

GOVERNMENT OF THE NORTHWEST TERRITORIES

WRITTEN SECURITY SUBMISSION

for

IMPERIAL OIL RESOURCES LIMITED  
NORMAN WELLS PRODUCTION FACILITY  
TYPE "A" WATER LICENCE RENEWAL S13L1-007

October 24<sup>th</sup>, 2014

Submitted To:

Sahtu Land and Water Board  
Box 1  
Fort Good Hope, NT  
X0E 0H0

## **INTRODUCTION**

As a component of the ongoing regulatory process to renew Type “A” Water Licence S13L1-007, Environment and Natural Resources (ENR) retained ARKTIS Solutions Incorporated (ARKTIS) to conduct a reclamation security assessment of Imperial Oil Resources Limited’s (IORL) Norman Wells Facilities. This estimate and associated rationale is being provided to the Sahtu Land and Water Board (SLWB) for their consideration in setting the amount of reclamation security held under the water licence.

ENR would like to inform the Board that the review of reclamation security for the Norman Wells Production Facility was difficult and complicated by the fact that the only approved Closure Plan for the facility is dated and lacking in sufficient detail. ENR is aware that the SLWB is currently initiating a review process for the Closure and Reclamation Plan and ENR will actively participate in that review and approval process. ENR recommends that following the review and approval process for the Closure and Reclamation Plan that security for the Norman Wells Production Facilities be re-assessed and updated as appropriate.

As part of this security review process, ARKTIS prepared a standalone estimate of reclamation liability for the Norman Wells Production Facilities, split between land and water related costs. Specific aspects of the ARKTIS estimate are discussed below and the detailed estimate is attached as Appendix 1. Additionally, a supporting memo and comparison table has been prepared by ARKTIS to support their assumptions and calculations in the RECLAIM Model. That document is provided as Appendix 2.

## **BACKGROUND**

Several meetings have occurred between IORL, SLWB, ENR and Aboriginal Affairs and Northern Development Canada (AANDC) regarding the security estimation for the Norman Wells Production Facility. Discussions focused specifically on the Oil & Gas RECLAIM Model and scope of reclamation work for the site. During the course of these meetings, information was shared to help develop the security estimate and describe the various assumptions used by government and regulators in the NWT in setting security for major development projects. The meetings also highlighted the importance of having a clear and detailed Closure and Reclamation Plan, as it would be used to determine and refine the security estimate as more detailed information becomes available on the scope of reclamation activities and anticipated closure timeframes. At present, it has been identified that there is a relatively high degree of uncertainty associated with components of the proposed reclamation.

All parties discussed the scope of reclamation activities, reclamation components, unit

costs and the associated inputs into the Oil and Gas RECLAIM Model. However, in many instances, IORL has not used unit cost information provided in the RECLAIM Model. Further, IORL's estimate was conducted in an altered RECLAIM format that made it somewhat difficult to track and assess inputs into the model.

Major areas of difference between the two estimates include the following components:

- Wells and Facilities
- Buildings and Equipment
- Chemical and Soil Management
- Interim Care and Maintenance
- Post-Closure Monitoring and Maintenance
- Contingency

The following sections further describe these areas of difference.

### **GUIDING PRINCIPLES – ENR's RECLAIM COST ESTIMATES**

The RECLAIM estimate, as presented, is developed in accordance with the principles of the Mine Site Reclamation Policy for the Northwest Territories. This Policy was developed to support sustainable resource development in the north, based on the following principles:

1. Adequate security should be provided to ensure the cost of reclamation, including shutdown, closure and post-closure, is borne by the operator of the mine rather than the Crown (public);
2. Following closure, companies or their future owners should continue to be responsible for the site, including the remediation of any additional environmental complications which develop;
3. Every development should, at all times, have a closure and reclamation plan, which includes measures to be taken in the event of a temporary closure.
4. Estimates of reclamation costs, for the purposes of financial security should be based on the cost of having the necessary reclamation work done by a third party contractor if the operator defaults. The estimates should also include contingency factors appropriate to the particular work to be undertaken.

### **ASSUMPTIONS – ENR's RECLAIM COST ESTIMATES**

This reclamation cost estimate is based on the following assumptions:

- The company goes bankrupt or abandons the property,
- No allowance for progressive reclamation,
- All work is based on independent contractor rates,
- All costs are 2014 Canadian dollars,
- The cost estimate does not include revenue from recovery of assets,
- The facility is developed substantially as planned and as per scope of the licence,
- The estimate does not include costs for catastrophic events such as failure of wells, dams, landfill, etc.

### **ENR's 2014 RECLAIM COST ESTIMATE - METHODOLOGY**

The Oil and Gas RECLAIM model, version 7.0, was used in the preparation of this estimate. This incorporates the most current unit cost information available for the north.

It is important to note that the RECLAIM model relies solely upon user entry values and does not manipulate those entry values other than to multiply or add the values for the user. Accordingly, a sound understanding and comprehension of the reclamation approach, principles and assumptions is required when preparing and or evaluating an estimate.

The final calculation provides an estimate of the reclamation security, calculated as the sum of the water related reclamation security and land related reclamation security.

Note, where possible information provided by IORL has been utilized, in an effort to minimize areas of difference within the cost estimates. However, ENR believes that should insufficient information exist or the level of detail be lacking, the "precautionary approach" should be utilized in the cost estimate. Should additional detailed information become available to Parties at a later date or as part of the Closure and Reclamation Plan review process, the estimate should be revised at that time.

### **COMPARISON WITH IORL's COST ESTIMATE**

To aid the SLWB in their decision-making process, a detailed comparison of the ENR and IORL cost estimates has been conducted. Upon comparison, it is apparent that there are six (6) major areas in difference in the cost estimates (difference greater than \$1 M) specifically tied to the following components:

- Wells and Facilities
- Buildings and Equipment

- Chemical and Soil Management
- Interim Care and Maintenance
- Post-Closure Monitoring and Maintenance
- Contingency

These components account for approximately \$48.7 million in difference between the respective estimates. Of this total difference, \$23.7 million (approx. 48%) is largely tied to respective differences in percentages used for Project Management, Engineering and Contingency (part of “indirect costs”). Combining this difference with the other main difference in the estimates (i.e. Post-Closure Monitoring) accounts for approximately 80% of the difference or \$39.4 million (\$23.7 + \$15.7 million).

The estimated land and water-related liability associated with the Norman Wells Production Facility is \$227,063,351. Full details of cost comparisons are provided in Appendix 2. It must be noted that this estimate is based upon the information available at this point in time, without an updated Closure and Reclamation Plan. Thus, any new information regarding closure or modifications to the existing operations will require a review of the adequacy of this estimate.

A summary of the estimates by mine component is provided in Table 1 below.

| Direct Costs                                  | ENR Estimate         | IORL's Estimate      | Difference         |
|---|----------------------|----------------------|--------------------|
| Wells and facilities                          | \$47,817,087         | \$42,667,251         | \$5,149,836        |
| Buildings and equipment                       | \$45,245,889         | \$41,126,888         | \$4,119,001        |
| Chemicals                                     | \$20,717,805         | \$16,605,839         | \$4,111,966        |
| Construction and operation of onsite landfill | \$18,650,000         | \$18,650,000         | \$-                |
| Water management                              | \$6,309,975          | \$12,371,181         | \$(6,061,206)      |
| Interim care and maintenance                  | \$6,787,503          | \$5,497,039          | \$1,290,464        |
| <b>SUBTOTAL: Direct Costs</b>                 | <b>\$145,528,259</b> | <b>\$136,918,198</b> | <b>\$8,610,061</b> |
| Mobilization/demobilization                   | \$3,008,630          | \$2,352,880          | \$655,750          |
| Post-closure monitoring and maintenance       | \$23,931,505         | \$8,210,561          | \$15,720,944       |
| Engineering (5%)                              | \$7,276,413          | \$6,846,410          | \$430,003          |
| Project management (5%)                       | \$7,276,413          | \$6,846,410          | \$430,003          |

|   |                        |                       |                     |
|---|------------------------|-----------------------|---------------------|
| Health and safety plans/<br>monitoring and QA/QC (1%) | \$1,455,283            | \$ 1,369,282          | \$86,001            |
| Bonding/insurance (1%)                                | \$1,455,283            | \$ 1,369,282          | \$86,001            |
| Contingency   | \$36,382,065           | \$13,692,820          | \$22,689,245        |
| Inflation 2014 Dollars (0.52%)                        | \$749,502              | \$705,210             | \$44,292            |
| <b>SUBTOTAL: Indirect Costs</b>                       | <b>\$81,535,094</b>    | <b>\$41,392,854</b>   | <b>\$40,142,240</b> |
| <b>TOTAL COSTS</b>                                    | <b>\$227,063,353 *</b> | <b>\$178,321,0512</b> | <b>\$48,742,301</b> |

\* Note there is a slight rounding difference in the comparison table above.

Major areas of difference are further described in the following sections.

### **Wells and Facilities**

The amount estimated by ENR is higher due to using a higher unit cost that would likely be required to haul and dispose of well site equipment from the numerous wells located at the production facility, including those on the natural and artificial islands. A contingency amount of 15 % was applied to the IORL lump sum as there was no rationale or basis for the amount proposed by IORL.

ENR's estimated costs associated with these activities is \$47.8 million. IORL's cost estimate was \$42.6 million. Overall, this component accounts for a difference of approximately \$5.1 million dollars, or approximately 10% of the difference between the respective reclamation estimates.

### **Buildings and Equipment**

The amount estimated by ENR for this activity is higher than the IORL estimate as the long haul rate was used rather than the short haul unit rate. ENR notes that the location of the landfill has not been determined yet but will likely be greater than 1500 m away from most of major infrastructure at the production facility. Additionally, IORL did not account for the height of the buildings when calculating the amount/area of the structures. The estimate includes the assumptions that on average buildings are at least 2 stories high.

ENR's estimated costs associated with these activities \$45.2 million. IORL's cost estimate for Buildings and Equipment was \$41.1 million. The difference is \$4.1 million or approximately 8% of the difference.

### **Chemicals and Contaminated Soil Management**

IORL's estimate did not provide any basis for their costing for the Phase 1 Hazardous Materials audit nor the basis for the quantities of hazardous materials from the

mechanical shops and their associated costs. A number of other items included in this component are also unclear and little supporting information has been provided by IORL.

ENR's estimate used a higher unit costs rate for longer haul of contaminated soil to the proposed landfill. Again the location of the landfill has not been determined at this time but it is noted that the distance between the islands and the mainland can be as far as 2 km.

ENR's estimated costs associated with these reclamation activities is \$20.7 million. IORL's estimate was \$16.6 million. Overall, this component accounts for a difference of \$4.1 million dollars, or approximately 8% of the difference between the respective reclamation estimates.

### **Interim Care and Maintenance**

The estimate included a provision for 2 years of monitoring during the interim care and maintenance period whereas IORL has not including monitoring during this period.

ENR's estimated costs associated with these activities is \$6.7 million. IORL's cost estimate was \$5.4 million. Overall, this component accounts for a difference of approximately \$1.2 million dollars, or approximately 2% of the difference between the respective reclamation estimates.

### **Post-Closure Monitoring and Maintenance**

The costs for post-closure monitoring and maintenance is significantly higher than that proposed by IORL. The timeframe for post-closure monitoring in the IORL estimate was limited to 25 years, however, it is unclear if this monitoring period would be sufficient to achieve the reclamation goals for groundwater remediation. Further, the monitoring programs that will be implemented have not been determined and the frequency and term of the monitoring may extend for a much longer period post-closure (e.g. 50+ years).

At present, the SLWB is initiating a process for the development of an Aquatic Effects Monitoring Program that will include project monitoring in the receiving environment and include both upstream and downstream monitoring. This monitoring program will add costs for sample collection, laboratory analyses, report writing, etc. This would be above and beyond any groundwater monitoring programs that would be required on the mainland and the natural islands.

ENR's estimate assumes a flat 3% discount rate (aligns with the discount rate applied by the Federal government in previous reclamation cost estimates). Additionally, the estimate only applies the discount rate (i.e. Net Present Value) for items that are to occur after a period of time post-closure, not those that occur immediately when the reclamation period is initiated. Furthermore, a contingency amount has been applied to the proposed monitoring period to address the potential for monitoring to extend much longer than 25 years after the production facility is closed. A separate contingency amount is added here as contingency in the RECLAIM model is only applied to "direct costs" shown in Table 2. It is possible that a much longer period of groundwater remediation is required to achieve the closure standards for the natural islands and portions of the facilities on the mainland. ENR presumes that discussions will be ongoing as part of the closure and reclamation planning process to determine the appropriate length of the post-closure monitoring period. Geotechnical monitoring and vegetation monitoring will also be required in the post-closure period. For further information and additional rationale for monitoring costs, please see Appendix 1.

ENR's estimated cost associated with post-closure monitoring and maintenance activities is \$23.9 million. IORL's cost estimate was \$8.2 million. Overall, this component accounts for a difference of approximately \$15.7 million dollars, or approximately 32% of the difference between the respective reclamation estimates.

### **Contingency**

IORL increased their contingency percentage in their model to 10% from 5%, which they proposed during earlier meetings and security discussions. However, given the outdated nature of the Closure and Reclamation Plan and the fact that we are only initiating a review of the Closure and Reclamation Plan at this time, ENR is of the opinion that a much higher contingency amount is warranted.

This is further justified as the main remediation measure proposed by IORL is the creation of a Class II Landfill, to handle all contaminated soil from the site. However, the design, location and details of the landfill have not been provided. Further, the long-term requirements for maintenance of the landfill and its potential monitoring and remediation activities have yet to be discussed and determined.

ENR notes that the existing closure and reclamation plan does not contain a sufficient level of detail to directly develop preliminary or budget level estimates and that the verification of the quantities or costs proposed by IORL cannot occur with the level of information presented in IORL's RECLAIM estimate. Thus, ENR's estimate includes a 25% contingency provision. Note this contingency amount would be re-assessed following the provision of an updated and approved Closure and Reclamation Plan.



ENR's contingency amount for the RECLAIM estimate is \$36.3 million. IORL's contingency amount was \$13.6 million. Overall, this component accounts for a difference of approximately \$22.6 million dollars, or approximately 46% of the difference between the respective reclamation estimates.

## **SUMMARY TABLE - ENR's COST ESTIMATE**

ENR has calculated the total reclamation liability for the Norman Wells Production Facility at \$227,063,351. This is comprised of a water related liability of \$35,435,551 and a land related liability of \$191,627,801. Full details of the land/water split are included in the Summary Table outlined in Table 2, below.

Table 2: ENR's Estimate Of Reclamation Liability – IORL Norman Wells

| CAPITAL COSTS  |  | COMPONENT NAME                             | COST                 | LAND LIABILITY       | WATER LIABILITY     |
|----------------|--|--|----------------------|----------------------|---------------------|
|                |  | WELLS AND FACILITIES                       | \$47,817,087         | \$47,817,087         | \$0                 |
|                |  | BUILDINGS AND EQUIPMENT                    | \$45,245,889         | \$45,245,889         | \$0                 |
|                |  | CHEMICALS AND CONTAMINATED SOIL MANAGEMENT | \$20,717,805         | \$20,717,805         | \$0                 |
|                |  | CONSTRUCTION OF ONSITE LANDFILL            | \$18,650,000         | \$18,650,000         | \$0                 |
|                |  | SURFACE AND GROUNDWATER MANAGEMENT         | \$6,309,975          | \$0                  | \$6,309,975         |
|                |  | INTERIM CARE AND MAINTENANCE               | \$6,787,503          | \$4,072,502          | \$2,715,001         |
|                | <a href="#">Update Ownership Percentages</a> | <b>SUBTOTAL: Capital Costs</b>             | <b>\$145,528,259</b> | <b>\$136,503,283</b> | <b>\$9,024,976</b>  |
|                |  | <b>PERCENT OF SUBTOTAL</b>                 |                      | <b>93.80%</b>        | <b>6.20%</b>        |
| INDIRECT COSTS |  |  | COST                 | LAND LIABILITY       | WATER LIABILITY     |
|                |  | MOBILIZATION/DEMOBILIZATION                | \$3,008,630          | \$2,822,049          | \$186,581           |
|                |  | POST-CLOSURE MONITORING AND MAINTENANCE    | \$23,931,505         | \$1,093,233          | \$22,838,272        |
|                |  | ENGINEERING                                | 5% \$7,276,413       | \$6,825,164          | \$451,249           |
|                |  | PROJECT MANAGEMENT                         | 5% \$7,276,413       | \$6,825,164          | \$451,249           |
|                |  | HEALTH AND SAFETY PLANS/MONITORING & QA/QC | 1% \$1,455,283       | \$1,365,033          | \$90,250            |
|                |  | BONDING/INSURANCE                          | 1% \$1,455,283       | \$1,365,033          | \$90,250            |
|                |  | CONTINGENCY                                | 25% \$36,382,065     | \$34,125,821         | \$2,256,244         |
|                |  | MARKET PRICE FACTOR ADJUSTMENT             | 0% \$0               | \$0                  | \$0                 |
|                | <a href="#">View</a>                         | INFLATION ADJUSTMENT                       | 0.52% \$749,502      | \$703,021            | \$46,481            |
|                |  | <b>SUBTOTAL: Indirect Costs</b>            | <b>\$81,535,093</b>  | <b>\$55,124,518</b>  | <b>\$26,410,575</b> |
|                |  | <b>TOTAL COSTS</b>                         | <b>\$227,063,351</b> | <b>\$191,627,801</b> | <b>\$35,435,551</b> |

**RECOMMENDATION**

***ENR recommends that the amount of security required for the Norman Wells Production Facility is \$227,063,351. This is comprised of a water related liability of \$35,435,551 and a land related liability of \$191,627,801.***

**Appendix 1**  
**ARKTIS Solutions Incorporated Technical Memo**  
**Imperial Oil Limited, Norman Wells Operations – RECLAIM Financial Security**  
**Estimate**



| <b>TECHNICAL MEMORANDUM</b> |  |
|-----------------------------|--|
| <b>File:</b>                | <b>2014-GNWT</b>   |
| <b>To:</b>                  | <b>Government of the Northwest Territories, Environment and Natural Resources</b>          |
| <b>Attention:</b>           | <b>Nathen Richea, Manager, Water Regulatory Division</b>                                   |
| <b>Subject:</b>             | <b>Imperial Oil Limited, Norman Wells Operations – RECLAIM Financial Security Estimate</b> |
| <b>Author:</b>              | <b>Jamie VanGulck, Ph.D., P.Eng., Chief Technical Officer</b>                              |
| <b>Page Total:</b>          | <b>18 plus appendices</b>  |
| <b>Date:</b>                | <b>October 21, 2014</b>  |

## 1.0 INTRODUCTION

The Government of the Northwest Territories (GNWT) has contracted ARKTIS Solutions Inc. (ARKTIS) to provide technical advisory and support regarding Imperial Oil Limited’s (IOL) financial security estimate for the Normal Wells Operation (herein after referred to as the “Project”). ARKTIS and the GNWT have participated in four meetings with IOL and other stakeholders that hold interests in this Project, including: Aboriginal Affairs and Northern Development Canada (AANDC) and the Sahtu Land and Water Board (SLWB).

The first meeting was held on July 24, 2014, where IOL provided an overview of the Project and discussion on the security estimate approach. During the second meeting on August 13, 2014, IOL presented their basis for cost estimate draft report. The working draft security estimate was discussed at the August 28, 2014 meeting. A summary of technical review comments from the August 13, 2014<sup>1</sup> and August 28, 2014<sup>2</sup> meetings were provided by the GNWT to IOL. As an outcome from the August 28, 2014 meeting, the GNWT requested the working draft of the RECLAIM model, used by IOL for their cost estimate, for further review. IOL provided this information on September 02, 2014 and technical review comments were provide by the GNWT to IOL on September 11, 2014<sup>3</sup>. A forth meeting was held on September 18, 2014 during which IOL’s updated security estimate and responses to the September 11, 2014 technical review were discussed.

As required by IOL’s Water Licence (S13L1-007), a security estimate for the Project was submitted to the SLWB on September 26, 2014<sup>4</sup>. Further to the SLWB’s Work Plan<sup>5</sup>, Intervener comments on the security

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<sup>1</sup> ARKTIS Solutions Inc. August 14, 2014 memorandum to the Government of the Northwest Territories titled “Imperial Oil Limited, Norman Wells Operations – Basis of Cost Estimate”.

<sup>2</sup> ARKTIS Solutions Inc. September 2, 2014 e-mail to the Government of the Northwest Territories titled “IOL Security Meeting Aug 28”.

<sup>3</sup> ARKTIS Solutions Inc. September 11, 2014 memorandum to the Government of the Northwest Territories titled “Imperial Oil Limited, Norman Wells Operations – September 2, 2014 Draft RECLAIM Submittal”.

<sup>4</sup> AMEC (2014). Abandonment and Reclamation Cost Estimate for Norman Wells Operations.



estimate are to be submitted to the SLWB by October 24, 2014. The purpose of this Memorandum is to present ARKTIS' financial security estimate for the Project. This Memorandum is provided to the GNWT for their consideration in issuance to the SLWB as part of their intervention submission.

ARKTIS' review is limited and primarily based on the information presented in AMEC (2014). Further, the current version of the closure and reclamation plan<sup>6</sup> for the Project was developed in 2003 and does not contain the level of detail to verify site infrastructure details (e.g., components and quantities) or a description of the reclamation activity, objectives and criteria for each Project component. The AMEC (2014) report has provided select components of the above mentioned items; however, many information gaps exist which would typically be addressed in a closure and reclamation plan. IOL has provided dollar values for reclamation by component but has not provided supporting documentation or rationale for the dollar values chosen in many instances. Further, many of these dollar values are low when compared to that included in the RECLAIM model or those used by other industrial projects in the north.

This Memorandum is organized as follows:

- Section 2.0 outlines the methodologies and assumptions to develop the reclamation security estimate.
- Section 3.0 presents the analysis and results of the reclamation security estimate.
- Section 4.0 summarizes the recommendations.
- Section 5.0 provides a disclaimer for the contents of the report and closure of the document.

## 2.0 METHODOLOGY

The reclamation security estimate has been developed utilizing a modified version of RECLAIM v7 oil and gas model. The model coding has not been verified by ARKTIS. The security estimate was completed in general accordance with the "Mine Site Reclamation Policy for the Northwest Territories" (AANDC, 2002<sup>7</sup>). Select principles with respect to sustainable resource development include:

- Adequate security is to be provided to ensure the cost of reclamation, including shutdown, closure and post-closure, is born by the operator of the Project.
- Following closure, companies or their future owners will continue to be responsible for the site, including the remediation of any environmental complication that may develop.
- Every operation will, at all times, have a closure and reclamation plan, which includes measures to be taken in the event of a temporary closure.
- Estimates of reclamation costs in reclamation security determination are to be based on the cost of having the necessary reclamation work completed by a third party contractor if the operator defaults. The estimates should also include contingency factors that are reflective of the reclamation undertaken.

The approach taken in preparing this reclamation security estimate generally involved the following:

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<sup>5</sup> Sahtu Land and Water Board September 26, 2014 notice titled "Updated Work Plan for Water Licence Renewal Application Imperial Oil Resources – Norman Wells Operation".

<sup>6</sup> Imperial Oil Limited (2003). Abandonment and Restoration Plan.

<sup>7</sup> Aboriginal Affairs and Northern Development Canada (2002). Mine Site Reclamation Policy for the North



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- Participation in meetings with IOL and technical review of IOL's draft security estimate documentation.
- Review of IOL's security estimate<sup>4</sup> and closure and reclamation plan<sup>6</sup> submitted to the SLWB.
- Assess the proposed reclamation activities for completeness and potential for success.
- Where there is uncertainty in the reclamation activities or if they were not present, the reclamation activities were selected based on author experience.
- Calculate the reclamation security estimate from direct and indirect costs.

The reclamation security amount for the Project was calculated from the sum of the direct costs and indirect costs associated with the Project. The reclamation security estimate is based on the information available at the time of this report development.

The following general approach was used to develop the direct costs:

- The Project was separated into reclamation components and categorized as follows:
  - Wells and facilities
  - Buildings and equipment
  - Construction of on-site landfill
  - Chemicals
  - Water Management
  - Interim care and maintenance
- For each reclamation component, the reclamation actions required to achieve the closure objective were selected.
- For each reclamation action, a quantity was specified and a unit cost was selected using the RECLAIM v7 costing database or based on experience.
- The reclamation security amount associated with each reclamation action was calculated as the product of the quantity and unit cost.
- The reclamation security amount for each reclamation component was calculated as the sum of the reclamation security amount for each reclamation activity.

The indirect costs were calculated as the sum of the following categories (as presented in the RECLAIM v7 model).

- Mobilization/demobilization
- Post-closure and monitoring and maintenance
- Engineering
- Project management
- Health and safety plans/ monitoring and quality assurance (QA)/ quality control (QC)
- Bonding / insurance
- Contingency

The RECLAIM v7 unit costs are reflective of 2013 Canadian dollars. An inflation adjustment was applied to direct costs to transform the estimate into 2014 Canadian dollars. For each direct and indirect budget line item, an estimate of the land and water liability split was applied.

## 2.1 Assumptions

The reclamation security estimate also applies the following assumptions:



- Any modifications to the site during operations or changes in closure planning were not considered.
- All costs are considered to be 2014 Canadian dollars. Net present value calculations have been conducted on longer term cost items (i.e., over 20 years beyond the cessation of operations). A discount rate of 3.0%<sup>8</sup> has been utilized on any items extending beyond 20 years after cessation of mining.
- There are no revenues from recovery of assets.
- There is no credit applied for progressive reclamation undertaken at the site.
- All work is based on independent third party contractor rates.
- There are no PCBs in the electrical equipment, radioactive sources for process control, lead-based painted surfaces, asbestos insulation or fibre-board on the site.
- Sufficient quantities and required qualities of the required earthen materials will be found in the area of the site.
- The AMEC (2014) custom unit rates used in a number of the costing line items are reflective of the remote northern location of the site and for the oil & gas extraction industry.
- This report utilizes the RECLAIM V 7 model and its unit rates unless none are available or more site relevant rates were available. The selection to use the low, high or specified unit rate for a particular line item was made by the author.
- The estimate does not include cost for catastrophic events such as failure of project infrastructure.

## 2.2 Direct Costs Assumptions and End of Life Status

The following sections provide a summary of the assumptions and end of life status that were applied to each primary mine component.

### 2.2.1 Wells and Facilities

- IOL applied a single cost of \$135,776 to the Hauling & Disposal of Well Site Equipment line item. The basis for the number is uncertain for it utilized the RECLAIM SC3H code (excavate soil/load/haul/spread/compact). The abandonment cost of the line items for the remainder of the items within the Abandonment of Wells section totalled over \$35,000,000; thus, ARKTIS considered the \$135,776 to be an unlikely cost for the Hauling & Disposal of Well Site Equipment. Without getting into detailed calculations to determine an accurate number, a provision of 15% of the \$35,000,000 cost (i.e., \$5,250,000) is considered more appropriate and applied herein.
- It is unclear why IOL applied the RECLAIM SC3H code (excavate soil/load/haul/spread/compact) instead of RECLAIM pipe costing code to the Above Ground Flowline line item. The item was re-costed using IOL's "flowline" sheet and summing all the above ground piping to arrive at 27,730 m at a unit cost of \$1/m (RECLAIM PSRL code) assuming the vast majority of the above ground piping is <6" diameter.

### 2.2.2 Buildings and Equipment

- IOL's sources for the Unit Costs for decontaminating the mechanical shop fluids and general decontamination are unknown, but have been retained herein. There is high uncertainty regarding the quantity and associated units of mandays; however without further information it is challenging to assess further. It is unclear which project components (e.g., facilities, buildings, etc.) have been included in the decontamination costs. ARKTIS has assumed that the

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<sup>8</sup> Discount rate obtained from GNWT.

decontamination costs include the activities associated with abandonment of facilities, and therefore the reason IOL did not apply the RECLAIM cost to abandon site facilities (e.g., batteries) within the “Wells and Facilities” RECLAIM category.

- The \$15,000 unit cost applied by IOL to decontaminate each fuel storage tank is not supported with any rationale, but has been accepted herein.
- The conversion of tanks size to volumes of steel and then applying a factor of \$500/tonne has not been seen by the author before and his knowledge of the RECLAIM costing model. However, due to the significant effort put forward by AMEC in using this method, it has been accepted.
- The “Tanks” worksheet does not differentiate the tanks according to the products it contained (i.e., different extracts from the wells, water, etc.). The AMEC costing appears to assume all the tanks stored petroleum products, and this has been accepted herein.
- Building reclamation quantities need to be adjusted to account for building heights. IOL’s approach was to assume a single story building, which is incorrect use of the RECLAIM model (although the section heading states that building heights have been factored in, the area numbers are identical to those utilized in the Break Basement Slabs section). It is necessary to incorporate the building heights. With this information not provided, the costing herein assumes the buildings are an average of 2 stories in height.
- The source of the data for the 57 m<sup>2</sup> of Freshwater Intake structures is not well identified by IOL. It appears to come from the listing of all the buildings, with lengths and widths to determine surface area, but again with no factor for heights.
- The RECLAIM Costing Code for the breaking of concrete foundation slabs (BRC) has been changed from LOW to HIGH in the ARKTIS estimate in recognition of the heavy gauge slabs that are likely utilized.
- The unit cost for removal of piles is shown as \$2,000. This is based on the amount of effort required, although each pile is assumed to have a volume of 0.5 m<sup>3</sup>. Additional information on the piles (locations, size, etc.) would reduce the uncertainty associated with this costing.
- The Cost Code for removal of demolition debris has been raised from SC3H to SC4H in the ARKTIS estimate in recognition of this difficult material and accesses to recover the materials and haul them to the site landfill.
- No costing has been provided for grading and contouring of the areas after structures have been removed and wells and all contaminated soils removed. A provision has been added utilizing the same area as is proposed for revegetation (120 ha) and a unit rate (\$20,000/ha) for dozer work, as a first, initial estimate.
- The AMEC (2014) unit price for vegetation of the disturbed areas and roadways has a note that it is based on the Alberta Energy Regulator Directive 11, and has therefore been accepted.

### 2.2.3 Chemicals

- IOL provided no basis for the costing for the Phase 1 Hazardous Materials audits. However the unit cost has been accepted herein, as it appears reasonable.
- IOL provided no basis for the quantities of hazardous materials from the mechanical shops and laboratories nor is there any basis for the AMEC (2014) unit cost of \$12,000/tonne to deal with these materials. Due to the higher unit cost number provided it has been assumed that this costing includes not only the consolidation of these materials for removal (as stated in the section heading) but also for their transportation and disposal in a licensed facility (and therefore not included as a separate line item).
- The RECLAIM Phase I/II Environmental Investigation cost is \$25,000 but is based on a “Low, small, “clean”, site”. This has been accepted herein as the cost is adjusted utilizing AMEC (2014) Table C-2 with an Environmental Assessment Factor that considers the subject sites and their relative complexity, with a range of prices from \$6,250 to \$50,000 per investigation. ARKTIS notes that it is unclear if the entire Project site (i.e., entire lease area) has been assessed for potential or actual contamination, or if only select Project areas have been assessed in this



regards. If the subject sites were selected on an incomplete assessment of the entire Project area, then the reclamation costing reported herein would be undervalued.

- The RECLAIM Cost Code for removal of contaminated soils has been raised from SC3H to SC4H herein in recognition that this is a more complex operation than a bulk excavation of loose clean materials for use in reclamation work. It is understood that the estimated quantity of contaminated soils originates in the Worley Parsons report (2014). This report was not available to ARKTIS at time of report preparation and therefore the quantity of contaminated soil used in IOL's estimate is uncertain.
- IOL provided no basis for the 24 ha of sump areas to be reclaimed, nor whether these sumps also require emptying, decontamination and refilling with clean soils. This area suggests the sumps cover an area equal to 15.5% of the total disturbed area of 152.19 ha, which is considered reasonable.
- IOL provided no basis for the total area of slurry wall to be constructed to enclose areas with on-going contamination, which is listed as being limited to only the Mainland and Bear Island areas. A unit price of \$75/m<sup>2</sup> for the slurry wall unit has been provided by AMEC (2014) without any rationale. This price appears very low to the author, based on a limited dataset to compare to, but it has not been changed in the ARKTIS estimate. For comparison, based on a 1996 report, Pearlman (1999)<sup>9</sup> reported a unit price of \$54 to \$75/m<sup>2</sup> and it was noted that the costing is dependent on the site conditions, type of slurry/backfill, depth, clean up of spoils and treatment of spoils. It is unknown the number of studies reviewed to develop the literature reported cost range, but it is likely that the locations are not subject to large mobilization fees for the backfill amendment. Further, the costing is US dollars and has not been adjusted for inflation. Thus, ARKTIS considers IOL's costing to be low and the uncertainties warrant a higher contingency.
- IOL applied a lump sum of \$100,000 for Occupational Health and Safety (OH&S) Department without any rationale. It has been assumed this is intended to cover the cost for an OH&S professional to be present during the active reclamation. Based on this and the estimated 2 years to undertake the program, the quantity has been raised from 1 year to 2 years.
- Removal of 8 tonnes of non-hazardous materials under the Chemical/Soils worksheet has been included. IOL has provided no basis in support of this number and the Cost Code applied is an AMEC (2014) unit cost, not a RECLAIM unit cost. ARKTIS' preliminary conclusion is that the quantity is very low, but it is unclear what it is intended to include. Thus, there is uncertainty regarding the reclamation activity and cost, which warrants a higher contingency.
- IOL provided no basis for selection of backfill volumes in excavations (i.e., 25% of soil excavated). The closure objective and criteria are unknown for this Project component but is assumed the reclamation will not result in ponding and the areas contoured to resemble natural conditions.

#### 2.2.4 Construction and operation of onsite landfill

- IOL landfill costing included capital and operation and maintenance (O&M). ARKTIS kept the capital cost to remain in the onsite landfill category and moved the O&M costs to post-closure monitoring and maintenance. Landfill capital costs were applied to the Construction of Onsite Landfill category.
- ARKTIS has assumed that a quarry for construction materials will be located in a short haul distance from the Project site and that the quarry materials will not create acid rock drainage or

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<sup>9</sup> Pearlman, L. (1999). Subsurface Containment and Monitoring Systems: Barriers and Beyond (Overview Report). Report prepared for the U.S. Environmental Protection Agency.



metal leaching fluids. IOL's report was silent on the location of the source construction materials and the volume of material required for construction.

## 2.2.5 Water Management

IOL allocated an "allowance" to remediate groundwater in three Mainland areas. The reclamation activity is stated to be similar to that employed at the Project. An updated closure and reclamation plan that summarizes the closure activity, objectives and criteria would assist to confirm if this is a reasonable assumption to apply to other site areas. Although not available at this time, a consolidation of the findings from site assessments and soil or groundwater results for the Project within an updated closure and reclamation plan would also assist in confirming IOL's assumption that only three areas require groundwater remediation.

IOL security estimate provided an "allowance" to complete all aspects of groundwater remediation based on estimates developed by a third party. The reclamation activities associated with the cost "allowance" are not described in IOL's cost estimate or the closure and reclamation plan. Without a description of the reclamation activities, or a detailed cost breakdown (i.e., not a lump sum or "allowance") it is uncertain if IOL's estimate is adequate. ARKTIS concludes that the groundwater remediation method to calculate security has not been rationalized by IOL and therefore is open to interpretation. Further definition of the reclamation activities is an initial step towards reducing this large uncertainty, in addition to, defining the extent of actual or potential contamination.

IOL's groundwater remediation "allowance" ranges from about \$3,100,000 to \$5,100,000 for a 25 year operation, which is comprised of a total capital and decommissioning costs range about \$800,000 to \$2,900,000 and operation costs range of about \$133,000 to \$146,000 per year. The IOL report is silent on how duration of 25 years was selected and if this duration was based on the time required to achieve the reclamation criteria. ARKTIS considers a 25 year period for groundwater remediation to be unsubstantiated and could be longer in duration (e.g., 50 to 100 years). ARKTIS notes that the time for treatment is a function of numerous factors, which at this time are unknown, including but not limited to: type of contaminant of concern, extent of contamination, location and quantity of source of contaminant (i.e., above or below the water table, within bedrock, etc.), site hydrogeology, design of the pump and treat system, type of treatment, and the reclamation criteria. A higher contingency is therefore justified to address the uncertainty regarding this line item.

To assess the reasonableness of IOL's costing, without further information ARKTIS assumed that the reclamation activity for groundwater remediation employed a conventional pump and treat system. Using costing data published by the United States Environmental Protection Agency (USEPA)<sup>10</sup>, the capital and operating costs (1999 US\$) of a pump and treatment site is summarized in the following table. The USEPA costs are based on 32 pump and treat sites, which vary in, but not limited to: scale, treatment, duration of operation, and type of contaminant of concern. IOL's "allowance" for groundwater remediation is within the USEPA median calculated costs and is 1.9 to 3.1 times lower than the USEPA average. Note this calculation does not account for Canadian to US dollar conversion, or inflation on the 1999 USEPA costing data. ARKTIS considers IOL's groundwater remediation costing to be low based on the comparison to the USEPA data and the remote nature of the site in comparison to the USEPA sites from which the costing was derived. Further, the IOL's reclamation activity, criteria and duration of reclamation are unknown which results in uncertainty in the costing. ARKTIS made no change to reclamation cost for groundwater remediation; however, the uncertainty was considered in the selection of contingency.

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<sup>10</sup> United States Environmental Protection Agency. Cost Analyses for Selected Groundwater Cleanup Projects: Pump and Treat Systems and Permeable Reactive Barriers.



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| Cost Category   | 25 <sup>th</sup> Percentile | Median      | 75 <sup>th</sup> Percentile | Average     |
|---|-----------------------------|-------------|-----------------------------|-------------|
| Years of system operation                             | 4                           | 5           | 8                           | 6           |
| Total capital costs (1999 US\$)                       | \$1,700,000                 | \$2,000,000 | \$5,900,000                 | \$4,900,000 |
| Average operating costs per year (1999 US\$)          | \$180,000                   | \$260,000   | \$730,000                   | \$770,000   |
| Calculated total operating costs (using USEPA data)   | \$720,000                   | \$1,300,000 | \$5,840,000                 | \$4,620,000 |
| Sum of capital and operating costs (using USEPA data) | \$2,420,000                 | \$3,300,000 | \$11,740,000                | \$9,520,000 |

\* From USEPA<sup>10</sup>

ARKTIS applied IOL's capital costs for Groundwater Remediation (\$5,401,990) and Groundwater Characterization and Monitoring (\$907,985) to the Surface and Groundwater Management category in the RECLAIM model. The O&M costs for Groundwater Remediation and Groundwater Characterization and Monitoring were applied to the Post-Closure and Monitoring and Maintenance category in the RECLAIM model.

IOL's operations and maintenance cost for Groundwater Remediation included discounting the costs to present day value for a 25 year duration activity. As per GNWT approach, discounting should only be applied to activities occurring for duration longer than 20 years; therefore no discounting occurs for the first 20 years an activity is completed ARKTIS' calculation follows the GNWT approach. ARKTIS' groundwater remediation O&M costs are shown in the following table. ARKTIS applied the groundwater remediation O&M costs are applied in the post-closure monitoring and maintenance category.

No surface water management costs were included in IOL's estimate, which contradicts IOL's costing report that states the post-closure monitoring includes surface water quality and groundwater (Section 4.8). Thus, it is assumed herein that during post-closure, water that has a quality that exceeds discharge criteria to the environment would be collected from their source location and transported to an existing injection well for disposal in the underground reservoir. Surface water that may require management during post-closure includes but are not limited to:

- Water in sumps post-operations
- Water in sumps during reclamation activities or until quality is acceptable for discharge directly to the environment
- Landfill leachate
- Biocell contact water

The practice of deep well injection of water is a current practice of the Project. An updated closure and reclamation plan would assist in setting the acceptable discharge criteria for site surface water and groundwater, as well as, ensuring this reclamation activity can be accommodated with the reclamation schedule for the Project. For example, if a small number of deep injection wells remain open for a 25 year period and all other wells reclaimed during the initial reclamation period, consideration needs to be given to mobilize resources to reclaim the remaining deep injection wells. It is unknown if this has been considered in IOL's costing estimate, which results in further uncertainty for this reclamation cost. A higher contingency is therefore justified to address this uncertainty.



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| Phase            | Year |    | Groundwater Remediation | Discounted Value   |
|------------------|------|----|-------------------------|--------------------|
| ICM              | 1    | 1  | 0                       | \$-                |
| ICM              | 2    | 2  | 0                       | \$-                |
| Reclamation      | 3    | 1  | \$413,722               | \$413,722          |
| Reclamation      | 4    | 2  | \$413,722               | \$413,722          |
| Post-Reclamation | 5    | 1  | \$413,722               | \$413,722          |
| Post-Reclamation | 6    | 2  | \$413,722               | \$413,722          |
| Post-Reclamation | 7    | 3  | \$413,722               | \$413,722          |
| Post-Reclamation | 8    | 4  | \$413,722               | \$413,722          |
| Post-Reclamation | 9    | 5  | \$413,722               | \$413,722          |
| Post-Reclamation | 10   | 6  | \$413,722               | \$413,722          |
| Post-Reclamation | 11   | 7  | \$413,722               | \$413,722          |
| Post-Reclamation | 12   | 8  | \$413,722               | \$413,722          |
| Post-Reclamation | 13   | 9  | \$413,722               | \$413,722          |
| Post-Reclamation | 14   | 10 | \$413,722               | \$413,722          |
| Post-Reclamation | 15   | 11 | \$413,722               | \$413,722          |
| Post-Reclamation | 16   | 12 | \$413,722               | \$413,722          |
| Post-Reclamation | 17   | 13 | \$413,722               | \$413,722          |
| Post-Reclamation | 18   | 14 | \$413,722               | \$413,722          |
| Post-Reclamation | 19   | 15 | \$413,722               | \$413,722          |
| Post-Reclamation | 20   | 16 | \$413,722               | \$229,068          |
| Post-Reclamation | 21   | 17 | \$413,722               | \$222,396          |
| Post-Reclamation | 22   | 18 | \$413,722               | \$215,918          |
| Post-Reclamation | 23   | 19 | \$413,722               | \$209,630          |
| Post-Reclamation | 24   | 20 | \$413,722               | \$203,524          |
| Post-Reclamation | 25   | 21 | \$413,722               | \$197,596          |
| Post-Reclamation | 26   | 22 | \$413,722               | \$191,841          |
| Post-Reclamation | 27   | 23 | \$413,722               | \$186,253          |
| Post-Reclamation | 28   | 24 | \$413,722               | \$180,828          |
| Post-Reclamation | 29   | 25 | \$413,722               | \$175,561          |
| <b>Total</b>     |      |    | <b>\$11,170,494</b>     | <b>\$9,045,889</b> |

## 2.2.6 Interim Care and Maintenance

IOL's costing provides for 4 pickup trucks at a cost of \$10,000/yr for each truck, this equates to a cost of \$833/mo which is too low a cost for rental or lease of such a vehicle in this northern location. A more reasonable figure is \$2,000/mo and this number has therefore been utilized herein.

In addition to IOL's activities for interim care and maintenance (ICM), ARKTIS has applied a cost to address monitoring during the 2 year ICM period. IOL does not include a monitoring cost during the ICM period. The ICM monitoring costs assumes a full-scale monitoring program during this period. A full description of the ICM monitoring program and costs are detailed within Section .



## 2.3 Indirect Costs Assumptions and End of Life Status

The following indirect fee percentages were applied to the estimate. The fee percentages for each of the following indirect items are typical in the Northwest Territories or based on GNWT input.

- Engineering – 5%
- Project management - 5%
- Health and safety plans / monitoring & quality assurance / quality control – 1%
- Bonding / insurance – 1%

Mobilization and demobilization, post closure monitoring and maintenance and contingency are discussed in the following section in greater detail.

### 2.3.1 Mobilization and Demobilization

- IOL does not include a cost to construct and operate an ice bridge to access the islands from the Mainland area during reclamation. ARKTIS assumed that reclamation equipment to/from the island and demobilized items from the islands will be via an ice bridge during the reclamation period. A cost for this transportation corridor is included in the cost estimate.
- Based on IOL's estimate of 44 flights required to mobilize and demobilize workers, ARKTIS assumed 22 flights per year for a crew of 20 people per flight. For an average of 20 people per rotation, 616 person days per year (22 flights per year x 2 week rotation x 14 days per rotation) is the resource requirement. For a 2 year reclamation activity, this totals 1,232 person days. IOL did not include any accommodation or per diem for the mobilized workers. ARKTIS assumed a camp would be utilized for worker accommodations (all inclusive) using the RECLAIM cost code ACCMH. ARKTIS considered an onsite camp to be more cost effective than utilizing existing accommodations in Norman Wells.
- ARKTIS assumed that any waste fuel that remained in the fuel tanks at time of reclamation would be disposed of by deep well injection and therefore no demobilization fee is applied for this item.
- IOL applied a reclamation fleet 32 items to be used during reclamation. ARKTIS considered this fleet size to be reasonable.
- IOL cost estimate does not include the cost to mobilize fuel to site for the reclamation equipment. The RECLAIM unit costs for equipment are inclusive of fuel and therefore the purchase price of fuel need not be added to the costing. Provided in the following table is ARKTIS' estimate of the fuel usage in a single year. ARKTIS assumed fuel to be mobilized to site via barge and therefore the lower end RECLAIM unit cost of \$0.22/L.

| Description                                   | Quantity Required | Consumption (L/day) | Total Fuel (L/d) |
|---|-------------------|---------------------|------------------|
| Service rigs                                  | 3                 | 200                 | 600              |
| Excavators                                    | 4                 | 200                 | 800              |
| Dump trucks                                   | 6                 | 100                 | 600              |
| Dozers  | 4                 | 200                 | 800              |
| Demolition shears                             | 2                 | 200                 | 400              |
| Crane   | 1                 | 100                 | 100              |
| Loader  | 4                 | 200                 | 800              |
| Light duty vehicles                           | 8                 | 50                  | 400              |
| <b>Total per day</b>                          |                   |                     | <b>4500</b>      |
| <b>Total per year (309 days x 75% in use)</b> |                   |                     | <b>1,042,875</b> |



## 2.3.2 Post-Closure Monitoring and Maintenance

### Landfill Operation and Maintenance

IOL allocated an “allowance” to account for landfill O&M costs based on a \$50,000 unit price allocated each year for 25 years. IOL’s estimate states that the on-site landfill will require physical conditioning and leachate monitoring; however, the specifics (schedule and program) of these reclamation activities are not detailed. Further, IOL’s estimate is silent on the selection of a 25 year period for monitoring and maintenance and if this duration is reasonable to achieve the reclamation criteria. ARKTIS considers a 25 year period for landfill O&M to be unsubstantiated and could be longer in duration (e.g., 50 to 100 years). A higher contingency is therefore justified to address this uncertainty. Note, the current water licence does not permit the use of a landfill for reclamation and no criteria have been established with regards to reclamation of this Project component. An updated closure and reclamation plan would assist in addressing these uncertainties. For this activity to occur, it would first need to be accounted for in the Project’s Water Licence.

IOL’s on-site landfill is to be constructed to a Class II facility. ARKTIS assumes this is a Class II landfill as defined by Alberta Environment<sup>11</sup>, which requires a liner and leachate collection system. The liner is assumed to be synthetic (i.e., geomembrane) since no on-site reconnaissance has been presented by IOL that sources an alternate low permeability material local to the Project site. Geomembranes have a service life and there is potential that this duration may be shorter than the time required for active landfill management (i.e., leachate collection and treatment). Thus, there is an uncertainty that the on-site landfill liner may degrade and additional management of the waste will be required in the future. If a new landfill was required in the future this could result in an increase in security above that addressed herein. Note that IOL’s capital cost of the landfill is set at \$18,650,000.

ARKTIS notes that the landfill design and location has not been determined at this time by IOL. In addition to engineering design of the facility, select other aspects that required consideration in reclamation costing for this Project component include: site reconnaissance and engagement to select location, identification of source construction materials and material extraction operations and closure, and construction.

IOL’s landfill operations and maintenance cost included discounting the costs to present day value for a 25 year duration activity. As per GNWT approach, discounting should only be applied to activities occurring for duration longer than 20 years; therefore no discount rate occurs for the first 20 years an activity is completed. ARKTIS’ calculation follows the GNWT approach and shown in the following table.

IOL’s security estimate for the landfill operation and maintenance cost was based on an estimate developed by a third party; however the scope of work that formed the basis for this reclamation activity is not provided. Without a description of the reclamation activities, or a detailed cost breakdown, it is uncertain if IOL’s estimate is adequate. An updated closure and reclamation plan would partially assist in addressing these uncertainties. A breakdown of IOL’s cost estimate would further reduce the uncertainty.

As a result of the uncertainties addressed above and without an updated closure and reclamation plan to address the reclamation activity, objectives and criteria, a higher contingency is therefore justified.

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<sup>11</sup> Alberta Environment (2010). Standards for Landfills in Alberta.



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| Phase            | Year |    | Landfill O&M       | Discounted Value   |
|------------------|------|----|--------------------|--------------------|
| ICM              | 1    | 1  | \$-                | \$-                |
| ICM              | 2    | 2  | \$-                | \$-                |
| Reclamation      | 3    | 1  | \$50,000           | \$50,000           |
| Reclamation      | 4    | 2  | \$50,000           | \$50,000           |
| Post-Reclamation | 5    | 1  | \$50,000           | \$50,000           |
| Post-Reclamation | 6    | 2  | \$50,000           | \$50,000           |
| Post-Reclamation | 7    | 3  | \$50,000           | \$50,000           |
| Post-Reclamation | 8    | 4  | \$50,000           | \$50,000           |
| Post-Reclamation | 9    | 5  | \$50,000           | \$50,000           |
| Post-Reclamation | 10   | 6  | \$50,000           | \$50,000           |
| Post-Reclamation | 11   | 7  | \$50,000           | \$50,000           |
| Post-Reclamation | 12   | 8  | \$50,000           | \$50,000           |
| Post-Reclamation | 13   | 9  | \$50,000           | \$50,000           |
| Post-Reclamation | 14   | 10 | \$50,000           | \$50,000           |
| Post-Reclamation | 15   | 11 | \$50,000           | \$50,000           |
| Post-Reclamation | 16   | 12 | \$50,000           | \$50,000           |
| Post-Reclamation | 17   | 13 | \$50,000           | \$50,000           |
| Post-Reclamation | 18   | 14 | \$50,000           | \$50,000           |
| Post-Reclamation | 19   | 15 | \$50,000           | \$50,000           |
| Post-Reclamation | 20   | 16 | \$50,000           | \$27,684           |
| Post-Reclamation | 21   | 17 | \$50,000           | \$26,877           |
| Post-Reclamation | 22   | 18 | \$50,000           | \$26,095           |
| Post-Reclamation | 23   | 19 | \$50,000           | \$25,335           |
| Post-Reclamation | 24   | 20 | \$50,000           | \$24,597           |
| Post-Reclamation | 25   | 21 | \$50,000           | \$23,880           |
| Post-Reclamation | 26   | 22 | \$50,000           | \$23,185           |
| Post-Reclamation | 27   | 23 | \$50,000           | \$22,509           |
| Post-Reclamation | 28   | 24 | \$50,000           | \$21,854           |
| Post-Reclamation | 29   | 25 | \$50,000           | \$21,217           |
| <b>Total</b>     |      |    | <b>\$1,350,000</b> | <b>\$1,093,233</b> |



## **Groundwater Characterization and Monitoring**

IOL's security estimate for the groundwater characterization and monitoring cost was based on an estimate developed by a third party; however the scope of work that formed the basis for this reclamation activity is not provided. Without a description of the reclamation activities, or a detailed cost breakdown it is uncertain if IOL's estimate is adequate.

IOL's post closure monitoring within Table C-10 of the cost estimate is focused on groundwater monitoring; however, Section 4.8 of IOL's report states the estimate includes surface water and groundwater remediation systems. The report is silent on the details regarding location of sampling and the purpose of the monitoring.

Post-closure water quality monitoring may be required to fulfill, but not limited to, the aquatic effects monitoring program (AEMP), and the surveillance network program (SNP) as required by the Water Licence, or demonstrate success of a reclamation activity. ARKTIS assumed IOL's operations costs for groundwater characterization and monitoring is adequate to address the monitoring requirements for the AEMP and SNP; however, ARKTIS notes that IOL does not mention the SNP or AEMP monitoring programs in their report. Thus, a post-closure the SNP and AEMP cost of \$406,732/yr was applied for the 2 year ICM period, the 2 year reclamation period, and also years 1 to 15 after reclamation. A cost of \$203,365/yr was applied from years 16 to 25.

## **Post Closure Monitoring Program**

In addition to post-closure water quality monitoring, IOL's report is silent on any requirements to monitor revegetation, geotechnical inspections, air quality, and wildlife effects. In addition to monitoring, IOL's estimate does not include a cost to cover activities to satisfy the Water Licence requirements, such as: annual reporting, management plans, progress reports, etc. Therefore, in addition to the AEMP and SNP costs described above, ARKTIS assumed that post-closure monitoring includes the following additional programs and activities.

- Regulatory costs (annual report, management plans, progress reports, etc.)
- Geotechnical inspections
- Vegetation monitoring program
- Air quality monitoring program
- Wildlife effects monitoring program

ARKTIS assumed full scale monitoring occurs during the early years post closure. After this time, the monitoring programs are reduced in scope and frequency based on the assumption that various criteria of evaluation will have improved sufficiently to enable amendments to the Water Licence and land use permits to allow the reduced programs to be implemented. The assumed schedule and scope of the post-closure monitoring programs are detailed below. A 25 year post-reclamation monitoring program was assumed, in addition to, 2 years ICM and 2 years of active reclamation. A 25 year duration is uncertain as described above. The annual costs and schedule for each monitoring program were considered reasonable based on comparison to security estimates for other industrial operations in the NWT. These costs and their uncertainty could be further refined upon development of an updated closure and reclamation plan.

### **2.3.3 Summary**

ARKTIS calculated the Post-Closure Monitoring and Maintenance category to be the sum of the following components with a 25% contingency applied to each.

- Landfill O&M
- Groundwater Remediation O&M
- Post Closure Monitoring Program





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A contingency was applied to this category to account for uncertainty in the estimate. The uncertainties were noted above, and include but are not limited to:

- The selection of a 25 year landfill O&M period was unsubstantiated and considered low.
- The Groundwater Remediation activity is unknown and assumed to be a pump and treat system that would be successful in achieving the reclamation criteria in a 25 year period. The reclamation criteria are not known and the 25 year period was unsubstantiated and considered low.
- No to limited definition of the Post-Closure Monitoring Programs and the schedule of their execution.



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| Phase            | Year |    | Regulatory Costs | SNP and AEMP | Geotechnical Inspections | Vegetation Monitoring | Air Quality | Wildlife Effects Monitoring | Total     | Discounted Value |
|------------------|------|----|------------------|--------------|--------------------------|-----------------------|-------------|-----------------------------|-----------|------------------|
| ICM              | 1    | 1  | \$150,000        | \$406,732    | \$20,000                 |                       |             | \$25,000                    | \$601,732 | \$601,732        |
| ICM              | 2    | 2  | \$150,000        | \$406,732    | \$20,000                 |                       |             |                             | \$576,732 | \$576,732        |
| Reclamation      | 3    | 1  | \$150,000        | \$406,732    | \$20,000                 | \$-                   | \$20,000    | \$25,000                    | \$621,732 | \$621,732        |
| Reclamation      | 4    | 2  | \$150,000        | \$406,732    | \$20,000                 | \$20,000              | \$20,000    |                             | \$616,732 | \$616,732        |
| Post-Reclamation | 5    | 1  | \$150,000        | \$406,732    | \$20,000                 | \$10,000              | \$10,000    | \$25,000                    | \$621,732 | \$621,732        |
| Post-Reclamation | 6    | 2  | \$75,000         | \$406,732    | \$10,000                 | \$20,000              |             |                             | \$511,732 | \$511,732        |
| Post-Reclamation | 7    | 3  | \$75,000         | \$406,732    | \$10,000                 | \$10,000              |             |                             | \$501,732 | \$501,732        |
| Post-Reclamation | 8    | 4  |                  | \$406,732    |                          |                       |             |                             | \$406,732 | \$406,732        |
| Post-Reclamation | 9    | 5  |                  | \$406,732    |                          |                       |             |                             | \$406,732 | \$406,732        |
| Post-Reclamation | 10   | 6  | \$75,000         | \$406,732    | \$10,000                 | \$20,000              |             | \$10,000                    | \$521,732 | \$521,732        |
| Post-Reclamation | 11   | 7  |                  | \$406,732    |                          |                       |             |                             | \$406,732 | \$406,732        |
| Post-Reclamation | 12   | 8  |                  | \$406,732    |                          |                       |             |                             | \$406,732 | \$406,732        |
| Post-Reclamation | 13   | 9  |                  | \$406,732    |                          |                       |             |                             | \$406,732 | \$406,732        |
| Post-Reclamation | 14   | 10 |                  | \$406,732    |                          |                       |             |                             | \$406,732 | \$406,732        |
| Post-Reclamation | 15   | 11 | \$30,000         | \$406,732    | \$10,000                 | \$10,000              |             | \$10,000                    | \$466,732 | \$466,732        |
| Post-Reclamation | 16   | 12 |                  | \$406,732    |                          |                       |             |                             | \$406,732 | \$406,732        |
| Post-Reclamation | 17   | 13 |                  | \$406,732    |                          |                       |             |                             | \$406,732 | \$406,732        |
| Post-Reclamation | 18   | 14 |                  | \$406,732    |                          |                       |             |                             | \$406,732 | \$406,732        |
| Post-Reclamation | 19   | 15 |                  | \$406,732    |                          |                       |             |                             | \$406,732 | \$406,732        |
| Post-Reclamation | 20   | 16 | \$30,000         | \$203,365    | \$10,000                 | \$10,000              |             | \$10,000                    | \$263,365 | \$145,819        |
| Post-Reclamation | 21   | 17 |                  | \$203,365    |                          |                       |             |                             | \$203,365 | \$109,319        |
| Post-Reclamation | 22   | 18 |                  | \$203,365    |                          |                       |             |                             | \$203,365 | \$106,135        |
| Post-Reclamation | 23   | 19 |                  | \$203,365    |                          |                       |             |                             | \$203,365 | \$103,043        |
| Post-Reclamation | 24   | 20 |                  | \$203,365    |                          |                       |             |                             | \$203,365 | \$100,042        |
| Post-Reclamation | 25   | 21 | \$30,000         | \$203,365    | \$10,000                 | \$10,000              |             | \$10,000                    | \$263,365 | \$125,785        |



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| Phase            | Year |    | Regulatory Costs   | SNP and AEMP       | Geotechnical Inspections | Vegetation Monitoring | Air Quality     | Wildlife Effects Monitoring | Total               | Discounted Value    |
|------------------|------|----|--------------------|--------------------|--------------------------|-----------------------|-----------------|-----------------------------|---------------------|---------------------|
| Post-Reclamation | 26   | 22 |                    | \$203,365          |                          |                       |                 |                             | \$203,365           | \$94,299            |
| Post-Reclamation | 27   | 23 |                    | \$203,365          |                          |                       |                 |                             | \$203,365           | \$91,553            |
| Post-Reclamation | 28   | 24 |                    | \$203,365          |                          |                       |                 |                             | \$203,365           | \$88,886            |
| Post-Reclamation | 29   | 25 | \$30,000           | \$203,365          | \$10,000                 | \$10,000              |                 | \$10,000                    | \$263,365           | \$111,758           |
| <b>Total</b>     |      |    | <b>\$1,095,000</b> | <b>\$9,761,558</b> | <b>\$170,000</b>         | <b>\$120,000</b>      | <b>\$50,000</b> | <b>\$125,000</b>            | <b>\$11,321,558</b> | <b>\$10,184,546</b> |



## 2.3.4 Contingency

Contingency was selected based on AANDC (2011)<sup>12</sup> recommendations that have been applied to their estimates of reclamation security for northern mining projects as detailed in Table 1. Based on Table 1, reclamation details of the Project were considered to range from “feasibility or advanced conceptual” (20% contingency) to “pre-feasibility, conceptual or trade-off study” (25% contingency) for the following primary reasons:

- The closure and reclamation plan does not contain a sufficient level of detail and is considered to be developed to a conceptual to interim level of completion. Thus, a 20% to 25% contingency is appropriate.
- Verification of quantities of Project components is not permissible with the level of information presented in IOL’s closure and reclamation plan and security estimate reports. Thus, a higher contingency is warranted.

With consideration to the above, a 25% contingency was applied to the reclamation estimate.

Table 1: Summary of contingency fees by estimate type.

| Estimate Type                                  | Description   | Accuracy or Appropriate Contingency |
|--|---|-------------------------------------|
| Detailed or project control                    | Based upon detailed engineering take-offs and written quotes            | +/- 5 %                             |
| Definitive or construction drawing phase       | Based upon detailed engineering take-offs and written quotes            | +/-10 %                             |
| Preliminary or budget level                    | Little detailed engineering and costs based upon verbal quotes          | +/- 15 %                            |
| Feasibility or advanced conceptual             | Engineering may be 10% complete and costs based upon typical unit costs | +/- 20%                             |
| Pre-feasibility, conceptual or trade-off study | Very basic engineering only and costs based upon typical unit costs     | +/- 25 %                            |

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<sup>12</sup> Aboriginal Affairs and Northern Development Canada (2011). Technical Intervention De Beers Canada Mining Inc. Snap Lake Water Licence MV2011L2-0004. Submitted to the MVLWB November 7, 2011.



### 3.0 ANALYSIS AND RESULTS

The details for costing information utilized in the reclamation estimate and RECLAIM v.7 outputs are presented in Appendix A. A summary reclamation security is provided in Table 2.

Table 2: Summary of total reclamation security for the Project.

| <b>Capital Costs</b>  | <b>Total Costs</b>   | <b>Land Liability</b> | <b>Water Liability</b> |
|---|----------------------|-----------------------|------------------------|
| Wells and facilities  | \$47,817,087         | \$47,817,087          | \$-                    |
| Buildings and equipment   | \$45,245,889         | \$45,245,889          | \$-                    |
| Chemicals   | \$20,717,805         | \$20,717,805          | \$-                    |
| Construction and operation of onsite landfill                                 | \$18,650,000         | \$18,650,000          | \$-                    |
| Water management  | \$6,309,975          | \$-                   | \$6,309,975            |
| Interim care and maintenance  | \$6,787,503          | \$4,072,502           | \$2,715,001            |
| <b>SUBTOTAL: Capital Costs</b>  | <b>\$145,528,259</b> | <b>\$136,503,283</b>  | <b>\$9,024,976</b>     |
| <b>PERCENT OF SUBTOTAL</b>  |                      | <b>93.8%</b>          | <b>6.2%</b>            |
| <b>Indirect Costs</b>   | <b>Total Cost</b>    | <b>Land Liability</b> | <b>Water Liability</b> |
| Mobilization/demobilization   | \$3,008,630          | \$2,822,049           | \$186,581              |
| Post-closure monitoring and maintenance                                       | \$23,931,505         | \$1,076,673           | \$22,838,272           |
| Engineering (5%)  | \$7,276,413          | \$6,825,164           | \$451,249              |
| Project management (5%)   | \$7,276,413          | \$6,825,164           | \$451,249              |
| Health and safety plans/monitoring and quality assurance/quality control (1%) | \$1,455,283          | \$1,365,033           | \$90,250               |
| Bonding/insurance (1%)  | \$1,455,283          | \$1,365,033           | \$90,250               |
| Contingency (25%)   | \$36,382,065         | \$34,125,821          | \$2,256,244            |
| Market price factor adjustment (0%)   | \$-                  | \$-                   | \$-                    |
| Inflation adjustment (0.52%)  | \$749,502            | \$703,021             | \$46,481               |
| <b>SUBTOTAL: Indirect Costs</b>   | <b>\$81,535,093</b>  | <b>\$55,107,957</b>   | <b>\$26,410,575</b>    |
| <b>TOTAL COSTS</b>  | <b>\$227,063,351</b> | <b>\$191,611,240</b>  | <b>\$35,435,551</b>    |

### 4.0 RECOMMENDATIONS

It is recommended that the amount of reclamation security for the Project be set at \$227,063,351. This is comprised of a water related liability of \$191,611,240 and a land related liability of \$35,435,551. The water related liability should be placed within the water licence and the land related liability within the land use permit or other appropriate authorizations.

### 5.0 DISCLAIMER AND CLOSURE

ARKTIS Solutions Inc. assumes no responsibility for inappropriate use of the contents of this report, and disclaims all liability arising from negligence or otherwise in respect of such information and recommendations presented in this report. General terms and conditions are available in Appendix B.

**ARKTIS SOLUTIONS INC.**

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Jamie VanGulck, Ph.D., P.Eng.  
 Geoenvironmental Engineer



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**APPENDIX A – RECLAIM OUTPUTS**

**Wells and Facilities - All Land Owners**

| ACTIVITY/MATERIAL   | Notes      | Units  | Quantity | Cost Code | Unit Cost | Cost % Land  | Land Cost | Water Cost   |
|---|------------|--------|----------|-----------|-----------|--------------|-----------|--------------|
| <b>OBJECTIVE: ABANDONMENT OF WELLS</b>  |            |        |          |           |           |              |           |              |
| All wells- Drilled / Cased  |            | wells  |          | #N/A      |           |              |           |              |
| Sweet Well - Completed / Active / Inactive                                    | <1000m     | wells  | 351      | SWWLS     | \$56,600  | \$19,866,600 | 100%      | \$19,866,600 |
| Sweet Well - Completed / Active / Inactive                                    | 1000-2000m | wells  | 2        | SWWL2S    | \$71,200  | \$142,400    | 100%      | \$142,400    |
| Sour Well (H2S>1%) - Completed / Active / Inactive                            |            | wells  |          | #N/A      |           |              |           |              |
| Vent Flow / Gas Migration   |            | wells  | 177      | VFGMS     | \$87,200  | \$15,390,800 | 100%      | \$15,390,800 |
| Additional Completion Zones   |            |        |          | #N/A      |           |              |           |              |
| Hauling and Disposal of Well Site Equipment                                   |            | m3     | 9562     | #N/A      |           | \$5,250,000  | 100%      | \$5,250,000  |
| <b>OBJECTIVE: ABANDONMENT OF PRODUCTION FACILITIES</b>                        |            |        |          |           |           |              |           |              |
| Above ground flowlines  |            | m3     | 27730    | PSRL      | \$1       | \$27,730     | 100%      | \$27,730     |
| Cut and cap of flowlines  |            | each   | 1046     | CNCS      | \$6,826   | \$7,139,557  | 100%      | \$7,139,557  |
| Oil / bitumen process or injection / disposal facility                        |            | m3/day | 1        | #N/A      |           |              | 100%      |              |
| Gas processing facility   |            | m3/day |          | #N/A      |           |              | 100%      |              |
| Gas dehydration facility  |            | m3/day |          | #N/A      |           |              | 100%      |              |
| Compressor station  |            | KW     |          | #N/A      |           |              | 100%      |              |
| Battery sites   |            | m3/day |          | #N/A      |           |              | 100%      |              |
| Battery sites w/ separation, compression, injection and/or disposal equipment |            | m3/day |          | #N/A      |           |              | 100%      |              |
| Satellite batteries   |            | m3/day |          | #N/A      |           |              | 100%      |              |
| Other stations  |            | m2     |          | #N/A      |           |              | 100%      |              |
| <b>Total</b>  |            |        |          |           |           | \$47,817,087 |           | \$47,817,087 |
| <b>% of Total</b>   |            |        |          |           |           |              |           | 100.00       |

**Comments:**

Line Item inserted by AMEC, assume high spec soil hauling rate. AMEC unsupported number of \$135,776 has been replaced with a more appropriate estimate.

Line item inserted by AMEC. Revised to work with length of above ground piping rather than volume of piping & bulk excavation costing. Assumes piping is less than 6" diameter.







**Chemicals/Soil Area Name - All Land Owners**

*Note: The procedures, equipment and packaging for clean up and removal of chemicals or contaminated soils are highly dependent on the nature of the chemicals and their existing state of containment. Government guidelines should be consulted on an individual chemical basis. Any estimate made here should be considered very rough unless specific evaluations have been conducted.*

| ACTIVITY/MATERIAL                                    | Notes    | Units  | Quantity | Cost Code | Unit Cost         | Cost         | % Land | Land Cost    | Water Cost |
|--|----------|--------|----------|-----------|-------------------|--------------|--------|--------------|------------|
| <b>HAZARDOUS MATERIALS AUDIT</b>                     |          |        |          |           |                   |              |        |              |            |
| Phase 1 audit  |          | each   | 7.50     | HMIS      | \$100,000         | \$750,000    | 100%   | \$750,000    |            |
| Phase 2 audit  |          | each   |          | #N/A      |                   |              |        |              |            |
| <b>CONSOLIDATE HAZARDOUS MATERIALS FOR REMOVAL</b>   |          |        |          |           |                   |              |        |              |            |
| Waste oils   |          | litre  |          | #N/A      |                   |              |        |              |            |
| Fuel - Type 1, eg diesel dregs                       |          | litre  |          | #N/A      |                   |              |        |              |            |
| Fuel - Type 1, eg gasoline dregs                     |          | litre  |          | #N/A      |                   |              |        |              |            |
| Waste batteries                                      |          | kg     |          | #N/A      |                   |              |        |              |            |
| Assay & environmental lab reagents                   |          | tonnes | 7.50     | #N/A      | \$12,000          | \$90,000     | 100%   | \$90,000     |            |
| Machine shop, paints, solvents etc                   |          | tonnes | 7.50     | #N/A      | \$12,000          | \$90,000     | 100%   | \$90,000     |            |
| Contaminated soils - hydrocarbon                     |          | m3     |          | #N/A      |                   |              |        |              |            |
| Metal contam. soil at conc. load-out                 |          | m3     |          | #N/A      |                   |              |        |              |            |
| Glycol   |          | litre  |          | #N/A      |                   |              |        |              |            |
| Nuclear sources                                      |          | each   |          | #N/A      |                   |              |        |              |            |
| <b>HAZARDOUS MATERIALS</b>                           |          |        |          |           |                   |              |        |              |            |
| Transportation to disposal facility                  |          | allow  |          | #N/A      |                   |              |        |              |            |
| Disposal fees  |          | allow  |          | #N/A      |                   |              |        |              |            |
| Other  |          |        |          | #N/A      |                   |              |        |              |            |
| <b>CONTAMINATED SOILS</b>                            |          |        |          |           |                   |              |        |              |            |
| Contam. soil investigation - technical               |          | each   |          | #N/A      |                   |              |        |              |            |
| Contam. soil investigation - drilling & sampling     |          | each   |          | #N/A      |                   |              |        |              |            |
| <b>CONTAMINATED SOIL REMOVAL</b>                     |          |        |          |           |                   |              |        |              |            |
| Remediate on site                                    |          | m3     |          | #N/A      |                   |              |        |              |            |
| Env. investigation Phase I/II                        |          | each   | 216      | CSEIL     | \$25,000          | \$5,406,250  | 100%   | \$5,406,250  |            |
| Contaminated soils - hydrocarbon                     |          | m3     |          | #N/A      |                   |              |        |              |            |
| Metal contam. soil at conc. load-out                 |          | m3     |          | #N/A      |                   |              |        |              |            |
| Load, haul, dump or doze                             |          | m3     | 445774   | SC4H      | \$23              | \$10,341,957 | 100%   | \$10,341,957 |            |
| Reagents/stabilizing agent                           |          | m2     |          | #N/A      |                   |              |        |              |            |
| Contour reclaimed area                               |          | m3     |          | #N/A      |                   |              |        |              |            |
| Type 2, heavy fuel and oil                           |          | m3     |          | #N/A      |                   |              |        |              |            |
| Reclaim sump areas                                   |          | ha     | 24       | VEGS      | \$42,125          | \$990,270    | 100%   | \$990,270    |            |
| Construct slurry wall for sumps                      |          | m2     | 16900    | SUMPS     | \$75              | \$1,267,500  | 100%   | \$1,267,500  |            |
| <b>CONTAMINATED SOIL VERY LOW PERMEABILITY COVER</b> |          |        |          |           |                   |              |        |              |            |
| Supply geomembrane, HDPE, ES3, GCL                   |          | m2     |          | #N/A      |                   |              |        |              |            |
| Upper and lower bedding layers                       |          | m3     |          | #N/A      |                   |              |        |              |            |
| Install geomembrane, HDPE, ES3, GCL                  |          | m2     |          | #N/A      |                   |              |        |              |            |
| Erosion protection layer                             |          | m3     |          | #N/A      |                   |              |        |              |            |
| Vegetate   |          | m2     |          | #N/A      |                   |              |        |              |            |
| Install infiltration/seepage instrumentation         |          | allow  |          | #N/A      |                   |              |        |              |            |
| Other  |          |        |          | #N/A      |                   |              |        |              |            |
| <b>OTHER</b>   |          |        |          |           |                   |              |        |              |            |
| Occupational Health and Safety Department            |          | years  | 2        | OHSPS     | \$100,000         | \$200,000    | 100%   | \$200,000    |            |
| Non-Hazardous materials removal                      |          | tonnes | 8        | NHMATS    | \$3,500           | \$26,250     | 100%   | \$26,250     |            |
| Load, haul, dump or doze                             | Backfill | m3     | 109548   | SC3H      | \$14              | \$1,555,578  | 100%   | \$1,555,578  |            |
|  |          |        |          |           | <b>Total</b>      | \$20,717,805 |        | \$20,717,805 |            |
|  |          |        |          |           | <b>% of Total</b> |              |        | 100          |            |

**Comments:**

Used High spec High cost excavate/load/short haul unit cost to landfill

Extended coverage from 1yr to duration of A&R implementation, estimated to be 2yrs.





**Interim Care and Maintenance - All Land Owners**

| ACTIVITY/MATERIAL                     | Notes | Units     | Quantity | Cost Code                              | Unit Cost   | Cost      | %Land | Land Cost      | Water Cost     |  |
|---------------------------------------|-------|-----------|----------|--|-------------|-----------|-------|----------------|----------------|--|
| <b>INTERIM CARE &amp; MAINTENANCE</b> |       |           |          |  |             |           |       |                |                |  |
| on-site caretaker                     |       | manmonths |          | #/N/A                                  |             |           |       |                |                |  |
| extra personnel                       |       | manmonths |          | #/N/A                                  |             |           |       |                |                |  |
| -electrician                          |       | manmonths |          | #/N/A                                  |             |           |       |                |                |  |
| -mechanic                             |       | manmonths |          | #/N/A                                  |             |           |       |                |                |  |
| annual fuel                           |       | litre     |          | #/N/A                                  |             |           |       |                |                |  |
| misc. supplies                        |       | allow     | 1        | #/N/A                                  | \$500,000   | \$500,000 | 60%   | \$300,000      | \$200,000      |  |
| pick-up truck                         |       | each      | 4        | #/N/A                                  | \$24,000    | \$96,000  | 60%   | \$57,600       | \$38,400       | Higher rate allowacated                |
| small dozer                           |       | allow     | 480      | DOZERSH                                | \$260       | \$124,800 | 60%   | \$74,880       | \$49,920       |  |
| small excavator                       |       | allow     | 480      | GRADL                                  | \$190       | \$91,200  | 60%   | \$54,720       | \$36,480       |  |
| snow machine                          |       | allow     | 2        | #/N/A                                  | \$10,000    | \$20,000  | 60%   | \$12,000       | \$8,000        |  |
| communications                        |       | allow     |          | #/N/A                                  |             |           |       |                |                |  |
| SNP/AEMP water sampling & reporting   |       | years     |          | #/N/A                                  |             |           |       |                |                |  |
| ICM monitoring                        |       | years     | 1        | #/N/A                                  | \$589,232   | \$589,232 |       |                | \$589,232      | See Monitoring Tab                     |
| geotechnical assessment               |       | each      |          | #/N/A                                  |             |           |       |                |                |  |
| interim water treatment               |       | years     |          | #/N/A                                  |             |           |       |                |                |  |
| Environmental coordinator             |       | hours     | 2080     | EnvccoL                                | \$74        | \$154,253 | 60%   | \$92,552       | \$61,701       | 1 worker                               |
| Electrician                           |       | hours     | 2080     | ElecL                                  | \$74        | \$153,920 | 60%   | \$92,352       | \$61,568       | 1 worker                               |
| Journeyman - various                  |       | hours     | 8320     | JourL                                  | \$72        | \$597,293 | 60%   | \$358,376      | \$238,917      | 4 Journeymen                           |
| Security / first aid                  |       | hours     | 6240     | safetyL                                | \$67        | \$417,893 | 60%   | \$250,736      | \$167,157      | 3 Security guards                      |
| Administrative staff                  |       | hours     | 2080     | adminL                                 | \$58        | \$120,411 | 60%   | \$72,247       | \$48,164       | 1 worker working                       |
| Construction                          |       | km        | 2.5      | WRCH                                   | \$11,500    | \$28,750  | 60%   | \$17,250       | \$11,500       | Winter road                            |
| other                                 |       | each      | 1        | #/N/A                                  | \$500,000   | \$500,000 | 60%   | \$300,000      | \$200,000      | Utilities and transportation allowance |
|                                       |       |           |          | <b>Annual Interim C&amp;M Cost</b>     | \$3,393,752 |           |       | \$1,682,712    | \$1,711,040    |  |
| Number of years of ICM                |       | years     | 2        | <b>Total Cost</b>                      | \$6,787,503 |           |       | \$3,365,423.52 | \$3,422,079.68 |  |
|                                       |       |           |          | % of Total                             |             |           |       | 60.0%          | 40.0%          |  |
| <b>Percentage Share of Liability:</b> |       |           |          | <b>Total Cost for: All Land Owners</b> | \$6,787,503 |           |       | \$3,365,424    | \$3,422,080    |  |

**Mobilization/Demobilization - All Land Owners**

| ACTIVITY/MATERIAL   | Notes | Units     | Quantity  | Cost Code | Unit Cost | Cost      |
|---|-------|-----------|-----------|-----------|-----------|-----------|
| <b>MOBILIZE HEAVY EQUIPMENT</b>                                   |       |           |           |           |           |           |
| Service Rigs  |       | each      | 3         | MHERH     | \$10.25   | \$67,650  |
| Excavators  |       | each      | 4         | MHERH     | \$10.25   | \$90,200  |
| Dump trucks   |       | each      | 6         | MHERH     | \$10.25   | \$135,300 |
| Dozers  |       | each      | 4         | MHERH     | \$10.25   | \$90,200  |
| Demolition shears   |       | each      | 2         | MHERH     | \$10.25   | \$45,100  |
| Crane   |       | each      | 1         | MHERH     | \$10.25   | \$22,550  |
| Loader  |       | each      | 4         | MHERH     | \$10.25   | \$90,200  |
| Compactor   |       | each      |           | MHERH     | \$10.25   |           |
| Light duty vehicles   |       | each      | 8         | MHERH     | \$3.40    | \$59,840  |
| <b>MOBILIZE MISC. EQUIPMENT</b>                                   |       |           |           |           |           |           |
| Pump shipping   |       | each      |           | #N/A      |           |           |
| Pipe shipping   |       | m         |           | #N/A      |           |           |
| Minor tools and equipment   |       | allow     | 1         | #N/A      | \$250,000 | \$250,000 |
| Truck tires   |       | allow     | 1         | #N/A      | \$100,000 | \$100,000 |
| Other   |       |           |           | #N/A      |           |           |
| <b>MOBILIZE CAMP</b>  |       |           |           |           |           |           |
| Mobilize Camp   |       | allow     |           |           |           |           |
| Reclamation activities  |       | allow     |           | #N/A      |           |           |
| Long term reclamation activities (eg pump flooding)               |       | allow     |           | #N/A      |           |           |
| <b>MOBILIZE WORKERS</b>   |       |           |           |           |           |           |
| crew transportation   |       | each      | 44        | MWH       | \$9,100   | \$400,400 |
| Reclamation activities - transport                                |       | each      |           | #N/A      |           |           |
| Reclamation activities - travel time                              |       | manhours  |           | #N/A      |           |           |
| Long term reclamation activities (eg pump flooding) - transport   |       | each      |           | #N/A      |           |           |
| Long term reclamation activities (eg pump flooding) - travel time |       | each      |           | #N/A      |           |           |
| Monitoring Airfare  |       | each      |           | #N/A      |           |           |
| <b>WORKER ACCOMODATIONS</b>                                       |       |           |           |           |           |           |
| Reclamation activities  |       | manday    | 1232      | ACCMH     | \$175     | \$215,600 |
| Long term reclamation activities (eg pump flooding)               |       | manmonths |           | #N/A      |           |           |
| <b>MOBILIZE FUEL</b>  |       |           |           |           |           |           |
| Fuel Mobilization   |       | litre     | 2,085,750 | FCML      | \$0       | \$417,150 |
| Fuel freight - reclamation activities                             |       | litre     |           | #N/A      |           |           |
| Fuel freight - long reclamation activities                        |       | litre     |           | #N/A      |           |           |
| Fuel freight accomodations  |       | litre     |           | #N/A      |           |           |
| <b>WINTER ROAD</b>  |       |           |           |           |           |           |
| Construction and operation  |       | km        | 2         | WRCH      | \$11,500  | \$23,000  |
| Limited winter use  |       | km        |           | #N/A      |           |           |
| Winter road tarriff   |       | km        |           | #N/A      |           |           |
| <b>DEMOBILIZE OTHER INFRASTRUCTURE AND SITE EQUIPMENT</b>         |       |           |           |           |           |           |
| Service Rigs  |       | km        | 3         | MHERH     | \$10.25   | \$67,650  |

616 person days per year x 2 years

1,042,875 L/year used x 2 years

2km/season of winter road x 2 seasons







| Phase            | Year |    | Regulatory Costs    | SNP and AEMP        | Geotechnical Inspections | Vegetation Monitoring | Air Quality      | Wildlife Effects Monitoring | Total                | Discounted Value     |
|------------------|------|----|---------------------|---------------------|--------------------------|-----------------------|------------------|-----------------------------|----------------------|----------------------|
| ICM              | 1    | 1  | \$ 150,000          | \$ 406,732          | \$ 20,000                |                       |                  | \$ 25,000                   | \$ 601,732           | \$ 601,732           |
| ICM              | 2    | 2  | \$ 150,000          | \$ 406,732          | \$ 20,000                |                       |                  |                             | \$ 576,732           | \$ 576,732           |
| Reclamation      | 3    | 1  | \$ 150,000          | \$ 406,732          | \$ 20,000                | \$-                   | \$ 20,000        | \$ 25,000                   | \$ 621,732           | \$ 621,732           |
| Reclamation      | 4    | 2  | \$ 150,000          | \$ 406,732          | \$ 20,000                | \$ 20,000             | \$ 20,000        |                             | \$ 616,732           | \$ 616,732           |
| Post-Reclamation | 5    | 1  | \$ 150,000          | \$ 406,732          | \$ 20,000                | \$ 10,000             | \$ 10,000        | \$ 25,000                   | \$ 621,732           | \$ 621,732           |
| Post-Reclamation | 6    | 2  | \$ 75,000           | \$ 406,732          | \$ 10,000                | \$ 20,000             |                  |                             | \$ 511,732           | \$ 511,732           |
| Post-Reclamation | 7    | 3  | \$ 75,000           | \$ 406,732          | \$ 10,000                | \$ 10,000             |                  |                             | \$ 501,732           | \$ 501,732           |
| Post-Reclamation | 8    | 4  |                     | \$ 406,732          |                          |                       |                  |                             | \$ 406,732           | \$ 406,732           |
| Post-Reclamation | 9    | 5  |                     | \$ 406,732          |                          |                       |                  |                             | \$ 406,732           | \$ 406,732           |
| Post-Reclamation | 10   | 6  | \$ 75,000           | \$ 406,732          | \$ 10,000                | \$ 20,000             | \$ 10,000        |                             | \$ 521,732           | \$ 521,732           |
| Post-Reclamation | 11   | 7  |                     | \$ 406,732          |                          |                       |                  |                             | \$ 406,732           | \$ 406,732           |
| Post-Reclamation | 12   | 8  |                     | \$ 406,732          |                          |                       |                  |                             | \$ 406,732           | \$ 406,732           |
| Post-Reclamation | 13   | 9  |                     | \$ 406,732          |                          |                       |                  |                             | \$ 406,732           | \$ 406,732           |
| Post-Reclamation | 14   | 10 |                     | \$ 406,732          |                          |                       |                  |                             | \$ 406,732           | \$ 406,732           |
| Post-Reclamation | 15   | 11 | \$ 30,000           | \$ 406,732          | \$ 10,000                | \$ 10,000             | \$ 10,000        |                             | \$ 466,732           | \$ 466,732           |
| Post-Reclamation | 16   | 12 |                     | \$ 406,732          |                          |                       |                  |                             | \$ 406,732           | \$ 406,732           |
| Post-Reclamation | 17   | 13 |                     | \$ 406,732          |                          |                       |                  |                             | \$ 406,732           | \$ 406,732           |
| Post-Reclamation | 18   | 14 |                     | \$ 406,732          |                          |                       |                  |                             | \$ 406,732           | \$ 406,732           |
| Post-Reclamation | 19   | 15 |                     | \$ 406,732          |                          |                       |                  |                             | \$ 406,732           | \$ 406,732           |
| Post-Reclamation | 20   | 16 | \$ 30,000           | \$ 203,365          | \$ 10,000                | \$ 10,000             | \$ 10,000        |                             | \$ 263,365           | \$ 145,819           |
| Post-Reclamation | 21   | 17 |                     | \$ 203,365          |                          |                       |                  |                             | \$ 203,365           | \$ 109,319           |
| Post-Reclamation | 22   | 18 |                     | \$ 203,365          |                          |                       |                  |                             | \$ 203,365           | \$ 106,135           |
| Post-Reclamation | 23   | 19 |                     | \$ 203,365          |                          |                       |                  |                             | \$ 203,365           | \$ 103,043           |
| Post-Reclamation | 24   | 20 |                     | \$ 203,365          |                          |                       |                  |                             | \$ 203,365           | \$ 100,042           |
| Post-Reclamation | 25   | 21 | \$ 30,000           | \$ 203,365          | \$ 10,000                | \$ 10,000             | \$ 10,000        |                             | \$ 263,365           | \$ 125,785           |
| Post-Reclamation | 26   | 22 |                     | \$ 203,365          |                          |                       |                  |                             | \$ 203,365           | \$ 94,299            |
| Post-Reclamation | 27   | 23 |                     | \$ 203,365          |                          |                       |                  |                             | \$ 203,365           | \$ 91,553            |
| Post-Reclamation | 28   | 24 |                     | \$ 203,365          |                          |                       |                  |                             | \$ 203,365           | \$ 88,886            |
| Post-Reclamation | 29   | 25 | \$ 30,000           | \$ 203,365          | \$ 10,000                | \$ 10,000             | \$ 10,000        |                             | \$ 263,365           | \$ 111,758           |
| <b>Total</b>     |      |    | <b>\$ 1,095,000</b> | <b>\$ 9,761,558</b> | <b>\$ 170,000</b>        | <b>\$ 120,000</b>     | <b>\$ 50,000</b> | <b>\$ 125,000</b>           | <b>\$ 11,321,558</b> | <b>\$ 10,184,546</b> |

Discount rate 0.03 %  
 ICM Monitoring Cost \$ 1,178,464 ICM Tab  
 Post-Closure Reclamation Monitoring Cost \$ 9,006,082 Post Closure

Landfill O&M \$ 1,093,233 Post Closure  
 Groundwater Remediation O&M \$ 9,045,889 Post Closure

**IOL's Groundwater Characterization and Monitoring**

| Geographic Area            | Years 1 to 15 OI  | Years 16 to 25    |
|----------------------------|-------------------|-------------------|
| Mainland East              | \$ 84,712         | \$ 42,356         |
| Mainland Central           | \$ 96,825         | \$ 48,412         |
| Mainland West              | \$ 52,398         | \$ 26,199         |
| Mainland Sumps             | \$ 52,590         | \$ 26,295         |
| Bear and Frenchy's Islands | \$ 93,835         | \$ 46,917         |
| Goose Islands              | \$ 26,372         | \$ 13,186         |
| <b>Totals</b>              | <b>\$ 406,732</b> | <b>\$ 203,365</b> |

| Phase            | Year |    | Landfill O&M        | Discounted Value    | Groundwater Remediation | Discounted Value    |
|------------------|------|----|---------------------|---------------------|-------------------------|---------------------|
| ICM              | 1    | 1  | \$ -                | \$ -                | \$ 0                    | \$ -                |
| ICM              | 2    | 2  | \$ -                | \$ -                | \$ 0                    | \$ -                |
| Reclamation      | 3    | 1  | \$ 50,000           | \$ 50,000           | \$ 413,722              | \$ 413,722          |
| Reclamation      | 4    | 2  | \$ 50,000           | \$ 50,000           | \$ 413,722              | \$ 413,722          |
| Post-Reclamation | 5    | 1  | \$ 50,000           | \$ 50,000           | \$ 413,722              | \$ 413,722          |
| Post-Reclamation | 6    | 2  | \$ 50,000           | \$ 50,000           | \$ 413,722              | \$ 413,722          |
| Post-Reclamation | 7    | 3  | \$ 50,000           | \$ 50,000           | \$ 413,722              | \$ 413,722          |
| Post-Reclamation | 8    | 4  | \$ 50,000           | \$ 50,000           | \$ 413,722              | \$ 413,722          |
| Post-Reclamation | 9    | 5  | \$ 50,000           | \$ 50,000           | \$ 413,722              | \$ 413,722          |
| Post-Reclamation | 10   | 6  | \$ 50,000           | \$ 50,000           | \$ 413,722              | \$ 413,722          |
| Post-Reclamation | 11   | 7  | \$ 50,000           | \$ 50,000           | \$ 413,722              | \$ 413,722          |
| Post-Reclamation | 12   | 8  | \$ 50,000           | \$ 50,000           | \$ 413,722              | \$ 413,722          |
| Post-Reclamation | 13   | 9  | \$ 50,000           | \$ 50,000           | \$ 413,722              | \$ 413,722          |
| Post-Reclamation | 14   | 10 | \$ 50,000           | \$ 50,000           | \$ 413,722              | \$ 413,722          |
| Post-Reclamation | 15   | 11 | \$ 50,000           | \$ 50,000           | \$ 413,722              | \$ 413,722          |
| Post-Reclamation | 16   | 12 | \$ 50,000           | \$ 50,000           | \$ 413,722              | \$ 413,722          |
| Post-Reclamation | 17   | 13 | \$ 50,000           | \$ 50,000           | \$ 413,722              | \$ 413,722          |
| Post-Reclamation | 18   | 14 | \$ 50,000           | \$ 50,000           | \$ 413,722              | \$ 413,722          |
| Post-Reclamation | 19   | 15 | \$ 50,000           | \$ 50,000           | \$ 413,722              | \$ 413,722          |
| Post-Reclamation | 20   | 16 | \$ 50,000           | \$ 27,684           | \$ 413,722              | \$ 229,068          |
| Post-Reclamation | 21   | 17 | \$ 50,000           | \$ 26,877           | \$ 413,722              | \$ 222,396          |
| Post-Reclamation | 22   | 18 | \$ 50,000           | \$ 26,095           | \$ 413,722              | \$ 215,918          |
| Post-Reclamation | 23   | 19 | \$ 50,000           | \$ 25,335           | \$ 413,722              | \$ 209,630          |
| Post-Reclamation | 24   | 20 | \$ 50,000           | \$ 24,597           | \$ 413,722              | \$ 203,524          |
| Post-Reclamation | 25   | 21 | \$ 50,000           | \$ 23,880           | \$ 413,722              | \$ 197,596          |
| Post-Reclamation | 26   | 22 | \$ 50,000           | \$ 23,185           | \$ 413,722              | \$ 191,841          |
| Post-Reclamation | 27   | 23 | \$ 50,000           | \$ 22,509           | \$ 413,722              | \$ 186,253          |
| Post-Reclamation | 28   | 24 | \$ 50,000           | \$ 21,854           | \$ 413,722              | \$ 180,828          |
| Post-Reclamation | 29   | 25 | \$ 50,000           | \$ 21,217           | \$ 413,722              | \$ 175,561          |
| <b>Total</b>     |      |    | <b>\$ 1,350,000</b> | <b>\$ 1,093,233</b> | <b>\$ 11,170,494</b>    | <b>\$ 9,045,889</b> |

**IOL's Groundwater Remediation**

|                        |                   |
|------------------------|-------------------|
| Mainland East          | \$ 133,749        |
| Mainland Tankfarm Area | \$ 133,749        |
| Mainland Central       | \$ 146,224        |
| <b>Totals</b>          | <b>\$ 413,722</b> |



# ARKTIS SOLUTIONS INCORPORATED

## **APPENDIX B – GENERAL TERMS AND CONDITIONS**

This report incorporates and is subject to these “General Conditions”

### **USE OF REPORT**

This report has been prepared for the specific site, design objective, development and purpose described to ARKTIS Solutions Inc. (ARKTIS) by the Client. The factual data, interpretations and recommendations pertain to a specific site, a specific development, and a specific scope of work. It is not applicable to any other sites, nor should it be relied upon for types of development other than those to which it refers. Any variation of site conditions, purpose, and development plans, or if the project is not initiated within three months of the date of the report may alter the validity of the report. ARKTIS cannot be responsible for use of this report, or portions thereof, unless ARKTIS is requested to review, and if necessary, revise the report.

This report and the assessments and recommendations contained in it are intended for the sole benefit of ARKTIS' Client. No other party may use or rely on this report or any portion thereof without ARKTIS' expressed written consent. If the report was prepared to be included for a specific permit application process, then upon reasonable request of the client, ARKTIS may authorize in writing the use of this report by the regulatory agency as an Approved User for the specific and identified purpose of the applicable permit review process. Any other use of this report by others is prohibited and is without responsibility to ARKTIS.

The report, all plans, data, drawings and other documents as well as all electronic media prepared by ARKTIS are considered its professional work product and shall remain the copyright property of ARKTIS, who authorizes only the Client and Approved Users to make copies of the report, but only in such quantities as are reasonable and necessary for the use of the report by those parties. The Client and Approved Users may not give, lend, sell, or otherwise make available the report or any portion thereof to any party without the express written consent of ARKTIS. The Client acknowledges that electronic media is susceptible to unauthorized modification, deterioration and incompatibility and therefore the Client cannot rely upon the electronic media versions of ARKTIS' report or other work products. ARKTIS does not accept any responsibility for the accuracy of any of the data, the analysis or the recommendations contained or referenced in the report when the report is used or relied upon by any party other than ARKTIS' Client or Authorized User unless otherwise authorized in writing by ARKTIS.

### **LIMITATIONS OF REPORT**

The report is of a summary nature and is not intended to stand alone without the reference to the instructions given to ARKTIS by the Client, communications between ARKTIS and the Client, and to any other reports prepared by ARKTIS for the Client relative to the specific site described in the report. In order to properly understand suggestions, recommendations and opinions expressed in this report, reference must be made to the whole of the report. ARKTIS cannot be responsible for use of portions of the report without reference to the entire report.

Unless otherwise stated, the suggestions, recommendations and opinions given in this report are intended only for the guidance of the Client in the design of the specific project. The extent and detail of investigations, including the number of test holes, necessary to determine all of the relevant conditions which may affect construction costs would normally be greater than has been carried out for design purposes. Contractors bidding on, or undertaking the work, should rely on their own investigations, as well as their own interpretations of the factual data presented in the report, as how subsurface conditions may affect their work, including but not limited to proposed construction techniques, schedule, and safety and equipment capabilities.

Classification and identification of soils, rocks, and geologic units have been based on commonly accepted methods employed in the practice of geotechnical engineering and related disciplines. Classification and identification of the type and condition of these materials or units involves judgment,



# ARKTIS SOLUTIONS INCORPORATED

and boundaries between different soil and rock or geologic types or units may be transitional rather than abrupt. Accordingly, ARKTIS does not warrant or guarantee the exactness of the descriptions.

## **LIMITATIONS OF LIABILITY**

The client, and any other parties using this report with the express written consent of the clients and ARKTIS, acknowledge that conditions affecting the financial liability of the site can vary with time and that the conclusions and recommendations set out in this report are time sensitive.

During the performance of the work and the preparation of this report, ARKTIS may have relied on the information provided by persons other than the client. While ARKTIS endeavors to verify the accuracy of such information when instructed to do so by the client, ARKTIS accepts no responsibility for the accuracy or the reliability of such information which may affect the report.

The client, and any other party using this report with the express written consent of the client and ARKTIS, also acknowledge that the conclusions and recommendations set out in this report are based on limited observations and testing on the subject site and that conditions may vary across the site which, in turn, could affect the conclusions and recommendations made.

The client acknowledges that ARKTIS is neither qualified to, nor is it making, any recommendations with respect to the purchase, sale, investment or development of the property, the decisions on which are the sole responsibility of the client.

## **STANDARD OF CARE**

Services performed by ARKTIS for this report have been conducted in a manner consistent with the level of skill ordinarily exercised by members of the profession currently practicing under similar conditions in the jurisdiction in which the services are provided, subject to the time limits and financial and physical constraints applicable to the services. Engineering judgment has been applied in developing the conclusions and/or recommendations provided in this report. No warranty or guarantee, express or implied, is made concerning the test results, comments, recommendations, or any other portion of this report.

## **ALTERNATE REPORT FORMAT**

Where ARKTIS submits both electronic file and hard copy versions of reports, drawings and other project related documents and deliverables (collectively termed instruments of professional service), the Client agrees that only the signed and sealed hard copy versions shall be considered final and legally binding.

The hard copy versions submitted by ARKTIS shall be the original documents for record and working purposes, and, in the event of a dispute or discrepancies, the hard copy versions shall govern over the electronic versions. Furthermore, the Client agrees and waives all future right of dispute that the original hard copy signed version archived by ARKTIS shall be deemed to be the overall original for the Project.

The Client agrees that both electronic file and hard copy versions of instruments of professional services shall not, under any circumstances, no matter who owns or uses them, be altered by any party except ARKTIS. The Client warrants that instruments of professional services will be used only and exactly as submitted by ARKTIS.

**Appendix 2**  
**ARKTIS Solutions Incorporated Technical Memo**  
**Imperial Oil Limited, Norman Wells Operations – RECLAIM Financial Security**  
**Comparison**



| <b>TECHNICAL MEMORANDUM</b> |   |
|-----------------------------|---|
| <b>File:</b>                | <b>2014-GNWT</b>  |
| <b>To:</b>                  | <b>Government of the Northwest Territories, Environment and Natural Resources</b>   |
| <b>Attention:</b>           | <b>Nathen Richea, Manager, Water Regulatory Division</b>                            |
| <b>Subject:</b>             | <b>Imperial Oil Limited, Norman Wells Operations –Financial Security Comparison</b> |
| <b>Author:</b>              | <b>Jamie VanGulck, Ph.D., P.Eng.</b>  |
| <b>Page Total:</b>          | <b>3</b>  |
| <b>Date:</b>                | <b>October 22, 2014</b>   |

## **PREAMBLE**

The Government of the Northwest Territories (GNWT) has contracted ARKTIS Solutions Inc. (ARKTIS) to provide technical advisory and support regarding Imperial Oil Limited's (IOL) financial security estimate for the Normal Wells Operation. The purpose of this Technical Memorandum is to compare the financial security estimates completed by ARKTIS to IOL.

Should you have any questions about the contents of this document, please feel free to contact Dr. Jamie VanGulck, P.Eng. at 867.446.4129 / vangulck@arktissolutions.com.



# ARKTIS SOLUTIONS INCORPORATED

| Direct Costs                                  | ARKTIS' Estimate     | IOL' Estimate        | Difference         | Primary Reason for Difference in Security Estimate   |
|---|----------------------|----------------------|--------------------|--|
| Wells and facilities                          | \$47,817,087         | \$42,667,251         | \$5,149,836        | <p>ARKTIS applied RECLAIM unit cost for removal of pipelines; IOL applied the RECLAIM unit cost for contaminated soil removal cost to this item.</p> <p>ARKTIS increased the quantity of "above ground flowlines" based on IOL data; unclear how IOL data was selected.</p> <p>ARKTIS considered IOL' quantity of equipment to haul from well sites to be unreasonably low. ARKTIS increased the quantity to be 15% of the abandonment cost for the well facilities.</p> |
| Buildings and equipment                       | \$45,245,889         | \$41,126,888         | \$4,119,001        | <p>ARKTIS applied the RECLAIM unit cost (\$23/m<sup>3</sup>) for long haul contaminated soil removal; IOL applied the RECLAIM unit cost for short haul (\$14/m<sup>3</sup>). Location of landfill not selected at this time to assess long versus short haul.</p> <p>ARKTIS applied grading and contouring of all areas.</p> <p>ARKTIS assumed all buildings were 2 stories; IOL applied a 1 story tall buildings.</p>   |
| Chemicals                                     | \$20,717,805         | \$16,605,839         | \$4,111,966        | <p>ARKTIS applied the RECLAIM unit cost (\$23/m<sup>3</sup>) for long haul contaminated soil removal; IOL applied the RECLAIM unit cost for short haul (\$14/m<sup>3</sup>). Distance between Islands and Mainland is about 2 km on ice bridge and considered long haul.</p>   |
| Construction and operation of onsite landfill | \$18,650,000         | \$18,650,000         | \$-                | n/a  |
| Water management                              | \$6,309,975          | \$12,371,181         | \$(6,061,206)      | ARKTIS moved groundwater remediation O&M from this category to indirect costs.   |
| Interim care and maintenance                  | \$6,787,503          | \$5,497,039          | \$1,290,464        | ARKTIS applied a 2 year monitoring program during interim care and maintenance; IOL has not monitoring during this period.   |
| <b>SUBTOTAL: Direct Costs</b>                 | <b>\$145,528,259</b> | <b>\$136,918,198</b> | <b>\$8,610,061</b> |  |



# ARKTIS SOLUTIONS INCORPORATED

| Indirect Costs                                     | ARKTIS' Estimate     | IOL's Estimate       | Difference          | Primary Reason for Difference in Security Estimate   |
|--|----------------------|----------------------|---------------------|--|
| Mobilization/demobilization                        | \$3,008,630          | \$2,352,880          | \$655,750           | ARKTIS added costs for fuel mobilization, worker accommodation, and ice bridge construction.   |
| Post-closure monitoring and maintenance            | \$23,931,505         | \$8,210,561          | \$15,720,944        | ARKTIS added regulatory costs, geotechnical inspections, vegetation monitoring air quality and wildlife effects costs. ARKTIS moved groundwater remediation O&M from direct cost to this category. ARKTIS applied a 2 year reclamation program followed by 25 year post-closure. IOL only applied a 25 year post-closure. ARKTIS applied discount rate of 3%; IOL applied discount rate of 3.3%. ARKTIS applied discount rate for periods greater than 20 years only; IOL appears to have applied the discount rate to all time periods post-closure. ARKTIS applied a 25% contingency to this category to address significant uncertainties and information gaps. |
| Engineering (5%)                                   | \$7,276,413          | \$ 6,846,410         | \$ 430,003          | Difference in direct costs   |
| Project management (5%)                            | \$7,276,413          | \$ 6,846,410         | \$ 430,003          | Difference in direct costs   |
| Health and safety plans/ monitoring and QA/QC (1%) | \$1,455,283          | \$ 1,369,282         | \$86,001            | Difference in direct costs   |
| Bonding/insurance (1%)                             | \$1,455,283          | \$ 1,369,282         | \$86,001            | Difference in direct costs   |
| Contingency  | \$36,382,065         | \$13,692,820         | \$22,689,245        | ARKTIS applied 25% contingency to address significant uncertainties and information gaps; IOL applied 10% contingency.   |
| Market price factor adjustment                     | \$-                  |                      |                     |  |
| Inflation (0.52%)                                  | \$749,502            | \$705,210            | \$44,292            | Difference in direct costs.  |
| <b>SUBTOTAL: Indirect Costs</b>                    | <b>\$81,535,094</b>  | <b>\$41,392,854</b>  | <b>\$40,142,240</b> |  |
| <b>TOTAL COSTS</b>                                 | <b>\$227,063,353</b> | <b>\$178,321,052</b> | <b>\$48,742,301</b> |  |