RECLAIM 7.0

USER MANUAL

OIL AND GAS VERSION

Revised November 2017

Government of
Northwest Territories

Government of Northwest Territories
Gouvernement des Territoires du Nord-Ouest

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OIL AND GAS VERSION

Prepared for: Government of the Northwest Territories

Prepared by: ARKTIS Solutions Inc.
Revised: November 2017

This manual supports the RECLAIM 7.0 Model for Closure and Reclamation Cost Estimates

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1 Introduction

The Oil and Gas RECLAIM Model has been updated by ARKTIS Solutions Inc. (ARKTIS) on behalf of Government of the Northwest Territories (GNWT) to assist the GNWT, the Land and/or Water Boards, and other stakeholders (typically proponents) to estimate closure and reclamation costs (the "closure cost estimate") at oil and gas exploration and production-sites in the Northwest Territories (NWT). The model format is specifically designed to help these parties better comprehend the multiple components of oil and gas site closure estimates. These estimates are intended to cover government liabilities associated with authorized development projects in the NWT. The Oil and Gas RECLAIM Model and this user manual build upon the Mining RECLAIM Model and user manual developed by Brodie Consulting Ltd.

Until such time as the GNWT issues its own Policy for Closure and Reclamation Cost Estimates, GNWT adheres to Indigenous and Northern Affairs Canada's (INAC) *Mine Site Reclamation Policy for the Northwest Territories*, 2002. Although that policy was developed for mining activities, the following select principles regarding reclamation security are directly applicable to oil and gas activities:

- Adequate security is required 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.
- 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 should default. The estimates should also include contingency factors reflective of the reclamation undertaken.

Presently, the authority for setting security in the NWT rests with the Gwich'in, Sahtu, Wek'èezhìi, and Mackenzie Valley Land and Water Boards (in the Mackenzie Valley) and the Inuvialuit Water Board (in the Inuvialuit Settlement Region). The Minister determines the form of security.[1] The Land and/or Water Boards are also guided by INAC's *Mine Site Reclamation Policy for the Northwest Territories*, which states that: "The recognized methodology for calculating reclamation costs for the purposes of financial security, should be the RECLAIM or some other appropriate model." The Land and/or Water Boards rely on the GNWT to develop and maintain the RECLAIM Model and User Manual.

This User Manual includes descriptions of:

- Considerations for closure cost estimates in northern settings (Section 2)

[1] Waters Act, s 35(1); MVRMA s 60(1.1)

- How different parties may approach the cost estimate for a given site (Section 3). An understanding of the perspectives may help resolve differences in the estimates prepared.
- The RECLAIM Model and guidance on how to use it (Section 4 and 5), which includes:
  - RECLAIM Model Worksheets (Section 4.1 to Section 4.5)
  - Data entry into spreadsheets (Section 4.6-4.8)
  - Menu descriptions (Section 5)

2 Considerations for Northern Settings

It cannot be over-emphasized that in order to derive an accurate closure cost estimate it is imperative that the company have a Closure and Reclamation Plan that demonstrates a comprehensive understanding of the closure and reclamation requirements and objectives and scope of work to achieve those objectives. The first step to using the RECLAIM Model effectively is to prepare a comprehensive Closure and Reclamation Plan with sufficient detail to list and quantify the activities required.

Factors that should be recognized when developing a Closure and Reclamation Plan and liability cost estimate for a site in northern Canada are discussed below:

- Low Unit Costs typically apply to work conducted in large volumes using appropriate equipment. However, in northern Canada, efforts to reduce mobilization costs to remote sites may result in some work being conducted with non-optimal equipment.
- Some activities are best conducted in summer, such as placement and compaction of soils, while others may require winter (i.e. frozen) conditions. As such, reclamation activities may need to extend over several seasons at some northern sites.
- Productivity of people and equipment is reduced in winter conditions.
- Fuel costs can be high due to the cost of mobilizing fuel to site.

3 Proponent Operating Costs vs. Security Estimate

There are important differences in the types of cost estimates that may be prepared by a proponent or a regulator. These are described below.

3.1 Company Operating Costs – Internal Use

A proponent's estimate for internal use presents costs the company expects to incur as part of the development project, and is typically based on operating costs. The estimates may be derived to assess the viability of the project or for corporate cash flow accounting. Typical factors which may affect this type of estimate are:

- Low Unit Costs are generally utilized as it is assumed the work will be conducted under the direction of the manager of the industrial project site utilizing existing staff and equipment.
- Equipment Unit Costs may exclude capital cost of the equipment as it may have been discounted to zero during operations.
- Equipment productivity may be assumed to be relatively high due to familiarity with working conditions on the site.
- Salvage and sale of equipment is typically included in a company's internal estimate to off-set costs.
- A low contingency may be applied based upon the assumption that the industrial project site development and closure activities will proceed as planned without upsets or deviations.

3.2 Security Estimate

A security estimate is assumed to cover the government's costs for closure and reclamation should the company become insolvent and abandon the site. Costs are therefore inherently higher than a proponent's operating cost estimate described above.

Typical factors which may affect this type of estimate are:

- Unit Costs are based on third-party contractors conducting all of the work.
- Mobilization costs are included for every piece of equipment or machine required for the work (i.e. does no assume that existing equipment is available and in good working condition, see Section 4.3.2).
- There is no allowance for salvage or sale of equipment.
- The closure costs are not reduced for progressive reclamation work until after the work has been completed and it is demonstrated it meets the approved closure objectives.
- A provision is included for interim site care and maintenance to address the period of time between the ceasing of operations and the commencement of closure work. If company has become insolvent, this period of interim care and maintenance would likely be a minimum of 2-3 years. Additional time could be required if a final Closure and Reclamation Plan has not been approved and/or there are complex issues that still need to be addressed.
- A contingency is applied that reflects the degree of uncertainty in the closure plan (i.e. address key areas of uncertainty in closure options until such time as the preferred option is demonstrated or verified during the life of the project).

3.2.1 Salvage Considerations

GNWT does not recognize salvage value because of the problems associated with creditor's rights, sale of equipment, and uncertainty as to the actual value at the time of insolvency.

3.2.2 Progressive Reclamation Considerations

Industrial site reclamation cost estimates are prepared assuming that progressive reclamation is not conducted. Until this work is completed it is still an outstanding closure cost (i.e. government liability) just like any reclamation which is put off until final closure of the site. Therefore, financial security should cover the costs to complete this work as proposed. If the company carries out progressive reclamation during operations as proposed, such as revegetation of disturbed areas during operations, then the closure cost estimate could be reduced by the associated costs for that component when the company demonstrates that the closure activity has been successfully completed and closure objectives and criteria have been met.

4 RECLAIM v.7.0

4.1 General Description

RECLAIM is a model developed in Microsoft EXCEL to aid in the calculation of costs associated with each activity required to meet the objectives of the Closure and Reclamation Plan. It provides line items for each reclamation activity which might be required at a given site. For each, the model presents the "quantity" of work multiplied by the appropriate "Unit Cost".

For example, a reclamation activity may involve using a dozer to contour overburden in a disturbed area. If the quantity of soil to be dozed is 500 m^3 and the Unit Cost is \$1.05/m^3, then the cost for that reclamation activity would be \$525. RECLAIM is designed to both assist the user in identifying each of the activities required by including a list of typical activities, as well as providing a range of Unit Costs.

RECLAIM lists many typical reclamation activities for each component. These default lists will likely cover the majority of reclamation activities required for decommissioning a given project site. The default lists do not attempt to include all possible reclamation activities as the spreadsheet would be too cumbersome. If a desired activity is missing from the default list the user may modify text within this area of the spreadsheet or insert rows within Excel. If rows are inserted, they should be checked to make sure they have been included in the total for the worksheet.

There are eight reclamation costing worksheets used to compute the overall closure cost estimate. These include **direct costs** associated with the following site components:

- Wells and facilities

- Buildings and equipment
- Chemicals, hazardous materials and contaminated soils
- Surface and groundwater management
- Interim care and maintenance

As well, there are worksheets for each of the following **indirect costs**:

- Post-closure monitoring and maintenance
- Mobilization and demobilization

Additional cost factors such as contingency, engineering, project management and bonding are calculated in the Summary Worksheet.

4.2 Direct Costs

Closure costs for typical site components are estimated in worksheets of the same name. A percentage of direct costs will be applied to either "land costs" upon which the land security is held, or "water costs" upon which the water licence security is held. Additional information regarding segregation of costs into either land or water is included in Section 4.5.

Most of the worksheets are self-explanatory based on the list of activities. However, the following worksheets warrant further description.

4.2.1 Abandonment and Reclamation of Wells and Facilities

Closure of an oil and gas well or facility involves several activities generally categorized by industry as abandonment and restoration (or abandonment and reclamation). This section outlines closure activities for the site that are to be captured in a Closure and Reclamation Plan (i.e. plan requirements under land and water authorizations in the NWT).

The Wells and Facilities worksheet outlines the closure costs for wells and production facilities typically found at an oil and gas exploration or production site. In addition to abandonment costs, it is necessary to include costs to complete reclamation of the well or facility area.

Well Abandonment

Well abandonment cost is a function of the well depth and characteristics (e.g. sweet well, sour well, completion zone, etc.). Abandonment of wells typically involves the following activities:

- Removing all downhole equipment, such as rods and tubing.
- Abandoning all completed formations, such as plugging the well with concrete.
- Testing for and eliminating surface casing vent flow and gas migration.

- Disposing of any remaining drilling waste contained on-site and or in temporary sumps.
- Protecting groundwater.
- Conducting the surface abandonment.

In the Oil and Gas RECLAIM Model, Unit Costs are provided for the following well types:

- All wells – Drilled / Cased – refers to a well drilled but not been used for oil/gas operations. Closure activity typically involves plugging the well with concrete, cutting off the casing string, capping of the well, and associated monitoring and reporting.
- Sweet well – refers to a well that does not contain hydrogen sulphide (H_2S). Closure activity typically involves plugging the well with concrete, cutting off the casing string, capping of the well, and associated monitoring and reporting.
- Sour well – refers to a well that contains hydrogen sulphide (H_2S). Closure activity typically involves plugging the well with concrete, cutting off the casing string, capping of the well, and associated monitoring and reporting.
- Source water well – well used to supply water for a camp / operations. Closure activity typically involves plugging the well with concrete and removing stick up and monument.

Note, Unit Costs are also provided if the well is equipped with vent flow / gas migration system used to control and monitor the flow of gas and/or liquid from the surface casing/casing annulus. For each well equipped with a vent flow/ gas migration system, a Unit Cost of $87,200 is added to account for surface casing vent flow activities, checks and tests and repairs where applicable.

Also, if a well has more than one completion zone, an add-on cost per completion zone is to be applied (i.e. an add-on of 30%). To describe this further, if a sweet well with a depth of < 1000 m had two completion zones but no vent flow / gas migration system, the Unit Cost for abandonment would be the Sweet well Unit Cost of $56,000 multiplied by 30%, for a total of $72,800.

Facility Abandonment

Abandonment of a facility refers to the decommissioning and dismantling and typically involves the following activities:

- Identifying dangerous materials and developing management plans.
- Shutting down, draining, and purging all lines, vessels, and ponds.
- Testing pond, liquids and sludge.

- Removing and transporting product, dangerous goods, and oilfield waste for off-site management.
- Dismantling and removing all equipment, vessels, structures, and utilities.
- Removing or disposing of pads, berms, ponds, foundations, piles, concrete, and other base and surfacing materials.
- Abandoning or removing pipe.
- Removing utilidors and cathode beds (where required).

Regarding facilities, the larger the throughput, the larger the facility. Therefore, larger throughput facilities have higher abandonment costs. Unit Costs are provided for the following facilities and are a function of the throughput levels:

- Oil / bitumen processing or injection / disposal facility.
- Gas processing facility – removes water from natural gas.
- Gas dehydration facility – removes impurities from natural gas.
- Compressor stations – compresses the natural gas for transport.
- Battery sites – liquids are stored before processed for market or are otherwise disposed.
- Battery sites with separation, compression, injection and/or disposal equipment – liquids are stored before processed for market or are otherwise disposed. May include equipment or other devices for separating the liquids into oil, natural gas or water.
- Satellite batteries – liquids are stored and then transferred to a main battery site for subsequent processing and transport to processing facilities.

A 10% surcharge cost can be added for facilities with hydrogen sulphide controls (i.e. facilities for Sour wells). For example, if a battery site of <49 m^3/d has hydrogen sulphide controls, the Unit Cost for facility reclamation would be the battery site Unit Cost of $46,600 multiplied by 10%, for a total of $51,260.

Also, a 20% surcharge cost can be added for legacy facilities constructed prior to 1990 which is intended to reflect the added complexity and/or degraded conditions of facility at time of abandonment. For example, if a battery site of <49 m^3/d was constructed prior to 1990, the Unit Cost for facility abandonment would be the battery site Unit Cost of $46,600 multiplied by 20%, for a total of $55,920.

Well and Facility Reclamation

In addition to abandonment costs outline above, it is necessary to include costs to complete reclamation of the well or facility area. Reclamation of a well and facility

refers to remediation and surface reclamation of all land and water directly affected by the development, and typically involves the following:

Remediation

- For each area of site requiring decontamination: delineating extent of soil contamination; excavation and management of contaminated soil, and confirmatory sampling.
- Treat contaminated soil on-site or transport if off-site for disposal.
- Transport all other wastes for disposing off-site.
- Treating and monitoring residual contamination that cannot be excavated.
- Placing and contouring backfill.

Surface reclamation

- Conducting a detailed site assessment.
- Recontouring and stabilizing disturbed areas and slopes.
- Removing gravel and other surface materials.
- Replacing topsoil.
- Restoring surface drainage patterns.
- Planting, maintaining, and monitoring vegetation.

Depending upon the specific characteristics and lay-out of site infrastructure, reclamation costs can be included in the Wells and Facility section of the RECLAIM Model, or they could be split by incorporating them within the Building and Equipment section of the RECLAIM Model. Unit Costs are available in the RECLAIM Model to execute these reclamation activities (e.g. earthworks construction, land restoration activities, building teardown, site stabilization, monitoring, revegetation and seeding, etc.).

4.2.2 Buildings and Equipment

This worksheet outlines the demolition costs for buildings typically found at an industrial site. It is assumed inert debris (e.g. steel, concrete, wood, glass, plastic) may be disposed on-site in an approved location such as a landfill or other approved area specifically designated to accept these types of waste materials. However, if the amount of this material is greater than on-site capacity, it must be transported to an approved disposal facility and costs for transportation should be included in the estimate.

The area of each building is typically scaled by the ratio of the total height over an average 3m height. For example, the total area of a 6m high building would be the area of the footprint of the building multiplied by two. Unit Costs are then applied per m^2.

The provision of demolition costs on a cost per area is such that the completion of demolition can be readily quantified, and the security for this component can be refunded. This is opposed to providing the costs in terms of person days, which is more difficult to quantify for security refunds.

Effort for disposal and burial of demolition waste needs to be included in this worksheet.

Users should be aware that the demolition Unit Costs included in RECLAIM are established at a point in time based on historically available information and as such may not represent all current costs. This is due to a number of factors responsible for increased demolition costs in recent years, as follows:

- Increased requirement for decontamination in advance of demolition to provide environmental protection. Where demolitions costs are expected to form a significant component of the closure cost estimate, users are encouraged to retain qualified persons to estimate costs.
- Increased health and safety workplace culture.
- Increased expectation for recycling, which then requires more careful demolition.

Proponents are encouraged to discuss demolition activities and requirements with the GNWT prior to finalizing the demolition costs, especially if decontamination is required for remediation purposes.

4.2.3 Chemicals, Hazardous Materials and Contaminated Soil

This worksheet is intended to itemize the costs for three aspects of this component of site closure and reclamation:

- Inventory, collect, and contain chemicals, hazardous materials and contaminated soil for treatment or transport.
- Physically gather materials from various locations around the oil and gas site and secure for on-site treatment or for transport off-site.
- Off-site disposal fees at a certified facility.

In the GNWT's experience, even the best managed industrial or oil and gas project sites will have minor problems with hydrocarbon contamination associated with fuel handling and storage of waste oil, lubricants, coolants and hydraulic fluid. It is common at older sites to encounter problems with asbestos and/or PCBs.

Management of any of these materials must be addressed on an individual basis. This typically involves off-site disposal, though some hydrocarbon contaminated soil can be remediated on-site. Some sites produce a significant volume of hazardous waste, which may require a hazardous waste landfill to be developed on-site. This requires

sophisticated design and long-term monitoring to ensure that the wastes remain encapsulated post-closure.

4.2.4 Water Treatment

Water treatment is generally considered for a site to be either short-term (≤20 years years), or long-term. Examples of short-term water treatment could include: treatment of sediment pond or sump water prior to release; or treatment of water expected to reach acceptable quality for direct discharge within 20 years.

Long-term water treatment may be required to address groundwater contamination from a pump and treat extraction system. A more comprehensive list of what might be considered short-term versus long-term (i.e. post-closure) is described in Table 1. It is recognized that this definition of short-term versus long-term is somewhat arbitrary and the user is encouraged to use the worksheets as it best represents the expected situation and costs.

Given that water treatment may be considered short-term or long-term, this worksheet does not appear directly within the summary sheet. Rather, the "Water Treatment" worksheet is used to calculate a cost that then feeds into either the "Water Management" worksheet when costs are for short-term water treatment or the "Post-closure Monitoring and Maintenance" worksheet when costs are for long-term water treatment. In the "Post-closure Monitoring and Maintenance" worksheet, there is a provision for the future costs to be calculated as a discounted net present value.[2]

Table 1. Examples of What Would Typically be Considered Short-term Versus Long-term Water Management and Treatment

		Short-term (≤ 20 years)	Long-term (> 20 years)
Wells and Facilities	construct diversion ditches	x	
	breach ditches	x	
	install groundwater/well water collection system	x	
	collect and treat groundwater/well water		x
	treat and drain sumps and ponds	x	
	install passive treatment system	x	
	operate and maintain passive treatment system		x
Water Management	refill lakes		x
	redirect creeks/streams	x	
	stabilize water management ponds	x	

[2] Net Present Value discount rates need to be discussed with the GNWT. The provision of Net Present Value results in certain requirements for the form of this security.

		Short-term (≤ 20 years)	Long-term (> 20 years)
	stabilize/close sediment ponds	x	
	construct contaminated water storage pond	x	
	fresh water supply - breach embankment	x	
	fresh water supply - remove piping system	x	
	construct water treatment plant	x	
	construct sludge pond	x	
	water control in reclamation quarry	x	
	remove water pipelines	x	
	operate/maintain water treatment plant		x

4.2.5 Water Management (and Short-term Water Treatment)

This worksheet provides a list of activities associated with water management; in essence the closure activities needed to collect, control or restore surface or groundwater flows. Capital costs of water treatment systems are calculated within this worksheet, both for conventional active water treatment system and passive water treatment system.

As described above, there is a line included within this worksheet for short-term, or defined duration, water treatment calculated from the worksheet “Water Treatment”.

Alternatively, short-term water treatment costs may be included within a component worksheet. For example, sump water treatment and drainage activities may be added within the worksheet “Wells and Facilities”.

4.2.6 Interim Care and Maintenance

Very few industrial or oil and gas project sites commence closure work soon after operations cease.

Based on experience at abandoned mine and orphaned industrial sites in the NWT, it is assumed that a minimum period of time of 2-3 years is required to transfer ownership of the site to the GNWT, finalize a Closure and Reclamation Plan, retain a water licence for closure, mobilize equipment to the site, and conduct procurement activities to retain reclamation contractors. Care and maintenance costs should include personnel, camp, fuel, equipment and supplies. Water licence and land use permit requirements for environmental monitoring and maintenance will have to be met during this period, and have been shown to be a significant driver in overall interim care and maintenance costs.

4.3 Indirect Costs

Worksheets for the indirect costs of Post-Closure Monitoring and Maintenance and Mobilization/Demobilization are described in more detail in the following sections.

4.3.1 Post-Closure Monitoring and Maintenance

Post-closure monitoring and maintenance costs are estimated in the "Post-Closure" Worksheet. These should reflect the monitoring and maintenance identified in the Closure and Reclamation Plan. Common monitoring programs are the Surveillance Network Program (SNP), Aquatic Effects Monitoring Program (AEMP), groundwater, geotechnical, vegetation, and seepage. Other monitoring programs may be included to reflect the approved closure objectives for a particular project. Commonly, monitoring is conducted on a declining frequency at progressively fewer sampling points after closure.

Post-closure maintenance is typically required for all industrial or oil and gas project sites. For example, water diversion structures may require occasional clearing of debris and ice, revegetation or repairs to erosion sensitive terrain may be required over time.

When post-closure costs extend into the long term (for example more than 20 years), a discount rate may be applied when calculating the Net Present Value of the future series of annual monitoring and maintenance cost. This is appropriate provided that the future costs are estimated on the basis of current (or end of mine life) as opposed to nominal (inflated) costs. Proponents must discuss discount rates and their use with the GNWT.

Note that determination of future costs must include all parameters, including: site access, monitoring, labour, fuel, power and all reagents and supplies. The calculation of the net present value of a future series of costs may be complicated as costs, and the frequency in which these costs are incurred, may change in future years (e.g. a reduced monitoring program with a declining frequency). In these cases, supporting worksheets and/or calculations may be required.

4.3.2 Mobilization/Demobilization

Costs are estimated based on the assumption that a site has been abandoned after the owner becomes insolvent. Further, the assumption is made that the equipment and infrastructure has deteriorated to an advanced state of disrepair and has no material value (as has been the case for many abandoned sites in the north). Any equipment of value or that is salvageable is likely to be removed or sold to other local operators.

Mobilization/Demobilization of Equipment and Supplies

It is assumed a contractor would have to mobilize all equipment and infrastructure to the site in order to carry out the closure and reclamation work. Mobilization of fuel (including the costs of the fuel and of transport) is assumed to be necessary for every site.

Personnel Movement and Accommodation
In the case of remote sites, mobilization of workers at the beginning/end of each work rotation is included. Modifications to an existing camp or mobilization of a workers camp may be required to allow for use by smaller numbers of support staff during closure and reclamation, or post-closure activities.

4.4 Indirect Costs as a Percentage of Direct Costs

In addition to the indirect costs of Monitoring and Maintenance, and Mobilization/Demobilization, there are a number of indirect costs calculated as a percentage of the direct costs in the RECLAIM Model.

4.4.1 Project Management

Project management covers general project coordination, accounting and project control, quality assurance/quality control and oversight, change orders and as-built reports. Project management is assumed to be at least 5% of direct project costs.

4.4.2 Engineering

In preparing a liability cost estimate, it is typical to assume there is an existing, approved Closure and Reclamation Plan that can be converted to contract ready documents for closure activities (i.e. engineering is not required develop a closure plan) and that there are no dramatic departures from the approved Closure and Reclamation Plan.

In the RECLAIM Model, the engineering provision is for advancing the Closure and Reclamation Plan into a scope of work that can be provided to a contractor. Engineering includes preparation of Issued For Construction (IFC) drawings and specifications for the closure and reclamation work. Additional engineering may be required while the work is being carried out to address any unexpected issues.

Engineering is normally assumed to be at least 5% of direct project costs.

4.4.3 Health and Safety and Bonding/Insurance

The inclusion of costs for workers health and safety as well as insurance for work related injury are common in government contracting processes and as such are relevant to reclamation of industrial project sites. A provision of 1% of direct costs provides for preparation and administration of safety protocols, and relevant worker training.

4.4.4 Contingency

A contingency is added to cover both the uncertainty in the costing estimate (i.e. variability in quantity of work, Unit Costs and required scope of activities) and the possibility that some aspects of the closure and reclamation activities may be more difficult to perform. The determination of the contingency percentage is a subjective and project-specific task that relies on the judgement of the estimator. There is

commonly considerable debate between proponents and regulators about the most appropriate contingency percentage. Table 2 provides some guidance.

Table 2. Guidelines for Contingency Percentage

Estimate Type	Description	Contingency
Detailed or Project Control	Based upon detailed engineering "take-offs" and written quotes	5%
Definitive or construction drawing phase	Engineering mostly complete, some 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%

Most industrial or oil and gas project site Closure and Reclamation Plans and associated closure cost estimates are at the "feasibility or advanced conceptual" level until nearing the end of operations. This is due to lack of detailed engineering and uncertainty in the quantities of work. During the life of the project, reclamation research, operational experience (possibly from other industrial project sites), data from environmental monitoring programs, and engagement with affected parties may reduce uncertainty.

A low contingency would be indicative of a comprehensive database of site specific parameters, detailed engineering, and proven closure and reclamation measures. Proven measures are those that have been shown to be effective in conditions similar to those at the site, and the effort and cost associated with that work is well understood.

To the extent possible, if there are major areas of uncertainty in a Closure and Reclamation Plan, these should be addressed in the appropriate site component spreadsheet (i.e. groundwater monitoring, landfarm size, landfill design, cover designs, post-closure monitoring term, etc.). In some cases, it may be appropriate to consider a different level of contingency for different components of the closure cost estimate.

In RECLAIM v.7.0, contingencies are only applied to direct costs. However, for some liability estimates where there is a similar level of uncertainty, it may be appropriate to apply contingency costs to indirect costs as well.

4.4.5 Market Price Factor Adjustment

To account for times when economic activity is very high the RECLAIM Model includes a Market Price Factor Adjustment. It is recommended companies contact the GNWT to determine if the Market Price Factor Adjustment would apply for their cost estimate.

4.5 Segregation into Land or Water Related Costs

For each activity, the user can assign a percentage of each cost to either be included as a land-related cost or as a water-related cost. Examples of each are as follows:

- An activity such as building demolition would be 100% land liability;
- Treating sump water prior to discharge would be 100% water liability;
- Placing a soil cover over a landfill could be say 50% land liability in promoting revegetation, and 50% water liability in reducing seepage loading. This could vary based on site-specific factors.

4.6 Unit Cost Table

After having developed a comprehensive Closure and Reclamation Plan from which the reclamation activities have been scoped and quantified, the selection of Unit Costs to apply to each of these activities is required to derive a security estimate.

The Unit Cost table contains a list of many of the common reclamation activities that may be carried out at an industrial or oil and gas project site and the associated Unit Costs for each activity. To the extent achievable, the Unit Costs in the table are independent third party costs obtained from a review of northern reclamation projects conducted by third party contractors. Unless specifically noted, all Unit Costs are inclusive of equipment, labour, maintenance, fuel, consumables, and contractor profit.

For each activity in the Unit Cost table, there is a brief description of the activity and a one to four-character acronym, called the cost code, for that activity. Additional activities, with user-defined cost codes and Unit Costs, may be added to the Unit Cost table by the user.

Acronyms have been developed to reflect the activity it is intended to apply to. For example, if a reclamation activity such as covering a landfill for re-vegetation involves the excavation of soil which is readily excavated, hauled a short distance and dumped, then the cost code SB1L would be appropriate. This acronym translates roughly as Soil, Bulk, 1 (for short haul), low. If the excavation involved careful or controlled work, such as in ditch or spillway construction, then the SC1L cost code for Soil, Controlled, 1 (for short haul), low would be more appropriate.

For each Unit Cost, a range is provided from low (L) to high (H), which is intended to capture the variability in level of effort that may be required. For the example provided above, SB1L, the suffix L in the acronym indicates the cost for this particular activity is believed to be at the lower end of the range for soil movement. Factors such as an uphill haul, difficult excavation due to density, frozen zones or excessive boulders would require the use of the high cost suffix, H. In this way the selection of the cost code allows others to understand the assumptions of the estimator for the scope of work and intended effort. Users should document the assumptions used to select the appropriate Unit Cost.

4.6.1 Inflation

Unit Costs are based on the Canadian dollar at the time of the RECLAIM Model update. Unit Costs in RECLAIM v.7.0 were updated March 2014, more than 3 years ago. Adjustments for inflation should occur using a function in the RECLAIM Model described in Section 7. Inflation rates can be obtained from Statistics Canada (http://www.statcan.gc.ca/daily-quotidien/170224/dq170224a-eng.htm) or Bank of Canada (http://www.bankofcanada.ca/rates/related/inflation-calculator/).

Proponents are encouraged to discuss whether to consider inflation with the GNWT prior to completing their security estimate. For example, inflation can be considered for reclamation estimates when there is a time lapse between the estimate date and the calendar year in which the RECLAIM was last updated.

4.7 Specified Costs and Estimator

In some cases, rather than selecting a Unit Cost from the Unit Cost Table provided in RECLAIM, it may be appropriate to derive a project specific Unit Cost. If a proponent is proposing a specified Unit Cost, it should provide sufficient detail and rationale to allow others to review and assess the adequacy of these specified costs. All supporting calculations and documentation should be provided.

When using a specified cost, the Unit Cost can be inserted in the Unit Cost Table. Where these specified costs are to be used in calculations, the suffix "S" would be used instead of "L" or "H". For example, FCES = $0.49 kW-h is specific to electricity generation from a diesel generator. Alternatively, the specified cost can be simply inserted directly into the applicable worksheet in the Unit Cost Column.

Specified costs are typically derived from one of the following three methods, which are further described below:

- Quotes from qualified 3rd party contractors,
- Information provided by equipment suppliers, or,
- First principle cost estimating.

Quotes from Contractors

It is important to be very clear in obtaining costs from qualified contractors. The contractor's cost should include capital cost, fuel (consumption and mobilization unless mobilization is included elsewhere), tires, maintenance, support equipment, and an operators hourly rate. Ideally, the contractor should have knowledge of local conditions and how they may vary with seasons. The more information the contractor has regarding the scope of work and conditions, the more reliable the cost estimate to carry out the work will be.

Equipment Suppliers
Unit Cost data can be obtained from equipment suppliers. However, caution is warranted as a supplier is likely to provide only peak or optimal performance data. In all cases, adjustments will be required to reflect local cost factors such as labour rate and availability, or specific job site factors which affect productivity (cycle-times) such as weather and daylight hours.

First Principle Cost Estimating
First principle cost estimating means evaluating equipment productivity in terms of hourly production divided by hourly cost of operation. Productivity evaluation is a series of adjustments or corrections to the peak or optimal productivity rate for a given piece of equipment. For example, adjustment factors for an excavator would involve difficultly in digging (type and hardness of material), job geometry (side-hill), finish condition (ditch versus quarry operation), operator skill (fair, good, excellent), working time per hour and other appropriate site factors. The "Estimator" worksheet provides examples for productivity adjustments based on the Caterpillar Performance Handbook Edition 42. Another source of Unit Cost data is the RS Means Heavy Construction Costs.

4.8 Summary Sheet

The summary sheet presents the subtotals of capital and indirect costs to derive the total closure cost estimate.

It is within the summary sheet that the percentage of indirect costs that are to be assigned to “land liability” and “water liability” are calculated for determining the appropriate security. These percentages correspond directly to the direct costs that make up the total direct cost subtotal. The RECLAIM Model then applies these direct cost percentages to indirect costs. For example, if direct costs are calculated as being 20% land and 80% water, then the same percentages are applied to each indirect cost.

5 Using RECLAIM v.7.0

When you open RECLAIM v.7.0, depending on your computer’s security settings, the user may receive a SECURITY WARNING “macros have been disabled”. Select “Enable this content” within the options menu. A pop-up box will request the Project Name. Typically this is the name of the industrial or oil and gas project site, which appears at the top right of each worksheet. The program will then initialize, which should only take a few seconds.

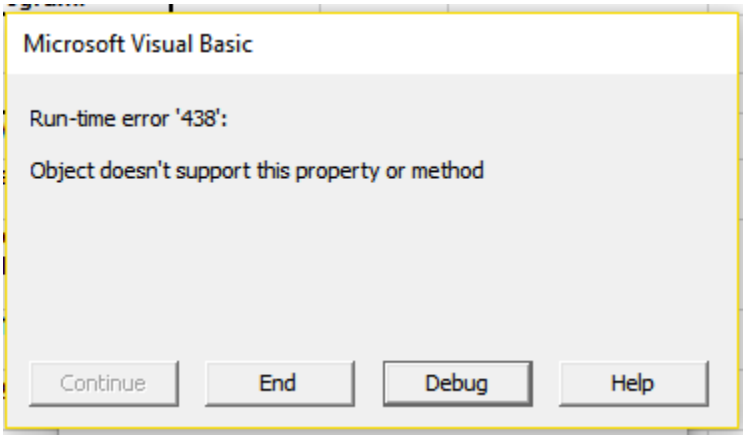
The program should open to the instructions sheet, which is an overview description of the program and details of program limitations. There are some requirements that must be met for the program to work. The following instructions should be reviewed prior to modifying the worksheets:

- The names of the worksheets must not be changed.

- Certain cells have defined names, which must not be changed. Where the cell is named, the name will appear in the name box.
- The first line of data for any component worksheet starts on line 4. Do not change the first line of a component worksheet.
- Cell A1 of the component sheet must always contain the "count" of that component for the duplicate function to work.
- The user can add lines to component activities in each worksheet and the Unit Cost table. However, the user should check that the new Unit Cost does not fall outside the named ranges. You can check the size of the named range by selecting the name from the drop-down box at the top left of the sheet. For example, in RECLAIM v.7.0 the Unit Costs range is to line 172 of the Unit Cost worksheet.
- A component will only be printed if its sub-total is greater than zero. In addition, a component and the summary sheet cannot be printed if there is an error. Printing has been set to print 1 page per worksheet.

5.1 Start-up Error Message

When you start RECLAIM, you may see the following dialogue box:



This message appears when the RECLAIM Model is opened with another Microsoft Excel file already open on the computer. In this situation, the RECLAIM Model macros have not been enabled. However, all other functions of RECLAIM Model are unaffected, and the calculation functions of RECLAIM are not affected in any way.

If you want the macros to function, the RECLAIM Model must be the first Excel file you open.

5.2 Completing Worksheets

Complete each of the individual worksheets by selecting the type of activity required, estimating the quantity (i.e. volume, area, length, etc.) in column E and assigning an appropriate Unit Cost code in column F.

Activity items can be added to component worksheets, either by changing the activity/material description in column B, adding the activity where the line item is purposely left as “other” or inserting a line and copying the content from an adjacent line.

As described in Section 4.5, activities are typically assigned a percentage as "land liability" which will be used to set land security and the remaining percentage as "water liability" which will be used to set water security.

5.3 Menu Descriptions

Functions specific to the RECLAIM Model are displayed in the tab “Add Ins” on the Excel menu bar. If this menu tab is not displayed, the functions are also found within the sheet titled “Tools”. A summary of the functions is provided in the Instructions worksheet and are described below:

Clear
Use this function to delete all input data, duplicated elements and to blank out the project name.

You can also hide or display segregation columns within the worksheets that ascribe the costs to either ‘water’ or ‘land” liability.

Note: The Clear function does not affect the Unit Cost table.

Duplicate
This function duplicates components of the project. For example, if you need more than one Chemicals worksheet, complete the activities and quantities for one Chemicals worksheet then use Duplicate to add a second Chemicals worksheet. Quantities for the new Chemicals worksheet are erased, but the Activities and Cost Codes are carried over from the original worksheet. The new Chemicals worksheet subtotal is added to the Summary page. The duplicate function can be used on the following worksheets: wells and facilities, buildings and infrastructure and chemicals.

Unit Costs
By selecting the show/hide function within Unit Costs a window of Unit Costs is displayed to the right of the open worksheet to allow the user to view the table of Unit Costs for ease of reference. The Unit Cost table has a filter in the 'UNITS' column. You can select to only see a particular unit (e.g. km) or multiple units (km and m^3) or all units.

By selecting the inflate function, Unit Costs can be increased by a percentage to account for inflation from the date the Unit Costs were last updated (RECLAIM v.7.0 was updated in March 2014).

Print All

This option prints the Summary Worksheet, Unit Cost Worksheet, and individual component worksheets that have non-zero balances. You can print individual worksheets directly using standard printing methods.