Report of the TASK FORCE - OPERATION OIL (Clean-up of the Arrow oil spill in Chedabucto Bay) to The Minister of Transport.

VOLUME IV

ISSUED BY THE MINISTRY OF TRANSPORT

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Report of the
TASK FORCE - OPERATION OIL
(Clean-up of the Arrow oil spill in Chedabucto Bay)
to
The Minister of Transport
OPERATION OIL
VOLUME IV

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Ottawa, Canada

23 May, 1972

The Hon. Don Jamieson, P.C., M.P.,
Minister of Transport,
Ottawa, Canada.

Dear Mr. Minister:

The three volume report of your Task Force on Operation Oil which we presented
to you on the 1st of September, 1970, covered our field operations up to July 1970, and,
while we had perhaps broken the back of the job, there was still a very considerable
mess in Chedabucto Bay which had to be cleaned up.

In the succeeding 22 months those working on the clean-up for us had had some
substantial successes which we feel should be reported to you and, through publication,
hopefully be made available to those elsewhere in the world who may have similar
misfortunes. In addition, we have some unsolved problems which we would like to
highlight so they can become the focus for ongoing research.

The beach cleaning operations were handled most efficiently by the Department of
Public Works and we would like to bring to your attention very specifically our
commendations of their Halifax Regional Office and the engineers who supervised the
work both for the main effort during the spring and summer of 1970 and throughout
the spring, summer and autumn of 1971.

In September of 1970 there was a most successful re-pump of the tanks in the stern
section of the Arrow and another 100,000 gallons of Banker C were recovered. Further
improvements were made in the technology base for the recovery of oil from sunken
tankers.

There was a fairly substantial slick-licking operation to recover mixtures of oil and
eel grass in Inhabitants Basin during the spring and early summer of 1971.

Navigation was re-established in the Canso Tickle by the removal of the Tickle
Dam in April of 1971 without incurring any new oil contamination below the dam site.

We left the Lennox Passage Dam in place through the 1971-72 winter because there
was still a strip of about three miles of coastline on the north side of Lennox Passage
with active oil on it. We felt the risk of this oil being entrained in the winter ice and, if
the dam was removed, carried eastward onto clean beaches, was sufficient to justify
leaving the dam in until the spring of 1972. We carried out a complete survey of the
Bay during the first week in May 1972 and there appears to be no need for further slick-
licking or beach cleaning this year within Chedabucto Bay. The nationally rated
beaches and the community beaches are in good shape. The oil in Lennox Passage has
stabilized to the point where it no longer constitutes a hazard and we have asked the
Regional Office of Public Works in Halifax to have the dam opened by the July 1st
week-end.
Two areas outside the Bay will require ongoing attention. Black Duck Cove beach is still badly fouled with oil chunks which have moved out of the adjacent rock filled lagoon. The oil in this lagoon is still active and there is no point in trying to clean the sand beach until this oil is stabilized. We still have little need for much research on the process of stabilization so that at present our judgment is only slightly better than a guess, but we think it will likely be the summer of 1974 before it will be worth cleaning this beach.

The second area is Louise Island. This uninhabited island, which can only be reached by boat or helicopter and has no community beaches, was contaminated probably at the same time as Black Duck Cove. The island is mainly bedrock shore with a scant covering of soil and scrub in the centre. The Bunker C is still lying in pools three to six inches deep in hollows in the bedrock. This oil is covered with a very thin oxidized layer, but under the action of the sun this layer is penetrated, revealing oil which gives the same appearance as it had in the spring of 1970, i.e., no apparent stabilization. Where the oil has been splashed on the trees or on the top of the rocks it has hardened as elsewhere. No clean-up of this area is warranted but it should be kept under observation for scientific reasons.

As these two areas can be handled by your pollution control officers, who are familiar with both areas, we suggest that our work as a Task Force on Operation Oil be considered terminated with the removal of the Lennox Passage Dam.

With regard to action being taken on the recommendations we presented to you in Volume 1 of our report in September, 1970, there are four aspects which cause us concern:

(1) We were delighted with the passage of your Bill C-2 to amend the Canada Shipping Act and felt that it caught the essence of our experience. We have seen a few drafts of the concomitant regulations and, unless there is some substantial redirection, we feel that the strength and intent of Bill C-2 might be eroded by timid and archaic regulations to the point where international merchant shipping will continue its sloppy ways in Canadian waters with impunity. We suggest that this was not the intent of Bill C-2.

(2) We understand that the responsibility for funding research and development in scientific and engineering projects to improve our capabilities of dealing with oil spills rests with the Department of the Environment. To date very little money seems to have been made available, insufficient, in fact, to follow up on problems identified during our operations. It is important that funds be made available to finance those projects in the physical and life sciences which are fundamental to our improved understanding and capabilities.

(3) We understand that the responsibility for prevention and clean-up rests with officers of your Ministry, while the money to support relevant research and to design, develop and test new equipment and improve existing equipment is in the budget of the Department of the Environment. We suggest that this will be a satisfactory arrangement only if your departmental officers have a major voice in the allocation of the financial support. There is evidence of unwarranted delays and frustrations which will do anything but encourage Canadian industry to develop skills in the area. We are sure that these projects will be pushed with the vigour necessary to ensure early completion if your officials with the responsibility for clean-up have a major involvement in the decisions.

(4) We would again urge that your headquarters pollution contingency team be strengthened with the addition of scientists, one from the physical sciences and another from the life sciences.

Yours sincerely,

[Signature]
F.D. McTaggart-Cowan

[Signature]
Harry Sheffer

[Signature]
M.A. Martin

A vigorous research program to improve our understanding of the problems involved in oil clean-up is essential, but so is the development and production of better equipment for prevention, containment and clean-up to facilitate field operations.

Tankers twenty times the size of the Arrow are now in regular operation. Canada has a growing number of superports for these supertankers. There is a growing body of data which suggests that portions of the world’s oceans are now chronically polluted with oil. There are, we suggest, no grounds for complacency, because tankers large and small continue to foul the shores of all the seas with monotonous regularity.
PART 2 – SUMMARY OF RECOMMENDATIONS

1. We recommend a substantial expansion of the scientific and engineering effort in R & D, particularly in industry and universities, in the environmental effects of oil pollution and methods of prevention, containment, and clean-up. (page 7)

2. We recommend that the officers in the Ministry of Transport who are responsible for clean-up should have a major voice in the funding of the engineering development of equipment concerned with prevention, containment and clean-up. (page 7)

3. We stress the urgency of research and development leading to a satisfactory way of disposing of the oil on the beach material and slick-licker debris by combustion. (page 10-11)

4. We recommend that the dumpsites should be re-visited in about five years’ time in order to determine the extent of biodegradation which has taken place over that period. (page 10)

5. We recommend that when Ministry of Transport helicopters are in the area (Chedabucto Bay) for any purpose and the weather is calm they should observe and report on the amount of iridescence. (page 12)

6. We recommend that new practices and procedures be developed to be used in the investigation of marine accidents to ensure a full technical, engineering, scientific and operational diagnosis of an accident, complete with recommendations on how to prevent similar accidents in the future, and that these investigations be carried out prior to the judicial inquiry. (page 20)

7. Positive en route and approach control of all merchant ships should become a world standard without delay. (page 21)
PART 3 – SUMMARY OF OPERATIONS

Introduction

Our previous reports (Volumes I, II, and III Operation Oil) gave details of our operations up to and including July 1970. Since then, the principal areas of activity have been beach cleaning, slick-licking, the re-pump of the stern section of the Arrow, the operation of dumpsters, and the maintenance and removal of the Canco Tickle and Lennox Passage Dams.

Competent people were in charge of each one of these operations so that the occasional telephone consultation with the Head of the Task Force, and visits by him to Chedabucto Bay at the close of operations in the autumn of 1970, prior to the opening of operations in the spring of 1971, following the close of operations in the fall of 1971, and in May 1972 was the extent of the operational involvement of the Task Force.

The Task Force maintained direct responsibility for the claims for damages and the requests for assistance by the residents and property owners of Chedabucto Bay and would like to publicly acknowledge the patience and courtesy of these people as we struggled to do the best we could for them.

There has been an ongoing scientific program guided and largely financed by the new Federal Department of the Environment but with some of the programs supported by grants in aid from the National Research Council of Canada. As the results of these research programs will be published in the scientific literature in due course, this report will not deal with them. Those readers wishing to get advance information on the nature and progress of the research programs are invited to write to Dr. William Ford, Director of the Atlantic Oceanographic Laboratory at the Bedford Institute, or those of his colleagues who are mentioned in Volume II of the report of the Task Force.

Without in any way denigrating the quality of this work, it is insufficient in quantity and most of it is internalized in government laboratories. In fact, we understand that the amount of government money to fund general research in this area is actually less this year than last. We recommend a substantial expansion of the scientific and engineering effort in R & D, particularly in industry and universities, in the environmental effects of oil pollution and methods of prevention, containment, and clean-up.

Development of new and improved operational equipment to aid in future clean-up has not progressed as fast as we would wish. We are aware of a number of good proposals that have been put forward to the federal government but few of these have been funded. We suggest there are deficiencies in the funding mechanisms that have been established, with their roots in the fact that the Ministry of Transport have the clean-up responsibilities while the Department of the Environment have the research and development funding responsibilities. We recommend that the officers in the Ministry of Transport who are responsible for clean-up should have a major voice in the funding of the engineering development of equipment concerned with prevention, containment and clean-up.
Operations

Beach Cleaning

During the initial stages of Operation Oil certain beach cleaning experiments were conducted by the Canadian Forces. By April 24th, 1970, the responsibility for beach cleaning had been transferred to the federal Department of Public Works who had assigned on-site engineers to work under the general direction of the Task Force. Under the able direction of these engineers the techniques of beach cleaning were developed soundly and quickly.

The report prepared by John W. MacKay, the engineer who had the major responsibility for conducting this operation, is included as Appendix A because we feel the documented experience therein will be of considerable value to others faced with similar responsibilities.

Initially we were aided by the advice of coastal geomorphologists, particularly Mr. E.H. Owens. We will not refer to their report in detail because it has been published elsewhere. Suffice it to say that with their help we were able to identify the sensitive beaches in advance of our clean-up operation. On occasion, when the sensitivity of the beach to erosion was high, clean material was trucked in to replace the eroded material that had been removed. On other beaches tideline was placed to stop erosion which had been going on for some years but which might otherwise have been speeded up by the cleaning operation. On most of the beaches the eroded material could be removed with impunity.

The Public Works engineers found that the most efficient way to clean the lightly polluted beaches was to use gangs of men, whom we designated “slick-pickers”, with shovels and plastic bags. In this way only the soiled material was removed.

The critical engineering judgement was, of course, to decide when the pollution on the beach reached a sufficient extent that the use of machinery — bulldozers, front end loaders and trucks — became the most efficient means of cleaning, with a secondary decision as to whether these equipments could be rubber tired or whether the nature of the beach required the use of tracked vehicles. The method of operating the vehicles proved to be most important. The cost effectiveness as well as the speed of clean-up operation depended critically on the engineer making these judgements, on the spot and on time.

The Emergency Measures Organization officers working with the Task Force provided a most important service by moving out ahead of the beach cleaning operation to get waivers signed by those owning property fronting on cleanable beaches so that the Task Force could move equipment so as to clear property with the owners’ consent. It is a tribute to those living in Chedabucto Bay that the Task Force was refused access on only one or two out of many hundreds such requests.

By the time the beach cleaning operation was closed down for the winter of 1970-71 approximately 30 miles of tourist beach and community beach had been cleaned. Several beaches close to heavily polluted rock or boulder shorelines had had to be cleaned two or three times.

We had good co-operation from the Provincial Government and the Tourist Bureau so we were able to schedule our beach cleaning in line with the tourist season. Thus, as far as we can assess, no tourist visiting the area was inconvenienced by the presence of oil on any of the nationally rated beaches. It was inevitable, however, that some Chedabucto Bay children would continue to get oil in their hair, on their skin and over their clothing because, like children everywhere, they loved to play on large boulders and on the bedrock shores in preference to the adjoining sand or gravel beaches.

The boulder and bedrock shoreline was virtually uncleanable by the techniques developed for the Task Force. Even in retrospect we think our ban on the use of chemicals in Chedabucto Bay was correct but this must be tested by continuing research. Our testing and use of various kinds of stabilizing materials was of such marginal success that a full-scale operation was not justified. Continuing research into this problem should be assured. By leaving the boulder and bedrock shoreline for natural stabilization to take place we have to live with the consequent recontamination of adjoining tourist and community beaches.

By October the beaches were all in good shape but a helicopter survey of the area at that time showed that some of the gravel shorelines directly opposite Cerberus Rock were still heavily contaminated, so it was presumed that with the onset of the winter storms oil would be brought back into circulation through the normal erosion of these exposed beaches and would be redeposited on the tourist and community beaches.

The Bay was re-surveyed by helicopter in March 1971 and a modest amount of recontamination was observed. As a result the Department of Public Works assigned another engineer to the job, and under his direction a survey of all beaches in the area was conducted by two university students who had been trained during our operations in 1970. Following this survey the clean-up work was authorized to commence immediately. Mr. Haskings assigned on-site responsibility for the cleaning operations to the two students, Mr. Bourque and Mr. MacInnis, and with local labour, mainly slick-pickers, all beaches were kept in good shape throughout the summer with the exception of Black Duck Cove. The sand beach at Black Duck Cove is immediately adjacent to a large rock-filled lagoon which was heavily contaminated at the time of the original spill and which was virtually uncleanable with the techniques we had developed. Consequently on almost every high tide oil moved out of the lagoon onto the sand beach. The beach could have been kept usable by cleaning it every second day but the people who lived at Black Duck Cove agreed with our on-site supervisors that this would be a waste of money and the intelligent course of action was to wait until nature had stabilized the oil in the lagoon. The residents moved their summer swimming and recreation program to an adjoining cove. This is a typical example of the kind of co-operation the Task Force has received from all those who live in Chedabucto Bay and which made substantial contributions to the efficiency and economy of the whole operation.

The beach cleaning operation was closed for the autumn immediately after Labour Day.

The beaches were again inspected by helicopter on September 18th. It is not expected that there will be any requirement for beach cleaning in the spring of 1972. Black Duck Cove should be watched and as soon as the oil in the lagoon has finally stabilized the sand beach should be cleaned. This is likely to be the summer of 1974. Louise Island should be kept under surveillance for several years for scientific purposes.
Slick-licking

The operation of the slick-lickers to recover oil and oiled material from the surface of the water continued until August 1970, and as a result the detailed report of this operation could not be included in Volume III. It is now included as Appendix B to this report. The total amount of oil recovered by the operation during the spring and summer of 1970 was approximately 150,000 gallons. The amount of weed and debris which had to be picked up to recover the oil was, of course, prodigious.

Our inspection of the Bay in March 1971 showed that there had been a considerable aggregation of oiled eel grass in the Inhabitants Bay area during the winter. This was not unexpected because the Basin in Inhabitants Bay is correctly named and seems to be the ultimate cesspool for most water-borne contamination in the area. It is also the best growth area for eel grass.

Accordingly, Mr. Michael Greenham, of the Ministry of Transport, who had operated the slick-lickers with such distinction in the summer of 1970, returned with his equipment, with some modifications, and was in operation by the 21st of May 1971. The operation was scheduled to last five to six weeks and was started as late as possible to permit the natural accumulation of the oil in the Basin and yet early enough to ensure that this operation would be completed before the tourist season commenced.

The slick-licking operation was concluded on the 26th of June, by which time a further 10,000 gallons of oil had been recovered, most of it contained within a mixture of about 90 per cent eel grass and 10 per cent oil.

This area was inspected again in September 1971 and the shoreline was still free of oiled eel grass. As it had remained clean from the end of June to the end of September, through the hottest portion of the year, it was presumed that this problem would not recur during the winter of 1971-72 and that further slick-licking would not be required.

The inspection of the area in May 1972 confirmed this.

A report on the 1971 slick-licking operation is included as Appendix C.

Dumpsites

The disposal of the substantial amount of soiled beach material and the considerable quantities of oil mixed with eel grass and all manner of debris picked up by the slick-lickers presented a problem.

Our first choice for disposal was by burning, but owing to the fact that the oil was in a water-in-oil emulsion and the percentage of combustible materials in most of the soiled material was low, no form of combustion short of a full blast furnace was found to be practical. We were unable to design a portable blast furnace for the occasion in the time at our disposal. It must be remembered that a design of this kind would have to handle material which is up to 99 per cent non-combustible. We still feel frustrated that we were not able to innovate a good solution in this area, but time ran out and the material had to be disposed of, and so we must leave as a high priority for continuing research and development a portable blast furnace that could be taken on site and handle a wide variety of materials on a continuous combustion basis.

Continuous extraction and washing techniques should also be investigated. One of the problems of the blast furnace approach is that the percentage of combustibles is insufficient to sustain combustion itself when the oil is in a water-in-oil emulsion, and the temperature must be above 1000° F. to break down the emulsion.

The solution we chose was the use of carefully selected dump-sites. We arranged, with the excellent co-operation of the provincial government, for the very careful selection of dump-sites to receive the material. These dump-sites had to have either a solid bedrock or a deep, clay underburden and preferably be on crown land. When this latter requirement proved impossible financial arrangements were made with the owners of the property.

Our main concern was that if the dump-site was imperfectly chosen oil would leach down into the groundwater and contaminate wells over a wide area. To guard against this we arranged, with the co-operation of the provincial government, for five independent assessments, plus our own engineering assessment, of a chosen site after it had been opened up. Only when each of these assessments was positive was a site used.

The public were kept informed. On one occasion, although the dump-site met all our requirements, the inhabitants in the area were opposed to a dump-site anywhere near their homes and after public meetings failed to resolve the problem an alternative site was located.

Sites meeting our requirements were not easy to find. They involved a lot of field work on the part of our own staff and the staff of the provincial government, particularly the Department of Lands and Forests who were most co-operative.

When a dump-site had been chosen it was excavated down to a reasonable depth, and when filled with soiled material it was covered over with clay, then with soil, and finally grass and trees were planted on it. In one location a municipal dump was used because it had satisfactory characteristics and there the soiled material was covered as soon as it had been placed.

We stress the urgency of research and development leading to a satisfactory way of disposing of oil on beach material and slick-licker debris by combustion. We have subsequently become aware of two or three Canadian companies with expertise in this field that might lead to a solution, but we stress the urgency of giving this development high priority. As far as we know, the capability of handling this problem is no better today than it was in the summer of 1970 and this we regret. The solution we used was very definitely second best and should not be repeated.

We also recommend that the dump-sites should be re-visited in about five years' time in order to determine the extent of biodegradation which has taken place over that period.

Debunkering

As reported in Volume I, we had ascertained that there was a sufficient amount of oil remaining in the stern section of the Arrow after the original debunkering to make a re-pump desirable and that this should be done in September when the water temperature would have risen above the four point of the Bunker C. It was also reported that Lieutenant-Commander D.B. Hope was assigned as salvage master for this operation and that his deputy would be Michael S. Greenham, Master Mariner, Ministry of Transport.
This operation was identified by the code name "Operation Scour" and was planned and executed with distinction by Lieutenant-Commander Hope and Mr. Greenham, as before with full co-operation by the Department of National Defence. The Navy diving team again did a magnificent job. The recovery vessel was the S.T. Imperial Cornwall chartered from Imperial Oil. The operation was "on schedule" throughout.

In the course of the operation Lieutenant-Commander Hope and Mr. Greenham improved in many ways on the innovative technology that had been developed under Captain Madsen's guiding hand on the first occasion and proved to our satisfaction that the technology for this operation is now in a mature form. It can certainly be improved but it is available to anyone in the world with a serious intent of recovering oil from a sunken vessel.

The detail of the story is best told in the language in which it was reported to the Task Force and this is presented as Appendix D.

A total of approximately 100,000 gallons was recovered in "Operation Scour".

By the spring of 1971 the bow section of the wreck had completely disappeared, having been broken up and driven off the top of Cerberus Rock into deep water by the severe winter storms.

There were one or two "scare reports" that the stern section had started leaking again over the next several months following Operation Scour. These were checked out on each occasion and the reports were not sustained by actual on-site observation. On at least one occasion we have reason to believe that the oil that was observed had come off one of the heavily contaminated beaches and moved around the coast as a result of a fairly vicious storm. These mechanisms were understood and were expected.

During the summer of 1971, fairly frequent inspections were made of the degree of leaching from the stern section.

On a day with no wind at all to ruffle the surface of the seas no sign of any iridescence can be seen. However, if there have been several hours of calm weather, a small amount of iridescence collects on the surface above the wreck and will travel about half a mile downstream in an iridescent patch about 3/10,000 of an inch thick and 10 yards wide. The amount of oil in this iridescence is inconsequential and has proven to be no impediment to any boating or fishing activity in the area.

To the best of our knowledge the hull is as clean as it can be made by mechanical methods and the iridescence that is slowly leaching off is due to oil still clinging to the outside of the hull and oil that is trapped between the beams and ceiling in the cabin area and under the deck strengtheners at the top of the tanks.

As it is no longer of any recreational or economic importance we believe the problem of the stern section has been resolved and no action to demolish it or remove it should be contemplated. However, we recommend that when Ministry of Transport helicopters are in the area for any purpose and the weather is calm they should observe and report on the amount of iridescence, if any, because we think it will be of advantage for future contingency planning to know how long a wreck lying in this depth and temperature of water takes to clean itself by normal water movement. There was no iridescence on 2 May 1972 in the vicinity of the wreck.

Caneso Tickle Dam

The inspection of the Caneso Tickle on the 24th of March 1971 showed that while there was still a substantial amount of oil in the small coves and on the rocks to the north of the Caneso Tickle Dam, it appeared to have stabilized to the consistency of soft asphalt by picking up some of the fine silts and clay particles that comprise most of the fines in the beach material in this area. While we had nothing but our own judgement to go on it appeared that this stabilization had proceeded beyond the point where the normal rise in temperature during the summer months would again put the oil back in circulation. On the other hand, the continued presence of that dam was a considerable inconvenience to the fishermen who had their boats south of the dam as it forced them to go around Durrell's Island to get into the Bay. This cost them both time and money and on occasion exposed them to unnecessarily rough weather.

Accordingly a decision was made to remove the dam before the opening of the 1971 lobster season and the work was undertaken by the Department of Public Works and supervised by their engineer, John D. Haikings. A local contractor did a good job. Water depths were returned to their original level and the area cleaned up so well that one could not tell that the dam had ever been there.

Lemmon Passage Dam

This dam had suffered fairly severe erosion during the winter storms and it was necessary to build it back up in the spring of 1971 to make sure that it would last through the season. This project was commenced on May 12th and completed on May 17th, 1971, and involved the placing of an additional 7,064 cubic yards of material at a cost of just under $13,000. As before the borrow pit used for this additional fill was leveled and contoured when the job was finished so there was no environmental degradation.

Because of the slick-dipping operation in Inhabitants Basin and the small amount of oil that was still moving around in the west end of Lemmon Passage a decision was made to leave the dam in place during the summer months and inspect it again in the autumn. This latter inspection was carried out on the 18th of September. The situation was greatly improved but there was a shoreline about three miles long on which there was still some unconsolidated active oil. This oil moved only a few inches on any one tide but there was the possibility that when ice formed during the winter it would be picked up by the ice and get back into circulation when the ice melted. If the dam was removed and the ice went out to the east this oil would constitute a major pollution risk for beaches in the Lousdale-St. Peter's area which had remained unpolluted owing to the presence of the dam. Accordingly the decision was made to leave the dam in during the winter. The area was inspected in May 1972. The oil was found to have stabilized sufficiently and the removal of the dam will be commenced in June of 1972. Thus navigation will be restored prior to the onset of the 1972 tourist season.

The plan approved by the Navigable Waters experts is that we will remove a 250-ft. section of the dam centered opposite the swing section of the bridge. This will involve the removal of some 20,000 cubic yards of fill and is estimated to cost $35,000.
PART 4 — COSTS

As the costs included in Volume 1 of our report were only up to the 15th of July 1970, with estimates to the 30th of September, it is considered appropriate to include a complete recapitulation of the costs of this operation.

There are three ways of looking at these costs. One is to include only those costs that are external to the government’s own forces. The second is to include only those costs that are over and above the normal budgetary provisions of the government. For example, the Navy divers were going to be paid anyway, so their salaries should not be included. The third is to treat the entire operation as a business proposition (excluding profit and the second generation overhead which cannot be identified in government and university accounting systems).

We have chosen the third method because the choice as to whether to use government forces or private sector forces was on us, and another Task Force on another occasion might make different decisions. The figures which follow were given to us to the nearest cent. We have arbitrarily rounded them off and anyone using them should add the second generation overhead mark up of their own choice.

Unless there is some entirely unforeseen contingency the only cost remaining will be the removal of the Lennox Passage Dam and a final cleaning of Black Duck Cove, for a total of under $45,000, and this has been included.
Summary of Costs

Operation Oil — re Grounding of S.T. Arrow, 4 February 1970

I Ministry of Transport and Task Force
  - Removal of oil from wreck 608,000

II Ministry of Transport and Task Force
  - Protection of Fisheries and Property 94,000

III Ministry of Transport and Task Force
  - Clean-up and Containment 863,000

IV Ministry of Transport and Task Force
  - General Support Costs
    a) Not allocated to specific activities 621,000
    b) Payment to DND 384,000
    c) Payment to ADL 295,000
    d) Payment to Fisheries and Forestry (now part of DOE) 13,000
    1,313,000 1,313,000

V Department of National Defence
  Less payment by MOT 384,000
  763,000

VI Atlantic Oceanographic Laboratory
  Less Payment by MOT 295,000
  295,000

VII Fisheries and Forestry (now DOE)
  Less payment by MOT 105,000
  13,000
  92,000

VIII Fisheries Research Board of Canada
  5,000

IX Canada Centre for Inland Waters
  86,000

X Canada Wildlife Service (not costed separately from regular operations)
  0

XI Government of Nova Scotia
  14,000

XII Estimated cost of removal of Lennox Passage dam and Black Duck Cove clean-up
  45,000
  3,883,000

PART 5 — PAST AND PRESENT

At the time of presenting the first three volumes of our report many of the operations were still under way and we had not yet participated in the marine inquiry. There are therefore a number of matters on which we wish to report at this time, some of which were in operation prior to August 1970.

Endemic Problems

We encountered some problems which appear to us to be endemic.

1) Ships clearing port seem very impatient to clean their bilges and tanks by dumping the slop of oil and water into the ocean. This is a disgusting habit and completely inexcusable when one realizes that facilities into which this mess could be pumped are available at almost all ports in Canada and should be extended to cover the remainder. This callous practice caused extra work because at least three ships outbound through Chedabucto Bay at night pumped tanks and/or bilge during the summer, leading to the re-fouling of beaches and extra clean-up costs. The Masters of these ships obviously considered that with all the Arrow's oil around they could do this with impunity.

We suggest this kind of nonsense, which we believe is widespread, has to stop. Why not require ships to pump bilge into shore tanks before they are given clearance to leave port? This would stop some of it by making the practice unnecessary.

2) There appear to be no regulations regarding the location or discharging of shore tanks holding petroleum products. A tank farm of the Irving Oil Company at Canso is located right at the water's edge with no surrounding dykes. Our clean-up of that harbour was prolonged and made more costly by a persistent slow leakage of oil from the shore into the waters of the harbour. Whether it was the result of current or previous leaks from this tank farm remains in doubt.

3) There appears to be a time honoured practice on the East Coast of Canada and elsewhere that it is fair game for private, or commercial divers to descend onto wrecks and take anything they wish and can. These scavengers, or pirates — the names are used interchangeably — make some money by removing brass fittings and the like for which there is a ready sale in the junk market. In spite of repeated public warnings by press, radio and television that Operation Oil was still working on the wreck and that it was not abandoned and therefore should not be scavenged, the stern section of the Arrow was visited, at night, at least three times by pirates. On one occasion they succeeded in removing the propeller by the use of explosives but were unable to lift it. (This propeller and the spare propeller in the bow section were subsequently recovered by the Task Force and taken to Dartmouth.) On another occasion, whether by accident while using explosives to loosen a piece of brass, or by design, one of the tank top parts was opened and a quantity of oil escaped. (This was in August, prior to Operation Scour.) Some beaches were recontaminated. For a period we had either a Coast Guard, Fisheries, or RCMP boat on police duty at the wreck site in an attempt to demonstrate to the pirates that we meant business. The situation is rather like the rum-running into the U.S. during the prohibition era — you knew who they were but could not catch them at it.
4) Finally, during the period from April 11th when the original debunkering operation was completed and September when Operation Scour was completed, there was a continual struggle to keep the leaking of oil from the wreck to an acceptable minimum. Most of this arose primarily because of the disgraceful condition of the wreck itself. The gaskets on the tank tops and parts were largely perished or non-existent. The venting pipes for the oil tanks (these pipes were on the deck) were in an advanced state of corrosion so that when the Navy divers attempted to drive plugs into the broken ends of these pipes they tore or split. The plugs could not therefore be driven home firmly and had to be wired in loosely. The engine room, and all the cabins and working space on the ship as well as the hull itself, had been filled with Bunker C as the ship sank in the middle of her own slick. As the water temperature rose this oil started to flow off the wreck and rise to the surface.

The Navy divers made several descents onto the wreck during the summer to re-seal the tanks and pipes or to tighten things up after a visit by the pirates. In this way the leaking of oil was kept to a minimum but was still very visible. After Operation Scour and throughout 1971 the leaking was insignificant and only visible on a completely calm day.

Operation of Net Laundry for Oil Contaminated Fishing Gear

The plans for the fishing gear laundromat were presented in Volume III and a brief reference to its operation is contained in Volume I. We now have pleasure in including as Appendix E a report on the operation of this net laundry prepared by the man who made it work, Mr. J.B. Myrick of the Fisheries Service of what is now the Department of the Environment.

We would like to stress that this particular aspect of our operation showed the importance of close co-operation between the scientists, industry and those with operating skills. The members of the scientific team co-ordinated by Dr. Ford produced the design of this laundromat within 72 hours and it was manufactured and installed within three weeks following our original request. Arrangements were made to have it installed in the compound of Nova Scotia Power at Point Tupper as in this way we would be able to get a good supply of steam and hot water. The crew under Mr. Myrick gained operating experience very quickly and when the job was finally completed in the autumn they had cleaned something in excess of $150,000 worth of gear with no failures or a capital investment of some $20,000. Considering that we would have otherwise had to compensate the fisherman not only the $150,000 but the awkward assessment of the value of lost fishing time, this is not a bad investment and not a bad contribution by science, industry and operating expertise.

This gear ranged all the way from a large purse seine net valued at $25,000, of which there were several, to gate valves and other equipment used in oil recovery operations prior to putting these in contingency stores.

There is no doubt in our mind that a laundromat of this sort will be required in any large scale clean-up operation in an area where fishing is taking place. The equipment which we had manufactured could be redesigned with advantage. We think the external dimensions of the high pressure steam and high pressure water cylinders were unnecessarily large and the mechanical agitation of the degreaser mixture could be improved. Also, there should be the opportunity of going back over the chemistry of the problem to see whether the choices of our scientists were optimum or not. Because of the speed with which they came up with the design it is altogether likely that while they were close to dead centre they were not optimum, and a modest expenditure on further development right now would bring the gear to an advanced stage where additional units could be manufactured on short notice if the need arose. But we must remark, as we pass the second anniversary of the grounding of the Arrow, that the work is not yet under way.

Co-operation

In these days when it seems to be a favorite pastime of Canadians to point out the antagonisms between municipal, provincial and federal governments and their servants and the supposed solidities between industry, universities and government, be it in operations or in science, it is a pleasure to be able to report that on the basis of our experience on Operation Oil, when the chips are down these differences seem to become inconsequential. Throughout the entire operation we have enjoyed wholehearted cooperation from the most senior to the most junior ranks in the government of the Province of Nova Scotia and particularly from their Department of Lands and Forests and the provincial Emergency Measures Organization. We have received tremendous co-operation from the Department of National Defence and the Department of Public Works. The field staff and field scientists of the Department of Fisheries (now the Fisheries Service of the Department of the Environment) and the Fisheries Research Board have also made magnificent and timely contributions.

The co-operation from the scientific community in university, industry and government laboratories was outstanding, and it is to our regret that we must record that much good research that is needed to improve Canada's capability to deal more efficiently with oil spillage disasters of this sort remains unfunded and the scientists frustrated. While the appointment of two experienced operations officers within the Ministry of Transport to deal with oil pollution has been a tremendous step forward, they still lack the scientific support needed to make proper assessments of both equipment and plans. Co-operation must be strengthened between the Department of the Environment and the Ministry of Transport if the Department of the Environment is to fund those things which are of importance to the Ministry of Transport's operational responsibilities.

As oil pollution is a world-wide disaster we suggest that if proper choices are made and very modest funds are put behind commercial enterprises to push devices to the operational stage, there is every possibility that we can capitalize on our Chedabucto Bay experience and develop products and devices that will be of use and value to the world. It is suggested, however, that before this will be accepted internationally these products must be ordered by the Canadian Government and placed in its contingency packages. This confidence in our knowledge and abilities will not only further our own readiness but will be of great value to Canadian developers and manufacturers by fostering sales abroad.
Marine Inquiry

The inquiry into the grounding of the Arrow and the subsequent major oil pollution of Chedabucto Bay, some adjoining areas and Sable Island, seemed to us to exhibit the constraints of a judicial character which effectively prevented the obtaining of answers to many questions which we consider important if the frequency of this type of accident is to be reduced.

Why, for example, was so much of the navigational equipment unserviceable? Was it faulty design, faulty manufacture, faulty maintenance, or improper use?

What was the real level of competence of the ship's officers? What training had they received? When had they received it, and how?

We have given much thought to how this situation might be improved. The technical, engineering, scientific and operational aspects of transportation accidents seem to us to have much in common regardless of the mode of transportation involved (land, sea or air). It seems to us that there should be a highly competent group of operations specialists, engineers and scientists who would carry out an immediate investigation of all serious accidents for which the Ministry of Transport has the investigative responsibility. This investigation should be preluded to a logical conclusion before any judicial inquiry is initiated. This expert investigation team should take full account of all aspects of the accident and will need to act with a substantial degree of independence. We would argue that such a procedure, far from usurping the prerogatives of the judiciary, would make their job more meaningful by providing a better base from which the legal considerations could be initiated.

We recommend that new practices and procedures be developed to be used in the investigation of marine accidents to ensure a full technical, engineering, scientific and operational diagnosis of an accident, complete with recommendations on how to prevent similar accidents in the future, and that these investigations be carried out prior to the judicial inquiry.

Marine Regulations

We were delighted by the passage of Bill C-2 and we have been eagerly awaiting the proclamation of the Regulations to give the new Act some teeth and some operational muscle to deal with the problems. We have quite naturally not been consulted in the drafting of these Regulations but our opinion has been informally sought on two or three occasions and we have developed a disquiet that the Regulations are being written in such a way as to emasculate Bill C-2 and frustrate the intent of Parliament. In the meantime minor spills go on and on and yet another tanker came into Canadian waters with radar trouble and no large scale coastal charts at all. Fortunately this one had the good sense to drop anchor and wait until a coastal chart had been taken out by the Canadian Coast Guard, but can one imagine an Air Canada airline pilot arriving over England and declaring a state of emergency because he did not have a landing chart for London Airport?

We must also draw attention to the recent grounding of the SS Vanlene off Barkley Sound on Vancouver Island. This is a classic repetition of the Arrow — substandard certificates of competency, virtually no navigational aids, and a Captain who was something in the order of 40 miles north of his estimated position. Not only did he hit the wrong piece of shore, he was even in the wrong country. Fortunately the cargo was not oil. Surely this is an ugly warning of what will happen if a major tanker route is developed from Valdez to Cherry Point.

We are delighted at the action taken to establish positive approach control for the supertankers coming into the new oil refinery at Point Tupper, but that refinery has already had its first spill, fortunately a minor one.

Positive on route and approach control of all merchant ships should become a world standard without delay.

We sincerely hope that the implementation of Bill C-2 and other corrective actions will be pushed vigorously, not only domestically but internationally. At the present time the shrewdness of some of those who sail merchant ships, and tankers in particular, is only exceeded by the tolerance of the public, which we hope is wearing a bit thin. There is evidence that the biological ability of the oceans to cope with this pollution is reaching its limit, adding a further note of urgency.
VOLUME IV
APPENDIX A
BEACH RESTORATION REPORT

by

John W. MacKay

December 1970

Activities during 1970 following the grounding of
the tanker Arrow in Chedabucto
Bay 4th February 1970
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INTRODUCTION

After the grounding of the tanker “Arrow” and subsequent spillage of oil into the waters of Chedabucto Bay, approximately 190 miles of coastline were subjected to varying degrees of oil pollution.

During the initial stages, oil was removed experimentally from a few beaches by the Army.

On April 24, 1970, a crew of labourers (“slick pickers”) were organized by the Department of Public Works of Canada to shovel the oiled material off the lightly oiled beaches into plastic bags in the Bay of Rocks area. Machinery commenced work on the heavily oiled shoreline of Arichat and Black Duck Cove on April 30.

This report deals with the beach cleaning directed by the Department of Public Works and attempts to give a description of the clean-up program. Seventy-eight beaches totalling approximately 30 miles of shoreline have been worked to date. Some areas have since been re-cleaned.

Part I is a generalized review of the program plus our observations and experiences. It may provide some guidance in the event of future spills.

Part II discusses 43 areas which are significant with respect to the beach type, the technique used, or the problems encountered. A detailed time, cost and equipment breakdown is given for each area.

Part 1

The restoration program commenced in May 1970 and ended the first week of November. Requests and work began to taper off in the September and October period. The beach restoration program aimed to clean oil contamination from the “nationwide-rated” beaches (this designation was provided by the Government of Nova Scotia and its Department of Lands and Forests) and the “community” beaches. The latter definition was interpreted very flexibly but generally used to classify a recreation area used by a number of people or some section of shoreline used for fishing purposes. The fishing areas received priority over recreation and the number of users was not considered. Wherever possible with the methods at our disposal an area used by fishermen was cleaned.

The selection of community beaches resulted solely from requests generated by the residents. Unfortunately, not all requests could be acted upon. The reasons for this will be discussed later. At no time was a clean-up of the entire shoreline ever attempted. Approximately 190 miles of shoreline were polluted (see chart, Appendix 1); about 30 miles were cleaned, some of which were recontaminated.

The following is a list of the areas worked (see chart, Appendix 2), plus a brief description of what was done:

Arichat Contract: Discussed in Part II. Recontamination in some sections by autumn storm action.

Babins Cove: 800 feet of the Babins Cove, Baisden Point Contract cleaned twice by contractor. Small amounts of recontamination observed continually during the summer. Pickers were employed in late July but work was terminated after heavy oiling during time of the unauthorized opening of the wreck. No further work was carried out in this area as recontamination continued, possibly coming from the adjacent rocky shoreline, Jerseyman Island or beds of eel grass between this Island and the beach. Future machinery clean-up not recommended as sediment supply is limited. Used extensively for recreation and also for a boat haul-up.

Black Duck Cove: Discussed in detail on page 46. Part II. Autumn storms have resulted in waves spraying oil over beach front road. A footpath was improved to make a usable access for one resident.

L.C. Bouvard: Adjacent to Cape Auget breakwater — cleaned by pickers.

Boudreauville: Usually referred to as the Point Beach: 280 feet cleaned under the Miscellaneous Beach Contract (Isle Madame areas); 340 feet cleaned by pickers. Recreation area.

Boudreauville: (Adjacent to the breakwater) 400 feet cleaned by pickers. Fishing and recreation.

Burke’s Cove: 320 feet cleaned by pickers. Fishing and recreation.

Baisden Point: This beach (850 feet), together with Babins Cove was to have been cleaned under contract. However, it proved impossible when the bearing capacity of the beach was not sufficient to support machinery. Contamination was too extensive to be feasibly cleaned by manual methods. Recreation area.
Cape Argos: Cleaned by pickers.

Cape Auget: Both sides of wharf for a linear footage of 560 feet cleaned under Miscellaneous Beaches (Isle Madame) Contract. Isle Madame fishing area.

Cape Auget (Gerald Marchand): Manual and machinery. Fishing and recreation. Some re-oiling in late August necessitated a second pickings.

Cape Auget (Clifford Boucher): Area of proposed recreation development by Mr. Boucher. Requested to clean approximately one mile but with the stipulation that we not remove any material. Bulldozer pushed oiled material up to backshore for a frontage of approximately 2,000 feet. Operation discontinued because of re-oiling of cleaned section, and because it was felt that the length requested was somewhat beyond the terms of reference of this program.

Chapel Cove: Approximately 1,500 feet cleaned by pickers. This area has remained clean.

Canso (Breakwater Beach): See page 59, Part II.

Canso Tickle: A dam constructed below the bridge to Durrell Island prevented contamination of the eastern section but both shores on the western side remain extensively oiled. As the movement of water is minimal and the depth of oil is considerable, the natural clean-up and stabilization in this area was not less than other parts of the Bay. In late October, the oil on the rocks was still fluid and indiscernible was present on the water surface. During the summer, pools of oil were shovelled into plastic bags and removed. In late August, a decrease of the oil-on-water was thought to have occurred. One small beach (Lumsden’s) was selected for clean-up. This was a 50 foot shingle beach bounded by boulders and was used to indicate whether effective clean-up could be accomplished. After all oil which could be removed was taken away, limestone was applied, then one foot of clean material was placed over the area. Unfortunately, recontamination continued until the appearance of this area was indistinguishable from the remainder of the western side of the Tickle.

The terrain of the Tickle consists mainly of boulders and rock cliffs interspersed with small pocket beaches to which vehicle access is largely limited. If the recontamination problem had not existed, the amount of clean-up possible would have been very small. To date, we have no non-chemical methods capable of cleaning rock and boulders or of effectively stabilizing the movement of oil off them.

Canso (adjacent to Government Wharf): 50 foot area cleaned by pickers; experienced periodic light re-oiling from an onshore source close to the fish plant wharf.

Cove Road (W. Archiat): Attempted machine clean-up but not effective. Most of the area consists of a heavily oiled clay beach with the water close to the surface, hence restricting vehicle movement.


Deep Cove: page 74, Part II


Eddy Point: See Sand Point, page 57, Part II


Evans: See Inhabitants River Area, page 68, Part II.

Fox Island Main: Also called Indian Cove, Part II, page 30. This beach re-oiled in early October. Further discussion on this matter is contained in the recontamination section.

No action was taken on the coastline of the Island.

Fox Island — Other Beaches: Two main areas cleaned by machinery behind the summer cottage area. Some material replaced. In another section, clean material was deposited over the contamination. This area has remained clean.

Glasgow Head: Situated close to Canso Marine Radio. Sand beach located on one side of an open lagoon, used for swimming instruction and other recreation. Despite heavy oiling, this area could be worked by pickers as the contamination had mixed with the sand, dried, and was beginning to flake off. Removal was difficult due to the terrain. A dozer and float was finally used at a cost of $4,766.00. This area is clean at time of writing.

Gudie Point: See page 66, Part II

Gracieville: See page 66, Part II

Grand Grave: See page 66, Part II

Grand River: See page 66, Part II

Hadleyville: See page 52, Part II (Hadleyville #1)

Hadleyville #2: See page 52, Part II

Half Island Cove: See page 52, Part II

Halfpenny Pond: The pond itself was impossible to clean except for debris. A brush boom was placed where the pond passed under a highway bridge to prevent contamination of shoreline adjacent to where the pond emptied into the Bay. Machinery cleaned this section of shoreline which was used by fishermen. It has remained clean.

Halfpenny (Douglas): Recreation area — material pushed up by dozer against backshore cliff. Clean.

Halfway Cove: Clean.

Irish Point: West Arichat (adjacent to RCMP). 150 feet cleaned by pickers. Experienced periods of slight re-oiling and natural cleaning during summer but was usable.

Inhabitants River Beaches: See page 68, Part II
Inhabitants River Bridge: Adjacent beach cleaned by machinery — used for recreation. Remained clean.

Janvrin Harbour Wharf Area: See page 55, Part II. Remained clean.


Janvrin Harbour (D.M. McNeil): Attempted cleaning after Janvrin Wharf area cleaned, but beach too soft to support machinery. Cleared by machinery in September but as material could not be removed it was deposited at the base of a cliff. No re-oiling.

Janvrin Harbour (Gunmar Peterson’s): Requested to clean the above as a recreational area for local residents and summer cottage owners, one of which was Mr. Peterson, residents state, owned the frontage property. Later, Mr. Peterson stated he was not the present owner and requested two other areas. One, adjacent to side area was impossible to clean, the other by Janvrin Island disposal area was being contaminated by oil floating off Rabbit Island. This latter area was cleaned by pickers, the material removed by privately owned barge, and the area remained clean.

Landry’s Cabin: (three miles from Mulgrave) Cleaned one-half requested area by pickers. Remainder was unworkable as it contained bedrock.

L’Ardoise Area (Rockdale): See page 66, Part II.

Martin Point: 3,000 feet cleaned by pickers. Also called Lower L’Ardoise; discussed in Part II, page 66.

MacDonald’s Beach: Nationally rated but access owned by Floyd MacDonald who stipulated that no machinery be used during cleaning. Pickers cleaned approximately one-third of the length before contamination became too heavy for manual methods. Work was discontinued; the cleaned section was re-oiled.

MacDonald’s (Janvrin Island West): Material removed from the beach by machinery and stockpiled along the backshore. Unable to haul material from site.

Martinique Park: Pickers cleaned a small area, no re-oiling.

Martinique: Pickers cleaned a recreation area on property owned by Edna Rowe. No recontamination.

Melford School and Melford Church: Areas used for recreation by the groups implied in their names. The first was worked by both pickers and machinery, the second by machinery. Small amounts of recontamination were observed after the unauthorized opening of the wreck, but this was removed by wave action.

Moose Bay: Also called Clam Harbour or Port Shoreham. Discussed in Part II, page 70. Clam Pond and Ragged Head, bodies of water behind this beach, contained oil around their perimeter and below the water level. They could not be cleaned by the methods available.

Petit de Grat areas: Discussed in Part II, page 73, they include:

1. Adjacent to Boudreau’s Fish Plant
2. Gros Nez
3. Louisiana Chicken Coop
4. Petit de Grat Bridge
5. Petit de Grat Point
6. Sampson’s Beach

Philips Harbour: See page 61, Part II.

Point Michaud: See page 66, Part II.

Pondville & Pondville South: — or Little Barachois. See page 49, Part II.

Port Richmond: See page 68, Part II.

Port Malcolm: See page 68, Part II.

Queensport (East of bridge): See page 59, Part II.

Queensport (West of bridge): Cleaned by pickers, as in previous case. Beach remained clean after installation of brush boom.

Rockdale: Discussed under L’Ardoise areas in Part II.

Rocky Bay and Rocky Bay North: See page 49, Part II.

Sampson (Eric) (W. Arichat): 320 feet cleaned under the Miscellaneous Beaches (Isle Madame) Contract. Another section cleaned by pickers. This area experienced heavy re-oiling during the pirates’ visit to the wreck. Re-cleaning was not considered as this area is subject to erosion.

Sand Point (Lighthouse): See page 57, Part II.

Sand Point (Breakwater): Recreation and fishing area, cleaned by machinery. No re-oiling.

Sam Scott’s: 200 feet; used extensively for recreation and fishing. Cleaned by pickers but re-oiled during the unauthorized opening of the wreck. Re-cleaned by machinery depositing the contaminated material against the backshore at the owner’s request.

Seacou Bay: See page 68, Part II.

St. Esprit: See page 66, Part II.

St. Francis Harbour: 2,200 feet was cleaned under contract, some of which was replaced. Also included in this contract was 2,200 feet in an adjacent area called Diggin’s Beach. The first area was used for fishing, the second for recreation. Both sections remained clean.

Steep Cove: Recreational area. Cleaned by pickers.

Walkerville: See page 68, Part II.

Whiteside: See page 68, Part II.
Unfortunately, we were unable to act on all requests received. The members of the beach restoration organization, being in daily contact with the residents of the area and the field staff being themselves residents, were well aware of the difficulties and frustration created by the pollution. Despite our regrets, we were limited by the capability of the methods at our disposal.

The most prominent reason for not acting on requests was inaccessibility of the site. This occurred on a few occasions where the users had always walked down the cliff to the beach. Another reason was the observed diminution of contamination. Such clean-up would have been futile and was not attempted unless some possibility existed that its effects could be lessened or the oiling would be minimal. It was not until the last part of the program that such a judgement could be made.

A few requests were considered unreasonable.

**ORGANIZATION AND PROCEDURE**

After the Department of Public Works’ Engineers had completed construction of the Lennox Passage and Canso Tickle dams, a resident engineer was placed in Port Hawkesbury for the beach restoration program. After inspecting the majority of the contaminated areas, an office was established at Operation Oil Headquarters in the Port Hawkesbury Motel. Eventually, three university students were selected as project coordinators, each with an assigned territory and working out of the office. Unfortunately, no experienced construction supervisors were available at the time. A helicopter was an invaluable asset in the initial stages as it allowed the engineer to inspect all sites at least once per day while the coordinators were gaining experience. All three plus the office clerk did an excellent job, working up to 16 hours per day.

All important jobs had an on-site fieldman, who under the direction of the coordinators supervised the labourers or contractors, recorded the hours worked and the amount of material removed. This was usually a local resident.

The uncertainty of mail delivery during this clean-up forced us to revise our tendering procedure. The revised procedure permitted us to survey a beach one day, write the conditions of the contract that night, phone all prospective bidders giving the details the next morning, and have the document picked up or delivered the same day. Depending on our schedule, this was often done in as little as three days (usually a weekend). The bids were teleaxed or telegraphed to the District Department of Public Works Office.

This method expedited the work tremendously and is recommended for any future programs where clean-up must proceed as rapidly as possible.

Rental of equipment by the hour rather than contracting was used where:

1. the total estimated value of the work was under $1,000.00,
2. such equipment was required immediately,
3. delays such as removal and replacement of skidways and fishing equipment would be encountered,
4. involved and intricate instruction coupled with extensive supervision were required and could not realistically be written into contract documents.

Further discussions on this matter are contained in the Methods of Clean-up section.

**DISPOSAL OF CONTAMINATED MATERIAL**

The disposal areas were selected by the Task Force Operation Oil with the help of the Nova Scotia Department of Lands and Forests but were only approved for use after a thorough inspection by five separate Provincial Agencies, all of whom agreed that the site met the rigid specifications that had been laid down by the Task Force.

Cape Auger (inaccessible and unusable)
Dover Municipal Dump
Doyle Road
Fox Island
MacIntyre Lake (not used)
Port Royal
Sand Point

The construction of these sites was supervised by the Department of Public Works. The construction consisted of bulldozing to a depth of 4-6 feet, grading the claysand loam and banking the sides with this material. At Sand Point, bedrock was encountered, and it was stipulated that a layer of clay be placed over the bottom. On one occasion, water had to be drained from the damsite by making an opening, constructing a filter stop to filter the oil from the water, then closing the opening.

Cape Auger site was not used during the D.P.W. clean-up but was covered, seeded with grass and trees planted during this time.

Other disposal areas covered with topsoil were: Doyle Road, Fox Island, Port Royal, and Sand Point. Trees have been planted at Port Royal and Doyle Road.

On evaluating our summer experience, we feel that less elaborate precautions would be sufficient. This is based on the observation that the usual depth of oil penetration in clays was 4 inches, in sand 6 inches. Also, the oil was mixed with beach material. If the disposal area is covered and sloped to facilitate runoff and streams of water are not present, it does not seem possible that the oil will reach the water table. Heavily contaminated beaches and backshore stockpiles of oil on the beach existed throughout the program within 100 to 1000 feet of drinking water sources at Walkerville and Janvin Harbour (McNeil). These areas were worked with great difficulty. The hearing capacity of the beach material was low due to the proximity of the water table.

Precautions should be taken, but in numerous areas removal was difficult and costly while unused backshore areas existed. Placement of such materials in the backshore should not substantially increase the danger of water contamination over that of having it on the beach.

**COST OF RESTORATION PROGRAM**

The total cost of the beach restoration program undertaken by the Department of Public Works in 1970 was $375,000.
METHODS OF CLEAN-UP

The methods of beach cleaning in Chedabucto Bay might be classified into two main categories:

(a) Labourers
(b) Machinery

(a) Clean-up Using Labourers

The men who removed the oiled material off the beaches were referred to throughout the operation as “dick pickers” or “pickers”. Their modus operandi consisted of:

1. using hoes, rakes or forks to gather material into piles. This was done only where required — the rakes and forks to pick up small accumulations of seaweed, the hoes to scrape off a thin layer of contaminated sediment.

2. shovelling this material into plastic bags. The type of bag used was 0.006 mil, 18 X 25, plain polyethylene, with a brand name of Milpack. They were manufactured by CIL and cost approximately $3 each, delivered. They were found to be satisfactory and could be used three times if material was not so oily as to stick the empty bags together and did not remain on the beach long enough to harden in the bags. The last factor made it impossible to re-use bags used in areas where the material had to be hauled out by barges. Larger bags tended to break when being loaded.

On a number of occasions, the material was shovelled directly into trucks. This was found not to be as productive, and did not permit optimum use of the truck.

3. Removal from Beach. A variety of vehicles were used for this purpose. For the small volume operations, a 4-wheel drive, 3/4 – 1 ton capacity truck was used. This vehicle drove onto the beach and was loaded with the bags. It was also used in high volume removal operations where the haul road was inaccessible to ordinary trucks. This applies mainly to early season clean-up when the beach roads were still soft and wet. The rate paid for this type of vehicle was from $6.00 to $9.00 per hour (including driver), depending on the lowest price that could be negotiated. Prices paid for all equipment was based on the Nova Scotia Road Builders Association schedule for equipment rental. When not listed in this schedule, the rate was calculated using the Nova Scotia Department of Highways formula:

Basic Monthly Rental = Replacement value x 9% = Sx
Running Repairs = Replacement value x 3% = Sy
Monthly non-operating rate = $ (x + y)
Hourly Rate = \frac{x + y}{225} = Sz

Operating Rate = Sz + operating expenses adjusted to round figures.

In large scale removal, it was more economical to use a two-stage operation. One vehicle moved material to a loading area, then 18,000 lb. capacity dump trucks would haul to the dump site. For moving the material to the loading area, 4-wheel drive trucks, farm tractors, labourers with stretchers, front-end loaders, small dozers hauling a float, and tree farmers (see page 67) were all used. The type of vehicle used depended on their availability and the particular circumstances in each area. When the beach has a uniform particle size, a 4-wheel drive truck and the tree farmer were best suited. Large trucks such as tandems were too difficult to load without machinery.

In two inaccessible areas — Janvrin Harbour (Gunnar Petersen) and Arichat (DeYong’s sand bar), motorized barge transported the bags to a loading area. This was only possible where the shoreline would permit a barge to come in sufficiently close for loading. At Janvrin, the barge was equipped with wheels and an outboard motor, thus allowing it to be towed up the beach. When the current was heavy, the barge was towed with a boat.

(b) Machinery

As discussed in Part II, two basic machine type operations were used in this clean-up — (i) bulldozer — loader — trucks (ii) loader - trucks.

During the Arichat, Black Duck Cove and Fox Island Main clean-ups, (pages 43 – 51), the trial and error method brought forth some simple guidelines on machine usage. Repeated briefly, they were:

1. keep machinery out of the water
2. remove all disturbed material before the tide rises
3. use a bulldozer only under specific circumstances
4. use a loader in deep oil contamination
5. clean or attempt to stabilize all potential re-cycling sources before working designated area.

Items (1) and (2) have been discussed throughout Part II. Generally, only the amount of contamination that the available machinery can remove in one tidal cycle should be marked for that day’s work. Work should proceed along the shore from the point of access and from high tide to low, staying approximately ten feet from the water at all times. Fortunately, the amount of contamination adjacent to low tide was usually small. Below low tide, it was usually confined to beds of seaweed.

Bulldozer-Loader-Trench Operation

Bulldozer (Item 3) usage in the initial stages of clean-up resulted in considerable mixing of clean and contaminated material, thus necessitating the removal of larger quantities than required. These were dozers of the 105 — 120 flywheel horsepower class and were found to be somewhat unmanageable. They did not have an adjustment which would permit the blade to be angled to the direction of travel. In numerous areas, the bearing capacity was not sufficient to support this heavy machine.

In addition to the limitations of the machine, the majority of operators are excavator oriented, that is, they tend to move large volumes of material without regard to the capability of loader and trucks.
Small dozers of the 65 H.P. (flywheel) class were found useful and efficient when used in specific ways.

One method used successfully was a dozer with a blade angled 45 degrees to the direction of travel. This was first used at Janvin Harbour (part II, p. 53) and performed well in uniform depth contamination of fine sediments. For best results, rows are constructed of two or less passes on each side and then removed by the loader. These rows can be either perpendicular or parallel to the water. The number of passes made by the dozer in forming the rows would naturally be limited by the depth of contamination, although our experiment indicated that for lateral movement greater than two blade widths, considerably more clean material would be removed. In coarse sand and gravel type areas, this procedure did work but not as well as on clay and fine sand beaches. In the latter, the material did not "peel off" so readily and move along the blade, but tends rather to pile up and flow in front of the dozer.

On the Inhabitants Bay and River shoreline dozers were used, with the operators' actions being closely supervised. This produced complaints from the contractors that we were interfering unduly in their work, but did result in satisfactory work. These objections from the contractors had been anticipated and consequently the specifications had been phrased to permit direction of the work by our staff.

The procedure used consisted of pushing the material up the beach to the edge of contamination and cleaning approximately 25 foot wide strips. A 65 H.P. dozer with no blade adjustment was used. The cleaning of narrow strips was beneficial in two ways:

1. It kept the amount of material on the blade to a minimum, thus lessening spillage along the sides.
2. It allowed the contractor to work with the tides.

In the Inhabitants River beaches, the dozer was used to push the contaminated material against the backshore cliff. Here it was impossible to remove the material. The width of beach varied but was usually 30 to 40 feet and the contamination was not deep. In other areas where these conditions existed, the material was left on the beach. On three beaches, the owners of the frontage property requested this to lessen wave action. In areas so worked, a small amount of clean material or limestone was placed over any fluid oil in an attempt at stabilization, thus lessening leaching and contamination by wave action.

Loader – Truck Operation

This combination of equipment was first used on Fox Island Main Beach; the encouraging results led to its usage on all subsequent oil contamination greater than 1 foot deep. The loader was particularly useful in the "deep trench" type contamination that existed on the gravel beaches on the west side of Chedabucto Bay. To lessen spillage, it was essential that the operator not fill the basket to its heaped capacity. A large loader (4 c.y.) with rubber tires was found suitable on all beaches except in muddy sections. A tracked loader was also used with success.

In depths of 3 – 4 inches of contamination, the loader was found to remove a high percentage of clean material. Due to the thickness of the teeth on the bucket and the limited precision of operation, from 1 – 2% of excess material was taken in each filling.

Loader Vs. Loader and Dozer

Based on our experience, which combination to use depended on the depth and distribution of material. For a blanket of oil 2 – 6", a dozer was found to be most effective and efficient. When the depth of contamination exceeded this value, a loader alone was best suited.

Machinery Vs. Pickers

Actually, there is no choice between these methods. The choice is dictated by the type of oiling. Picking is feasible where the contamination is in scattered spots and depths of less than 4 inches. Except where the rate of erosion is substantial, the removal of greater depths of contamination is neither economical nor effective (see Moose Bay, p. 64). As pickers remove less volume of material, they were used in depths and distribution of oiling greater than above, because certain beaches did not have an ample supply of sediment replenishment, i.e. Queensport and some portions of Petit de Grat.

Effectiveness of Clean-up

For the majority of beaches with moderate to heavy oiling, it was found almost impossible to remove 100% of the contamination on the first attempt. Mainly this was due to two factors:

1. Isolated spots of oil which had been covered over with clean material at the time of work but were later revealed by sediment movement.
2. “Sediment Shield Effect” for want of a better term, used to describe the covering of oiled particles with clean sand or clay so they appeared non-contaminated, these fine sediments having been "stirred up" by pickers or machine action. This condition was found usually in heavy concentrations of semi-fluid oil. Following clean-up wave action washed off some of this adhering material re-exposing the oiled particles. This condition was never observed in clay and sand type areas, but was experienced in gravel and fine sediment beaches. Both factors 1 and 2 were relatively harmless as they comprised less than 2% of the surface area and were usually less than the accumulation of jellyfish, debris, bottles and decaying seaweed. In case No. 1, the material was usually dry and solid; in case No. 2, the oil soon stabilized and became non-adhesive when separated from the main body of oil (two to four weeks).

To obtain a beach approaching completely oil free status (assuming heavy oiling), it was found necessary to have a group of labourers remove this material after four or five tidal cycles. This was done at the Point Beach, Petit de Grat and Half Island Cove. Fortunately, the most frequently used areas in the gravel type beaches were cleaned before June 15, and not used until mid-July. This allowed time for stabilization of the occasional oil particle which remained. No complaints were received by users in this regard.
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1. Isolated spots of oil which had been covered over with clean material at the time of work but were later revealed by sediment movement.
2. “Sediment Shield Effect” for want of a better term, used to describe the covering of oil by large particles of clean sand or clay so that the material under it remained clean.

In both cases, the material had been “stirred up” by pickers or machine action. This condition was found usually in heavy concentrations of semi-fluid oil. Following clean-up wave action washed off some of this adhering material re-exposing the oil. This condition was never observed in clay and sand type areas, but was experienced in gravel and fine sediment beaches. Both factors 1 and 2 were relatively harmless as they comprised less than 2% of the surface area and were usually less than the accumulation of jellyfish, debris, bottles and decaying seaweed. In case No. 1, the material was usually dry and solid; in case No. 2, the oil soon stabilized and became non-adhesive when separated from the main body of oil (two to four weeks).

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OTHER MEANS OF BEACH RESTORATION

Only conventional earth moving equipment was used in the beach restoration program because:

(a) Initially, we did not know the capabilities and limitation of available machinery and hence we could not suggest intelligent modifications.
(b) The cost of such modifications would be relatively high. The type of heavy equipment used varied in price from $20,000 to $60,000. To have the most important areas cleaned before summer usage, it was necessary at times to use four contractors each with a number of units. For this operation, to use a similar number of extensively modified units, the cost of modification would be greater than the total cost of the restoration operation. Machinery specifically designed for oil removal from beaches would probably cost more than modified conventional types.
(c) No serious thought was given to this aspect because of the time involved in manufacturing and because of (a) and (b) above.

One modification that appears to merit further investigation is a new bucket design for a front-end loader, a longer, wider, less deep bucket which would remove, almost undisturbed, a slab of contaminated material. This would permit such machinery to work at full capacity and prevent the mixing of clean and oiled material resulting when the loader moves ahead to force material into the bucket. It could be interchangeable with the standard bucket.

One method attempted was to push the material down to the water at high tide. This resulted in a slick which re-oiled the cleaned area the next tide.

In another test area, the oiled material was raked by labourers using garden rakes. The oiled material had a 1/8 solid skin under which was semi-fluid oil. The disturbed material set up a slick when the tide came up; the oiled particles gradually flowed together and the surface began to harden. The end result was barely distinguishable from the initial situation.

It could be surmised that raking would hasten the natural oil removal action in dry oil contamination, but based on the Magdalene Islands experience with dry oil particles, this material would possibly be carried in and out, the majority of it eventually ending up on this beach or an adjacent beach.

On one occasion an experiment was conducted with the steam cleaning equipment used on wharves. A small area composed of clay and stone contaminated with oil was banked at the lower tidal zone and sides with peat moss to absorb the oil. The steam was applied until no more oil could be observed flowing off the test area. The experiment was not judged a success as the clay particles were not really clean; also the time required to steam the area, place and remove the peat moss was considerably more than other methods. Test holes dug before and after the application appeared to indicate an increase in depth of contamination.

As discussed in Part II, page 32, a motorized grader was used at Half Island Cove. It experienced difficulty maintaining traction. This area of the beach was shingle with an average oil depth of 2 inches, lightly scattered. The United States Federal Water Pollution Control Administration, in a project which evaluated earth moving equipment in oil contaminated beach restoration, found this machine to be very efficient in 1 inch oil depth penetration on flat, sandy beaches. They recommended flotation tires or rubber-belted half-tracks for situations where maintaining traction would be a problem. However, the majority of areas worked in our program were either loosely packed shingle or wet fine sand-silt-clay combination types. The depth of oiling was usually 4 inches or greater in the machinery removal areas; thus, we felt, as did heavy equipment operators, would seriously impair the operation of a grader even if equipped with flotation tires or half-tracks.
RECONTAMINATION

The term recontamination is used in this report to refer to all oil contamination which occurred after the initial sinking of the tanker "Arrow" and after the subsequent arrival of this oil on the beaches.

This type of contamination came from a number of sources, the most prominent of which were:

1. Oil moving on the water from one section of shoreline to another, or adjacent area re-oiling. Throughout the operation, this problem hindered the effective clean-up of certain areas. Generally, the source shoreline types were bedrock and boulders or clay and silt, i.e., surfaces on which the oil accumulated to appreciable depth rather than penetrated. At first, it was thought that a potential source could be identified from the fluid nature of the oil and the presence of iridescence, but this applied only to the obvious. With increasing land and air temperatures in late June and early July, adjacent area re-oiling revealed itself in another form. The oil on the rocks and the fine sediments became sufficiently fluid to move or be picked up by water action. The presence of a dry surface or skin did not prevent this as the oil would break through and slowly move down the surface.

Except in two instances (Fox Island Main & Limestone Beach) the amount of oil which came from this source was usually small, resulting in a thin black film, but nevertheless, sufficient to render the area unsuitable for recreation purposes. In some cases, patches or chunks of oil of 1 - 3 diameter would move to cleaned sections giving widely scattered oil contamination; in other cases, the contamination resulted in uniform blackening of a large area. The movement of the latter was usually detectable as it was accompanied by iridescence.

The Inhabitants Bay area shoreline and islands represented one of the most heavily oiled sections of Chedabucto Bay. The movement of oil between beaches delayed restoration procedures until late summer. Although iridescence was still visible in the vicinity of the islands, it was not sufficient to cause serious pollution. Only the Limestone Beach area suffered heavy adjacent area pollution.

In areas such as the western side of Janvin Island and Canso Tickle, no serious restoration efforts were attempted as the movement of oil from shore to shore would have made such efforts futile.

2. Oil from the wreck. It was difficult to distinguish between sources of recontaminating oil. It was not possible to be certain whether oil seeping from the wreck contributed at all to shoreline pollution. When a beach was being re-oiled from nearby shoreline sources, the iridescence could sometimes be seen extending over the intervening water. This was observed in Black Duck Cove, Canso Tickle, and from Rabbit Island to Janvin. In only two instances of which we were aware was the oil traced directly from the tanker to shore after the initial pumping. Nevertheless, certain circumstances appeared to indicate this as a re-oiling source.

In the initial stages of the program, before increasing temperatures caused adjacent area pollution to become noticeable, re-oilings in Arichat and Deep Cove usually coincided with high winds from the direction of the wreck. Only from about June 25 until July 20, when unauthorized divers opened the wreck, was there any recontamination which could be associated with this source.

The opening of the tanker resulted in varying degrees of re-oiling in Cape Auget, Arichat, Janvin Island and along the north shore of Inhabitants Bay. A slick was observed as far from the wreck as Melfort (south of Eddy Point).

3. Shallow Water Areas. Oil deposited in sheltered coves, lagoons and shallow basins tended to remain in such areas during the summer. Protected from the wave action which removed the contamination on most shingle beaches and lessened it in other areas, they seeped varying amounts of oil depending on the temperature or the energy generated by the water at that particular time. During the cleaning program, no method of effectively dealing with this problem was devised, although steps were taken to lessen its severity.

Some of the areas concerned and the remedial measures taken are as follows:

(a) The shallow basins on Inhabitants Bay contained large amounts of eelgrass. The dead leaves of eelgrass would run with the oil and be deposited on the beaches. This contaminated seaweed would pollute clean beaches. The slicklicker operation kept this source to a minimum until suspended at the end of July. The proliferation of oiling by eelgrass on the clean beaches in Inhabitants Bay followed indicated the value of this operation.

(b) Lagoons, protected shallow coves and estuaries presented recontamination problems. The lagoons which gave the most trouble were those situated directly behind the beaches to be worked. The natural openings to the lagoons periodically close with the deposition of beach material, then open when the water height becomes sufficient to cut a new channel. When this occurred, oil from within would be carried to the adjacent shoreline. This situation existed at Babins Cove, Port Richmond and Seacoal Bay. In the first two cases, where the water within the lagoon was effectively isolated from the sea, a trench was dug, packed with fir boughs and the water released. The fir boughs effectively filtered the oil. In Seacoal Bay, at high tide there were numerous wide channels from the ocean to the lagoon so this action could not be taken.

The coves which contained oil were usually exposed to wave action during a portion of the tidal cycle. However, this was sufficient to ensure a minimum amount of oil remained in these sources, hence pollution from this type of contamination was minimal.

Estuaries such as existed in Hadleyville #2 Contract and Seacoal could not be dealt with in any effective manner. In Hadleyville, a dozer removed and disturbed the oiled material. In Queensport and Halfpenny Pond a brush boom successfully prevented oil from coming out onto the beach.
Fortunately for the beach restoration program in Chedabucto Bay, the sinking of the tanker took place early in February and beach clean-up was not required until May. This allowed the oil which arrived on the shoreline to be stabilized to varying degrees. Based on our experience, it would be futile to attempt beach restoration where the oil was still fluid. The shoreline must be sufficiently solid that water action has little noticeable influence on it. The presence of iridescence in the water or of shiny, liquid oil on the beach indicates there will be some degree of contamination of adjacent uninflated shoreline.

Lagoons should be closed by filling in the entrance with a bulldozer before oil reaches the shoreline. Lagoons which cannot be closed in this manner along with estuaries and other shoreline water areas should be protected by booms. In addition to being areas where present clean-up methods are ineffective, they are usually wildlife feeding areas. To lessen the possibility of adjacent area re-oiling in the cove, they were usually cleaned from headland to headland if the extra distance was not too great or boulders were not present. In an attempt to lessen the effects of adjacent area recontamination and to permit clean-up of the heavily oiled Canso Tickle and a section of Inhabitants Bay that came to be known as the Limestone Beach, an experimental program of stabilization using limestone was conducted in these areas. Scientific co-ordination was supplied by Mr. Tom Foote of the Bedford Institute of Oceanography.

Initially, application using a sand blaster was tried unsuccessfully. After a number of unsuccessful trials (see page 72, Part II), a procedure was used whereby repeated light applications were made whenever fluid oil appeared through the hardened surface. This procedure, though expensive in terms of labour costs, did prevent recontamination from the treated areas. Application in both areas had decreased to once every two weeks by August 9 and was discontinued on August 24. Both areas remained clean during the applications and until about October 1. A survey on October 4—5 revealed that both areas were extensively re-oiled. Limestone was also applied to the mounds of oiled material pushed up against the backshore cliffs when removal was impossible. An analysis of the effectiveness of this means of stabilization or what actually happened is rather difficult. Apparently, the limestone hardened only the surface. During the warm summer weather, the fluid oil beneath this surface would break through and cause recontamination if limestone was not re-applied. During the September period, it appeared that the storms and the natural movement of beach material removed portions of the surface thereby exposing the fluid oil. If re-application had been continued, possibly the cleaned beaches would have remained uncontaminated.

The effort involved in application and doubt about its effectiveness ruled out its use in large scale shoreline application, but it appears to be beneficial on accessible pockets of contamination if they are observed constantly and the limestone re-applied as needed.

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Part II

ARICHAT

Data

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<th>Measurement</th>
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<tr>
<td>Depth</td>
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<tr>
<td>Width</td>
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<tr>
<td>Time</td>
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<td></td>
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<td>Contractor</td>
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<td>Cost/Ton</td>
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<tr>
<td>Distance to Disposal</td>
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Equipment and Actual Hours Worked

The machinery was on the site from start to completion of the contract but due to tides worked the following hours:

- IH-TD15 Dozer
- 39 hours

- IG-TD9 Loader (tracked)
- 39 hours

- Tandem Trucks
- 64 hours

This section of shoreline was generally composed of gravel, cobblesize rock and a few boulders underlain by fines, mostly silt and clay. Behind the shore is a till cliff, five to 20 feet high which is actively eroding in most sections. This cliff is the backyard boundary for residents of this section of Arichat, and consequently, cribwork boulders, etc., have been placed by some owners in the most active areas in an attempt to arrest erosion.
On the initial day of work the dozer entered the site by Le Noir Forge (centre of site) and proceeded to the western contract limits to start work. This road disturbed oiled material which then was picked up by the incoming tide and carried over the cleaned area. At this time, concern was expressed about the effects on the erosion of the cliff when the material (average depth of removal including rocks was one foot) was excavated. Depth of contaminated clay was four to six inches.

A procedure was developed, based on geological considerations, whereby in certain sections the material was either pushed up against the base of the cliff, removed completely, replaced or left undisturbed.

This project, being the area where machinery began work, provided some "Do's" and "Don'ts" which were incorporated into later contracts. They were:

1. The contract specifications had to be adapted in an attempt to cope with the unanticipated and to insert more flexibility, thus allowing the site supervisors more latitude in field decisions.

2. A large bulldozer (100 H.P. Flywheel class) with its blade perpendicular to the direction of travel was found to remove considerably more than required and to mix oiled and clean material. (See Part I for more discussion of this aspect.)

3. All material disturbed by machinery must be removed before the tide rises. Otherwise, an oil slick will be created which will blacken cleaned areas.

4. All large scale removal of sediment should be avoided in actively eroding areas.

Recontamination

Before the job was completed and on a number of occasions during the summer, the Anchat contract area experienced some degree of re-oiling. Some of the possible causes were:

1. During the course of the work, oil slicks covered sections of the cleaned beach. They were caused by:
   (i) Machinery travelling on oiled areas without prompt removal of material.
   (ii) Oiled material stockpiled within range of the tides. The water tended to wash oil out of these piles.
   (iii) Machinery working in the water. All of the above have been previously discussed. They were caused by improper use of machinery and resulted in a surface coating of oil of no appreciable thickness and were re-cleaned by the contractor.

2. Before sealing the wreck of the tanker, reports were received of iridescence slicks coming from that direction. On one occasion, a helicopter traced such a slick from the Anchat shoreline to the tanker. This source seemed to contribute only a minimum thickness of oil.

3. In May, a 2" – 3" deposit of oil was reported west of Le Noir Forge. Pickers were moved in immediately but within 48 hours the oil had penetrated to depths of approximately two feet. Work was discontinued as it was thought that this amount of material removal would endanger the adjacent property. It was planned to remove and replace this material later in the program. Tests on this oil revealed it was not from the tanker "Arrow".

4. Adjacent area oiling was a possible source but never observed in this area.

5. Oil washed down from the material pushed against the cliff blackening a one to two foot wide strip. This type of contamination was limited to sections where heavily oiled material was exposed.

It was impossible to discern the contribution of each source, as most occurred simultaneously.

The present state of this shoreline can be described as (a) deep oil pollution which is confined to the area adjacent to Le Noir Forge and (b) surface re-oiling over the remainder of the contract. This oil has now dried. A footprint reveals clean material.
BLACK DUCK COVE

Data
Location: Little Dover, Guysborough County, N.S. Situated approximately one mile beyond Little Dover Village after end of pavement.

Length 0.5 miles
Started April 30, 1970
Completed May 12, 1970
Actual Days Worked 9 days
Approved May 14, 1970
Contractor C.R. MacDonald Limited
Value $6,000.00
Rip-Rap 4,460 cubic yards removed
Material 360 cubic yards hauled in
Equipment Cat. 950 Loader — 78 hours
Cat. D-6-C Dozer — 78 hours
Tandem Trucks — 140 hours
3-ton Trucks — 62 hours
Equipment Hours Total: 358 hours
Disposal Area Little Dover Dumpsite-3.6 miles
Cost per foot $7,080.00 $2.68/foot
2,640.00 ft.
Cost per Ton $0.91
Comments
The section worked consisted of a medium to coarse grained sand beach at the centre backed by a vegetated berm and brackish marsh.

The beach is generally about 100 feet wide but at low, ordinary spring tides up to 250 feet wide. Both ends of the section are composed of mud and silt. The north end was covered with some rock and boulders.

As this area contained varied beach forms and as it was one of the first two areas cleaned, it provided an indication at the time of the problems and capabilities of machine clean-up beach types commonly found in Chedabucto Bay.

The Contractor first worked the 1,000 foot sandy beach, then the rock-mud section and finally the bog or mud flat.

Two important aspects of the clean-up were reinforced or revealed on this job:

1. All excavated material has to be removed from the tidal zones before wave action removes the oil, setting up a slick. When the hardened surface on the oil is broken, any contact with water results in such an oil slick.

2. For the same reason machinery must never be allowed to operate or travel in the water.

3. The sequence of clean-up was wrong. The small rock-boulder-mud end should have been cleaned first because even at low tide, pools of oil and water remained trapped which at high tide were carried over the sand beach. The bog should have never been worked as it contained pools of oil and water which were impossible to remove with machinery. These pools of oiled mud, when disturbed, tended to clean during subsequent tides but contributed to an oil slick. The Contractor at the end of the job re-cleaned the sand beach.

The boulder removal stipulation — remove all under 1/2 cubic yard size — was not enforced as the boulders provided protection to the homes on the beach front and were in a high wave energy, actively eroding zone.

For the same reason, it was decided to replace the stone removed with rip-rap. The Contractor supplied and placed rip-rap for $3.00 per cubic yard.

The depth of oil varied from two inches to 36 inches and varied in different sections of the same beach types.

The cost per foot was relatively high. Actually, using the hours worked at Nova Scotia Road Builders Association rates, the cost would have been $5,318.00 versus $6,000.00 (the lowest tender). However, two factors influenced the above:

1. Reluctance on the part of Contractors to attempt an unfamiliar situation.

2. Machine operators and construction companies tend to work more efficiently under contract situations than on a pay by the hour arrangement.

   The cost per ton is very low.

Machinery could capably clean the sand beach. However, in the soft mud areas, some mixing of clean and contaminated material occurred. The loader was, at times, working in four feet of muck. After a few tides, this area appeared relatively clean.
Care was taken to protect the backshore areas from damage by movement of trucks and tractors. Travelling was limited to one track. Areas where the vegetation had previously been destroyed showed evidence of wind erosion.

Unfortunately, before the rip-rap was placed, oil floated down from the lagoon above the beach and later from the rocky headland directly across the cove from the lagoon.

This lagoon is composed of mainly large boulders and rock between which are deep pools of oil. It is inaccessible by land and in any case unworkable. This was our first experience with re-contamination from adjacent shoreline.

Re-oiling has continued during the summer. A boom was placed across the entrance to the lagoon but because of tidal conditions (almost a tidal bore) tended to tip over in some sections and this lessened its effectiveness.

### BEACHES ADJACENT TO THE BAY OF ROCKS

Four beaches cleaned in this area are:

1. Rocky Bay North
2. Rocky Bay
3. Pondville
4. Pondville South (Little Barachois)

All were similar in material composition and oil contamination. With regard to beach types, all were fine-gravel beaches with sand in the tidal zones. Small storm ridges are evident in some locations as is a backshore till cliff. The sediment supply is ample in all areas.

These were the first beaches cleaned by pickers (labourers who shoveled the oiled material into plastic bags). No re-oiling has occurred. Original oiling was limited to scattered spots of no appreciable depth.

<table>
<thead>
<tr>
<th></th>
<th>Rocky Bay North</th>
<th>Rocky Bay</th>
<th>Pondville</th>
<th>Pondville South</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length (ft.)</td>
<td>2,120</td>
<td>2,400</td>
<td>2,640</td>
<td>1,120</td>
</tr>
<tr>
<td><strong>Cost</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pickers</td>
<td>$663.60</td>
<td>134.60</td>
<td>241.50</td>
<td></td>
</tr>
<tr>
<td>Hauling</td>
<td>288.60</td>
<td>144.00</td>
<td>150.00</td>
<td></td>
</tr>
<tr>
<td>Tonnage</td>
<td>140</td>
<td>50</td>
<td>35</td>
<td></td>
</tr>
<tr>
<td>Cost/ft. Labour</td>
<td>0.15</td>
<td>0.05</td>
<td>0.21</td>
<td></td>
</tr>
<tr>
<td>Other Costs:</td>
<td></td>
<td></td>
<td></td>
<td>469.80</td>
</tr>
<tr>
<td>Repairs to road</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Cost/ft.</td>
<td>0.21</td>
<td>0.11</td>
<td>0.76</td>
<td></td>
</tr>
<tr>
<td>Cost/ton</td>
<td>6.80</td>
<td>5.57</td>
<td>24.60</td>
<td></td>
</tr>
</tbody>
</table>
This is also known as Indian Cove. It is a small concave pocket beach set back between two rock headlands. The beach is mainly gravel (mineral 1/2") with some sand especially in the intertidal zone. The slope of the beach is gentle and the sediment supply limited. This beach was contaminated above the normal high water mark with a six to twelve inch layer of oil of an average width of 10 feet.

At this stage, the clean-up program was still experimenting with techniques. It was decided to accept the Black Duck Cove contractor's price, on the basis of his previous performance, his interest in the projects, and his willingness to try suggestions on new approaches. It was decided to use only a loader rather than the bulldozer-loader-truck combination used previously. The experiment was successful providing the loader was filled on each scoop only to a capacity which did not allow spillage, i.e., about one-half full, and the operator and inspector remained sufficiently alert to pick up scattered spots of contamination outside the heavily oiled cross-section. Although variations of this method were tried from time to time, the technique was found most effective in terms of machinery efficiency and oil removal for a deeply oiled cross-section on a shingle beach.

After removing this trench of material, the beach was sloped to a uniform gradient pushing material from the storm ridge or the lower tidal zone.

On May 25, the eastern 300 feet was observed to be badly oiled in the high tide zone; after analysis it was thought to have come from adjacent rocky areas which contained pools of oil trapped in crevices between boulders. These pools resulted from the oil flowing off the boulders due to the warmer temperatures, accumulating over several days because they were exposed to wave action only during the monthly high tides. The water at this time picked up the water-in-oil emulsion and carried it over the beach.

A remedial program was initiated whereby the pools were scooped out, and sand and limestone applied to rocks and the crevices to stabilize the semi-solid oil. This was successful and after re-cleaning the beach remained clean for approximately one month.

After June high tides, contamination was again observed on the east end. Investigation of the previous source showed a sufficient degree of stabilization but the west end was found to have a similar source of potential pollution. The portion of this rocky headland adjacent to the shore had been checked but the actual source was some distance from the beach and almost inaccessible by land and sea. The remedial action was as before except only limestone was used. A road had to be cleared and a ramp built to slide the bags of limestone down a 30 foot cliff. The limestone was applied lightly over a three-week period; the first week — five applications, the next two weeks — three and two applications respectively. It was applied when the oil showed evidence of beginning to flow. Twelve tons were used. During the three weeks to the time of report writing, the rocks have remained stabilized and the beach clean.
HALF ISLAND COVE, HADLEYVILLE #1 and #2

These three beaches represent almost identical oil contamination situations and are similar in geological structure.

Half Island Cove is a wide shingle beach with a maximum width of 80 feet. The lower tidal zone is composed of fines and gravel while the upper beach zone and storm ridge is shingle. The along-shore movement of the material appears to be from east to west. The beach at one section is backed by a 20-ft active till cliff. Another section has a lagoon at the rear. The central 200 feet was excluded from the contract as it contained bedrock and boulders. The area worked consisted of 1,500 feet of recreation beach and 700 feet adjacent to the Government wharf (eastern end of cove).

Most of the contamination material was above the tidal zone in a 10 – 20 foot wide strip. As this is a regenerative beach, some clean gravel had been pushed over the oiled material giving the appearance of large spots of oil.

The eastern end of the cove and the breakwater section was more heavily oiled, with the latter almost uniformly covered. The eastern end of the 1,500 foot section had two to three feet of contamination while the western end was oily to an average depth of one foot.

Hadleyville #1, located on the north-west of Chedabucto Bay, is similar in material make-up. It is a well developed steep shingle beach but has a greater proportion of large size particles than Half Island Cove. The inter-tidal zone varies from 80 to 100 feet.

Oiling here was similar to Half Island Cove only deeper. The eastern end contained some pools; the removal depth was up to five feet; the average depth over the rest of the beach was three to five feet.

Hadleyville #2 is located north of Hadleyville #1 and south of Cape Argos. This beach contains more sand than the others. The northern end is all sand except for a storm ridge of gravel and rock, approximately 12 feet wide, and located immediately above normal high tide marks. Towards the southern limit, the beach gradually changes until it resembles the two previously discussed beaches in composition.

The amount of contamination was greater here, in both the predominantly sandy and gravel sections. The gravel section contamination pattern was similar to that found in others but the sand section was above the tidal zone with depths of three to five feet in the storm ridge. There were large pools of oil on the surface of the sand above the tidal zone. The depth here averaged 1.5 feet.

The following table gives the data on cost, time, etc., for the three areas:

<table>
<thead>
<tr>
<th></th>
<th>Half Island Cove</th>
<th>Hadleyville #1</th>
<th>Hadleyville #2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length/ft</td>
<td>1,500 + 700</td>
<td>4,400</td>
<td>3,670</td>
</tr>
<tr>
<td>Time: Commenced</td>
<td>May 15</td>
<td>June 3</td>
<td>July 6</td>
</tr>
<tr>
<td>Completed</td>
<td>June 12</td>
<td>June 11</td>
<td>July 20</td>
</tr>
<tr>
<td>Days worked</td>
<td>5</td>
<td>7</td>
<td>11</td>
</tr>
<tr>
<td>Contract cost</td>
<td>$3,000 + 1,500</td>
<td>$9,450</td>
<td>$8,495</td>
</tr>
<tr>
<td>Actual cost including picking</td>
<td>$4,980</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost/ft</td>
<td>$2.28</td>
<td>$2.15</td>
<td>$2.31</td>
</tr>
<tr>
<td>Tonnage</td>
<td>3,422</td>
<td>7,219</td>
<td>9,840</td>
</tr>
<tr>
<td>Cost/ton</td>
<td>$1.45</td>
<td>$1.31</td>
<td>$0.87</td>
</tr>
<tr>
<td>Distance to dumpsite</td>
<td>6.0 mi.</td>
<td>5.4 mi.</td>
<td>3.0 mi.</td>
</tr>
<tr>
<td>Dump</td>
<td>Fox Island</td>
<td>Sand Point</td>
<td>Sand Point</td>
</tr>
<tr>
<td>Equipment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cat. 950 Loader</td>
<td>59</td>
<td>98</td>
<td>169 1/2</td>
</tr>
<tr>
<td>Cat. D6-C Dozer</td>
<td></td>
<td>39</td>
<td></td>
</tr>
<tr>
<td>Tandem Trucks</td>
<td>62</td>
<td>237</td>
<td></td>
</tr>
</tbody>
</table>

The importance of having a disposal area close to the work site when large quantities are involved is reflected in cost/ton figures. A price of $1.31 for the cost/ton and a cost/foot of $2.25 represent the usual price paid for this type of clean-up. Most of the contamination was located above high tide, hence the contractor could make optimum use of his machinery. Studies indicated an average rate of removal under these conditions was 1,300 square feet per hour for a three foot depth.
Here, as on all beaches, equipment operators found tandem trucks (dual rear axles) to be the most efficient conventional haul unit. The loader-truck combination of equipment was used in all areas except the south eastern end of Hadleyville #2 where it was impossible to haul the oiled material out. Here, a dozer was used to push the oiled sand up to prevent contamination.

At Half Island Cove, considerable oiled material remained after the initial cleaning. Our field inspection was retired and the contractor was requested to return to finish the job. On June 12, he did, and the final job was satisfactory. One probable reason for this was that it rained during the initial cleaning making it difficult to distinguish between wet dark beach material and lightly oiled stone.

After a few tides, scattered oiled rocks were revealed in all areas. This was attributed to the "sediment shield" effect discussed in Part I. Separated from the main body of oil, these spots soon hardened, becoming non-adhesive and harmless. The total surface area occupied by such material was less than 1 per cent of the beach area.

Experiments with a road grader at Half Island Cove were not successful. This area was chosen because it contained a large portion of fines, hence the tractive qualities were better than most shingle beaches. The grader was not able to work on the lower tidal areas and the efficiency of cleaning was less than the loader.

The clean material removed usually consisted of a 2" – 3" layer around the almost rectangular cross section of contamination. As all beaches in this area have an ample sediment supply, this was not considered harmful.

JANVRIN HARBOUR

DATA:

Location: Area adjacent to Government Wharf
Length: 1,085 feet
Depth of Oil: 2" – 5"
Width: Average of 60 feet
Time: Commenced: June 2
Completed: June 4
Contractor: MacKenzie Brothers
Value: $1,240.00
Cost/ft: $1.14

Equipment and hours worked:

- Komatsu D50A Dozer 13 1/2 hours
- TD-9 Loader 13 1/2 hours
- Tandem Trucks 29 hours
- Material removed 312 tons
- Distance to disposal 7.6 miles

This contract was composed of a 150-foot section east of the wharf plus 935 feet on the west. The beach is mainly silt, mud, and sand. Behind the beach is a cliff of average height (1 ft.) on the center west, rising at each end to about 6 feet.

The west shore bounds a sheltered section of the harbour thus allowing fine sediment deposition. Erosion is more pronounced towards the eastern limits.

Preliminary estimates of tonnage removal costs indicate that about 1000 tons would be removed at a cost of $2,000. This was based on the premise that a high percentage of clean material would be removed because its oil depth was in the 2" – 3" range.

Prior to this, experiments with a grader had proved unsuccessful, but when writing the Janvrin Harbour specifications, it was decided to recommend a tracked dozer with its blade angled to the direction of travel. The type used by the contractor had one adjustment of 45 degrees.
The material was bladed into long rows, usually by two passes on the water side and one on the upper. These rows were then removed with a loader. This method proved successful for this beach type. As the quantities (much smaller than preliminary estimate) indicate, the amount of clean material removed was almost negligible.

The western section is used by fishermen to haul up their boats and also by the residents as a swimming area. No re-oiling has taken place.

<table>
<thead>
<tr>
<th>DATA:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Length:</td>
<td>2,800 feet cleaned</td>
</tr>
<tr>
<td></td>
<td>500 feet rip-rap</td>
</tr>
<tr>
<td></td>
<td>3,300 feet total</td>
</tr>
<tr>
<td>Time:</td>
<td>Commenced: June 11</td>
</tr>
<tr>
<td></td>
<td>Completed: June 23</td>
</tr>
<tr>
<td>Equipment:</td>
<td></td>
</tr>
<tr>
<td>5 Tandem Trucks</td>
<td>180 loads</td>
</tr>
<tr>
<td>Cat. 950 Loader</td>
<td>82 hours</td>
</tr>
<tr>
<td>D6-C Dozer</td>
<td>22 hours</td>
</tr>
<tr>
<td>Costs:</td>
<td></td>
</tr>
<tr>
<td>Original contract cost</td>
<td>$4,495.00</td>
</tr>
<tr>
<td>Rip-Rap</td>
<td>2,340.00</td>
</tr>
<tr>
<td>Footage cleaned</td>
<td>4,600.00</td>
</tr>
<tr>
<td>Actual cost</td>
<td>$6,340.00</td>
</tr>
<tr>
<td>Material excavated:</td>
<td>3,600 tons</td>
</tr>
<tr>
<td>Depth of oil:</td>
<td>2 feet – 4 feet</td>
</tr>
<tr>
<td>Original contract cost/lineal foot</td>
<td>$1.36</td>
</tr>
<tr>
<td>Amount cleaned/lineal foot</td>
<td>$1.36</td>
</tr>
<tr>
<td>Amount covered/lineal foot</td>
<td>$4.68</td>
</tr>
<tr>
<td>Cost/ton of material removed</td>
<td>$1.11</td>
</tr>
<tr>
<td>Distance to dumpsite:</td>
<td>1.5 miles (Sand Point)</td>
</tr>
</tbody>
</table>
This project is located on a point of land protruding into the Strait of Canso and is composed of two beaches. The north is eroding at an estimated rate of 1 foot/year, the point and the south beach are being built up.

On the point is a D.O.T. lighthouse, while in the centre of this land area, behind both beaches, is a lagoon. Both beaches are composed mainly of gravel.

The oil contamination was usually confined to a 5 to 20 foot wide strip adjacent to the high tide level. The depth observed early in the season was less than 24" with the majority of test holes indicating 12".

However, actual clean-up required 2 to 4 foot removal, with one location at 7 feet. This depth of contamination was reported in other loosely packed, low fine material content beaches and appeared to be due to the increasing land temperatures.

After awarding the contract, it was decided to place rip-rap over the actively eroding section of the north beach. Consequently, 500 lineal feet of contamination was covered with 585 cubic yards of stone.

The reasons for this decision were:

1. An appreciable amount of material would have to be removed; a section worked by the contractor indicated a depth of up to 5 feet.
2. The absence of a storm ridge and a small tidal zone would make it difficult to move gravel into the excavated area for sloping this shore after cleaning.
3. Both of the above would contribute to the already active rate of erosion.
4. The owner of the property directly behind the erosion zone objected to the removal of large amounts of material because of the active erosion. He was involved at the time in a dispute with D.O.T. over access to lighthouse property, claiming that the D.O.T. road had already eroded away and they were driving on his land. He had a "NO TRESPASSING" sign on his property. He stated he would be happy to have rip-rap placed to arrest the erosion and would in return provide access to the D.O.T. property. This was done.

The bidding on contracts by this time was highly competitive.

If this job had been done by equipment rental, it would have cost at least $5,400.00 vs $4,000.00.

The contractor agreed to break the contract and be paid for each lineal foot cleaned at the following rate:

\[
\text{Value of contract} = \frac{\text{rate/foot}}{\text{Total lineal footage}}
\]

He agreed to supply the rip-rap at $4.00/cubic yard.

The method used was the loader-truck combination and was effective with this type of oil and beach material. No oil recontamination was observed to have come out from under the rip rap. The north beach is now being used extensively.

QUEENSPORT AND CANSO BREAKWATER BEACH

QUEENSPORT

DATA:

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length</td>
<td>1,500 feet</td>
</tr>
<tr>
<td>Depth of Oil</td>
<td>2' - 6', Average 6'</td>
</tr>
<tr>
<td>Width of Oil</td>
<td>5' - 20', Average 5'</td>
</tr>
<tr>
<td>Time</td>
<td>Commenced: June 16</td>
</tr>
<tr>
<td></td>
<td>Completed: June 30</td>
</tr>
<tr>
<td>Days worked</td>
<td>2</td>
</tr>
<tr>
<td>Re-cleaning costs:</td>
<td></td>
</tr>
<tr>
<td>Pickers</td>
<td>$5,691.25</td>
</tr>
<tr>
<td>Picking cost/lineal foot</td>
<td>$3.80</td>
</tr>
<tr>
<td>Cost of removing material</td>
<td>$1,998.00</td>
</tr>
<tr>
<td>Total cost/foot</td>
<td>$5.30</td>
</tr>
<tr>
<td>Number of tons</td>
<td>480</td>
</tr>
<tr>
<td>Cost/ton</td>
<td>$15.80</td>
</tr>
<tr>
<td>Distance to dumpsite</td>
<td>14 miles</td>
</tr>
</tbody>
</table>

This beach is of the same material type as Fox Island Main, Half Island Cove, Hadleyville, etc., except that the rate of replenishment is low.

The only point of interest on this job is that cost breakdown indicates the high cost of using hand labour to remove the contaminated material when the depth is upwards of six inches. The cost/foot, however, resembles Moose Bay which represents similar circumstances.
CANSO BREAKWATER BEACH

DATA:

Length: 280 feet
Contractor: C.R. MacDonald Limited
Value: $750.00
Cost/linear foot: $2.68
Number of tons removed: 500 tons
Cost/ton: $1.50
Disposal distance: 4.0 miles (Little Dover)

Equipment and actual hours:

950 Loader 17 hours
Tandem Truck 17 hours
Days worked 2

This beach was composed of fine sand with a few rocks scattered over the surface. Rocks and the remains of jetties mark the limits of the beach. It is used for both recreation and fishing.

The contamination consisted of a blanket of oil which had penetrated the sand 6 to 8 from mid-tide. Below mid-tide level, oiling depth rapidly tapered down to traces. The width was approximately 60 feet.

Two relevant points came out of this job:

1. Tenders were called on this project to check our assumption that prospective bidders would not be interested in jobs under a certain size, i.e. under 1,000 feet for moderate oiling. This was confirmed only when only one bid was received, and this was by C.R. MacDonald Limited whose policy is to submit a price on all operation oil contracts. The price, though somewhat high, was not unreasonable and was accepted.

2. This was the first occasion on which only a loader was used for removal of a moderate depth of uniform oiling. This technique was successful in terms of cleaning the beach but tended to remove more clean material than a small dozer with its blade at an angle, especially when the material dropped below three inches.

PHILIPS HARBOUR

This cove is mainly a gently sloping fine gravel beach with a limited sediment supply.

The eastern end has a well developed storm ridge on which fishing buildings and skidways are located.

Both ends are bounded by large rocks.

The beach was contaminated as follows:

The south and western sections contained a heavy scattering of patches of oil. The penetration of this oil was usually from 1 to 4. There were some sections of rocks adjacent to the low water mark which were covered with a coating of surface oil. The eastern section was oiled for a 10 to 20 foot wide section, 8 to 14 deep.

In view of the slow rate of replenishment of gravel on the south and western sections, and the possible consequence to the skidway and building if large amounts of material were removed in the eastern section, it was decided:

1. To use "slick pickers", whenever oiling penetration was small enough to make this economical.

2. To remove the heavily oiled portion with machinery hired on an hourly rental basis. The area to be decontaminated was too small to be of interest to prospective bidders and the instructions had to be flexible. Delays would be encountered as skidways were moved and then replaced. Fishermen were using this area. The actual removal and replacement (next item) would have to be almost simultaneous and would require direct supervision and co-ordination by the Field Inspector and would be on as "we'll see what to do as we proceed" basis (depending on oil depth and location). This would be impossible to write into a contract.

3. Gravel would be hauled in to replace that removed from in front of the fishermen's buildings. The source was Half Island Cove's middle to lower tidal zones.
Length: 600 feet

Machinery:

Cat. 950 Loader  34 1/2 hours
Tandem Trucks  56 1/2 hours

Cost of machinery including float time: $1,414.25
Cost/linear foot $2.36
Picking Cost: $828.20
Cost/linear foot $1.38

The per foot cost does not represent a cost comparison of methods as pickers worked the lightly oiled areas.

Material hauled out from equipment operation: 960 tons
Material hauled out from labour operation: 330 tons
Material hauled in: 560 tons
Cost per ton — equipment: $1.48/ton
Cost per ton — Pickers: $2.50/ton
Distance to disposal area: 7.5 miles (Fox Island)

Note: Machinery tends to move more material than required.

One month later, pickers returned to Philips Harbour to remove patches of oil which had floated in. Approximate cost: $45.00

The clean-up program at Philips Cove was successful. The beach is free of contamination except for the occasional blob which floats from adjacent rocks.

This recontamination is very small, as indicated by the re-cleaning costs. However, it appears the quality of the work was not appreciated by the residents and although no complaints were received in regards to the cleaning, the “can of worms” effect was generated by the replacement of material in a certain area. Almost all residents with water frontage requested we replace “their gravel”. This was not possible or necessary, as we informed them, because:

(a) The material was removed from the tidal zone and would be replaced by natural deposition action. No material was taken from beyond normal high tide mark.

(b) This would be a dangerous precedent. It would be impossible for all areas cleaned as there was not sufficient clean gravel in the area.
Geologically, this beach is similar to the previously discussed beaches on the western side of the Strait of Canso.

It is a well developed gravel beach with a plentiful sediment supply and a large storm ridge. Except for the storm ridge, the gravel is in the minus 1” size range. On the eastern end is Ragged Pond, in the centre, a river called Clam Pond which empties into the Bay, while on the western end, behind the beach, is Stewarts Pond.

Oil contamination resembled that of other beaches of this type and area, varying only in depth. The contamination was limited to a 5 to 25 foot wide strip close to the high tide mark and depths of 6’ to 48’. Generally, the oil depth increased from east to west.

Pickers were started in the most lightly oiled area. Eventually, a work force of approximately 60 men was mobilized; farm tractors and wagons hauled the plastic bags of material to a loading area where trucks moved it to the dumpsite.

The picking operation was successful where the oiling was less than 6 inches deep and removed a minimum of material. However, as the depth increased, the pickers’ efficiency decreased. A bag-holder device was constructed using two rings and three legs of 1/4” steel. The plastic bag was attached inside and the stand would support it while being filled. It was thought that an increase in production would result because no one would be required to hold the bag while it was being filled. However, time-motion studies indicated that no increase in productivity resulted; the increase in production was nullified by the increased time needed to place the bag in the stand.

During the latter days of the picking operation when depths of 1 foot were encountered, the cost reached approximately $3.00/foot. A considerable amount was being lost due to the “sediment-shield effect” and consequently it was necessary to put the remaining 4,400 feet out to contract. The western end of the project contained a small cove which was heavily oiled under the low tide level. At this stage of the operation, it was possible to predict the cove as a potential re-oiling source. It was written into the contract specifications that the contractor attempt to clean this area initially, even though it was known that underwater oil could not be efficiently removed. It was felt that some would be removed and the remainder disturbed, hence accelerating wave action clean-up.

The resulting contamination would be picked when the remainder of the clean-up was effective.

A cost comparison can be made between labour and machinery on this project to evaluate each method in a heavily oiled beach. It is definite that only machinery is effective and efficient when the depth of penetration of the oil is considerable.

Recent observations indicate the sediment shield effect was more pronounced in the labour cleaned section.

Both sections are now being used extensively for swimming.

---

**DATA:**

**MOOSE BAY**

Location: Located at Moose Bay (Clam Harbour), Guysborough County, N.S. – adjacent to the community of Port Shoreham.

**Length:** Contract length is 4,400 feet

**Disposal area:** Sand Point Dumpsite – 13.5 miles

**Time:**
- Commenced: June 26
- Completed: July 8

**Days worked:** 8

**Contractor:** C.R. MacDonald Limited

**Value:** $6,995.00

**Cost/linear foot:** $ 1.58

**Material excavated:** 5,049 tons

**Cost/ton:** $ 1.37

**Equipment:**
- Cat. 950 Loader 96 hours
- Tandem Trucks, 224 loads 300 hours

**Pickers Operation on Moose Bay:**

- Commenced: May 19, 1970
- Completed: June 15, 1970

**Cost:** $17,986.00

**Length cleaned:** 5,260 feet

**Cost/linear foot:** $3.42

**No. of tons:** 4,000 tons

**Cost/ton:** $4.50
BEACHES EAST OF ST. PETER’S

All the beaches on this shoreline have an ample supply of sediment, usually with sand and light beach stones. The construction of a dam at Lennox Passage prevented oil from entering some beaches in St. Peter’s Bay and from recontaminating the beaches that were cleaned.

The contamination was generally light to moderate, and on most beaches was on the surface. The width of oil varied from 20’ to 75’ and the depth was 2’-4’ with slightly more in the areas cleaned by machinery. This area is suitable for “slick pickers”, i.e., labourers equipped with shovels, who removed the oiled material and placed it in plastic bags.

The pickers’ operation worked well in this area where there was surface oil and they removed only the contaminated substances. The area has remained clean.

DATA

<table>
<thead>
<tr>
<th></th>
<th>Feet</th>
<th>Tons</th>
<th>Cost</th>
<th>Machinery</th>
</tr>
</thead>
<tbody>
<tr>
<td>Point Michaud</td>
<td>7100</td>
<td>300</td>
<td>$3280.20</td>
<td>$1578.50</td>
</tr>
<tr>
<td>St. Esprit</td>
<td>4500</td>
<td>163</td>
<td>1992.90</td>
<td>1270.99</td>
</tr>
<tr>
<td>Gracieville</td>
<td>4800</td>
<td>400</td>
<td>1089.90</td>
<td>2439.00</td>
</tr>
<tr>
<td>Grand River</td>
<td>500</td>
<td>5</td>
<td>136.50</td>
<td>36.65</td>
</tr>
<tr>
<td>Godie Point</td>
<td>1600</td>
<td>70</td>
<td>514.50</td>
<td>230.10</td>
</tr>
<tr>
<td>L’Ardoise Area</td>
<td>7700</td>
<td>285</td>
<td>3143.70</td>
<td>2788.05</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Total Picker Cost/Foot</th>
<th>Total Cost/Ton</th>
<th>Cost/Ton For Cleaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Point Michaud</td>
<td>$0.68</td>
<td>$16.20</td>
<td>$10.93</td>
</tr>
<tr>
<td>St. Esprit</td>
<td>0.73</td>
<td>20.09</td>
<td>12.23</td>
</tr>
<tr>
<td>Gracieville</td>
<td>0.74</td>
<td>8.82</td>
<td>2.72</td>
</tr>
<tr>
<td>Grand River</td>
<td>0.35</td>
<td>34.63</td>
<td>27.30</td>
</tr>
<tr>
<td>Godie Point</td>
<td>0.75</td>
<td>10.64</td>
<td>7.35</td>
</tr>
<tr>
<td>L’Ardoise Area</td>
<td>0.77</td>
<td>20.81</td>
<td>11.04</td>
</tr>
</tbody>
</table>

This difference between the total cost/ton and the cleaning cost/ton represent hauling and dumpsite maintenance costs.

The cost/ton for Gracieville is low as machinery cleaned 80% of the area.

POINT MICHAUD

It is an excellent sandy shore extending for more than a mile in a semicircular pattern. The oil on Point Michaud was scattered in blobs on the surface of the sand. Consequently, “slick pickers” were most effective here as the oil was 1’-4’ deep (generally 1’).

The oiled material was shovelled into bags and trucked to the municipal dump at l’Ardoise. A four wheel drive Dodge Power Wagon, a one-ton truck and a tandem were used to remove the bags of oiled material. The dump site was covered regularly as stipulated by municipal authorities.

Clean-up of Point Michaud was successful, economical, and the area remained clean.

GRACIEVILLE

Gracieville together with Point Michaud forms a well developed tombolo connecting a rocky island.

Only one-fifth of the beach was cleaned by pickers. The vegetated areas along a bank adjoining the beach had varying amounts of oil in it. This bank was cleaned using a loader as the material was too heavy for pickers. Where the vegetation was lightly oiled, it was not cleaned so as to reduce the probability of wind erosion.

A tree farmer was used to haul the bags to a loading area so the trucks could haul them to the dump. The tree farmer is a 4-wheel drive vehicle, with large tires, a winch, and a loading platform. It is used in logging operations.

ST. ESPRIT

St. Esprit beach was done completely by pickers. Utilization of the tree farmer enabled the material to be hauled to a loading area for the trucks. The beach was typical of all beaches in the area.

GRAND RIVER

Grand River, Godie Point and the beaches in the l’Ardoise area, Rockdale, Burkey’s Cove, Chaple Cove and Martin Point were all cleaned by pickers. The same methods were used, except at Martin point where the east end was more heavily oiled and a loader was used.
INHABITANTS RIVER AREA

This area, which was very heavily oiled, created two problems, one being that cleaned small sections would be re-oiled from the adjacent shoreline. Another problem which arose was the inaccessibility of the shoreline for removal of the material.

Only in two of the six areas cleaned did there exist a usable road to the beach. The terrain between the river and the highway was often swampy; also, a vertical 10—15 foot cliff bounded the backshore. These areas were usually used by the local residents who walked to the shore.

The beach surface was composed of small stone and clay.

A boom placed across the mouth of the river prevented re-oiling from Inhabitants Bay, and consequently, by July the shore had sufficiently stabilized to attempt cleaning.

In the inaccessible areas, the material was simply pushed up against the backshore cliff making certain all oiled material was covered with clean material.

These beaches remained clean possibly because the adjacent areas have stabilized to some degree and the small amount of wave action in this river did not leach the oil out of the “pushed up” material. The oil did not penetrate the beach material beyond a depth of 5 inches in the sections worked.

INHABITANTS BAY BEACHES

This section deals with the beaches on the north shore of Inhabitants Bay. The five areas worked were:

(i) Seacoal Bay

(ii) Port Malcolm

(iii) Port Richmond

(iv) Walkerville

(v) Whiteside

Generally, this shoreline is unvarying with regard to material type, consisting of a surface of rock, pebbles underlain by mud, and silt. Bedrock is sometimes close to the surface (1 foot). The intertidal zone is narrow and the sediment supply is limited; one source is material from the erosion of a 10 to 20 foot cliff behind each beach. One section of Seacoal project involved clean-up of the bar.

The pollution consisted of a blanket of oil from high to low tide levels. The depth of penetration varied from 1” to 12” and decreased as the fine material increased. Generally, 4” to 6” of material had to be removed. Seacoal and Limestone Beaches had the greatest depth of oiling. Most of Whiteside had no appreciable penetration, thus the oil had absorbed beach material, dried up, and “flaked off”, permitting the use of pickers.

STATISTICAL BREAKDOWN

<table>
<thead>
<tr>
<th></th>
<th>Seacoal</th>
<th>Port Malcolm</th>
<th>Walkerville</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length (feet)</td>
<td>1584</td>
<td>1075</td>
<td>2850</td>
</tr>
<tr>
<td>Time:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Completed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Actual days worked:</td>
<td>8</td>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td>Method used:</td>
<td>Machinery</td>
<td>Machinery</td>
<td>Machinery</td>
</tr>
<tr>
<td>Contract value:</td>
<td>$2730.00</td>
<td>$1990.00</td>
<td>$3135.00</td>
</tr>
<tr>
<td>Actual cost:</td>
<td>$2730.00</td>
<td>$1990.00</td>
<td>$3135.00</td>
</tr>
<tr>
<td>Cost/ton:</td>
<td>$1.72</td>
<td>$1.23</td>
<td>$1.00</td>
</tr>
<tr>
<td>Contractor:</td>
<td>MacKenzie Brothers</td>
<td>F.W. Digdon</td>
<td>F.W. Digdon</td>
</tr>
<tr>
<td>Material removed:</td>
<td>2592 tons</td>
<td>1248 tons</td>
<td>720 tons</td>
</tr>
<tr>
<td>Cost/ton:</td>
<td>$1.05</td>
<td>△ $1.57</td>
<td>△ $6.35</td>
</tr>
<tr>
<td>Disposal site:</td>
<td>Doyle Rd.</td>
<td>Doyle Rd.</td>
<td>Doyle Rd.</td>
</tr>
<tr>
<td>Distance to dumpsite:</td>
<td>14 miles</td>
<td>8.5 miles</td>
<td>5.0 miles</td>
</tr>
</tbody>
</table>

△ Not applicable. Cost includes moving material up to base of cliff.
<table>
<thead>
<tr>
<th>Data:</th>
<th>Port Richmond</th>
<th></th>
<th>Whiteside</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Length (feet):</td>
<td>1000</td>
<td></td>
<td>800</td>
<td></td>
</tr>
<tr>
<td></td>
<td>350</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time: Commenced</td>
<td>July 22</td>
<td></td>
<td>June 13</td>
<td></td>
</tr>
<tr>
<td></td>
<td>July 27</td>
<td></td>
<td>June 20</td>
<td></td>
</tr>
<tr>
<td>Actual days worked:</td>
<td>4</td>
<td></td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Method used:</td>
<td>Machinery</td>
<td></td>
<td>Machine Rental plus Pickers</td>
<td></td>
</tr>
<tr>
<td>Contract value:</td>
<td>$2245.00</td>
<td>Rental $612.00</td>
<td>$126.00</td>
<td></td>
</tr>
<tr>
<td>Actual cost:</td>
<td>$3376.88</td>
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<td>$738.00</td>
<td></td>
</tr>
<tr>
<td>Cost/foot:</td>
<td>$ 2.53</td>
<td></td>
<td>$ 0.92</td>
<td></td>
</tr>
<tr>
<td>Contractor:</td>
<td>F.W. Digdon</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Material removed:</td>
<td>1544 tons</td>
<td></td>
<td>204 tons</td>
<td></td>
</tr>
<tr>
<td>Cost/ton:</td>
<td>$ 2.18</td>
<td></td>
<td>$ 3.61</td>
<td></td>
</tr>
<tr>
<td>Disposal site:</td>
<td>Doyle Rd.</td>
<td></td>
<td>Port Royal</td>
<td></td>
</tr>
<tr>
<td>Distance to dumpsite:</td>
<td>16.7 miles</td>
<td></td>
<td>17.0 miles</td>
<td></td>
</tr>
</tbody>
</table>

The equipment used and the hours worked are:

**Seacoal Bay**
- D505 Komatsu Dozer 36.5 hours
- TD9 Caterpillar 36.5 hours
- 3 Tandem Trucks 126 hours

**Port Malcolm**
- D4 Dozer 21 hours
- TD9 Loader 16 hours
- 6 Tandem Trucks 135 hours

**Port Richmond**
- 450 Case Dozer 32 hours
- 977 Caterpillar Loader 16 hours
- Tandem Trucks 94.3 hours

**Walkerville**
- Case 450 Bulldozer 60 hours
- 977 Caterpillar Loader 41 hours
- 2 Tandem Trucks 25 hours

The above hours represent the actual time worked. All the projects in this area had to be worked between tides; hence the machinery was on the site longer than indicated by these figures, and usually from start to completion.

The method of clean-up consisted of using a dozer with angled blade and a loader to pick up the rows of bladed material and place it into trucks. An effort to determine how much clean material was removed was undertaken. It was found that at uniform depths of 1 – 1 1/2, clean material was usually removed regardless of the penetration. In varying depths, less than 2 1/2 – 3 of clean material was removed. Also, a study was made to estimate the time to clean this type of beach under optimum conditions. The results indicated for 3 – 4 depth, 6,000 square feet/hour could be removed while for 6 – 14 depth, it was 3,500 square feet/hour.

In Walkerville, after the surface of oil was removed, it was found impossible in some sections to travel with trucks. As there was only one access, this slowed down the removal of material, the rate being limited by what a loader could carry to the access road. Eventually, the loader was unable to travel. A small light tracked dozer was then used to push the material up against the base of a cliff. Where this material appeared likely to leach down over the beach, limestone was applied. The unworkable areas were always where the water table was close to the surface; the coat of oil obscured the nature of the material. By the time the contract was let for Port Malcolm, the situation was recognizable and the “push-up” procedure was specified for 550 feet of the contract length.
The cost per unit for Seacoal is not representative as the contractor lost approximately $600.00. The difference between the contract and actual cost for Port Richmond represents (a) overall costs; the road to the specified dumpsite became unusable, (b) one half the cost of reclaiming the limestone beach.

Behind both Port Richmond and Seacoal Bay, lagoons containing oil provided a source of recontamination. The lagoons were oiled during high tides when the initial oil slicks covered these areas. Seacoal lagoon was too large to take remedial measures. Consequently, the bar was gradually blackened after clean-up. A ditch was constructed between the Port Richmond lagoons and filled with fiberglass to filter out the oil. The Limestone Beach lagoon was kept oil-water emulsion when clean-up was started.

The clean-up in this area was delayed until the end of the program because of the amount of unstable oil on the beach and the potential sources of recontamination (heavy oiled islands, And floating oil in Inhabitants Bay). The limestone beach contained fluid oil between rocks and thus was most susceptible to “adjacent area re-oiling”. It was decided this area would be used to evaluate limestone as a stabilization agent. Initially, a small area was liberally coated with limestone but it was re-oiled, probably from adjacent beaches and from the oil pools which formed within the area itself. A second attempt was made. This time approximately 1,000 feet was treated; two more applications were used on the pools. The area remained relatively dry for five days; gradually pools of oil emerged from under the hardened surface and flowed down the beach eventually recontaminating approximately 75% of the area. It appeared that the pools within the treated area were the main sources of contamination. Consequently, a third attempt was made. This time, the limestone was applied in amounts only sufficient to cover the oil but was reapplied to the pools whenever they became evident. At time of writing (October 1970) this is continuing, usually only on a bi-weekly basis. Stabilization is now approximately 100%, and the 350 foot section of beach which has since been worked has to date remained relatively clean.

Despite the potential re-oiling sources previously discussed, the area remained clean except for Seacoal Bay until July 25. All areas experienced some re-oiling when the tanker was opened by unauthorized divers. An agreement was made with the contractors to re-clean the limestone beach with our operation absorbing one half the cost. Unfortunately, the oil from the tanker prevented an evaluation of the re-oiling from other sources. However, the presence of oiled seaweed at the high tide mark indicates some contamination from the islands in the Bay. The re-oiling was confined to a one-foot wide strip at the normal high tide mark.

**PETIT DE GRAT AREA**

The beaches cleaned in the Petit de Grat area were:

- Sampson’s Beach
- Petit de Grat Bridge
- Petit de Grat Point
- Gros Nez
- Boudreauxville

Boudreauxville

This area consists of many pocket beaches whose boundaries are limited by rocks, ledges, boulders and cliffs. Since these beaches replenish themselves slowly, our method of cleaning has been mostly by pickers. As a result, a minimum amount of material was removed. The beaches were mainly shingle type with sandy sediment at the lower tidal zone.

The oil on these beaches was mostly superficial with depths of 2 – 4 inches. The width varied with the individual beaches but the oil contamination averaged 10⁹ to 15⁵ situated near the upper tidal zone. Unlike Anjel, little re-oiling has occurred in this area. Machinery was used only where picking was not feasible.

**DATA**

<table>
<thead>
<tr>
<th>Length (feet)</th>
<th>Tons</th>
<th>Cost</th>
<th>Average cost/ft</th>
<th>Average cost/ton</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sampson’s Beach</td>
<td>350</td>
<td>125</td>
<td>$30.95</td>
<td>$247.22</td>
</tr>
<tr>
<td>Petit de Grat Bridge</td>
<td>120</td>
<td>9</td>
<td>$2.40</td>
<td>$200</td>
</tr>
<tr>
<td>Petit de Grat Point</td>
<td>300</td>
<td>193</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gros Nez</td>
<td>250</td>
<td>75</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boudreauxville</td>
<td>340</td>
<td>243</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boudreauxville (break water)</td>
<td>400</td>
<td>179</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Petit de Grat South (Gus Marchand)</td>
<td>125</td>
<td>198</td>
<td>$2.30</td>
<td></td>
</tr>
<tr>
<td>Petit de Grat, Boudreaux’s Fish Plant</td>
<td>150</td>
<td>40</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boudreauxville (contract)</td>
<td>280</td>
<td>150</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Petit de Grat South (contract)</td>
<td>300</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Machinery</td>
<td></td>
<td>$4,722.95</td>
<td>$3,304.04</td>
<td>$10076.99</td>
</tr>
<tr>
<td>Pickers</td>
<td></td>
<td>$3,304.04</td>
<td>$3,304.04</td>
<td></td>
</tr>
</tbody>
</table>

**TOTAL**  2,635  1,332  $10,076.99  $3.83  2.53
DEEP COVE

The area referred to as Deep Cove in this report comprises both sides of a bar joining two islands between Janvrin Island and Isle Madame.

The movement of sediments is predominantly from west to east. Consequently, there is a varying particle size distribution where the water, as its velocity decreases, ceases to move the gravel and starts depositing the sand, clay and silt. On the western end of the south shore is an actively eroding cliff. In the cove at the eastern end, the material varies from mud at lower tidal zones to sand in the upper. The north shore is an area of gravel deposition (fig. 1). This bar provides a tenuous link between the islands and if severely breached would probably not heal due to water movement.

All sections were covered with a blanket of oil contaminated material that ranged in depth from 3” in the fine material to at least 4 feet in the coarse gravel. It extended in the bar section from low tide on the north shore to low tide on the south. On the south, the depth of oiling decreased from the high to low water mark. In the eastern cove, the contamination extended from below low tide into the grass above the beach.

In view of the morphology and the oiling situation of the area, the following procedure was planned:

1. To use pickers wherever possible. This would mainly be limited to the mid to lower tidal zones on the south side of the bar section and the upper portion of the beach in the centre eastern section.

2. To leave the roadbed intact on the bar. The oil has almost stabilized with the gravel, providing a good driving surface. Approximately 2 inches of clean gravel was placed over the road.

3. To remove a triangular cross-section on the south shore of the bar to a vertical depth of 4 feet, as required, and to replace it with gravel from the south eastern section of the cove. Considerable oil remained on the surface from the edge of the road down to the high tide mark. This oil tended to flow down the beach in the warm weather.

4. To use a dozer with its blade on an angle to remove the fine material in the centre south eastern end.

5. To remove the contaminated material down to a safe depth on the north shore and replace it with material from the far south eastern end and the lower north shore tidal zones.

It was estimated the clean-up would be difficult and costly. The clean-up was accomplished in three stages. They were:

1. This phase of the operation consisted of picking the upper zone of the centre section of the cove and also the lower zones on the eastern section of the south side of the bar. The oil flowing down from the edge of the road delayed the remaining picking. Machinery work under this phase consisted of the angled-bladed dozer operation previously described.

The cost, time and equipment breakdown were as follows:

**Pickers**

<table>
<thead>
<tr>
<th>Time</th>
<th>May 25 — May 30</th>
<th>June 1 — June 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Labour</td>
<td>$2.01/hour</td>
<td></td>
</tr>
<tr>
<td>Total including 153 time + 1/2 overtime hours</td>
<td>$1799.53</td>
<td></td>
</tr>
<tr>
<td>Trucking</td>
<td>518.50</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>$2,318.03</td>
<td></td>
</tr>
<tr>
<td>Material</td>
<td>380 tons</td>
<td></td>
</tr>
</tbody>
</table>

**Machinery**

<table>
<thead>
<tr>
<th>Time</th>
<th>June 1 &amp; June 11 — 16 inclusive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equipment and hours:</td>
<td></td>
</tr>
<tr>
<td>TD9 Loader</td>
<td>38 hours</td>
</tr>
<tr>
<td>Komatsu Dozer D50A</td>
<td>34 hours</td>
</tr>
<tr>
<td>Tandem Trucks</td>
<td>56 hours</td>
</tr>
<tr>
<td>Total machinery cost</td>
<td>$1711.00</td>
</tr>
<tr>
<td>Material removed:</td>
<td></td>
</tr>
<tr>
<td>Total cost Phase 1:</td>
<td></td>
</tr>
<tr>
<td>1248 tons</td>
<td>$2,318.03</td>
</tr>
<tr>
<td>1711.00</td>
<td>$4029.03</td>
</tr>
</tbody>
</table>

| Total tonnage: | 1628 tons |
| Length:        | 750 feet  |
| Cost/lineal foot: | $ 5.37   |
| Width: 60' — 110', average 90 feet | $ 2.44 |
2. This phase consisted of picking the western end, south shore of the bar. The length was 450 feet while the width was almost constant at 30 feet.

<table>
<thead>
<tr>
<th>Time:</th>
<th>June 15 — 21 inclusive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost:</td>
<td>280 regular hours</td>
</tr>
<tr>
<td></td>
<td>120 overtime hours</td>
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<tr>
<td>Picking cost:</td>
<td>$804.00</td>
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<tr>
<td>Trucking:</td>
<td>$125.00</td>
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<tr>
<td>Total:</td>
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</tr>
<tr>
<td>Tonnage:</td>
<td>93 tons</td>
</tr>
<tr>
<td>Cost/lineal feet:</td>
<td>$2.05</td>
</tr>
<tr>
<td>Cost/ton:</td>
<td>$10.00</td>
</tr>
</tbody>
</table>

3. This phase of the operation consisted of the removal and replacement of material on both sides of the bar.

<table>
<thead>
<tr>
<th>Time:</th>
<th>June 23 — June 30</th>
</tr>
</thead>
<tbody>
<tr>
<td>Days worked:</td>
<td>8</td>
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<tr>
<td>Equipment:</td>
<td></td>
</tr>
<tr>
<td>Float:</td>
<td>6 1/2 hours</td>
</tr>
<tr>
<td>D505 Komatsu Loader:</td>
<td>65 hours</td>
</tr>
<tr>
<td>Tandem Trucks:</td>
<td>112.5 hours</td>
</tr>
<tr>
<td>Total machinery cost:</td>
<td>$2416.50</td>
</tr>
<tr>
<td>Length:</td>
<td>650 feet south shore</td>
</tr>
<tr>
<td></td>
<td>600 feet north shore</td>
</tr>
<tr>
<td>Cost/foot:</td>
<td>$1.93</td>
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<tr>
<td>Material removed:</td>
<td>894 tons</td>
</tr>
<tr>
<td>Material replaced:</td>
<td>1836 tons</td>
</tr>
<tr>
<td>Cost/ton:</td>
<td>$2416.50 / 2750 ft. = $0.89</td>
</tr>
</tbody>
</table>

**OBSERVATIONS**

1. The angled-blade dozer worked well on the mud material in lower zones of the eastern end. In the coarse sand and fine gravel, this technique was unsatisfactory. It was difficult to ascertain the reason from observations, but considerable mixing of clean and contaminated material occurred. The oil depth was approximately 3” in the sand.

2. Evidence of “fresh oiling” was observed on the east to centre section of the causeway (approximately 600 feet including 350 feet cleaned by pickers) until approximately mid-June. This was the reason for delaying the removal and replacement operation.

As usual, it was difficult to determine the actual cause; until the first week in June, observations indicated that a small amount of oil, depending on wind direction, would be carried to this area from the wreck. With increasing temperatures in June, iridescence started streaming off rocks beyond the western end. Also, iridescence was observed around the far eastern end by the fishing building. Contamination had ceased from the first source by June 20, and had decreased considerably from the second.

3. The removal and replacement operation went smoothly. Although some deep contaminated material was allowed to remain, no oil had surfaced through the clean material.

4. A section approximately 250’ long x 25’ wide containing scattered patches was observed the first week in August. This material was dry, hard and dull in appearance indicating “old oil”. It was located in the eastern, upper tidal (sandy) zone. It is possible that a layer of oil was deposited during the initial stages of pollution and later covered with sediment. If this is actually what happened, it may indicate that more oil will be exposed in autumn storms.

**PRESENT STATUS**

The areas worked in Deep Cove remained clean until July 26 when a 900-foot section on the south was re-oiled. The re-oiling coincided with the opening of the week by unauthorized divers. Re-cleaning costs are estimated at approximately $2,000.00.

(Note: Re-cleaning was carried out subsequent to the writing of this section of the report)