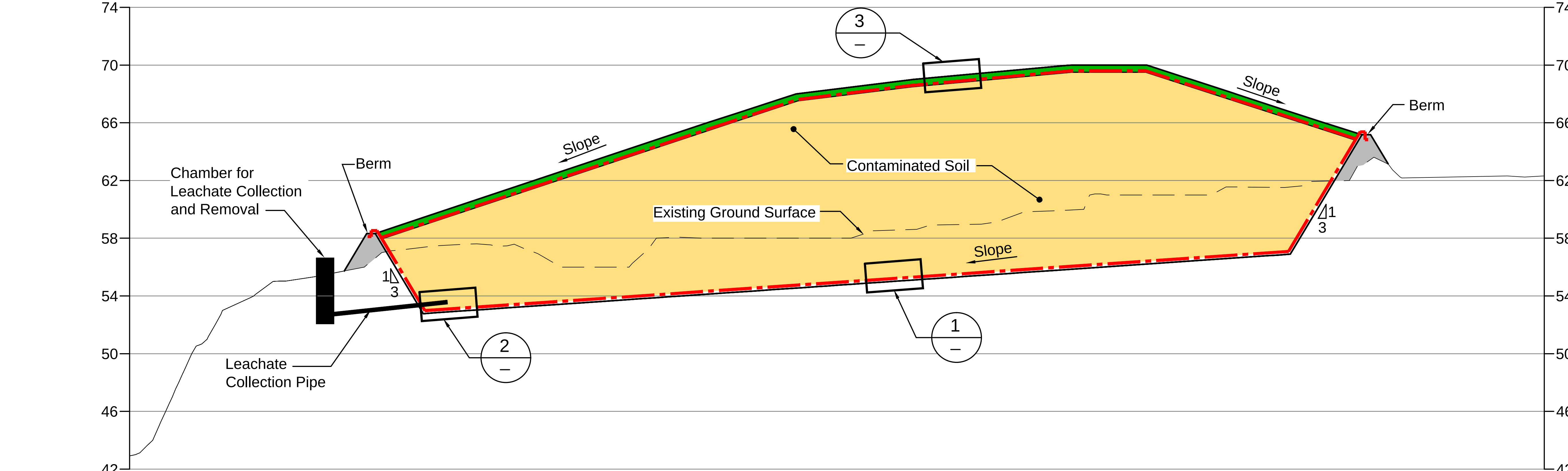
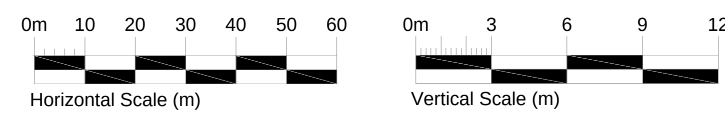
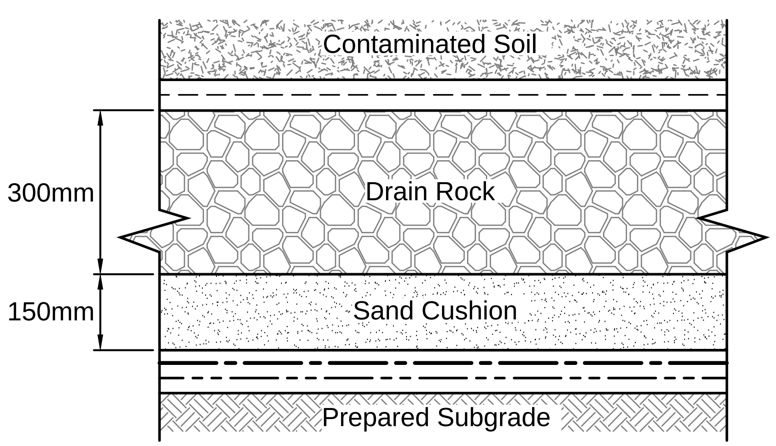
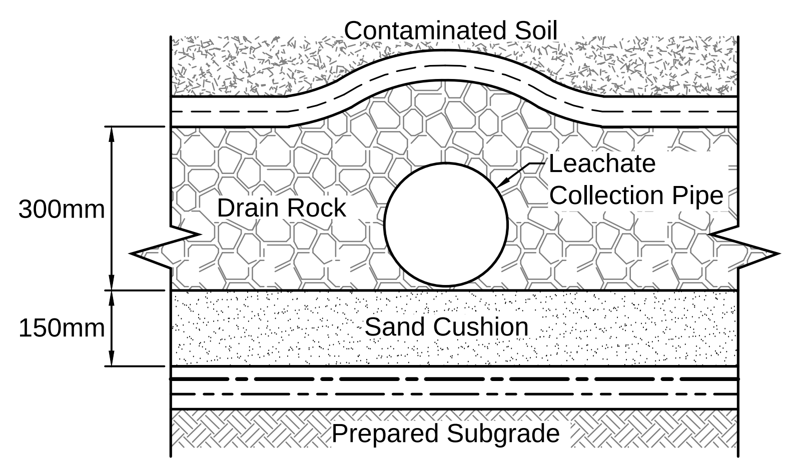


TYPICAL LANDFILL SECTION

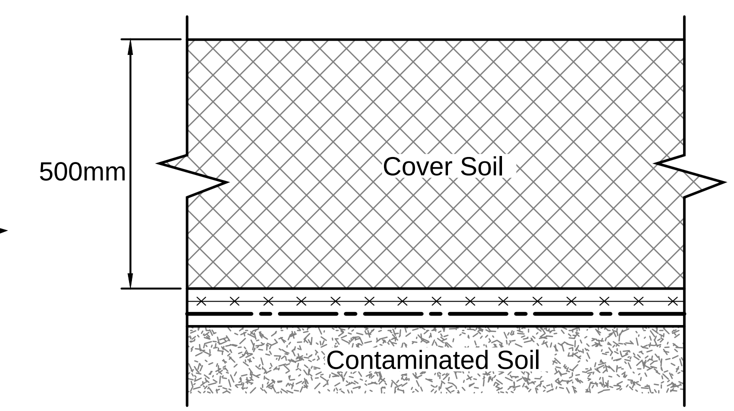




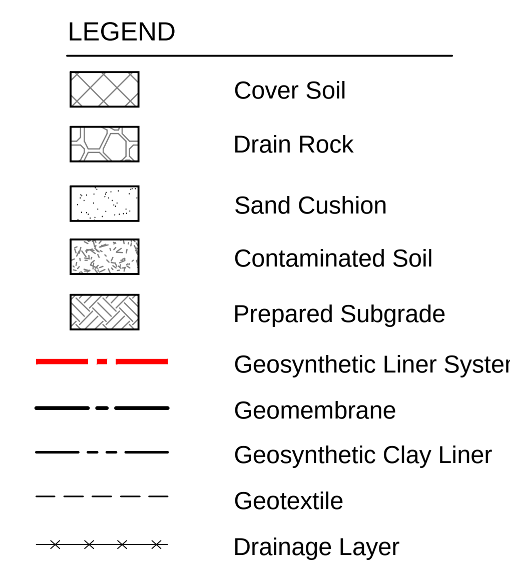
1 – **TYPICAL SECTION ON BASE**
NTS



2 – **TYPICAL SECTION AT LEACHATE COLLECTION PIPE ON BASE**
NTS



3 – **TYPICAL SECTION CAPPING**
NTS



This area will be the focus of long term management efforts, and will require comparatively extensive disturbance to complete the consolidation and containment of material that will be required. In keeping with the General Principles outlined in Section 5.2.1 (specifically, the "Minimizing Post Remediation Land Use Restrictions" and "Consolidation of Environmental Liabilities" principles), it was concluded that this perimeter should, therefore, be the preferred location for the LTMF that features in the C&R Plan. The facility evaluations that are detailed in Sections 5.5.1.3 and 5.5.1.4 flow from these general observations.

5.4.2.3 Surface Reclamation Designs

The following sections outline the issues relating to the reconstruction and reclamation of remediated ground surfaces that influenced the general nature of the proposed surface reclamation plan represented in Figure 5-3 and detailed by project component in subsequent sections.

.1 General Concepts

The proposed surface reclamation plan was developed on the basis of the following general concepts that, in turn, flowed from the C&R Planning Principles and Closure Objectives and Criteria outlined in Sections 5.2.1 and 5.2.3, respectively:

- Revegetation will be accomplished by reconstructing soil profiles using locally available soils (selected components of the clean overburdens overlying bedrock, and/or easily recoverable river sediments).
- Acceptable soil profile productivities will be achieved via targeted soil material selections, fertilizer applications and/or appropriate seed mix/planting designs; not via large scale import of alternate soils or amendments, or by large scale materials handling/mixing requirements that would be incremental to the general materials relocation scope (i.e., that required in any case for contaminated source area removal, backfilling and recontouring).The scope of revegetation efforts will be defined in concert with detailed materials management plan development, but will not require, by definition, revegetation of all disturbed footprints. Alternate concepts involving contoured granular materials mimicking natural scree slopes will be considered for selected areas where this can be defended technically and aesthetically.
- Similarly, the scope of shale removal and relocation will be defined in concert with detailed materials management plan development and revegetation scope definition (i.e., in some locations, local consolidation and recontouring of shales may be preferred over mass relocations).

.2 Soil Characteristics

A review of the reclamation characteristics and capabilities of locally available soils was undertaken based on test hole and analytical data. From the limited soil fertility analysis within these areas and reported in recent Imperial Abandonment & Restoration (A&R) annual reports, it was concluded that the surface soils will likely and generally exhibit consistent physical and chemical characteristics that will not preclude their use as a suitable growth medium. In general the soils are fine textured of fluvial origin, have near neutral pH, low electrical conductivity and sodicity that are within CCME guideline ranges.

.3 Preliminary Reclamation Approaches

The available reclamation information and data were reviewed in conjunction with the general reclamation concept outlined above to assemble the following preliminary outline of reclamation methods and specifications that is reflected in the reclamation plan illustrated on Figure 5-3 and detailed by project component in subsequent sections.

Site Preparation

All sites to be revegetated will require some form of preparation to provide a suitable environment for seeding, transplanting or natural reinvasion of species. The first step will be the removal of surface shale from those areas of the mainland and islands where this material was placed to allow for construction on unstable muskeg areas, and where shale relocations are required by the detailed materials management and revegetation plans. Once this material is removed, it is likely that many of the underlying materials will be suitable, or at least acceptable, for revegetation without the need to import surface amendments other than fertilizer. This is especially true of areas where shale was placed over organic or mineral soil. In some areas, especially along former roadways, compacted overburden may require scarifying to a depth of 0.3 m using heavy equipment such as a dozer with a toothed-blade or a ripper.

Disposal of Unsuitable Mineral Materials

For successful growth, plants require a medium that allows for root penetration, adequate moisture and nutrients. In addition to mineral materials that contain elevated contaminant levels (and that will be directed to the LTMF), there are some natural occurring materials (shale and siltstone) that are not suitable for reclamation. These materials will need to be buried a minimum of 30 cm and wherever practical up to 100 cm below the surface, again, in those areas where revegetation is called for under detailed plans.

Soil Fertilizer Application

Application of fertilizer will likely be required in some areas to promote the initial establishment of a grass cover crop. Although there is limited data available on soil fertility levels, the fluvial soils that dominate the surface in the Norman Wells area are typically low in organic matter content and deficient in nitrogen, phosphorus and potassium. Therefore, a starter fertilizer containing these essential nutrients should be applied at rates that will support revegetation without creating risks of excess nitrogen releases to local watersheds.

Reclamation Species Selection

Imperial’s current species selection for use in revegetation mixtures has been modified over the years based on the results from ongoing revegetation trials. Some native seed reclamation trials have been conducted, but the availability of sufficient quantities of native seed prohibited the use of “native only” seed mixtures. Some select species substitution trials have also been conducted and these have served as a method to introduce pioneer native species into reclaimed areas. Since there will be limited time and seed availability to assess more native grass and forb species within units treated under progressive reclamation, most of the sites will be reclaimed using a combination of agronomic grasses and legumes followed by planting of native trees and shrubs.

Grasses and Seedlings

For much of the reclaimed landscape over the Proven Area, Imperial's reclamation experience to date suggests that it will be most effective to allow native species to re-establish naturally. For some areas, it may be productive to seed using a mix similar to that described in Table 5-3. The seed mix shown in Table 5-3 is a variant to the Imperial seed mixture which includes a nitrogen-fixing species that has showed success in typical revegetation trials and species typically occurring on fluvial terraces.

Table 5-3: Seed Mix

Percent by Weight	Common Name[1]	Scientific Name
20	western wheatgrass	*Pascopyrum smithii*
20	bluejoint	*Calamagrostis canadensis*
20	slender wheatgrass	*Elymus trachycaulus*
10	hard fescue	*Festuca brevipila*
10	glaucus bluegrass	*Poa glauca*
10	nutracoat spike trisetum	*Trisetum spicatum*
5	alpine bluegrass	Poa alpina
5	Siberian alfalfa	*Medicago falcata*

Note: [1] common names follow ACIMS 2014.

This mix is the standard mix that could be used for revegetation. The exact species used and percentages of individual species may vary depending on seed availability.

Shrubs and Forbs

Attempts have been made in the past to harvest and propagate local seedlings and transplant shrubs at the Operations. Preferred species include willow (*Salix spp*.), bog birch, and green alder. Other riparian candidates that are native to the area and are already adapted to the site include a range of grasses, sedges, forbs and horsetails which do well in moist areas. It is expected that these species will naturally invade reclaimed areas.

Trees Species Selection (Coniferous and Deciduous Species)

White spruce, black spruce and tamarack[1] (*Larix laricina*; a deciduous coniferous species) are the only coniferous tree species that are native to the project area. These species are readily available from commercial tree nurseries, although it may be difficult to obtain materials that are ecotypically adapted to the project area.

Alaska paper birch, bog birch, and several willows (*Salix spp.)* have a localized distribution in the study area. It may be possible to propagate these species by planting rooted cuttings. These species will increase wildlife habitat value.

Select reclamation areas can be hand-planted with appropriate species. Stocking density will likely be in the range of 1,000 stems/ha and preferred species will vary from site to site. Black spruce would likely be planted on the mesic to wet poorer nutrient sites, while tamarack would be planted on the wet nutrient rich sites. White spruce could be planted on the relatively drier sites. Deciduous species, especially willows could be planted on the relatively wet benches.

5.4.3 Consideration of Options

This section presents the consideration of C&R alternatives at the integrated, property wide level. Alternative assessments at the project component level are included in Section 5.5.

5.4.3.1 Options Considered

C&R approaches for sites exhibiting the nature and range of contaminant sources on the Operations are defined largely on the basis of the remedial strategy selected for the plan. The remedial strategies considered in the alternatives evaluation were as follows:

- on-site disposition (selected alternative);
- off-site disposition;
- on-site, ex-situ treatment;
- in-situ containment; and
- in-situ treatment.

.1 <u>On-Site Disposition</u>

The On-Site Disposition alternative is the LTMF (with limited soil treatment) based remediation and reclamation strategy described generally in Section 5.4.1 and more specifically in the discussion for the Mainland Project Component provided in Section 5.5.1.

.2 <u>Off-Site Disposition</u>

The Off-Site Disposition alternative was assumed to involve excavating the same contaminated soil inventory defined for the On-Site Disposition alternative (i.e., the volumes described in Section 5.3) and transporting them via truck to a third party treatment/disposition facility in Northern Alberta or British Columbia. The specific reclamation concept assumed was as follows:

- excavation to limits and using equipment and methods similar to those for the on-site disposition alternative;
- truck haul via winter road (potentially over multiple winter seasons) to Wrigley, NWT, and from there via all-weather road to Rainbow Lake, Alberta; and
- disposition to the existing third party industrial landfill at Rainbow Lake (likely modified and/or expanded to accommodate the Operations' inventory).

Given the scale of the Operations' C&R project, the disposition facility modifications/expansions needed would potentially be developed via some form of project specific development and commercial agreement between Imperial and the third party operator.

The reclamation component of the C&R Plan would be similar to that described for the on-site option except, of course, that the final Mainland area would not include the LTMF facility and the long term operation and maintenance obligations and land use limitations associated with it.

.3 <u>On-Site, Ex-Situ Treatment</u>

The On-Site, Ex-Situ Treatment alternative would involve removing the defined soil inventory (i.e., Section 5.3) and processing all, or most, of the soils to meet CCME Industrial criteria in some form of biological, thermal and/or physical process. The reclamation component of this alternative would be similar conceptually to the on-site LTMF based approach (i.e., source areas backfilled, recontoured and revegetated), except that the treated soil inventory would require final placement, likely in some style of landform earth feature, within the Mainland component perimeter.

.4 <u>In-Situ Containment</u>

This alternative would be similar conceptually to the On-Site Disposition Strategy, with the primary difference being that instead of a centrally located LTMF, the strategy would feature a centrally located in-situ containment structure. This structure would likely be located on the Mainland, co-incident with the largest concentration of contaminated soil and would be comprised of:

- a subsurface barrier (e.g., soil-bentonite slurry wall) extending from grade down to bedrock;
- an engineered cover design to minimize the ingress of precipitation; and
- a water management and treatment system designed to maintain hydraulic gradients towards the structure (i.e., so that contaminated groundwaters do not leave the structure).

The structure would be configured so that the proportion of the contaminated soil inventory (i.e., the Section 5.3 volumes) located outside the structure could be excavated and reconsolidated within its contained perimeter, below the engineered cap.

Surface reclamation for this alternative would be the same as that described for On-Site Disposition in areas off the Mainland. Concepts on the Mainland would be similar as well, with some details associated with the containment structure changing.

.5 <u>In-Situ Treatment</u>

The In-Situ Treatment alternative would involve maximizing the application of available in-situ techniques designed to mitigate contaminant impacts via the removal, degradation and/or transformation of contaminants of concern (e.g., vapour extraction, bio-slurping, oxidation treatments). The nature of the contaminant inventory and the limitations of these technologies constrain the proportions of the soil inventory that could be addressed in this way. In all likelihood, this approach would, therefore, be undertaken in conjunction with one of the other strategies described above (most probably a smaller LTMF or containment structure).

Surface reclamation for this alternative would be based on concepts similar to those for other approaches. The scope of the associated materials management effort would be reduced commensurate with the proportion of the soil inventory that could be successfully treated.

5.4.3.2 Comparative Assessment of Options

A qualitative, comparative assessment of the above alternatives was undertaken and presented in Table 5-4. This table characterizes the ability of each alternative to address the general objectives established for the C&R Plan (Section 5.2), and their capability to mitigate the following risks or issues that will be relevant during execution of proposed C&R activities:

- Consumption of Resources: refers to the energy resources required to execute an alternative including the associated greenhouse gas emissions.
- Performance Uncertainties/Risks: refers to uncertainties in the post closure outcomes provided by an alternative and limitations in Imperial's ability to reliably mitigate this uncertainty via predictive analyses.
- Health & Safety Risks: refers to incremental health and safety risks to site workers and/or the public during execution of the proposed C&R activity.
- Environmental Risks: refers to risks to environmental media created by the potential for uncontrolled releases of contaminated and/or dangerous materials during execution of the proposed C&R activity.

The other differentiating issue that warrants consideration is the community benefit that would be associated with each of the options. These benefits refer to the potential business and/or employment opportunities local to the Norman Wells area that might be created by execution of the proposed C&R activity and/or through the maintenance and operation of structures or facilities developed as part of the C&R Plan. Those options that involve long term management of soils on-site (i.e., the On-Site Disposition and In-Situ Containment Options) would be relatively attractive with respect to the community benefits issue because of the ongoing need for local labour resources. Conversely, the off-site disposition alternative is less attractive because there is no need for local resources following the point in time remediation at closure.

Table 5-4 provides a qualitative and relative ranking by alternative against each project objective. The risk/issue rankings characterize the features and capabilities of each option relative to the alternatives; they are not absolute indications of capability (e.g., a neutral ranking doesn't mean the alternative cannot adequately address or mitigate the objective or risk in question; it simply indicates that the alternative is no more or less effective than other options at addressing the objective or issue). The table includes notes that expand on the reasons for assigning selected rankings that have a particular influence on differentiating the alternatives. The final column of the table provides concluding summaries of the rationales for selecting or rejecting a remedial alternative.

Table 5-4: Comparative Rankings of C&R Remedial Strategy Alternatives

Remedial Strategy Alternative	Ability to Address Closure Objectives for Media (see descriptions below)							Ability to Mitigate Major Execution Risks and Issues				Costs	Conclusions
	Air	Land	Water	Wildlife	Community	Health & Safety	Operations	Consumption of Resources	Performance Uncertainties/Risks	Health & Safety Risks	Environmental Risks		
1. On-Site Disposition		1			3				5			11, 12	The preferred alternative; selected based on its ability to limit post closure land use restrictions, the predictability of closure outcomes and performance, the associated community employment and commercial opportunities and lowest cost.
2. Off-Site Disposition		2	2					4	5	7	9	13	Discounted largely on the basis of its resource consumption characteristics, the safety and environmental risks associated with large scale, long distance material relocations and cost.
3. On-Site Ex-Situ Treatment		2	2										Discounted largely because of the uncertainties relating to treatment technology performance endpoints and cost.
4. In-Situ Containment					3								Comparable in many respects to the On-Site Disposition alternative, but discounted because it offers less certainty on post closure performance outcomes and is unlikely to offer any material cost advantages over an LTMF development.
5. In-Situ Treatment		2	2						6				Discounted largely because of the significant uncertainties in treatment technology performance endpoints for this alternative and the difficulties of predicting the scope and costs of the supplemental storage and/or containment that would be required for non-treatable materials.

Ranking Legend	
	Strongly Positive
	Mildly Positive
	Neutral
	Mildly Negative
	Strongly Negative

Media Descriptions	Notes
Air: dust levels at the closed and reclaimed site safe for people, vegetation, aquatic life and wildlife.	1. Reduces the footprint of post closure land use restrictions by efficiently consolidating the contaminated soil inventory.
Land: Soil that is safe for people and the environment and compatible with the defined future land use. Closed and reclaimed landscape that is physically stable, safe and generally compatible with the surrounding natural area	2. Alternatives that treat the contaminants or remove them from the Proven Area effectively mitigate land use restrictions and post closure risks to ground and surface waters.
Water: Water quality that is safe for humans and wildlife. Hydrology and drainage of the reclaimed land surface generally consistent with the character of the local watershed.	3. Alternatives involving long term storage or containment on-site require that the associated structures be accepted by, and accommodated within, the post closure community.
Wildlife: Terrain restoration to allow safe wildlife utilization and passage.	4. Hauling the entire contaminated soil inventory off-site would consume in the order of 70 million L of diesel and produce about 200,000 tonnes (the equivalent of 34,000 cars driven for one year) of incremental greenhouse gas emissions (US EPA 2014), both substantially higher than any of the other alternatives.
Community: Archaeological and historically significant sites are protected and preserved. Incremental disturbance of land required to support remediation and reclamation activity is minimized. Landscape closed and reclaimed with consideration to Traditional Use.	5. Disposition to an LTMF (on or off-site) is a well understood strategy with many precedents at scales similar to the Operations.
Health & Safety: Removal or mitigation of physical and chemical hazards.	6. There are a number of significant uncertainties relating to the performance endpoints of in-situ techniques that would be difficult to reliably mitigate with predictive analyses.
Operations: Compliance with post closure and reclamation legal, regulatory and corporate obligations.	7. Relocating the soil inventory to Rainbow Lake, Alberta, would involve movements amounting to 1.6 billion tonne•km. Statistical measures (WARS 2007; Transport Canada 2010; and GNWT 2015) suggest that truck hauls of this scale would generate 40 large ungulate strikes (caribou, moose, bear) and one human fatality.
	8. On-site relocations of the entire soil inventory create a modest risk of uncontrolled releases of contaminated material.
	9. Long haul transport of the entire soil inventory, a portion of which would be over an ice road, creates a comparatively high risk and consequence for uncontrolled releases of contaminated materials.
	10. The ongoing operations and maintenance requirements associated with on-site storage and containment structures create employment opportunities within the community.
	11. LTMF developments create commercial opportunities for local or regional businesses.
	12. On-site LTMF developments typically provide for the most cost effective and certain long term management of the risks generated by contaminated materials.
	13. The transport costs and third party tipping fees associated with Off-Site Disposition will make this option far more costly than most other alternatives.

5.5 Closure Activities by Component

5.5.1 Mainland

The Mainland component of the Operations' Proven Area is one of the primary focus areas for C&R activity because of its scale and because of its location at the centre of both the Proven Area and Imperial's historical operations. The area contains much of the Proven Area's inventory of impacted soil and, as a consequence, the Long Term Management Areas (LTMAs) that have been identified on the Proven Area to date. Its central location also makes it the primary area of siting interest for the LTMF that is a central feature of the broader C&R Plan.

5.5.1.1 Existing Conditions

.1 <u>Topography and Stratigraphy</u>

Evaluating potential LTMF siting options and facility costs required that topographic and stratigraphic models be developed to provide the requisite inputs for civil designs. In addition, some representation of the areal and vertical distribution of soil contamination was required to properly assess materials handling scope differences amongst the various options. The Mainland topography used in these assessments and illustrated on Figure 5-5 was compiled from GNWT (2015 and 2015a).

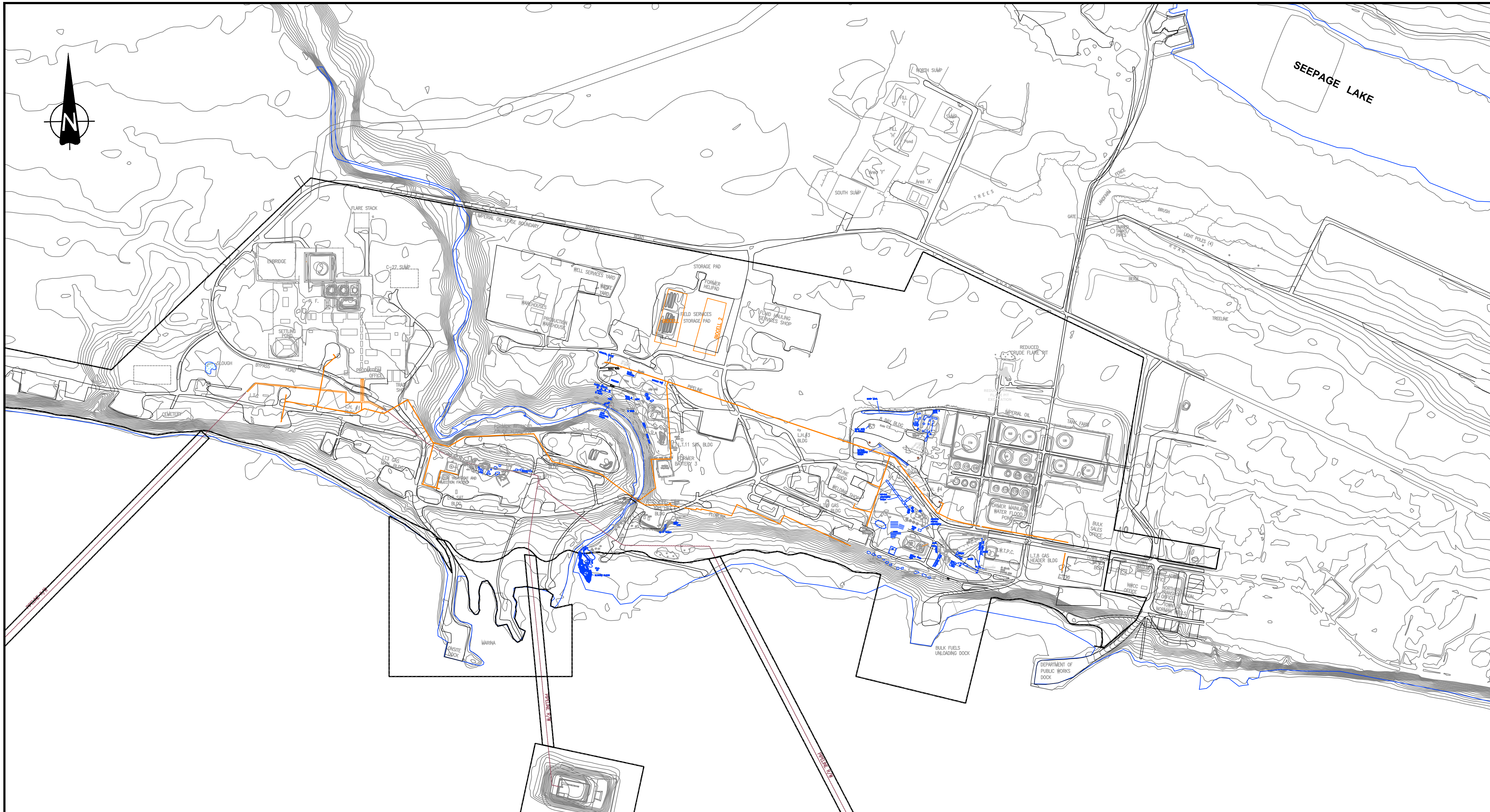
A simplified representation of the bedrock topography in the Mainland area was prepared to support civil design assessments. This simplified topographic model (Figures 5-6 and 5-7) was developed from test hole information provided by WorleyParsons. The representation developed did not make use of all the available data, but enough to develop a general understanding of bedrock occurrence and slope. If during later stages of project development it becomes evident that a more robust understanding of the LTMF base/bedrock interface is necessary, consideration can be given to upgrading and expanding this representation.

.2 <u>Permafrost</u>

It was assumed for this early stage of LTMF planning that permafrost occurrence and slope in the Mainland area would not be determining issues. While permafrost is known to exist intermittently in the area, reliable representations of its locations and conditions are not available. Permafrost conditions could impact final LTMF base elevations, geometries and designs, as well as contaminated material excavation methods, but it was assumed these influences would not be material at this preliminary planning stage. That said, Imperial will make all reasonable efforts to maintain permafrost as required to protect the physical integrity of the post closure landscape including any requisite modifications to management facility design.

.3 <u>Contamination Model</u>

The representations of impacted soil distribution used in the conceptual civil designs were provided on Figures 5-1 and 5-2. These figures were developed as described in Section 5.2.4.



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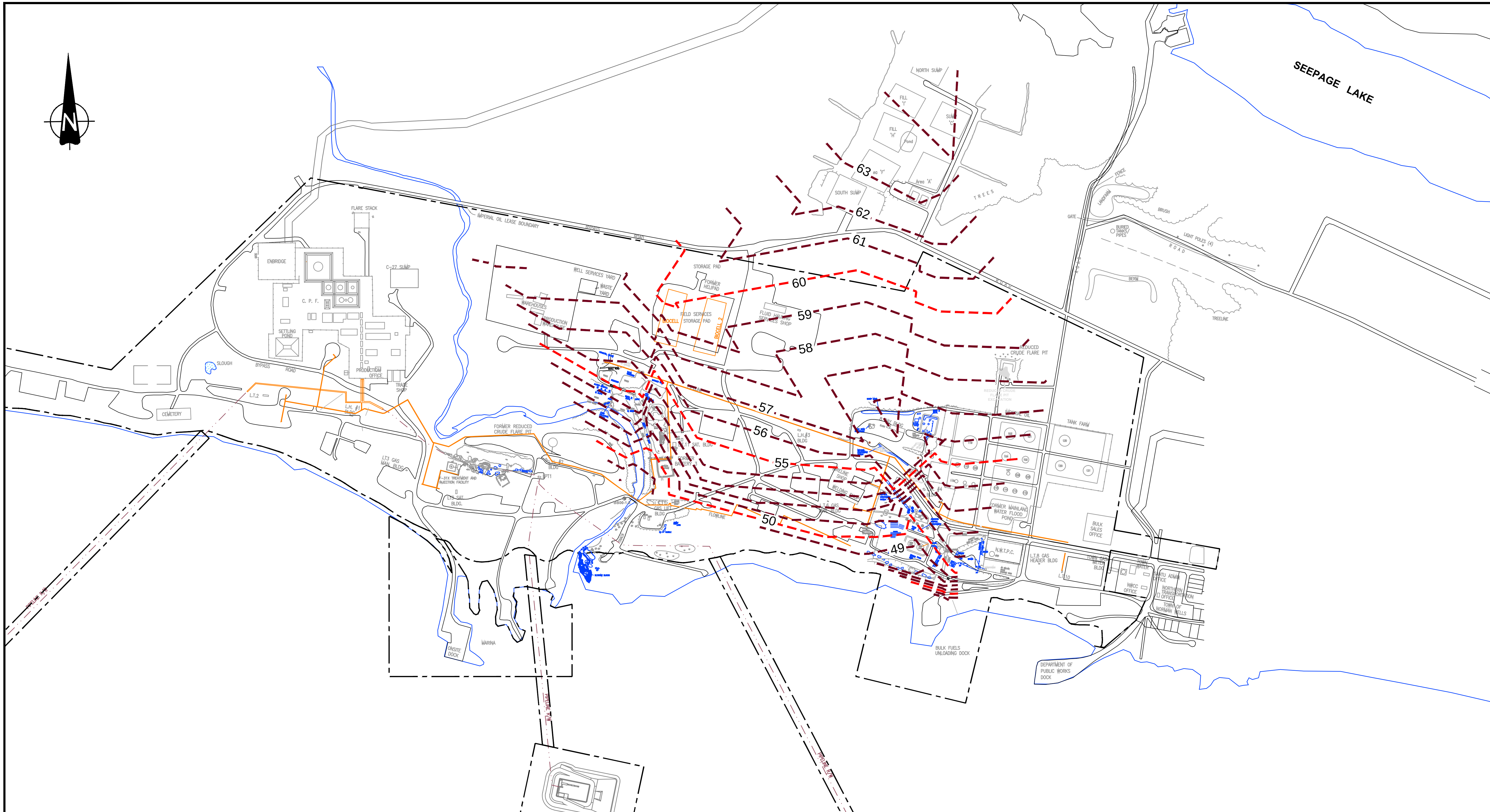
CLIENT: IMPERIAL OIL LIMITED	DWN BY: MDDS	PROJECT: NORMAN WELLS INTERIM CLOSURE AND RECLAMATION PLAN	DATE: OCT. 2015
amec foster wheeler	CHK'D BY: BG		PROJECT No.: CC4058.300
	DATUM: NAD 27	TITLE: MAINLAND TOPOGRAPHY	REV. No.: A
	PROJECTION: ZONE 9		FIGURE No.: FIGURE 5-5
	SCALE: AS SHOWN		



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CLIENT:

IMPERIAL OIL LIMITED

amec foster wheeler

DWN BY: MDDS

CHK'D BY: BG

DATUM: NAD 27

PROJECTION: ZONE 9

SCALE: AS SHOWN

PROJECT:

NORMAN WELLS INTERIM CLOSURE AND RECLAMATION PLAN

TITLE:

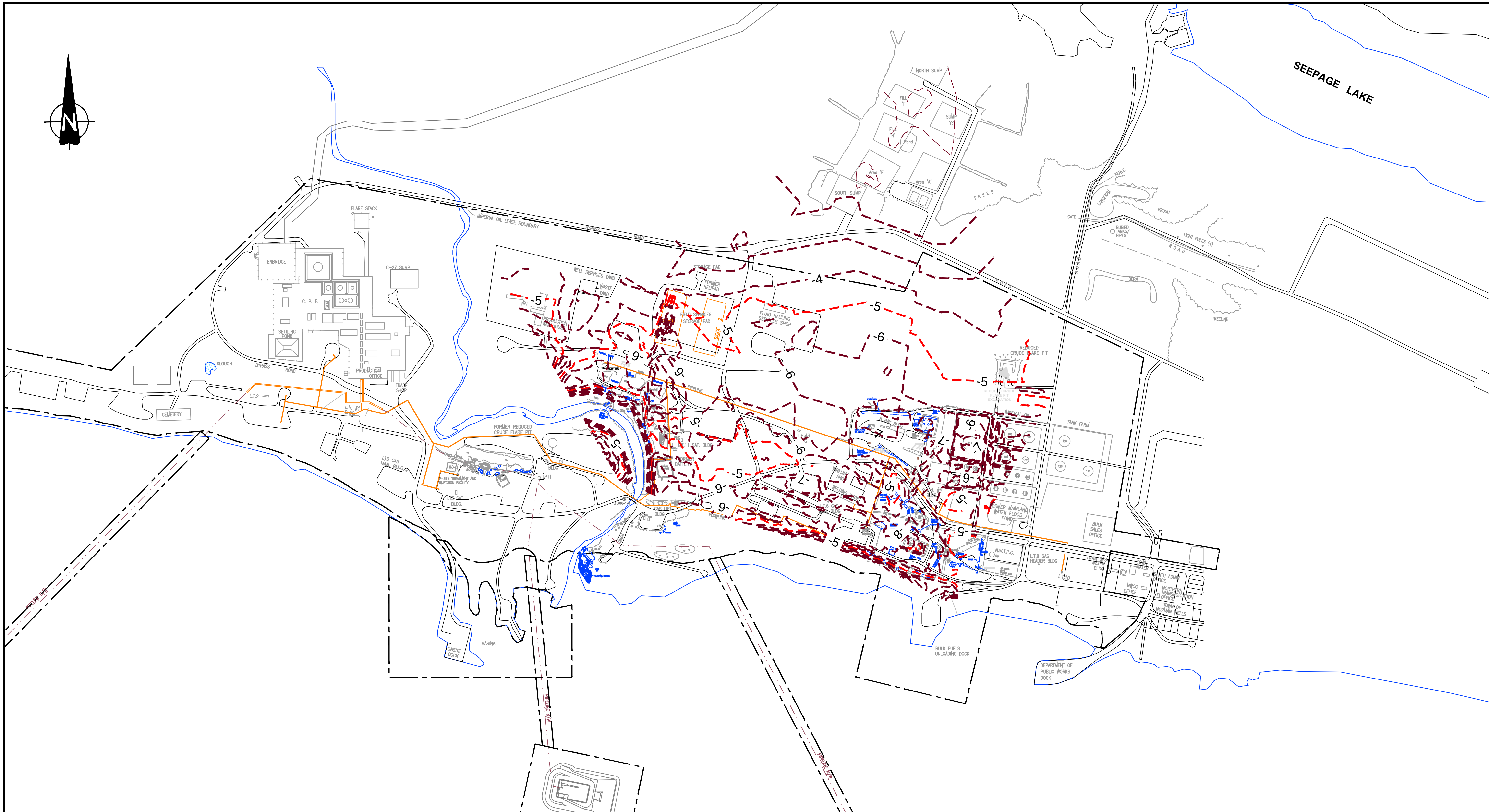
BEDROCK CONTOURS

DATE: OCT. 2015

PROJECT No.: CC4058.300

REV. No.: A

FIGURE No.: FIGURE 5-6



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CLIENT:

IMPERIAL OIL LIMITED

amec foster wheeler

DWN BY:	MDDS
CHK'D BY:	BG
DATUM:	NAD 27
PROJECTION:	ZONE 99
SCALE:	AS SHOWN

PROJECT:

NORMAN WELLS INTERIM CLOSURE AND RECLAMATION PLAN

TITLE:

BEDROCK DEPTH CONTOURS

DATE:	OCT. 2015
PROJECT No.:	CC4058.300
REV. No.:	A
FIGURE No.:	FIGURE 5-7

5.5.1.2 Component Specific Objectives

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

5.5.1.3 Proposed C&R Scope and Activity

.1 <u>LTMAs</u>

LTMAs, as described and defined in Section 5.4.2.1, have been identified on the Mainland in the Refinery Bank area and around the former Flare Pit north of Battery 3.

Refinery Bank Area

The Refinery Bank area exhibits the impacts of refined hydrocarbon products that were released from underground distribution lines that had been used to move product from the refinery to the dock. Imperial is currently mitigating any releases of non-aqueous phase liquids (NAPLs) via a groundwater/product containment and recovery system. This system reduces releases to a fraction of the natural hydrocarbon seeps in the area. However, it is likely that containment and/or recovery efforts will need to be maintained indefinitely, notwithstanding the lack of evident impacts to mitigate concerns about potential small volume releases. Hence, the Refinery Bank area has been identified as an LTMA, albeit one with a limited areal footprint.

Flare Pit Area

The former Flare Pit north of Battery 3 exhibits anthropogenic salt impacts that extend into the underlying fractured bedrock. Removing the salt impacted overburden would leave a significant portion of the salt inventory in the area. Most of this salt is dissipating very slowly by diffusion in the bedrock and the contaminant characteristics and hydrogeological environment make recovery impractical. The former Flare Pit area has, therefore, been identified as an LTMA.

The pit area however, is not, and is unlikely to, create any incremental restrictions on local land or aquifer use, and/or degradations in Bosworth Creek water quality. The natural hydrocarbon seeps at depth in this area likely have associated salt contents that increase levels in Bosworth Creek. The incremental impacts of any anthropogenically derived salt impacts from the Flare Pit area are unlikely to be of material ecological significance. It has been assumed then that the indefinite management liability in this area will be limited to a commitment to monitoring and future mitigation should that monitoring demonstrate the need.

Other Candidate LTMAs

The Mainland Sumps were considered as a potential LTMA because of their scale and the persistent characteristics of some elements of the contaminant inventory. However, the sump area was ultimately discounted as an LTMA because there is little evidence of pervasive groundwater impacts that are likely to persist indefinitely following a relocation effort, and because the relatively shallow material depths make excavation and relocation technically and logistically straightforward. Indeed this area was ultimately selected as the preferred location for the LTMF that forms a central element of the C&R Plan.

Table 5-5: Objectives and Criteria for the Mainland Component

Component	Media	Objective	Criteria	Actions-Measurements
Mainland	Air	Dust levels at the closed and reclaimed site safe for people, vegetation, aquatic life and wildlife	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 Industrial 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
		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	Water quality that is safe for humans, wildlife and aquatic life	Surface water and groundwater 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
		Hydrology and drainage of the reclaimed land surface consistent with the character of the local watershed and appropriate to the defined land use	Surface contours that promote drainage consistent with natural drainage patterns	Post-reclamation monitoring of surface water drainage by qualified professionals
	Wildlife	Terrain restoration to allow safe utilization and passage by terrestrial wildlife	Safe use of formally disturbed areas by wildlife within the defined future land use	Wildlife monitoring by qualified individuals

Similarly, the former Battery 3 area was considered because of the volume of impacted material in the area. It was discounted however, because removal of the predominantly hydrocarbon impacted material would be straightforward and because of the lack of pervasive and persistent groundwater/aquifer impacts.

The Mainland area also exhibits many other discrete areas or zones of contamination, all of which are considered practically removable and, therefore, discounted as LTMAs.

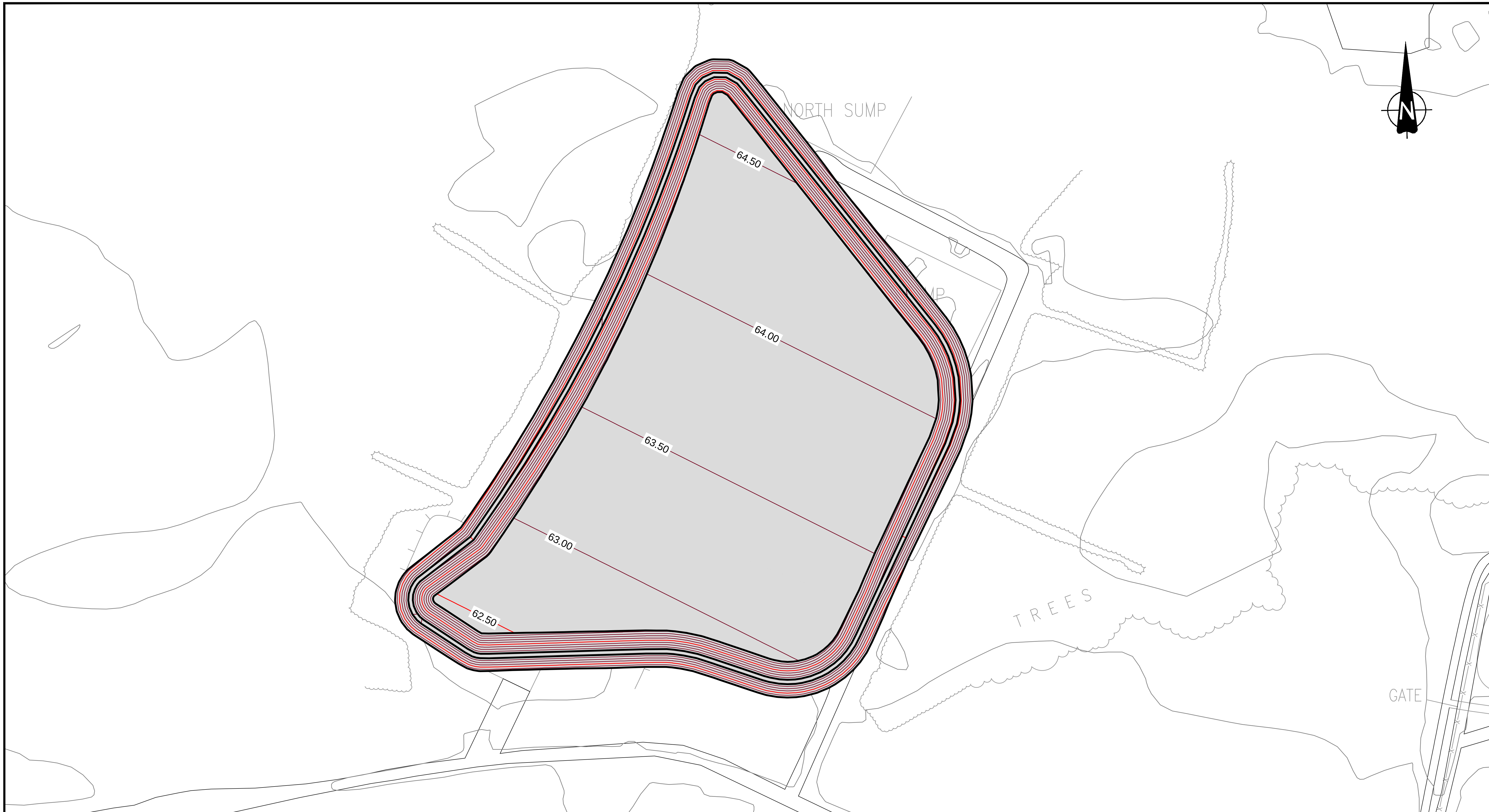
.2 LTMF Development

The Mainland area was considered as the primary candidate location for a Long Term Management Facility (LTMF) because of its central location on the Proven Area and because it is geographically co-incident with the largest proportion of the Proven Area's impacted material inventory. A variety of potential LTMF locations and configurations were considered for a Mainland LTMF. This consideration of options is detailed in the section following (i.e., 5.5.1.4). The assessment concluded with the selection of a site in the current Mainland Sumps areas as the preferred location for the Norman Wells LTMF, largely because the location is co-located with an existing contaminant source, avoids interference with existing operations and treatment facilities, and maintains appropriate offsets from the Mackenzie River and the Town of Norman Wells.

Civil Designs and Disposal Capacity

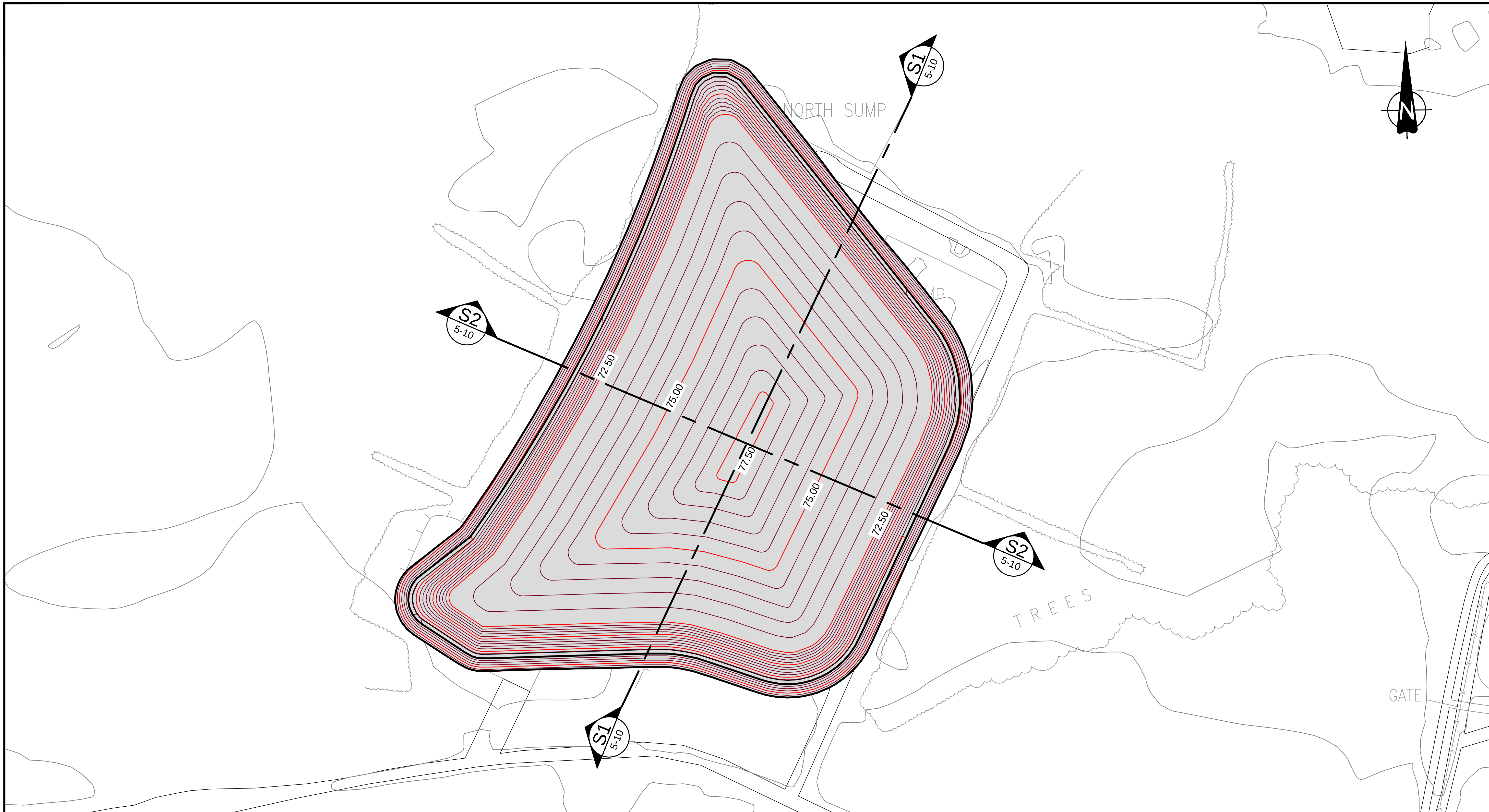
The proposed location for a Mainland Sumps area LTMF development is shown on Figure 5-8. The design concepts for the facility are illustrated on Figures 5-8 through 5-13. The content of these figures is as follows:

- Figure 5-8: Base Design - illustrates the base design and footprint for a facility with a capacity adequate to accommodate the material volumes described in Section 5.3 (i.e., 670,000 m^3 plus a 50,000 m^3 provision for dismantling and demolition waste/debris).
- Figure 5-9: Cap Design - illustrates the slopes and contours for the LTMF cap.
- Figure 5-10: Sections - provides major sections illustrating LTMF profiles, slopes and heights above existing ground.
- Figure 5-11: Base Construction Contours - illustrates the earth cut and fill depths from existing ground required to construct the LTMF base.
- Figure 5-12: Total Depth Contours - illustrates the total depth contours of the completed facility (i.e., contours between the design base and top of cap) and, therefore, its total available air space or capacity.
- Figure 5-13: Bedrock Depth - illustrates the elevation difference between the LTMF base and bedrock.



0m 20 40 60 80 100
1 : 2500

CLIENT: IMPERIAL OIL LIMITED	DWN BY: MDDS	PROJECT: NORMAN WELLS INTERIM CLOSURE AND RECLAMATION PLAN
amec foster wheeler	CHK'D BY: BG	DATE: OCT. 2015
	DATUM: -	PROJECT No.: CC4058.300
	PROJECTION: -	TITLE: MAINLAND LTMF CONCEPT 720,000m3 CAPACITY - BASE PLAN
	SCALE: AS SHOWN	REV. No.: A
		FIGURE No.: FIGURE 5-8



0m 20 40 60 80 100
1 : 2500

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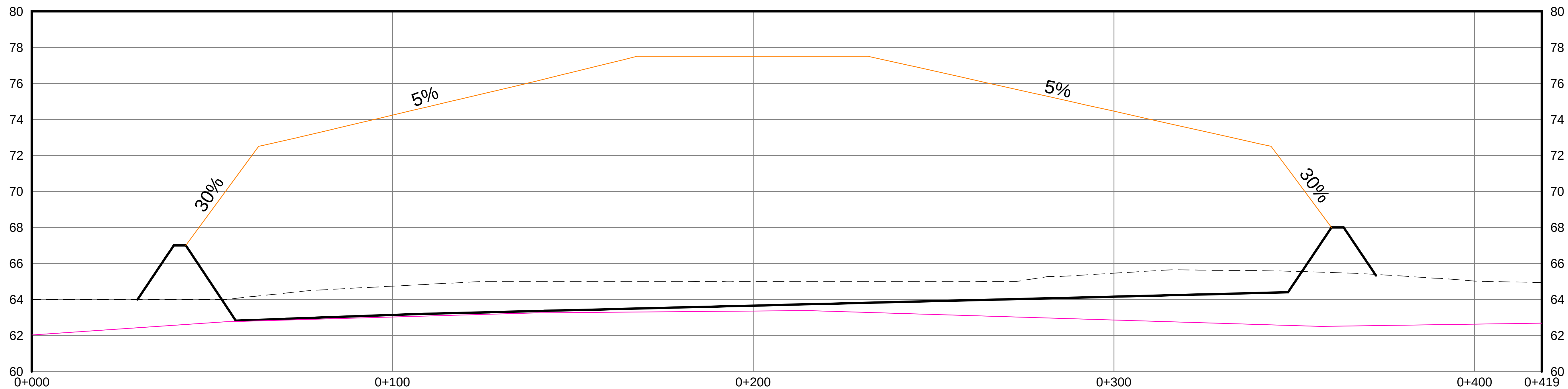
DATUM:	-
PROJECTION:	-
SCALE:	AS SHOWN

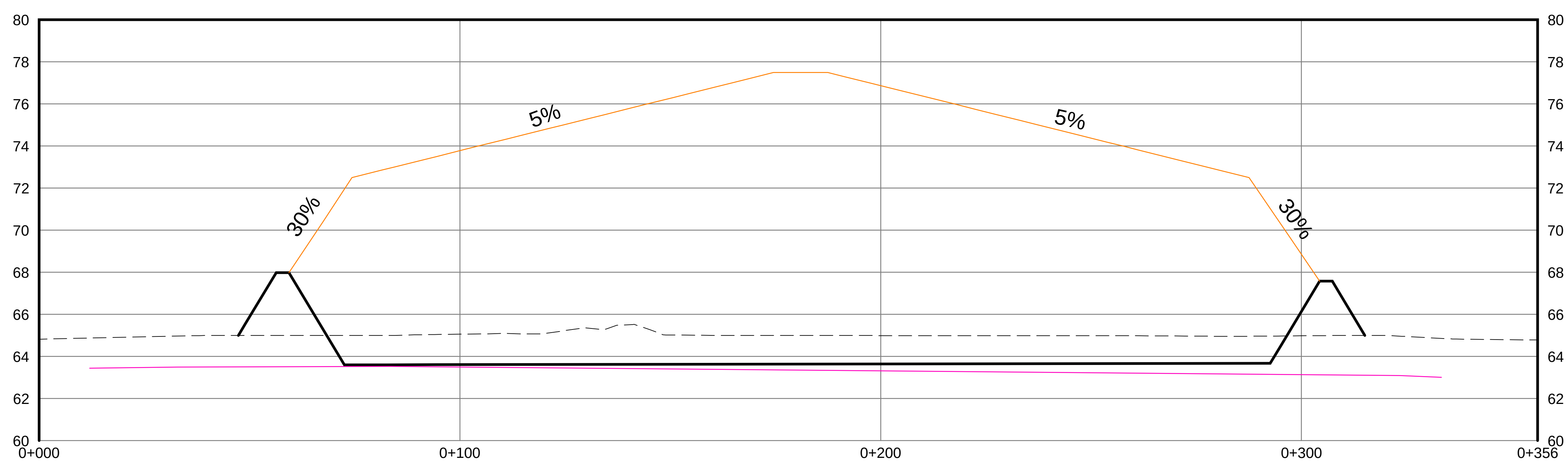
PROJECT:
NORMAN WELLS INTERIM CLOSURE AND RECLAMATION PLAN

TITLE:
MAINLAND LTMF CONCEPT 720,000m3 CAPACITY - TOP OF CAP

DATE:	OCT. 2015
PROJECT No.:	CC4058.300
REV. No.:	A
FIGURE No.:	FIGURE 5-9



S1 Fig. 5-9 SECTION AT LTMF
5x Exaggeration



S2 Fig. 5-9 SECTION AT LTMF
5x Exaggeration

Ground Surface — Approx. Bedrock — Base Design — Top of Cap Design

0m 10 20 30 40 50
1 : 1250

0m 2 4 6 8 10
1 : 250

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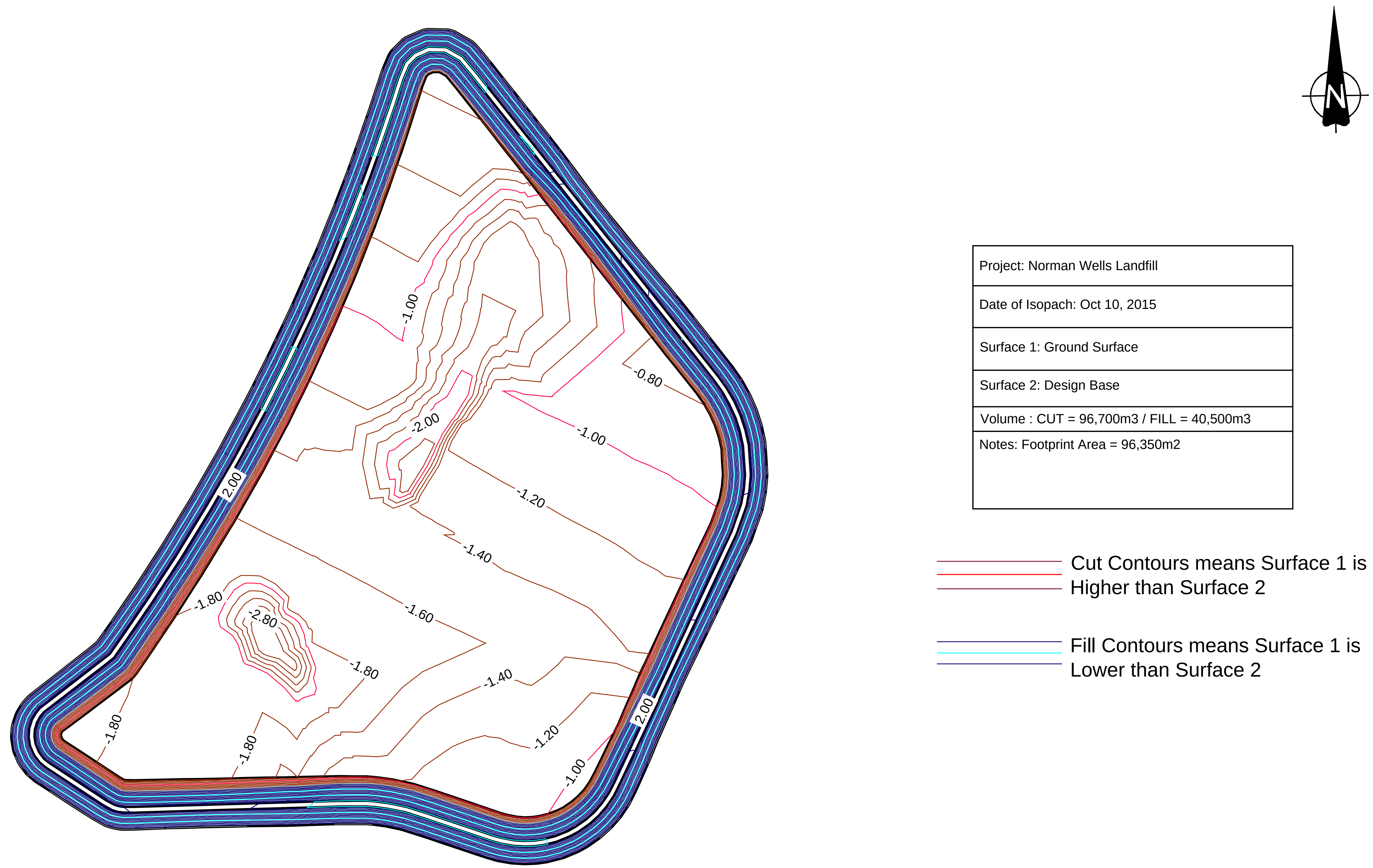
PROJECTION:	-
SCALE:	AS SHOWN
PROJECT:	NORMAN WELLS INTERIM CLOSURE AND RECLAMATION PLAN
TITLE:	MAINLAND LTMF CONCEPT 720,000m3 CAPACITY - SECTIONS S1 AND S2
DATE:	OCT. 2015
PROJECT No.:	CC4058.300
REV. No.:	A
FIGURE No.:	FIGURE 5-10



Project: Norman Wells Landfill
Date of Isopach: Oct 10, 2015
Surface 1: Ground Surface
Surface 2: Design Base
Volume : CUT = 96,700m3 / FILL = 40,500m3
Notes: Footprint Area = 96,350m2

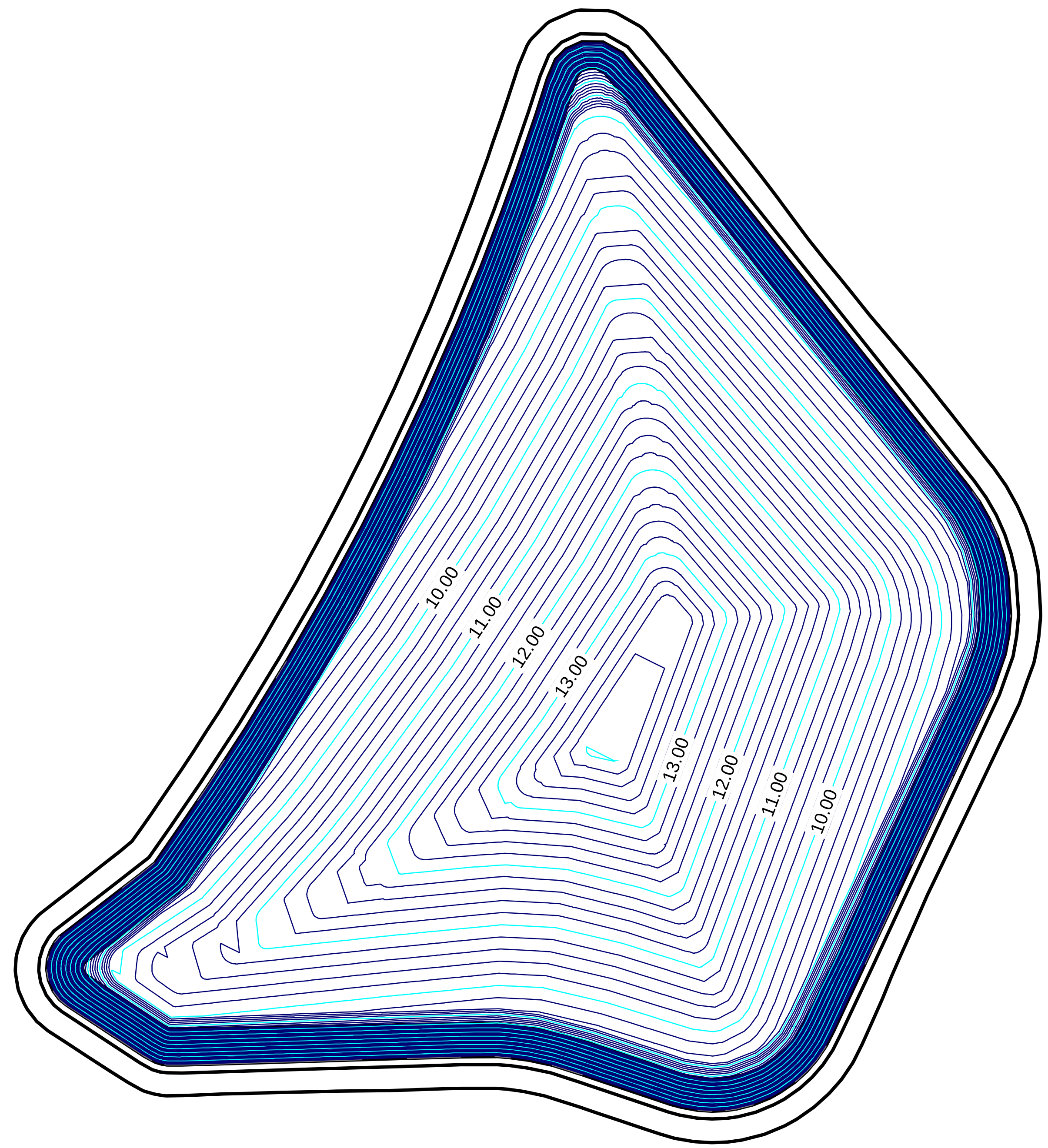
Cut Contours means Surface 1 is Higher than Surface 2

Fill Contours means Surface 1 is Lower than Surface 2

0m 20 40 60 80 100

1 : 2500

CLIENT: IMPERIAL OIL LIMITED	DWN BY: MDDS	PROJECT: NORMAN WELLS INTERIM CLOSURE AND RECLAMATION PLAN	DATE: SEPT. 2015
	CHK'D BY: BG		PROJECT No.: CC4058.300
amec foster wheeler	DATUM: -	TITLE: MAINLAND LTMF CONCEPT 720,000m3 CAPACITY DEPTH CONTOURS BETWEEN GROUND SURFACE AND DESIGN BASE	REV. No.: A
	PROJECTION: -		FIGURE No.: FIGURE 5-11
	SCALE: AS SHOWN		



Project: Norman Wells Landfill
Date of Isopach: OCT 10, 2015
Surface 1: Design Base
Surface 2: Design Top of Cap
Volume :
Notes: Surface area of Cap = 82,771m2

Cut Contours means Surface 1 is Higher than Surface 2

Fill Contours means Surface 1 is Lower than Surface 2

0m 20 40 60 80 100

1 : 2500

CLIENT:

IMPERIAL OIL LIMITED

amec foster wheeler

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

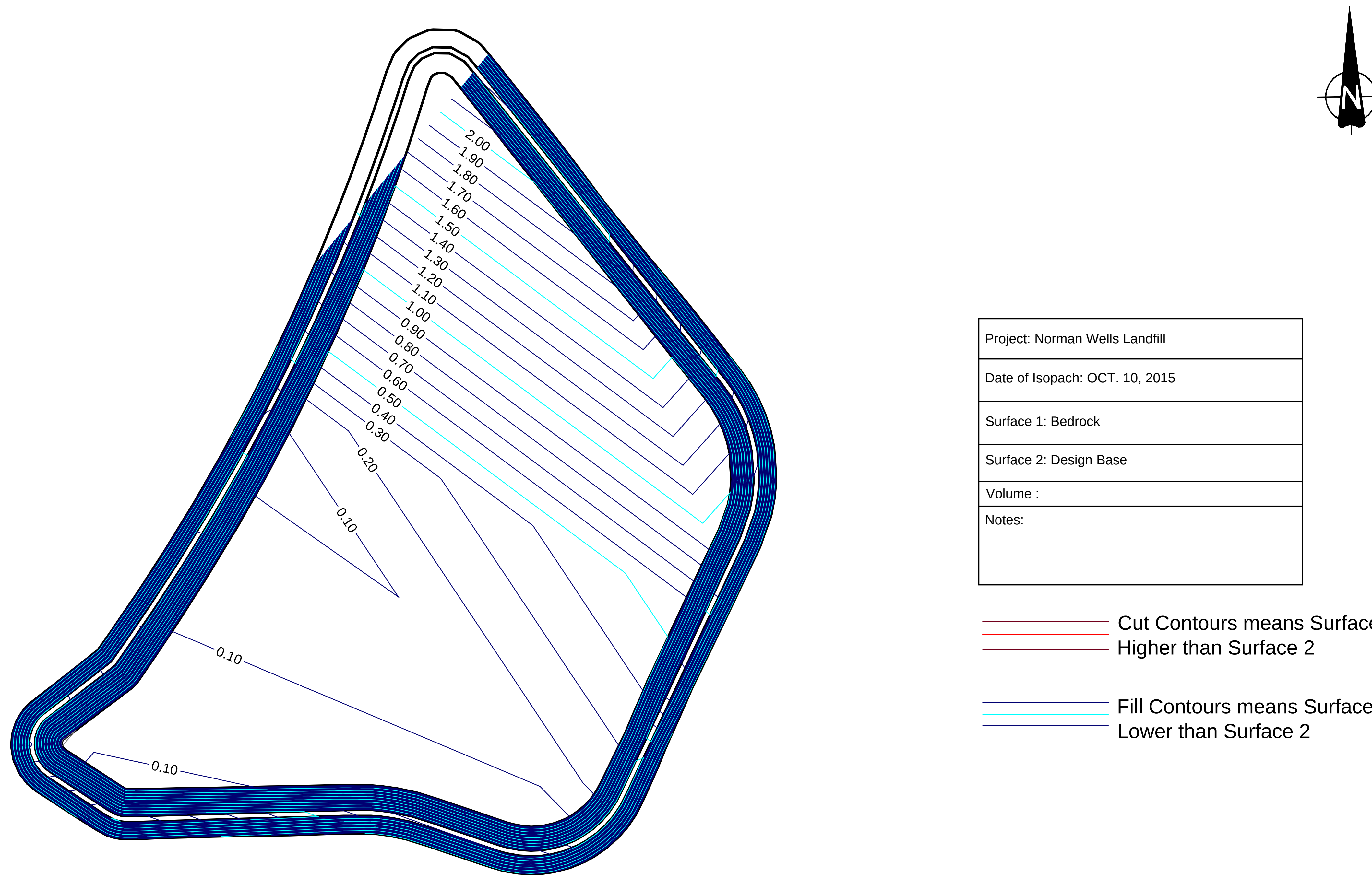
PROJECT:

NORMAN WELLS INTERIM CLOSURE AND RECLAMATION PLAN

TITLE:

MAINLAND LTMF CONCEPT 720,000m3 CAPACITY
DEPTH CONTOURS BETWEEN
DESIGN BASE AND TOP OF CAP

DATE:	OCT. 2015
PROJECT No.:	CC4058.300
REV. No.:	A
FIGURE No.:	FIGURE 5-12



Project: Norman Wells Landfill
Date of Isopach: OCT. 10, 2015
Surface 1: Bedrock
Surface 2: Design Base
Volume :
Notes:

Cut Contours means Surface 1 is Higher than Surface 2

Fill Contours means Surface 1 is Lower than Surface 2

0m 20 40 60 80 100

1 : 2500

CLIENT: IMPERIAL OIL LIMITED	DWN BY: MDDS	PROJECT: NORMAN WELLS CONSERVATION AND RECLAMATION PLAN BASE CASE REMEDIATION AND RECLAMATION REPORT	DATE: OCT. 2015
amec foster wheeler	CHK'D BY: BG		PROJECT No.: CC4058.300
	DATUM: -	TITLE: MAINLAND LTMF CONCEPT 720,000m3 CAPACITY DEPTH CONTOURS BETWEEN BEDROCK AND DESIGN BASE	REV. No.: A
	PROJECTION: -		FIGURE No.: FIGURE 5-13
	SCALE: AS SHOWN		

The concepts in the figures reflect a facility sized to accommodate the entire inventory of impacted soil described in Section 5.3. The facility capacity has not been reduced to reflect soils that may be treatable (see discussion in Section 6.3) for the following reasons:

- the proportion of the inventory that may be treatable at closure has not been defined with certainty and a preliminary sizing of the LTMF to accommodate the entire soil inventory conservatively impacts facility siting and configuration assessments;
- the volumes in Table 5.2 do not include the estimating variance typically associated with contaminated soil volumes and there is a significant probability that volumes will increase as subsurface conditions are more comprehensively understood (either before, or during C&R Plan execution); and
- reducing LTMF capacity before or after initiating C&R activity would be relatively straightforward and would most likely involve reducing the LTMF footprint by moving the southern limit of the facility north as required to reflect the inventory volumes that eventually prove to be treatable.

The concept illustrated on Figures 5-8 through 5-13 differs from the associated option considered in the alternatives assessment (i.e., Option 5; At Depth LTMF (shallow bedrock) as described in Section 5.5.1.4) in the following respects:

- the LTMF location has been adjusted slightly to provide minimum offsets of 300 m from Seepage Lake and 50 m from the Carol Drive centreline;
- the capacity of the facility has been increased to 720,000 m^3 to accommodate the current estimate of 50,000 m^3 for building dismantling and demolition waste (Section 5.5.5) that will be incremental to the 670,000 m^3 estimate for impacted soil (Section 5.3);
- the corners of the facility have been rounded and slight curves introduced on the longitudinal perimeters to provide an LTMF appearance that is more consistent with a natural landform than a civil embankment; and
- the facility's top and slide slopes have been adjusted slightly to better align with the landform features and slopes typically prescribed for facilities of this nature.

Leachate Management

One of the important components of LTMF development and one that will require ongoing operational and maintenance activity, is the system required to manage the leachate that will accumulate at the base of the LTMF. As noted in Section 5.4.2.2, the assumed LTMF leachate management concept calls for management using existing systems during LTMF construction followed by treatment with local surface discharge after placement of the permanent LTMF cover. The volumes of water requiring management would be as follows:

- pre LTMF completion: a function of the average precipitation over the duration of LTMF construction. For this preliminary stage of planning, a quantitative estimate of this volume was not attempted although it is clear that this precipitation driven volume will be much greater than the ongoing post construction leachate volume; and
- post LTMF completion: determined on the basis of preliminary modelling on an LTMF footprint and concept similar to the Mainland Sumps LTMF (note: at this preliminary level of modelling detail, predicted leachate volumes are not highly sensitive to the assumed LTMF configuration).

The model applied to the post LTMF completion phase was the US EPA's Hydraulic Evaluation of Landfill Performance (HELP) model, which was developed as a tool for analyzing water balances in landfill lining and capping systems. Key inputs for the modelling effort included:

- local precipitation data (from the Norman Wells Airport weather station);
- LTMF footprint and cap slope and length;
- the water holding capacity of soils stored in the LTMF; and
- the assumed cover and liner leakage rates.

The HELP run completed for the Base Case LTMF is included on the worksheet provided in Appendix J. This run predicted that the ongoing rate of leachate generation following placement of the LTMF cover can be expected to be in the range of 5 litres per minute (the 20 mm annual leakage rate predicted in the worksheet converted to a flow over the LTMF footprint).

The proposed LTMF concept assumes that this leachate would be directed to a dedicated treatment plant operated indefinitely following facility closure and LTMF development. It was assumed that the primary leachate treatment parameters would be hydrocarbons and chlorides, and that the basic treatment train would be comprised of a pre-treatment system (to remove hydrocarbons and other organics) discharging to a membrane system (to remove salts). The specific treatment train assumed would consist of a pre-filter system to remove any particulate (5 micron bag/cartridge filter) material followed by a granular activated carbon (GAC) system to remove hydrocarbons (this system would only be able to remove dissolved phase material). The GAC effluent would be filtered using a nominal 1 micron cartridge filter followed by a reverse osmosis system. The RO system would produce a clean permeate stream (perhaps on the order of 85% of the water flow based on the preliminary estimated quality) and a dirty reject stream. The reject stream would be directed to a crystallizer producing a concentrated brine/solid waste stream.

The outputs of the plant would be a water stream suitable for direct discharge and a low volume concentrated rejects stream that would be directed to a dedicated, and relatively small, adjunct to the LTMF facility, or to a third party off-site disposition facility.

The capital cost of the water treatment plants in the Appendix K workbooks is based on a flow capacity of 10 litres per minute, or roughly twice the estimated average annual leachate generation rate. This higher plant capacity provides the ability to accommodate short term peak flows that may develop from time to time.

It is worth noting that the operation and maintenance of this treatment facility is one of the C&R scope areas where there may be commercial opportunities for local partners, per the discussion outlined previously in Section 2.5.2.

.3 Remediation

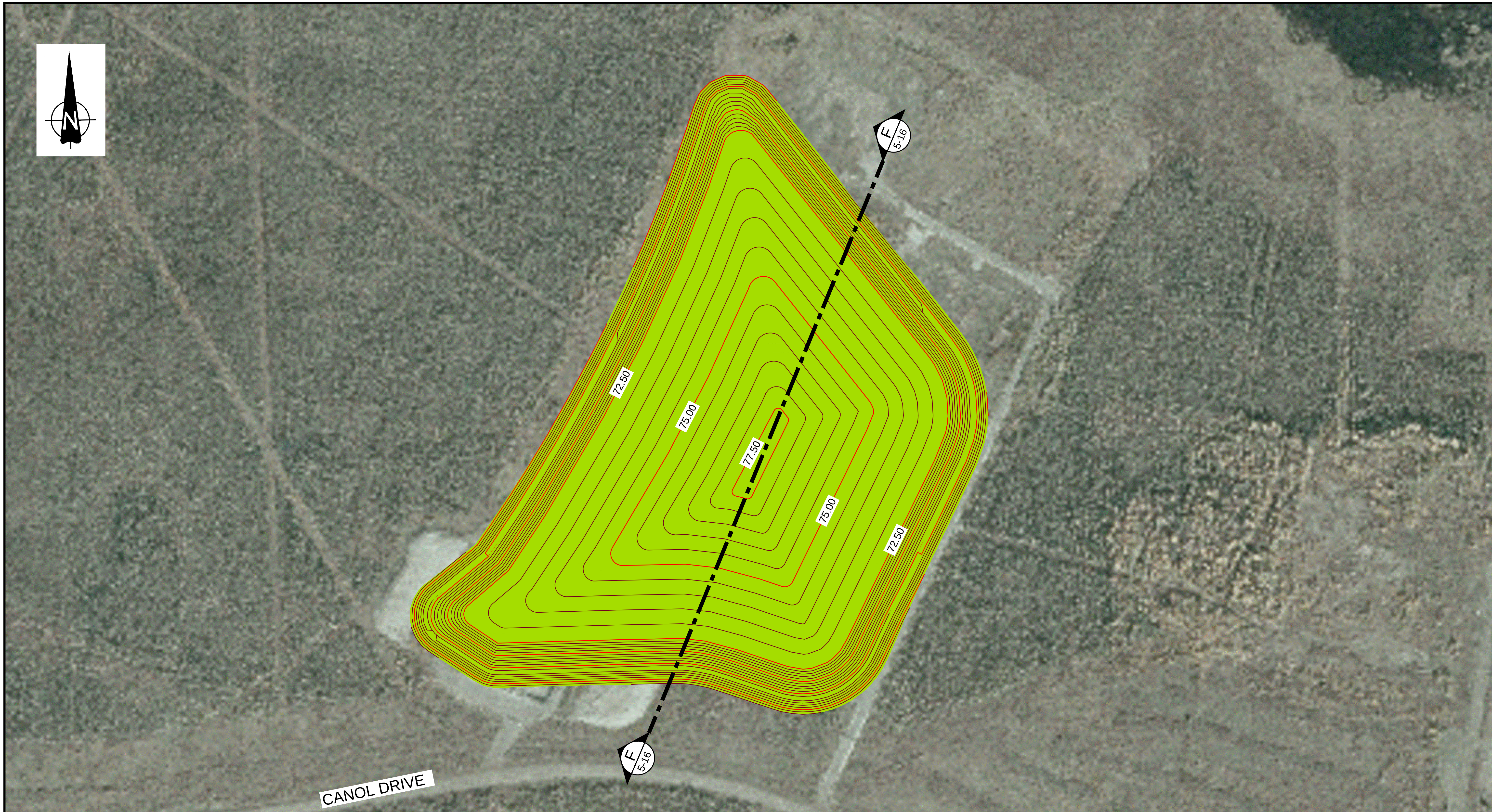
The basic remedial concept for the Mainland flows from the general site remediation strategy outlined in Section 5.4.1 and is technically straightforward. Impacted soil volumes incompatible with the criteria in Table 5-5 will be excavated using conventional methods and equipment and either treated (see discussion in Section 6.3) or consolidated within the LTMF. While there may be localized areas or circumstances within the mainland that require more specialized equipment and/or methods (e.g., wet materials, sloughing sands)), it is not anticipated that these circumstances will have a material impact on the general nature of the remedial plan. The logistical issues associated with completing and scheduling the required soil transfers are described in the Materials Management Plan outlined in Section 5.6. It is anticipated that the characteristics of soils transferred to the LTMF will be compatible with placement and compaction via largely conventional means (perhaps with some blending to mitigate localized high water contents), and the development and maintenance of stable final LTMF surfaces.

.4 Reclamation

Reclamation in the Mainland area will be undertaken according to the general principles and methods outlined in Section 5.2. Broadly speaking, this will involve backfilling contaminated material source areas as described in the general Materials Management Plan (Section 5.6) and re-establishing land surfaces and capabilities that are consistent with the specified reclamation objectives. The specific interpretations of these methods and objectives for the Mainland component are illustrated in the general arrangement of the post reclamation land surface that is provided in Figure 5-14. Figures 5-15 to 5-17 provide additional detail on the Mainland LTMF following reclamation. General comments and observations on the content of these figures are as follows:

- the reclaimed areas shown on Figure 5-14 reflect exposed overburden surfaces, or contaminated soil excavations backfilled with shale and an overburden cover;
- final overburden surfaces will generally be allowed to revegetate naturally, or in selected areas, be seeded to grass; again, select areas will also be planted with native tree saplings at the edges of formerly disturbed areas to provide an aesthetic transition to adjacent woodlands;
- the LTMF cap will also be seeded to grass similar to and compatible with native grasses; and
- the existing roads that have been assumed retained post closure are shown on Figure 5-14.

CLIENT: IMPERIAL OIL LIMITED	DWN BY: MDDS	PROJECT: NORMAN WELLS INTERIM CLOSURE AND RECLAMATION PLAN	DATE: OCT. 2015
	CHK'D BY: BG		PROJECT No.: CC4058.300
amec foster wheeler	DATUM: -	TITLE: MAINLAND RECLAMATION PLAN	REV. No.: A
	PROJECTION: -		FIGURE No.: FIGURE 5-14
	SCALE: AS SHOWN		



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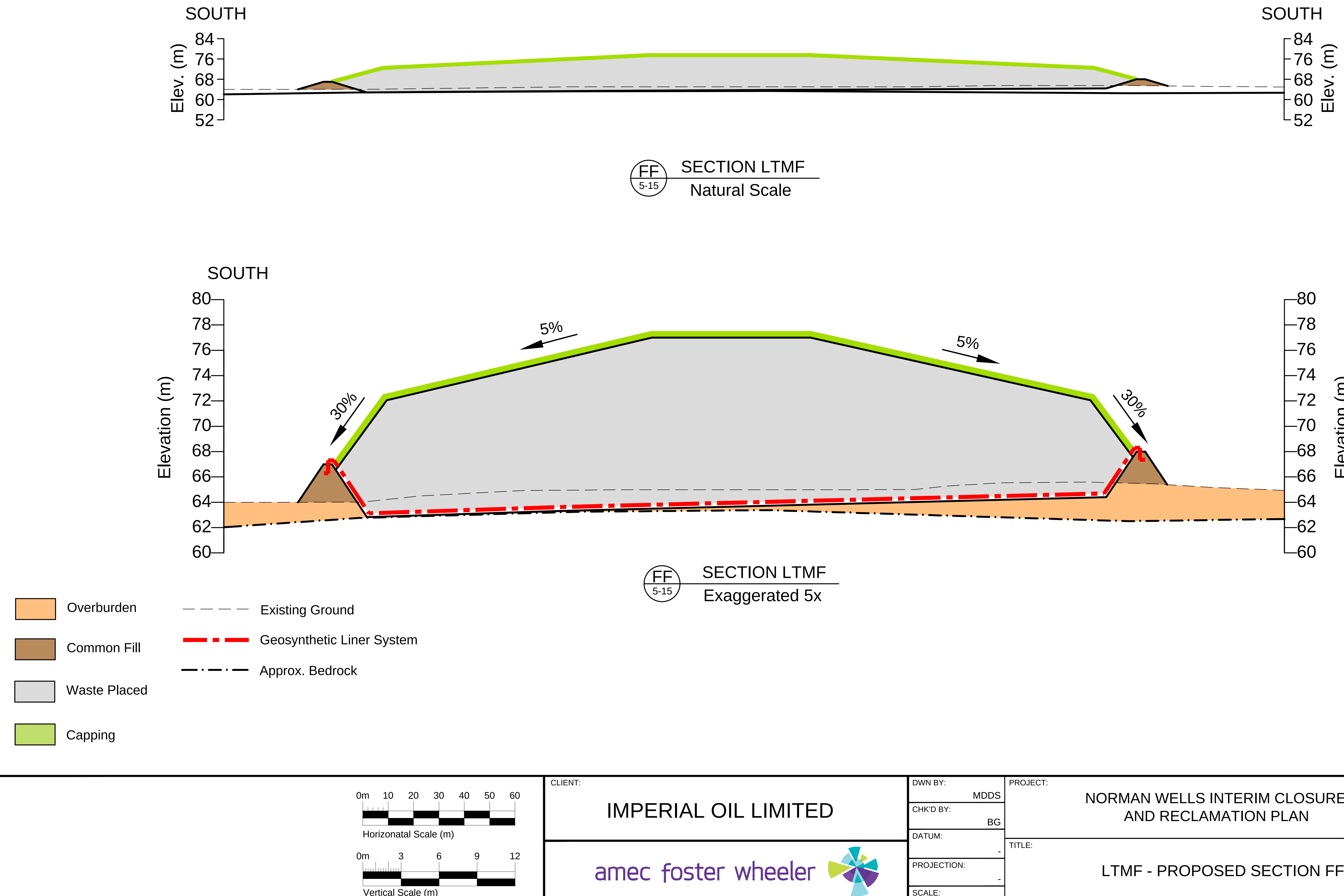
	DATUM: -	TITLE: LTMF - PROPOSED POST CLOSURE CAP	REV. No.: A
	PROJECTION: -		FIGURE No.: FIGURE 5-15
	SCALE: AS SHOWN		



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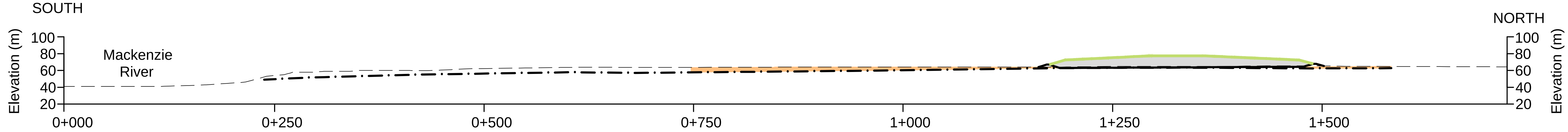
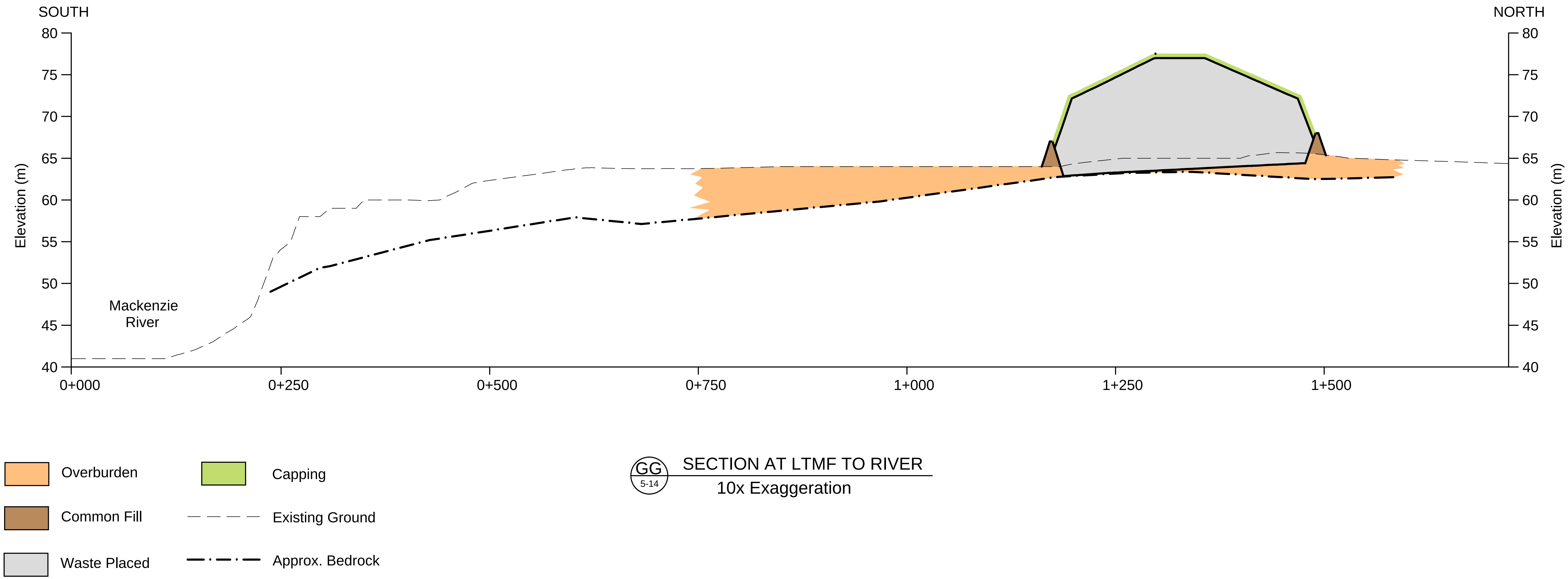
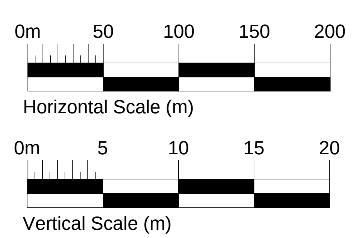
	DATUM: -	TITLE: LTMF - PROPOSED SECTION FF	REV. No.: A
	PROJECTION: -		FIGURE No.: FIGURE 5-16
	SCALE: AS SHOWN		



GG 5-14 SECTION AT LTMF TO RIVER
Natural Scale



GG 5-14 SECTION AT LTMF TO RIVER
10x Exaggeration



CLIENT: IMPERIAL OIL LIMITED	DWN BY: MDDS	PROJECT: NORMAN WELLS INTERIM CLOSURE AND RECLAMATION PLAN
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	DATUM: -	PROJECT No.: CC4058.300
	PROJECTION: -	TITLE: LTMF - PROPOSED SECTION GG
	SCALE: AS SHOWN	REV. No.: A
		FIGURE No.: FIGURE 5-17

5.5.1.4 Consideration of Options

The component specific consideration of options for the Mainland was comprised of an assessment of siting alternatives for the LTMF that is a central feature of the overall C&R Plan. The LTMF siting options were selected to highlight the influence of a range of key design issues on facility characteristics and costs. The general configurations that different siting options might take, and the associated implications on earth materials handling requirements and costs were examined with enough detail to guide final site selection efforts. This detailed consideration of LTMF siting options is provided in Appendices K through M. The following sections summarize the outcomes of this options evaluation.

.1 Siting Options Assessment Overview

The siting options and cost evaluations outlined in Appendices K through M demonstrate that there are a variety of locations and configurations that could be considered for a Norman Wells LTMF facility, and that the available lands within the Mainland Central and East areas are large enough to offer considerable flexibility in LTMF siting and design. The evaluations suggest that there may be a moderate cost advantage to co-locating the LTMF at depth within the most heavily impacted portions of the Mainland. However, this benefit is not material within the broader context of C&R costs and may be offset by stakeholder concerns about proximities to the groundwater table and/or the river.

The evaluation of the Mainland sumps siting option (Options 5 and 6) demonstrates that areas adjacent to this primary Mainland perimeter are technically feasible at comparable cost. The Mainland sumps assessment predicts costs for this siting option between the deep bedrock “At Depth” option and “At Grade” option. However, the cost differences involved are modest and unlikely to materially influence final siting decisions.

The Best Total Value (i.e., least cost, technically defensible) perspective applied to the current assessment has produced facility concepts with profile heights up to about 15 m above the surrounding ground elevations, and final cover slopes in the range of 6 to 10%. While these parameters are technically feasible and well supported by precedent, reductions in both could be accommodated if necessary. The associated cost increment would be proportional to the expansion of the LTMF footprint; however, for most configurations this increment would be manageable. One general conclusion that can be taken from the current assessment is the Imperial has a good deal of flexibility in the specific design parameters adopted.

.2 LTMF Option Selection

Of the available options described, Option 5 (At Depth LTMF, located in the Mainland Sumps area) was identified as the preferred alternative and used as the basis of the C&R planning outlined in this document. This option was selected because it offers the advantages described in the comparative evaluation, and because of the following features or issues particular to the site:

- this site co-locates the LTMF with an existing area of contamination and, therefore, minimizes the incremental land disturbance required for facility development;

- any interim LTMF development undertaken in this area to support progressive reclamation efforts (see Section 6.0) will not interfere with pre-closure operations, or the operation of existing soil treatment facilities (i.e., the biotreatment and soil washing facilities);
- utilization of the sumps area for the LTMF development leaves the entire Mainland site available as a contiguous property for potential post closure reuse or redevelopment;
- the sumps area provides extended physical and aesthetic buffers between the LTMF and the Mackenzie River and Bosworth Creek (i.e., mitigates concerns about proximity to key water bodies and/or potentially unstable slopes);
- LTMF development in the sumps area maintains an existing local land use (i.e., for waste management) that is accepted by the community;
- the site can accommodate some expansion to the west and east should material volumes increase beyond current estimates (i.e., the site mitigates material volume uncertainties); and
- the site footprint (including any potential expansions) avoids overlaps with existing well sites (i.e., avoids the complexities associated with integrating well abandonment with the development of an overlying storage facility).

5.5.1.5 Engineering Required

For the Mainland concept, it is anticipated that planning and engineering activities will be required for:

- LTMF development;
- impacted soil remediation;
- management of LTMAs; and
- reclamation.

These activities will become progressively more defined as the C&R Plan is refined in the run-up to closure and would supplement the assessment of soil treatability that would be undertaken as part of the Progressive Reclamation scope (see Section 6.0). Specific planning and design requirements are outlined in the following sections.

.1 <u>LTMF Development</u>

Planning and/or engineering development activities for the Mainland LTMF would include:

- <u>Geometric Studies</u>: detailed evaluations of alternative slopes, contours, configurations, and footprints that address capacity requirements, technical constraints, reclamation requirements, and stakeholder objectives and/or preferences.

- Geotechnical and Hydrogeological Evaluations: detailed investigations designed to supplement existing information for the specific LTMF location, configuration and footprint proposed.
- Civil Designs and Stability Assessments: evaluations of placed soil settlement characteristics and the associated impacts on cover performance and integrity; assessments of the geotechnical stability of LTMF surfaces, underlying stratigraphy and any adjacent slopes.
- Leachate Treatment Assessments: treatability assessments, pilot studies and the technology evaluations and selections needed to define a leachate treatment process design; evaluations of the storage and pumping systems and infrastructure needed to support a leachate management system.

.2 Remediation - Impacted Soil Removal

Planning and/or engineering development activities for the remediation of impacted soils on the Mainland via removal and consolidation within the LTMF would include:

- Excavation Plan: development of processes for the detailed field delineation of excavation limits and protocols for making observationally driven field adjustments to limits during execution.
- Remediation Materials Management Plan: more detailed, area specific supplements to the general Materials Management Plan (Section 5.6) that define how movements of various material categories will be sequenced, scheduled and executed; the plan would include the definition of safe excavation slopes and methods for the range of subsurface materials and conditions anticipated.
- Verification Plan: definition of the processes and protocols to be applied during execution to confirm that final excavation surfaces satisfy the prescribed C&R Plan cleanup criteria (i.e., CCME Industrial on the Mainland) and to prepare the documentation needed to validate this compliance through the project stakeholders.

.3 Remediation - Long Term Management Areas (LTMAs)

Planning and/or engineering development activities required to confirm the post closure performance and integrity of LTMAs would include:

- Containment and Recovery System Design: detailed development of the post closure product and groundwater containment/recovery systems and protocols needed to provide for, and monitor the level of contaminant control, in the Refinery Bank area that has been prescribed by the final C&R Plan.
- Product Disposition System Design: options assessment and design of selected alternative for post recovery management and/or treatment of product and groundwater (would include an assessment of the feasibility of integrating components of this requirement with the LTMF leachate management and treatment system).

- Battery 3 Management: detailed review of the long term fate of contaminants, particularly salts, in the Battery 3 area to confirm that passive containment via monitoring meets C&R Plan objectives, and to develop the technical bases for the monitoring systems and protocols that will be required to validate these conclusions post closure.

.4 Reclamation

Planning and/or engineering development activities required to provide reclaimed surfaces meeting the C&R Plan objectives for the Mainland would include:

- Reclamation Materials Management Plan: detailed, area specific Materials Management Plan, again supplementing the general plan in Section 5.6, describing material movements required to backfill impacted source area excavation (this plan would be integrated with the Remediation Materials Management Plan).
- Regrading Plan: a detailed, area specific regrading, recontouring and surface reclamation plan that defines the rough grading, landform development and soil profile reconstruction needed to support C&R Plan objectives.
- Revegetation Plan: detailed plans for establishing the revegetated areas called for in the final C&R Plan.

5.5.1.6 Final Site Conditions

The reclaimed landscape of the Mainland component post closure was illustrated on Figure 5-14 and comments and observations on the content of this figure were provided in Section 5.5.1.3.4.

5.5.1.7 Residual Effects

Long term impacts or effects associated with application of the proposed C&R Plan to the Mainland component are outlined below.

.1 LTMF Development

- The presence of an LTMF creates limits on the future use of lands occupied by and immediately adjacent to the facility.
- The LTMF creates a maintenance and management obligation (e.g., treatment and management of leachate) that extends indefinitely post closure.

.2 LTMAs

- The nature of an LTMA is that soil and groundwater impacts are managed in place. The impacts themselves will, therefore, survive indefinitely post closure, albeit in ways consistent with the objectives established for the C&R Plan.

.3 Remediation/Reclamation

- The CCME Industrial remediation standards proposed for the Mainland component place, by their nature, some limitations on future use of the subject lands.

- The reclaimed landscape will vary from pre-development conditions and, in some respects, from surrounding lands. However, the reclaimed lands will be compatible physically and aesthetically with the regional landscape.

These residual effects are either anticipated by the C&R Plan, or created by features inherent to the proposed C&R Plan elements and activities. In both cases, the effects are mitigated by the C&R Plan in ways that satisfy the prescribed component objectives.

5.5.1.8 Uncertainties

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

- Subsurface/Hydrogeological Conditions: it is possible that detailed geotechnical and/or hydrogeological investigations at the proposed LTMF site will identify conditions incompatible with the current design concept. Should this be the case, mitigation would likely involve changes to the specific location selected for the LTMF and/or facility configurations, footprints and design details. It is unlikely that unanticipated ground conditions would require a material change in the proposed LTMF concept.
- Excavation Methods: it is also 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, these conditions could be adequately mitigated via adjustments to excavation methods, temporary slopes and/or equipment.
- LTMF Capacity: the facility capacity ultimately required will depend on final impacted material volumes (which will not be understood with certainty prior to plan execution) and the proportion of soils that are ultimately determined to be treatable (see discussion in Section 6.3).
- LTMA Management: it is possible that the nature and/or mobility of contaminants in the Refinery Bank and Battery 3 areas will be more difficult to contain, recover or otherwise manage than is currently anticipated. However, this can be effectively mitigated via an appropriate combination of adjustments during detailed design and the application of Adaptive Management measures and protocols post closure (see Section 5.7).
- Revegetation: the success of revegetation efforts may vary across the site and fail to meet objectives in some areas. This will be mitigated by appropriate monitoring and Adaptive Management protocols (again, see Section 5.7).

5.5.2 Natural Islands

This section focuses on the remediation and reclamation activities proposed for Bear, Goose and Frenchy's Islands. 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.

5.5.2.1 Existing Conditions

.1 Topography and Stratigraphy

The topography on the natural islands was included on the illustrations of general Proven Area contours provided on Figure 5-5 (Section 5.4.1.2). A representation of bedrock topography for the islands was not prepared because all of the materials movements proposed for the C&R Plan will occur in the overburdens and shales above the bedrock contact. It has been assumed as well that there is no permafrost on the islands that would materially impact materials management plans.

.2 Contamination Model

The representations of impacted soil distributions on the natural islands used to support C&R planning were provided on Figure 5-1. This figure was developed as described in Section 5.2.4.

5.5.2.2 Component Specific Objectives

The closure objectives and criteria that apply specifically to the Natural Islands Component are outlined in Table 5-6. The basis and derivation of these objectives and criteria were described in the general planning discussion included in Section 5.2.

5.5.2.3 Proposed C&R Scope and Activity

.1 Remediation

Remedial activity proposed for the natural islands is comparatively straightforward and follows from the general description of the C&R Plan outlined in Section 5.4.1. Impacted 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.

Table 5-6: Objectives and Criteria for the Natural Islands Component

Component	Media	Objective	Criteria	Actions-Measurements
Natural 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	Water quality that is safe for humans, wildlife and aquatic life	Surface water and groundwater 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
		Hydrology and drainage of the reclaimed land surface consistent with the character of the local watershed and appropriate to the defined land use	Surface contours and substrate types that promote drainage generally consistent with pre-development drainage patterns	Post-reclamation monitoring of surface water drainage by qualified professionals
	Wildlife	Terrain restoration to allow safe utilization and passage by terrestrial wildlife	Safe use of formally disturbed areas by wildlife within the defined future land use	Wildlife monitoring by qualified individuals

.2 Reclamation

The proposed post closure, reclaimed landscape for Goose and Bear Islands are illustrated on Figures 5-18 through 5-26, as follows:

- Figures 5-18 and 5-24 show the general arrangements of reclaimed landscapes on Goose and Bear Islands, respectively;
- Figures 5-19 through 5-22 show the recontoured GIT structures on Goose Island following relocation and consolidation of local island road shales;
- Figure 5-23 shows typical sections through the Goose Island GIT structures following recontouring;
- Figure 5-25 shows the recontoured BIT structure on Bear Island following the relocation and consolidation of local shales; and
- Figure 5-26 shows a typical section through the Bear Island BIT structure following recontouring.

The central elements of the proposed reclamation activity shown on Figures 5-18 through 5-26 can be summarized as follows:

- the completed contaminated soil excavations are backfilled with shales sourced locally from island road alignments;
- the backfilled shales are then covered with 20 cm of overburden sourced locally;
- the remaining shale accumulations on island road alignments are removed and consolidated at the GIT/BIT sites;
- shale accumulations at the GITs/BITs are contoured to provide final land slopes and features that will be physically stable and aesthetically compatible with the surrounding landscape;
- finished overburden surfaces (i.e., on backfilled soil excavations and reclaimed road alignments) will be seeded to grass or left to revegetate naturally; and
- select areas around the GITs/BITs and some road alignments will receive tree or shrub plantings to provide an aesthetic transition between reclaimed grass areas and the surrounding lands.

5.5.2.4 Consideration of Options

The comparative assessment of options described in Section 5.3.3.2 for the overall property C&R Plan applies to those elements of the plan relating to the Natural Islands component. The additional component specific option that was given some consideration was the possibility of developing a separate LTMF for the islands inventory of contaminated materials, most likely in the general vicinity of the Bear Island drilling sumps. This possibility was discounted for the following reasons:

LEGEND

- Re-graded GIT Surface
- Road/Pad Removal

NOTES

1. Impacted soil is relocated to the Mainland LTMF.
2. Shale surfaces are relocated to excavations for use as fill.
3. Remaining shale surfaces from roads and well sites is relocated to Goose Island Terminals (GIT)'s.
4. GIT's are graded to slope of 3H:1V or less.

0m 100 200 300 400
1 : 10000

CLIENT: IMPERIAL OIL LIMITED

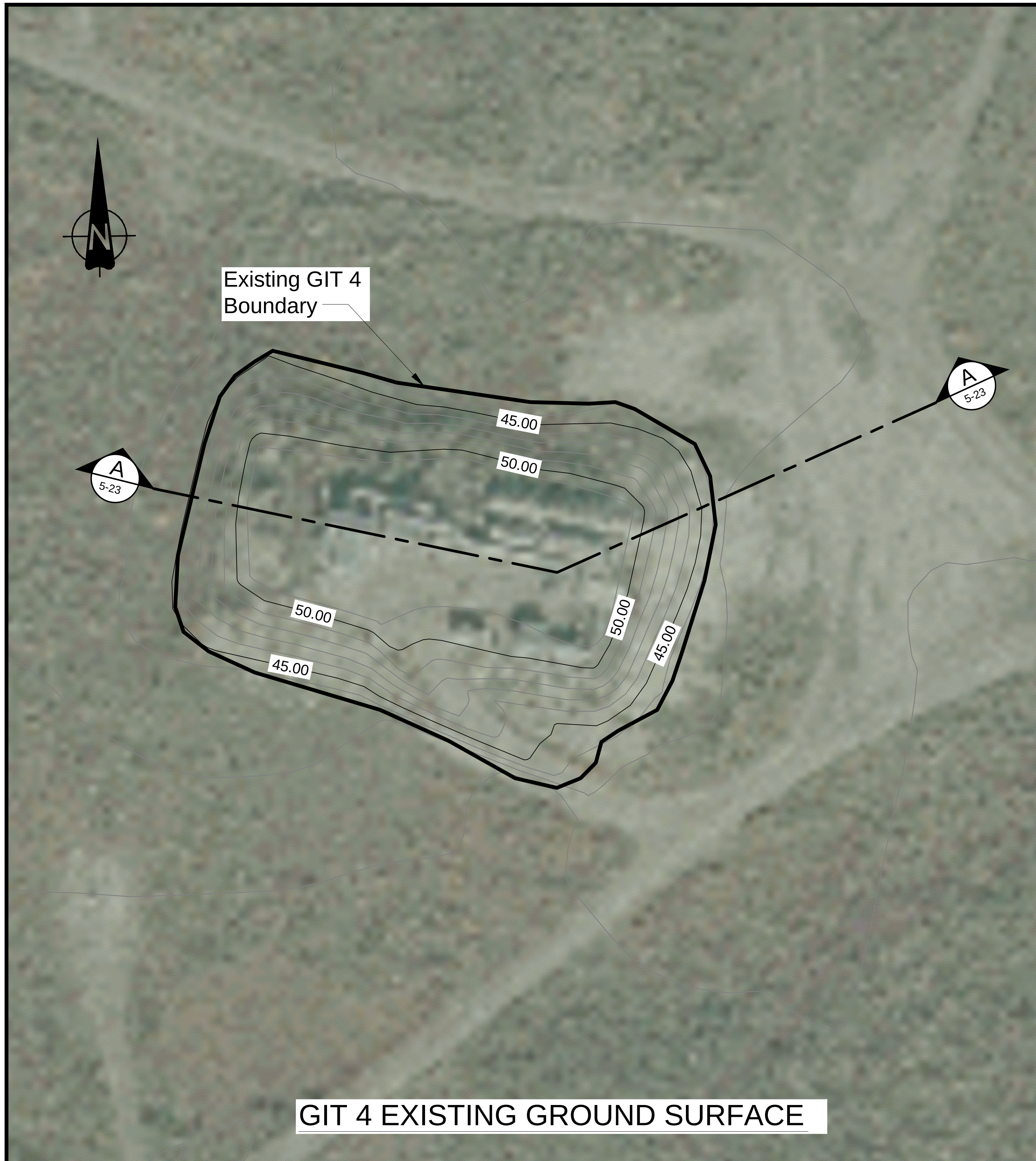
amec foster wheeler

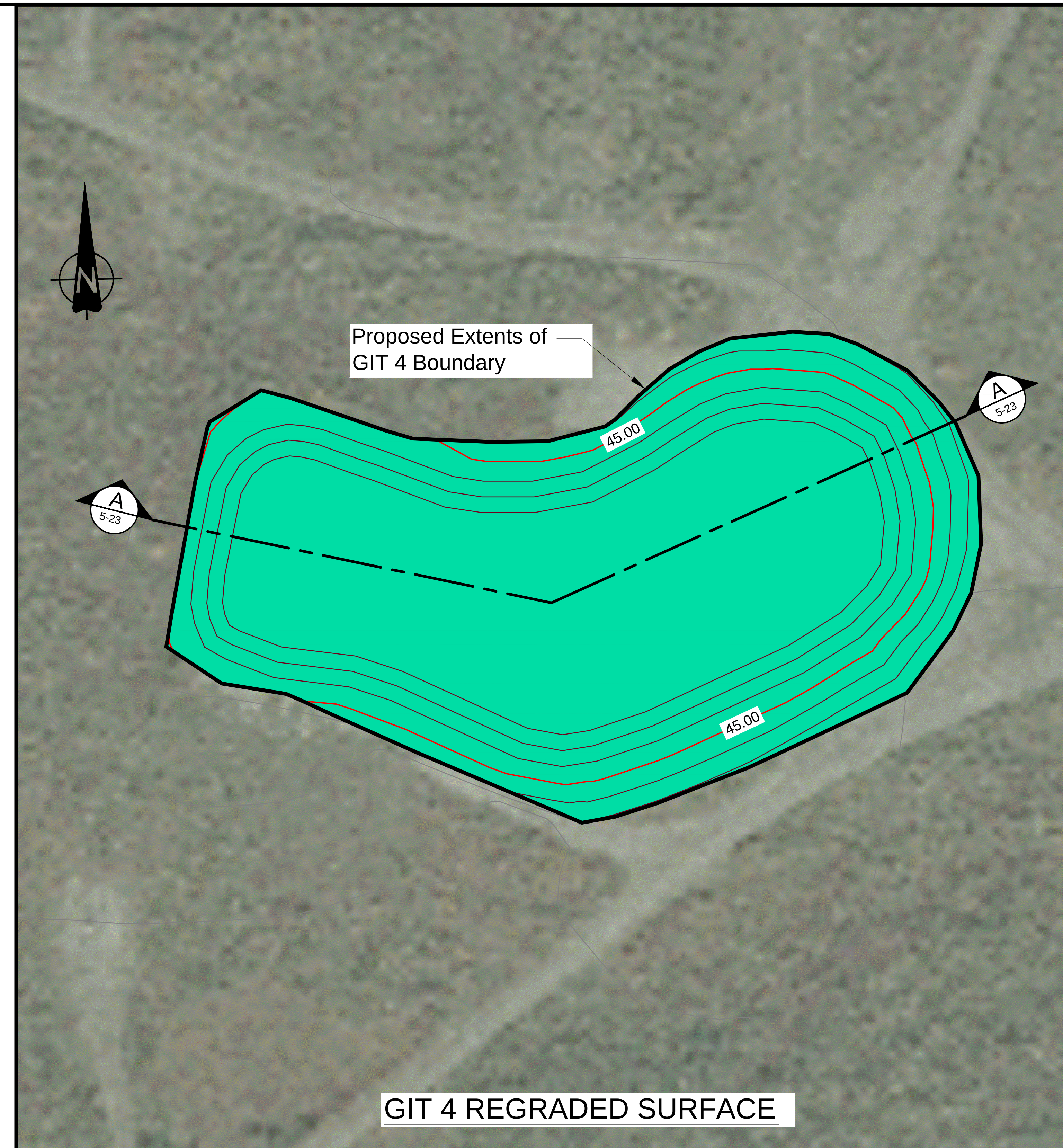
DWN BY:	MDDS
CHK'D BY:	BG
DATUM:	-
PROJECTION:	-
SCALE:	AS SHOWN

PROJECT: NORMAN WELLS INTERIM CLOSURE AND RECLAMATION PLAN

TITLE: GOOSE ISLAND RECLAMATION PLAN

DATE:	OCT. 2015
PROJECT No.:	CC4058.300
REV. No.:	A
FIGURE No.:	FIGURE 5-18

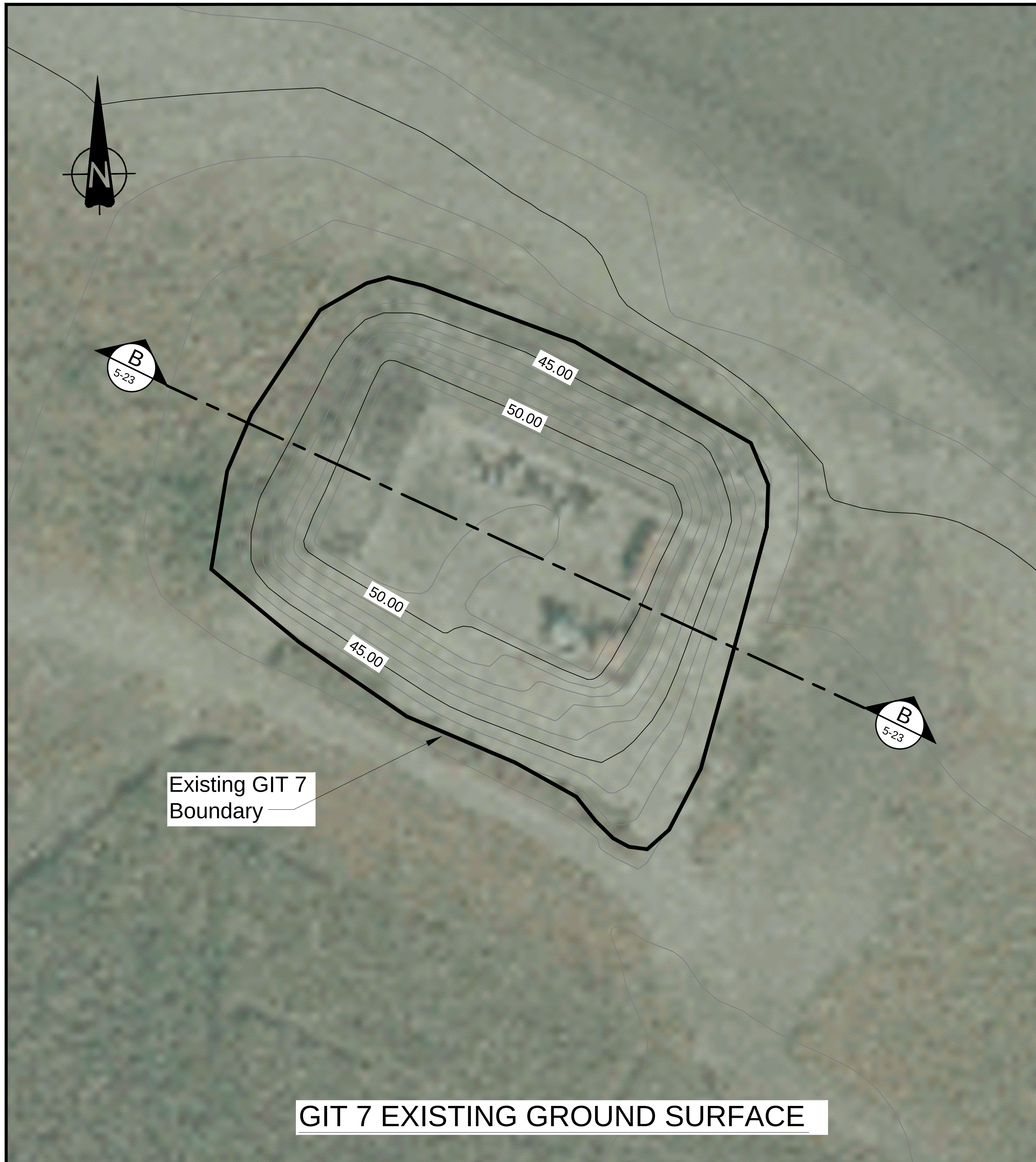




0m 10 20 30 40 50 60

1 : 1500

CLIENT: IMPERIAL OIL LIMITED	DWN BY: MDDS	PROJECT: NORMAN WELLS INTERIM CLOSURE AND RECLAMATION PLAN	DATE: OCT. 2015
	CHK'D BY: BG		PROJECT No.: CC4058.300
amec foster wheeler	DATUM: -	TITLE: GIT 4 PROPOSED REGRADED SURFACE	REV. No.: A
	PROJECTION: -		
	SCALE: AS SHOWN		FIGURE No.: FIGURE 5-19



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:

GIT 7 PROPOSED REGRADED SURFACE

DATE:	OCT. 2015
PROJECT No.:	CC4058.300
REV. No.:	A
FIGURE No.:	FIGURE 5-20