



FINAL

**Assessment of Oil Seepage at Shoal Point  
Port au Port Peninsula,  
Newfoundland and Labrador  
Summary Report**

Submitted to:

**Department of Environment and Conservation**

Pollution Prevention Division  
35 Alabama Drive  
Stephenville, NL  
A2N 3K9

Submitted by:

**Amec Foster Wheeler Environment & Infrastructure,  
a Division of Amec Foster Wheeler Americas Limited**

133 Crosbie Road  
St. John's, NL  
A1B 4A5

7 August 2015

Amec Foster Wheeler Project #: TF1512739

#### **IMPORTANT NOTICE**

This report was prepared exclusively for Department of Environment and Conservation by Amec Foster Wheeler Environment & Infrastructure, a Division of Amec Foster Wheeler Americas Limited (Amec Foster Wheeler). The quality of information, conclusions and estimates contained herein is consistent with the level of effort involved in Amec Foster Wheeler's services and based on: i) information available at the time of preparation, ii) data supplied by outside sources and iii) the assumptions, conditions and qualifications set forth in this report. This report is intended to be used by Department of Environment and Conservation only, subject to the terms and conditions of its contract with Amec Foster Wheeler. Any other use of, or reliance on, this report by any third party is at that party's sole risk.

## EXECUTIVE SUMMARY

Amec Foster Wheeler Environment and Infrastructure was retained by the Government of Newfoundland and Labrador Department of Environment and Conservation (NLDEC) to conduct a field investigation in order to provide recommendations for practical containment and remediation measures with respect to observed oil seepage on the western shoreline of Shoal Point on the Port au Port Peninsula in western Newfoundland. The oil seepage is resulting in a visible sheen on water in the Bay.

A site visit was conducted on July 15, 2015 by a representative of Amec Foster Wheeler accompanied by a representative of NLDEC. Earlier investigations by NLDEC and the investigations undertaken as part of this study identified the presence of three damaged oil well casings and an oil seepage area not associated with a visible well casing along a 190 m long section of this shoreline. The visible well casings, although damaged, were not found to be leaking at the time of inspection. An area of oil seepage in the tidal zone of the shoreline was identified as the source of an oil sheen that was carried by water currents in the Bay following inundation of the seep area by tidal waters. A potential buried well casing was identified below the area of the oil seepage using a metal detector.

Seepage rates were estimated to be on the order of one litre per hour during the site visit. It is not known if the rate of seepage is constant over time or how the tide and groundwater fluctuations may affect the rate. Further monitoring would be required to appropriately evaluate potential variability in the seepage rate.

Two practical options are provided which facilitate oil containment and isolation of the oil seepage area from tidal water. One consists of using a double culvert system that can be constructed quickly using the tidal beach for transport of equipment and materials. The other consists of using a containment berm that will allow for a larger and potentially drier work area. Construction of a road will be required for the containment berm option. Both options allow for safe excavation of overburden and rocky materials above the suspected well casing, and removal of contaminated liquids and solids for subsequent treatment and disposal. Once the well casing is exposed, casing integrity will be assessed such that the source of the oil seepage will be identified and the well will be sealed, preventing further oil seepage. Cost estimates for each option are provided within the report.

**TABLE OF CONTENTS**

EXECUTIVE SUMMARY ..... I

1.0 INTRODUCTION ..... 1

    1.1 Scope of Work ..... 1

        1.1.1 Study Area ..... 1

2.0 BACKGROUND ..... 2

    2.1 Historical Background ..... 2

    2.2 Local Geology ..... 5

3.0 SITE INVESTIGATION ..... 6

4.0 DISCUSSION OF FINDINGS ..... 9

5.0 RECOMMENDATIONS FOR CONTAINMENT AND REMEDIATION ..... 10

6.0 CONCLUSIONS ..... 15

7.0 CLOSURE ..... 16

8.0 REFERENCES ..... 17

**LIST OF TABLES**

Table 1: Locations of Wells Drilled on Shoal Point between 1965 - 2012 ..... 4

Table 2: Distances Between Visible Well Casings and the Seep Area ..... 6

Table 3: Visual Inspection Details for Well Casings and Oil Seep Area ..... 8

**LIST OF FIGURES**

Figure 1: Port au Port Peninsula Showing Locations of Documented Wells and Seeps ..... 3

Figure 2: Location of Well Casings and Seep Identified during July 15, 2015 Site Visit ..... 7

Figure 3: Cross Section of Double Culvert Containment ..... 11

Figure 4: Typical Cross Section of Containment Berm ..... 13

**LIST OF APPENDICES**

APPENDIX A SITE INVESTIGATION PHOTOGRAPHS

APPENDIX B REPORT LIMITATIONS



## 1.0 INTRODUCTION

Amec Foster Wheeler Environment and Infrastructure, a division of Amec Foster Wheeler Americas Limited (Amec Foster Wheeler), was retained by the Government of Newfoundland and Labrador Department of Environment and Conservation (NLDEC) to conduct a field investigation and to provide a report on observed oil seepage on the western shoreline of Shoal Point on the Port au Port Peninsula in western Newfoundland (Figure 1) that is resulting in a visible sheen on water in the Bay.

### 1.1 Scope of Work

To achieve this objective, Amec Foster Wheeler was tasked to:

- ▶ Conduct a site visit to assess the oil seep area;
- ▶ Advise as soon as possible of any practical immediate containment measures;
- ▶ Perform investigative testing to determine if the oil seepage is naturally occurring or if it is associated with an abandoned exploration well or wells;
- ▶ Develop an estimate on the quantity of oil released;
- ▶ Provide remediation options with discussion and cost estimates for each;
- ▶ Perform visual and/or investigative testing of the three visible casings to assess the need for remedial action;
- ▶ Provide recommendations, discussion and rationale for any recommended action;
- ▶ Provide a cost estimate for recommended action; and
- ▶ Provide a summary report of the assessment based on the scope of work.

#### 1.1.1 Study Area

The study area includes Shoal Point on the Port au Port Peninsula in western Newfoundland. Geological and background information related to the Port au Port Peninsula was assessed as part of this study. The field investigation was limited to the seep area located on the western side of Shoal Point approximately 2.5 km south from the tip of the point (Figure 1).

## 2.0 BACKGROUND

Background information was obtained from the Government of Newfoundland and Labrador, Department of Natural Resources website, the Canada - Newfoundland and Labrador Offshore Petroleum Board website, petroleum industry publications and conversations with NLDEC staff.

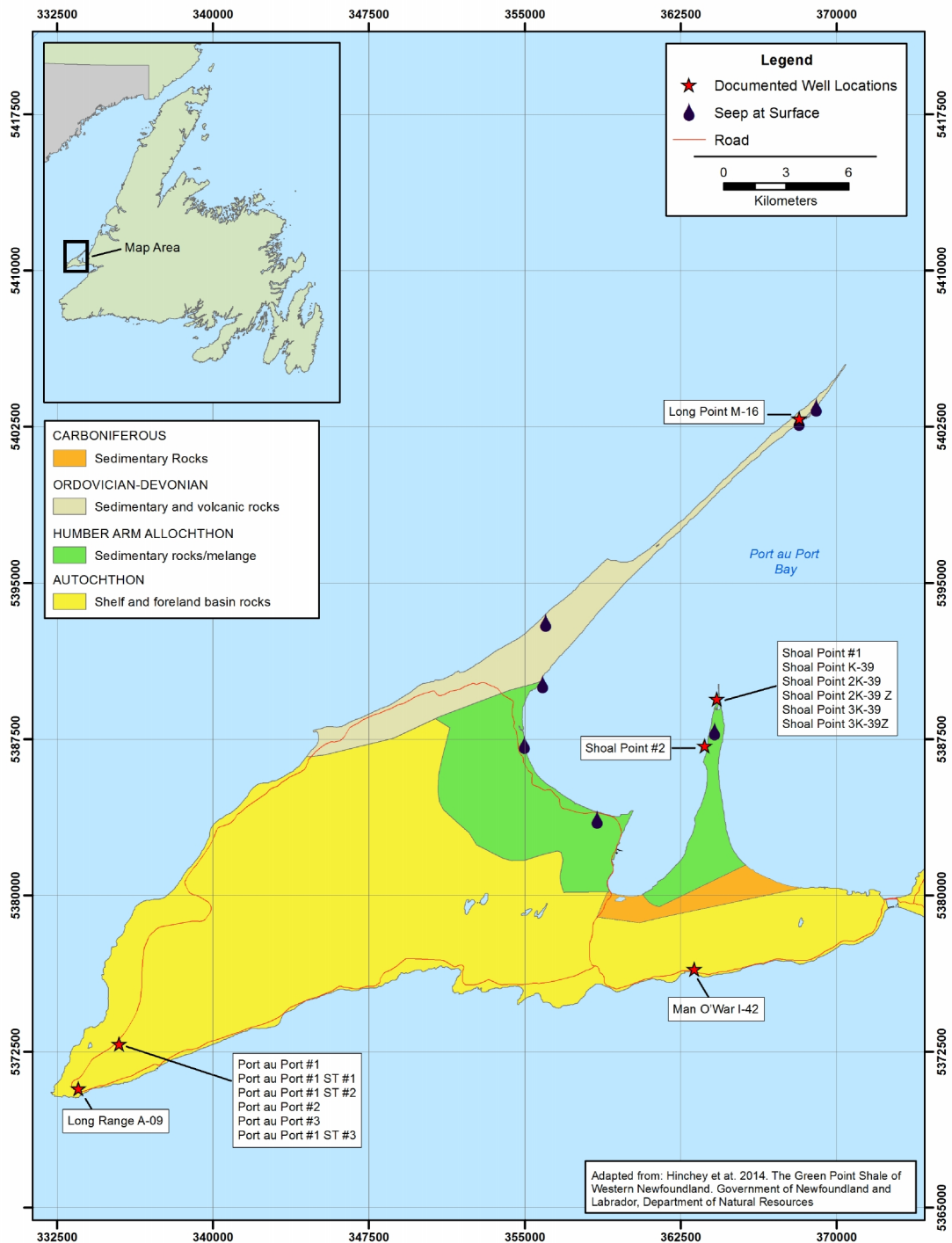
### 2.1 Historical Background

Hicks and Owens (2014) indicate the first known record of a liquid hydrocarbon seepage at Shoal Point was documented by James Howley, a government geologist, in 1874. The presence of oil seepage in this area sparked well drilling activity around 1890, with the Western Oil Company of New Brunswick drilling four to six wells at Shoal Point (Hicks and Owens, 2014; Benoit First Nation, 2002). It is reported in Benoit First Nation (2002) that oil was found at 800 feet but the quantities were too low to justify a commercial operation. An unnamed English company is also reported to have drilled at least one well and up to seven wells in the area in 1908 or 1911 (Benoit First Nation, 2002; Hicks and Owens, 2014). Drilling records are not available for these early wells.

In 1965, Golden Eagle Refining Company of Canada Limited drilled two wells on Shoal Point (Golden Eagle, 1965a; Golden Eagle, 1965b). The location of the two wells are identified in Table 1. Shoal Point No. 1 well was drilled on the northern tip of Shoal Point, approximately 2.5 km north of the present identified seepage area (Golden Eagle, 1965a). Shoal Point No. 2 well was drilled at a location described in the drilling report as 150 yards north of the old oil wells, and is located in the general area of the present problem seepage (Golden Eagle, 1965b). This well was drilled to a depth of 2335 feet (711 m). The Shoal Point No. 2 well drilling report indicates that at the conclusion of drilling a “7” x 2” swage and 2” 2000 lb. plug valve” were installed on top of the casing. It is also worthwhile noting that the drilling report for this location states that:

“The ... location was quite difficult to build as a depth of 10 feet of peat moss had to be stripped from a 5,000 sq. ft. area adjacent to the beach and then filled with shale from an outcrop nearby. As the outcrop was under water on-half of each day (as was the location in its early stages) the massive fill up job was a very a slow operation with one crawler tractor.”

There was no reported additional oil well drilling activity at Shoal Point until 1999. Five wells were drilled in the area of the northern tip of Shoal Point between 1999 and 2012 (Figure 1). The locations are identified in Table 1; however, these are not in the immediate area of the present identified oil seepage.



**Figure 1: Port au Port Peninsula Showing Locations of Documented Wells and Seeps.**

**Table 1: Locations of Wells Drilled on Shoal Point between 1965 - 2012.**

| Well Designation  | Location Coordinates           |
|---|--------------------------------|
| Golden Eagle Canada Limited - Shoal Point No. 1                       | 48°38'35"N<br>58°50'36"W       |
| Golden Eagle Canada Limited - Shoal Point No. 2                       | 48°37'22"N<br>58°51'00"W       |
| PanCanadian Resources - Shoal Point K-39                              | 48°38'27.75"N<br>58°50'34.11"W |
| CIVC, PDI, Shoal Point Energy - Shoal Point 2K-39                     | 48°38'35.12"N<br>58°50'34.17"W |
| CIVC, PDI, Shoal Point Energy - Shoal Point 2K-39Z                    | 48°38'35.12"N<br>58°50'34.17"W |
| Shoal Point Energy Limited, CIVC, Dragon Lance-<br>Shoal Point 3K-39  | 48°38'35.62"N<br>58°50'31.71"W |
| Shoal Point Energy Limited, CIVC, Dragon Lance-<br>Shoal Point 3K-39Z | 48°38'35.62"N<br>58°50'31.71"W |

In addition to the well drilling activity, Hicks and Owens (2014) indicate that live oil shows, where liquid or tacky oil is seen at the surface, remain common at Shoal Point. To highlight this point they include a photograph in their report of live oil collected from depressions dug into beach sands on the west side of Shoal Point.

In 2013, the NLDEC received complaints of oil seepage in the Shoal Point area. An inspection by NLDEC personnel observed three abandoned well casings located in the intertidal zone. The inspection confirmed the presence of an oily sheen which appeared to be originating from one of these well casings. Anecdotal evidence suggested that the release of oil from these wells has been ongoing for decades.

More recently, the NLDEC was made aware, by concerned local citizens, of additional, previously unobserved, oil seepage in this general area. A further six inspections were carried out by NLDEC staff. An oily sheen was observed on some, but not all occasions. Through these investigations, it was determined that the oily sheen was not associated with any of the known well sites and was welling up through the rock and/or sand. As is the case with the sheen associated with the wells, the seep is underwater at high tide and exposed at low tide.

On June 18, 2015 NLDEC obtained three samples of oil at the site of the seep which were submitted to Environment Canada for analysis. The samples were analyzed using CEN/TR 15522-2 (2012) protocol to allow a comparison of biomarker compounds to the oils released as part of the Kurdistan and MV

Minor oil spills. The Shoal Point oil samples were characterized as lightly weathered crude oil that showed significant differences from the Kurdistan and MV Miner oils.

## **2.2 Local Geology**

The bedrock geology in the vicinity of the observed seepage consists of vertically dipping, folded and faulted sedimentary sequences of the Humber Arm Allochthon (Williams and Cawood, 1989; Figure 1). A fault-bounded, large anticlinal structure beneath Shoal Point is considered an ideal location for oil exploration (Cooper et al., 2001; Hinchey et al., 2014). The sedimentary sequences were laid down prior to the Taconic Orogeny, which faulted and uplifted the carbonate and shale sedimentary sequences of the Humber Arm Allochthon (Hinchey et al., 2014).

Exposed bedrock is limestone and shale in thin beds, steeply to vertically dipping, folded and faulted (Williams and Cawood, 1989). Core records for Shoal Point (Golden Eagle, 1965a; Golden Eagle, 1965b; Hinchey et al., 2014) indicate that the Green Point Formation of the Humber Arm Group reaches depths of approximately 2000 m below ground surface, below which the autochthonous (local) shelf succession and basement rocks lie.

The surficial geology is a beach and near shore environment. The stratigraphy at the high tide mark consists of bog as deep as three metres overlying a thin layer of bluish grey glaciomarine sediment (silt/clay/sands/gravel with the occasional boulder). Bedrock outcrops are abundant at the low tide mark and further out into the shallow water. Liverman and Taylor (1993) describe the surficial geology as accumulations of organic matter (bog).

The whole of the Point is showing the effects of global sea level rise and local subsidence. The flat nature of the land makes these effects more dramatic as a small vertical rise of water level translates into a significant horizontal distance, creating a dramatic loss of shoreline.

### 3.0 SITE INVESTIGATION

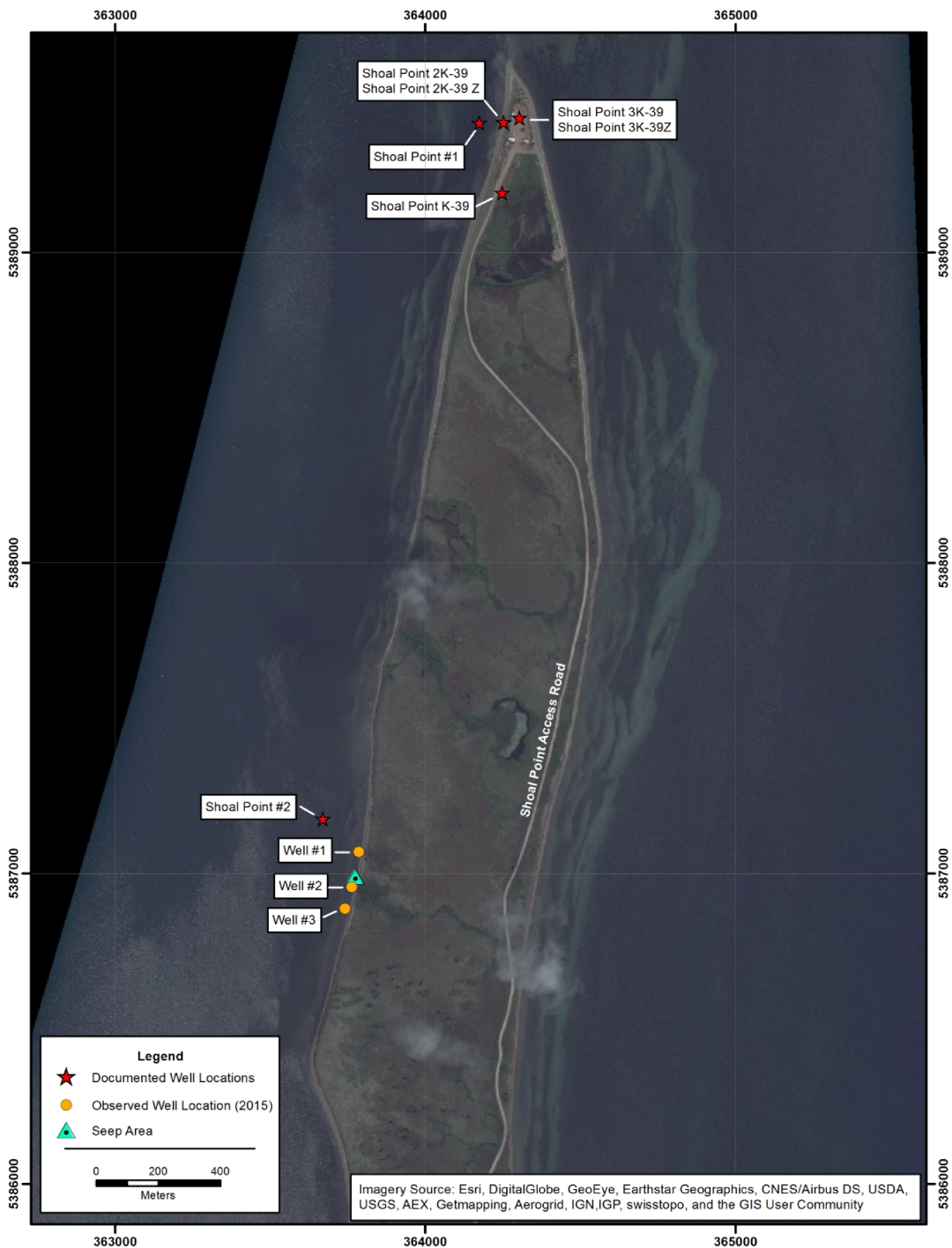
The area of the present oil seepage on the western shoreline of Shoal Point was visited on July 15, 2015 by a representative of Amec Foster Wheeler accompanied by a representative of NLDEC who had visited the site on previous occasions in 2015. The area was accessed by walking across approximately 450 m of boggy land between the access road on the eastern side of Shoal Point and the western shoreline (Figure 2). The area was visited during low tide, which occurred at approximately 5:35 PM on that day. The investigators visually inspected the visible well casings and the oil seepage area, took photographic records, and scanned the area of shoreline and intertidal zone with a Schonstedt MAC – 51Bx metal detector.

The visual inspection in this area identified three exposed well casings and the seep area, which is not located at a visible well casing location, as was previously observed by NLDEC. The locations of these items are identified on Figure 2 and the distance between each is provided in Table 2. The location of the Shoal Point No. 2 well drilled by Golden Eagle Refining Company of Canada Limited in 1965 was also indicated by the NLDEC representative, however, this well was neither specifically found nor inspected during the July 15, 2015 site visit.

**Table 2: Distances Between Visible Well Casings and the Seep Area.**

| Location                      | Distance (m) |
|-------------------------------|--------------|
| Well 1 to Well 2              | 115          |
| Well 2 to Well 3              | 74           |
| Well 1 to Well 3              | 189          |
| Seep to Well 1                | 80           |
| Seep to Well 2                | 35           |
| Seep to Well 3                | 109          |
| 1965 Shoal Point #2 to Well 1 | 157          |
| 1965 Shoal Point #2 to Well 2 | 237          |
| 1965 Shoal Point #2 to Well 3 | 298          |
| 1965 Shoal Point #2 to Seep   | 211          |

Visual inspection of the three visible well casings identified that each consisted of an outer casing and an inner casing with an annular space between the two. Table 3 provides visual inspection details on each well casing and the seep area.



**Figure 2: Location of Well Casings and Seep Identified during July 15, 2015 Site Visit.**



**Table 3: Visual Inspection Details for Well Casings and Oil Seep Area.**

| Well No.      | Location                     | Outer Casing Diameter (cm) | Inner Casing Diameter (cm) | Comments  |
|---------------|------------------------------|----------------------------|----------------------------|---|
| 1             | 48°37'18.7"N<br>58°50'54.2"W | 30                         | 20                         | <ul style="list-style-type: none"> <li>▶ Strong detection on metal detector from 7 m away;</li> <li>▶ Inner casing has cap with threaded coupling;</li> <li>▶ No odour and no artesian flow apparent;</li> <li>▶ Casing extends approximately 3 m out of the substrate and is fully out of the water at low tide;</li> <li>▶ The pipe enters the substrate at a 70° to 80° angle.</li> </ul>                              |
| 2             | 48°37'15.0"N<br>58°50'55.2"W | 20                         | 15                         | <ul style="list-style-type: none"> <li>▶ Strong detection on metal detector from 7 m away;</li> <li>▶ Evidence of slight artesian flow almost drying up before reaching the water approximately 20 cm below the top of the casing;</li> <li>▶ No visible hydrocarbon or odour;</li> <li>▶ The casing extends less than 0.5 m above the substrate, is exposed at low tide, but is fully submerged at high tide.</li> </ul> |
| 3             | 48°37'12.7"N<br>58°50'56.2"W | 30                         | 20                         | <ul style="list-style-type: none"> <li>▶ Strong detection on metal detector from 7 m away;</li> <li>▶ Outer casing has a blackened coating;</li> <li>▶ No evidence of oil on or around piping;</li> <li>▶ No visible hydrocarbon or odour;</li> <li>▶ The casing extends less than 1 m above the substrate, is exposed at low tide, but is fully submerged at high tide.</li> </ul>                                       |
| Oil Seep Area | 48°37'16.1"N<br>58°50'54.8"W | Unknown                    | Unknown                    | <ul style="list-style-type: none"> <li>▶ Strong detection on metal detector from 7 m away;</li> <li>▶ Bubbles coming up from several locations in the immediate area of a small rock dammed pool surrounding a shallow pool of oil water mixture;</li> <li>▶ Is exposed at low tide, but is fully submerged at high tide; observed oil flow estimated on the order of 1.0 litre per hour.</li> </ul>                      |



A length of well casing was observed on the rocks in the area of the oil seepage at the time of the site visit. This corroded metal casing was removed by the investigator and placed at the edge of the bog adjacent to the shoreline. This was done in order to scan the area using the metal detector with the discarded section of casing outside of the area of scan. The metal detector indicated a strong response even after the section of casing was removed. The metal detector also showed response to boulders along the beach area, indicating presence of magnetic rock, however, the response was significantly stronger in the areas associated with the visible casing lengths and in the vicinity of the observed seepage area.

Each of the three visible well casings and the identified seep area are located in the intertidal zone of the shoreline and within a metre of the low water mark at the time of the investigation. The investigators accessed the area during the low tide period and remained in the area for about two hours as the tide returned to the seepage site and the visible well pipes. This allowed the investigators to visually locate any sheen of oil on the water surface as the tidal water submerged these locations. It was apparent that an oily sheen was emanating from the seepage site and that no other source of sheen was apparent.

The immediate area of the oil seepage was found to be surrounded by a small rock dam in which a shallow pool of water remained at low tide. Intermittent bubbling occurred within this pool during the time of inspection and oil accumulated on the surface of the water in the pool over that period. The quantity of oil seepage was sufficient to cover the pool in an hour and was roughly estimated by comparison of visible coverage at initial inspection and visible coverage at the end of the inspection period to be on the order of one litre per hour at that time. It is not known if the rate of seepage is constant over time or how the tide and groundwater fluctuations may affect the rate. Further monitoring would be required to appropriately evaluate potential variability in the seepage rate.

Photographs of each visible well casing and the seepage area are included in Appendix A.

#### **4.0 DISCUSSION OF FINDINGS**

The origin of the three visible well casings investigated in the Shoal Point western shoreline intertidal zone, as part of this study, are unknown. These may be three of the original four to six wells drilled by the Western Oil Company around 1890, or they may be wells drilled by an unnamed English Company in the 1908 to 1911 period. Although the visible well casings have been damaged from being exposed to wind, wave and ice pressures, they do not appear to be the source of the current oil sheen that is evident on the water in this area.

This sheen is emanating from an area located between two of the wells casings, where oil is seeping through soil comprising of clay, silt, sand, gravel and some cobble and small boulders. This seepage appears to be isolated to a single location in the intertidal zone. Bubbling is evident throughout the small pool where this seepage is occurring, indicating the presence of gas release. The signal received by the metal detector at the seepage area indicates there is strong potential that the oil is originating from, or

near, a fourth well casing that has broken off, or was terminated at the time of drilling, below the surface at this location.

## **5.0 RECOMMENDATIONS FOR CONTAINMENT AND REMEDIATION**

Assessment of the condition of the evident subsurface well casing, and remediation of the leakage, cannot be undertaken without first removing the surrounding overburden and rocky materials to reveal the casing. In order to safely excavate in this area, and to provide protection to the surrounding environment against the continued release of hydrocarbon, it is necessary to isolate the seepage area and the associated excavation from flooding during high tide. Once the area has been isolated and the casing uncovered, the condition of the casing and the appropriate means of repairing the leakage can be assessed.

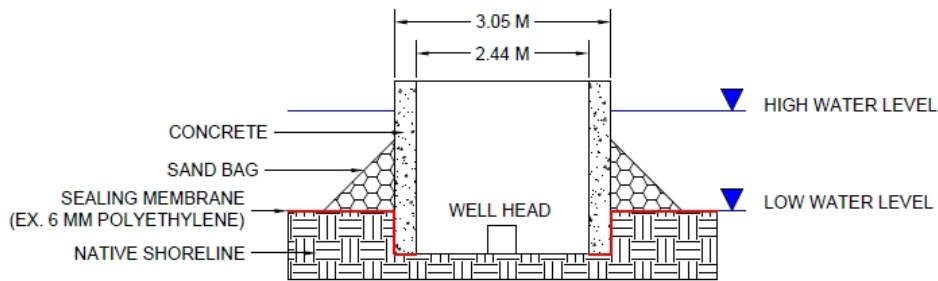
At present, although road access is available to the eastern shore of Shoal Point, the area of the oil seepage on the western shoreline is not directly accessible by road. The placement, operation and maintenance of hydrocarbon containment measures, such as booms, absorbents and skimmers are difficult without direct land access. Access by water for barging equipment and materials is also limited by shallow depths in the area. The effectiveness of such measures would also be limited by the twice daily tidal fluctuations. This tidal influx would require adjustments and flexibility to the placement and control of containment equipment and limit effectiveness. However, the exposure of the seepage area during low tide does provide an opportunity to be able to potentially isolate the seepage flows from tidal waters and thus prevent the ongoing direct contact of seepage flows with waters in the Bay. Options for undertaking the work required to provide containment surrounding the oil seepage, expose the casing, and provide potential options for remediating the leakage are identified below.

### Shoal Point Oil Seepage Excavation - Option 1

As the area of evident oil seepage is free of tidal water during low tide, it is possible to undertake a controlled excavation of the area surrounding the potentially buried well casing for a short period with minimal potential risk of contaminated materials reaching the surrounding environment. For this option, double culverts would be used to isolate the seepage area from tidal influx and control discharge of oil. This system in conjunction with sump pumps will assist in providing a dry working area to conduct work during periods when the tide would normally encompass the area. Hydrocarbon contaminated materials that are excavated will be removed and placed into approved receptacles positioned above the high tide zone on the beach. Hydrocarbon contaminated water in the seepage area will be pumped into approved containment drums/tanks/bladders positioned above the high tide zone. The area surrounding the initial excavation will be protected with oil absorbent booms to provide additional protection if small quantities of contaminated water escape from the excavation area.

Conceptual design of this system is shown in Figure 3. The base will be prepared by excavating a trench of appropriate diameter to a depth of 0.3 m into the glacio-marine silt/clay/gravel or the bedrock surface,

whichever is first encountered. The larger diameter culvert (3.05 m or 10 feet) will first be positioned followed by the smaller diameter culvert (2.44 m or 8 feet) inside of the larger culvert. A uniform annular space of 0.3 m will be maintained between the two culverts for the entire circumference. Sand bags weighing less than 22 kg (50 pounds) shall be placed around the exterior circumference of the larger culvert and the interior circumference of the smaller culvert to reduce movement. Once in place, concrete will be poured between the two culverts to provide ballast and to reduce the inflow of sea water. It is not necessary for the concrete to be structural and can, therefore, be manufactured from a combination of sand and gravel, Portland cement and bentonite. Once the concrete has set, the interior sand bags can be removed to provide additional area for working. Additional sand bags and a sealing membrane may be required around the exterior to further reduce infiltration of sea water.



**Figure 3: Cross Section of Double Culvert Containment.**

Access to the culvert would be via a steel shoring supported walkway leading to a point above high tide. A steel shoring supported platform would be constructed near the reinforced culvert to place equipment, such as pumps, steam Jennies and small tools.

It is assumed that all materials required for its construction will be transported approximately 2.5 km along the shoreline utilizing track mounted equipment. Equipment will include a medium size excavator (15 tonne), tracked loader, and tracked utility vehicle (Muskeg, Gotrack or Nodwell). Culverts will be one piece and 2.44 m (8 feet) in length and delivered to the site either by the use of slings on the excavator or secured to the flat bed of the tracked utility vehicle. It is anticipated that concrete will be mixed on site and that aggregates would be transported via the tracked utility vehicle or tracked loader.

This option provides opportunity for relatively quick and effective containment of the oil seepage by isolating the seepage area from direct contact with tidal waters. There will still be potential for subsurface water infiltration, however, this can be captured inside the culvert containment area and removed for appropriate treatment as required. This approach has significantly more potential for effective containment than use of booms as a short term containment approach.

Once the culvert and walkway have been installed it will be possible to excavate inside of this protected area without exposing the excavation to subsequent flooding by tidal water. Although the work area will be accessible by way of the constructed walkway, a Health and Safety Plan will be required and consideration for personnel safety during extreme events will need to be included. As mentioned above, contaminated solids and water from shallow excavation will be collected in suitable containers on the shoreline for subsequent removal and treatment.

The estimated cost for this work is for materials, labour, and equipment only. The cost is largely dependent on site access, tides, and weather. Costs will range between \$40,000 and \$60,000, which includes a \$10,000 allowance for removal and disposal of the containment materials. Other costs will include project management and contract supervision and will be dependent on the approach employed by the responsible agency. In addition to the above noted costs, there will be a cost of approximately \$10,000 - \$15,000 associated with containment, treatment and disposal of hydrocarbon contaminated materials.

This option is subject to the following assumptions and limitations:

- ▶ Since road access is not available to the seep area this option is intended as a means of providing separation of the seep area from tidal water with minimal equipment and materials that can be brought to the site by using the beach for access.
- ▶ Since the area inside of the culvert will be limited, the depth of the excavation will also be limited. In order for this excavation to be effective in exposing the buried well casing, it must be accessible within 1 to 2 m of excavation.
- ▶ The potential options for remediation of a leaking well casing will be limited when utilizing this option as it will not permit the use of drilling equipment to access the well casing. The options to be used during remediation of a leaking well casing will be subject to approval by appropriate regulatory agencies.
- ▶ In a significant storm and/or tide event, washout of the work area and containment structure may occur.
- ▶ A number of components of this option will be subject to approvals by government agencies. These would include approval for works in and around water bodies, and the handling and disposal of contaminated solids and liquids. Time and resources will need to be applied to requesting these approvals and addressing any concerns before any work is undertaken.

### Shoal Point Oil Seepage Excavation - Option 2

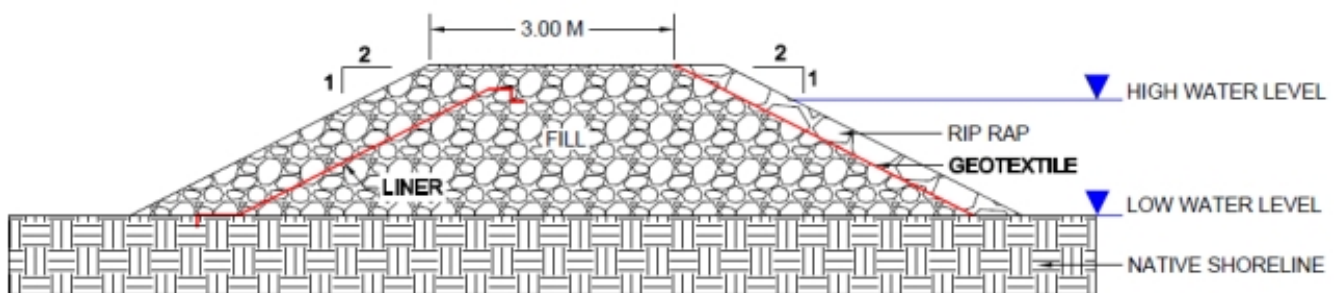
The second option is based on providing greater access to the site and enclosing the work area with a more substantial impermeable barrier, using a containment berm. This will allow for a more extensive and controlled excavation, including excavation to a much greater depth, if such is required to expose

the buried well casing. Although Option 1 (above) provides containment and protection of the seepage area during excavation, access to the area is still limited, which in turn limits the size and timeliness of excavation in the seep area. The containment berm is considered the preferred containment option under the following conditions:

1. If the damaged well casing is located deeper than 1 to 2 m, then the excavation will require isolation of a larger area than is achievable through option 1 and the potential quantity of contaminated materials that will have to be captured and removed from site for treatment will be larger than is suitable for transport using the beach for access.
2. If the well casing is damaged to the extent that it cannot be sealed without re-drilling within the casing, to allow proper abandonment of the well a suitable area will need to be provided around the casing for safe establishment and operation of a suitable drill rig. It should be noted that costing of possible use of a drill rig for well casing abandonment is outside of the scope of the present study.

The containment berm will be constructed from the shoreline at a greater elevation than the high tide elevation with a minimum 1 m freeboard and loop around the well head and tie back to the shoreline in a 'U' shape. Additional study will be required to determine possible wave heights, minimum freeboard height, and berm dimensions.

Conceptual design of this system utilizes an earthen berm with a typical cross section shown in Figure 4. The berm shall have a minimum crest width of 3 m and maximum 2H:1V slopes on both the inside and outside slopes. Rip-rap protection will be required on the outside slope. A geosynthetic liner will be required on the inside slope and covered with sufficient ballast to prevent uplift from artesian forces.



**Figure 4: Typical Cross Section of Containment Berm.**

Due to the quantity of material required to construct the berm, an access road will be required to be constructed from the current road on the east side of the point to the west shore of the point. The anticipated length of this road is ~450 m and will cross a bog. In an effort to minimize disturbance to the

ecosystem, geosynthetic geogrid and fabric will be placed on top of the bog prior to placement of the road base. Once placed, a nominal 1 m thick layer of blast rock fill will be placed to construct the road. The road will allow one way movement of traffic with one pull out to allow passage of oncoming vehicles.

The base of the berm will be prepared by removing any boulders, cobbles, and gravel to provide a flow path for water seepage. The berm will be constructed in accordance with the cross section shown above (Figure 4) to allow for installation of the geosynthetic liner and geotextile. It is anticipated that the total length of 100 m will be required for the berm construction.

In this option, it will be required, as in Option 1, to manage hydrocarbon contaminated solids and liquids encountered during the excavation. Hydrocarbon contaminated materials that are excavated will be removed and placed into approved receptacles within the containment berm area.

The estimated cost for this work is for materials, labour, and equipment only. The estimated cost for this work will range between \$400,000 and \$600,000, which includes a \$100,000 allowance for removal and rehabilitation of disturbed areas at completion of the project. Other costs will include project management and contract supervision and will be dependent on the approach employed by the responsible agency. In addition to the above noted costs, there will be a cost of approximately \$17,000 - \$20,000 associated with containment, treatment and disposal of hydrocarbon contaminated materials.

This option is subject to the following assumptions and limitations:

- ▶ In a significant storm and/or tide event, washout of the work area and containment structure may occur.
- ▶ A number of components of this option will be subject to approvals by government agencies. These would include approval for works in and around water bodies, and the handling and disposal of contaminated solids and liquids. Time and resources will need to be applied to requesting these approvals and addressing any concerns before any work is undertaken.

## Remediation

The approach taken to remediating leakage from the suspected well casing once it has been uncovered will be dependent on the condition of the casing in terms of its structural integrity, the presence of obstructions within the well casing, and the pressure generated by gas and liquid flow. The approach will also be subject to approval of regulatory agencies and compliance with regulatory requirements including the provincial *Petroleum Drilling Regulations*. Due to uncertainty related to the integrity of the suspected well casing and the degree of obstruction within this casing, options are provided below that address both remediation of the casing and potential opportunities for appropriate sealing and capping of the well. Potential approaches include:



- ▶ If the well casing is found to be in good condition, it will be possible to install a dresser sleeve on the casing, which will allow installation of a valve to capture and control the leakage flows. This will be a temporary measure to allow for assessment of the feed rate and pressure requirements for pumping cement to enable the well to be plugged.
- ▶ Pumping Portland cement grout into the well to a suitable depth to seal the leakage and welding of a steel plate on top may be possible if the casing integrity is good and there are no obstructions in the bore. This will allow for sealing of the potential oil seepage zones at depth and the sealing and capping of the well casing near the surface.
- ▶ If the casing integrity is good but the well bore is obstructed, it may still be possible to establish a feed rate and pump grouting material into the well bore while monitoring pressure and the surrounding area for return flow. Once a suitable plug has been established a steel cap can be welded on top of the casing. This can also allow for sealing of the potential oil seepage zones at depth and the sealing and capping of the well casing near the surface.
- ▶ If it is not possible to pump water and / or cement into the well bore due to obstruction, it may be necessary to mobilize a drill rig to re-drill and / or clean out the well bore and suitably plug and cap the well once a suitable unobstructed pathway has been established in the casing.

The costs for the equipment, manpower and materials associated remediating the apparent leakage will range between \$12,000 and \$15,000 daily. The length of time required will be dependent on the condition of the well casing and degree of obstruction. These costs do not include those associated with mobilization and utilization of a drill rig, if that is required, as these costs will be dependent on the conditions encountered during further investigation and the type of equipment required. As with the excavation options, any hydrocarbons encountered during casing remediation will require storage in suitable containers and treatment prior to disposal.

## 6.0 CONCLUSIONS

Amec Foster Wheeler conducted a field investigation of observed oil seepage on the western shoreline of Shoal Point on the Port au Port Peninsula in western Newfoundland in order to provide recommendations for practical containment and remediation measures. Earlier investigations by NLDEC and the investigations undertaken as part of this study identified the presence of three damaged oil well casings and an oil seepage area not associated with a visible well casing along a 190 m long section of this shoreline. The visible well casings, although damaged, were not found to be leaking at the time of inspection. An area of oil seepage in the tidal zone of the shoreline was identified as the source of an oil sheen that was carried by water currents in the Bay following inundation of the seep area by tidal waters. A potential buried well casing was identified below the area of the oil seepage using a metal detector.

Seepage rates were estimated to be on the order of one litre per hour during the site visit. It is not known if the rate of seepage is constant over time or how the tide and groundwater fluctuations may affect the rate. Further monitoring would be required to appropriately evaluate potential variability in the seepage rate.

Two practical options are provided which facilitate oil containment and isolation of the oil seepage area from tidal water. One consists of using a double culvert system that can be constructed quickly using the tidal beach for transport of equipment and materials. The other consists of using a containment berm that will allow for a larger and potentially drier work area. Construction of a road will be required for the containment berm option. Both options allow for safe excavation of overburden and rocky materials above the suspected well casing, and removal of contaminated liquids and solids for subsequent treatment and disposal. Once the well casing is exposed, casing integrity will be assessed such that the source of the oil seepage will be identified and the well will be sealed, preventing further oil seepage. Cost estimates for each option are provided within the report.

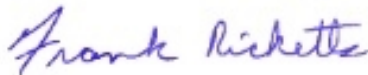
## 7.0 CLOSURE

This report has been prepared for the exclusive use of the Government of Newfoundland and Labrador, Department of Environment and Conservation. The assessment was conducted using standard assessment practices and in accordance with written requests from the Client. No further warranty, expressed or implied, is made. The conclusions presented herein are based solely upon the scope of services and time and budgetary limitations described in our contract. Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. Amec Foster Wheeler accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report. The limitations of this report are attached in Appendix B.

Yours sincerely,

**Amec Foster Wheeler Environment & Infrastructure,  
a Division of Amec Foster Wheeler Americas Limited**

Prepared by:



Frank Ricketts  
Senior Environmental Advisor

Reviewed by:



Rod Winsor, P.Eng.  
Office Manager



## 8.0 REFERENCES

- Benoit First Nation, 2002. History of Communities of the Peninsula. Available Online: <http://www.benoitfirstnation.ca/page1history.htm>. (Accessed July 2015).
- Cooper, M., Weissenberger, J., Knight, I., Hostad, D., Gillespie, D. and Williams, H., 2001. Basin Exploration in Western Newfoundland: New Insights from Hydrocarbon Exploration, AAPG Bulletin, v. 85, no. 3: 393–418.
- Golden Eagle Refining Company of Canada Limited (Golden Eagle), 1965a. Shoal Point No. 1 Drilling Report. Available Online: <http://www.nr.gov.nl.ca/nr/publications/energy/t0k7tss2.pdf>.
- Golden Eagle Refining Company of Canada Limited (Golden Eagle), 1965b. Shoal Point No. 2 Drilling Report. Available Online: [http://www.nr.gov.nl.ca/nr/publications/energy/golden\\_eagle\\_shoal\\_point\\_2.pdf](http://www.nr.gov.nl.ca/nr/publications/energy/golden_eagle_shoal_point_2.pdf).
- Hicks, L. and Owens, J. 2014. The History of Petroleum Exploration in Western Newfoundland. Government of Newfoundland and Labrador, Department of Natural Resources. Available Online: [http://www.nr.gov.nl.ca/nr/energy/pdf/history\\_petroleum\\_exploration\\_western\\_nl.pdf](http://www.nr.gov.nl.ca/nr/energy/pdf/history_petroleum_exploration_western_nl.pdf).
- Hinchey, A.M., Knight, I., Kilfoil, G., Hynes, K.T., Middleton, D., and Hicks, L.G. 2014. The Green Point Shale of Western Newfoundland. Government of Newfoundland and Labrador, Department of Natural Resources. Available Online: [http://www.nr.gov.nl.ca/nr/energy/pdf/green\\_point\\_shale\\_west\\_nl.pdf](http://www.nr.gov.nl.ca/nr/energy/pdf/green_point_shale_west_nl.pdf).
- Liverman, D. and Taylor, D.M., 1993: Surficial geology of the Stephenville and Bay of Islands (NTS 12B and 12G) map areas. Government of Newfoundland and Labrador, Department of Mines and Energy, Geological Survey, Map 93-80, scale 1:250,000. Open File NFLD (2341).
- Williams, H. and Cawood, P A., 1989. Geology, Humber Arm Allochthon, Newfoundland. Geological Survey of Canada, "A" Series Map 1678A, scale 1:250,000.

## **APPENDIX A SITE INVESTIGATION PHOTOGRAPHS**



**Photo 1: July 15, 2015 Shoal Point Investigation - Well 1.**



**Photo 2: July 15, 2015 Shoal Point Site Investigation – Well 2**





**Photo 3: July 15, 2015 Shoal Point Site Investigation – Well 3.**



**Photo 4: July 15, 2015 Shoal Point Site Investigation – Shoreline Oil Seep.**





**Photo 5: July 15, 2015 Shoal Point Site Investigation – Oil Sheen Emanating from Shoreline Seep.**

## **APPENDIX B REPORT LIMITATIONS**



## LIMITATIONS

1. This report was prepared specifically for the Client (NLDEC). Any other use which a third party makes of this report, or any reliance on or decisions to be made based on it are the responsibility of such third parties. AMEC Foster Wheeler Environment & Infrastructure accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions taken based on this report.
2. The report has been prepared in accordance with generally accepted environmental study and/or engineering practices. No other warranties, either expressed or implied, are made as to the professional services provided under the terms of our contract and included in this report.
3. The services performed and outlined in this report were based, in part, upon visual observations of the site and attendant structures. Our opinion cannot be extended to portions of the site which are unavailable for direct observation reasonably beyond the control of AMEC Foster Wheeler Environment & Infrastructure.
4. The objective of this report was to assess the environmental conditions at the site, given the context of our contract, with respect to existing environmental regulations within the applicable jurisdiction. Compliance of past owners with applicable local, provincial and federal government laws and regulations was not included in our contract for services.
5. The site history research performed herein relies on information supplied by others, such as local, provincial and federal agencies as well as the homeowner. No attempt has been made to independently verify the accuracy of such information, unless specifically noted in our report.
6. Our visual observations relating to potential contaminant materials in the environment at the site are described in this report. Testing of soil samples included field screening and analytical testing for specific parameters referred to in the report. Testing of groundwater samples included analytical testing for specific parameters referred to in the report. It should be noted that other compounds or material may be present in the site environment.
7. The conclusions of this report are based in part, on the information provided by others. The possibility remains that unexpected environmental conditions may be encountered at the site in locations not specifically investigated. Should such an event occur, AMEC Foster Wheeler Environment & Infrastructure must be notified in order that we may determine if modifications to our conclusions are necessary.
8. The work performed in this report was carried out in accordance with the Standard Terms of Conditions made as part of our contract. The conclusions presented herein are based solely upon the scope of services and time and budgetary limitations described in our contract.