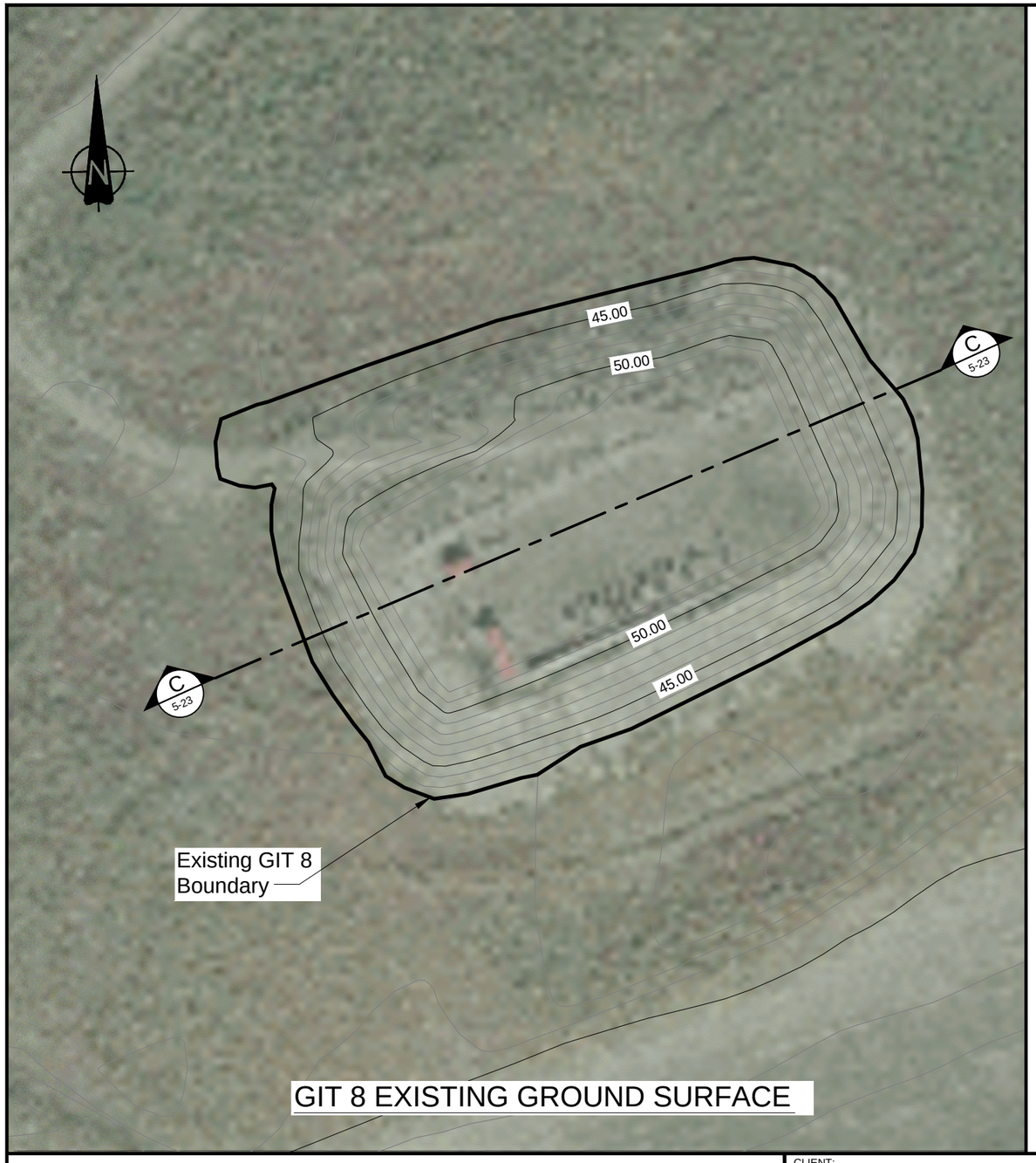
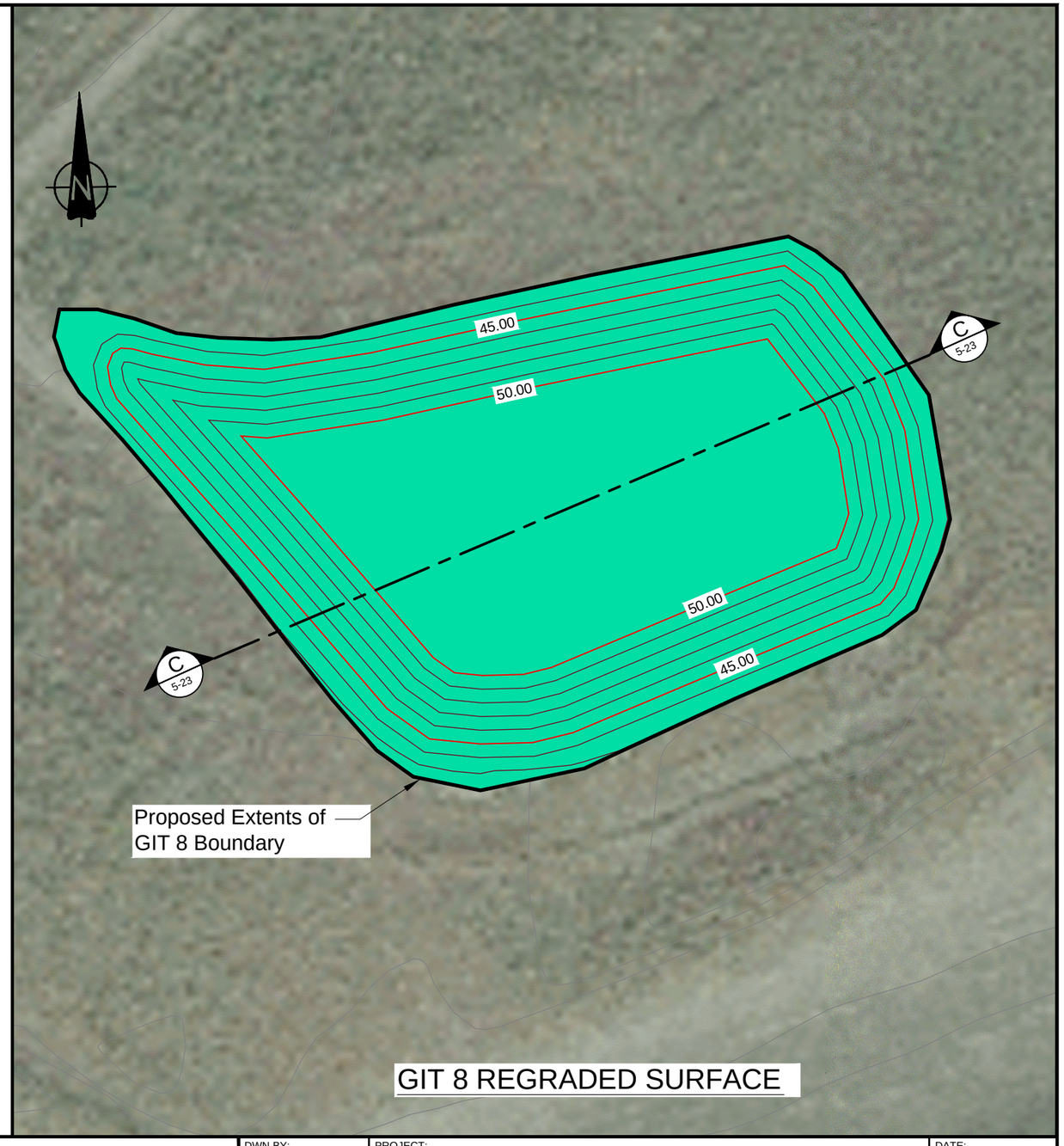


GIT 8 EXISTING GROUND SURFACE



GIT 8 REGRADED SURFACE

0m 10 20 30 40 50 60

1 : 1500

CLIENT:

IMPERIAL OIL LIMITED

amec foster wheeler

DWN BY:	MDDS
CHK'D BY:	BG
DATUM:	-
PROJECTION:	-
SCALE:	AS SHOWN

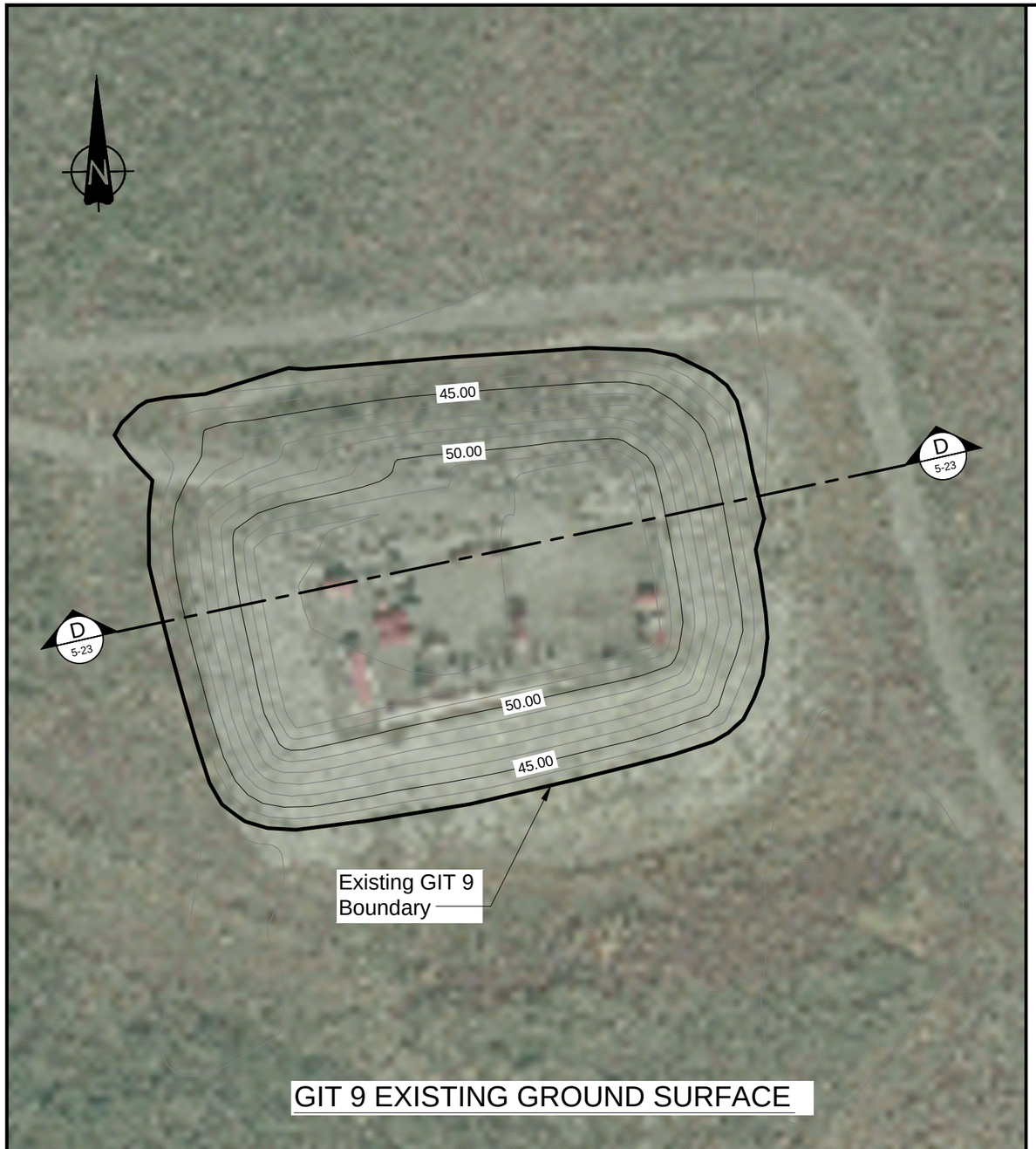
PROJECT:

NORMAN WELLS INTERIM CLOSURE
AND RECLAMATION PLAN

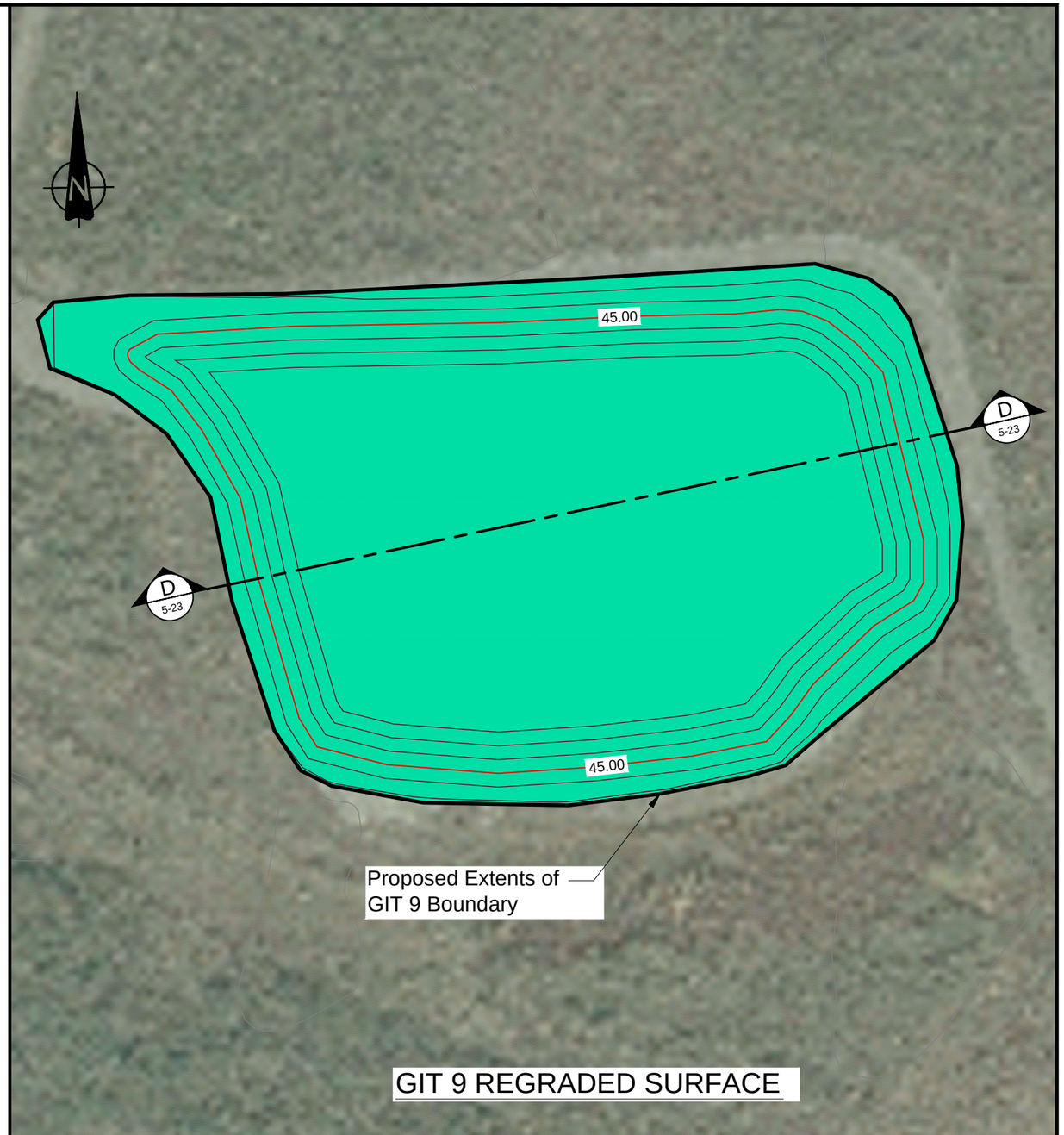
TITLE:

GIT8 PROPOSED REGRADED SURFACE

DATE:	OCT. 2015
PROJECT No.:	CC4058.300
REV. No.:	A
FIGURE No.:	FIGURE 5-21



GIT 9 EXISTING GROUND SURFACE



GIT 9 REGRADED SURFACE

0m 10 20 30 40 50 60

1 : 1500

CLIENT:

IMPERIAL OIL LIMITED

amec foster wheeler

DWN BY:	MDDS
CHK'D BY:	BG
DATUM:	-
PROJECTION:	-
SCALE:	AS SHOWN

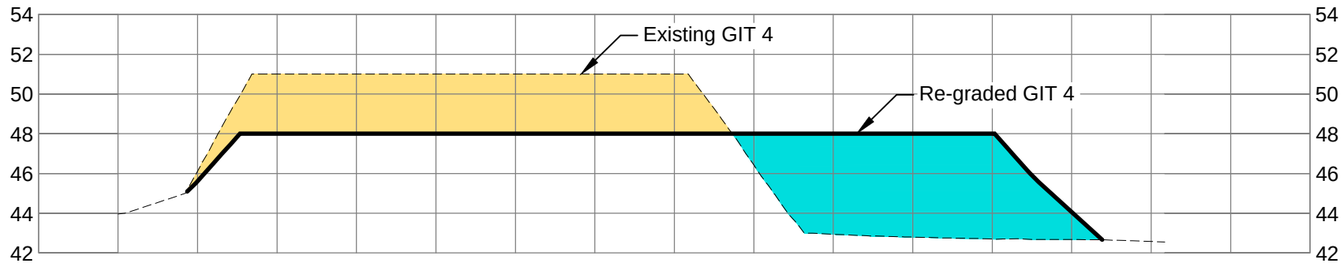
PROJECT:

NORMAN WELLS INTERIM CLOSURE AND RECLAMATION PLAN

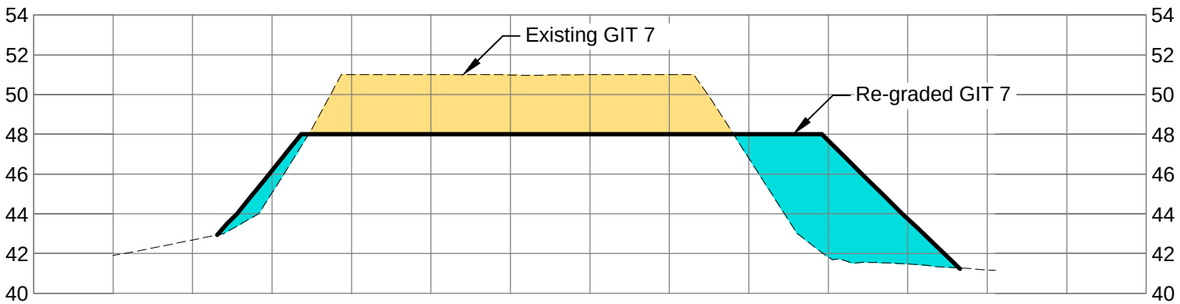
TITLE:

GIT9 PROPOSED REGRADED SURFACE

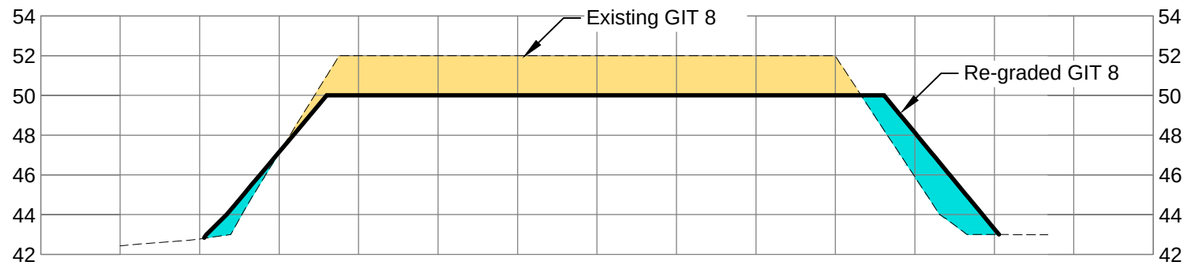
DATE:	OCT. 2015
PROJECT No.:	CC4058.300
REV. No.:	A
FIGURE No.:	FIGURE 5-22



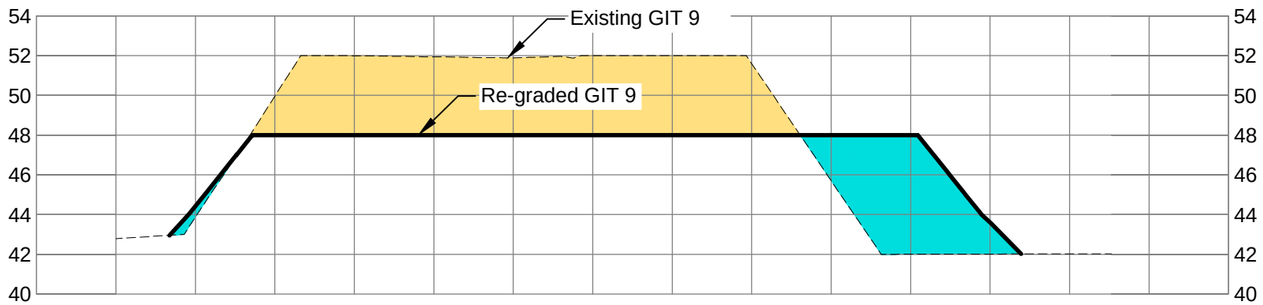
AA 5-19 GIT 4 - SECTION
5x Exaggeration



BB 5-20 GIT 7 - SECTION
5x Exaggeration



CC 5-21 GIT 8 - SECTION
5x Exaggeration



DD 5-22 GIT 9 - SECTION
5x Exaggeration

Cut Surface

Fill Surface

0m 10 20 30 40 50 60
1 : 1500

0m 3 6 9 12
1:300

CLIENT: IMPERIAL OIL LIMITED

amec foster wheeler

DWN BY:	MDDS
CHK'D BY:	BG
DATUM:	-
PROJECTION:	-
SCALE:	AS SHOWN

PROJECT: NORMAN WELLS INTERIM CLOSURE AND RECLAMATION PLAN

TITLE: GOOSE ISLAND GIT SECTIONS

DATE:	OCT. 2015
PROJECT No.:	CC4058.300
REV. No.:	A
FIGURE No.:	FIGURE 5-23

LEGEND

- Re-graded BIT Surface
- Road/Pad Removal

NOTES

1. Impacted soil is relocated to the Mainland LTMF.
2. Shale surfaces are relocated to impacted excavations for use as fill.
3. Remaining shale surfaces from roads and well sites is relocated excavated sump area.
4. BIT's are graded to slope of 3H:1V or less.

0m 100 200 300 400

1 : 10000

CLIENT: IMPERIAL OIL LIMITED

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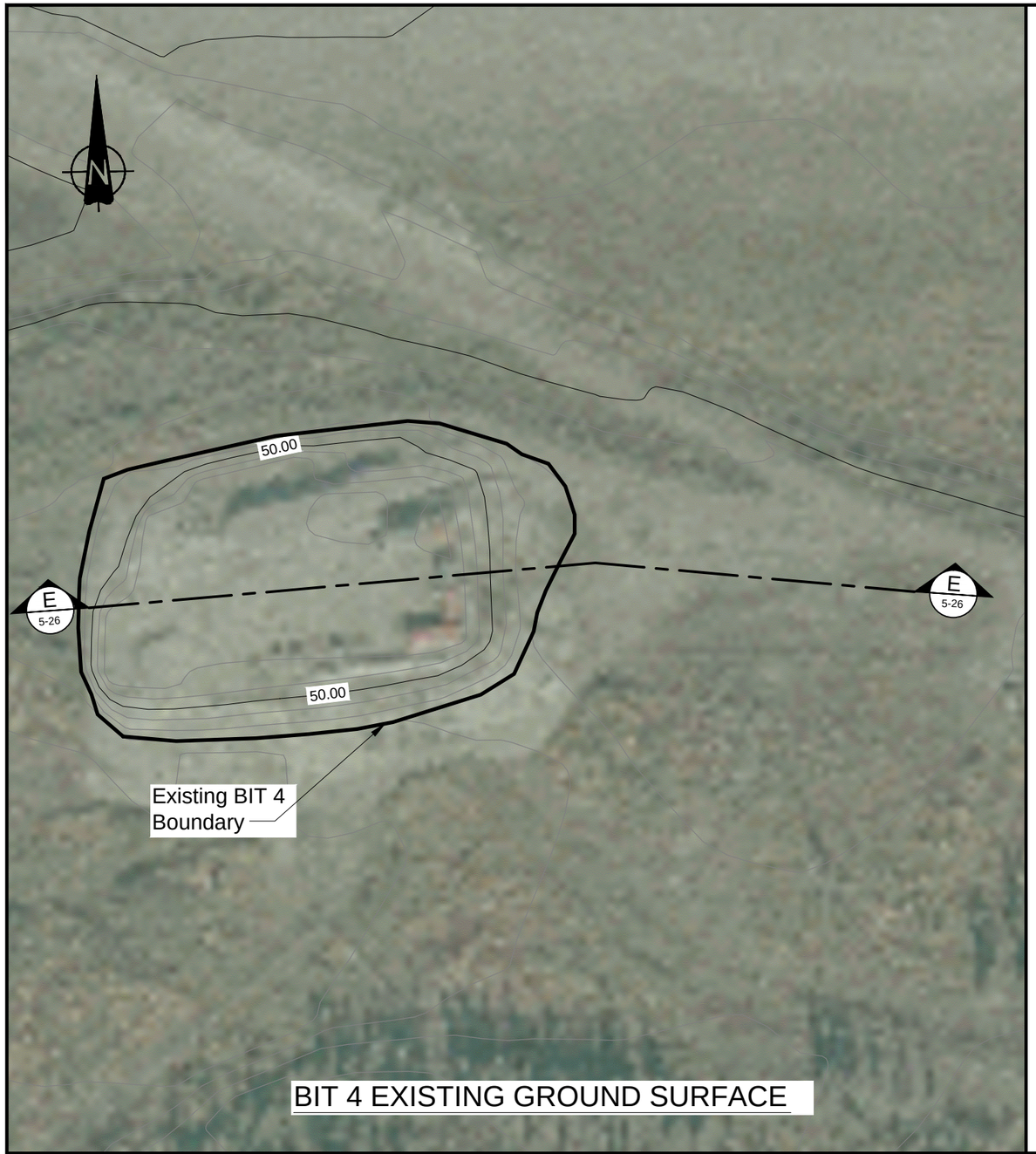
DWN BY:	MDDS
CHK'D BY:	BG
DATUM:	-
PROJECTION:	-
SCALE:	AS SHOWN

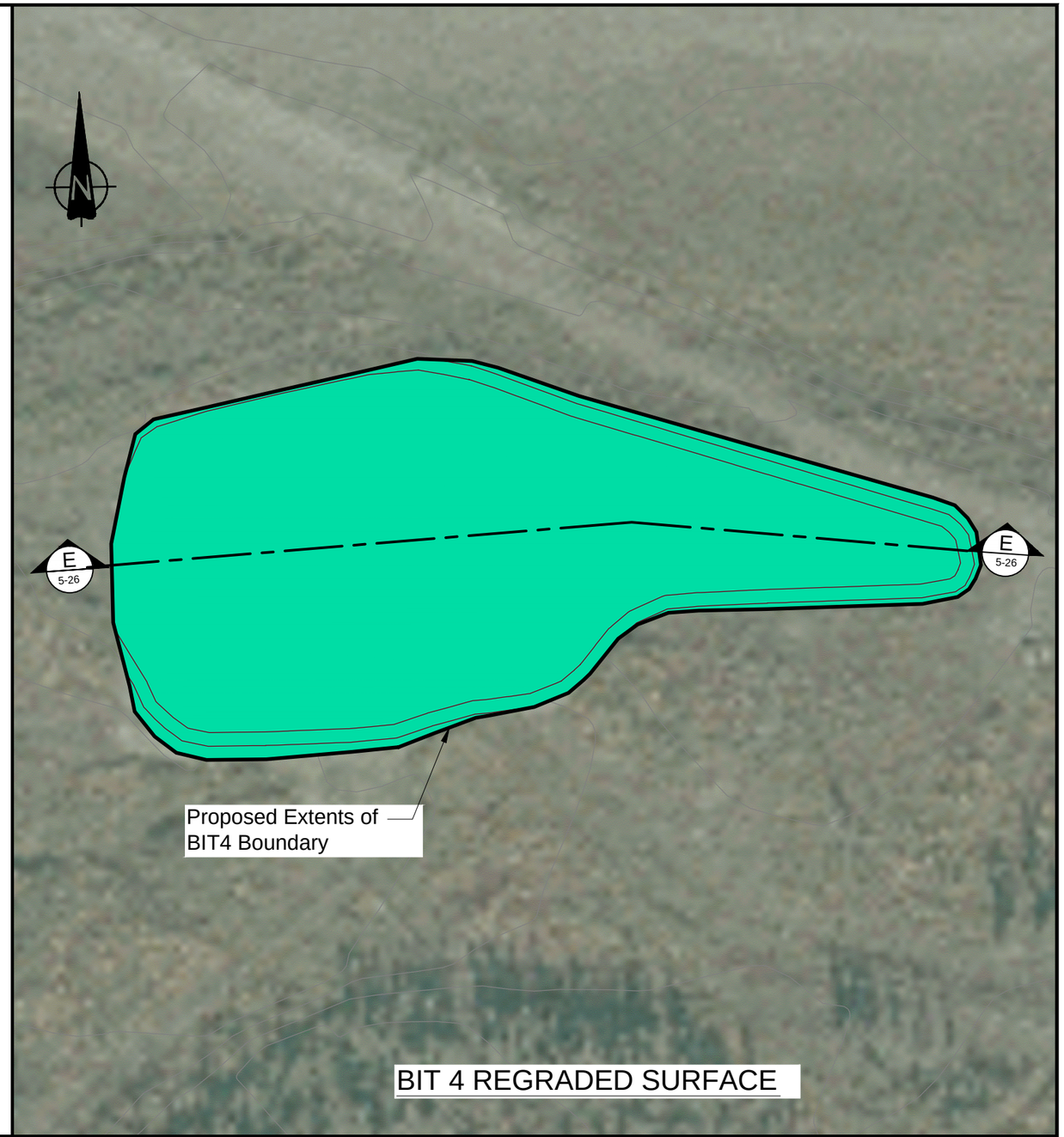
PROJECT: NORMAN WELLS INTERIM CLOSURE AND RECLAMATION PLAN

TITLE: BEAR ISLAND RECLAMATION

DATE:	OCT. 2015
PROJECT No.:	CC4058.300
REV. No.:	A
FIGURE No.:	FIGURE 5-24



BIT 4 EXISTING GROUND SURFACE



BIT 4 REGRADED SURFACE

0m 10 20 30 40 50 60

1 : 1500

CLIENT:

IMPERIAL OIL LIMITED

amec foster wheeler

DWN BY:	MDDS
CHK'D BY:	BG
DATUM:	-
PROJECTION:	-
SCALE:	AS SHOWN

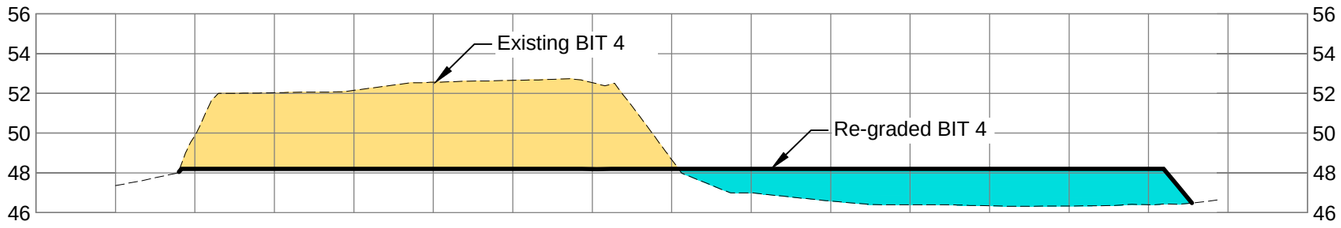
PROJECT:

NORMAN WELLS INTERIM CLOSURE
AND RECLAMATION PLAN

TITLE:

BIT4 PROPOSED REGRADED SURFACE

DATE:	OCT. 2015
PROJECT No.:	CC4058.300
REV. No.:	A
FIGURE No.:	FIGURE 5-25



EE 5-25 BIT 4 - SECTION
5x Exaggeration

Cut Surface

Fill Surface

0m 10 20 30 40 50 60
1 : 1500

0m 3 6 9 12
1:300

CLIENT: IMPERIAL OIL LIMITED

amec foster wheeler

DWN BY:	MDDS
CHK'D BY:	BG
DATUM:	-
PROJECTION:	-
SCALE:	AS SHOWN

PROJECT: NORMAN WELLS INTERIM CLOSURE AND RECLAMATION PLAN

TITLE: BEAR ISLAND BIT SECTION

DATE:	OCT. 2015
PROJECT No.:	CC4058.300
REV. No.:	A
FIGURE No.:	FIGURE 5-26

- it runs counter to the general C&R planning principle of consolidating post closure land use restrictions over as limited a geographic footprint as feasible;
- it would create a separate post closure operations and maintenance liability; and
- it would place a long term waste management facility in close proximity to an active river channel subject to substantial ice action.

5.5.2.5 Engineering Required

The planning and engineering required for the Natural Islands component would be integrated with requirements described previously for the Mainland component. More specifically, the following plans described in Section 5.4.1.6 would include sections addressing scope on the Natural Islands:

- the Excavation Plan;
- the Remediation and Reclamation Materials Management Plan;
- the Verification Plan;
- The Regrading Plan; and
- the Revegetation Plan.

In addition, the LTMF planning and design activities outlined in Section 5.4.1.6 relate to the Natural Islands component in as much as a significant portion of LTMF capacity will be devoted to the management of contaminated materials from the Natural Islands.

5.5.2.6 Final Site Conditions

The final conditions proposed for the Natural Islands component are those illustrated on Figures 5-18 and 5-26, and described in Section 5.5.2.3.2.

5.5.2.7 Residual Effects

The reclaimed landscape on the Natural Islands will vary from pre-development conditions and, in some respects, from surrounding lands. In particular, the contoured shale consolidation sites around the GITs represent a change to the local landscape. However, the result is compatible physically and aesthetically with the regional landscape.

5.5.2.8 Uncertainties

The following technical uncertainties will have an influence on the development and/or execution of the proposed C&R activity for the Natural Islands component:

- Excavation Methods: it is possible that unanticipated ground conditions could increase the complexities associated with excavating contaminated soils and relocating them to the LTMF (e.g., sloughing sands, very wet soils); however, it is likely that these conditions could be adequately mitigated via adjustments to excavation methods, temporary slopes and/or equipment.

- Revegetation: the success of revegetation efforts may vary across the site and fail to meet objectives in some areas. This will likely be mitigated by appropriate monitoring and Adaptive Management protocols (again, see Section 5.7).

5.5.3 Artificial Islands

This section focuses on the remediation and reclamation activities for the Artificial Islands in the Mackenzie River channel. C&R activities related to the Buildings and Equipment, Wellbores and Subsurface Infrastructure components that include scope on these islands is described in Sections 5.5.5, 5.5.6 and 5.5.7, respectively.

5.5.3.1 Existing Conditions

.1 Physical Description

As described previously in Section 4.0, the following islands were constructed by Imperial in the Mackenzie River channel:

- Artificial Island 1 (RAYUKA);
- Artificial Island 2 (RAMPART);
- Artificial Island 3 (DEHCHO);
- Artificial Island 4 (EKWE);
- Artificial Island 5 (ITEH K'EE); and
- Artificial Island 6 (LITTLE BEAR).

The islands were constructed between 1983 and 1984 to the following general design (Loman et al. 1983 and Glenbow Museum 1983):

- islands are located in relatively shallow water (in the range of 5 m at low water conditions) near the edge of the main river channel;
- islands are constructed with a sand core dredged from the river channel contained with a rock berm sourced from the local quarry;
- the rock berm is protected as required by armour comprised of riprap, stone and/or gabions constructed with the necessary filter layers; and
- the upstream slope of the islands is constructed with an ice pile-up storage berm with a comparatively shallow slope (i.e., in the range of 10:1 (horizontal to vertical)).

Imperial routinely monitors the physical integrity of the islands via a Water Licence obligation to conduct annual physical inspections and bathymetric surveys. These surveys are undertaken to (Imperial 2014c):

- determine the amount of cover that exists over eight cross river flowline bundles located in the bed of the Mackenzie River;

- monitor the riverbed immediately adjacent to eight cross river flowline bundles enabling interception of scour hole (areas where removal of underwater bed material has taken place) movement towards flowline bundles;
- monitor the riverbed at the base of the six artificial islands, and Bear and Goose causeways for possible erosion or scouring;
- monitor the build-up or movement of the sandbars over the flowline bundles; and
- identify any changes in the shape and elevation of the riverbed in the areas adjacent to the islands, causeways and dock.

These surveys form the basis of annual maintenance efforts for the islands, typically via the replacement and/or supplementing of riprap armour. The general riverbed and Artificial Islands contours following the 2014 survey are shown on Figure 5-27.

.2 Contaminant Conditions

The representations of contaminated soil distributions on the Artificial Islands used to support C&R planning were provided on Figure 5-1. This figure was developed as described in Section 5.2.4. For the most part, the Artificial Islands soil representations on this figure are general provisions for the contaminated material volumes that are anticipated to be associated with the comparatively minor spills of produced fluids and glycol that have occurred over the years. Accurate characterizations of the volumes involved are not available, but the totals are expected to be minor to modest in the context of the entire Proven Area contaminated soil inventory, and likely to be captured by the total volume provisions on Figure 5-1.

5.5.3.2 Component Specific Objectives

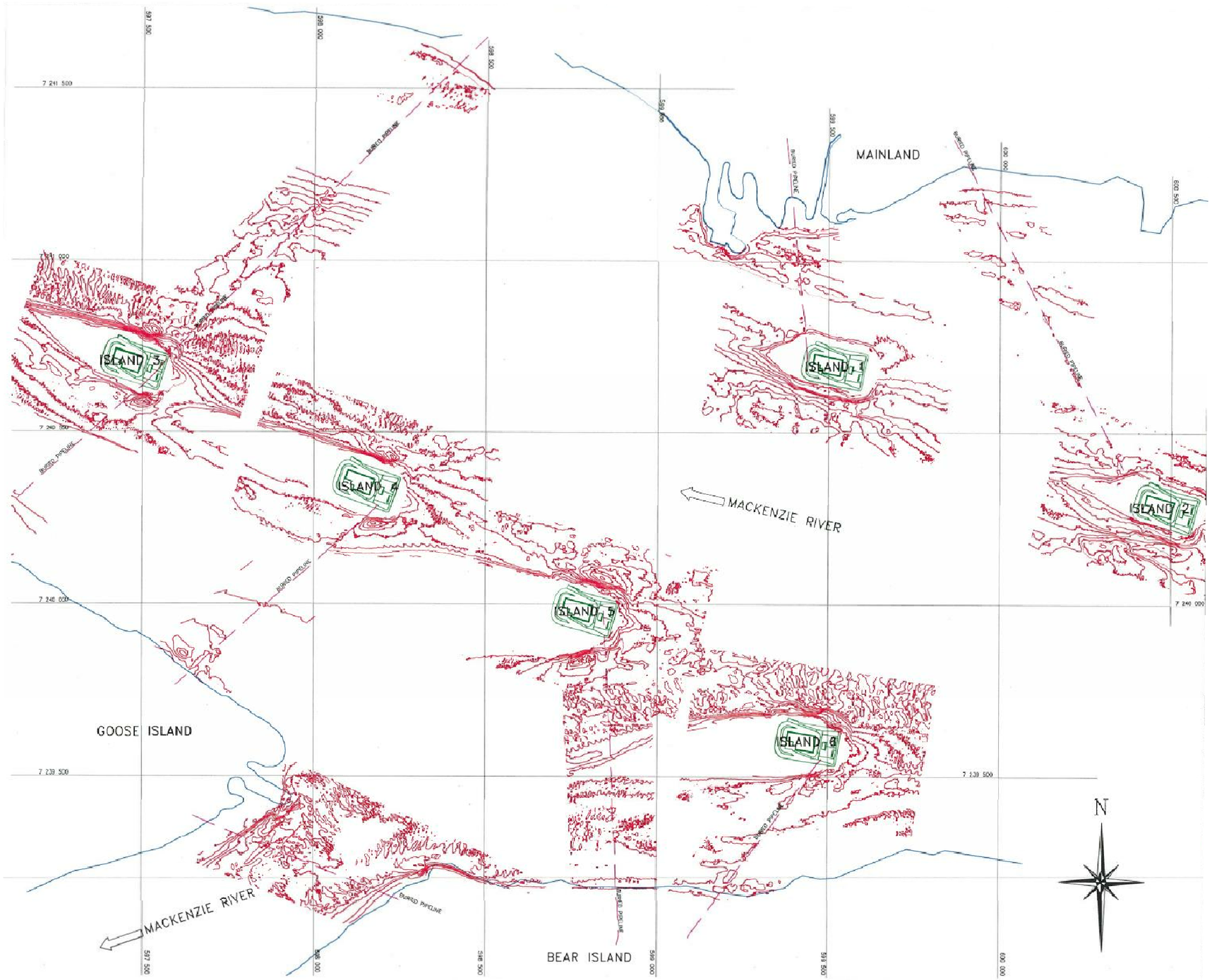
The closure objectives and criteria that apply specifically to the Artificial Islands Component are outlined in Table 5-7. The basis and derivation of these objectives and criteria were described in the general planning discussion included in Section 5.2.

As discussed in Section 5.5.3.7, the suitability of the CCME Parkland soil remediation criteria for the long term protection of Mackenzie Rover sediments will be assessed in future updates to this Interim C&R Plan.

5.5.3.3 Proposed C&R Scope and Activity

.1 Remediation

Remedial activity proposed for the Artificial Islands is comparatively straightforward and follows from the general description of the C&R Plan outlined in Section 5.4.1. Contaminated soils will be excavated to limits satisfying CCME Parkland Criteria, with the excavated soils relocated and either treated (see discussion in Section 6.3) or consolidated within the Mainland LTMF. The associated materials movements will be undertaken according to the plans and schedules outlined in the general C&R Materials Management Plan in Section 5.6 and the Integrated Schedule of C&R Activities provided in Section 8.0.



amec foster wheeler	PROJECT NAME: NORMAN WELLS	PROJECT NUMBER: CC4058
CLIENT: IMPERIAL OIL LIMITED	SHEET TITLE: CLOSURE AND RECLAMATION PLAN ARTIFICIAL ISLANDS RIVER BED AND ISLAND CONTOURS	FIGURE NUMBER: 5-27
		ISSUE/REVISION: A

Table 5-7: Objectives and Criteria for the Artificial Islands Component

Component	Media	Objective	Criteria	Actions-Measurements
Artificial Islands	Air	Dust levels at the closed and reclaimed site safe for people, vegetation, wildlife, and aquatic life	Dust/total suspended particulate levels that meet appropriate *NWT ENR Guideline for Ambient Air Quality Standards in the Northwest Territories*	Monitoring of dust levels by qualified professionals
	Land	Soil that is safe for people and the environment and compatible with the defined future land use	Remediated soils that meet: 1. CCME criteria suitable for Parkland Land Use, or site-specific risk based criteria (as appropriate for future land and water use and protection of site-specific human and ecological receptors); or 2. If greater, background conditions	Confirmatory sampling by qualified professionals
		Closed and reclaimed landscape that is physically stable, safe and generally compatible with the surrounding natural area	Satisfactory final inspection by qualified professional engineers	Post-closure assessment and documentation by qualified professionals
	Water	Closed and reclaimed artificial islands that do not cause an adverse effect to Mackenzie River water quality	Surface water and groundwater quality (at representative downstream locations) that meets: 1. CCME guidelines, or site-specific risk based criteria (as appropriate for future water use and protection of site-specific human and ecological receptors); or 2. If greater, background water quality	Surface water quality monitoring, at representative downstream locations, by qualified professionals

.2 Reclamation

Imperial has examined various alternatives for post closure disposition of the Artificial Islands and concluded that the preferred approach will likely be to let the natural erosional and displacement processes of the Mackenzie River return the sands in the core of the islands to the riverbed after removal of all or portions of the existing island armouring. The armour material (i.e., riprap, gabions, large gravels) will be returned to the Mainland at closure and incorporated into surface reclamation plans or returned to the source quarry owned by the Town of Norman Wells. Any filter cloths exposed in the removal of armour will be directed to the Mainland LTMF for disposal. The island berms below the armour will be left in place and displaced over time by the combined actions of ice and river flows.

5.5.3.4 Consideration of Options

Disposition options for the Artificial Islands are considered as part of Imperial's regular examination of abandonment and restoration costs for the Operations. A discussion of the available alternatives was provided in AGRA (1999) and is summarized as follows.

The four scenarios considered for disposition of the islands were:

- Partial Dismantlement and Passive Erosion - remove areas of critical slope protection and allow the river to gradually erode the remaining armour and sand core of the islands.
- Full Dismantlement and Passive Erosion - removal all slope protection and island armouring down to the winter water level. Allow the river to erode and dispense the sand core of the islands.
- Full Dismantlement and Active Removal of the islands.
- Minimal Action - leave the islands intact removing only the wellhead and associated production facilities.

.1 Methodology

A deconstruction plan was developed for the complete removal of a typical island. In general, the work was split into summer and winter phases, with deconstruction and removal of the frozen above-water island materials taking place in winter and deconstruction of the unfrozen, wet, below-water materials effected during the summer.

.2 Technical Feasibility

While there would be some complexities associated with the more active deconstruction options, there were no technical constraints that would prevent consideration of any of the scenarios.

.3 Potential Impacts

Sediment

The principal environmental impact arising from island dismantlement would be sediment dispersion as a result of removal or erosion of materials below water level. Of the four plans, active removal of the islands would induce the largest sediment impact. However, the increase in river sediment concentrations would be marginal when compared to the high natural sediment loading typical of the Mackenzie River in summer. Under the passive erosion scenarios, it is likely that the sand particles transported by normal summer flows would increase the deposition along the north and west shoreline of Goose Island. This is an area of natural aggradation of the riverbed, and additional material provided by the Artificial Islands would simply increase the rate of accretion in these areas.

Water Quality

No major water quality impacts, apart from the increased sediment loading and any associated turbidity discussed above, were anticipated. The potential impact of turbidity increases on any local fishery may require additional assessment.

Ice Jam Formation and Break-up

Removal of the Artificial Islands would reduce the local potential for ice pile-up on the upstream face of the islands. Removal of Islands Nos. 1 and 2 may reduce the severity of ice pile-up along the north shore of the river by allowing larger ice floes to pass more readily through this presently constricted flow area.

As far as ice jams are concerned, there has been no recorded instance of solid ice at Norman Wells holding back an ice jam. Furthermore, the channel configuration in the area is not conducive to the formation of an ice jam key. The Artificial Islands, or absence of them, are unlikely to have any impact on the occurrence of ice jams in this reach of the river.

Navigation

Removal of the islands would not significantly affect overall navigability of the Mackenzie River. However, the passive erosion plans (Scenarios 2 and 3 above) will likely result in the retention of some restrictions to vessel movement in the area (i.e., the continuation of current constraints imposed by the islands).

Total “erosion” of the partially deconstructed islands by river and ice action may take years to decades, or even centuries. While the sand core may be relatively quickly dispersed (on the order of years), larger rock and armour would likely be slowly removed by ice plucking. Even so, the islands are only susceptible to attack by ice on those portions of the island above the break-up water level (i.e., between 44 and 46 masl).

Inside the islands’ sand cores, below the level of ice action, are large rock berms that can only be transported by infrequent flood events, occurring as seldom as every 500 to 1,000 years. Hence, remnant “mounds” of sand and exposed rock would be left submerged in the river at

summer water levels. These mounds would need to be flagged as navigation hazards. The nature and significance of these hazards, and the specific methods for marking them, would need to be reviewed with Transport Canada. However, they are not anticipated to create unworkable impediments to the navigational utility of the river.

The minimal action scenario will result in a river erosion process similar to the passive erosion scenarios unless an armour maintenance program is implemented. Without an armour maintenance program, the islands may come, over geologic time, to resemble relatively stable mounds with partial armour cover and lower profiles than the existing artificial islands.

.4 Costs

The costs for the disposition options vary with the scale of the materials management effort associated with each. The minimal action alternative is, of course, the least costly approach and the full, active dismantlement the most costly. The passive erosion options offer significant economies over full, active dismantlement, again, with the specific benefits directly related to the proportion of the armouring materials inventory removed.

Selected Alternative

The Partial Dismantlement and Passive Erosion alternative was selected to strike a reasonable balance between cost and the time lag associated with developing a comparatively stable riverbed and bank topography. The specific proportion of the armouring inventory that would be removed under this scenario would be defined on the basis of a more detailed analysis. This alternative is anticipated to have minimal and tolerable impacts on the ecology and navigational utility of the river. Again, this view will be further examined and validated on the basis of more detailed analysis.

5.5.3.5 Engineering Required

Over the intermediate term, Imperial is planning to undertake a more detailed analysis of river dynamics with a view towards refining the predictions of material displacements following the removal of armouring. The outcomes of this study will also be used to validate the current proposal for reclamation of the Artificial Islands and would be described in subsequent updates of this C&R Plan.

The river dynamics study will provide inputs to the detailed execution plan for the Artificial Islands component that would be developed prior to closure. This plan will detail the armour removal requirements and describe how the associated schedules would be integrated with the broader C&R program execution schedule.

The river dynamics study will also include a consideration of the fishery local to the Artificial Islands and the potential impacts to that fishery of island material displacements.

5.5.3.6 Final Site Conditions and Residual Effects

The displacement of Artificial Islands materials will have the impacts on riverbed topography, ice action and navigation described above for the passive erosion alternatives. The specific nature and scale of these impacts, and the definition of any associated mitigative actions that may be required, will be defined on the basis of the upcoming river dynamics study. Any mitigative action defined on the basis of this study will be outlined in subsequent updates to this C&R Plan.

Imperial recognizes that any long term impacts to the navigational characteristics and constraints of the Mackenzie River following closure will be a significant issue. The specific measures required to ensure the viability and safety of the river as a transportation corridor will be addressed in consultation with local and regulatory stakeholders, and will be included in those updates to this C&R Plan prepared following the proposed river dynamics study.

5.5.3.7 Uncertainties

The outcomes of the river dynamics study may lead to adjustments in the scope of the Artificial Islands removal scope (e.g., unanticipated material displacements creating unacceptable residual effects could require mitigation via an increase in the proposed material removal scope). While these changes could have a significant influence on the scope of this component, the likely impacts on the general nature and scale of the proposed C&R Plan would be limited.

One specific issue that will be re-evaluated in light of the outcomes of the river dynamics study will be the suitability of CCME Parkland criteria for the relatively small inventory of impacted soil on the Artificial Islands. Once the long term disposition and fate of all islands soils is more clearly defined, the suitability of these Parkland remediation criteria for protecting the quality of river sediment post closure will be assessed.

5.5.4 Natural Watercourses

The Natural Watercourses component is comprised primarily of the surface waters and sediments in the Mackenzie River and Bosworth Creek. This component also captures the relatively small, local waterbodies that are present on the Natural Islands and other areas on the Proven Area.

5.5.4.1 Existing Conditions

The conditions of surface waters and sediments in the Mackenzie River and Bosworth Creek were described in the discussion of baseline conditions provided in Section 3.3.1. These conditions are routinely monitored and reviewed with community stakeholders under the mandate of the Aquatic Effects Monitoring Program (AEMP) that Imperial undertakes and manages. For emphasis, highlights of the baseline description outlined in Section 3.0 are provided below.

.1 Sediment Quality

Mackenzie River sediments have been sampled as part of Imperial's Aquatic Effects Monitoring Program (AEMP) to assess the effects of the Operations on the river. Sediments were collected over a two year period (2003/2004) from sites located upstream of the Town of Norman Wells, downstream of a naturally occurring hydrocarbon seep, and downstream of the Operations. Samples were analyzed for Polycyclic Aromatic Hydrocarbons (PAHs). Small concentrations of PAHs (below levels harmful to fish and other aquatic life) were present in all of the sediment samples collected from the Mackenzie River.

Concentrations of PAHs downstream of the Operations were the same as that measured upstream; which suggests that the Operations are not adding more PAHs to the river sediments than what is naturally occurring. Sediment samples taken in proximity to natural hydrocarbon seeps did show small increases in PAHs as compared to upstream samples; which indicates these natural seeps are a source of PAHs entering the river and suggests that contamination of sediments, where it might be observed, is linked to naturally occurring seepage.

.2 Surface Water Quality

Several in-depth water quality studies have focused on hydrocarbons in the Mackenzie River at Norman Wells were conducted in the 1980s and 1990s (EVS 1985, 1986; Nagy et al. 1987; Hrudey and Associates 1988; Indian and Northern Affairs Canada 1997; Environment Canada 1998). In general, levels of anthropogenic contaminants and petroleum hydrocarbons downstream of Norman Wells have been found to be similar to levels observed upstream in the Mackenzie River or in other northern rivers. In summary, the main findings have been previously summarized as follows (Imperial 2003):

- Analysis of water samples collected upstream and downstream of the Imperial Refinery showed very low concentrations of alkanes and polynuclear aromatic hydrocarbons (PAHs), despite the presence of natural hydrocarbon seepage at Norman Wells.
- Slightly higher concentrations of polychlorinated biphenyls (PCBs) were found in both the east and west portions of the Mackenzie River compared to other northern rivers studied.
- Concentrations of hexachlorocyclohcxane (HCH) were lower in the Mackenzie River than in other rivers flowing to either the Arctic Ocean or Hudson's Bay.
- Dinitrodimethyl toluene (DDT) concentrations were roughly similar among rivers flowing to the Arctic Ocean, but they were higher than those in rivers draining into Hudson's Bay.
- Concentrations of chlorobornancs (CI-Ms) were too close to the limit of detection to be interpreted.

An additional water quality study took place from just prior to the decommissioning and dismantling of the Operations' Refinery (Imperial 2003). Environment Canada (1998) analyzed six samples from the Mackenzie River at Norman Wells for 16 PAHs over the study period (June 1995 to June 1996). The majority of the PAHs were at or near the limit of detection (i.e., 10 to 30 ng/L) in all samples. The only exception was one sample (from of a total of 96)

with detectable concentrations of 2-methylnaphthalene (2-MTNPH) (20 ng/L) and l-methylnaphthalcne (1-MTNPH) (13 ng/L). These results were consistent with those obtained in the previous studies highlighted above, which found low levels of PAHs in all segments of the Mackenzie River examined.

Water quality information for Bosworth Creek appears to be limited prior to dismantling of the weir (ESRF 2009). Preliminary water chemistry sampling was done on nine streams including Bosworth Creek as part of a winter road stream survey in the Norman Wells area during July to September (Low et al. 1997). Sampling at Bosworth Creek included measurements of water and air temperature, dissolved oxygen, pH, and minimum and maximum flows. Water velocities varied from 0.55 to 0.88 m/s, pH averaged 8.3, and dissolved oxygen averaged 6.2 mg/L (ESRF 2009).

River water quality monitoring data compiled under the AEMP and reviewed with the community are summarized in Table 5-8.

Table 5-8: Mackenzie River Water Quality Summary (Imperial 2015a)

Parameter (Open Water)	Mackenzie River Above Norman Wells (Reid, Block and Chapman 1975)	Mackenzie River Above Norman Wells (Community Monitoring 2012)*	Mackenzie River Above Norman Wells (Community Monitoring 2013)*	Mackenzie River Downstream at Radar Island (Community Monitoring 2013)*
pH	8.1	8.2	7.9	8.1
Chloride (mg/L)	5.4	7.3	5.4	6.3
Total Organic Carbon (mg/L)	13	10.1	3.2	6.4
Dissolved Arsenic (mg/L)	<0.004	0.0003	0.0005	0.0008
Total Cadmium (mg/L)	<0.001	0.0002	0.00005	0.0002
Total Iron (mg/L)	4.9	11.9**	0.063	4.3
Total Lead (mg/L)	0.005	0.0067	0.0003	0.0023
Total Mercury (mg/L)	<0.05	0.00005	0.00006	0.00002
Total Zinc (mg/L)	0.011	0.0507	0.0025	0.0242

* Some parameters were converted from micrograms per litre to milligrams per litre.
** Event in August 2012 increased average iron for that year.

.3 Quality Overview

The water and sediment quality data compiled over the years for local watercourses provides no indication of any significant anthropogenic impact that can be associated with the Operations.

5.5.4.2 Component Specific Objectives

The closure objectives and criteria that apply specifically to the Natural Watercourses Component are outlined in Table 5-9. The basis and derivation of these objectives and criteria were described in the general planning discussion included in Section 5.2.

Table 5-9: Objectives and Criteria for the Natural Watercourses Component

Component	Media	Objective	Criteria	Actions-Measurements
Natural Watercourses	Land	River and creek banks that are stable and compatible with surrounding lands	Satisfactory final inspection by qualified professional engineers and representative project stakeholders	Post-closure assessment and documentation by qualified professionals
	Sediment	River sediment quality that is safe for humans, aquatic life and fish habitat	Sediment quality downstream of the closed and reclaimed site that meets: 1. CCME criteria, or site-specific risk based criteria (as appropriate for future land and water use and protection of site-specific human and ecological receptors); or 2. If greater, background conditions	Removal of source area contaminants to levels that address criteria for both the source areas and downstream watercourses
	Water	Water quality that is safe for humans, wildlife, aquatic life, and fish habitat	Surface water quality (at the final receptor or point of use) that meets: 1. CCME guidelines, or site-specific risk based criteria (as appropriate for future water use and protection of site-specific human and ecological receptors); or 2. If greater, background water quality	Surface water and groundwater quality monitoring, at final receptor and/or point of use locations, by qualified professionals

5.5.4.3 Proposed C&R Scope and Activity

Given the lack of anthropogenic impact, there are no C&R activities proposed that focus specifically on media under the Natural Watercourses Component. That said, it is important to note that a number of the C&R activities (both remediation and monitoring) proposed for other components are ultimately intended to mitigate long term risks to surface water and sediment quality. This would include the central element of the C&R Plan, that being removal and secure containment of all contaminated source areas, a primary feature of which is the long term protection of downstream environmental media.

5.5.4.4 Consideration of Options

Options were not considered for this component because no specific C&R activity is required or proposed.

5.5.4.5 Engineering Required

Engineering is not required for this component because no specific C&R activity is required or proposed.

5.5.4.6 Final Site Conditions and Residual Effects

There are no departures from current conditions or post closure residual effects for Natural Watercourses that have not been described in other component sections. The reclamation measures proposed for the Artificial Islands will have the long term impacts on the Mackenzie River channel that are described in Section 5.5.3.6.

5.5.4.7 Uncertainties

There are some technical challenges and limitations inherent to the process of distinguishing between anthropogenic impacts on Natural Watercourses and those associated with the natural hydrocarbon seeps described in Section 3.3.1.1. It is possible that these challenges/limitations could be masking minor anthropogenic impacts to the Natural Watercourses Component. However, it is considered unlikely that any such impacts would rise above thresholds that would justify the disruptions to aquatic environments generated by remedial activities.

5.5.5 Buildings and Equipment

This section describes the C&R activity proposed for all above grade buildings and equipment on the Proven Area, and the subsurface foundations associated with those buildings and equipment. C&R activities related to the downhole portion of production and injection wells and other subsurface infrastructure are described in Sections 5.5.6 and 5.5.7, respectively.

5.5.5.1 Existing Conditions

.1 Above Grade Structures and Infrastructure

The following sections provide an overview of the above grade buildings and equipment that are present on the Mainland, the Natural Islands, and the infrastructure on the Artificial Islands. It should be noted that operations of the scale and complexity of the Operations routinely undergo modifications and/or additions to facilities. At any given time, there may be some comparatively minor departures from the inventories outlined in the following sections.

Mainland

Figure 5-28 shows the above grade facilities that are present on the Mainland. The Central Processing Facility (CPF) is the primary functional area on the Mainland and it includes:

- a flare stack;
- a tank farm (see Table 5-10);
- water and oil pumping facilities;
- settling ponds and retention area (CPF Impound);
- glycol heaters and waste heat recovery equipment;
- gas processing, drying and refrigeration facilities;
- MCC power generation facilities;
- gas compression and crude oil chilling equipment;
- an office area; and
- miscellaneous skids and mechanical buildings.

LEGEND

- INJECTION WELL LOCATION
- PRODUCTION WELL LOCATION
- PSSG / FASP BOUNDARY
- UTILIDOR LOCATION
- FLOWLINE R/W
- PROVEN AREA
- NORMAN WELLS MUNICIPAL BOUNDARY

amec foster wheeler

CLIENT: IMPERIAL OIL LIMITED

PROJECT NAME: NORMAN WELLS

PROJECT NUMBER: CC4058

SHEET TITLE: CLOSURE AND RECLAMATION PLAN
MAINLAND GENERAL ARRANGEMENT

FIGURE NUMBER: 5-28

ISSUE/REVISION: A

Table 5-10: Mainland Tank Inventory

Tank #	Geographic Area	Capacity (m^3
T102	Mainland CPF	870
T103	Mainland CPF	318
T114	Mainland CPF	6,430
T201	Mainland CPF	240
T202	Mainland CPF	500
T203	Mainland CPF	480
T204	Mainland CPF	870
T206	Mainland CPF	310
T104	Mainland CPF	2
T110	Mainland CPF	0.97
T113	Mainland CPF	35
T115	Mainland CPF	1.5
TK251	Mainland CPF	0.5
TK252	Mainland CPF	1
TK253	Mainland CPF	1
TK254	Mainland CPF	2.4
TANK 101	Mainland Tank Farm	3,680
TANK 102	Mainland Tank Farm	3,680
TANK 103	Mainland Tank Farm	9,222
TANK 104	Mainland Tank Farm	6,550
TANK 105	Mainland Tank Farm	1,635
TANK 106	Mainland Tank Farm	1,635
TANK 107	Mainland Tank Farm	937
TANK 109	Mainland Tank Farm	1,693
TANK 110	Mainland Tank Farm	1,693
TANK 111	Mainland Tank Farm	1,693
TANK 112	Mainland Tank Farm	1,636
TANK 113	Mainland Tank Farm	1,635
TANK 114	Mainland Tank Farm	1,552
TANK 115	Mainland Tank Farm	1,555
TANK 116	Mainland Tank Farm	761
TANK 117	Mainland Tank Farm	761
TANK 118	Mainland Tank Farm	759
TANK 119	Mainland Tank Farm	13,848
TANK 120	Mainland Tank Farm	7,909
TANK 121	Mainland Tank Farm	9,169
TANK 130	Mainland Tank Farm	11,286

Other related above grade Mainland infrastructure includes:

- four land terminals (LT) 2, 3, 7, and 11;
- on land pipeline terminal (LPT) 1;
- a bermed area for storage of methanol;
- a road network, helicopter pad and two docks;
- a waste storage yard;
- F-31X treatment and injection facility;

- a well servicing yard;
- a warehouse, various other buildings for equipment storage and laydown yards;
- tank farms at both the CPF and a separate location to the east; and
- a crude oil unloading dock and a general on-site dock (note: these docks are on federal lands and will be retained post closure following removal of surface infrastructure and any contaminated soils).

The buildings and equipment inventory for the Mainland area is summarized on the material quantity development worksheet in Table 5-11.

Table 5-11: Volume of Scrap Metal and Debris (from AMEC (2014))

Area and Component	Mass (t)	Volume of Scrap Metal and Debris (m^3)
CPF: Structural and Miscellaneous Steel	2,100	2,625
CPF: Vessels	1,600	2,000
CPF: Pipes and Valves	3,100	3,875
CPF: Cable Trays	800	1,000
CPF: Piles	1,000	1,250
GIT: Structural and Miscellaneous Steel	182	228
GIT: Vessels	95	119
GIT: Pipes and Valves	59	74
GIT: Cable Trays	102	128
GIT: Piles	353	441
BIT: Structural and Miscellaneous Steel	198	248
BIT: Vessels	104	130
BIT: Pipes and Valves	65	81
BIT: Cable Trays	112	140
BIT: Piles	390	488
Mainland: Gas Lift Stations	82	103
Mainland: Line Heaters	96	120
Mainland: Satellites	398	498
Mainland: Fire Hall	100	125
Mainland: Maintenance Building	370	463
Mainland: Mechanical Shops	1,000	1,250
Mainland: Offices	380	475
Mainland: Warehouse	930	1,163
Mainland: Waterflood Facilities	290	363
Mainland: Docks	120	150
Mainland: Flare Anchors	2	3
Mainland: Roadways	20	25
Mainland: Process Facilities	110	138
Mainland: Storage Facilities	200	250
Mainland: Tanks	410	513
Mainland: Injection Facilities	560	700
Mainland: Helipad	20	25
Mainland: Service Yards	40	50
Mainland: Tanks	2,440	976
Flowlines	134	149
Wells (including Artificial Islands)	6,225	7,781
	Total	**28,147**
	Contingency	**21,900**
	Total Including Contingency	**50,000**

Natural Islands

Figures 5-29 and 5-30 show the above grade facilities that are present on Bear and Goose Islands (there are no facilities, apart from production wells and their associated flow lines, present on Frenchy's Island.

Above grade infrastructure on Bear Island includes:

- four terminals (BIT 2, 3, 4, and 5);
- two production terminals (BPT 1 and 2);
- a fuel and methanol storage area; and
- helicopter pads and barge loading and unloading area.

Multi-phase product (crude oil, produced water and gas) from Frenchy's Island and Bear Island flow into BIT 4, from BIT 4, is flows to GIT 4 (Goose Island) in two flow lines under the river.

Above grade infrastructure on Goose Island includes:

- four terminals (GIT 2, 3, 4, and 5);
- a fuel and methanol storage area; and
- helicopter pads and barge loading and unloading area.

Multi-phase product from Goose Island and BIT 4, from BIT 4 comes into GIT 4 where the produced gas is separated from crude oil and produced water. The produced gas from GIT 4 is sent to the CPF in a 14" flow line under the river and the emulsion is sent to the CPF in a 10" flow line under the river.

The buildings and equipment inventory for the Natural Islands is included in the quantity tabulations provided in Table 5-11.

Artificial Islands

Buildings and equipment on the Artificial Islands are included in the quantity tabulations provided in Table 5-11. This Artificial Islands infrastructure is limited to equipment associated with the island production wells.

Wells

C&R activity related to the downhole portion of production and injection wells on the Operations is described in Section 5.5.6. Disposition of the above ground equipment associated with wells is included in this Buildings and Equipment component. Table 5-12 identifies the number of wells equipped with bunkers or pumpjacks.