mm).
- Figure 26. Comparisons between control groups for *Balanus glandula* (> 3 mm) mortality data.
- Figure 27. Comparisons of *Balanus glandula* (> 3 mm) mortality data between years and to control groups.
- Figure 28. Comparisons of one year post-treatment mortality versus water pressure for *Balanus glandula* (> 3 mm).
- Figure 29. Comparisons of one year post-treatment mortality versus water temperature for *Balanus glandula* (> 3 mm).
- Figure 30. Comparisons of one year post-treatment abundance versus water pressure for *Balanus glandula* spat (< 3 mm).
- Figure 31. Comparisons of one year post-treatment abundance versus water temperature for *Balanus glandula* spat (< 3 mm).



Figure 32. Comparisons between control groups for *Balanus glandula* spat (< 3 mm) abundance data.

Figure 33. Comparisons of *Balanus glandula* spat (< 3 mm) abundance data between years and to control groups.

### **VOLUME 1 (REPORT): APPENDICES**

APPENDIX A Summary tables of post-treatment (48-72 hrs and one year) mortality data by species.

APPENDIX B Graph figures of post-treatment (48-72 hrs and one year) mortality data by species.

APPENDIX C Summary tables and graph figures of one year post-treatment abundance data for *Balanus glandula* spat (< 3 mm).

APPENDIX D McInnes Island Lightstation air temperature data and Ryan Instruments RTM-2000 water (and air) temperature data recorded at Lizzie Cove donor beach from June 7, 1997 to June 26, 1998.

### **VOLUME 2: DATA APPENDICES**

APPENDIX E Immediate (48 to 72 hours) post-treatment (1997) biological observation data.

APPENDIX F One year post-treatment (1998) biological observation data.

**OPTIMIZING HYDRAULIC CLEANING TECHNIQUES  
FOR OILED COARSE SEDIMENT BEACHES**

**MESO-SCALE FIELD TRIALS  
FINAL REPORT**

**June 1999**

**EXECUTIVE SUMMARY**

**Introduction**

Hydraulic cleaning, or water washing, is a common type of cleanup method for bedrock, man-made shoreline structures and coarse sediment (cobble/boulder) shorelines contaminated by oil. Methods consist of variable combinations of a wide range of water pressures, temperatures, and application times, which move oil from the shore zone to a location for collection, removal and disposal. Although hydraulic cleaning has often been the technique of choice, there is a lack of certain knowledge needed to help decide when this technique is most appropriate and how to improve its effective usage. Although it has been the opinion of many scientists that certain shoreline cleanup techniques can result in increased adverse impacts, sometimes greater than the oil spill itself, there has been insufficient research or monitoring data available to assess these cleanup options. One information deficiency is the identification of temperature, pressure and duration conditions where hydraulic cleaning causes undesirable direct biological effects to intertidal biota, and where such cleaning affects the rate of the biological recovery. The focus of this project is to provide information on these conditions.