Vince Eggleston
Operations Support Manager
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March 13, 2026

Paul Ferensowicz
Alberta Energy Regulator
Suite 1000, 250-5 Street SW
Calgary, Alberta T2P 0R4

Dear Mr. Ferensowicz,

The Quality Assurance Report was prepared by FMFN Group-Stantec in collaboration with Imperial in fulfillment of the administrative penalty issued by Alberta Energy Regulator, in relation to the Kearl shallow seepage incident reported in 2022. Its purpose is to provide a clear account of the incident, outline contributing factors, and present lessons learned and recommendations intended to reduce the likelihood of similar events occurring across the industry.

Imperial endorses the findings and recommendations presented in this report. Imperials response actions informed its development, and the report now guides the additional measures being implemented. These actions demonstrate Imperials commitment to continuous improvement, environmental stewardship, and the safe, responsible operation of our assets. Imperial trusts that this report fulfills the conditions of the administrative penalty. While this project is considered complete, Imperial remains committed to ongoing learning, open dialogue, transparency, and relationship building.

Imperial recognizes that each operator and regulator will need to determine how these recommendations apply within their own unique contexts—including variations in geology, project stage, design, and operational practices. Imperial encourages others across the industry to review the report's findings and consider how best to integrate the relevant learnings into their own systems and processes.

Illustrative response actions completed or underway related to the Quality Assurance lessons learned and recommendations:

- **Refined subsurface characterization:** ~250 additional boreholes completed around northern areas of the Kearl lease near the External Tailings Area (ETA) and Seepage Interception System (SIS) facilities have greatly enhanced the conceptual understanding of the groundwater flow paths in these areas and have been incorporated into subsurface models. From a hydrostratigraphic perspective, the state of understanding of the local hydrogeologic framework and groundwater flow regime is now more robust and mature.

- **Expanded seepage monitoring and management systems:** Installed nearly 800 additional wells around the ETA, including nested wells to vertically monitor each flow unit and comprehensive source, delineation, compliance, and offsite regional wells and an expanded surface water monitoring program for earlier detection and stronger response. Installed and activated over 50 additional pumping wells, 3 trenches, a sump, and well point vacuum system and lined sections of the closed loop ditch system to improve seepage management.

- **Incorporation of the observational method**: Ongoing monitoring of the SIS performance and response of local scale water levels are being used to validate numerical modeling predictions and adjustments to the design or operation of the SIS are being implemented via adaptive management.

- **Source characterization studies:** Ongoing geochemical studies such as fresh and weathered coarse sand tailings (CST) field bins and overburden material sampling campaigns are aiding in source characterization and assessing sulphide mineral oxidation and acid rock drainage potential. Profiles created for CST, process affected water and natural groundwater are being applied to aid in identification of anthropogenic affects on groundwater.

- **Updated key indicator parameters (KIPs):** Learnings from source geochemical characterization work have been incorporated into updated KIPs in Kearl's Groundwater Monitoring and Response Plan.

- **Collaborative communications protocols:** Imperial worked collaboratively with local Indigenous Communities to update notification protocols. These improvements are essential to rebuilding confidence, supporting community well being, and upholding our responsibility as a neighbour and operator in the region.

Sincerely,

Vince Eggleston
Operations Support Manager

Kearl - Quality Assurance Project

Report summarizing lessons learned from the Kearl seepage release

Prepared for:

Imperial Oil Resources Limited

Prepared by:

FMFN Group – Stantec

March 12, 2026

Project No.: 123515273

FMFN Group - Stantec

Limitations and Sign-off

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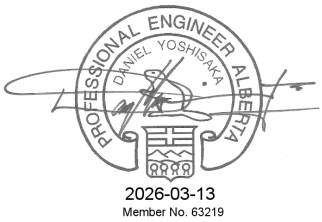

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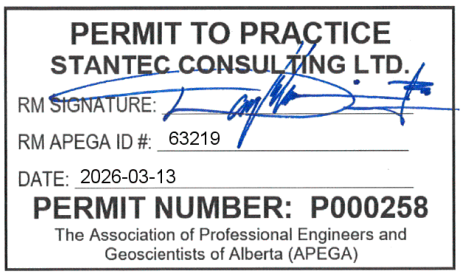

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Abbreviations

ACFN	Athabasca Chipewyan First Nation
AER	Alberta Energy Regulator
ARD	Acid Rock Drainage
CST	Coarse Sand Tailings
COSIA	Canadian Oil Sands Innovation Alliance
DIAC	Dam Integrity Advisory Committee
DP4	Drainage Pond 4
ECC	Environmental Consultation Committee
EETA	East External Tailings Area
EIA	Environmental Impact Assessment
EPEA	Environmental Protection and Enhancement Act
ESA	Environmental Site Assessment
ETA	External Tailings Area
ETA-SIS	External Tailings Area Seepage Interception System
FCMN	Fort Chipewyan Métis Nation
FMFN 468	Fort McMurray 468 First Nation
FMkFN	Fort McKay First Nation
FMMN	Fort McKay Métis Nation
GMP	Groundwater Monitoring Plan
IOL	Imperial Oil Limited
ITA	Internal Tailings Area
KIP	Key Indicator Parameter
MCFN	Mikisew Cree First Nation
MM	McMurray Métis
NODA	North Overburden Disposal Area
ODA	Overburden Disposal Area
PAW	Process Affected Water
QA Project	Quality Assurance Project

SIS ..... Seepage Interception System

SMO ..... Sulphide Mineral Oxidation

SMP ..... Sampling & Monitoring Plan

WB3 ..... Water Body 3

WETA ..... West External Tailings Area

WPVS ..... Well Point Vacuum System

Glossary

Acid Rock Drainage	Acidic, metal-rich water produced when sulphide-bearing rocks are exposed to air and water and undergo chemical weathering
Anthropogenic	Caused or influenced by human activities
Aquifer	A geological layer that can contain or transmit groundwater
Aquitard	A geological layer that restricts the flow of groundwater
Bitumen Froth	Refers to the various mixture of viscous bitumen, water, sand, clay, and air that is produced during the extraction of bitumen from oil sands
Containment Dyke	A containment dyke in oil sands tailings management is a structure designed to hold and contain tailings
Coarse Sand Tailings	A byproduct of the oil sands extraction process, consisting primarily of larger, heavier sand particles that settle out during bitumen separation
Cretaceous Period	A time period on Earth, spanning from about 145 to 66 million years ago
Dewatering	Removing excess water from mining areas
Facies	In geology, facies refer to the distinctive characteristics of a rock layer, including its composition, texture, color, and fossil content, which reflect the environment of deposition
Fluvial	Of or found in a river
Fluvial Environment	A fluvial environment refers to a landscape characterized by the processes and landforms created by the flow of water, particularly rivers

Glacial Environment	A glacial environment refers to a landscape shaped by the movement and melting of glaciers
Hydrogeologic Complexity	The degree to which the physical and hydrological characteristics of subsurface materials, such as rock layers, aquifers, and groundwater flow paths, vary across a site
Hydrogeologic Interpretation	Is the process of understanding how water moves through the ground based on the types of rocks and soil in an area
Hydrostratigraphic Method	A way of studying underground layers based on how water moves through them. Grouping layers into aquifers and aquitards to understand groundwater movement and connections between layers.
Integrated Monitoring	In the context of this report, integrated monitoring refers to the deliberate linkage of environmental monitoring programs between different media, potentially including surface water / wetlands, aquatics, soils and groundwater
Internal Tailings Areas	Mine pits that have completed active mining and are subsequently backfilled with tailings
Key Indicator Parameters	Are specific measurements chosen for detailed assessment because they can show changes in environmental conditions. These parameters are potentially useful for telling the difference between changes caused by human activities and those that happen naturally
Lithofacies-Based Model	A way of studying underground layers by describing their physical features to understand how and where the sediments were originally deposited.
Lithologic Observations	Observations about the physical characteristics of rocks and soil in a specific area, they help describe what the ground looks like, what it is made of, any layers, and how it might affect things like groundwater flow
McMurray Formation	A stratigraphic unit of the Early Cretaceous age, located in the Western Canada Sedimentary Basin in northeastern Alberta. The formation is known for its rich bitumen reservoirs and sandstone

Overburden	The material that lies above an ore body or coal seam which must be removed to access the resource beneath. This includes soil, rock, and ecosystem materials that cover the area intended for exploitation
Oxidation	Oxidation is the loss of electrons or increase in oxidation state of a molecule, atom, or ion in a chemical reaction. A chemical reaction that occurs when a material reacts with an oxidizing agent, often causing it to break down or change form. (In CST, oxidation of sulphide minerals produces acidic compounds)
pH	A measure of how acidic or basic (alkaline) a solution is, expressed on a scale from 0 to 14. A pH of 7 is neutral, values below 7 indicate increasing acidity, and values above 7 indicate increasing alkalinity
Primary Separation Cell	Refers to a vessel used in oil sands extraction processes where bitumen is separate from sand using gravity separation
Quaternary Period	The Quaternary Period is the most recent geological period, spanning from about 2.58 million years ago to the present.
Residual Bitumen	Refers to bitumen that remains after the extraction process of crude petroleum oil
Saturation Point	The stage at which a material can no longer hold or absorb any more of a substance.
Seepage	The orange discoloured surface water near the ETA that Imperial reported to the AER on May 19, 2022, at Kearl north of Fort McMurray, AB.
Sulphide Minerals	Minerals that contain sulphur combined with metals, such as pyrite (iron sulphide).
Sulphide Mineral Oxidation	The chemical reaction in which sulphide-bearing minerals (such as pyrite) react with oxygen, producing oxidized products like sulfate and releasing acidity and metals

Strata	A layer or series of layers of rock in the ground that have formed over time
Stratigraphy	Geology concerned with the study of rock layers (strata) and layering (stratification). It deals with the origin, composition, distribution, and succession of strata
Tailings	The residual materials left over after the extraction of minerals or bitumen from mined ore
Tailings Pond	An engineered containment area used to store tailings

Executive Summary

In May 2022, Imperial Oil Resources Limited (Imperial) discovered discolored water near its Kearl Oil Sands site north of Fort McMurray. After an investigation, the water was confirmed to be industrial wastewater that had seeped from the External Tailings Area (ETA). As a result, Imperial was issued an administrative penalty from the Alberta Energy Regulator (AER) and directed to complete a Quality Assurance Project, which included conducting a review of what happened, sharing lessons learned with industry peers and neighbouring Indigenous Communities and land users and developing quality assurance recommendations and processes.

This report summarizes the Quality Assurance Project undertaken by Imperial, including an explanation of the site's physical setting, the seepage event, Imperial's response, contributing factors, lessons learned and recommendations for the future.

The seepage occurred because shallow groundwater pathways were not fully understood during early design and operation. Complex geology, resulting in incomplete monitoring and mitigation systems allowed water to move outside the lease area. At the same time, materials in the tailings dykes created unanticipated reactions which changed water chemistry over time. These shifts made it harder to identify seepage using the original chemical indicators. As a result, early warning signs were misunderstood, and detection was delayed.

Imperial responded with additional infrastructure, studies, updated models and improved communication including:

- Installing nearly 800 monitoring wells and expanding water sampling programs.
- Adding new seepage interception trenches and pumping wells.
- Conducting detailed studies of soil, water, and tailings chemistry.
- Updating groundwater models to better predict seepage pathways.
- Improving communication and transparency with neighbouring Indigenous Communities.

Imperial compiled a list of lessons learned and shared the following with industry and neighbouring Indigenous Communities and land users:

- Understand the ground: Appropriately detailed geological and hydrogeological studies are critical for each design phase.
- Choose the right indicators to monitor: Select chemical markers that reflect actual site conditions and materials to detect changes quickly and update monitoring plans as new data emerges.
- Engage Communities: Share information early, listen to feedback.

Imperial continues to improve its seepage management systems and monitoring programs. It is also working with industry groups to make these lessons available as part of best practice documentation across the oil sands mining sector. The goal is to prevent similar incidents and rebuild trust with Communities and regulators.

1 Introduction & Background

On May 19, 2022, Imperial reported to the Alberta Energy Regulator (AER) the discovery of discoloured surface water near the External Tailings Area (ETA) at four low-lying seeps at the Kearl Oil Sands Processing Plant and Mine (”Site”) north of Fort McMurray, AB. This discovery initiated an investigation by both the AER and Imperial to determine the source and pathway of the discoloured water.

Following months of water quality sampling, monitoring and technical evaluation, Imperial confirmed on November 29, 2022, that the source of the water at each of the seep locations was industrial wastewater from Kearl operations (referred to as the Seepage herein). On August 22, 2024, the AER found Imperial to be in contravention of its Environmental Protection and Enhancement Act (EPEA) approval in relation to the Seepage and issued Imperial an administrative penalty.

As part of the administrative penalty, Imperial was directed to undertake the Kearl Oil Sands Mine Development EPO Quality Assurance Project (“QA Project”) that addressed the design, construction and operation of tailings seepage management to ensure quality assurance and quality control. Imperial was also directed under the Quality Assurance Project to share lessons learned from the Seepage, investigation, and conclusions with industry and Kearl’s neighboring Indigenous Communities and land users.

Imperial has worked since 2022 to better understand the contributing factors leading to the Seepage. Their work has encompassed a comprehensive review of seepage management at the ETA, including geological and hydrogeological settings, subsurface delineation, interpretation and modeling, source characterization and differentiation, and Key Indicator Parameter (KIP) selection. Over the past two years, Imperial has expanded the groundwater monitoring network to improve the understanding of the contributing factors. This included installing almost 800 monitoring wells at the Site and collecting 1000's of groundwater samples.

Plain Language - Explanation

Throughout this document you’ll notice blue font content intended to add plain language to help communicate the information.

1.1 Report Objectives and Intent

This Report summarizes the undertaking of the QA Project by Imperial. It includes observations, learnings, and associated recommendations to avoid unmanaged tailings seepage. In early 2025, Imperial hired FMFN Group – Stantec as a third-party subject matter expert to review the work and conclusions completed and to support Imperial in sharing the findings to industry and the Indigenous Communities. This Report encompasses the observations of Stantec as well as the outreach that was taken with industry and the Indigenous Communities to share Imperial’s findings.

Section 1 of the Report describes the physical setting of the ETA and the events that occurred following the discovery of the discoloured water. Section 2 discusses the contributing factors that led to the Seepage and the related lessons learned and recommendations while Section 3 presents additional important elements for seepage management not considered contributing factors. Sections 4 and 5 document the discussions that resulted from Imperial sharing the information from the QA Project with Indigenous Communities and industry as directed by the AER.

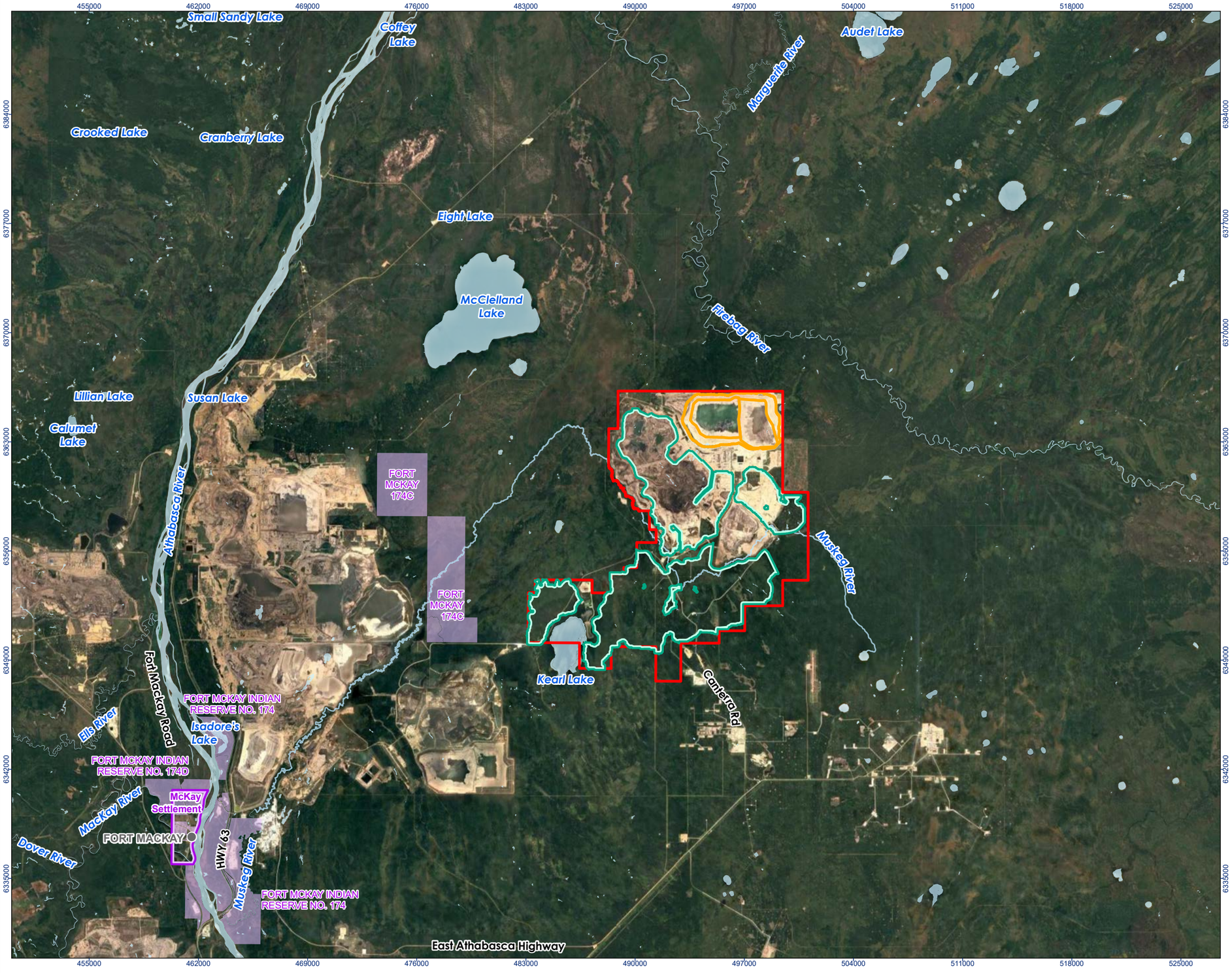
As per the AER direction, this Report has been made public and will be published on the Imperial website.

1.2 Physical Site Setting

The Site is located within Townships 95 to 97 and Ranges 6 to 8, West of the 4th Meridian. The Site is located within Lower Athabasca region of Alberta, approximately 40 km northeast of Fort McKay, and 70 km north of Fort McMurray, in the Regional Municipality of Wood Buffalo. The Site covers an area of approximately 197 km^2, within which the Kearl Surface Mineral Lease (MSL) covers approximately 165.9 km^2. The Site became operational in April 2013.

The Site is situated within the Surface Minable Area of the Lower Athabasca region, northwest of the base of Muskeg Mountain, a broad topographic high. A second local topographic high in the Northeastern portion of the lease divides drainage of the site between the Firebag River and Muskeg River watersheds. The Firebag River is located approximately 3 km north of the Site, with headwaters of several tributaries within about 400 m of the Site boundary and a surface waterbody (WB3) east of the ETA within the boundary that discharges into an unnamed tributary of the Firebag River. The upper reaches of the Muskeg River are located within the site, with tributaries generally flowing from SE to NW. Both rivers are tributaries to the Athabasca River situated further to the west. Kearl Lake occupies portions of the southwesterly areas of the lease within the Muskeg River watershed. The lease is surrounded by natural areas consisting of boreal forest uplands combined with wetland complexes in the lowland areas. Other oilsands operations are also prevalent further afield. Figure 1.1 illustrates the general location of the Site, while Figure 1.2 provides a more detailed depiction of the lease area. The lease area is currently subdivided into several different infrastructure and operational areas including:

- Active mining pits where oilsands mining operations are ongoing
- Process areas where ore preparation and extraction activities take place
- Overburden disposal areas (ODAs), where excess overburden materials are stored
- External tailings areas (ETAs), where wet and dry tailings are stored
- In-pit tailings areas (ITAs), where tailings are stored in depleted areas of the mine pits
- Site access roadways, water management ditches, drainage ponds, utilities and other site infrastructure are distributed throughout the lease



FMFN Group - Stantec

Imperial

- Kearl Lease Outline
- External Tailings Area (ETA)
- Mine pit, existing and planned
- First Nation Reserve
- Settlement
- Watercourse (AltaLIS)
- Waterbody (AltaLIS)

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Notes

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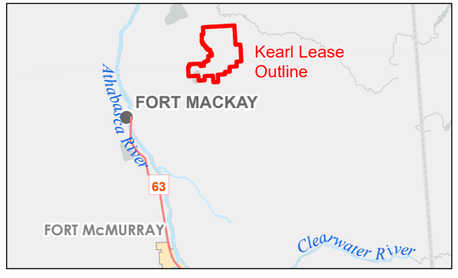

Project Location
Athabasca Region, Alberta

Prepared by MK on 2025-10-13
TR by DY on 2025-11-10
IR by JC on 2025-12-15

Client/Project
Imperial Oil Resources Limited
Quality Assurance Project

123515273

Figure No.
1.1

Title
General Location of the Site

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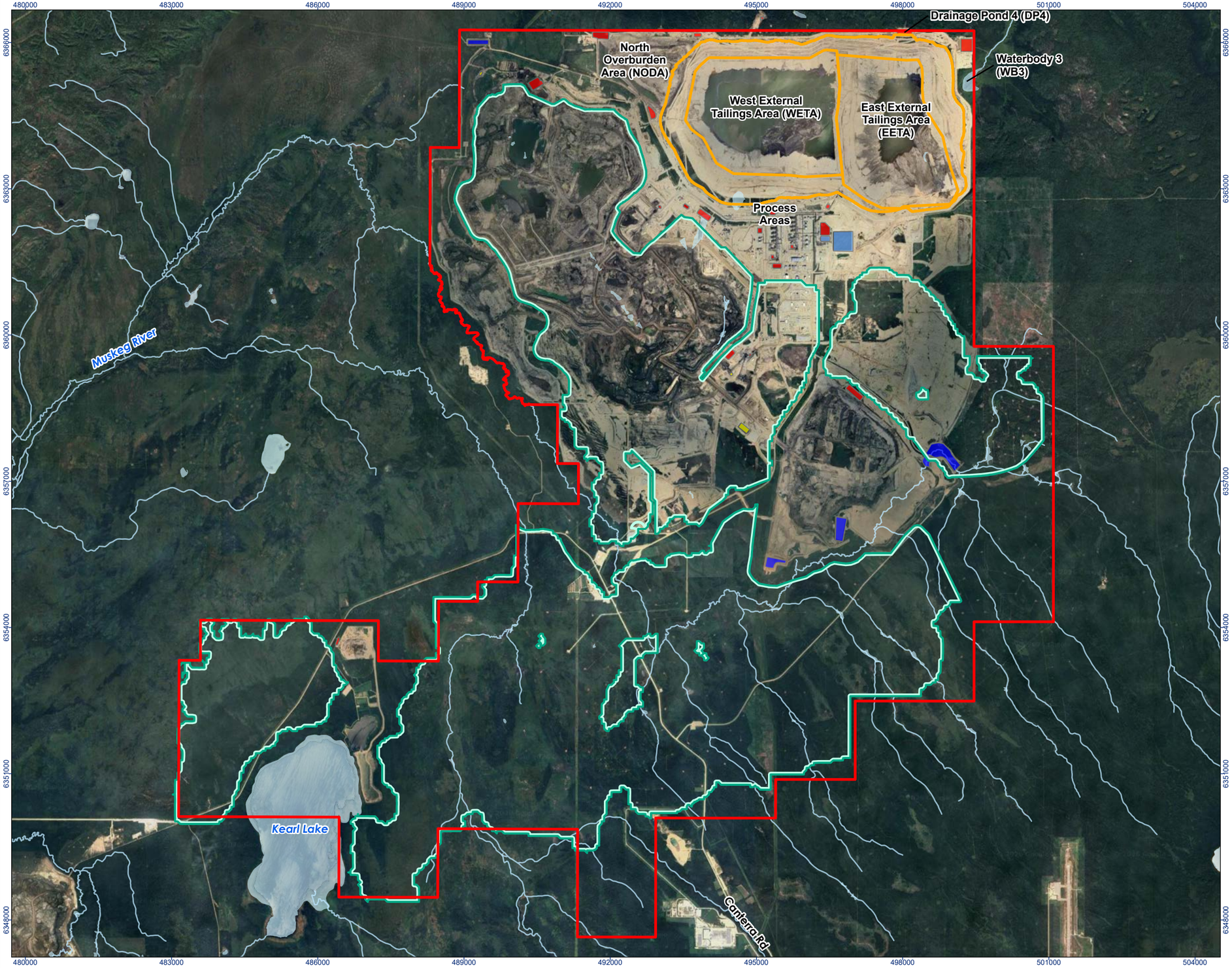

FMFN Group - Stantec

Imperial

- Kearl Lease Outline
- External Tailings Area (ETA)
- Mine pit, existing and planned
- In-Pit Mine/Overburden Dewatering Sump
- Clean River Water Pond
- Closed-Circuit Water Pond
- Release Water Pond
- Watercourse (AltaLIS)
- Waterbody (AltaLIS)

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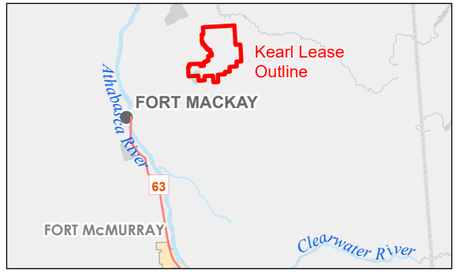

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Quality Assurance Project

123515273

Figure No.
1.2

Title
Kearl Lease Area Map

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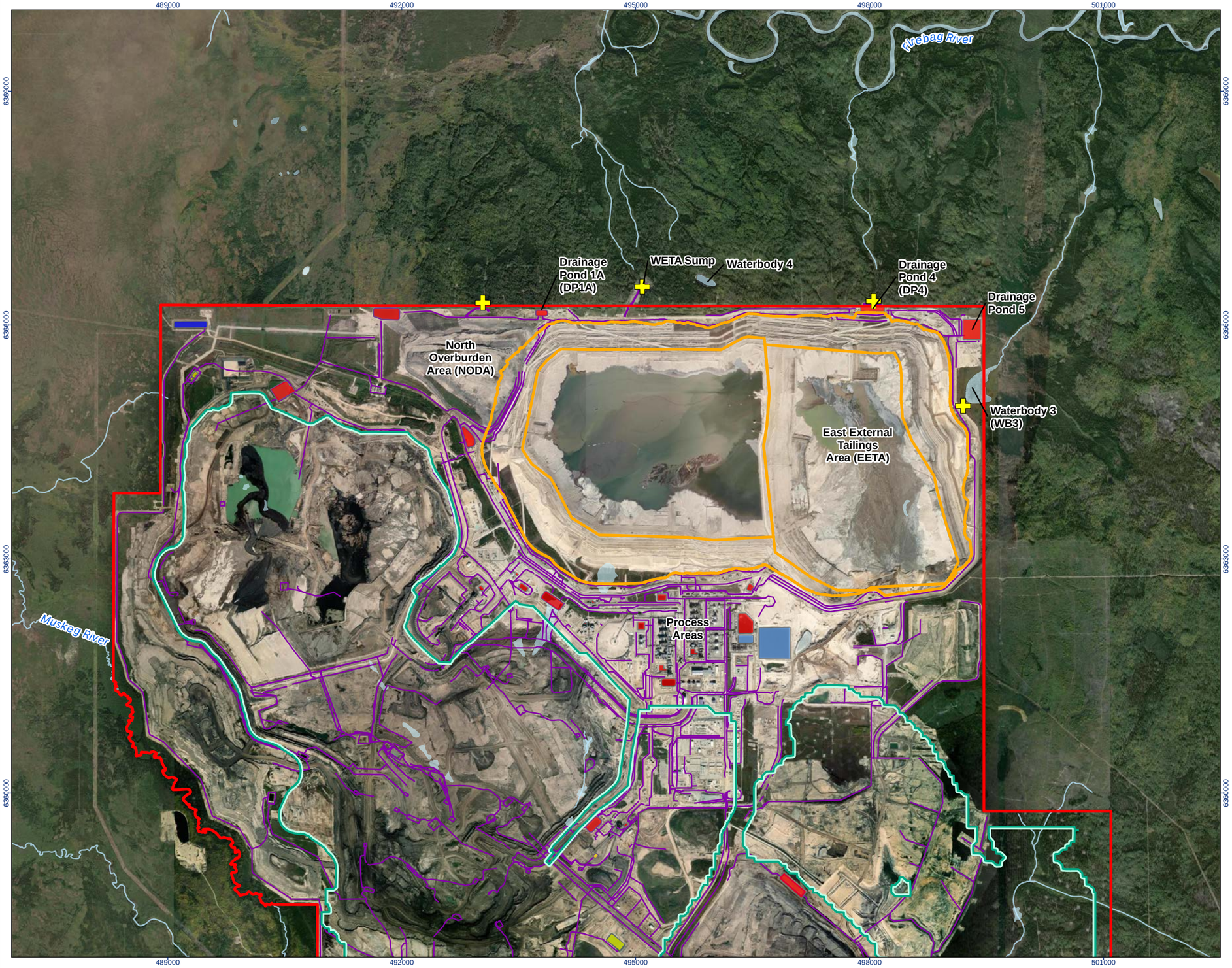
The northern areas of the Kearl lease are occupied by the West External Tailings Area (WETA), East External Tailings Area (EETA), North Overburden Disposal Area (NODA), drainage ponds and ditches and Waterbody 3 (WB3). These areas are the primary focus of this Report, since the sources of industrial wastewater, pathways of migration, and physical contributing factors leading to the Seepage are all situated in this area. Figure 1.3 presents the layout of the northern area of the Kearl lease, including the four seep locations where industrial wastewater was found to be migrating outside of the mitigation and control systems.

Tailings, consisting of water used in the bitumen extraction process, solids remaining after separation from bitumen and extraction additives, are currently sequestered in two external tailings areas (WETA and EETA) and one in-pit tailings area. For this Report, only the ETA will be discussed. The ETA footprint occupies an area of 19.2 km^2 and is separated into two cells: the west cell (WETA) and east cell (EETA) (Figure 1.3). The two cells are separated by the centre dyke and are contained by dykes on all other sides. The dykes are comprised of Coarse Sand Tailings (CST). The WETA, a wet tailings pond, is approximately 2.8 km west-east by 3.2 km north-south. The EETA, a dry tailings pond, is approximately 3.0 km west-east by 3.4 km north-south.

The location and design of the ETA was determined by considering factors such as geotechnical conditions, environmental setting, resource conservation and tailings infrastructure requirements.

Water that results from any industrial process is referred to as industrial wastewater and must be contained onsite. This includes drainage and seepage control at tailings facilities. At the Site, this is done by a closed-circuit system, which is comprised of drainage ponds with pumping systems, ditches, and culverts.



FMFN Group - Stantec

Imperial

- Kearl Lease Outline
- Seep Location
- External Tailings Area (ETA)
- Ditch
- Mine pit, existing and planned
- In-Pit Mine/Overburden Dewatering Sump
- Clean River Water Pond
- Closed-Circuit Water Pond
- Release Water Pond
- Watercourse (AltaLIS)
- Waterbody (AltaLIS)

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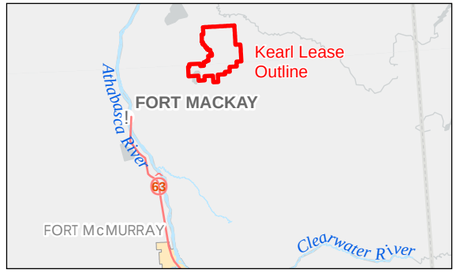

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Figure No.
1.3

Title
Kearl Lease Northern Area

For the layout location path, use the Layout Properties/Metadata Description. Figure: 1_3_kearl_lease_northern_area Revised: 2026-03-09 By: mkuhl

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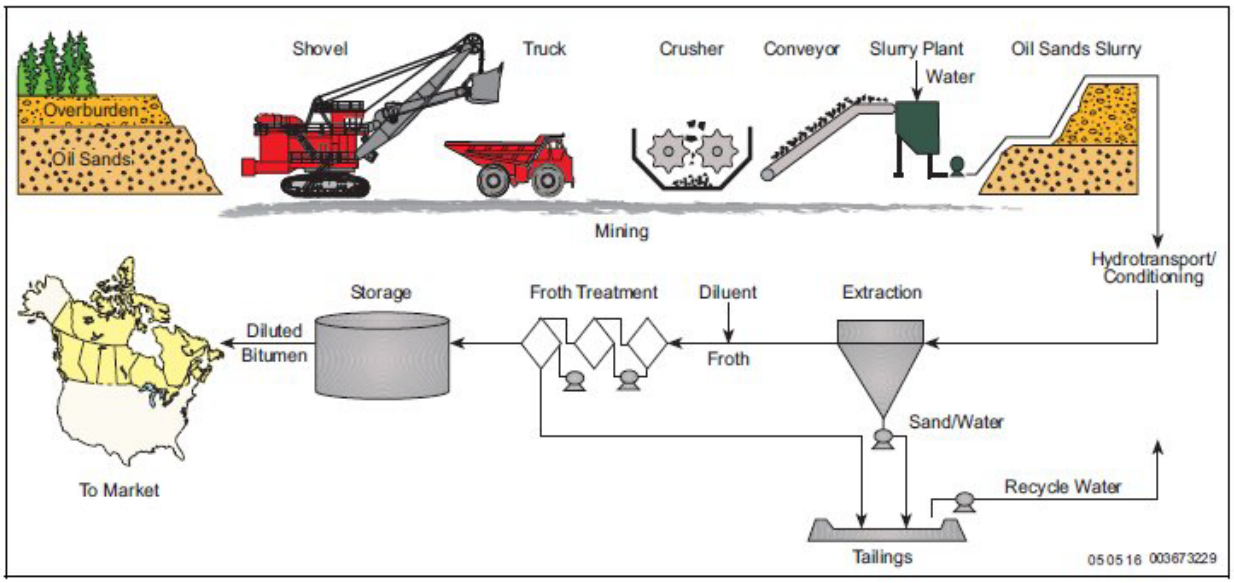
1.3 Overview of Mining, Processing and Tailings Storage

This section provides a summary of the oil sands mining and extraction process, as shown in Figure 1.4, including site preparation, ore processing, and tailings deposition. The intent is to explain how the ore is mined, processed, and managed, and to highlight the origin of minerals within the tailings deposits that influence the chemistry of the water.

Figure 1.4 Oil Sands Mining Process - Schematic



1.3.1 Mining and Site Preparation

The oil sands mining process begins with extensive site preparation. This includes developing infrastructure, dewatering the area, and removing and storing soil for future reclamation and to expose competent material. Once prepared, surface mining techniques are employed, using trucks and shovels to strip and store overburden in the ODA's and extract the oil sands ore. The mined ore is then transported to ore preparation facilities for processing.

1.3.2 Ore Preparation and Extraction

At the preparation stage, the ore is crushed and mixed with warm water to create a slurry, which is pumped to extraction plants. In these plants, bitumen is separated from sand and clay in a Primary Separation Cell. The resulting bitumen froth is diluted with light hydrocarbons and undergoes further treatment to remove residual water, solids, and fines. The bitumen is then shipped offsite for upgrading.

1.3.3 Tailings and Waste Management

After extraction, the remaining mixture of sand, clay, water, and residual hydrocarbons becomes tailings. These tailings are deposited in tailings areas (ETA, ITA1). The coarse (sandy) fraction of tailings is used to construct the walls of the structure, while fine particles (mud/silt) and fluids fill the central portion of the pond. The mineral composition of tailings, originating from the ore, is a factor influencing the chemistry of the water interacting with these deposits. Tailings management includes ongoing monitoring, and eventual reclamation to restore the land to an equivalent capability.

1.4 Overview of Seepage and Chronology of Response Actions to Date

This section provides an overview of the timeline from the initial Seepage through the responses to current conditions as broken down in the below phases.

1.4.1 Initial Discovery

Timeline: May 2022

On May 11, 2022, discoloured water and vegetation was discovered north of Drainage Pond 4 (DP4) during routine groundwater sampling. The discoloured water was described as having orange precipitation. Further investigation through field surveillance and a desktop review of aerial imagery identified three additional areas of interest: north of the NODA, north of the WETA, and west of WB3. On May 19, 2022, Imperial notified the AER and the Indigenous Environmental Consultation Committee (ECC) representatives that discoloured surface water was found at locations both on the Site and to the north of the Site boundary.

Figure 1.5 presents a site photo obtained at the location of the initial discovery.

Figure 1.5 Photo of Initial Seep Location North of Drainage Pond 4

1.4.2 Investigation

Timeline: May 2022 – November 2022

In response to the discovery, Imperial assembled a team to investigate the source of the water and understand any potential environmental impacts. As discoloured water and orange precipitation can occur naturally in Alberta due to the presence of iron, the source of the water was unknown at the time. The Site is in a geological setting where sulphide-bearing minerals, such as pyrite (FeS_2), are present. The technical response team included members of Kearl's Hydrogeology and Environmental teams.

Wildlife, water quality, soil and vegetation assessments were initiated. A preliminary wildlife assessment conducted May 28 and 29, 2022, found no observable impacts to fish or fish habitat, amphibians or other species. Early water chemistry results received indicated that water quality at downgradient receptors were not affected.

In June 2022, a third-party company was tasked with developing a conceptual geochemical model that explained the likely mechanisms of the orange precipitate. Over the summer, 26 groundwater monitoring wells and 8 drive point wells were installed to aid in the investigation. The groundwater results from these new wells indicated that KIP of sulphate, sodium, ammonia, boron and naphthenic acids were elevated in some wells upgradient of the seep locations.

In November 2022, the geochemistry study concluded that the likely sources of the discoloured water in the four areas of interest were weathering of CST that comprises the dykes of the ETA, or process affected water (PAW) from the ETA. The orebody, and therefore CST contains sulphide-bearing minerals. Disturbance through mining and plant operations causes exposure to oxygen and water and may lead to acid rock drainage (ARD), which pose a risk to groundwater quality. The term Acid Rock Drainage (ARD) refers to drainage impacted by acid-generating reactions, typically resulting from the oxidation of sulphide minerals (SMO) such as pyrite (FeS_2) when exposed to oxygen and water, often through mining and plant processing activities. This process produces acid and mobilizes dissolved metals into surrounding water. Varying buffering capacities and mineralogy of host materials results in ARD, neutral mine drainage (NMD) or saline drainage (SD) however, these are collectively referred to as ARD. NMD occurs under similar conditions but in the presence of buffering minerals (e.g., carbonates), which neutralize acidity. Although pH remains near neutral, elevated metal concentrations may still be present due to ongoing sulphide oxidation. SD, by contrast, is characterized by elevated salts and total dissolved solids and may be slightly alkaline to acidic. The terms ARD and SMO are used interchangeably throughout this report.

To provide complete and accurate information to local Indigenous Communities and land users, Imperial deferred communication until the geochemical study confirmed that all seep locations were attributable to its operations. As the study concluded late in the year, communication of the results to Indigenous Communities and land users was scheduled for the Q1 ECC forums, which are regularly planned forums with Communities to discuss environmental related topics. However, in February—prior to the planned meetings—a separate and unrelated incident led to the issuance of an Environmental Protection Order and the sharing of these results. The implications of this development are discussed in Section 1.5.

1.4.3 Response

Timeline: May 2022 – June 2023

The response initially focused on preventing further seepage releases. Following the discovery, water levels in ditches and ponds around the ETA were lowered to help manage any potential leak.

After determining the source of the seepage in November 2022, response plans (source control and remedial action plans) were submitted to the AER in December 2022. During the response stage, the water quality monitoring network was expanded, seepage control measures were installed, and monitoring programs for vegetation, fish and wildlife were expanded to address potential impacts.

Specifically, source control measures including trenches, sumps, and a Well Point Vacuum System (WPVS), were implemented to prevent migration. Photos of this response infrastructure are presented in Figure 1.6. Over the winter of 2022-23 an additional 114 monitoring wells and 17(ETA-SIS) pumping wells were installed.

Figure 1.6 Photos of Initial Seep Response Infrastructure

WB3 Well Point Vacuum System

DP4 Trench

NODA Trench

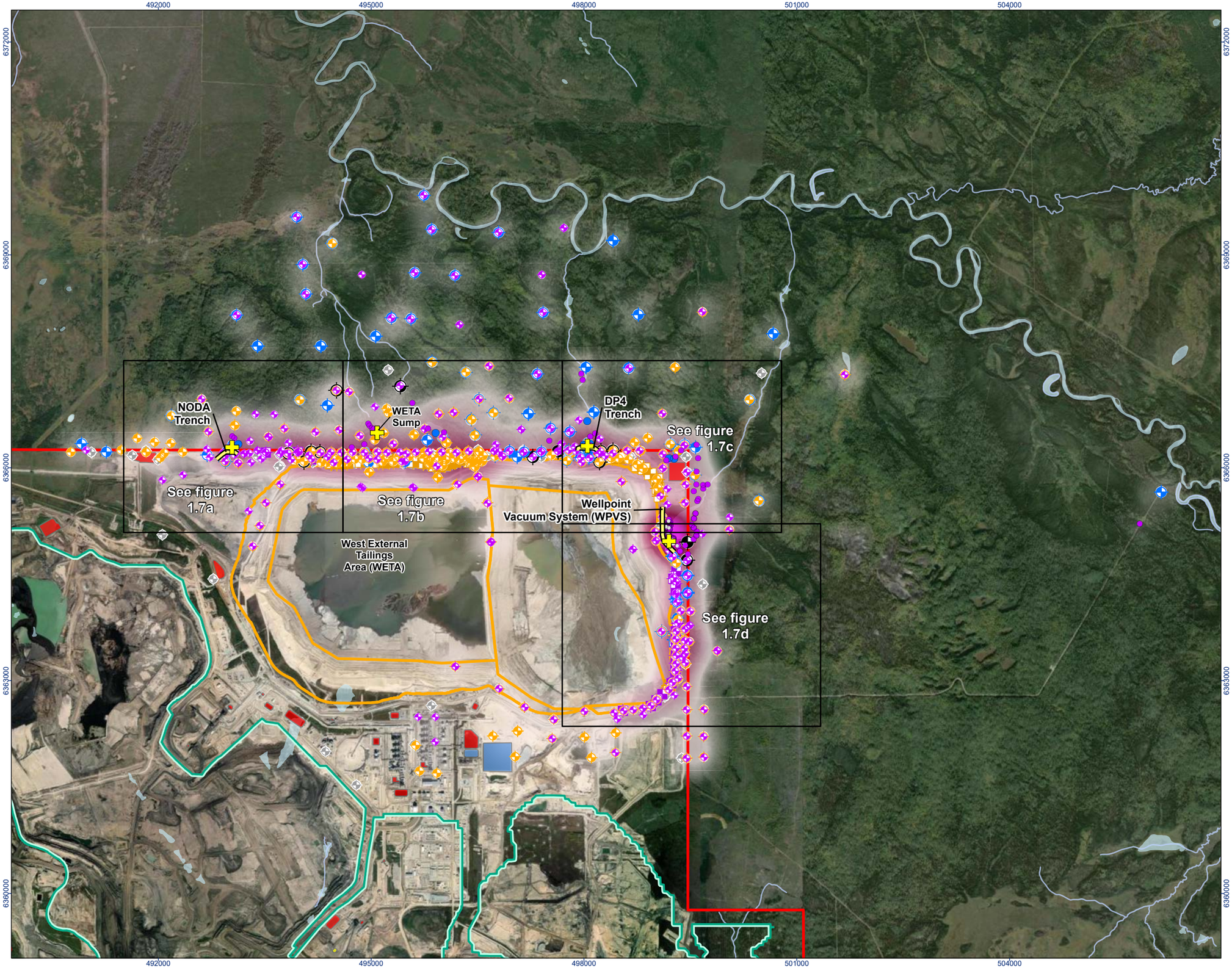
WETA Sump

1.4.4 Assessment and Improvements

Timeline: Ongoing

Imperial continues to evaluate the need for further source control, risk management and remediation. Ongoing studies build on the knowledge gained by the initial geochemistry study, conceptual site model (CSM) and Phase II Environmental Site Assessment (ESA).

Since the Sampling and Monitoring Plan (SMP) version 5 was issued in May 2023, extensive work has been undertaken to delineate, mitigate, and improve understanding of the potential environmental impacts due to the releases. This includes the installation and sampling of an additional ~500 groundwater wells on and off lease in the EPO area, along with 100+ drive point wells and 44 ETA SIS pumping wells (Figure 1.7). More than 80 surface water locations have been sampled. Soil and Vegetation Assessments and Fish Health Assessments were conducted in 2023 and 2024. As mentioned above, a CSM was developed, along with a Phase II Environmental Site Assessment, Groundwater Modelling, and a Site-Specific Risk Assessment. Remediation efforts have also progressed, including soil remediation north of DP4 and NODA mitigation trenches. Imperial is updating its groundwater monitoring and management plan to incorporate learnings from the seepage incident and Quality Assurance project. Enhanced environmental monitoring continues through expanded water quality, wildlife, and environmental monitoring.



FMFN Group - Stantec

Imperial

- Kearl Lease Outline
- Seep Location
- External Tailings Area (ETA)
- Ditch
- Existing Management Infrastructure
- Mine pit, existing and planned
- In-Pit Mine/Overburden Dewatering Sump
- Clean River Water Pond
- Closed-Circuit Water Pond
- Watercourse (AltaLIS)
- Waterbody (AltaLIS)

Monitoring and Pumping Well Groupings

- Drivepoint Well (Surface)
- Drivepoint Well (Shallow)
- Drivepoint Well (Aquitard)
- Monitoring Well (Shallow)
- Monitoring Well (Deep)
- Monitoring Well (Aquitard)
- Monitoring Well (Lowermost)
- Pumping Well (Shallow)
- Pumping Well (Deep)
- Pumping Well (Aquitard)
- Previously Existing Monitoring Well
- Previously Existing Pumping Well

Monitoring and Pumping Well Distribution

Sparse

Dense

N

0 500 1,000 1,500 metres

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1:55,000

Notes

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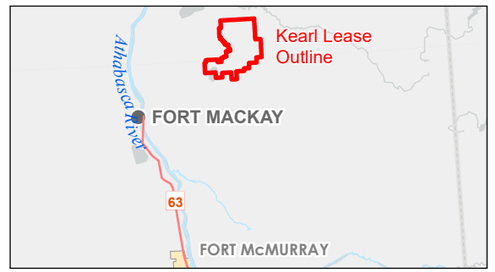

Project Location
Athabasca Region, Alberta

Prepared by MK on 2025-10-13
TR by DY on 2025-11-10
IR by JC on 2025-12-15

Client/Project
Imperial Oil Resources Limited
Quality Assurance Project

123515273

Figure No.
1.7

Title
Seepage Monitoring and Management Infrastructure

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492000
493500
6367500
6366000
NODA Trench

FMFN Group - Stantec

Imperial

- Kearl Lease Outline
- Seep Location
- External Tailings Area (ETA)
- Ditch
- Existing Management Infrastructure
- Closed-Circuit Water Pond
- Watercourse (AltaLIS)

Monitoring and Pumping Well Groupings

- Drivepoint Well (Surface)
- Drivepoint Well (Shallow)
- Drivepoint Well (Aquitard)
- Monitoring Well (Shallow)
- Monitoring Well (Deep)
- Monitoring Well (Aquitard)
- Monitoring Well (Lowermost)
- Pumping Well (Shallow)
- Pumping Well (Deep)
- Pumping Well (Aquitard)
- Previously Existing Monitoring Well
- Previously Existing Pumping Well

Monitoring and Pumping Well Distribution

- Sparse

N

0 100 200 300 metres

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1:12,000

Notes

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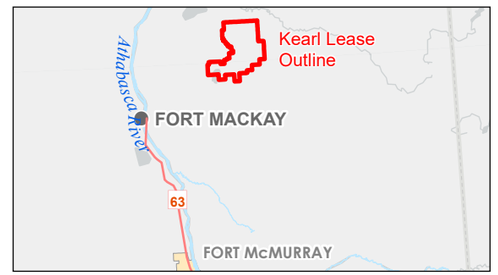

Project Location
Athabasca Region, Alberta

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Client/Project
Imperial Oil Resources Limited
Quality Assurance Project

123515273

Figure No.
1.7a

Title
Seepage Monitoring and Management Infrastructure

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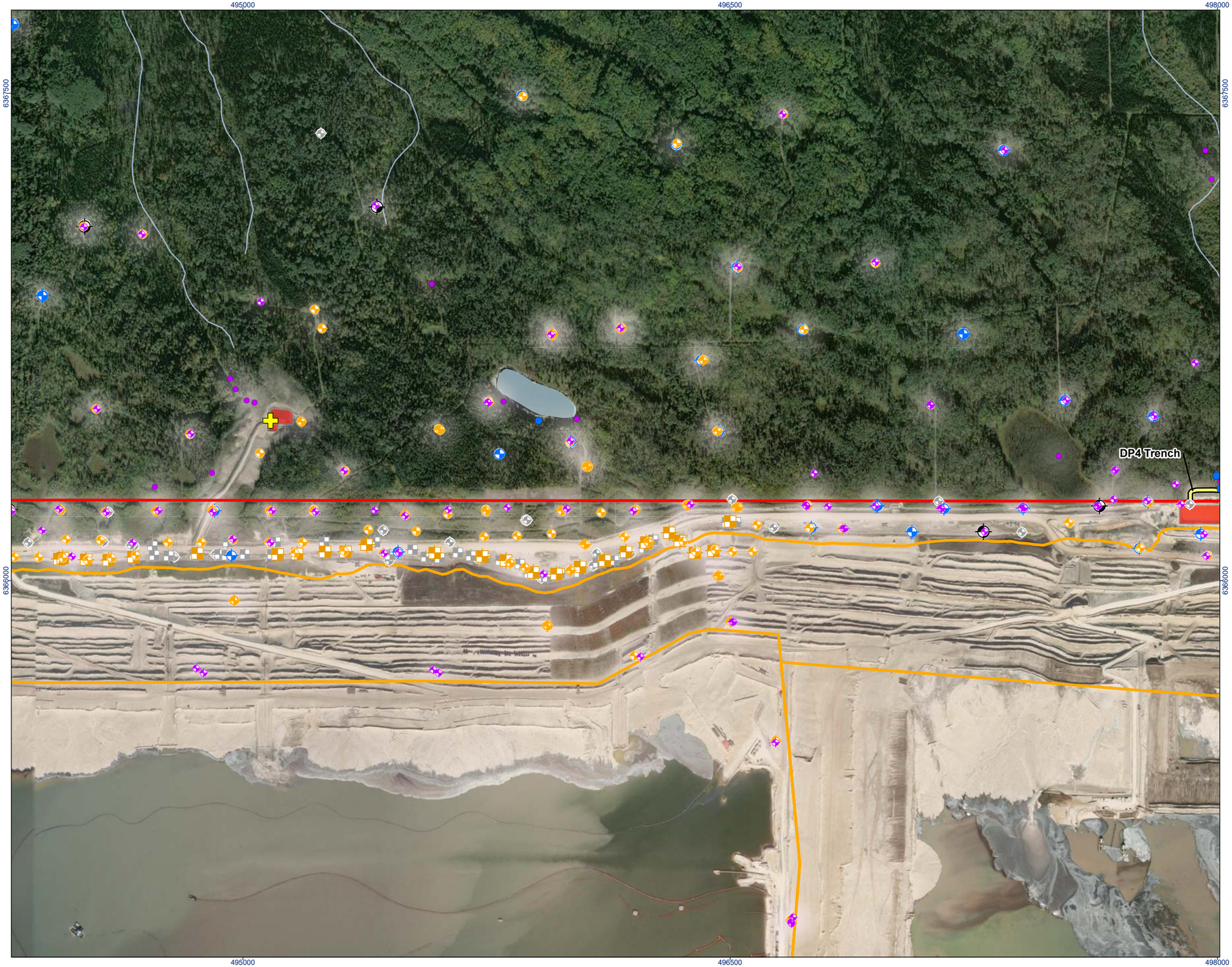

FMFN Group - Stantec

Imperial

- Kearl Lease Outline
- Seep Location
- External Tailings Area (ETA)
- Ditch
- Existing Management Infrastructure
- Closed-Circuit Water Pond
- Watercourse (AltaLIS)
- Waterbody (AltaLIS)

Monitoring and Pumping Well Groupings

- Drivepoint Well (Surface)
- Drivepoint Well (Shallow)
- Drivepoint Well (Aquitard)
- Monitoring Well (Shallow)
- Monitoring Well (Deep)
- Monitoring Well (Aquitard)
- Monitoring Well (Lowermost)
- Pumping Well (Shallow)
- Pumping Well (Deep)
- Pumping Well (Aquitard)
- Previously Existing Monitoring Well
- Previously Existing Pumping Well

Monitoring and Pumping Well Distribution

- Sparse

N

0 100 200 300 metres

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Notes

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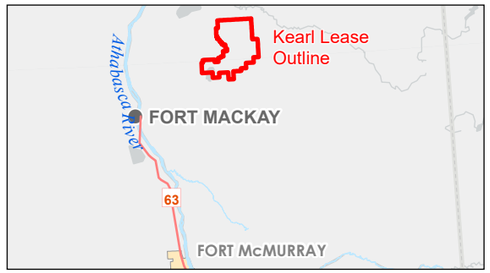

Project Location
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Client/Project
Imperial Oil Resources Limited
Quality Assurance Project

123515273

Figure No.
1.7b

Title
Seepage Monitoring and Management Infrastructure

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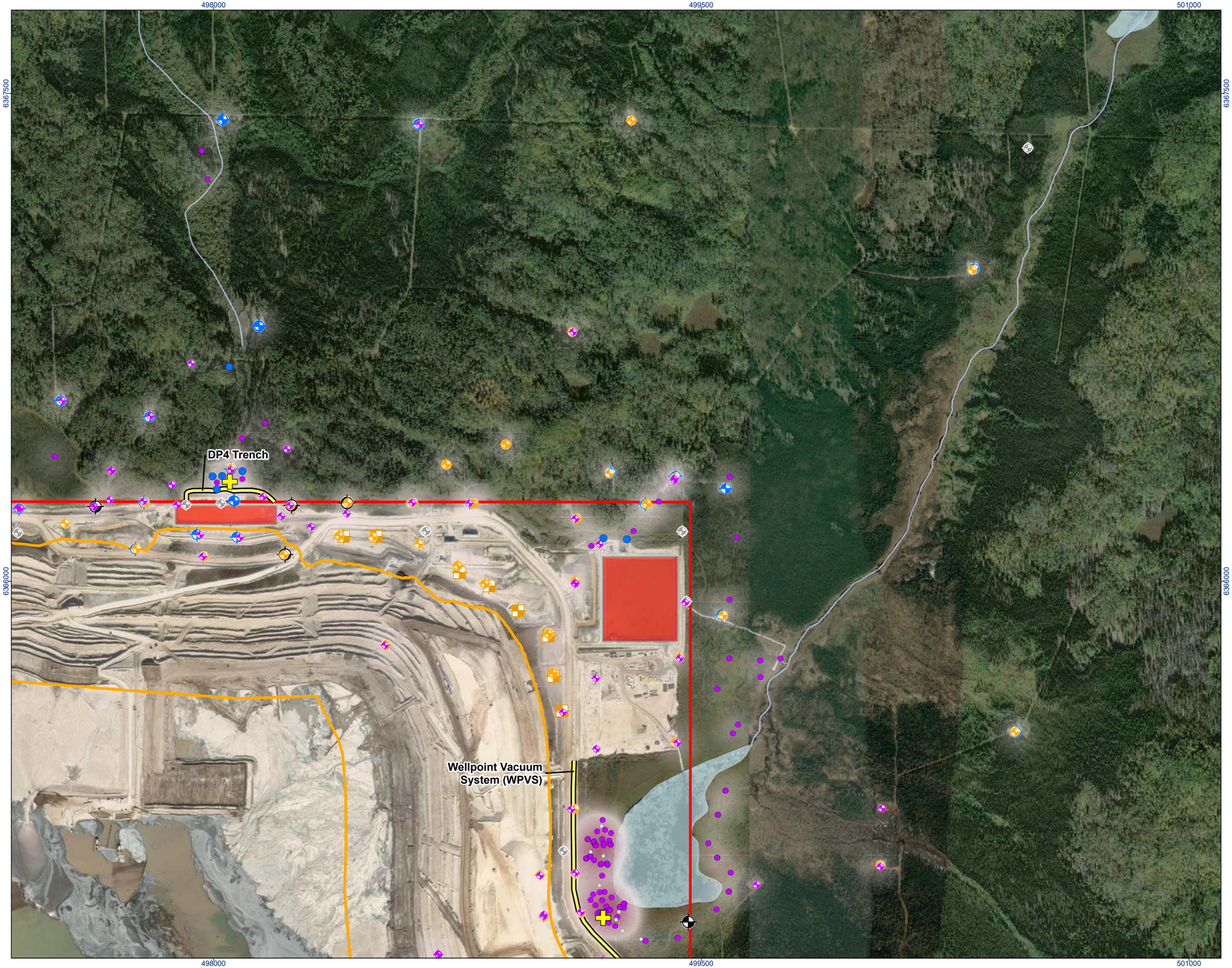

FMFN Group - Stantec

Imperial

- Kearl Lease Outline
- Seep Location
- External Tailings Area (ETA)
- Ditch
- Existing Management Infrastructure
- Closed-Circuit Water Pond
- Watercourse (AltaLIS)
- Waterbody (AltaLIS)

Monitoring and Pumping Well Groupings

- Drivepoint Well (Surface)
- Drivepoint Well (Shallow)
- Drivepoint Well (Aquitard)
- Monitoring Well (Shallow)
- Monitoring Well (Deep)
- Monitoring Well (Aquitard)
- Monitoring Well (Lowermost)
- Pumping Well (Shallow)
- Pumping Well (Deep)
- Pumping Well (Aquitard)
- Previously Existing Monitoring Well

Monitoring and Pumping Well Distribution

- Sparse

N

0 100 200 300 metres

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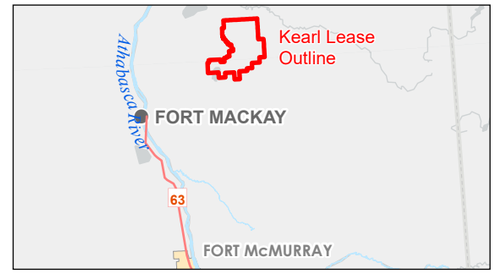

Project Location
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Client/Project
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Quality Assurance Project

123515273

Figure No.
1.7c

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Seepage Monitoring and Management Infrastructure

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FMFN Group - Stantec

Imperial

- Kearl Lease Outline
- Seep Location
- External Tailings Area (ETA)
- Ditch
- Existing Management Infrastructure
- Waterbody (AltaLIS)

Monitoring and Pumping Well Groupings

- Drivepoint Well (Surface)
- Drivepoint Well (Shallow)
- Drivepoint Well (Aquitard)
- Monitoring Well (Shallow)
- Monitoring Well (Deep)
- Monitoring Well (Aquitard)
- Monitoring Well (Lowermost)
- Pumping Well (Shallow)
- Pumping Well (Deep)
- Pumping Well (Aquitard)
- Previously Existing Monitoring Well

Monitoring and Pumping Well Distribution

Sparse

Dense

N

0 100 200 300 metres

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1:12,000

Notes

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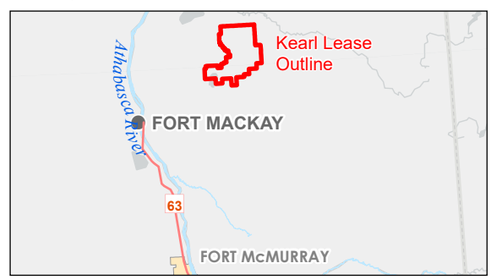

Project Location
Athabasca Region, Alberta

Prepared by MK on 2025-10-13
TR by DY on 2025-11-10
IR by JC on 2025-12-15

Client/Project
Imperial Oil Resources Limited
Quality Assurance Project

123515273

Figure No.
1.7d

Title
Seepage Monitoring and Management Infrastructure

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1.5 Community Engagement

Following the Environmental Protection Order (EPO) issued by the Alberta Energy Regulator in February 2023, Imperial heard from neighboring Indigenous Communities that Imperial's approach to communication did not meet community expectations during the seepage investigation, which contributed to fear, confusion, and anger in these Communities. A public apology was issued by Imperial President and CEO Brad Corson on their website reading:

> "I regret this has happened and, on behalf of our entire company, am deeply apologetic. We have broken trust with these incidents and by failing in our commitment to provide sufficient communications to neighboring Indigenous Communities. I know the process of rebuilding trust will take time, and it will require listening and learning. All of us at Imperial have dedicated ourselves to this important journey."

Imperial has continued to engage directly with Indigenous leaders, Community members and Community representatives to answer questions and provide information. Imperial hosted numerous site tours, information sessions and Community visits to support full transparency with Communities during the EPO response phases. Imperial has shared their mitigation and monitoring plans with Communities and have offered independent, Community-led reviews of technical work and regulatory submissions. Imperial has also sought input from Communities on plans to improve their communications going forward.

Through Imperial's engagement with Community environmental representatives, they have collaborated with technical experts from Indigenous Communities to conduct technical reviews to assess the documents and data related to the Seepage incident. While this work is occurring outside the scope of the QA Project, it is directly applicable to the feedback regarding the Seepage incident and has been included in this report for completeness.

Imperial's approach to Indigenous Community engagement strives to build strong and lasting relationships with Indigenous peoples built on mutual trust, respect and prosperity. This effort focuses on transparency, listening deeply and acting collaboratively on key issues affecting Communities.

1.5.1 Community Technical Review Feedback External to the QA Project

The feedback summarized in this section was provided by Communities following the Seepage and informed the initial QA learnings. Specific feedback provided by Communities during and shortly after the Quality Assurance workshops held in June and July 2025 is provided in Section 4.

Indigenous Communities collaborated to bring together their technical experts to review information spanning from Imperial's 2005 Environmental Impact Assessment (EIA) submission (Imperial 2005) through to the discovery of the discoloured water in May 2022. They reviewed technical documents, including the EIA, regulatory applications, approval conditions, and annual monitoring information.

The feedback focused on the following topics:

- **Policy and Integrated Review:** Indigenous Communities raised concerns about water and tailings management as early as 2005, when the EIA was completed for Kearl. Indigenous Communities noted concerns during the Joint Review Panel (JRP) process regarding tailings management, dyke design, seepage potential, location of the ETA, and notes permeable surficial deposits as likely pathways for PAW transmission. Technical reviews completed by Indigenous Communities for EPEA and Water Act approvals identified concerns related to hydrogeology and surface water quality. Review of Tailings Management Reports identified comments from Indigenous Communities regarding seepage risks and concerns.
- **Groundwater:** Identified a need for additional monitoring wells at shallower depths. Effective groundwater management is critical to prevent PAW from moving offsite. The EIA should have identified pathways for PAW and mapped areas where groundwater flows into wetlands or offsite receptors, with monitoring in place before and during all project phases. Indigenous Community input is important for choosing monitoring locations, especially in culturally significant areas. Baseline groundwater data should have been collected quarterly for two to three years to compare against operational conditions and shared transparently with the Communities. Mitigation measures must be built deep enough to detect and contain PAW along the main groundwater pathways.
- **Surface Water:** Identified the absence of surface water monitoring between the lease boundary and Firebag River and noted opportunities to improve the source/pathway/receptor design and statistical analysis. A spatially expanded off lease surface water monitoring program should have been implemented and additional sampling between the north seep areas should have occurred. Surface water sampling should have complemented groundwater monitoring, to account for potential groundwater-to-surface water flow paths, not just surface flow paths. Sampling locations should have been reported with surficial geology maps.
- **On Lease Monitoring and Analysis:** Identified best practices that could have improved the understanding of how contaminants are moving inside the lease, particularly for reconciling predictive modeling with actual monitoring data.
- **Fluid Tailings and Process Water Management:** Noted that Indigenous Communities have been identifying the buildup of fluid tailings and need for improved tailings monitoring through the Tailings Management Framework (TMF) and annual Tailings Management Reviews (TMR). Recommended the volume of fluid tailings and elevation of impounded water must be controlled and reduced to reduce the risk of seepage.
- **Geology & Geomorphology:** A surficial geology map would be beneficial to identify monitoring needs outside the lease and support seepage control. Across the NODA, WETA, and EETA areas, mitigation strategies differ, but the causes of KIP exceedances are still unclear. Further work is also recommended to identify potential cross contamination between sand aquifers, which may influence KIP trends and monitoring areas.

1.5.2 QA Project Engagement Timeline

The following timeline outlines the milestones and engagement activities conducted as part of the QA project:

- September-October 2024: Imperial project proposal development
- November-December 2024: AER proposal review, discussion, and approval
- December 2024-project close: AER monthly progress and stewardship report
- January – May 2025: Engagement planning and background review
- June-July 2025 – Host Indigenous Community Workshops, Industry Sessions, and AER review
- October 2025: Review draft report outline with AER SME's and management
- December 2025 – Draft report provided to Indigenous Communities, industry and AER for review and comment
- March 2026 –QA Project Report Finalized

The input received through QA Project engagement is reported in sections 4 and 5.

2 Contributing Factors, Lessons Learned and Recommendations

This section reviews the key factors that contributed to the Seepage and outlines lessons learned and recommendations to help prevent recurrence. This review focuses on two critical areas: the complexity and insufficient early understanding of seepage flow pathways that allowed industrial wastewater to migrate off-lease and challenges in monitoring and source identification, including the selection of KIPs and attribution of chemical changes. These topics are included because they represent fundamental technical elements necessary for improving mitigation strategies, strengthening oversight, and ensuring regulatory compliance.

2.1 Identification of Potential Seepage Flow Pathways

In the context of this report, seepage flow pathways are considered physical routes of travel of groundwater from its initial source location to the off-lease locations where the Seepage was identified. The movement of groundwater through insufficiently defined seepage flow pathways was found to be one of the primary reasons why industrial wastewater migrated from its source and was not intercepted by mitigation systems that were in place. This section of the report examines the contributing factors to why the seepage flow pathways were not fully characterized early enough to allow for adaptation of the mitigation systems and capture of this water prior to it migrating off-lease. The contributing factors included:

- complexity of the geologic / hydrogeologic setting of the upper sediments underlying the ETA
- density of borehole and monitoring well coverage and related geologic / hydrogeologic interpretive methods and models employed
- impact of geological complexity and interpretations on well placement
- presence of constructed infrastructure acting as an additional shallow groundwater flow path

Plain Language Summary

Seepage occurred because water from the site found unexpected underground pathways that allowed it to escape before it could be captured. Early studies didn't fully recognize how complex the geology was, and some construction features unintentionally created extra routes for water to move. This combination meant that these unexpected shallow layers carrying water were not monitored, so seepage went undetected until the discoloured water was discovered in May, 2022.

The ground beneath the site is made up of layers left behind by glaciers, with some sandy layers that let water flow easily and others with more silt and clay that block the passage of water. Early models, limited by the modeling approach and data density oversimplified how water moves. Later drilling and testing revealed a much more complicated system. Updated models now group layers by how easily they can transmit water, and use much more drilling data, which makes predictions more accurate.

Construction also played a role. Materials used for tailings dykes and fill were more permeable than the natural ground, creating new shallow pathways. Ditches built to catch water were not fully sealed, so some seepage escaped unnoticed.

Once the problem was discovered, the company drilled hundreds of new wells to monitor water at different depths and expanded pumping and interception systems to include shallow layers. Models were improved to better predict water movement.

The report recommends doing appropriately detailed underground studies for each project phase, using models that show all possible water pathways, and installing monitoring wells at multiple depths. It also suggests updating plans as new data comes in and considering how construction might create new seepage routes. These steps can help prevent similar issues in the future.

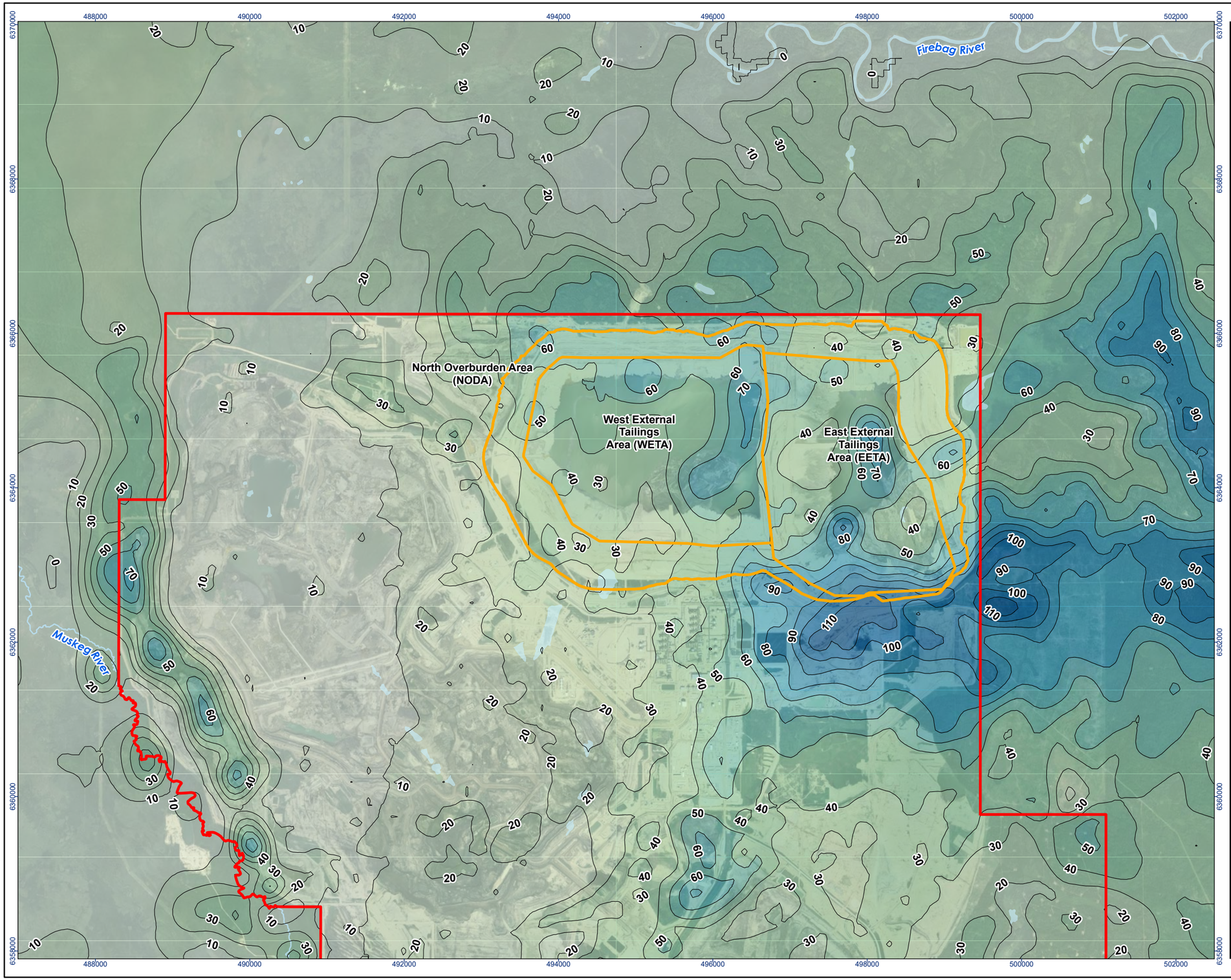
2.1.1 Examination of Contributing Factors

2.1.1.1 Geological and Hydrogeological Setting

The following discussion of factors contributing to the Seepage focuses on the unconsolidated Quaternary-aged deposits that form both the predevelopment and present-day land surface. These deposits constitute the uppermost geologic units, on which project infrastructure was constructed and through which industrial wastewater can migrate. Subsurface investigations, interception systems, and monitoring networks relevant to this Report are largely situated within these Quaternary deposits, making them the primary subject of this subsection.

The surficial deposits in the Seepage area consist of Quaternary sediments formed through multiple glacial and post-glacial processes—a complexity that played a role in the incident. In particular, the extent and hydraulic significance of certain low-permeability units were not fully recognized prior to the event, resulting in isolation of the overlying seepage from monitoring and mitigation wells installed within deeper, more permeable strata. An overview of this geology and its implications are discussed in more detail below.

Quaternary deposits in the ETA area range in thickness from 10m in the NW to over 110m South of the EETA (Figure 2.1).



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- Kearl Lease Outline
- External Tailings Area (ETA)
- Quaternary Thickness Contour (m)[4.]
- Waterbody (AltaLIS)

Quaternary Thickness (m)[4.]

- 1 - 10
- 11 - 20
- 21 - 30
- 31 - 40
- 41 - 50
- 51 - 60
- 61 - 70
- 71 - 80
- 81 - 90
- 91 - 100
- 101 - 110
- 111 - 120

N

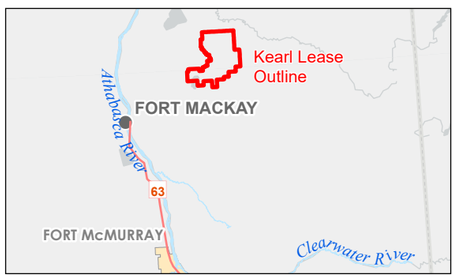
0 500 1,000 1,500 metres

(At original document size of 11x17)
1:50,000

Notes

1. Coordinate System: NAD 1983 UTM Zone 12N
2. Data Sources: Geogratis, ©Department of Natural Resources Canada, All rights reserved.
3. Background: Light Gray Base: Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community
   Google Satellite: © OpenStreetMap (and) contributors, CC-BY-SA
4. Unconsolidated Deposit (Quaternary Thickness): Created by Stantec using client point data (Quat_Thickness_Predisturbance.dxf) and ArcGIS Pro Topo to Raster tool.

m - metres



Project Location
Athabasca Region, Alberta

Prepared by MK on 2025-10-13
TR by DY on 2025-11-10
IR by JC on 2025-12-15

Client/Project
Imperial Oil Resources Limited
Quality Assurance Project

123515273

Figure No.
2.1

Title
Quaternary Thickness Map

For the layout location path, use the Layout Properties/Metadata Description Figure: 2_1_quaternary_thickness_map Revised: 2025-12-18 By: MKuhl

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The wide variability in Quaternary thickness across the area reflects the complex depositional history associated with multiple glacial advances and retreats. Most preserved sediments were deposited during or following the most recent major glaciation—the Last Glacial Maximum (LGM)—approximately 18,000 years ago, when glacial ice covered the Athabasca region (Andrews and Dyke, 2007). Deglaciation in the Kearl area occurred between 10,000 and 9,700 years ago (Fisher et al. 2009) and likely included several short-lived, localized readvances (Utting and Atkinson 2019). A schematic representation of this glacial history and associated sedimentation is provided in Figure 2.2. This complex glacial evolution resulted in highly heterogeneous Quaternary deposits within the ETA area that affects groundwater flow patterns and rates of movement. This includes multiple aquifers that are isolated in some areas by aquitards and connected in others.

Figure 2.2 Schematic Cross Section Showing Interpreted Glacial History of the ETA Area and Related Deposits

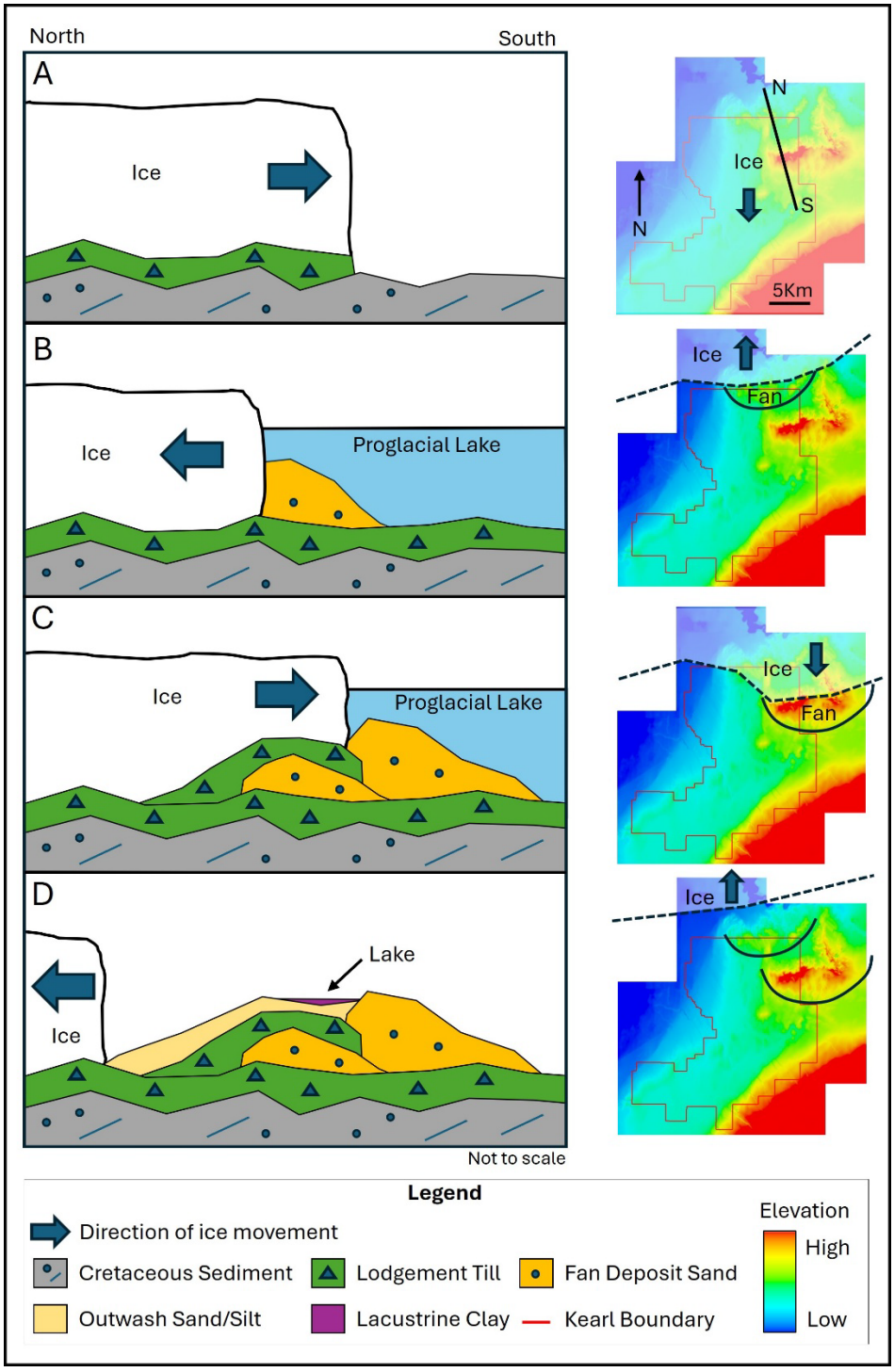


Figure 2.2 schematically presents the depositional history of the main Quaternary sequences that form the upper hydrostratigraphic units in the ETA area as follows:

A) Glacial lodgement till is a dense, compact sediment comprising poorly sorted mixtures of clay, silt, sand, gravel, and boulders—formed by debris pressed and consolidated beneath moving ice. At Kearl, this unit was deposited during the main glacial advance (~18 kya) forming a regional low-permeability barrier (aquitard) at the base of the Quaternary deposit.

B) A glacial fan is a sedimentary deposit formed when sediment is deposited where a glacier's base meets a proglacial water body, such as a lake. It consists of coarse-grained material being delivered by meltwater, creating a fan-shaped body that reflects dynamic interactions between ice, meltwater, and sediment transport. The permeable middle sand unit on the northern side of the ETA is interpreted to have formed through this process and was the primary focus for seepage monitoring and pumping infrastructure prior to the incident.

C) Local readvancement of the glacier occurred in the ETA area resulting in deposition of a second lodgement till on top of the middle sands, which acts as a hydraulic barrier between upper outwash sands and the lower permeable middle sands. The extent and influence of this till in creating distinct aquifers over operational time was not sufficiently defined prior to the seepage incident. A second fan formed to the south at the new glacial terminus.

D) Retreat of the glacier resulted in deposition of outwash sediments- meltwater-derived silts, sands, and gravels with variable permeability which form the upper sand aquifer unit, which is one of the pathways for seepage migration. The outwash sediments generally have lower permeability than the middle sand due to the higher percentage of fines. Lacustrine clays were deposited in the topographic low between the two glacial fans following glacial retreat in areas where surface waterbodies formed (e.g. WB3).

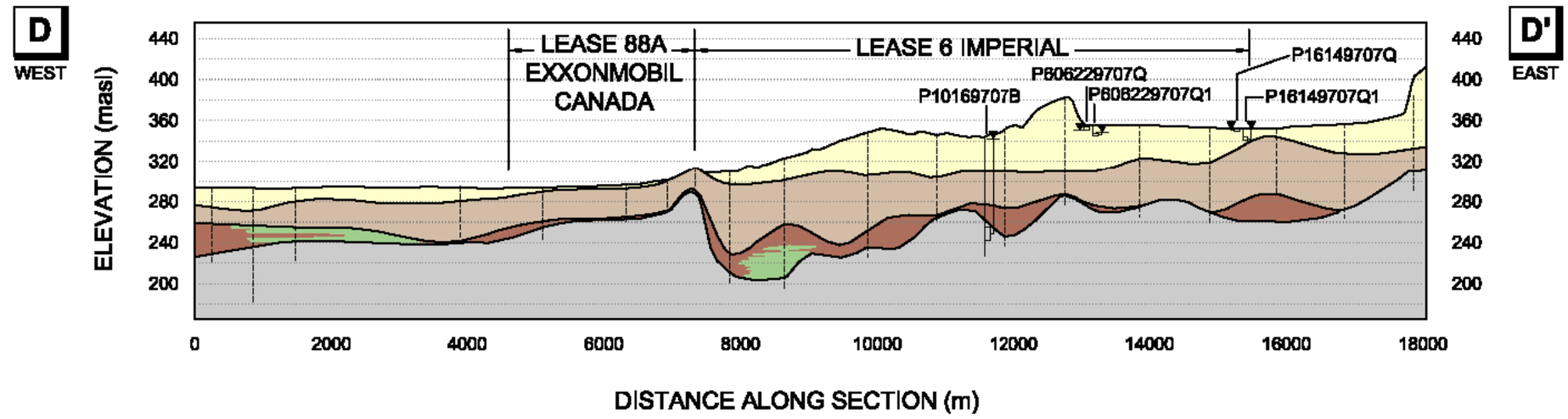
2.1.1.2 Assessments, Interpretations and Modeling

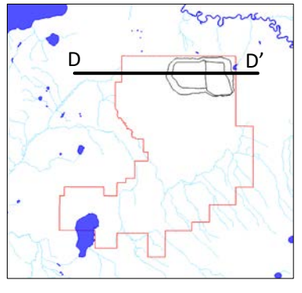
The complex geology of the ETA area requires a sufficient network of boreholes and monitoring wells to accurately define the geologic and hydrogeologic framework. Groundwater flow paths in this setting are highly variable and can change with water level fluctuations or project-related stresses, making predictive modeling challenging without sufficiently defined subsurface data.

Characterization of the Quaternary deposits has evolved over time—from broad regional studies during early project development to detailed, site-specific investigations following the seepage event. Boreholes are drilled to collect soil and sediment samples for visual classification, chemical analysis, and physical testing. After sampling, boreholes may be completed as monitoring wells to measure water levels, chemistry, and hydraulic properties.

As data density increases, interpretations of subsurface conditions improve through iterative analysis of borehole information, enabling identification of facies, stratigraphic correlations, and spatial trends. In complex geologic settings like the ETA, higher borehole density is essential due to irregular lithology, variable unit thickness, and indistinct contacts between geologic units.

Early interpretive work at the Kearl lease during the EIA phase was based on a borehole and monitoring well network suited to the objectives of that stage. Consequently, the Quaternary sediments were represented as a single undifferentiated unit, grouping varying lithologies such as clay and sand, which did not allow for the mapping of individual hydrostratigraphic units. Figure 2.3 presents an example of a geologic cross section presented in the EIA, highlighting the relative simplification of the subsurface geology at the time.





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Imperial

QUATERNARY

McMURRAY FORMATION

MIDDLE McMURRAY

LOWER McMURRAY OIL SANDS AND CLAY

LOWER McMURRAY WATERSAND

DEVONIAN

GROUNDWATER SURFACE ELEVATION

SCREENED INTERVAL

CORE HOLE LOCATION

PIEZOMETER LOCATION

15x Vertical Exaggeration

Figure ID: 074-1000-335-110 000

Notes

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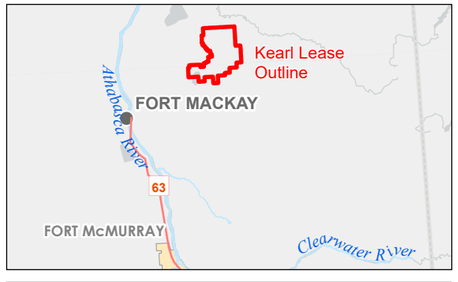
2. Data Sources: Geogratis, ©Department of Natural Resources Canada, All rights reserved.

3. Background: Light Gray Base: Esri Canada, Esri, TomTom, Garmin, FAO, NOAA, USGS, EPA, NRCan, Parks Canada



Project Location
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TR by DY on 2025-03-09
IR by JC on 2025-03-10

Client/Project
Imperial Oil Resources Limited
Quality Assurance Project

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Figure No.
2.3

Title
Example Geologic Cross Section Presented in the EIA (adopted from Imperial 2005)

For the layout location path, use the Layout Properties/Metadata Description Figure: 2_3_cross_section_example_from_eia Revised: 2026-03-09 By: mkuhl

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Numerical groundwater flow models are used to represent hydrogeologic systems and predict changes in groundwater conditions under various stressors, such as water level fluctuations, pumping, impoundments, and changes in material properties. These models apply mathematical formulations and numerical methods to simulate groundwater levels, flow directions, movement rates, and solute transport over time and are heavily influenced by the geological representation used. At Kearl, several generations of such models have been developed to support assessment, planning, and design studies.

The first numerical groundwater flow model for the Kearl lease was a regional-scale MODFLOW model developed to support the EIA. This model was based on the simplified hydrostratigraphic framework shown in Figure 2.3 and designed to evaluate multiple project-related processes, including overburden dewatering, ETA operations, basal aquifer depressurization, and post-reclamation groundwater levels. The simplified Quaternary unit was assigned a hydraulic conductivity representative of sand, an approach considered conservative and appropriate for the project stage. Later versions of the MODFLOW model (2006-2008) used three continuous layers-silt, sand and clay across the model domain to represent the transmissivity of the Quaternary aquifer. While proportionally correct, these simplifying assumptions did not account for local-scale heterogeneity or its influence on groundwater flow, a limitation that became important as site-specific complexity was later revealed.

The typical progressive nature of subsurface characterization in relation to project stage is illustrated in the Joint Review Panels (JRP) 2007 approval of the EIA, where the JRP noted that the ETA was situated on permeable surficial deposits that could allow process-affected water to seep northward, potentially degrading groundwater quality and impacting the Firebag River and its tributaries. The JRP also noted that Imperial's understanding of these deposits—particularly their northern extent—was incomplete. To address this, the JRP recommended that Alberta require a detailed hydrogeological investigation, updated seepage modelling, and mitigation design as part of the dike design under the Dam Safety Regulations.

The recommendation of the JRP was included in Kearls 2007 EPEA approval (Alberta Environment, 2007, Approval No. 46586-00-00) in Section 4.6.1 which, among other conditions included the requirement that Imperial must develop a comprehensive hydrogeological plan that included additional data collection, detailed geological and groundwater characterization, and mapping of drainage, lithology, groundwater flow, and hydraulic properties.

In accordance with the JRP findings and EPEA conditions, and aligned with progressive stages of the project, significant hydrogeological characterization work was undertaken in 2008 and 2009 and continued beyond the start of active operations with expansion of the monitoring and management network. During the 2008 and 2009 evaluation programs over 120 monitoring and pumping wells were installed, single and multi-well pumping tests were completed and geophysical surveys conducted which improved spatial coverage and aquifer characterization, enabling more detailed interpretations. The geologic model was updated using a lithofacies-based modeling approach, which classified sediments based on physical characteristics such as grain size, color, and stiffness to infer depositional environments (e.g., fluvial or glacial). While this approach helped describe lateral and vertical changes in depositional conditions, it did not explicitly define hydraulic connectivity. Figure 2.4 presents the lithofacies-based model developed for the Kearl lease (Golder Associates 2012). Many different facies

groups representing several Quaternary and Cretaceous units were characterized and defined in this model based on their predominant lithology and interpreted depositional environment.

Figure 2.4 Lithofacies-based Model for the Kearl Lease (adopted from Golder 2012)

Facies Code	Colour	Facies Description	Depositional Environment	Predominant Soil Type
Ho2		peat	organic deposits	peat
Ho1		organic soil	organic soil	clay and silt, numerous roots, carbon fragments, wood fragments
Hf		alluvium	fluvial	sand and silt, minor clay and organics
Hl		lakeshore & lake bottom	lacustrine	silt and clay, occasional shell fragments, up to 40% sand
Pl		lake bottom	glacio-lucustrine	clay, minor silt and sand, no shell fragments
Pls		lake shore	glacio-lucustrine	very fine grained sand and silt
Pfs		fluvial sand	glacio-fluvial	sand
Pfsa		outwash sand	glacio-fluvial	finer grained than Pfs, and more fines
Pfsb		outwash silt	glacio-fluvial	silt, clayey silt (often with oily sheen and bitumen odour)
Pfg/Pfsg		fluvial gravel	glacio-fluvial	clay to boulders (generally sandy gravel)
Pga		ablation till	glacial	mainly silty sandy, trace to some clay, occasional gravel. Compositionally between PGL1 and Pfsa
PGL2		clayey silty till	glacial	clayey silty till
PGL1		sandy silty till	glacial	sandy silty till
PGcb		bounded clearwater clayey till	glacial	gravel, sand, and clay. Essentially a clay till with reworked Clearwater Fm. In matrix.
PGcr		rafted Clearwater clayey and glauconitic sand	glacial	ice rafted, thrusted Clearwater Fm, stiff to hard clay till
PGk		rafted/disturbed McMurray Formation	glacial	fine grained sand and mud, bitumen odour, ice rafted/thrusted McMurray Fm.
Pfsv		fluvial sand	interstadial	fine to coarse sands (within buried bedrock channels)
Pfg/Pfsg		fluvial gravel	interstadial	poorly sorted pebble and cobble deposits, and gravelly sands
HP		?	undifferentiated	undifferentiated
Km		McMurray Formation	Bedrock (deltaic sands with clay interbeds)	predominantly sands with mud/clay interbeds (**bedrock**)
Km Mud		McMurray Formation	clay interbeds	mud/clay interbeds (**bedrock**)
DW		Paleosol, marine shelf, collapse breccia	Clearwater Formation	argillaceous carbonate (**bedrock**)

In addition to the geologic model changes, in 2009, the original MODFLOW simulation was migrated to the FEFLOW platform. This transition not only changed numerical modeling code but also improved the representation of subsurface heterogeneity by replacing simplified continuous stratigraphic layers with a facies-based geological approach, providing a more realistic depiction of complex material distributions—an advancement in modeling strategy. At that time, construction features such as overburden dykes and tailings structures were incorporated into a single layer.

Simulations during this phase focused on evaluating seepage interception design. Despite the enhanced geological representation provided by the FEFLOW model, predictions for ultimate seepage interception requirements were broadly consistent with those from the earlier MODFLOW modeling. While the facies-based approach improved characterization compared to the previous three-layer model, it relied heavily on drilling data to connect facies into continuous hydraulic units. In such a complex geological environment, this limitation meant that, even with a more advanced modeling strategy, local-scale heterogeneity and its impact on groundwater flow were still not fully captured, and some drawbacks of earlier models persisted.

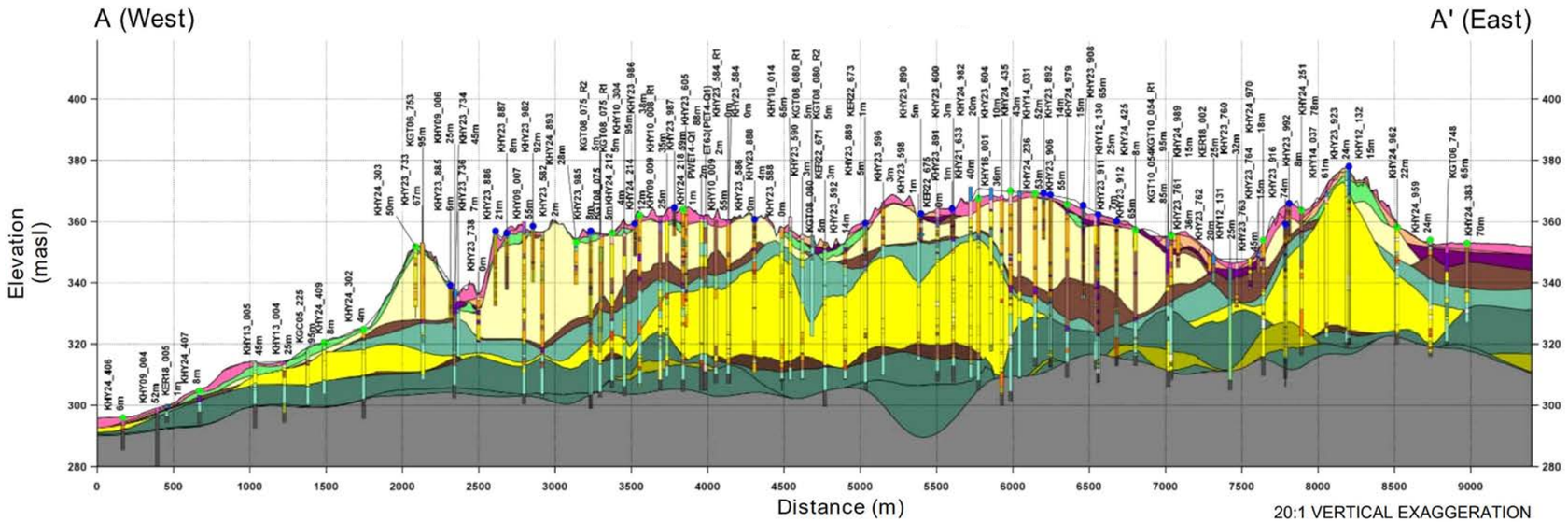
In response to divergence between the FEFLOW predicted groundwater levels and field observations, in 2020 the conceptual model began to evolve toward a hydrostratigraphic approach, which grouped units based on hydraulic properties—such as permeability and transmissivity—rather than depositional origin. This method focused on identifying aquifers and aquitards and their connectivity, which is critical for groundwater management. Figure 2.5 shows the initial hydrostratigraphic framework developed for the Kearl lease circa 2020 (adapted from Golder 2020).

Figure 2.5 Hydrostratigraphic Model Developed for the Kearl Lease circa 2020 (adopted from Golder 2020)

Unit	Aquifer/ Aquitard	Facies*
Upper Sediment	Aquitard	1599, Hf, Hl, Ho1, Ho2, Pl, Cl
Upper Till	Aquitard	**Pga, PGL1,** PGL2, PGL,
Upper Sand	Aquifer	**Pfs, Pfsa**, Pfg, Pfsg, Pls
Upper Silt	Aquitard	**Pfsb**
Middle Sand	Aquifer	**Pfs, Pfsa**, Pfg, Pfsg, Pls
Lower Silt	Aquitard	**Pfsb**
Middle Till	Aquitard	**PGL1,** PGL2, PGL, Pga
Lower Sand	Aquifer	**Pfs, Pfsa**, Pfg, Pfsg, Pls
Lower Till	Aquitard	**PGL1**, PGL2, PGL, Pga
McMurray Formation	Aquitard	Km

*Bold text denotes dominant facies in hydrostratigraphic unit

Figure 2.6 presents a geologic cross section along the northern edge of the Kearl lease, developed in 2024. Much more detail in the Quaternary deposits is now evident in the interpretation relative to early works, and several hydrostratigraphic units have now been differentiated and correlated across the cross section.



CROSS-SECTION LEGEND

BOREHOLE LITHOFACIES

- Fill
- Holocene Fluvial
- Holocene Organic
- Holocene
- PGcb and PGcr
- PGa
- PGk
- PGkr
- PGL
- PGL1
- PGL2
- Pfg and Pfsg
- Pfsc
- Pfs
- Pfs-Pfsa1
- Pfsa
- Pfsa1-2
- Pfsa1
- Pfsa2
- Pfsa3
- Pfsa2-Pfsa3
- Pfsa2-Pfsb
- Pfsa3-Pfsb
- Pfsb
- Pfsa2-PGm
- PGm
- Pl
- Pls
- Clearwater
- McMurray
- Devonian
- P_uncertain
- Undifferentiated

HYDROSTRATIGRAPHY UNITS

- Holocene
- Sandy Silt
- Lake Bottom
- Upper Till
- Upper Silt
- Upper Sand
- Middle Silt
- Middle Till
- Middle Sand
- Lower Silt
- Lower Till
- Lower Sand
- Channel Sand and Gravel
- Channel Till
- McMurray

NOTES

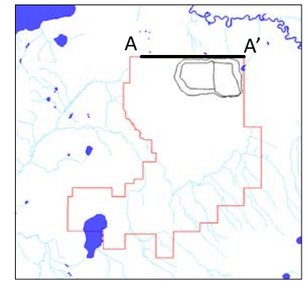
Aquitards in the numerical model are composed of both silt and till.

BOREHOLES

- Borehole Drilled in Summer 2023
- Borehole Drilled in Winter 2023-2024
- Borehole Drilled prior to Summer 2023
- 5 m Borehole Offset

SURFACES

- 2023 LiDAR



Notes

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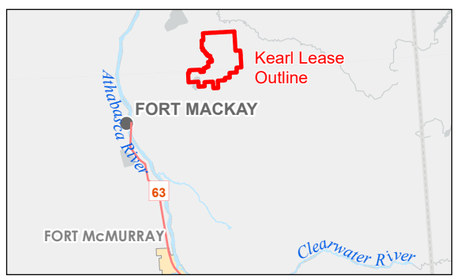

Project Location
Athabasca Region, Alberta

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TR by DY on 2025-03-09
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Client/Project
Imperial Oil Resources Limited
Quality Assurance Project

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Figure No.
2.6

Title
Geologic Cross Section along the Northern Edge of the ETA, circa 2025 (adopted from WSP 2024)

For the layout location path, use the Layout Properties/Metadata Description. Figure: 2_6_cross_section_northern_edge_2025_wsp2024 Revised: 2026-03-13 By: mkuhl

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Incorporation of the hydrostratigraphic framework began in 2020 but was not fully implemented until 2022 and has since undergone multiple updates. The latest models are sub-regional in scale, focusing on the northern Kearl lease and ETA areas, and have been refined using extensive subsurface data collected after earlier versions. These models now integrate hydrostratigraphic-based interpretations, as-built ETA structures, and the actual distribution of tailings to improve parameterization. If this approach had been applied in 2020, with higher borehole density, the two distinct flow systems might have been identified earlier and mitigated, prior to the Seepage event. The shallow groundwater flow pathway consists of the Quaternary upper sand (when not confined) and sandy silt, fill and Holocene units. The deep groundwater flow pathway consists of the Quaternary middle sand and upper sand (when confined) units. Both groundwater flow pathways have both been affected by the ETA operations.

All numerical groundwater models rely on simplifying assumptions and field-based descriptions of the physical environment, which means limitations will always exist. Hydrogeologists must consider these constraints when applying models for planning, design, and environmental management decisions. Despite these limitations, numerical modeling remains a best practice and an essential tool for predicting groundwater behavior at complex sites where analytical methods cannot capture system dynamics. At Kearl, earlier adoption of a hydrostratigraphic modeling approach could have mitigated some shortcomings of previous models.

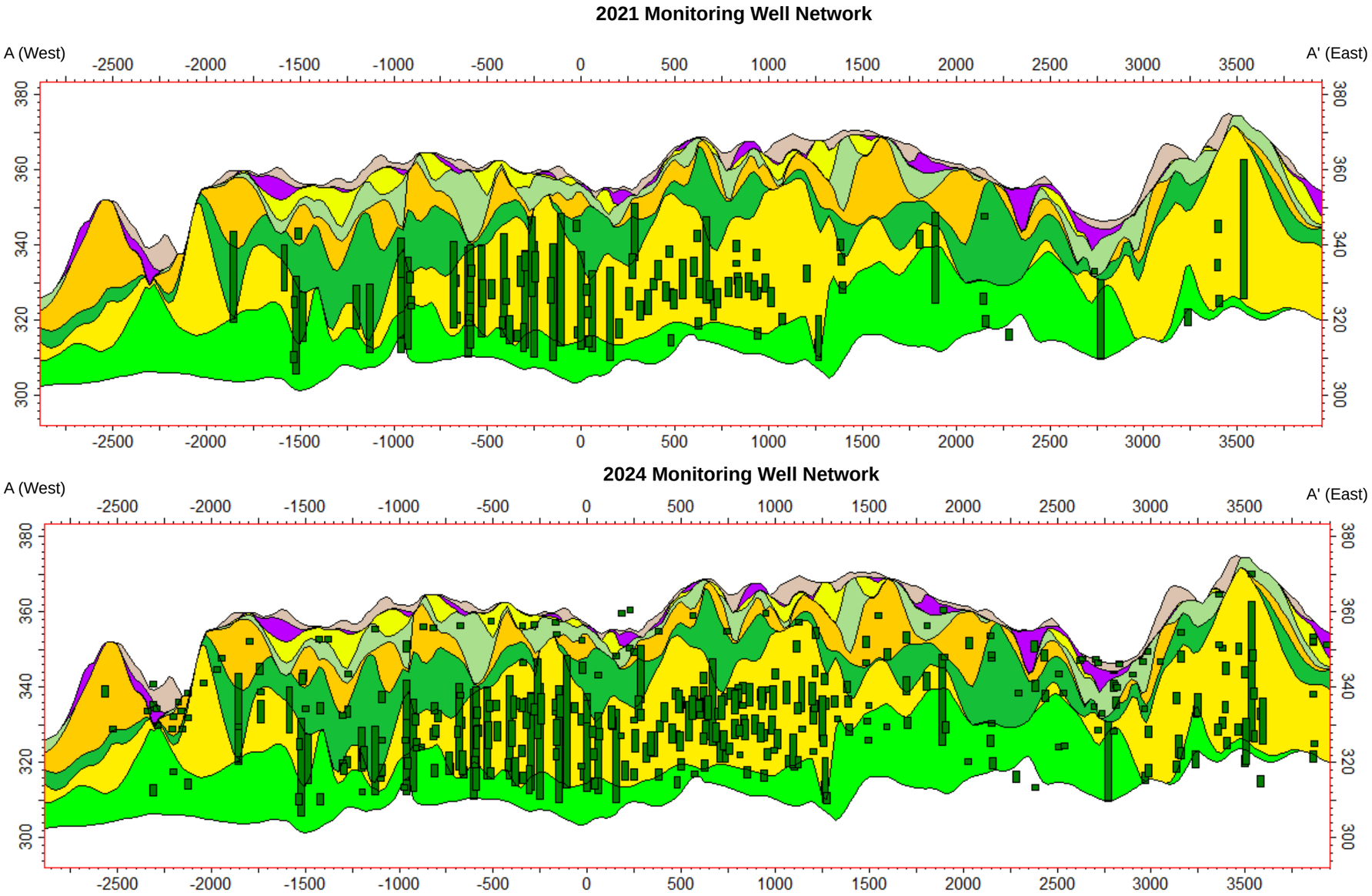
2.1.1.3 Geology and Hydrogeology Impact on Well Placement

Prior to operations, groundwater monitoring was conducted under near-static conditions, with the groundwater flow regime in quasi-equilibrium with the greater hydrologic system. The upper hydrostratigraphic units, while appearing permeable, were largely assumed to be unsaturated, and therefore monitoring wells were not installed in the shallow groundwater flow pathway. Additionally, as discussed in earlier sections the presence and hydraulic significance of the localized readvancement till—which acts as a vertical barrier—were not fully appreciated.

As a result, initial monitoring and ETA-SIS pumping wells were installed deeper within the middle sand unit, under the assumption that these wells would detect and mitigate any seepage across the system. Subsequent detailed geological and hydrogeological investigations revealed this assumption was incorrect: the upper sand unit, hydraulically separated by the till over most of the ETA, with increased water levels due to operations, became an additional seepage pathway, rendering the deeper monitoring and ETA-SIS pumping wells ineffective for early detection and interception.

Figure 2.7 illustrates this progression, showing the original well network (2021) targeting deeper sands compared to the expanded, shallow groundwater flow pathway monitoring network (2024) implemented after the seepage event.

Early designs for the ETA-SIS pumping network were developed prior to the incorporation of the hydrostratigraphic approach and assumed seepage would occur in deeper units (e.g., “middle sand”), resulting in preferential installation of deep monitoring wells. An additional seepage pathway, later identified in the “upper sand” unit, was not adequately monitored prior to being identified.

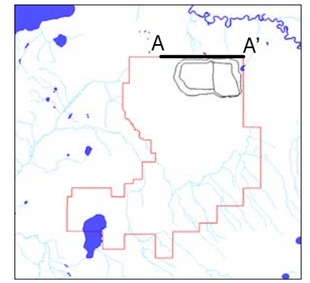


FMFN Group - Stantec

Imperial

- Holocene
- Lake Bottom
- Sand/Silt
- Upper Till
- Upper Sand
- Middle Aquitard (Silt and till)
- Middle Sand
- Lower Till

Well screen interval



Notes

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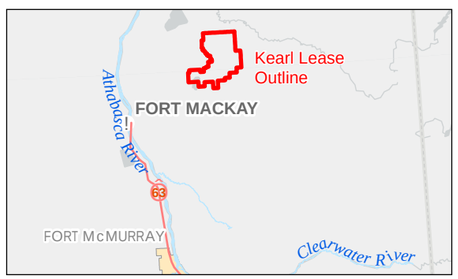

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Figure No.
2.7

Title
Geologic Cross Section along the Northern Edge of the ETA

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2.1.1.4 Constructed Infrastructure

Seepage through the ETA dykes is duly considered within the design of the structure. Some amount of seepage through the ETA dykes is required to control pore pressures within the structure to maintain an adequate factor of safety for the structures' stability. Seepage through the ETA structure is controlled through installation of drain pipes and blanket drain which intentionally direct seepage through the ETA structure toward toe ditches where it is collected and returned to the ETA in a closed loop system.

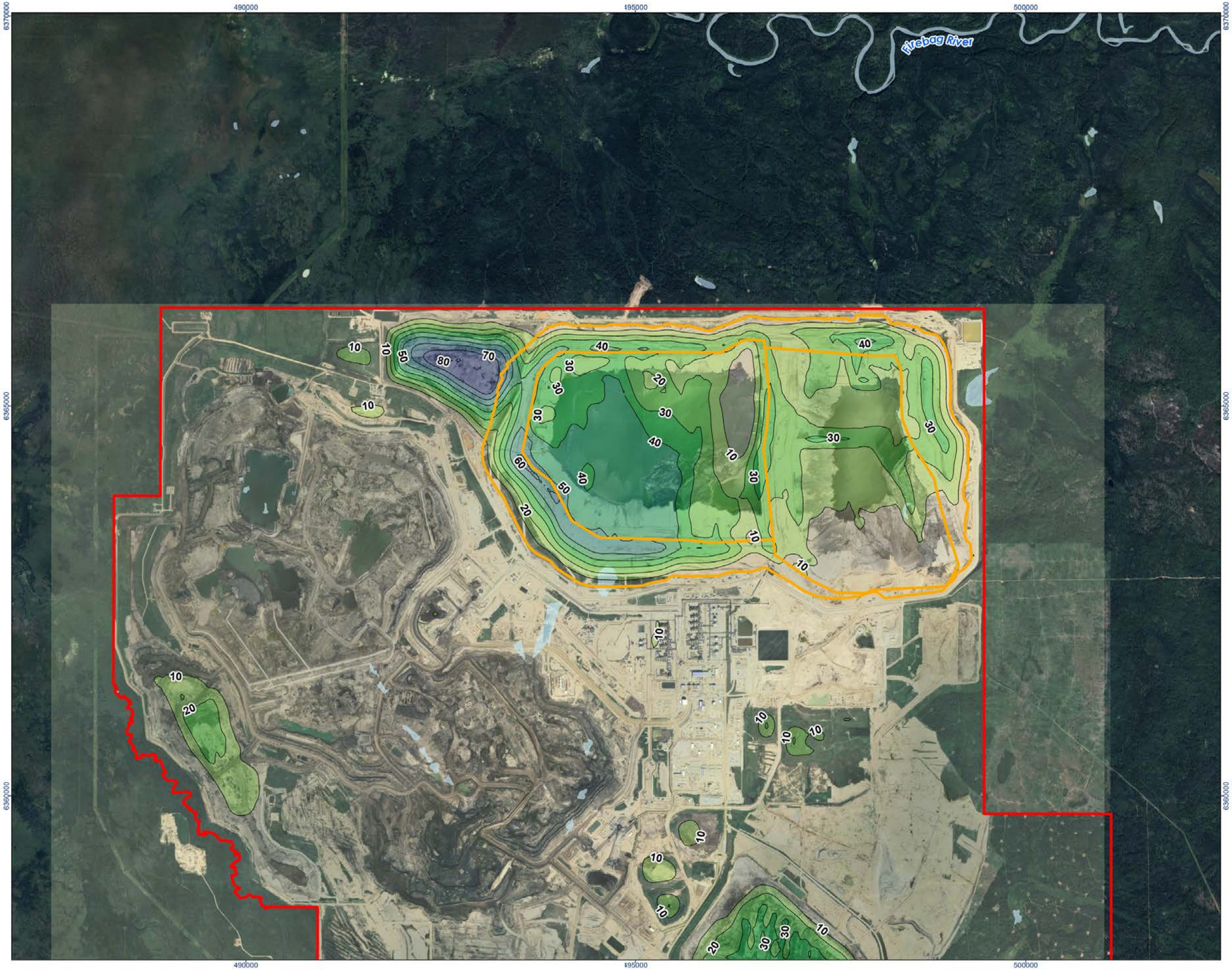
As per design specifications, prior to construction of the ETA area, rough grading of the original ground surface was completed to yield a nearly level surface on which construction of the Site infrastructure would progress. This involved placement of fill materials in various areas of lower elevation (as per the design of the ETA), and in construction of access roads, under piping and buildings, and other supporting infrastructure. Construction of the ETA starter dyke and internal ETA dykes also involved placement of fill materials in a series of lifts to achieve the design configuration as per the design specifications.

Materials used to achieve rough grades, build project infrastructure, and to build the starter dyke consisted of a mix of overburden sediments with grain sizes varying from clays to sands. Overall, the starter dyke materials were relatively permeable in comparison to native sediments due to the preferential use of sand dominated materials and their more favourable mechanical properties.

As mining operations progressed, waste overburden materials were placed in the NODA. These materials can be more permeable than the native foundation materials and due to their elevated position can create a flow path and drive the potential water northward toward the lease boundary. Progressive construction of the ETA and buildup of CST benches also continued to add fill material that had higher permeability relative to the native sediments at original ground surface.

Figure 2.8 presents an isopach map representing the thickness of placed materials above the original ground surface circa 2022. Thicknesses ranges from zero near the central processing areas and southern regions of the lease, up to 60+ m in the ETA dykes and the NODA.

The introduction of a relatively thin, but permeable layer of construction fill beneath the ETA dykes resulted in the creation of an additional shallow flow path for seepage of water out of the ETA in localized areas. This fill material was placed above the undisturbed native sediments, which by comparison were less permeable at surface. The primary mechanism to control this flow path was a network of perimeter ditches constructed around the ETA to intercept seepage through the placed material. However, these ditches were neither lined nor keyed into an impermeable substrate, allowing potential bypass and infiltration into the shallow Quaternary units. Due to the absence of monitoring wells in these units, this potential bypass remained undetected.



FMFN Group - Stantec

Imperial

- Kearl Lease Outline
- External Tailings Area (ETA)
- Placed Material Isopach Contour (m)[4]
- Watercourse (AltaLIS)
- Waterbody (AltaLIS)

N

0 500 1,000 1,500 metres

(At original document size of 11x17)
1:50,000

Notes

1. Coordinate System: NAD 1983 UTM Zone 12N
2. Data Sources: Geogratis, ©Department of Natural Resources Canada, All rights reserved. Background: Light Gray Base: Esri Canada, Esri, TomTom, Garmin, FAO, NOAA, USGS, EPA, NRCan, Parks Canada
   Google Satellite: © OpenStreetMap (and) contributors, CC-BY-SA
4. Added Material Isopach: Created by Stantec using client point data (Placed_Material_May01_2022.dxf) and ArcGIS Pro Topo to Raster tool.

m - metres

Project Location:
Athabasca Region,
Alberta

Prepared by MK on 2025-10-13
TR by DY on 2025-11-10
IR by JG on 2025-12-15

Client/Project
Imperial Oil Resources Limited
Quality Assurance Project

123515273

Figure No.
2.8

Title
Placed Material Isopach Map, circa 2022

For the layout location path: use the Layout Properties/Metadata Description: Figure: 2_8_placed_material_isopach Revised: 2025-12-18 By: mkuthl

Disclaimer: This document has been prepared based on information provided by others as cited in the Notes section. Stantec has not verified the accuracy and/or completeness of this information and shall not be responsible for any errors or omissions which may be incorporated herein as a result. Stantec assumes no responsibility for data supplied in electronic format, and the recipient accepts full responsibility for verifying the accuracy and completeness of the data.

2.1.2 Lessons Learned and Recommendations

2.1.2.1 Lessons Learned

- **Subsurface Characterization:** Early representations of the Quaternary sediments (e.g., undifferentiated layers and later facies-only approaches) thought to be conservative underestimated the continuity and impact of local low permeability units, which delayed identification of an additional shallow seepage pathway.
- **Monitoring Depths:** Monitoring and ETA-SIS wells were preferentially installed in deeper sands based on unsaturated shallow units and an incomplete understanding of the hydrostratigraphy which resulted in undetected seepage along the shallow flow path.
- **Infrastructure as Flow Paths:** Construction fill created relatively permeable shallow pathways; unlined, non-keyed perimeter ditches allowed potential bypass into near-surface Quaternary units, which went undetected due to lack of shallow monitoring.
- **Model Limitations & Observational Method**: Numerical models carry inherent simplifications and predictions may deviate from observed field results; applying an explicit observational method (iterative, rapid updates to design/monitoring as data emerges) keeps decision-making aligned with field conditions.

2.1.2.2 Recommendations

- Develop appropriately detailed conceptual models aligned with the intended model purpose supported by sufficiently high-resolution data early in the project to support groundwater monitoring and mitigation design. Conservative assumptions may overestimate seepage but can obscure actual flow paths. Development of hydrostratigraphic models is a tool that can aid in identifying potential seepage pathways from source to receptors.
- Design borehole investigations and monitoring networks to capture vertical connectivity across discrete depth intervals, consider unsaturated zones that may become saturated. Nested monitoring wells can aid in monitoring multiple potential flow paths from a single location.
- Include as-built or planned infrastructure in assessments to account for new pathways created during construction. New potential groundwater flow paths that are created through placement of fill materials, and their connectivity with pre-existing flow paths needs to be considered in the design of monitoring and mitigation systems intended to capture and return seepage water to the industrial wastewater system.
- Incorporate methods such as adaptive management and the observational method to assess dynamic system responses to operational changes for early anomaly detection and timely updates to designs and monitoring plans as new data emerges. Numerical models should be validated on a routine basis aligned with the model intent, operational pace and maturity. An iterative cycle of investigation, re-parameterization, and re-calibration should be considered where divergence in system behavior exists.

2.2 Selection of Key Indicator Parameters and Source Identification

KIPs are analytical parameters that are selected for monitoring surveillance due to their ability to identify changes in conditions and potentially help discriminate those that are anthropogenic in nature from those that could be related to natural causes. KIPs are often a subset of the analytical parameters that are measured by laboratories and are those that have been chosen based on their relevance to the potential sources of contaminants, sensitivity to change, relative conservatism in the natural environment, and relative abundance to enable their detection using standard analytical methods. At Kearl, KIPs serve multiple functions, including detecting changes in groundwater conditions, supporting initial decision-making, triggering the groundwater response plan, and assessing risk. Because these functions differ, KIP lists are maintained for each purpose. Groundwater sampling follows the full suite of parameters outlined in the Groundwater Monitoring Plan (GMP; Imperial, 2022). While KIPs play an important role in seepage management, response plans and mitigation actions are informed by a comprehensive evaluation of all available data, rather than relying solely on KIPs.

Source identification describes methods and means to attribute observed chemical changes to a particular source of contaminants or mechanism of chemical change. Implementation of mitigation or remedial measures requires sound identification of the source of contaminants to properly plan and develop actions to manage risks to potential receptors. Inadequate source identification can lead to ineffective mitigation measures or expenditure of resources without appreciable benefit.

The following section examines the contributing factors, lessons learned and recommendations pertaining to the selection of KIPs and source identification methods employed at the Kearl Project.

Plain Language Summary

Understanding where changes in groundwater chemistry come from—called source identification—is critical for effective monitoring and response. If the source of contaminants is misunderstood, interpretation of monitoring results and any potential actions taken may not be effective. At Kearl, source identification did not initially identify chemical reactions happening in the tailings dykes. These reactions, called sulphide mineral oxidation (SMO), occur when sulphide minerals are exposed to air and water, creating acidic conditions and releasing metals and salts. Because these processes were not fully understood at first, later warning signs—like rising sulphate levels—were misinterpreted as natural variation rather than indicators of seepage.

This misunderstanding shows why Key Indicator Parameters (KIPs) must be chosen carefully and based on a solid understanding of site chemistry. KIPs are specific chemical measurements used to track water quality changes and detect potential problems. If the underlying chemical processes are not well characterized, KIPs may give misleading signals. At Kearl, the lack of early understanding of tailings dyke reactions meant that the initial KIPs did not clearly indicate seepage risk until much later. This delayed recognition of issues and response efforts.

After the seepage incident in 2022, Imperial carried out detailed studies to better understand these reactions and improve source identification. They used chemical diagrams and models to separate water from different sources—natural groundwater, process-affected water (PAW), and water from tailings dykes.

The report recommends defining KIPs early and linking them to a clear understanding of site-specific chemical processes. This approach will help prevent misinterpretation of data and support continued effectiveness of monitoring and mitigation strategies as conditions change.

2.2.1 Examination of Contributing Factors

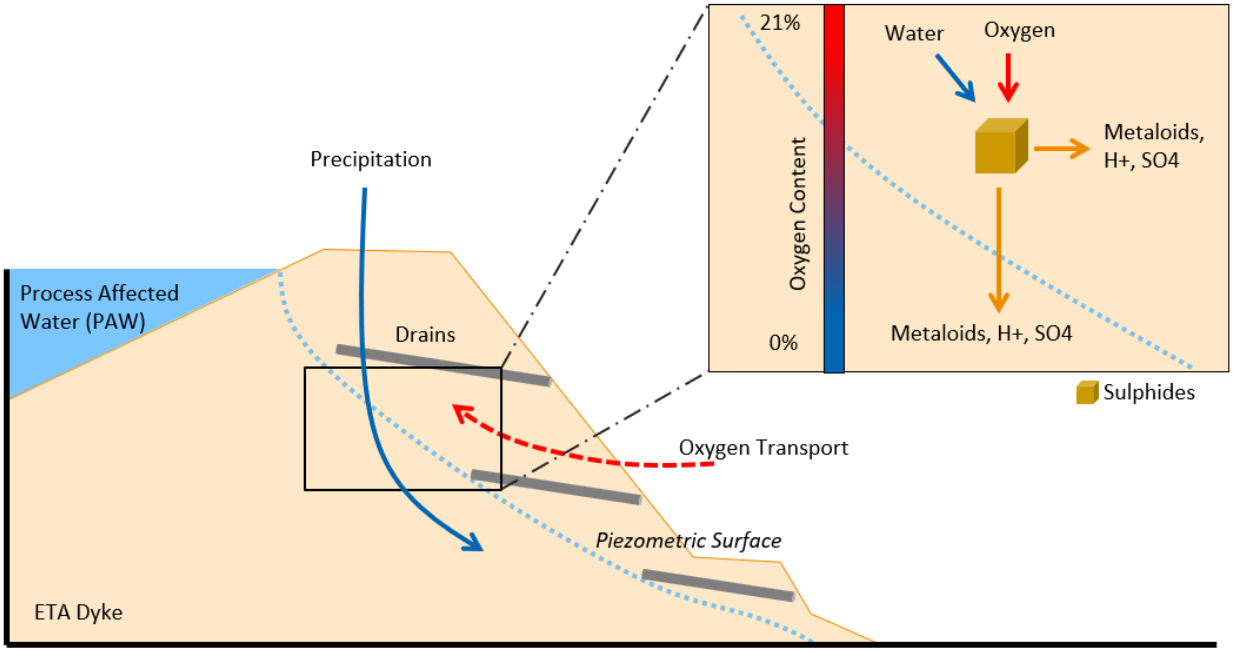
Retrospective examination of the historical groundwater assessments and monitoring conducted at the Kearl project revealed inadequate characterization of geochemical reactions that could give rise to changes in groundwater quality. This resulted in an incomplete selection of primary KIPs and misattribution of seepage as in-situ geochemical reactions at monitoring well locations. Selection of the KIPs for the Kearl Project was initially determined during pre-operations (circa 2009) based upon the anticipated potential interactions between the project and groundwater resources. At the time, the main project-groundwater interactions considered included: dewatering of Quaternary sediments and depressurization of the Basal Aquifer; seepage of river water (for startup), Basal Aquifer water, and later tailings and process water from the ETA areas; and incidental spills and leaks of substances during construction and operations. Based upon these interactions and expected chemical composition of the project sources (e.g. Basal Aquifer, tailings, etc.), the main KIPs selected for the groundwater monitoring program included field parameters, chloride, bromide, sodium, ammonia, boron, and naphthenic acids.

Shortly after ETA operations began, groundwater monitoring showed increasing sulphate concentrations over several sampling events. These occurrences were investigated as potential PAW seepage, however, similar trends in other PAW KIPs such as chloride and sodium were not observed. Because sulphate occurs naturally in groundwater in the region, it was hypothesized that in-situ geochemical reactions, similar to those now understood to occur within the dyke, were responsible for the increase rather than ETA operations. The absence of changes in other PAW indicators reinforced this interpretation. Subsequent evaluations discussed below have highlighted the importance of Sulphate as a KIP for industrial wastewater.

Between 2017 and 2018, low pH values observed in placed CST prompted Imperial to initiate investigations into the mechanisms causing acidity. From 2018 to 2021, laboratory and field studies examined CST geochemical behavior under ambient conditions, focusing on acidity storage, timing of sulphide oxidation, and transport mechanisms for oxidation products.

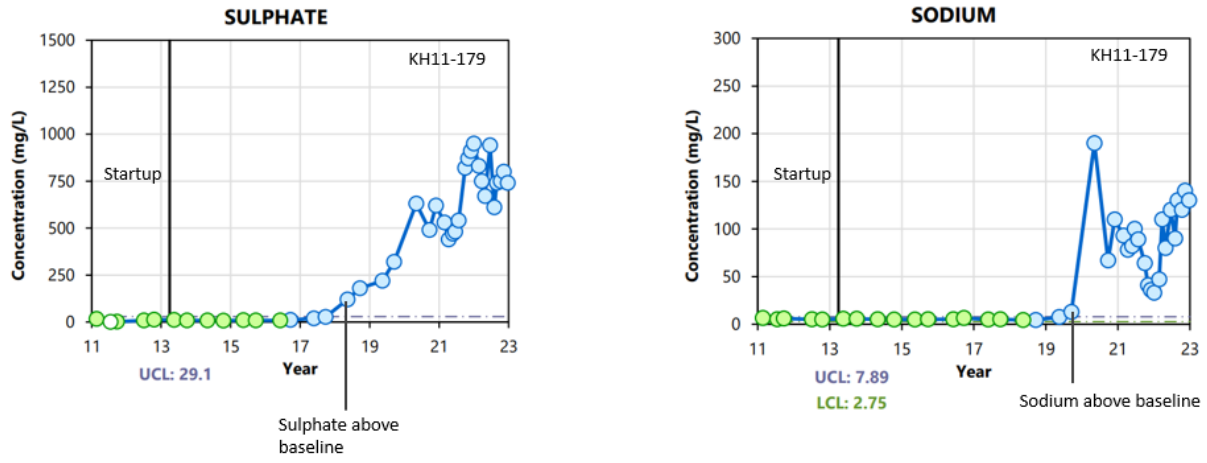
These investigations refined the conceptual model of CST weathering processes (Figure 2.9). As discussed in Section 1.4.2, SMO occurs when the sulphide minerals are exposed to oxygen and water. Over time, evaporative conditions and limited neutralizing capacity led to salt buildup until saturation. As water levels in the ETA and dyke structures rose during operations, previously deposited salts became submerged, and infiltrating water dissolved these salts, mobilizing acidity, sulphate, and metals out of the ETA dykes.

Figure 2.9 Refined Conceptual Model of CST Behavior (modified from Okane 2022)



Sodium concentrations, one of the initial KIPs of PAW migration, did not begin to rise until 2020. Figure 2.10 compares time-series data for sulphate and sodium from a monitoring well downgradient of the ETA, illustrating the earlier sulphate increase and the delayed sodium response. This pattern explains why initial sulphate trends were attributed to natural geochemical processes in the absence of other PAW indicators and prior to understanding CST as a source of sulphate.

Figure 2.10 Sulphate and Sodium Concentration Comparison Time Series Graphs

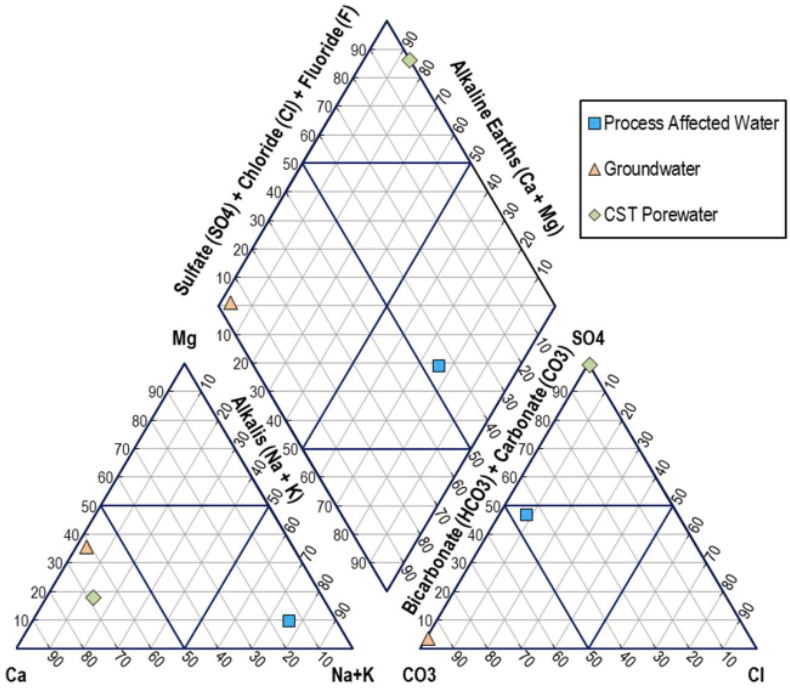


The Geochemical assessment of CST and conceptualization of potential reactions revealed that SMO reactions within the ETA dykes was a significant contributor to the increasing sulphate trends. While sulphate can also be found in PAW, the conclusions drawn about CST porewater were further supported through examination of seepage water collected from the dyke drains, which was found to be higher in sulphate concentrations relative to the PAW stored in the ETA, suggesting that an additional mechanism was responsible for the generation of dissolved sulphate.

Following the seepage incident in May 2022, a third-party company was engaged to develop a conceptual geochemical model explaining the occurrence of orange precipitate observed in the affected areas. The geochemistry study leveraged piper diagrams and conceptual site models to conclude that the likely sources of the precipitate and discolored water were the weathering of CST used in the ETA dykes and process-affected water (PAW) from the ETA.

The 2022 geochemistry study (Okane 2023) defined water quality profiles for three water-type “end members” of particular relevance to the groundwater monitoring programs. Profiles for PAW, natural groundwater, and CST porewater (indicative of SMO) were created through compilation of historical chemical analysis and creation of Piper diagrams. The natural groundwater chemistry was based on wells outside of operational areas. The wells are screened in the middle sand hydrostratigraphic unit. The piper diagrams and interpretation completed through this study allowed for development of characteristic water quality profiles for the PAW, natural groundwater, and CST porewater end members. Figure 2.11 presents the Piper diagram plotting the water types as defined through compilation and averaging of longer-term monitoring data. Through use of this method, it was found that it was possible to identify and differentiate between PAW, natural groundwater, and CST porewater since the relationships between the major cationic and anionic species were distinct, as is visually evident within the diagram. The study then reviewed groundwater monitoring results for several wells in the ETA area associated with the seepage and identified results that appeared to be most similar to one of the source water types, or in other cases appeared to fall between water types suggesting that some mixing of water types was occurring along the subsurface flow paths. It should be noted that in-situ geochemical reactions have a similar profile to CST porewater, which complicates the source determination.

Figure 2.11 Piper Diagram of the Three Main Source Waters near the ETA (adopted from Okane, 2022).



Ongoing work continues to advance understanding of site geochemistry through detailed analysis of ground and tailings composition at Kearl. This includes kinetic field bin programs of fresh and weathered material, static grab samples from facilities and core and principal component analysis and stable isotope studies to improve source identification (especially between CST and in-situ SMO) and refine predictive models.

The weathering behavior of CST and potential mechanisms leading to movement of sulphates, acidity, and metals out of the ETA dykes was not contemplated during early development of the groundwater monitoring program and was a contributing factor leading to the Release Incident. Early monitoring plans did not identify these products as primary KIPs for seepage surveillance and as such increases in those parameters were not interpreted correctly during review of monitoring results.

2.2.2 Lessons Learned and Recommendations

2.2.2.1 Lessons Learned

- **Incomplete Source Material Characterization:** The potential for CST in the dykes to oxidize, generate acidity, and mobilize sulphate and metals (SMO/ARD reactions) was not considered in the original monitoring program. As a result, key indicator parameters (KIPs) were not aligned with important groundwater quality indicators.
- **Misattribution of Sulphate Trends:** Sulphate increases were observed early in operations, but because other PAW indicators (e.g., chloride, sodium) did not rise concurrently, the changes were attributed to natural in-situ geochemical processes.

2.2.2.2 Recommendations

- Complete geochemical characterization of source material and water chemistry, which may vary through time. Build a thorough understanding of chemical change mechanisms in the subsurface, including SMO/ARD reactions associated with constructed infrastructure such as sulphide-bearing CST in ETA dykes. Include fresh and weathered samples as available, particularly for material that may not be continually saturated. Through this understanding, appropriate KIPs and mitigation measures may be developed to detect changes and mitigate effects prior to endpoint exposures.
- Define and update KIPs based on source characterization and develop methods to distinguish water sources to reduce misattribution and improve interpretation of groundwater trends as site conditions evolve.

3 Important Additional Elements for Consideration

This section highlights additional insights from the Quality Assurance Project. While not primary contributing factors, these considerations are important elements of effective seepage monitoring and management practices.

3.1 Value of Community and External Perspectives

Imperial values the Traditional Knowledge and technical expertise that is provided by external parties and the neighboring Communities in which we operate. In depth, collaborative communication builds trust and provides valuable insights to environmental monitoring and management results. Imperial engages with neighboring Indigenous Communities on environmental and technical tailings matters which enables Communities and their technical representatives to provide feedback to site activities.

This section underscores the significance of these discussions and acknowledges the importance that operators adequately address the observations that are brought forward through these discussions. An example of this is the selection of indicator parameters.

Indicator selection for the groundwater monitoring program began with assumptions about expected water chemistry and geochemical signatures. Over time, observed trends and recommendations from the Communities' technical experts prompted reconsideration of indicator priorities.

As operations progressed, improved characterization and knowledge of geochemical interactions revealed limitations in earlier assumptions, leading to adjustments in key indicators and strengthening the overall effectiveness of seepage monitoring and management practices. Adaptive management ensures that monitoring programs remain responsive to emerging data and evolving scientific understanding.

Imperial strives to continue and improve collaborative efforts, through open and transparent engagement with community environmental representatives. They have collaborated with technical experts from Indigenous Communities to conduct Community technical reviews to assess the documents and data related to the Seepage incident.

3.2 Communication

Effective communication is essential to maintaining trust with neighbouring Indigenous Communities and local land users. Trust is built through strong relationships, and those relationships depend on clear, timely, and transparent information. As discussed in section 1.5, Imperial's communication following the incident did not meet the expectations of the Communities. The recommendations presented here are based on those learnings.

A key priority is providing timely notification when events occur, including incidents that may affect land, water, or harvesting areas. This requires sharing information early—even while details are still developing—so Communities can understand potential impacts and make informed decisions.

Equally important is ensuring that communication reaches the right people, particularly those whose livelihoods and cultural practices depend on the land. Trappers and harvesters working in areas that may be affected by a project or seepage must receive direct, relevant information.

Imperial has worked closely with local Indigenous Communities to refresh and strengthen notification protocols. These updates play a key role in restoring trust, promoting community well-being, and demonstrating Imperial's commitment to being a responsible neighbour and operator in the region.

3.3 Model Assumptions and Validation

Numerical groundwater models can be useful tools for predicting complex subsurface behavior, but they rely on simplifying assumptions that can be misleading, especially when assumed to represent conservative worst-case scenarios. Model validation compares predictions against independent data sets to confirm performance. However, such data often only becomes available after operations begin, making ongoing validation critical.

The first Kearl groundwater model, a regional MODFLOW model developed for the EIA, used a simplified hydrostratigraphic framework and assumed uniform sand-like hydraulic conductivity for Quaternary units. These simplifying assumptions were considered conservative for the application of the model at that time and were appropriate for the project stage. Subsequent model updates incorporated additional data as it became available.

In all cases the hydrogeological assumptions impacted modeled seepage rates and flow paths which ultimately informed system design and operation. These simulations predicted PAW arrival at ETA-SIS wells within two years, but monitoring data did not show expected trends in water levels or key indicator parameters (KIPs) within this timeframe. This discrepancy did not trigger timely model review or validation.

Establishing a structured validation process within operational management systems—along with defining key scenarios and signposts for deviation—is critical to detect evolving conditions and adjust mitigation strategies.

3.4 Integrated Monitoring

The first observation of the seepage was made during routine environmental monitoring. Further investigation revealed three additional seep locations.

Integrated monitoring approaches may help limit the extent or duration of seepage migration off site. Through deliberate field investigation and surface water sampling there are additional opportunities to detect changes in other media than with just groundwater or ad hoc opportune investigation alone.

Examples of opportunities to leverage integrated monitoring include:

- Observed changes in the chemistry of surface water or wetlands. While it would be better if such change was detected in groundwater prior to it reaching its discharge point, having another point of monitoring to act as a 'backup' in case groundwater monitoring wells were placed just outside of the path migration is an asset to the overall surveillance efforts.
- Observations of vegetative stress noted during vegetation monitoring events could trigger further monitoring in surface water or groundwater to determine if the water chemistry has changed, as was done during the initial seepage investigation. Similarly, changes in groundwater quality could trigger additional monitoring events in vegetation in potential discharge areas.
- Changes in soil chemistry, even where unsaturated by water could identify the need to monitor for dissolution products in groundwater following major precipitation events or in areas of rising groundwater levels.
- Remote sensing data used for surveillance of vegetative health could be augmented to enable detection of changing saturation levels or groundwater discharge patterns.

There are many other potential ways in which monitoring programs can be linked to each other, and ideally there is discussion between environmental disciplines to identify sets of KIPs or other metrics that can serve the needs of multiple monitoring domains.

4 Community Feedback on Lessons Learned

Two workshops were held in June and July 2025, as shown in Table 4.1. Invitations were sent to Athabasca Chipewyan First Nation (ACFN), Fort Chipewyan Métis Nation (FCMN), Fort McMurray 468 First Nation (FMFN 468), Fort McKay First Nation (FMkFN), Fort McKay Métis Nation (FMMN), McMurray Métis (MM), and Mikisew Cree First Nation (MCFN).

Table 4.1 Community Meeting Summary

Group	Date	Time	Location	Participants
Community Workshop 1 • Athabasca Chipewyan First Nation (ACFN) • Fort Chipewyan Métis Nation (FCMN) • Fort McKay Métis Nation (FMMN) • Mikisew Cree First Nation (MCFN)	June 26, 2025	10:00 a.m. – 2:00 p.m.	Fort McMurray with online option	11 participants (4 in-person, 7 virtual)
Community Workshop 2 • Fort McMurray 468 First Nation (FMFN 468) • Fort McKay First Nation (FMkFN) • McMurray Métis (MM) • Mikisew Cree First Nation (MCFN)	July 7, 2025	10:00 a.m. – 2:00 p.m.	Fort McMurray with online option	12 participants (11 in-person, 1 virtual)

In total, 23 people attended the workshops. The format of the workshop consisted of a presentation delivered by Imperial, during which participants were invited to pose questions or offer comments at any point. Imperial was represented by specialists from multiple disciplines to provide prompt and accurate responses. Imperial presented the same information to the Communities as had been presented to industry except the information was communicated using plain language.

Various comments, questions and suggestions were discussed to assist Imperial in developing the QA Project Report. The purpose of the workshops was to share information, gather input, and listen to community perspectives regarding the QA Project. The meeting notes for the two workshops are included in Appendix A.

4.1 What We Heard

Several topics were raised at both workshops; the discussions that appeared to be of greatest importance based on the amount of time spent included:

- Communication – Expectations include timely, tailored, and targeted information
- Indigenous Participation – Communities want their voices heard and used
- Transparency – Build trust for productive and collaborative working environments

- Root Cause – Actual root cause was debated; however, Communities wanted the information shared with industry to avoid seepage migration offsite
- Key Indicator Parameters

Each topic is discussed below in more detail. Where applicable, quotes from participants have been added to provide context to the feedback received.

4.1.1 Communication

Participants discussed their expectations with respect to communication, which includes timely, tailored, and targeted information. The foundation of effective communication is trust, which is built through relationships. Some participants expressed appreciation of Imperial's acknowledgment of the need to work together to improve communication.

Indigenous Communities want to be informed of events, such as that which resulted in this EPO Quality Assurance Project, in a timely fashion. This means communicating potential impacts early, even before certainty, managing risks as information develops, and advising Indigenous Communities directly rather than through secondary sources.

Participants prefer information that is tailored for their community rather than receiving templates of general public relations messaging. Communities want to receive the facts rather than filtered information and believe agreements such as Community Benefit Agreements should accommodate that.

Targeting communications with the right, relevant, people was also discussed. Participants emphasized the need to communicate information that is relevant to the users of the land affected by a project or seepage. Trappers and those harvesting areas affected by a project or seepage need to be informed directly. They don't want to learn information second hand.

> *"Thank you for acknowledging that we need to communicate better and communicate before things happen. It's not just because you didn't tell us, you need to be able to take into consideration our warnings in our technical reports in order to prevent this from happening. Communication goes both ways; we are trying to reciprocate. It is a major learning, and it hasn't been acknowledged yet. We have been telling you and this is probably a good place to put that." (Athabasca Chipewyan First Nation Workshop 1, pg. 11*)

> *"Our leadership received information through unofficial channels before we heard it from you. … It would be good to receive the heads up if you are going to hit the compliance dashboard. Those issues can be emotional but if we know about it, and we meet and are well informed, we can have a briefing note waiting … you have to get ahead of it through the official channels. Relationships needs to be a factor. When you have longstanding relationships that you trust then you can change your approach."" (Mikisew Cree First Nation Workshop 2, pg. 16)*

> *"Communication is the number one thing that can help with the safety of land users and trappers." (Fort McKay First Nation Workshop 2, pg. 6)*

4.1.2 Indigenous Participation

Participants emphasized their connection with the land and their continued use of the land and that this information is important to Imperial. There were many questions regarding how Imperial had used input from Indigenous Communities in the QA Project. Imperial confirmed that the comments are incorporated in the information being presented and will be reflected in the final Report. The Communities emphasized that they take their roles and submissions seriously and Imperial needs to make better use of the knowledge they share. They stressed that incorporating community input meaningfully into the lessons learned is critical.

Participants recommended that moving forward, Imperial needs to listen more closely to the Communities and make use of their expertise. This would address the efforts the Communities put into reviewing material, the expertise that they bring, and their perspective on Indigenous and Treaty rights. Communities explained that they were concerned about seepage during the development of Kearl.

> *"We also look at it from a rights perspective, Section 35 rights. Parts of our IBAs [Impact Benefit Agreements] are meant to do that bilateral process. When we look at it through the rights holder, we are trying to create a space where rights can be brought forward, and concerns can be mitigated and accommodated. Take a second look at our technical reviews like FCMN said but also remember it is your job.*
>
> *Once the Report gets into draft form, there is an anchoring bias to their work. We are looking for a collaborative process, and we want to collaborate before it becomes a baby that you don't want changed." (Athabasca Chipewyan First Nation Participant, Workshop 1, pg. 5 and 13)*
>
> *"From a community perspective when we think about lessons learned, we want to make sure that input from Indigenous Communities is considered and incorporated into these lessons learned.*
>
> *Over the years, we (Communities) really try to do a thorough and thoughtful job looking at plans and reports, and we attempt to give recommendations and express community concerns that may arise. I think Imperial going forward is looking at those more critically. They are given to a company for consideration, but they aren't acted upon. A lesson learned and what would be good to say is 'hey, we had Communities review, and they did identify elevated sulfates among other things. How are we going to consider and respond to those?' In the future when you get these reviews from Communities know we aren't doing it for the sake of an exercise; we do a good job, and we want to help the company." (Fort Chipewyan Métis Nation Workshop 1, pg. 3 and 4)*

Indigenous Communities explained that they would like to have direct contact with the AER:

> *"What role does the regulator have when approving projects that were designed on assumptions that were wrong? That needs to be incorporated in here because the AER has to respond to making a decision on data they had at the time, that turns out to be wrong and then has major environmental responses." (McMurray Métis Workshop 2, pg. 13)*

4.1.3 Transparency

Participants questioned how the information submitted by Imperial will be reviewed. Questions were raised regarding who would be responsible for verifying accuracy and ensuring the absence of bias. The discussion created a perception that the role of the AER may have changed, and the AER no longer was the body to review and assess the document. Concerns were raised that without an impartial, third party, Imperial would not report accurate information or be held accountable. There is interest in building trust for productive and collaborative working environments going forward to protect the land and the health of the people who depend on it.

A participant from Fort McKay First Nation emphasized the importance of honesty and transparency during the Report creation, noting:

> *"I have two comments … normally investigations like this where you get a root cause analysis, it is being done by an independent third party. How honest will Imperial be with itself in the final Report? On this one the system was not designed correctly, and it's not that it got past the system, it's the fact it wasn't designed correctly, and you are at fault because of that. In this situation I am concerned the AER is not involved seems to be just saying its Imperial's Report and we will maybe ask some questions. I'm concerned the AER is not authoring this Report as well. … Are they useful findings, and does the public gain trust through this Report? Is it transparent to rebuild trust? … How do you get the most credibility out of this work? It should be useful, honest, and transparent. If the Report doesn't do that then it will not rebuild trust." (Workshop 2, pg. 20)*

4.1.4 Root Causes

Imperial identified the root cause of the seepage as soil conditions that created pathways for process affected water that the SIS were not designed to monitor and a lack of understanding of geochemical implications of CST. Some participants disagreed with this characteristic of the root cause and stated that a lack of data was the root cause. Another stated the root cause was an incorrectly designed system. Some argued that the original EIA and ground water predictions were incorrect, and the SIS and tailings pond were designed based on flawed assumptions. There appeared to be agreement that the information gained by Imperial should be shared with industry to avoid similar seepage with respect to other tailings ponds.

> *"What was happening under the surface was that the subsurface was different and required a better understanding. For some reason Imperial and the AER didn't find that. The Communities identified that. The understanding of the subsurface was not pursued. It was underestimated. …I think the depth of learnings are not reflective of the real depth of learnings. I hope they are reflected and considered going forward. We don't want this to happen again, and I hope there can be a revision in terms of the learning and not just limited to this conversation today."" (Fort McKay Métis Nation Workshop 1, pg. 9)*

> "*I think the learning here is much bigger than that. The learning is that the assumptions in the EIA* were incorrect. The seepage and pond were designed based on incorrect assumptions." *(McMurray Métis Workshop 2, pg. 13)*

"I disagree that the seepage was the root cause. There was not enough data collected to properly design a seepage interception system. The fact the seepage went through isn't the root cause it is the symptom." (Fort McKay First Nation Workshop 2, pg. 11)

"In particular, what we discussed was Imperial's assumptions and the use of rules of thumb attempts to simplify issues and guess the worst-case scenario and mitigations didn't work. That is much more important. I hope that the only thing you have learned is not just the underground layers. I am wondering if that would be added as a learning because it would be much more accurate." (Fort Chipewyan Métis Nation Workshop 1, pg. 8)

"When we look at this, we also look at EIAs from all over; we look at one, but all these best practices build off each other. That is important for the generations ahead of us. There are many layers to the importance of capturing these lessons." (Athabasca Chipewyan First Nation Workshop 1, pg. 9)

4.1.5 Key Indicator Parameters

Imperial explained that they initially monitored five key indicator parameters in the process affected water, which included Chloride-Bromide ratio, Sodium, Ammonia, Boron, and Naphthenic Acids. One participant stated that the KIPs should be based on the chemistry of the source water and that they had pointed out in 2018 the need to include sulphate. Not monitoring sulphate until later is seen as an oversight.

"The amount of effort that goes into community's technical submissions to you for multiple years, seeing those comments and recommendations, and seeing those considered in a deep and thoughtful way and actually evaluating those comments, there was really great information through multiple reports on KIPs on monitoring on below the surface, that resource to you was not considered. I'm not saying you need to adopt all those recommendations, but there were lots of really great recommendations that were not considered." (Fort McKay Métis Nation Workshop 1, pg. 12)

"I know that a lot of the people at Imperial now haven't been around as long as some of us. I want to point out in my review of the 2018 TMR, I mentioned that sulphate was increasing at these wells, and I wanted to know why it wasn't an indication of PAW. I was told the focus was on chloride, chloride would arrive faster and before sulphate because of that conservative approach. In my review of the 2019 TMR in response to Imperial saying chloride is a better tracer, I mentioned the chloride concentration was very low at Kearl. Not only is it low, but it is close to what we see for surface water and here I am. I feel like history has been rewritten in terms of mistakes that were made. The KIPs should be made based on the chemistry of the source water. Talking with Imperial years ago it was chloride and when the Communities specifically asked about sulphate, they were told 'no we're waiting for chloride.' At a basic level you should have looked at tailings water to choose your KIPs. It seems like it was out of your control, but I think it was a pretty major oversight. I was looking for some mention of that mistake and I don't see it here. I am looking for acknowledgement." (Fort Chipewyan Métis Nation Workshop 1, pg. 11)

4.2 Post-Workshop Feedback

Following the Indigenous Community workshops, the meeting notes were circulated to the Indigenous Communities for review and comment. In response to the meeting notes, Imperial received correspondence from Fort Chipewyan Métis Nation highlighting the areas from the meeting notes they considered to be report outcomes and learnings. Mikisew Cree First Nation, Athabasca Chipewyan First Nation, Fort Chipewyan Métis Nation and Fort McKay Métis Nation also provided additional learnings. This correspondence is attached in Appendix B. This input reinforces earlier feedback provided regarding:

- Using the report as a prevention tool for similar incidents by sharing best practices with industry
- Incorporating, investigating and evaluating Indigenous Community feedback and technical reviews, including KIP selection for groundwater monitoring
- Learnings related to understanding of subsurface and hydraulic connectivity to improve groundwater monitoring, and the importance of updating your assumptions/models with monitoring data
- Establishing reference groundwater quality and level data, and improvement to the communication protocols with the Communities when changes are detected from reference conditions
- Characterization of discharges to offsite receptors, where locations are identified prior to construction through consultation with the Communities, and monitored before and during all phases of the project
- Expanded surface water monitoring aligned with groundwater monitoring
- Designing mitigation measures to capture the full pathway by which impacted groundwater might migrate offsite.
- Missed opportunities through the EIA process including the joint review panel recommendations for additional geotechnical work, assumptions and rules of thumb used to design for worst case scenarios and mitigation planning, and validating EIA predictions of the operating model prior to the 10-year renewal
- A desire for improved communication between Indigenous Communities and Imperial.

5 Industry Peer Feedback on Lessons Learned

In June 2025, Imperial met, and shared lessons learned on the Quality Assurance Project with two industry groups: the Alberta Chamber of Resources Dam Integrity Advisory Committee (DIAC), and the Canada's Oil Sands Innovation Alliance (COSIA). Imperial met with these groups based on their experience, expertise, regulatory involvement, and direct interest in industry best practices.

At each meeting Imperial presented information on the Quality Assurance Project including the background of the Kearl site, the Seepage, Imperial's response to the Seepage, the seepage root cause learnings, the quality assurance plan, and next steps. The meetings were casual and encouraged questions and discussion throughout and after the presentation. Approximately 84 people attended the two meetings either in person or virtually. Table 5.1 summarizes the discussion and feedback from each meeting.

Table 5.1 Industry Meeting Summary

Group	Date	Time	Location	Participants
Dam Integrity Advisory Committee (DIAC)	June 10, 2025	1:00 p.m. – 2:30 p.m.	Calgary (online option)	12 participants (10 in-person, 2 online)
Canada's Oil Sands Innovation Alliance (COSIA)	June 12, 2025	1:00 p.m. – 2:30 p.m.	Online	72 participants

5.1 What We Heard

Although many of the comments during the workshops with DIAC and COSIA were raised as questions, they served as important feedback by drawing attention to areas of interest for industry stakeholders. It is important to note that no major omissions or errors with the Quality Assurance project were identified during these meetings.

5.1.1 DIAC

A special agenda item was added to the regularly scheduled Dam Integrity Advisory Committee (DIAC) meeting to host a sharing session on Imperial's quality-assurance project for the Kearl Oil Sands operation and to review lessons learned from the environmental seepage incident. The discussion focused on five major themes: Incident and response, hydrogeology impact on seepage management and monitoring, modelling considerations and KIP's, seepage management infrastructure and performance and forward-looking improvements in design and surveillance.

5.1.1.1 Incident and Response

Participants listened to the timeline and analytical approach used to confirm the nature and source of the impacted water. Discussion/questions included:

- Initial field observations of discoloured water occurred in May 2022 during routine field activity.
- Confirmation that all four identified locations represented industrial wastewater was achieved progressively through geochemical and source/pathway analysis, culminating in late 2022.
- The differentiation between process-affected water (PAW), sulfide mineral oxidation (SMO), and naturally occurring signatures required both water chemistry evaluation and an understanding of local hydrostratigraphy to establish source pathways with confidence.
- The existing inspection program identified the presence of orange precipitate; however, these observations occurred opportunistically rather than through a dedicated inspection event.

Key questions from DIAC focused on the analytical methods used to determine water origin, the timing of source confirmation across different seep locations, and the role of field inspections in early detection.

5.1.1.2 Hydrogeology Impact on seepage Management and Monitoring Systems

The committee discussed the original placement of monitoring and interception wells, the hydrogeological complexity of the site, and factors affecting seepage migration. Highlights included:

- Early well locations reflected pre-operations simulation work and were refined as operational data accumulated. Initial simplification of the quaternary deposits was driven by initial low drilling density in the area.
- After the seepage event, additional monitoring and pumping wells were installed to improve delineation in both shallow and deep groundwater systems.
- Travel times in the subsurface are variable and sensitive to changes in pond level and formation conductivity, making the use of a single representative value inappropriate.
- DIAC inquired into fingerprinting and tracer studies; Imperial noted ongoing analytical work (e.g., PCA, isotopes) but no tracer testing to date.
- Discussion acknowledged challenges posed by geological complexity leading to variable hydraulic conductivity, and natural mineralization processes.

5.1.1.3 Modelling and Key Indicator Parameters

The committee reviewed the alignment between model predictions and field observations, as well as the evolution of key indicator parameters (KIPs):

- Differences between predicted and observed water levels in certain areas were attributed to the time elapsed since the last model calibration and changing conditions within the ETA, including tailings behaviour.

- Field measurements showed lower water levels than modelled in some cases, indicating slower movement than predicted. 3D geology and hydrogeology is likely more complex than illustrated through 2D sections and analysis.
- Sulphate was discussed extensively as a parameter whose significance became clearer over time; earlier regulatory documents emphasized chloride, and sulphate was not initially recognized as a primary indicator of concern.

5.1.1.4 Seepage Management Infrastructure and Performance

A portion of the discussion examined the effectiveness of seepage interception systems and potential alternative or complementary technologies:

- Deep pumping wells were initially installed in the deep aquifer (transmissive units), though shallow systems with lower conductivity would require additional approaches to address all seepage pathways.
- In some locations, seepage was observed to bypass original well networks, emphasizing the need for refined placement and additional infrastructure.
- Options under consideration for shallow zones include tighter well spacing, cutoff walls, trenches, and other hydraulic control measures. Questions were asked if this similar condition exists at other facilities and what initial design features were incorporated to manage any potential seepage.
- Constructed materials can create unintended flow pathways so need to have an adaptive management approach.
- DIAC explored whether alternative designs (e.g., cutoff walls during initial construction, more intensive early-stage characterization) might have reduced uncertainty or improved performance.

Spacing, drawdown capacity, geological heterogeneity, and limitations in changing conditions (such as water level) were also discussed. Imperial confirmed that expanded systems will be included in ongoing operations and closure planning.

5.1.1.5 Lessons Learned and Forward-Looking Improvements

The meeting concluded with a discussion on overarching lessons and how they are being applied across operations:

- Improved early-stage characterization, especially of hydrostratigraphy and construction materials, was identified as two key lessons that may have reduced risk had they been more extensive during initial design. Tightening the feedback loop between data, models, and decisions via structured QA/QC and review were needed.
- Participants emphasized the importance of density in borehole spacing, adaptive monitoring, and recognizing high geological uncertainty in design assumptions.
- The need for periodic updates to FMEA processes was noted; while an initial FMEA was completed prior to operations, the follow-up occurred later than originally planned.

- Learnings from the ETA seepage event are actively being applied to other facilities, including increased monitoring and borehole density in select areas. Some of the key takeaways were:
  - Vertical coverage (nested wells in all relevant units).
  - Lateral density (systematic approach, not just at predicted seep lines)
  - Recognition that hydraulic conditions evolve with pond rise, so early dry units may later become critical pathways.
- The need to develop geochemical QPOs during the facility design state and implement performance monitoring programs (including TARPs) to monitor them. Coarse Sand Tailings (CST) can generate sulphates through mineral oxidation.
- Closure considerations need to be addressed – different options to be reviewed in regards to "long term" care and ensuring robust controls are in place.
- Review Stakeholders/Rightsholders notification: How and when indigenous Communities and others were notified.

5.1.2 COSIA

Imperial Oil provided an overview of the seepage incident at Kearl and shared key technical learnings, with the intent of supporting broader industry understanding and continuous improvement. The session covered incident response actions, subsurface characterization, monitoring approaches, geochemical interpretation, and forward-looking quality assurance processes. Imperial emphasized the value of shared learning and highlighted opportunities for continued collaboration across the industry to enhance environmental performance and subsurface understanding. Participants were invited to give feedback and identify areas of shared industry interest.

5.1.2.1 Incident Response and Early Characterization

Imperial reviewed the steps taken to confirm the nature and origin of the seepage following initial observations. Key points included:

- Multiple lines of evidence, including geochemistry analysis and subsurface characterization, were used to differentiate between industrially influenced water and naturally occurring changes.
- Principal component analysis and isotopic work were highlighted as elements of ongoing efforts to distinguish natural geochemical evolution from process-affected water.
- Hydrostratigraphic assessments around observed seepage areas were critical in understanding potential pathways and determining the likely source of the seepage.
- Questions were raised for Imperial regarding risk management, onsite monitoring networks, and the ability to detect earlier signals; Imperial noted that monitoring continues to evolve as characterization improves.

5.1.2.2 Root Cause Insights and Subsurface Learnings

Imperial summarized findings from its root cause evaluations, focusing on geological complexity and seepage pathways:

- Imperial discussed how initial models relied on simplified assumptions of subsurface units that later proved to be more heterogeneous.
- Multiple shallow flow pathways were identified as contributors to observed seepage movement, emphasizing the importance of detailed and continuously updated stratigraphic models.
- Clarifications were provided regarding the function of seepage interception systems, ditches, and construction materials.
- Participants raised questions regarding the hydrogeologic modelling history, with Imperial noting that long-term model calibration and updated datasets have strengthened understanding and could enable future transport modelling.

5.1.2.3 Detection Approaches and Key Indicator Parameters (KIPs)

Imperial described how geochemical indicators were used to detect and differentiate seepage:

- Sulphate and sodium were key parameters, though some indicators presented challenges due to natural variability.
- Additional monitoring wells have improved plume delineation and characterization of existing seeps.
- Imperial shared how geochemical interpretation evolves with new data and noted that industry's understanding of KIPs continues to mature.

5.1.2.4 Monitoring, QA Processes, and Seepage Management

Imperial discussed its ongoing quality assurance and monitoring initiatives:

- The seepage management quality assurance plan focuses on robust surveillance tied to source characterization and improved understanding of geological units.
- Borehole data, pumping responses, and refinement of hydrostratigraphic models have become increasingly important for identifying flow units and evaluating system performance.
- Discussions also touched on operational decisions such as lining certain ditches, material selection, and considerations for potential tracer studies.

5.1.2.5 Forward Work and Industry Knowledge Sharing

Imperial outlined next steps for the QA project and related activities:

- Isotope studies and advanced geochemical analyses are ongoing.
- Continued efforts are underway to distinguish industrial contributions from naturally occurring constituents.
- Participants expressed appreciation for the transparency and depth of learning shared.

6 Closure

This report is intended to comply with the requirements of the AER in response to the Kearl shallow seepage incident in 2022. FMFN Group-Stantec has worked, as a neutral-third party, with Imperial to understand and document the work completed by Imperial in their Quality Assurance Project, which included reviewing what happened, confirming lessons learned and recommendations. This information is documented in this report and has been shared with industry members, neighbouring Indigenous Communities and land users as described above.

Indigenous Communities emphasized they would like to see the findings and lessons learned from this Quality Assurance Project applied as a standard recommendation across all industry to prevent similar seepages in the future. Imperial continues to work with COSIA on the incorporation of the Quality Assurance project results into their industry best practices database.

> *"I really like your comments about what you have done. The important part of this is what other people should do. It's one thing to up the monitoring for yourself but the recommendation should be to industry." (*Fort McMurray 468 First Nation*, Workshop 2, pg. 18)*

> *"I hope this Quality Assurance Project will become best practice not only for Imperial but for the region. You put in your application 3-year data and a conservative approach, and you have to validate that for your first 10 years, that to me would be very helpful. We've got some lines out there that are decades old that have not validated what is in their EIA from decades ago. Getting that in front of the eyes of the AER will make them more diligent as well." (Fort Chipewyan Métis Nation Workshop 1, pg. 8)*

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Appendices

Appendix A Meeting Notes – Indigenous Community Workshops

A.1 Community Meeting Notes, June 26, 2025, Imperial Final

Imperial

Community Meeting –Imperial Oil Limited
EPO Quality Assurance Project Meeting

Date	June 26th, 2025 – 10:00 AM – 2:00 PM
Location	Chez Dube Country Inn - 10102 Fraser Avenue, Fort McMurray, AB
Purpose	Share and discuss lessons learned from the Kearl seepage release incident and gather feedback on Imperial's quality assurance plan for seepage monitoring and mitigation processes.

Attendees	Organization or Identifier
Nathan Pittman	IOL
John Tuttauk	IOL
Sarah Theberge	IOL
Duane Rose	IOL
Colson Foster	IOL
David Earle	IOL
Vince Eggleston	IOL
Gillian Savage-Knight	IOL
Michele Perret	Stantec
Zoe Rezac	Stantec
Kaylee Welsh	Stantec
Dan Yoshisaka	Stantec
Nikki Jane *(Virtual)*	FCMN
Megan Thompson *(Virtual)*	FCMN
Eber Araujo *(Virtual)*	FCMN
Lisa Schaldemose *(Virtual)*	FCMN
Tahina Choudhury (*Virtual)*	MCFN
Shannon McDonald *(Virtual)*	FMMN
Emily Nebesny	FMMN
Margie Wood	FMMN
Monique Dube *(Virtual)*	FMMN
Callie Davies-Flett	ACFN
Timothy Bebeteidoh	ACFN

Abbreviations
ACFN – Athabasca Chipewyan First Nation
AER – Alberta Energy Regulator
CST – Coarse Sand Tailings
ECC - Environmental Consultation Committees
EIA – Environmental Impact Assessment
EPEA – Environmental Protection and Enhancement Act
EPO – Environmental Protection Order

ETA – External Tailings Area
FCMN – Fort Chipewyan Metis Nation
FMMN – Fort McKay Metis Nation
IBA – Impact Benefit Agreement
IOL – Imperial Oil Limited
KIP – Key Indicator Parameter
MCFN – Mikisew Cree First Nation
NODA – North Overburden Disposal Area
PAW – Process Affected Water
SIS – Seepage Interception System
SME – Subject Matter Expert
SMO – Sulphide Mineral Oxidation
SO4 – Sulphate
TMR – Tailings Management Report
UCL – Upper Control Limit
WB3 – Water Body 3
WETA – West External Tailings Area

Item #	Topic/Discussion
1	Prayer by Elder – FMMN
2	Land Acknowledgement – IOL
3	Round table introduction
4	**Presentation:** Nathan Pittman, IOL <u>Summary of Discussion</u> FCMN: What is Stantec's role in this conversation? IOL: We have been working with Stantec on the learnings; Dan Yoshisaka is here from Stantec to help support with answering questions. Stantec will continue to work with us on this Project. Please feel free to direct questions to Dan. FCMN: Is Stantec helping with the Quality Assurance or the investigation of the EPO itself? IOL: Stantec is helping with all aspects. Quality assurance measures have been worked on and put in place over the last several years and Stantec is reviewing those measures. We are also sharing these measures with COSIA and DIAC to get their thoughts. It has been a collaborative effort on this project.
4.1	1. Background IOL: Nathan, remind people what NODA stands for?

Item #	Topic/Discussion
	IOL: NODA stands for the North Overburden Disposal Area. It is a placement area for material can't or shouldn't go through the plant; NODA is the first overburden area for the Kearl lease. Overburden materials are comprised of glacial deposits, sand, mud, tills, and McMurray oilsands that doesn't meet ore cutoff. The NODA is where we put that material. It is a large positive relief feature. IOL: We have gone on reclamation tours and have started tree planting. It can be considered a big soil pile with trees on it. We will finish the reclamation this year. FCMN: I have a comment and a question. Thank you for sharing all of this information and providing an opportunity for communities to have input. From a community perspective when we think about lessons learned, we want to make sure that input from Indigenous communities is considered and incorporated into these lessons learned. The goal in my mind is that once this Quality Assurance Project and report is finalized, we want it to be given to other companies to be used as best practices to prevent similar incidents from happening again. The question I have is will we be able to see the record prior to the final report to see what industry has said and potentially the concerns they had? It would be helpful for the communities to understand and provide additional input, whether it's in this workshop forum, written feedback, etc. IOL: Yes. As a part of the sharing sessions, we are gaining feedback. The draft report will address various feedback from industry, and some organizations have committed to providing written feedback. We will respond to their feedback in that report. We will share the learnings and feedback we have received in the draft report. You will see those and have an opportunity to provide additional feedback on that. FMMN: Do you have a particular date when you have to submit the report to the AER? IOL: We have committed to a date sometime in December. We will continue to look at that date as we get closer. I am assuming the AER is going to value more discussion and feedback, so I am assuming those dates may be flexible if required.
4.2	2. Timeline of Events FCMN: At the time when you guys were performing the installation of the ditches, there was a question regarding WETA, I understand you did some assessment at the time? Was that repeated over the years? IOL: I can't speak specifically to the geotechnical assessments that were done. I am confident those studies continue to be done and have been reviewed and analyzed since then; we have a lot of data collection. I am confident with the stability of the dam. IOL: In our third quarter ECC we are bringing in an engineer to talk about dam safety. I'll save your question for that meeting and I can get you a response at our next ECC meeting.

Item #	Topic/Discussion
	IOL: We can say that all four seep locations are a couple hundred meters from the toe of the tailings pond. We have ongoing monitoring of the tailings area for both water quality and geotechnical stability and safety. FCMN: With respect to the plans, I recall there was a containment plan, remediation plan, sampling plan, and one other plan. The point being communities did have the opportunity to review those plans and provide input to Imperial. Understanding those plans evolved over time. We received the first draft of the plans and we got revisions as Imperial learned more. I am hoping our feedback continues to be considered. Thank you for that. From a context perspective, for those communities involved in the Bucket review, we pointed out based on the original EIA the joint review panel suggested that geotechnical work be done on the substrate the tailings pond would be in. I hope that it is included in this is what we learned. Some of the communities here weren't involved in those early days before 2005. Is there any clarity in terms of what that timeline was? For me the lesson was that identification from the joint review panel should have carried on to the final approval, but it did not. Even way back when it would have been good for further studies. I understand risk management. It was a 1/100 chance, but here we are. I hope that we see these things that we identified from bucket 1 included in the draft report. IOL: I am hearing two topics related to subsurface characterization and looking for a greater understanding of what is in the ground. I am also hearing something related to communication. That the communities are responded to and informed of what happens to their feedback. I hope we will address these topics throughout the presentation. FCMN: Thank you for bringing up past input from Indigenous communities, as detailed in the Bucket 1 review. Over the years, we (communities) really try to do a thorough and thoughtful job looking at plans and reports, and we attempt to give recommendations and express community concerns that may arise. I think Imperial going forward is looking at those more critically. They are given to a company for consideration, but they aren't acted upon. A lesson learned and what would be good to say is 'hey, we had communities review, and they did identify elevated sulfates among other things. How are we going to consider and respond to those?' In the future when you get these reviews from communities know we aren't doing it for the sake of an exercise; we do a good job, and we want to help the company. ACFN: Yes, to helping the company, but we also look at it from a rights perspective, Section 35 rights. Parts of our IBAs are meant to do that bilateral process. When we look at it through the rights holder, we are trying to create a space where rights can be brought forward, and concerns can be mitigated and accommodated. Take a second look at our technical reviews like FCMN said, but also remember it is your job. IOL: Thank you. FCMN: Just for background for communities - When a conceptual model and site-specific risk assessment was being done, we had a number of workshops. Communities went back to members and got feedback; whether things got changed on the model is a different discussion. That discussion is being carried over to the other wastewater research project that we are working on with Imperial.

Item #	Topic/Discussion
	IOL: Thanks for that. Prior to the EPO we were hesitant to come forward without having all the information. Since then we have seen a step change in the way we communicate and are now going fully transparent, hopefully the trust has increased as a result and we are in a better place now. FCMN: Suggest you share the entire geotechnical assessment with everyone. IOL: The ECC has confidentiality agreements, will it be in the report where we send information on this or alternate materials based on requests? IOL: Yes, my understanding is alternate materials. *[Break from 11:20 AM – 11:30 AM]*
4.3	3. Seepage Root Cause Learnings and Quality Assurance Plan IOL: Thank you for providing context between 2023 and now. It helps the Project team understand that there has been an ongoing dialogue with communities. I continue to encourage feedback and comments. I appreciate the dialogue and candor. *Seepage Flow Pathways* MCFN: To clarify what I am looking at, are you saying your previous understanding was that water moved across the northeast boundary pretty easily? Now you have a better understanding of where the lower layers are? IOL: In the seepage modelling prior to the EIA the Quaternary was treated as one zone with a single hydraulic conductivity. Since 2022 we installed more wells and what we know now is that there are multiple layers. We have several distinct flow units MCFN: In 2005, is that what you installed your pumping wells based on? IOL: Yes, that is right. We assumed it was all hydraulically connected. By 2013, which was the beginning of active operations, we knew there were baffles throughout there, but the modeling primarily leveraged the borehole data and did not connect these baffles into barriers. As a result we were installing the wells all deep. MCFN: When you say installed the wells deep, what were you targeting to install the wells deep? IOL: The initial wells were put in closer to the bottom of the sand because we thought it was one big sand unit; the sand can be >50 m deep and we used 20-30 m of screen, the assumption was that we would catch any seepage as it entered the subsurface and traveled north towards the lease boundary. Between 2013 and 2024 we worked out that there were these different layers. In 2020 we started working on the updated subsurface model that we continue to build on now. FCMN: Wondering what conservative means in the 2013 knowledge?

Item #	Topic/Discussion
	IOL: It had more to do with the properties they were using for modeling. In 2005 we knew we didn't have enough data density for a detailed model so a single model unit was used and the hydraulic conductivity that we applied to that unit in the model was that of sand. In sand water would flow faster than something with mixed properties so by using only sand properties it was a conservative approach. In 2013 we had more boreholes and the hydraulic properties were populated by material type. At that point it wasn't intended to be conservative but was thought to be high resolution and accurate. With our current model we have continued to update those properties, and using the new hydrogeological information we have changed the model quite a bit. FCMN: That helps explain, I have listened to people saying they have assessed the worst-case scenario especially if I ask for more information. There does seem to be a desire to say and mitigate the worst-case scenario. What you need is accurate information; it seems to be much more complex than what it is. It is not the best way to plan mitigations and preventions. IOL: Thanks, that is helpful. The other thing we have learned is to look at different cases. There were other confounding factors that impacted the mitigation. In 2013 we could have asked the question 'how connected can those green blocks be?' and 'what sort of data do we need to confirm our understanding and see how connected they are?' Testing the different ways, it could look like and figuring out what data we would need to get to test those different scenarios. MCFN: Building off of what I asked earlier with the pumping wells, how did you determine where they would go? There is a seep location at Waterbody 3 (WB3). Was it assumed that water flowed easily there in earlier studies? Or was it assumed it was the geology of the northern and eastern area? How were those locations previously selected? IOL: Early days in the box on the far left, one continuous sand was our understanding and that drove the early well locations and Seepage Interception System (SIS). As we moved into active operations, there was an increase in well drilling density. Two different flow systems were identified on the eastern side, though the layer that separates the eastern side is different than the north. I will point it out on the cross section. IOL: Our understanding of east versus north, was a bit different. We knew in the east there was a clay layer. North is where we saw the one package. The other piece is that originally when we were doing this work, in 2005 we were going to remove Waterbody 3. As part of our EIA, it was supposed to be gone and not a receptor. We made a decision during construction to keep Waterbody 3 in place, and at this stage we have no intention of removing it. ACFN: When was Waterbody 3 supposed to be removed? Our findings say it was supposed to be spring 2022. IOL: No, it was when we were constructing the east tailings pond in 2015. ACFN: From your reports, I read somewhere it was supposed to be removed in 2022. IOL: We can figure out exactly what that date would be later, but it predated 2022.

Item #	Topic/Discussion
	MCFN: To clarify the schematic, this applies to the northern boundary. In the east we understand there was that clay unit. For the pumping wells, how did you select the locations where the pumping wells would be installed along the north side. IOL: I don't have the exact answer, but it was based on the modelling and where it was assumed most likely the seepage would be coming out. MCFN: Thanks. Stantec: The context of EIA, in the early days you were looking at issues across the life of the project. If you are looking at long-term issues, it may not lend itself well to looking at things in the operational time frame. Through the lens of the EIA, it would have made sense to adopt that approach. IOL: We have a few more slides to go through. We do show the placement of the first 7 versus where the first seepage showed up. FCMN: A quick question because the EIA came up. My understanding is you develop your EIA broadly across plans and activities, and you do your best guess because you only have some baseline data and a general understanding. Once you get your approval and prior to your first 10-year EPEA renewal, you have to provide some justification for approval conditions or what have you. I am wondering in terms of EPEA renewal applications, it sounds to me that we are still trying to go through data collection to validate those earlier predictions, if that's the case and we had a better understanding in 2013, I would have assumed it would have triggered some additional investigation prior to the seepage. Initial predictions about what that substrate looks like required some additional thought - Would that not have been the case? IOL: You are exactly on point. There was a lot of work done for seepage modelling and comparisons done on seepage modelling between 2009-2015. When we looked at it in 2018, the model was no longer well calibrated, and it spurred some of the revamp. We started this work in 2020 to compare the model to actual measurables. In hindsight we would do that faster now. We have slides on process and standards, that review processes are needed to drive that evaluation faster. FCMN: That would be great, based on my previous comments I hope this Quality Assurance Project will become best practice not only for Imperial but for the region. You put in your application 3-year data and a conservative approach, and you have to validate that for your first 10 years, that to me would be very helpful. We've got some mines out there that are decades old that have not validated what is in their EIA from decades ago. Getting that in front of the eyes of the AER will make them more diligent as well. If it became a best practice, it would be very helpful for all the communities in their dealings with all the companies. FCMN: This learning. What we actually discussed over the last 2 slides is a lot more than just this learning. In particular, what we discussed was Imperial's assumptions and the use of rules of thumb attempts to simplify issues and guess the worst-case scenario and mitigations didn't work. That is much more important. I hope that the only thing you have learned is not just the underground layers. I am wondering if that would be added as a learning because it would be much more accurate?

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	IOL: You will see that incorporated into those draft reports. IOL: Isn't that in the process discussion? IOL: Yes, I just wanted to double check with Nathan because there are other ways this has been considered. FCMN: Specifically, about the operations. Do not underestimate the geological and geotechnical complexity of this area. For the operations during mining where your in the McMurray Formation. It is quite simple. All you need is sparse data. When you are talking about glacial related overburden. You are missing very important information. Don't be misled about the level of information you need to have for your operations. You need to figure out how to manage seepages. In a nutshell, that is what I wanted to highlight. IOL: Exactly. You may need more boreholes to understand the glacial environment. The level of delineation you need for a glacial environment versus a river environment is different. FCMN: The cost of putting the wells in has been outmatched by how much you have had to do due to the seepage incident. ACFN: When we look at this, we also look at EIAs from all over; we look at one, but all these best practices build off each other. That is important for the generations ahead of us. There are many layers to the importance of capturing these lessons. IOL: It goes to the point of not just hearing feedback, but taking those lessons learned to see how we take the comments and dig into them, investigate, and ask questions to understand where you are coming from. ACFN: We don't have a direct conversation with the AER. We need to be mindful that this is a really good forum for communities to have a voice. FMMN: What was happening under the surface was that the subsurface was different and required a better understanding. For some reason Imperial and the AER didn't find that. The communities identified that. The understanding of the subsurface was not pursued. It was underestimated. It does relate to FCMN's comments about the predictions of EIAs. If those cautions had been reflected through routine intervals, you would have evaluated the cautions. Monitoring and monitoring designs are a big learning, and I think you will get to that. Communities have conducted a lot of really good, deep reviews. If those reviews had been considered in the technical framework, some of those could have been considered as well. In this presentation I am not seeing the feedback we have provided from Bucket 1 reflected in these learnings. I think the depth of learnings are not reflective of the real depth of learnings. I hope they are reflected and considered going forward. We don't want this to happen again, and I hope there can be a revision in terms of the learning and not just limited to this conversation today. IOL: I'm sorry about that, we are listening as you share now; we will take another run at it, we will circulate that draft report. Thank you for sharing those comments.

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	IOL: I will make sure I bring it forward, we have looked at Bucket 1 and the feedback on the site specific risk assessment, so we have looked at it from that lens as well. IOL: If not addressed in the slides, there is the opportunity to provide feedback to us and include it in the final report as well. IOL: I'd like to thank everyone for their openness and sharing. This is a really good start and I hope it will continue *[Lunch Break– 12:25 pm – 1:00 pm]* *Source Characterization and Key Indicator Parameters* FCMN: Clarification question. You are going back and forth between sulphide mineral oxidation seepage and process water seepage. Are you saying that you used the wrong KIPs? And that you missed the SO4? And that the SO4 was not all the source? Are you saying that both PAW and SMO water have elevated sulphate levels? IOL: Both PAW and SMO can have higher sulfates, and we have associated sulphate with process affected water (2018 Groundwater Monitoring Program); however, the concentrations and rates of sulphate from PAW is lower than what we see in the SMO. So though Sulphate is associated with both it is more associated with SMO. The locations where there was seepage have different chemical signatures. WB3 was more of PAW signature compared to other seeps across the northern boundary which were SMO signature. This higher sulphate was indicating we had flow through the dyke, and it was largely associated with the SMO. FCMN: It is hard to follow when you mix them together. In the slide before this one you said that indicators were wrong, but then it moves on to this SMO. Then it just focuses on the SMO and doesn't circle back to the other KIPs. It would be a good idea in this document to separate the two rather than mix them together. IOL: Apologies for that; it is around having the right KIPs to identify seepage. To distill it down you need the right KIPs to tell you when you are seeing seepage flow through the dyke. MCFN: The ground water monitoring plan from 2018, all the east KIPs were listed, how were the KIPs looked at if they were already being considered as a part of the ground water monitoring plan? At the time sulphate was not considered seepage, but yet it was in the groundwater monitoring plan? What was the mechanism as it crept up, were people still considering the SMOs. Was there any additional drilling to delineate the potential source. IOL: It was an evolution, prior to 2018 the response plan didn't have sulphate as a KIP, we had no understanding of the SMO reactions. In 2018 sulphate was added to the KIP for process water, and it had come up in a number of monitoring wells, but because we didn't see the other KIPs it was thought of as an in-situ geochemical reaction. Over the years, more studies were done. The first study to look at the increase in sulphate was done in 2018, looking at the source on the northern lease boundary. Four different potential sources were suggested in 2018, PAW, SMO reactions, water mixing, and gypsum dissolution. Though SMO was identified it was proposed as a result of the overburden and not through coarse sand tailings

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	(CST). The first flag for SMO potential of CST was study work kicked off in 2019-2021 that helped our understanding. FCMN: I know that a lot of the people at Imperial now haven't been around as long as some of us. I want to point out in my review of the 2018 TMR, I mentioned that sulphate was increasing at these wells, and I wanted to know why it wasn't an indication of PAW. I was told the focus was on chloride, chloride would arrive faster and before sulphate because of that conservative approach. In my review of the 2019 TMR in response to Imperial saying chloride is a better tracer, I mentioned the chloride concentration was very low at Kearl. Not only is it low, but it is close to what we see for surface water and here I am. I feel like history has been rewritten in terms of mistakes that were made. The KIPs should be made based on the chemistry of the source water. Talking with Imperial years ago it was chloride and when the communities specifically asked about sulphate, they were told 'no we're waiting for chloride.' At a basic level you should have looked at tailings water to choose your KIPs. It seems like it was out of your control, but I think it was a pretty major oversight. I was looking for some mention of that mistake and I don't see it here. I am looking for acknowledgement. IOL: Chloride was also brought up in our EIA as well. Seepage was always expected, some amount was expected to go off lease, and chloride was the tracer. We agree with you that sulphate was not on the list. We were not looking at that change. We weren't looking at what our tailings water was telling us. It has changed now with our geochemistry study; it was based on what the chemicals are in the water that we have and what can we recognize in the water. We recognize that and it will be said in the document, I wish I could rewind time and get back to that date in 2019 and wish we would have listened to that perspective from you. *Communication* ACFN: Thank you for acknowledging that we need to communicate better and communicate before things happen. It's not just because you didn't tell us, you need to be able to take into consideration our warnings in our technical reports in order to prevent this from happening. Communication goes both ways; we are trying to reciprocate. It is a major learning, and it hasn't been acknowledged yet. We have been telling you and this is probably a good place to put that. IOL: In the process section we discuss having dialogue and capturing those learnings you provide to us. I fully appreciate communication being a two-way street. ACFN: This learning is reading very one way. What you are saying is great, but we need that two-way dialogue. FCMN: ACFN did a good job explaining. Yes, our voice is technical, and it should be heard. Many of the professionals sitting here have experience as operators and as multi-discipline reviewers. We are reviewing coal, oil sands, dams. We have experience and know this. These are professionals that can help you. In many ways Imperial is failing in those consultations. It makes the most sense to use us. FCMN: ACFN, you hit the nail on the head, it is a two-way street, this is learning and having that as learnings and having best practices that's what I want. It is super important. Imperial, you have been pretty open. You are sharing data with us when we ask. You are understanding

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	our rationale when we ask for things. That is appreciated. On the flip side. It isn't just us providing the information. Primarily we want to help you. Communities find SMEs that are the best in the country, and we take a lot of pride in that. It is about the communities' rights as well. We are very selective in who we have coming to the table to help come and represent communities' key concerns and translate that into technical information related to their expertise. Key learning here is that it has to be a two-way street. That should be front and center. It would go a long way with the communities and the AER and those who will be more broadly reviewing this report. MCFN: Related to source water characterization. Gillian mentioned that measures will be taken before KIPs reach the UCL. Will you be adding this in your QA report? And detail what that looks like? Essentially, I'm hoping that going forward, I'm hoping for a more wholesome look at the groundwater results for KIPs and WLs to avoid another incident. Additionally, as FCMN mentioned, KIPs should be tailored to the source water. I think I heard there's a geochem study to establish this. Will the geochem study be revisited every few years to assess any changes in the source water geochem? If not, will it be done under a separate umbrella such as the tailings management report? IOL: The Quality Assurance report will discuss the important leading indicators, including KIP's and water levels. Maintaining an up to date understanding of our sources as they change or evolve through time is an important aspect of Quality Assurance and will be covered. Specific triggers and actions to be taken will be discussed in the updated Groundwater Monitoring Plan we will be doing this year. *Standards, Processes, and Administrative Controls* FMMN: The amount of effort that goes into community's technical submissions to you for multiple years, seeing those comments and recommendations, and seeing those considered in a deep and thoughtful way and actually evaluating those comments, there was really great information through multiple reports on KIPs on monitoring. That resource to you was not considered. I'm not saying you need to adopt all those recommendations, but there were lots of really great recommendations that were not considered. It is technical info from other sources that is available to you. It is about considering those technical submissions when they are provided; you wait for those and manage your documents, and somehow, we need to find a better way where that information can be considered before you submit or finalize. There is great information in there, and it is a great resource that should be considered. That is something I would like to see as an improvement as well. IOL: I think you will see it reflected in the learning but not as strongly as you put it, we really appreciate the way you phrased that.
4.4	4. Moving Forward IOL: If you have any other feedback you want to provide, we are looking for written submissions before August 8, 2025. To put into a draft report and get it back to communities by November, we will respond and incorporate the advice we get from this session and the next. We have December on here as finalizing the report but depending on how it goes it may take longer. This specific Project will end, but this isn't the end of the conversation.

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	FCMN: Thanks for that Nathan, based on the conversation we had, and I appreciate getting a draft report in November for submission in December. I would request that Imperial thinks about a working session once the communities have provided additional information. I'm thinking August is our plan to have a draft of the Bucket 2 review, and you can use that feedback as well. It would be really meaningful to have some sort of a working session before or when the draft is done. A meaningful exchange. My fear is that we will get something in November, and we will all be rushing, the demands on the communities will be crazy. I don't want this to be a rushed process, not time to make substantive changes or questions or clarity and interpretation. Somewhere in that timeline can we include a 'hey, let's get together, let's discuss this well with communities.' I am putting a lot of stock into this report and ACFN mentioned we don't have an opportunity to talk to the AER in as much detail and even if we did, I don't think they have the expertise and understanding when it comes to communities. Building out that timeline to have a really good conversation with community. ACFN: Once the report gets into draft form, there is an anchoring bias to their work. We are looking for a collaborative process, and we want to collaborate before it becomes a baby that you don't want changed. IOL: We are trying to do better as Imperial to make time and space for that. We have done a good job over the last 8 months. It's understanding where does a workshop fit into in the process? Internally we have processes we need to follow, for release of technical information for external reviews and it can be challenging to maintain deadlines. Sometimes we get so much feedback that it becomes a resource demand. I think our heart is in the right place, but there are constraints sometimes. ACFN: I think so, multi-community reviews and a standard way of communicating in order to be able to help drive this process better, we can work on it too. Different Project Managers may communicate differently. I recognize that different consultants also write differently. IOL: We can look at that and try to find the right approach to get that done.
5	<u>Closing Prayer</u> Closing prayer from Elder *[End of meeting: 2:00 PM]*
6	<u>Action Items</u> • IOL to consider a third working session to discuss draft report with communities and gather/incorporate additional input prior to submission.
	• IOL will share the learnings and feedback we have received in the draft report. The Indigenous communities will see those and have an opportunity to provide additional feedback on that.
	• IOL will bring their engineer to the third quarter ECC meetings to discuss dam safety. At this meeting the engineer will respond to FCMN's question: o FCMN: At the time when you guys were performing the installation of the ditches, there was a question regarding WETA, I understand you

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	did some [geotechnical] assessment at the time? Was that repeated over the years?
	• Imperial to re-review the ACFN/MCFN/FCMN/FMMN Bucket 1 findings as well as the feedback on the site specific risk assessment to contribute to the report in a more thorough way.

A.2 Community Meeting Notes, July 7, 2025, Imperial Final

Imperial

Community Meeting –Imperial Oil Limited
EPO Quality Assurance Project Meeting

Date	July 7th 2025, 10:00 AM – 2:00 PM
Location	Chez Dube Country Inn - 10102 Fraser Avenue, Fort McMurray, AB
Purpose	Share and discuss lessons learned from the Kearl seepage release incident and gather feedback on Imperial's quality assurance plan for seepage monitoring and mitigation processes.

Attendees	Organization or Identifier
Nathan Pittman	IOL
Colson Foster	IOL
John Tuttauk	IOL
Sarah Theberge	IOL
Duane Rose	IOL
David Earle	IOL
Robert McNally	IOL
Michele Perret	Stantec
Zoe Rezac	Stantec
Dan Yoshisaka	Stantec
Kaylee Welsh	Stantec
Anne Simpson	FMFN 468
James Woodward	FMFN 468
Jennie Cockerill	FMFN 468
Rochelle Young	ML 1935
Gillain Donald *(Virtual)*	ML 1935
Allen Hansen	ML 1935
Kyle Boomstrom	ML 1935
Ryan Abel	FMkFN
Dennis Shott	FMkFN
Bruce Jr	FMkFN
Dan Stuckless	MCFN
Bilsen Xavier	MCFN

Abbreviations
ACO – Aboriginal Consultation Office
AER – Alberta Energy Regulator
BOD – Biochemical Oxygen Demand (Associated with PP6, water analysis parameter)
CST – Coarse Sand Tailings
COSIA – Canadian Oil Sands Innovation Alliance
DIAC – Dam Integrity Advisory Committee
DP4 – Drainage Pond 4

ECC – Environmental Consultation Committees
EIA – Environmental Impact Assessment
EPEA – Environmental Protection and Enhancement Act
EPO – Environmental Protection Order
ETA – External Tailings Area
FMFN 468 – Fort McMurray 468 First Nation
FMkFN – Fort McKay First Nation
IBA – Impact Benefit Agreement
IOL – Imperial Oil Limited
KIP – Key Indicator Parameter
ML 1935 – McMurray Metis 1935
MCFN – Mikisew Cree First Nation
NODA – North Overburden Disposal Area
OSCA – Oil Sand Conservation Act
PAW – Process Affected Water
PP6 – Polishing Pond 6
SIS – Seepage Interception System
SME – Subject Matter Expert
SMO – Sulphide Mineral Oxidation
WB3 – Water Body 3
WETA – West External Tailings Area

Item #	Topic/Discussion
1	Prayer by Elder – FMFN 468
2	Land Acknowledgement – IOL
3	Roundtable Introductions
4	**Presentation:** Nathan Pittman, IOL Summary of Discussion
4.1	1. Background MCFN: Are you going to provide a high-level summary of what your takeaways have been from the community to date? IOL: No, that is not the focus for today. Today we are presenting the root cause failures of the seepage incident. Some community feedback has been incorporated in our root cause learnings as you will see in the presentation. MCFN: Why isn't there a section on what you have heard from the communities? That is the most important part, isn't it?

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	IOL: Our intent is to capture feedback from the communities and incorporate it into the report. We have tried to capture the feedback so far and incorporate it in the learnings section that I will present but that is a fair statement. As we write the final report, we will highlight the feedback received and how it is reported. Stantec: There has been some feedback already, but the reason we are here today is to generate more feedback. FMFN 468: Are you saying our feedback will be in a table, showing what we heard, and we will be able to go back and see how our feedback has been used? IOL: Yes.
4.2	2. Timeline of Events FMFN 468: Was this area mined before it became a tailings area? IOL: No. FMFN 468: In May 2022 who identified the orange surface water? IOL: We had a consultant doing some ground water sampling and they noticed the orange water and notified us. FMFN 468: It was 6 months later when you determined the source of the water. Why did it take so long? IOL: We wanted to be certain of the source; we were doing geochemistry studies. The three northern locations had taken more time for us to become certain it was industrial wastewater. We were trying to wait until we had all the answers. That was a mistake. FMkFN: In August the EPO confirmed the quality of that water was consistent with industrial wastewater. IOL: That was for the WB3 one, there are 4 locations. We will address that when we come to the map in the next slide or 2. FMFN 468: Are you having sessions like this with industry? Are you reviewing the same information with them? IOL: Yes, we have held two so far: DIAC on June 10 and COSIA on June 12. There is the intention to circulate a draft report later in the project. FMFN 468: Are other operators using the same materials to build the tailings pond? IOL: Many oil sand operators use similar material to build their tailings ponds. Each site is unique, and Kearl is unique as well. Some of the observations we are making at Kearl are unique. Generally speaking, tailings ponds are constructed the same way.

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	FMkFN: How did you start filling the tailings pond? Do you just free pour? Do you follow what other companies do? I worked for Syncrude, and I worked in tailings for 18 years. Imperial has never used any liners in their tailings ponds. IOL: For Kearl, the foundation is prepped different depending on where you're looking. Some areas had more preparation work than others. The areas were cleared prior to using that CST. In terms of lining, there is no geosynthetic or plastic liner that was used in the tailings area. The clay particles tend to seal off the bottom of the structure. Similar to observations made at other tailings facilities as well. Around the perimeter of the dam, it is prepped similar to other tailings ponds. FMkFN: On a free pour the higher you go the more the pressure will increase. IOL: The original design incorporated the elevation of the tailing's facility, including the seepage management. We can see where things went sideways and what we needed to do differently in managing the seepage. There wouldn't have been many changes to the original design but now in hindsight we would have changed the monitoring. FMFN 468: You are hearing that operators use similar methods to build tailings ponds, therefor it is plausible this could happen to other tailings ponds. You may see a recommendation come through for this to be examined on other ponds that are already built. The concern is that what has been noted in one may be happening on other tailings ponds as well. The reality of how people feel, is it's good to use lessons learned for new tailings ponds but the concern is with the ones that are already built. IOL: The intent of sharing this project out with industry is to share the lessons learned. IOL: The application of these learnings can apply to future tailings facilities, but also to the existing ones as well. FMkFN: Are the pictures on the bottom corner of the slide showing orange? IOL: Yes, that is what we wanted to highlight, that not all orange water is industrial wastewater. FMkFN: When the water comes up, then the water drops, it leaves that behind. I see that stuff all the time. ML 1935: Why didn't you start sampling right away? Why did it take so long? It only takes a week to get water samples back. IOL: That is one of our learnings that we will get to. Our definition of industrial wastewater was not well defined. It wasn't clear to us at the time. WB3 was industrial wastewater because it had the classic indicators. We wanted to be sure that the 3 spots in the north were also industrial wastewater, as they didn't have the obvious indicators. The next slide shows some of the actions that we took to identify the orange precipitate.

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	ML 1935: Wouldn't you have samples documented previously of animals, plants, etc. If you had a leak, would you not you just compare the data? It took you 6 months to take any action, why the delay? IOL: One of the challenges we had, and it is evident looking at the photos before the incident, is the chemicals in the water also occur naturally. It is the same chemicals that are causing the orange discolouration also occur naturally; so it wasn't apparent that it was being caused by the operation. The team was working through the process of how the orange discoloured water arrived at the new locations. We have the benefit of hindsight now to say that we didn't move through that process fast enough. They were trying to determine whether it was natural or from operations and it was a difficult assessment. We do have extensive soil and wildlife assessments prior to disturbance. I am not sure if we had that level of resolution to make comparisons. ML 1935: 6 months is too long. You could have just taken a sample. IOL: We were taking samples. The same orange chemicals we were finding were also found in the Muskeg River as being naturally occurring. ML 1935: You never sampled the water, you waited. IOL: We did do sampling; we didn't wait 6 months. I don't have the specifics of where exactly we sampled. There was surface water sampling and new wells were installed for groundwater sampling. FMFN 468: Some of us are land users, we are trappers. Was there an attempt to determine how long the tailings pond was seeping and what the extent of the seepage was? IOL: We apologize. Our communication wasn't great. FMkFN: Why does the communication happen like this? You should be following and learning what the other industries are doing. Communication is the number one thing that can help with the safety of land users and trappers. The AER $50,000 fine is not enough. You made three point something billion in the first quarter, that is a lot of money. I have never seen that orange water before; I've worked for tailings; it is not natural. My friend from McMurray Metis works for tailings and says that is not normal. Let's be truthful. Don't just sit there and say yes, yes. We are very well educated. FMkFN: My trapline is just down from Dennis. We are respected. Before all this, we were drinking the water right from the Firebag River. Our grandkids went swimming there. FMkFN: The water from WB3 goes to our land and the Firebag River. Let's be honest and be truthful. I know you Imperial workers are in Calgary. We live here; all of our kids live here. We are concerned for the future of our kids. So just to give you a heads up, this is not our first time. Stantec: We appreciate you mentioning that you would drink water from the Firebag River. FMkFN: We do not drink from there anymore.

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	IOL: To answer your question in terms of the extent of seepage, we don't have an image of all the monitoring wells in this presentation. There are wells about a kilometer from the lease. We missed some indicators earlier on. Our understanding of what comprises industrial wastewater and our indicators have changes. There are other markers to indicate seepage. MCFN: Did you measure the depth of the soil where the seepage was, and how long did it effect the land? How long has it been leaking for? My question is that in May 2022, when the seepage was discovered, when was the last time you did the monitoring that same year? How long was the seepage there before it was discovered? IOL: I don't have the specifics of the last time we did a surface analysis in that area. It is routinely monitored, so within months to a year, this was the first time it was noted. We will walk through some of the subsurface information in later slides. ML 1935: With the 3 purple dots showing the seepage areas on the map, can you describe the land features around those areas and if there is anything in common or specific to those areas that would allow the surface water to create that precipitate there? The second question is whether there is anything on the seepage collection system on the northern boundary that would enable the water to pool like that? IOL: That information is coming up. Can we hold and then circle back to make sure your questions are answered? ML 1935: Yes, that is fine, as long as the questions get answered. FMkFN: How many wells are there in total now? IOL: There are around 900 now. Since the incident we have drilled about 600. Before the incident we had about 200. FMFN 468: Before the incident there were 200? IOL: Yes, we have significantly expanded our ground water monitoring network, and we will get into that in later slides. FMkFN: Did you find anything in the Firebag River? How far is the closest well to the Firebag River? IOL: It is about 2 km. There is no indication that seepage made it into the Firebag River. FMFN 468: Where would that be on the map? IOL: There are more wells north of what is in this map, so it cuts off on the map here. ML 1935: Why haven't you done anything on the south and west sides, only focusing on the north? What makes you think it isn't leaking over there, if it's a flaw, why wouldn't you be concerned about the whole thing?

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	IOL: The first reason is that there is a mine pit on the southwest, it will intercept any seepage in that direction ML 1935: The Muskeg River runs through there too. IOL: Yes, the mine pit is in-between the tailings pond and the Muskeg River. The open mine pit will intercept any flow towards the Muskeg River, as it will run into the big open whole excavation. Similar, we will have a mine pit on the south side as well. These two big mine pits will intercept the flow. The geology is different as you move to the south and southwest than there is to the north. There is more material in the north that water can flow through and seep. What is in the ground controlled where we are seeing seepage. There are 2 things: the mine pits and what is in the ground. ML 1935: So, you are not concerned about the southwest side because of the mine pit, is that what you are saying? IOL: Yes, the open pit excavation will intercept any flow. MCFN: What is the minimum distance between the most concentrated points in the wells? IOL: 50 meters or less. FMFN 468: If you found a seepage in the south boundary, would you be required to report it if it is on lease? IOL: No. ML 1935: What do you mean when you say investigation and response actions? IOL: The wells that were drilled since the incident that we have done in response to the seep. It is just the terminology that I've used to break it up. FMFN 468: If you look back at your timeline. when was the first public communication that went out? Was that the AER, or the EPO? IOL: We shared it through emails to the ECCCs, but it was not public until the AER issued the EPO. *[Break from 11:10 AM – 11:20 AM]*
4.3	3. Seepage Root Cause Learnings and Quality Assurance Plan *Seepage Flow Pathways* FMkFN: How deep are the boreholes? IOL: The depth varies around the ETA, all the dots on the maps are deep boreholes, which are up to 90 meters deep. I removed the shallow ones as they don't go all the way to the deep flow path.

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	FMkFN: Why aren't there more wells on the outskirt? Why are there more well holes in the south area when your seepage was in the north? IOL: We are focused on capturing seepage before it leaves our lease. Most of the seepage has been found along that northern lease boundary. Prior to the EPO we were focused on our internal seepage, and we didn't have seepage on the north side of that line. We are learning more about the sand qualities and how far the seepage could extend to the north beyond the lease. FMkFN: Is there anything different for the wells inside the tailing ponds? Aren't you creating a nice pathway for seepage or you are relying on the seepage interception system? IOL: There would all be backfilled with impermeable material to protect from that seepage. ML 1935: It doesn't stop it altogether? It could move slowly and continue. ML 1935: What kind of stratified rock is there? IOL: In the north it is a glacial till that separates the two flow units. That is a very compacted mix of mud, silt, rock compacted together – it is what is called lodgement till, which forms when a glacier advances and grinds the materials together. At the time when these deposits formed there was a glacier about one kilometre high and that kilometre of ice pushed down and compacted that till making an impermeable layer. Other areas like WB3 have a clay layer that is causing the separation. The material type causes the separation; it isn't the same everywhere around the lease. ML 1935: Is it possible to provide a description of the landscape along the boundary? IOL: Yes, on the next side. MCFN: Are you saying from the surface then, the tailings pond sits on the yellow box. And water infiltrates the yellow box then will hit the green boxes and that is the pathway in how it moves out? IOL: Yes, that is correct. MCFN: Community concerns from way back. Looking at the 2005 superimposed. Prior to any footprint, with the natural landscape you assumed it was a sand layer. You assumed it was a sand layer it was in your EIA, correct? IOL: Yes. MCFN: At the time the communities raised the concern of the site. On one hand you assume maximum drainage. You put your collection system in. Community raised concerns about proximity to the Firebag River, that was a main concern. Now that you know the data that should have been required prior to putting the tailings pond there in the first place – is that not a concern itself? What is the engineering data? That is an awful big decision to be made with no data, where is the consequence for that decision?

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	IOL: That is a fair point. MCFN: That is not related to the EPO. At Kearl in 2005, when those decisions were made, I understand that you all might not have been there, but someone made those decisions. This was probably avoidable. That is why we have heartburn – because this was avoidable. Dennis and Bruce brought this up earlier. A lot of operations have occurred on the west side of Athabasca by other operators, and they have 40 years dealing with this. Stantec: Does this relate to FMFN 468's point earlier, on being related to the fact that these tailing ponds are existing now and need to be monitored? MCFN: It's not monitoring, it is more a lack of data that has created baseless assumptions and the level of standard that allow for decisions to be made on crappy assumptions. There has been no accountability for those decisions, that is the frustration I hear. The use of this model, and that the AER signed off that this is appropriate. Stantec: At the time the potential complexity of the subsurface was recognized, however they overestimated the amount of sand. Knowing what the complexity is now, it did lend itself to miss that complexity, and there is a different pathway. At the time it was a more conservative basis for design that didn't pan out in the end for subsurface pathways. MCFN: I don't disagree. If it truly was an anomaly, then it is an oops and a mistake. At that time Kearl was poaching operators and staff from other oil sands facilities. This truly wasn't an issue for the other operators then we can wait and see what the learnings from other operators are. I can't get over the fact that this model showed this amount of data then clarity comes 19 years later you find out that this is not the case then what do you do? IOL: We are trying to share this learning with other operators. If you look at 2013, the data was there, we needed to connect the dots. but the overlays are what helps tell the story to identify cases earlier. How do you put those different cases together earlier, and what data do we need to figure out the real case? MCFN: If that tailings pond had been lined, would you have experienced this issue? IOL: No. If you have an impermeable barrier then it would stop things from flow and seeping. A liner may help with PAW seepage -such as was found near WB3- however SMO that results from precipitation flowing through the dyke and reacting with the pyrite in CST would still occur even with a liner. IOL: I have done work with landfills, and they all have these liners and they all leak. MCFN: What is the fail rate? IOL: 100%. At some point they will all leak. It is construction and installation quality that effects it too. FMkFN: The more you fill the tailings pond, the higher you go, the pressure will increase.

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	MCFN: From an avoid-ability perspective, you bring it back to the core principles avoiding the impact in the first place. Choosing not to line is one measure that Kearl decided not to do. That is a failure of the duty to consult. It's a choice, an obligation that has not been met. There is a lot of frustration around this incident, it was avoidable at least in theory. All those things we have heard in the past, not using a liners, not all measures were implemented to keep the Firebag River safe. That was a major concern of the community when this was proposed to being constructed. Kearl was not bound to the principles of the duty to consult. FMkFN: I disagree that the seepage was the root cause. There was not enough data collected to properly design a seepage interception system. The fact the seepage went through isn't the root cause it is the symptom. IOL: When we look back with the content we have now, as of 2013 we could have made the case. The feeling was that the modelling at the time was on the cutting edge, really detailed version of what was in the ground. But in hindsight, when connected with other data it gives you a better idea and we need to put the cases together. FMkFN: It isn't the data; it is that you didn't understand how to build the model properly. IOL: Fair point. ML 1935: Along the north boundary, I assume there is seepage collection along there. The water flowed through the yellow pockets close to the surface and bypassed the seepage mitigation system. IOL: Yes, that is right. I'll come back to part 2 of your question. FMkFN: Are there tailings that sit on top of this monitoring network? IOL: Yes, this is kind of on the side. This is 2 dimensional, but there is a 3rd dimension that does connect to yellow. The pond can drain down and exit toward the north. The green is non-porous. FMkFN: Is there movement around the perimeter of the dyke? IOL: A little bit. On the west side it is static at that elevation. On the east side we have another few lifts. FMkFN: It just gets heavier the more tailings you pour in. Do you have a plan if the dyke fails? IOL: We have an emergency response plan, and an emergency preparedness plan. We do have plans today in case of that kind of event. We have done work on the perimeter to build a toe berm as a contingency. MCFN: How deep have the chemicals been treated, and what is the extent of the spread of chemicals? IOL: We are seeing two different pathways out from the tailings areas. The extent – the shallow stuff is close to the lease boundary.

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	MCFN: When was the last monitoring done in the same area before May 2022? Any pictures and data available of the same? IOL: We do routine monitoring. I don't have the information on monitoring here with me today, but we will follow up on the exact frequency of the monitoring programs. MCFN: How routine is the monitoring? IOL: There are different monitoring networks. We have surface and ground water monitoring, compliance, and other programs. They are on different frequencies. We are currently working on updating our monitoring plan. MCFN: Did you find out the volume of chemicals leaked in that areas of seepage? If yes, what did you find? IOL: We don't have the volume because it is difficult to calculate a meaningful number. Variations in the hydrogeology such as porosity and hydraulic conductivity along with changing water levels make it very challenging to calculate. Unfortunately, we don't have that detail. MCFN: How long was it leaking before May 2022? IOL: It was identified during routine monitoring. When looking back we don't see anything in earlier air photos. We think we caught it early. FMkFN: Is it clear how deep you are seeing contamination down into the system? IOL: It has to do with the glacial till, the green area, is not the same across the whole site. As you go south, about halfway through, you lose that glacial till, so they are connected completely. *Source Identification and Key Indicator Parameters* FMkFN: We don't call that water – the water in the tailings pond – that is not water. You cannot drink that. ML 1935: There is silica content in there. FMkFN: That is gross. All the stuff that is in there, you can't call that water. FMFN 468: Maybe the problem is that it is shown in blue on the slide. Is this sand that you extracted in the process? And the sulphur is a compound left in it? IOL: That is exactly right. It is in the ground when we go to mine it. FMkFN: When you look at aerial photos. There is a lot of water and flow in those toe drains. It is a rusty color.

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	IOL: The first photo I found of orange water was in 2016. What I would highlight is that we didn't see the other markers that we would have associated with seepage. We were looking for the other indicators. Though we saw sulphate come up, we didn't see those other key indications. We didn't understand that it was a reaction happening as the water was moving through the dyke structure. From 2019 through 2021 we did a field bin study. We took coarse sand that had been sitting for some time, it was initially high then in 2 years we saw that depleted. We also took new material and saw there was elevated sulphur for some time. FMkFN: You didn't see the other 5 indicators that you expected? IOL: I haven't looked at each and every well. But generally, we were not seeing the markers associated with process affected water. FMkFN: How long were you monitoring? IOL: We had about 200 wells that were in the lower (deep) layer. Some of these wells had been monitored since before tailings deposition. More monitoring wells were installed as operations progressed. FMkFN: How do you monitor now to keep up with seepage? IOL: Earlier it was once to several times a year. Now there are various seepage frequencies for monitoring. MCFN: Is 'start up' the start of mining overburden? IOL: Start up is the start of pouring tailings. ML 1935: I have a question about slide 21. You went through the evolution of understanding seepage through 2013-25. You went through the ground layers too. I think the learning here is much bigger than that. The learning is that the assumptions in the EIA were incorrect. The seepage and pond were designed based on incorrect assumptions. Are there any learnings to inform EIAs or investigate at other facilities. It seems like the ground water impact assessment that was done for the EIA – all those predictions were incorrect. Is there the idea that a new EIA will be done so that the communities can understand what the impacts are? What role does the regulator have when approving projects that were designed on assumptions that were wrong? That needs to be incorporated in here because the AER has to respond to making a decisions on data they had at the time, that turns out to be wrong and then has major environmental responses. IOL: You are speaking to data standards. It is site specific, and it matters what the geology is. At our tailings pond we needed more. It may be challenging to apply industry wide. I can't answer the AER component. MCFN: That is the kind of feedback that needs to be explicit. You need to tell the regulator that they screwed up. If this report comes out and our feedback is in there, then we can point to it. We are great at writing reports that include recommendations that are never acted upon. It is important for that to be explicit in that report.

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	FMkFN: Will the report have more than one root cause and more key learnings? IOL: These are the highlights, there is a lot of detail that is not addressed in these slides. FMkFN: The capacity that the AER has, they don't have the capacity or expertise to verify the models the information brought before them. The AER needs to improve their capacity to validate and verify that the models and data can catch things before they approve. They need to do a better job. MCFN: ML 1935 did a good job explaining. I think generally, this also needs to speak to informing directive 85, tailings forums, and life of mine, bureaucratic work. This informs participation in those as well. Cascading it down to importance of those directives on why this is such a big deal. This largely informs the reassessment side but also the implementing of those approvals and at the very minuscule side of things, we aren't getting to that level of detail industry wide. We are communicating into a void with not a lot of change. *[Break for lunch 12:30 PM - 1:00]* *Communication* MCFN: There needs to be strategies depending on who you're communicating with. I don't think it is the biggest issue. I appreciate Imperial communicates and provides updates, but its as if we're still aliens. Most communities have IBAs with Imperial, we should be able to communicate staff to staff and fairly and efficiently. In the oil sands in the last 20 years, the communication has been very 'publicist'. It is harder to form an opinion when you don't have the data. I feel like someone is evaluating the risk for us, and it makes it really hard to get to the issue. We need to get at root issues. When a risk is being managed for you, or communicating guidelines you know the communities don't support, there has to be a lot more direct communication. If your goal here is to improve communication and the relationship, then there needs to be some honesty here. When we don't have full access to the information, it is not helpful, it raises more questions. Again, getting filtered information, its not always helpful. We want the actual facts of what is happening not the public relations communications version. We appreciate when we get the unofficial information through Colson and Sarah. Not all issues are going to require communication, regular operational issues continue to occur. You should have a variety of tools in your communication strategies. IOL: I would like to hear an example. We have tried hard to strike a balance at the ECCs to share data and speak to what we can within the time that we have rather than inundating you with data. We have tried to be honest even when we don't have all the answers. We have asked how we can provide information better for you to share with your community. If you have suggestions, we are open to them. We have made mistakes in the past. In the last year we have been open and honest. MCFN: This is not an attack on current practices, the information you provided at the last ECC - that was excellent. What I am talking about is the 'in the moment' compliance communications. In the issue with the flaring incident, there was a number of assumptions I made about the types of hydrocarbons being flared off. I assumed and you confirmed it. That was the end of it for me. You went and checked and provided the information back – and that was great. It is better that you can provide access to environmental information when there is

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	crisis communication. I like getting access to environmental people on call because you aren't getting it filtered through a communications person. Your ECC reports, yes, that's great it's different than having crisis communications. It is going to be a case-by-case basis, and it will vary community by community. Downstream communities may be more sensitive to the water issues. They will likely want more than just the cookie cutter stakeholder emails. IOL: For a notification we have a template for question and answer of items we think might be valuable to include. What and how were environmental receptors impacted. Let us know if you have common questions and we can add it to our list and start to pre-emptively answer through notifications as well. MCFN: Southern PP6, there was a question that was missing – what the time frame between the time of water being released to the time it has been tested was. There is a gap where there may be non-compliance. It is one thing to know what is happening, but there are also different questions that staff are being asked by land users, that is different than your standard templated information? Anticipating those questions would probably help. IOL: I think we intend to do that in most cases; the notifications are trying to get information out the door quickly. Get it out soon as possible while knowing there will be follow up questions. MCFN: There is a quote from the World Health Organization – precision is like the opposite of perfection, something like that. That if you wait and wait until you're comfortable, it is already too late. It's the case here, if you can communicate with accountability, even if you don't have all the answers, it is better. We don't expect perfection. We have Impact Benefit Agreements with you that allow for information sharing, there is an acceptance there will be development. IOL: Good point, I think looking back at the PP6 notification incident. The notification went out quickly and we didn't have all the information, but we wanted and tried to fill out all the gaps at the next meetings. IOL: We do have agreements, you are right. With the ECCs we have more trust and improved relationships. We want to get the right message out. We were afraid of the wrong message blowing up into something causing a lot of concern. We don't want to raise concern where there is none. Transparency is the way to go. FMkFN: Awareness is number 1. Tell the people 'hey we have this problem'. Let the people be aware of it. There is something happening, but I want to let you know we are working on it. We don't want to be the last to know. Awareness is a big thing. Even the simple things. IOL: We have learned that lesson. FMkFN: Right now, its fix as we go. You can't keep fixing as you go, people are getting tired of it. MCFN: You are dealing with a diverse group, there is not a one size fits all. Maybe you do need to split it up. Maybe you have different levels of trust and relationships. That needs to be a factor. If you have different levels of trust and relationship in the community, I don't want to be subject to someone else's limitations that will impact the level of information you provide.

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	Relationships - that needs to be a factor. When you have longstanding relationships that you trust then you can change your approach. My expectations are high, likely higher than what most communications people would like. FMkFN: Since there are trappers in this room, you need to say communications with trappers and land users. On certain things when there is an important finding, you should have leadership to leadership communications. It is an important practice. MCFN: On the BOD Issue, our leadership received information through unofficial channels before we heard it from you. If it is going to hit the compliance dashboard giving us a heads up. It would be good to receive the heads up if you are going to hit the compliance dashboard. Those issues can be emotional but if we know about it, and we meet and are well informed, we can have a briefing note waiting. There are other people who spread information through unofficial channels, and you have to get ahead of it through the official channels. IOL: Great feedback. We don't know how communication disseminates through your office. We try to strike a balance of who do we need to send it to. There are varying degrees. For instance, the BOD was minor compared to seepage. When we send out a communication, we send it to ECC reps. If there is anything we can do to help support, you let us know. FMkFN: When you communicate with us you can say that you have also provided this to leadership. A courtesy heads up would be good. If it has been flagged as going to leadership then we can do some work right away. MCFN: Be prepared for it not to be perfect. There will be a level of imperfection. As staff we know we will be yelled at regardless of how many avenues you try to communicate through. IOL: Thank you for the feedback. *Standards, Processes, and Administrative Controls* MCFN: Is this a result that is part of the Quality Assurance Project or is it a principle at Imperial now being applied to seepage? IOL: We have a robust process that is company-wide. What we are looking at is enhancing those key process areas with the quality assurance learnings specific to seepage. MCFN: So, it is completely self-derived? On slide 8 it talks about the AER terms and conditions. Did they offer any parameters around the scope of that? IOL: They had indicated some items but broadly speaking they left it to us to develop the proposal and share our key learnings here. MCFN: There is a huge concern, that the conversation happened between AER and Imperial. That was not a conversation that happened with the people, its land users, trappers, etc. Those people. To have that conversation without knowing what is important on the people's side – that is a mistake on the AER's part. If they told you what to do, we would like to see that. In 2022 and 2023 we were meeting it the AER quarterly and it is less now. This is the first time that I have heard they have given you any direction.

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	IOL: We can happily distribute the AER terms and conditions to you. We have received a fair amount of feedback. Broadly through some of the previous discussions, we felt it was enough to get us started. MCFN: You have that information? IOL: Yes, it's highlighted at the start. In terms of incorporating feedback from communities, we felt that had enough to get us started through the Bucket reviews. We wanted to take that feedback and leverage it. We haven't written a word of the final report. We tried to do a broad first pass with what we have found. We are here to share our initial findings, check in with you, get more feedback, and then write the report. There is a lot of room to influence the final report. MCFN: The Bucket process is our engagement window. FMFN 468: Who did you share this information with? Did you send it to these people here? IOL: We haven't provided a written update. We met with some of the folks in the room today previously but more from a technical perspective. FMFN 468: It would be nice to know exactly where you are sending it. Will you be sending this to our Nation? Stantec: To clarify, we are talking about the final report? FMFN 468: Yes. IOL: Yes, we will share the draft report. FMFN 468: I really like your comments about what you have done. The important part of this is what other people should do. It's one thing to up the monitoring for yourself but the recommendation should be to industry. If you are saying you are doing an annual review, then is that a recommendation to industry that they also do annual reviews? IOL: It is difficult to specify things for other operators to do. We will suggest where other sites should look deeper based on our experience but every site is different. We can't say this is the data and you need to space your wells like this, it will be more of a suggestion to share with other operators and say look at this and figure out your well spacing. FMFN 468: I think this needs to be stated quite strongly in the recommendations to the AER. I am encouraging you to be prescriptive. Say we learned this, do a review of your geology. Otherwise, you have not complied to understand your own lease. The AER has the role to protect the public and these steps should be taken in order to do that. Stantec: Imperial doesn't have the authority to tell other operators what to do. FMFN 468: Yes, but it's about encouragement.

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	MCFN: I am not sure how forceful Imperial is with the AER, but if that is something that imperial is not comfortable with, you could give permission to communities to write it and sign it to bring forward to the AER. We can push that from our side, to apply the learnings across companies. IOL: I can't speak for the AER, but we have had candid conversations, and I get the impression that they are asking for this work so that they can use it to be better regulators. Talking with SMEs, they have told us that what we are sharing is now informing the line of questioning. I am encouraged this will lead to some important improvements, it will help the regulator do their job better. FMkFN: We, the trappers, should be the first to be notified. You have to make the trappers aware of what is going on. That is why awareness is so important. Let the trapper know before they eat the berries or whatever. You have to let the trappers and land users know first, not the community. FMFN 468: And that relationship, if they had called you in May 2022, you might have had the right input to help them understand. Understanding who the right people are in the area and using them. That is the relationship that matters. What a great way to work together. FMkFN: Yes, we are the ones that stay there. Right now, they go to the band office not the trapper. We want to know what it's going to do to the future if you find something there that isn't good. Make us aware then we can avoid it. We have to work together. Communication with the trappers and land users should be number 1. Not the community. FMkFN: For me there's not a final report - you always have to be reporting. IOL: That's a great point. We talk about a final report and this Project does have an end date but that cannot be the end of the conversation. We have to keep the channels open. Sorry I missed saying that earlier.
4.4	4. Moving Forward Stantec: Back to the earlier question from FMFN 468, regarding communicating about the report. IOL: Yes, so from January – April it was putting this path together, today is the second session in Fort McMurray and we will take the feedback from today and put into a draft report ready for November. The communities and trappers will receive a draft report around beginning of November. We want to make sure you have adequate time to review. There may be some adjustment on those dates. FMFN 468: Will you have another session with us then at the end of November for the draft report? IOL: We haven't scheduled anything yet, but this came up at the last session as well. I hear you that there might be something else.

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	FMFN 468: I think it would be valuable for the communities to be involved. It would be good to see what was said from the COSIA meeting and to get a summary of that discussion. If you have a one-day session even, that would be helpful. It would be interesting to understand the view of the rest of the operators. IOL: We will share the feedback we have received from industry and addressing it in the final report. FMkFN: I have two comments. The first one is normally investigations like this where you get a root cause analysis, it is being done by an independent third party. How honest will Imperial be with itself in the final report? On this one the system was not designed correctly, and it's not that it got passed the system, it's the fact it wasn't designed correctly, and you are at fault because of that. In this situation I am concerned the AER is not involved seems to be just saying its Imperial's report and we will maybe ask some questions. I'm concerned the AER is not authoring this report as well. How public will this report be? Imperial is in court on DP4. I wonder big picture if this report will be published while that is happening, will there be legal concerns about saying things while you are also in court. Are they useful findings, and does the public gain trust through this report? Is it transparent to rebuild trust? IOL: Thanks for sharing. To the independent review point, Stantec has been working with us. The Bucket reviews have provided a lot of information and data. FMkFN: I am not worried about the data, in the report #1 it got back the seepage interception system – that is not the root cause. How do you get the most credibility out of this work? It should be useful, honest, and transparent. If the report doesn't do that then it will not rebuild trust. It is a corporation that is going to publish a report and send it to the AER. There are pieces that can still be done to improve the honesty and outcomes of the report. IOL: We appreciate the feedback. IOL: If the report doesn't meet those objectives, then we won't make it past those steps. It won't get past November. FMkFN: Yes, but I don't want to get to November to tell you though. IOL: That is the intent of sharing the draft report with you. I have zero concerns about overlap with DP4 enforcement actions. Maybe there is a sensitivity there, but we aren't seeing anything that causes concern because we see them as separate incidents with separate root causes. FMkFN: I generally agree but from long term legal risks I'm not sure what Imperial is willing to say. ML 1935: For me it's not very clear what decision making is occurring between the AER and Imperial through this seepage management issue. This project is about the root cause, but as introductory content maybe there could be a description of the communication between AER and Imperial. Can you be clearer on what the AER is providing, and the EPO approval going forward and how they might use this info to amend the EPEA approval. That would be useful to me. I would like to recommend the review of the report be done collaboratively with the

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	communities and regulator. The communities should be afforded contact with the regulator so we can ask questions of the AER. It's supposed to be lessons learned for all industry. It is pretty site specific and very narrowly focused, bigger implications of the lessons learned. The AER needs to be present to answer questions that are part of this process. MCFN: I agree with Gillian. That would be really important if Suncor was going to buy your site. FMFN 468: Are we saying the geology is so different that this couldn't happen anywhere else? IOL: No. FMFN 468: Exactly. You wouldn't be able to say you can't apply these. IOL: There are specific learnings to this area, but we wanted them to be applied broadly. General learnings for all operators. Gillian I can appreciate your point on AER. What we have tried to highlight are specific examples from our area, the intent is that the learnings of the right characterization at the right time, monitoring, and having the right processes in place are broad and for all operators. MCFN: The AER is not engaging with us. You can't commit them but in a certain way you are acting as a delegate of the crown. I don't expect you to accept that, but that is my position and the advice that I would give to Mikisew because there is no interaction with the AER. This is the only window we have been provided to deal with this, we have not interaction with ACO or AER. FMFN 468: My understanding of this project was that it was about lessons learned. Is the expectation that in this report to go through all the root causes? IOL: Yes. We want to use the root causes to highlight the lessons learned. FMFN 468: OK, well communication is not a root cause. So, you will be going through chemistry, etc. to highlight the lessons learned? IOL: Yes. FMFN 468: If a lesson learned we wanted to make ditches wider like that would be in there? IOL: Yes. <u>Closing Prayer</u>
5	Closing prayer from Elder *[End of meeting 2:10 PM]*
6	<u>Action Items</u> • IOL to provide the frequency of monitoring programs. • FMFN 468 asked for a summary of discussion at the COSIA meeting.

Item #	Topic/Discussion
	• IOL to consider a third working session to discuss draft report with communities.

Appendix B Post Workshop Community Feedback

B.1 Key Learnings and Take Aways from June 26th EPO Quality Assurance Project Meeting

Key Learnings and take aways from June 26th EPO Quality Assurance Project Meeting:

1. REPORT OUTCOME: Once the Quality Assurance Project and report is finalized, we want it to be given to other companies to be used as best practices to prevent similar incidents from happening again.
2. REPORT OUTCOME: The point of not just hearing Indigenous community feedback, but taking those lessons learned to see how we take the comments and dig into them, investigate, and ask questions to understand where Indigenous communities are coming from when they provided their input and expertise.
3. LEARNING: based on the original EIA the joint review panel recommended that geotechnical work be done on the substrate the tailings pond would be in. This recommendation from the joint review panel should have carried on to the final approval, but it did not. In hindsight this study should have been done, even if was not stipulated in the approval and considered a low risk not to do so by IOR.
4. LEARNING: better understanding of the subsurface and hydraulic connectivity leads to better subsurface and hydraulic/groundwater monitoring – depending on baseline borehole data alone can lead to a mischaracterization. Once operations begin, additional hydrogeological data is required to validate previous assumptions and/or update models as necessary. Don't be misled about the level of information you need to have for your operations (e.g. the level of delineation you need for a glacial environment versus a river environment is different).
5. LEARNING: do not be misled by 'worst case scenarios' as assessed in your original EIA and do not ignore Indigenous community concerns or requests for more information because you have assessed the 'worst case scenario'. Imperial's assumptions and the use of rules of thumb simplified issues for the worst-case scenario and mitigations didn't work. There does seem to be a desire to say and mitigate the worst-case scenario, however, what you need is accurate information; it seems to be much more complex than what it is. It is not the best way to plan mitigations and preventions. Industry needs to ask itself what sort of data is needed to confirm their understanding. Testing the different ways it could look like and figuring out what data is needed to get to test different scenarios
6. LEARNING: EIA predictions should be validated prior to the first 10-year operating approval renewal. There was a lot of work done for seepage modelling and comparisons done on seepage modelling between 2009-2015. When Imperial looked at it in 2018, the model was no longer well calibrated, and it spurred some of the revamp. Imperial started this work in 2020 to compare the model to actual measurables. In hindsight Imperial would do that faster now.
7. LEARNING: the selection of KIPs should be made based on the chemistry of the source water as well as be consistent with other related plans (e.g. GWMP). If and when Indigenous community reviews of plans and reports (e.g. TMP/TMR, GWMP/GWMR) identify elevations or omissions of KIPS they need to be taken into serious consideration.
8. LEARNING: going forward Imperia will look at Indigenous community technical reviews more critically because communities are doing these reviews to help Industry do a better job in the construction, operation and closure of their operations. At the bilateral tables, Indigenous communities look at it through the rights holder, to create a space where rights can be brought forward, and concerns can be mitigated and accommodated. This is Industry's job and such reviews must be meaningfully considered (e.g. technical reviews have identified multiple issues [e.g. elevated sulphate] that have not been acted upon). . It should be viewed as relevant

technical information from other sources that is available to you. It is about considering those technical submissions when they are provided and making space to revise your submissions accordingly. We need to find a better way where that information can be considered before Imperial submits or finalizes these documents

9. LEARNING: communication with Indigenous communities is a two-way street. The current seepage incident is just about a delay in communications, it was also that warnings in our technical reports that may have prevented this from happening wasn't considered. The amount of effort that goes into community's technical submissions to you for multiple years, seeing those comments and recommendations, and seeing those considered in a deep and thoughtful way and actually evaluating those comments, there was really great information through multiple reports on KIPs on monitoring. That resource to you was not considered. I'm not saying you need to adopt all those recommendations, but there were lots of really great recommendations that were not considered

B.2 Learnings from Preliminary Results of Bucket #2 Data Review

KEY LEARNINGS FOR THE QUALITY ASSURANCE REPORT BASED ON PRELIMINARY FINDINGS FROM BUCKET #2 DATA REVIEW:

BACKGROUND:

On August 21st, 2024 the Alberta Energy regulator imposed upon Imperial to develop a Quality Assurance Project on lesson's learned. The final report is to *document feedback…, describe how feedback was incorporated into final report, and how feedback will be implemented in future and current operations.*

The Indigenous Nations consisting of Mikisew Cree First Nation, Athabasca Chipewyan First Nation, Fort Chipewyan Métis Nation and Fort McKay Métis Nation have been working with Imperial to conduct a number of analysis, termed as 'Buckets'. Bucket #1 was a review up to the time of the discovery of discolored water and was intended to answer the key questions coming from Leadership and Members of the Nations "could this incident have been prevented?". The focus of Bucket #2, currently in its final stages of analysis, revolves around questions from the Communities' Leadership and Members about what has happened since the EPO was issued and if the measures being taken through the Remediation, Containment and Monitoring Plans and/or other EPO related requirements are working (or not).

On June 26th, 2025 Imperial hosted a workshop on the Quality Assurance Project. Representatives from the Communities as well as their subject matter experts working on Bucket #2 attended. In follow up to this workshop, the Communities provided feedback to the meeting summary with minor additions (the minutes captured much of the input provided and were considered quite thorough) as well as key learnings that, in the Communities' opinion, identified at that workshop.

Imperial has the Bucket #1 report in hand to help support and inform the key learnings from that work however, because the Bucket #2 work is still preliminary in nature, the Communities are provided some preliminary findings to help support the Quality Assurance Report in the areas of: geology and geomorphology, hydrogeology and surface water.

Key Learnings (Geology & Geomorphology)

- Geological and geotechnical complexity is present, however additional campaigns since the original interpretation improved knowledge of the geological framework and demonstrated that preferential pathways through aquifers (potentially outcropping at surface) extend beyond the mining lease. Further assessment will be necessary to account for these potential monitoring locations.

- The geological cross sections have been updated every year; however no relevant information has been shared (other than 2 isopach maps - thickness of middle and upper sands of the deep aquifers) regarding surface geology maps or other spatial distribution and thickness of relevant units and aquifers. According to the current level understanding of Quaternary deposit stratigraphy at the ETA region demonstrated by WSP in September 2024, this information should have been prepared and made available as soon as possible.

- A surficial geology map should have been prepared to highlight locations of future monitoring outside of the lease and confirm successful mitigation strategy to control seepage.

- Each region (NODA, WETA and EETA) has different proposed mitigations to minimize the seepage, even though the original mechanism causing the exceedances of key indicator

parameter (KIP) is not yet clearly defined. These mechanisms associated to the underlying geology of the area must be clearly understood, as proposed solutions for each case may induce further exceedances in future seasonal variations.

- Further investigation should occur to determine points of aquifer cross-contamination between the upper and middle sand, either within or outside of the lease. These locations may define further areas of monitoring to understand potential KIPs trend increases.

Key Learnings (Groundwater):

- Identifying the preferential pathway for PAW to potentially migrate outside of the lease boundary should have been identified and delineated (horizontally and vertically) during the hydrogeological assessment for the Site in the development of the Kearl EIA.

- Locations where groundwater from the Site, discharges into offsite receptors (such as wetlands and surface waters) should have been identified during the hydrogeological assessment prior to construction and monitored before and during all phases of the project. This is an item that was highlighted several times throughout PGL's review of the Kearl Remedial Action Plan (RAP), Source Control and Containment Plan (SCCP) and the Sampling and Monitoring Plan (SMP)[1].

    - Monitoring locations at groundwater discharge locations should be confirmed upon consultation with the Communities to support the development of the EIA. This is especially important for the Communities as this would support the Communities confidence in, and ability to, carry out traditional and cultural pursuits, understanding that culturally significant areas are being monitored to assess any evolving impacts from baseline or reference conditions.

- Prior to the start of a project, reference groundwater quality and level data should be collected quarterly over the span of two-three years. As a part of the baseline assessment, seasonal fluctuations should be assessed, and the hydrogeochemistry should be well understood. This allows a comparison of the groundwater quality and levels during operation, against reference conditions. Changes from reference conditions should be communicated to the Communities and the cause for the change must be thoroughly investigated. The results of the investigation of cause should be promptly shared with the Communities, with budgets allocated for the Communities to complete a review.

- Mitigation measures (such as the seepage interception systems) and groundwater monitoring wells should extend to the depth of the Hydrostratigraphic Unit identified as the preferential pathway. This prevents offsite migration of PAW, and early detection in case groundwater impacted by PAW is migrating offsite.

Key Learnings (Surface Water):

- A spatially expanded off-lease surface water monitoring programshould have been implemented. This is because KIP concentrations are not consistently decreasing in

[1] PGL, 2023. Review of Plans in Response to AER's EPO for IOL's Kearl Oil Sands Processing Plant and Mine Releases 1 and 2 – Hydrogeological Review (Final). April 13, 2023.

concentration/value with distance from the identified seeps, as may have been initially expected.

- Additional samples should have been collected between the seep locations north of the site, especially where KIP concentrations have been measured as localized peaks.

- The surface water sampling should have complemented and aligned with groundwater monitoring, covering potential groundwater flow paths to surface water and not just surface flow paths.

- Surface water sampling locations should have been reported with surficial geology information including a surficial geology map with the sampling locations plotted in it.