FORT HILLS ENERGY CORPORATION
FORT HILLS OIL SANDS PROJECT

McCLELLAND LAKE WETLAND COMPLEX OPERATIONAL PLAN OBJECTIVE 2

December 2021

Operated by SUNCOR ENERGY

McClelland Lake Wetland Complex Operational Plan

Executive Summary / Introduction / Supporting Attachments

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3. OBJECTIVE 2: DEFINE FUNCTIONALITY

3.1. Introduction

The purpose of Objective 2 is to develop a suite of indicators that "evaluate the tolerance of the McClelland Lake Wetland Complex (MLWC) to Project effects" and "maintain ecosystem diversity and function of the non-mined portions of the MLWC during operation and reclamation of the Project" (*Water Act* Approval No. 151636-01-00 [as amended] Conditions 3.13 [f] and [g]).

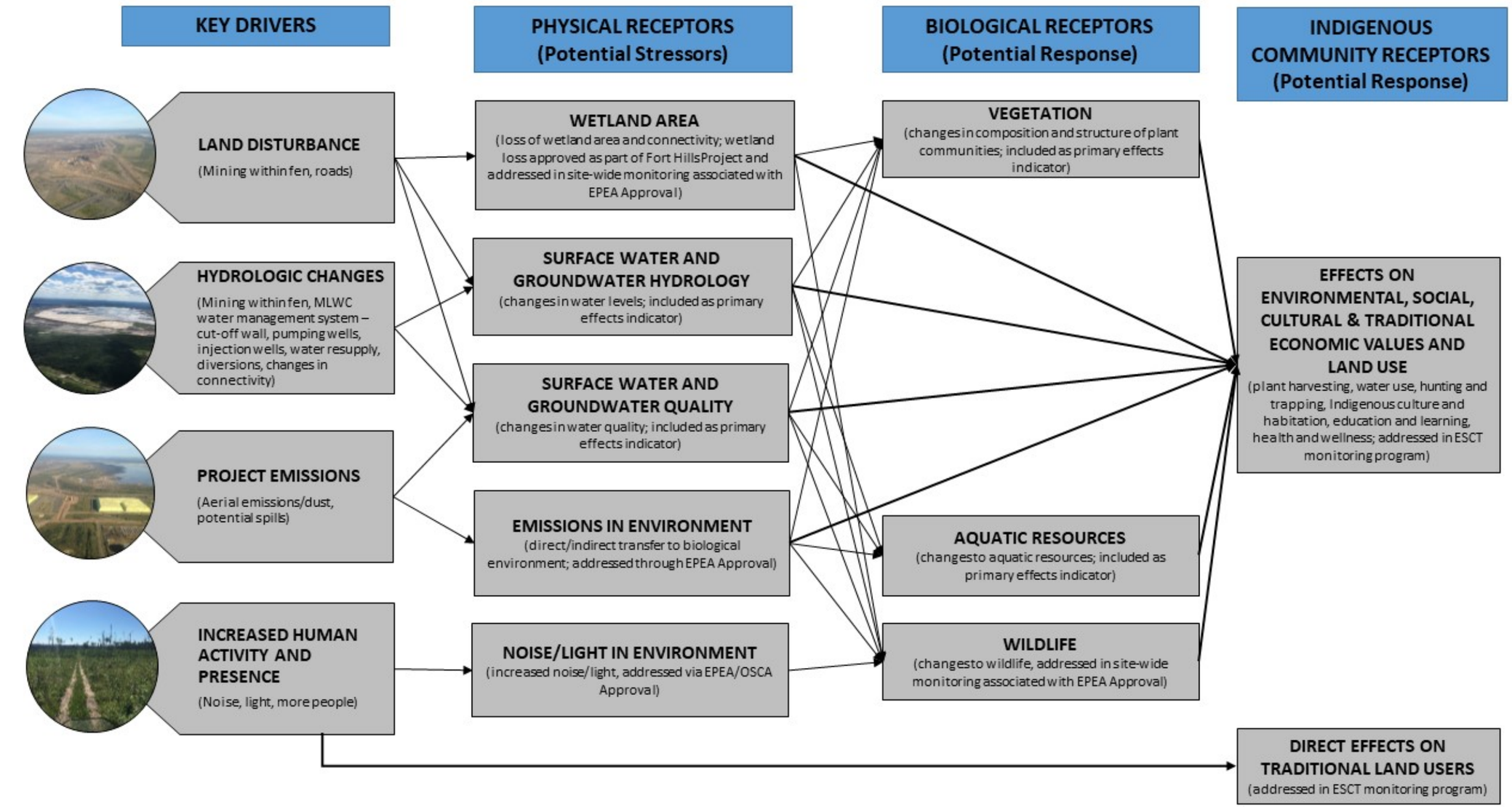
Functionality refers broadly to the individual and collective physical, hydrological, chemical, and biological processes performed by the MLWC that relate directly to the characteristics of the ecosystem and its capacity to interact with the adjacent landscape (ICF Jones and Stokes 2009). The MLWC also performs social and cultural functions that go beyond the ecological functions that are also viewed as critical to the overall function of the MLWC (IEG 2020). For a peatland to persist, peat accumulation rates must exceed peat decomposition rates. To maintain this imbalance between peat accumulation and decomposition, the physical, hydrological, chemical, and biological functions need to be maintained in the system. The purpose of Objective 1 (Section 2) was to characterize pre-development baseline conditions, pre-mining baseline conditions, and associated natural range of variability (NRV) and measured range of variability (MRV). With this understanding of baseline conditions within the MLWC, under Objective 2, indicators and metrics are selected to maintain conditions, processes, and functionality within the non-mined portion of the MLWC, which includes McClelland Lake.

3.2. Key Driver Stressor Response Relationships

Key drivers, potential stressors, and potential responses were identified for the MLWC to characterize Project-scale factors with the potential to affect wetland functionality. Key drivers are the factors directly attributable to the Fort Hills Oil Sands Project (Fort Hills Project) most likely to cause effects on the MLWC. Key drivers for the Fort Hills Project include land disturbance associated with mining operations within the fen; hydrologic changes in groundwater and surface water associated with mining in the fen, if not mitigated; hydrologic changes associated with the MLWC water management mitigation system including the cutoff wall, pumping wells, injection wells, water resupply, diversions, and changes in connectivity; aerial deposition associated with Fort Hills Project emissions, dust or potential spills; and increased human activity and presence in the watershed associated with noise, light, and the presence of more people carrying out activities related to the Fort Hills Project (Figure 3.2-1).

Stressors are the actions, agents or conditions in the physical environment that may impair the structure or function of a biological system and affect Indigenous land use and land users. Potential stressors associated with the Fort Hills Project include changes in wetland area, surface and groundwater hydrology, surface water and groundwater quality, contaminants in the environment, and noise/light in the environment (Figure 3.2-1). Changes in the physical environment associated with these potential stressors may affect biological receptors and function of the MLWC (Figure 3.2-1). Changes in the physical and biological environments may affect Indigenous community receptors, both directly and indirectly, and alter social, cultural, and traditional economic values, and land use (Figure 3.2-1).

The purpose of Objective 2 is to identify indicators and metrics, which are measurable or observable characteristics that can be correlated with, but not necessarily causally linked to, a specific physical, hydrological, biological, or chemical process that is occurring in the MLWC (ICF Jones and Stokes 2009). The indicators and metrics selected under Objective 2 will be measured in the effects monitoring program described under Objective 5 (Section 6), and assessed against triggers and limits in the response framework described under Objective 6 (Section 7).



EPEA = *Environmental Protection and Enhancement Act*; ESCT = Environmental, Social, Cultural and Traditional; MLWC = McClelland Lake Wetland Complex; OSCA = *Oil Sands Conservation Act*.

Figure 3.2-1: Key Drivers, Receptors, Potential Stressors, and Potential Responses

3.3. Approach to Indicator Selection

3.3.1. Background and Sustainability Committee Input

To support the knowledge gathering and shared work of the Aboriginal Advisory Group (AAG) and Technical Advisory Group (TAG), the Sustainability Committee (SC) organized a series of workshops on indicators, starting in 2019. During these workshops, the AAG and TAG co-created a list of indicators and methods that could be used to monitor the function and biodiversity of the MLWC using the Two Roads Approach. Linking these two ways of knowing provides a more robust, integrated monitoring system to assess environmental changes that may result from the Fort Hills Project and the socio-cultural responses to these environmental changes. Joint workshops were held to develop recommendations on indicators and methods. A summary was prepared and reviewed and approved by the SC. Indicators and methods were developed and documented for nine environmental and socio-cultural and economic values identified for the MLWC:

- Wildlife and aquatic resources
- Vegetation (communities and plants)
- Surface and groundwater levels and flows and/or ice conditions
- Surface and groundwater quality (including sediment)
- Biodiversity
- Harvesting and subsistence use
- Indigenous culture and habitation
- Education and learning
- Health and wellness

The indicator development process began with an outdoor workshop, referred to in this process as the “On-the-Land Workshop”. This workshop was a way for all participants in the process to share an embodied experience, discuss aspects of the MLWC, and explore next steps in an informal and relaxed setting in the MLWC. The workshop took place on September 10-11, 2019. Twelve Indigenous Traditional Knowledge (ITK) holders together with community staff, supporting social scientists, researchers and Suncor staff attended the workshop. The workshop included fireside discussions and the option for a tour of the northwestern tip of McClelland Lake and the southern portion of the fen.

The next workshop took place directly following the On-the-Land Workshop on September 12-13, 2019. The intent of this workshop was to identify and select ITK and science indicators with a focus on indicators that would be useful in detecting change in wetland function, biodiversity and identified traditional knowledge holder values. In addition, the TAG presented on hydrology, wildlife, water quality, aquatic resources, and vegetation related to the MLWC. ITK holders and social scientists supporting the communities discussed indicators from an ITK worldview.

A subsequent workshop took place November 26-27, 2019 with the AAG and TAG members. During this workshop, environmental indicators from the previous workshop were verified and appropriate methods to measure change of the indicators were discussed. It was emphasized in this workshop to select indicators that would be sensitive to potential environmental changes from the Fort Hills Project, and indicators with sufficient baseline data to measure changes.

On March 12-13, 2020, another indicator workshop was held with AAG members and ITK holders to verify social, cultural, and traditional economic indicators, and to develop the methods and measures for monitoring indicators. Note, the format for this workshop was modified the week of the workshop to protect the health and safety of committee members from the newly emerging COVID-19 virus. Members were given the option to participate by phone or video, and while all participants understood the gravity of the situation and adapted to the format change, it is noted that face-to-face dialogue is the preferred form of communication for committee members and provides a more conducive atmosphere for sharing knowledge.

The SC worked through 2020 and early 2021 and continued to compile and validate the information provided in these workshops. One outcome of the workshops is Figure 3.3-1, which shows the linkages between the environmental and socio-cultural functions, and highlights the interrelated nature of ecological and socio-cultural elements in the MLWC. An additional outcome is a preliminary list of recommended indicators.

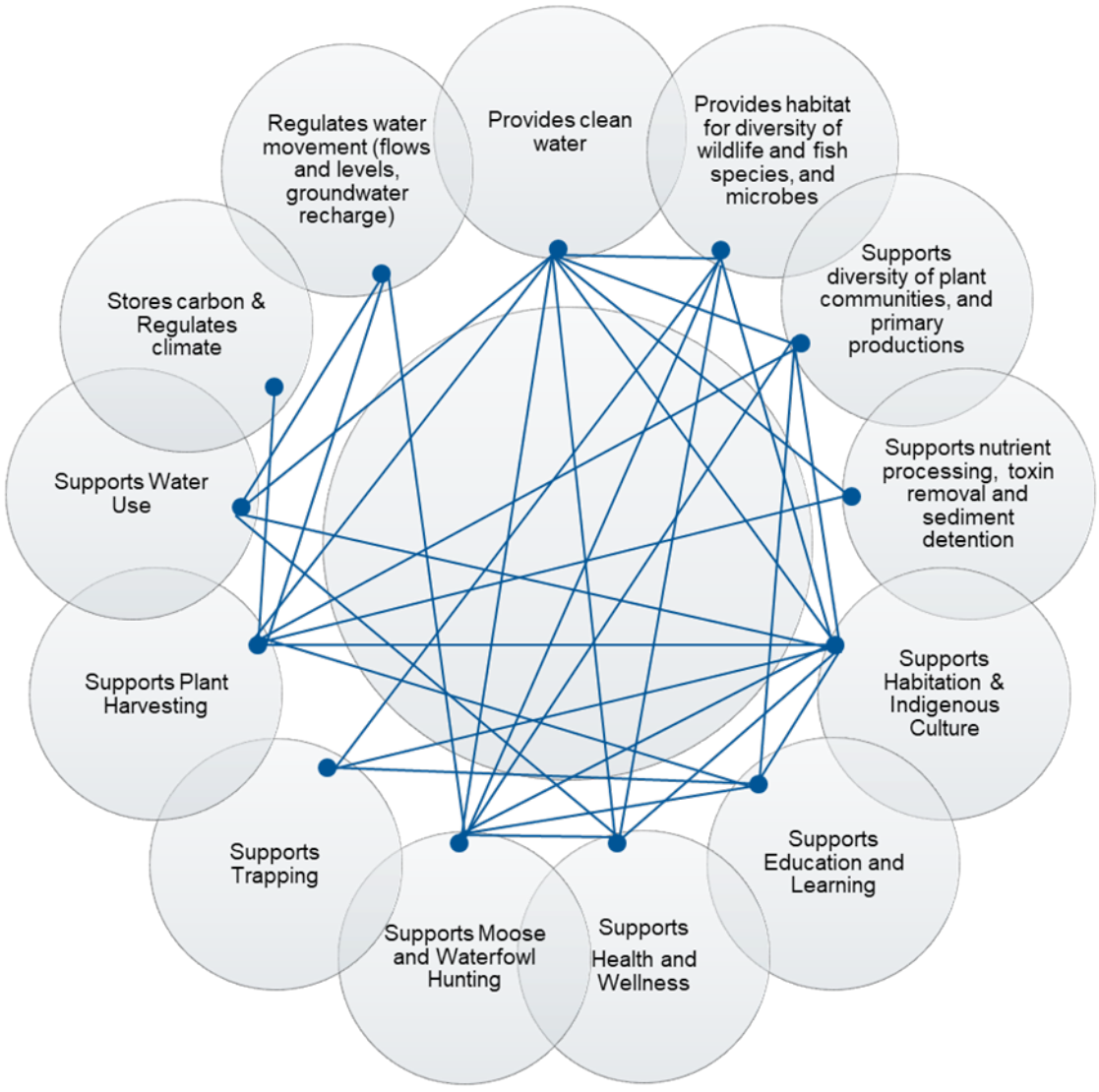


Figure 3.3-1: Linkages Between Environmental and Socio-Cultural Functions

In 2021, discussions continued on indicators, monitoring methodologies, classification and thresholds with workshops on January 25 and 26, February 19 and 26, and April 29 and 30. During the January 2021 workshop, the SC reviewed previously proposed indicators and began discussing the importance of selecting indicators capable of detecting early change. During the meeting, Fort Hills Energy Corporation (FHEC) presented a preliminary draft list of indicator selection criteria. During the April 2021 workshop, FHEC presented an updated draft list of indicator selection criteria, and the SC discussed indicator categories and opportunities to include indicators in aspects of Fort Hills Project monitoring outside of the Operational Plan (OP). The SC then worked to compile a table of "Early Warning Indicators and Methods" (dated May 29, 2021) which was subsequently approved by the SC. This list was used to finalize the indicators for the Operational Plan and are provided in Table 3.3-1.

Table 3.3-1: List of Indicators Recommended by the Sustainability Committee

Indicator	Metric
Water Table/ Quantity	McClelland Lake water elevation – elevation trends, variability
	Wetland water levels (patterned and non-patterned fen) – elevation, depth, trends, variability
	Differential groundwater elevations between the North Outwash Plain, the Fort Hills, the sand beneath the fen and the fen peat groundwater – elevation, depth, trends, variability
	McClelland Lake outflow rate – flowrate, trends, variability
	McClelland Lake residence time – calculated
	McClelland Lake water budget and flushing rate
	Seepage rates from springs – flowrate, trends, variability
	Gradient/flow reversals – magnitude and direction, trends, variability
	Groundwater level/flowpath patterns – observations and interpretations
	Vertical gradients – magnitude and direction; trends, variability
	Inundated and dry extent (patterned and non-patterned fen) – mapping
Ice	Ice thickness on the lake and wetland – thickness in time and space, trends, and variability
	Timing of ice – date of ice on/off
Water Chemistry – Lake Water	pH – trends, variability
	Electrical conductivity – trends, variability
	Alkalinity – concentration, trends, variability
	Base cations (calcium, magnesium, potassium and sodium) – concentration, trends, variability
	Chlorophyll *a* – RAMP data
	Temperature – graphical seasonal profiles
	DO – graphical seasonal profiles
	Sediment quality, organic content, particle size – basic statistics and trends
	Sediment quality, metals, PAHs, toxicity – basic statistics and trends, sediment quality guidelines
	Nutrients, colour, TSS, DOC, and TOC – concentration, trends, variability
	TDS – concentration, trends, variability
Water Chemistry – Groundwater and Wetlands	TDS – concentration, trends, variability
	Inorganic species, metals – concentration, trends, variability
	pH – trends, variability
	Electrical conductivity – trends, variability
	Alkalinity – concentration, trends, variability
	Base cations (calcium, magnesium, potassium and sodium) – concentration, trends, variability
	Nutrients, naphthenic acids, PAHs, hydrocarbons, DOC – concentration, trends, variability
	Temperature (patterned and non-patterned fen) – time and space (including depth profiles)

Table 3.3-1: List of Indicators Recommended by the Sustainability Committee

Indicator	Metric
Aquatic Resources	Fish populations and health – diversity, dominance, health metrics, abnormalities
	Lake vegetation (shoreline and littoral zone) – biomass, species richness, diversity
	Lake aquatic invertebrates (zooplankton) – diversity, abundance
	Aquatic birds – diversity, dominance, changes over time
Vegetation	Vegetation communities (bryophyte and vascular plants) – species abundance, presence/absence, population and species diversity
	Vegetation structure (vascular plants) – mean height
	Rare and sensitive species – abundance and distribution
	Dominance of plant functional groups – change in relative ratio
	Tree growth – width of tree rings located on strings
	Shrubs – distribution width on each side of strings
	Dominant bryophytes and lichens – change in dominance/ratio associated with wetland habitat
Wildlife	Wood frog egg masses – frog population, egg mass count
	Bird communities – population, species diversity
	Bird habitat – habitat distribution, abundance
	Mammals – distribution, abundance, species diversity, loss/absence of species
	Biodiversity – rare/sensitive wildlife species, loss/absence of species
	Mammal habitat – distribution, habitat use
Social, Cultural and Traditional Economic Indicators	Water use – access to and use of clean water in the fen, wetland and McClelland Lake including ice/snow
	Aquatic resources – waterfowl – abundance, health, and behaviour
	Vegetation health and usability – changes in single plant species; focus on plants important to Indigenous communities at gathering locations; health is defined as contaminants and good nutritional and medicinal components for evaluation; usability (protocol and preference)
	Plant harvesting (consumption, medicinal, ceremonial plants) – accessibility to harvest sites and change in harvest effort
	Wildlife health – moose, beaver and muskrat health, abundance, and usability
	Hunting – harvest effort; change in usability of hunted products; community observation logs of eggs; quality and taste of meat/eggs; usability of fur, feathers and other parts of wildlife; seasonal changes in moose hunting or waterfowl hunting; increased conflict and competition use with non-Indigenous users; change in purpose of hunting; use of traditional practices related to hunting (before harvest, after kill, preparing meat, sharing meat); use of traditional names and language specific to hunting
	Trapping – harvest effort; usability of fur and other parts of furbearers; use of traditional practices related to trapping; use of traditional names and language specific to trapping
	Indigenous culture and habitation – maintain culture; maintain and access important gathering places, ceremonial sites, sacred sites, and historic sites; sense of place
	Education and learning – transfer of Indigenous knowledge
	Health and wellness – ability to practice and enjoy, food security, spiritual well being

DO = dissolved oxygen; DOC = dissolved organic carbon; PAH = polycyclic aromatic hydrocarbons; RAMP = Regional Aquatic Monitoring Program; TDS = total dissolved solids; TSS = total suspended solids; TOC = total organic carbon.

It is recognized that the members of the AAG and TAG of the SC have tremendous knowledge about the MLWC and the environmental and socio-cultural impacts associated with oil sands development. They also have valuable insight and experience that has led to a range of indicators that can be used to monitor environmental and social change caused by specific project impacts. While all of the indicators are individually important, knowledge holders emphasized that it is the sum or holistic sense of all of these indicators throughout the seasons that is important for assessing the integrity and health of a site. Linking two ways of knowing – ITK and western science – provides a robust, integrated monitoring system to assess environmental changes that may result from the Fort Hills Project and the socio-cultural responses to these environmental changes.

3.3.2. Indicator Selection Process

Indicator selection criteria were developed to provide a transparent process through which the parameters on the recommended indicator list developed with the SC could be evaluated. Based on the indicator selection criteria presented in Section 3.3.2.1, each parameter was assigned to one of the following five groups:

- Primary effects indicators included in the effects monitoring program and response framework.
- Complementary data collected as a component of ongoing monitoring programs.
- Site-wide operational monitoring data.
- MLWC environmental, social, cultural, and traditional economic values and land use indicators (ESCT indicators).
- Excluded from ongoing monitoring programs.

The relationship between indicator selection criteria and the five groups is shown in Figure 3.3-2, and each group is discussed in more detail in Sections 3.3.2.1 to 3.3.2.5.

3.3.2.1. Primary Effects Indicators

Each parameter selected for inclusion as a primary effects indicator met the following indicator selection criteria (Figure 3.3-2):

- It is a measure of wetland functionality.
- It can be measured effectively, safely, and economically.
- It has a sufficient pre-mining baseline dataset to assess its efficacy as an indicator.
- It can detect early change in MLWC functionality.
- It is potentially responsive to Fort Hills Project mitigations.

Parameters identified as primary effects indicators are included in the effects monitoring program and response framework described under Objectives 5 and 6, respectively (Sections 6 and 7). FHEC has reviewed the selection criteria and the groupings with the SC and provided rationale for the indicators that were included and those that were not included.

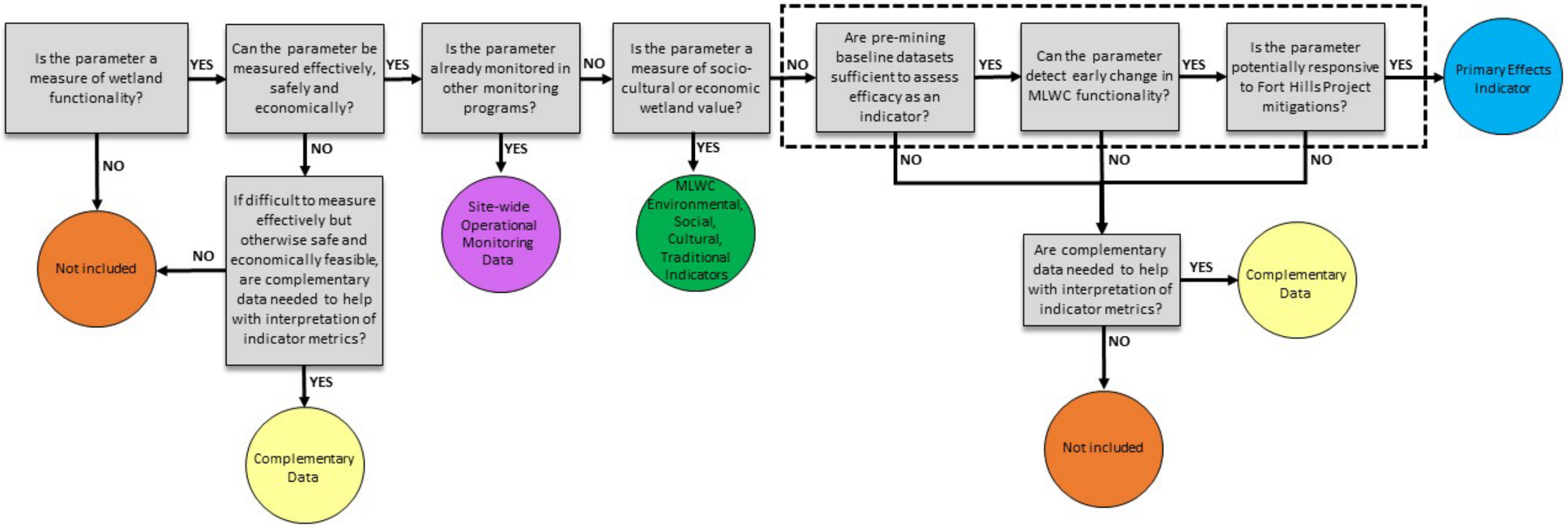


Figure 3.3-2: Indicator Selection Criteria

3.3.2.2. Complementary Data

As outlined under Objective 1 (Section 2), FHEC has gathered a comprehensive baseline dataset to characterize pre-mining baseline conditions within the MLWC. While not all parameters are appropriate for inclusion as primary effects indicators, many provide additional context that may support interpretation of primary effects indicator data and are accordingly included as complementary data. For example, if a parameter is difficult to measure effectively but is otherwise safe and economically feasible to include, and complementary data are needed to support interpretation of indicator metrics, it was included as complementary data (Figure 3.3-2). Similarly, if a parameter did not have a sufficient pre-mining baseline dataset to assess efficacy as an indicator, could not detect early change in MLWC functionality, or may not be responsive to Fort Hills Project mitigations, but would be useful for interpretation of indicator metrics, it was included as complementary data (Figure 3.3-2).

Complementary data will continue to be collected alongside data for primary effects indicators in future monitoring programs but will not be included as primary effects indicators in the effects monitoring program and response framework described under Objectives 5 and 6, respectively (Section 6 and 7). Analysis and interpretation of complementary datasets may be triggered in the response framework to provide additional context for interpretation of documented effects.

3.3.2.3. Site-Wide Operational Monitoring Data

The Fort Hills Project currently operates under *Environmental Protection and Enhancement Act* Approval No. 151469-01-00, as amended (EPEA Approval). As a component of the EPEA Approval, many site-wide monitoring programs are already underway (e.g., air emissions, industrial wastewater and runoff, aquatic environmental effects, groundwater, wildlife, and wetlands). If a parameter on the recommended indicator list did not meet selection criteria for primary effects indicators or complementary data, and is already part of monitoring programs conducted under the EPEA Approval ongoing monitoring for that parameter will occur under these existing site-wide monitoring programs (Figure 3.3-2). Parameters included as site-wide monitoring data will not be included in the effects monitoring program and response framework described under Objectives 5 and 6, respectively. However, mitigation and management plans are included for many of these parameters in the monitoring programs designed to meet the EPEA Approval conditions, as outlined in Section 3.4.3.

3.3.2.4. Social, Cultural, and Traditional Economic Values and Land Use Data

Social values include the ability to practice and have confidence in traditional, current uses and desired future uses to support maintaining the socio-cultural fabric of communities. Social values include, but are not limited to, trapline use and harvesting; passing on of culture, family time and events; and integration of traditional ways and on-the-land practices into the school curriculum. Cultural values include ways of living and knowing and their oral transmission; beliefs and spiritual practices; customs, history and language; medicinal knowledge, art, music, dance, sacred sites, and overall well-being that is supported by a healthy, undisturbed land base. Traditional economic values consider how the MLWC can continue to support resource and land use activities and livelihoods including, but not limited to, hunting, trapping, and gathering traditional food sources.

If a parameter on the recommended indicator list was a measure of socio-cultural or economic wetland value of importance to Indigenous land users, it was included as an ESCT indicator (Figure 3.3-2). Parameters identified as ESCT indicators will be monitored by Indigenous communities and used to inform the effects monitoring program and response framework described under Objectives 5 and 6, respectively.

3.3.2.5. Excluded Parameters

Parameters on the recommended indicator list that did not meet selection criteria for primary effects indicators, complementary data, site-wide operational monitoring data, or ESCT indicators were excluded from the effects monitoring program and response framework described under Objectives 5 and 6, respectively (Figure 3.3-2).

3.4. Selected Indicators

Parameters on the recommended indicator list developed by the SC were each assigned to one of five groups: primary effects indicators, complementary data, site-wide operational monitoring data, ESCT indicators, and excluded parameters. Indicator selection criteria and parameter assignments are presented in Figure 3.4-1 and discussed in Sections 3.4.1 to 3.4.5.

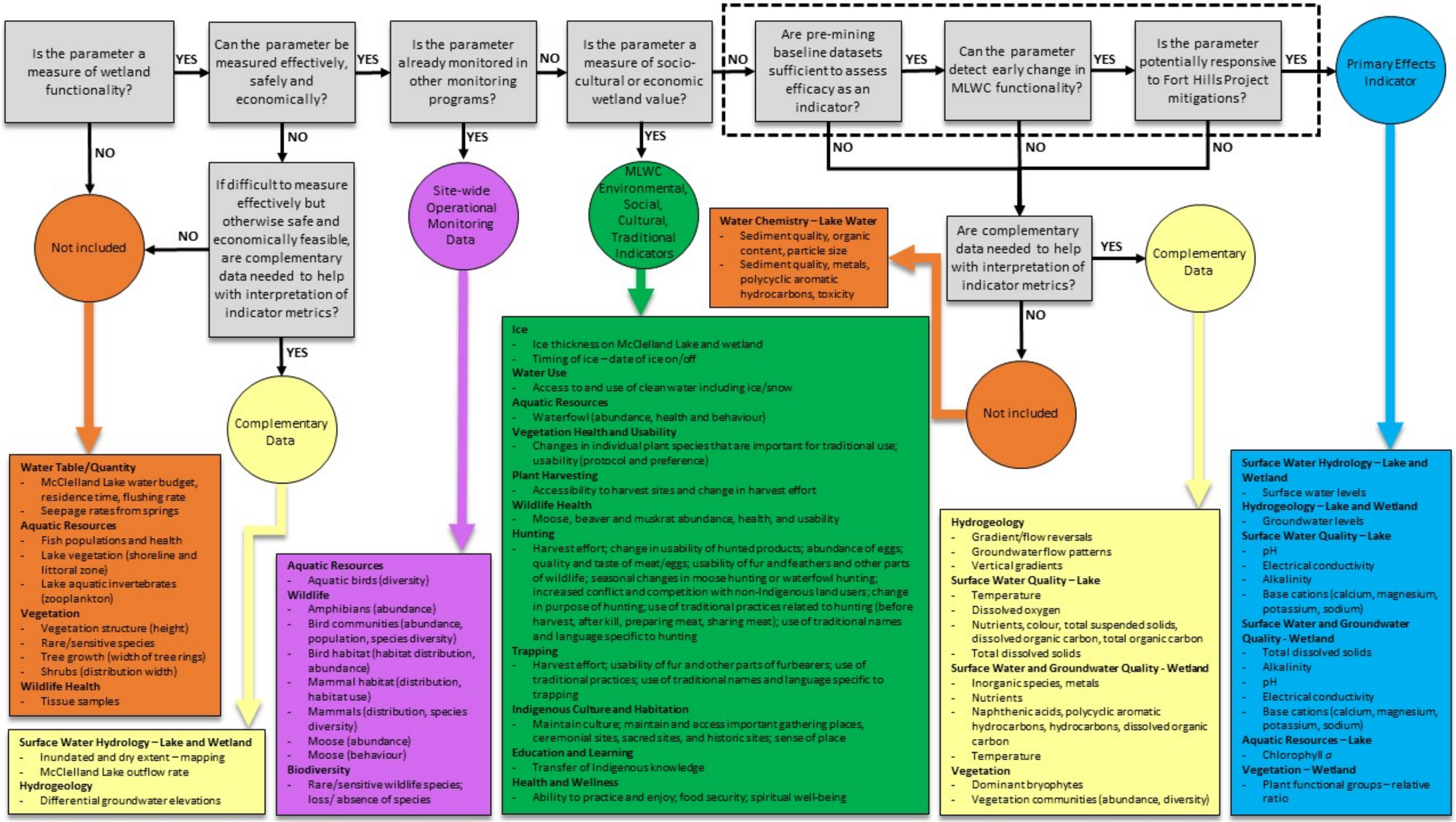


Figure 3.4-1: Indicator Selection Criteria and Assignment

3.4.1. Primary Effects Indicators

Primary effects indicators are parameters that provide a measure of wetland functionality; can be measured effectively, safely, and economically; have sufficient pre-mining baseline datasets to assess efficacy as an indicator; can detect early change in MLWC functionality; and are potentially responsive to Fort Hills Project mitigations (Figure 3.4-1). Parameters selected as primary effects indicators are shown in Table 3.4-1 and are included in the effects monitoring program and response framework described under Objectives 5 and 6, respectively.

Table 3.4-1: Primary Effects Indicators and Metrics to be Included in Effects Monitoring Program (Objective 5) and Response Framework (Objective 6)

Indicator	Metric
Hydrogeology – lake and wetland	Groundwater levels – elevation, trends, variability
Surface water hydrology – lake and wetland	Surface water levels – elevation, trends, variability
Surface water quality – lake	pH – trends, variability
	Electrical conductivity – trends, variability
	Alkalinity – concentration, trends, variability
	Base cations (calcium, magnesium, potassium and sodium) – concentration, trends, variability
Surface water and groundwater quality – wetland	TDS – concentration, trends, variability
	Alkalinity – concentration, trends, variability
	pH – trends, variability
	Electrical conductivity – trends, variability
	Base cations (calcium, magnesium, potassium and sodium) – concentration, trends, variability
Aquatic resources – lake	Chlorophyll *a* – concentration, trends, variability
Vegetation – wetland	Dominance of plant functional groups – change in relative ratio

TDS = total dissolved solids.

3.4.1.1. Surface Water Hydrology

Surface water levels in McClelland Lake and the non-mined portion of the MLWC were selected for inclusion as primary effects indicators in the effects monitoring program and response framework under the surface water hydrology indicator (Table 3.4-1). A detailed description of surface water elevation, trends and variability based on pre-mining baseline data collected from 1997 to 2020 and simulated by model from 1945 to 2019 is provided under Objective 1.

3.4.1.2. Hydrogeology

Groundwater levels for McClelland Lake and the non-mined portion of the MLWC were selected for inclusion as primary effects indicators in the effects monitoring program and response framework under the hydrogeology indicator (Table 3.4-1). A detailed description of groundwater elevation, trends and variability based on pre-mining baseline data collected from 1997 to 2020 is provided under Objective 1.

3.4.1.3. Surface Water and Groundwater Quality

A total of nine water quality metrics – pH, electrical conductivity, alkalinity and base cations in McClelland Lake, and pH, electrical conductivity, alkalinity, base cations, and total dissolved solids in the MLWC – were selected for inclusion in the effects monitoring program and response framework under the surface water and groundwater quality indicator (Table 3.4-1). A detailed description of each metric and associated MRV, based on pre-mining baseline data collected from 2002 to 2019, is provided under Objective 1.

3.4.1.4. Aquatic Resources

Chlorophyll a was selected for inclusion in the effects monitoring program and response framework under the aquatic resources indicator (Table 3.4-1). A detailed description of this metric and associated MRV, based on pre-mining baseline data collected from 2002 to 2019, is provided under Objective 1.

3.4.1.5. Vegetation

Relative abundance of plant functional groups was selected for inclusion in the effects monitoring program and response framework under the vegetation indicator (Table 3.4-1). A description of each plant functional group and associated MRV, based on pre-mining baseline data collected from 2008 to 2018, are provided under Objective 1.

3.4.2. Complementary Data

Complementary data are included in the OP to provide context and support interpretation of primary effects indicator data. Complementary data may be difficult to measure, may have insufficient pre-mining baseline datasets to assess efficacy as an indicator, may not be indicative of early change in MLWC functionality, or may not be responsive to Fort Hills Project mitigations; however, they may provide valuable information to complement primary effects indicator data interpretation (Figure 3.4-1). Parameters selected for inclusion as complementary data are shown in Table 3.4-2. Complementary data will be collected at the same time as the primary effects indicator data in future monitoring programs, but these parameters are not included as indicators in the effects monitoring program and response framework described under Objectives 5 and 6, respectively. Monitoring of the following complementary data parameters will provide valuable information to assist with interpretation of primary effects indicator data: gradient/flow reversals, groundwater flow patterns, vertical gradients, water temperature, dissolved oxygen, nutrients, colour, total suspended solids, dissolved organic carbon, total organic carbon, total dissolved solids, inorganic species, metals, nutrients, naphthenic acids, polycyclic aromatic hydrocarbons, hydrocarbons, dissolved organic carbon, and dominant bryophytes (Table 3.4-2). While some parameters such as McClelland Lake outflow rate and inundated and dry extent of the fen are difficult to measure effectively, they can assist in the evaluation and interpretation of primary effects indicators and other observations (Table 3.4-2). String and flark remote sensing, as described in Objective 1, Sections 2.4.1.2 and 2.6.2, is included as complementary data to meet part of Condition 3.13(c) of *Water Act* Approval No. 151636-01-00 (as amended).

Table 3.4-2: Complementary Data Included in Operational Plan to Support Interpretation of Primary Effects Indicator Metrics

Category	Parameter	Justification for Classification as Complementary Data
Hydrogeology	Gradient/flow reversals – magnitude and direction, trends, variability	Calculated from groundwater levels and supports understanding of flows
	Groundwater flow patterns – observations and interpretations	
	Vertical gradients – magnitude and direction; trends, variability	
	Differential groundwater elevations between the North Outwash Plain, the Fort Hills, the sand beneath the fen and the fen peat groundwater – elevation, depth, trends, variability	
Surface water hydrology – lake	McClelland Lake outflow rate – flowrate, trends, variability	Difficult to measure effectively due to undefined outlet and beaver impoundments; there is a downstream monitoring station which is not indicative of actual lake outflow.
Surface water hydrology – wetland	Inundated and dry extent (patterned and non-patterned fen) – mapping	Not an indicator of early change
Surface water quality – lake	Temperature – graphical seasonal profiles	Highly variable and supports primary effects indicators
	Dissolved oxygen – graphical seasonal profiles	
	Nutrients, colour, TSS, DOC, TOC – concentration, trends, variability	Supports primary effects indicators
	TDS – concentration, trends, variability	
Surface water and groundwater quality – wetland	Inorganic species, metals – concentration, trends, variability	Any changes in water chemistry would most likely be observed by changes in base cations and alkalinity concentrations (which are included as primary effects indicators) before seeing any changes in dissolved metal concentrations
	Nutrients, naphthenic acids, polycyclic aromatic hydrocarbons, hydrocarbons, dissolved organic carbon – concentration, trends, variability	Supports primary effects indicators
	Temperature – time and space	Highly variable and supports primary effects indicators
Vegetation – wetland	Dominant bryophytes – change in dominance/ratio associated with wetland habitat	Supports primary effects indicators
	Vegetation communities (bryophyte and vascular plants) – species abundance, presence/absence, population and species diversity	Not indicative of early change

DOC = dissolved organic carbon; TDS = total dissolved solids; TOC = total organic carbon; TSS = total suspended solids.

3.4.3. Site-wide Operational Monitoring Data

If a parameter on the recommended indicator list was already part of a monitoring program conducted under the EPEA Approval ongoing monitoring for that parameter will continue under existing site-wide monitoring programs. Wildlife parameters on the recommended indicator list were not included as primary effects indicators because they are already accounted for under the existing Wildlife Mitigation

and Monitoring Plan (WMMP) (FHELP 2017), which, along with several other programs includes the following specifically within MLWC (Table 3.4-3):

- Camera trap monitoring for medium/large mammals
- Songbird point counts
- Wetland bird acoustic monitoring
- Amphibian acoustic monitoring
- Amphibian egg mass surveys
- Species at risk monitoring for yellow rail

The Fort Hills Comprehensive Wildlife Report (CWR) is submitted on a three-year cycle (last submitted in 2020) and FHEC is committed to sharing the MLWC specific wildlife monitoring results from the CWR with the SC.

Table 3.4-3: Parameters Collected for Site-wide Operational Monitoring Programs for Wildlife

Category	Parameter	Site-wide Operational Monitoring Programs[(a)]
Aquatic Resources	Aquatic birds – diversity, dominance, changes over time	Accounted for through incidental observations, avian point counts, and acoustic monitoring
Wildlife	Amphibians – abundance	Accounted for through amphibian acoustic monitoring program
	Bird communities – abundance, population, species diversity	Accounted for through songbird point counts and wetland bird acoustic monitoring
	Bird habitat – habitat distribution, abundance	Wildlife disturbance due to noise, light and reduced habitat connectivity accounted for through the safety observation system (i.e., employee reporting), and wildlife reporting tool,
	Mammal habitat – distribution, habitat use	
	Mammals – distribution, species diversity	Accounted for through snow tracking and camera trap monitoring
	Moose – abundance	
	Moose – behaviour	Regional habitat use and distribution accounted for through Wildlife Habitat Effectiveness and Connectivity study
Biodiversity	Loss or absence of species; rare and sensitive wildlife species	Accounted for through species at risk monitoring program for yellow rail and other wildlife monitoring components

(a) from the Fort Hills WMMP

3.4.4. Environmental, Social, Cultural, and Traditional Economic Values, and Land Use Indicators

Indicators that were identified as important to ITK holders reflect a holistic perspective, and can be collected by knowledge holders are included as ESCT indicators. As can be expected, many of the important indicators that were identified overlap with many aspects of the primary effects indicators, complementary data, and site-wide data. Specific ESCT indicators have been developed and can be used to inform a holistic assessment of overall environmental health, and suitability for cultural and spiritual practice. ESCT indicators included to assess values at MLWC, based on recommendations from the SC, include aspects of environmental indicators, such as:

- wildlife and aquatic resources

- vegetation
- surface and groundwater levels, flows and/or ice conditions
- surface and groundwater quality
- biodiversity

and socio-cultural indicators such as:

- harvesting and subsistence use
- indigenous culture and habitation
- education and learning
- health and wellness

A list of ESCT indicators is included in Table 3.4-4. FHEC will work with the SC to develop an ESCT monitoring program that ties into the effects monitoring program and response framework described under Objectives 5 and 6, respectively. The ESCT monitoring program is expected to include community observation logs and land user interviews. FHEC expects to have details of this program finalized by the end of 2022.

Table 3.4-4: Environmental, Social, Cultural, and Traditional Economic Values, and Land Use Indicators

Category	Indicator
Ice	Ice thickness on the lake and wetland – thickness in time and space, trends and variability
	Timing of ice – date of ice on/off
Water use	Access to and use of clean water in the fen, wetland and McClelland Lake including ice/snow
Aquatic resources	Waterfowl – abundance, health and behaviour
Vegetation health and usability	Changes in single plant species; focus on plants important to Indigenous communities at gathering locations; health is defined as contaminants and good nutritional and medicinal components for evaluation; usability (protocol and preference)
Plant harvesting (consumption, medicinal, ceremonial plants)	Accessibility to harvest sites and change in harvest effort
Wildlife health	Moose, beaver and muskrat health, abundance, and usability
Hunting	Harvest effort; change in usability of hunted products; abundance of eggs; quality and taste of meat/eggs; usability of fur, feathers and other parts of wildlife; seasonal changes in moose hunting or waterfowl hunting; increased conflict and competition use with non-Indigenous users; change in purpose of hunting; use of traditional practices related to hunting (before harvest, after kill, preparing meat, sharing meat); use of traditional names and language specific to hunting
Trapping	Harvest effort; usability of fur and other parts of furbearers; use of traditional practices related to trapping; use of traditional names and language specific to trapping
Indigenous culture and habitation	Maintain culture; maintain and access important gathering places, ceremonial sites, sacred sites, and historic sites; sense of place
Education and learning	Transfer of Indigenous knowledge
Health and wellness	Ability to practice and enjoy, food security, spiritual well being

3.4.5. Excluded Parameters

Some parameters that were recommended by the SC are not included in FHEC monitoring programs. Parameters on the recommended indicator list that did not meet selection criteria for primary effects indicators, complementary data, site-wide operational monitoring data, or ESCT indicators were excluded from the effects monitoring program and response framework described under Objectives 5 and 6, respectively (Table 3.4-5). Further details and rationale on why each parameter was excluded (such as they are not indicative of early change, or they are difficult to measure effectively) is provided in Table 3.4-5.

Table 3.4-5: Parameters Excluded from Operational Plan and Rationale for Exclusion

Category	Parameter	Rationale for Exclusion from Operational Plan
Surface water hydrology	McClelland Lake residence time – calculated	Not indicative of early change; difficult to measure effectively due to complex and undefined inlets, outlets and beaver impoundments. Would be reassessed if required.
	McClelland Lake water budget and flushing rate	Difficult to measure effectively or accurately due to multiple and undefined inlets, outlets, groundwater interactions and beaver impoundments. Alternate approaches to accurately measure residence time, such as dye release, are complicated and sensitive.
	Seepage rates from springs – flowrate, trends, variability	Baseline data not available to assess its efficacy as an indicator; difficult to measure effectively
Surface water quality	Sediment quality, organic content, particle size – basic statistics and trends	Not indicative of early change due to low sedimentation rates in McClelland Lake; not needed as complementary data
	Sediment quality, metals, PAHs, toxicity – basic statistics and trends, sediment quality guidelines	Not indicative of early change due to low sedimentation rates in McClelland Lake; not needed as complementary data
Aquatic Resources	Fish populations and health – diversity, dominance, health metrics, abnormalities	The three small-bodied forage fish species present in McClelland Lake are short-lived, not sensitive to environmental changes, do not typically show signs of external abnormalities, do not bioaccumulate contaminants, are not harvested for human consumption, and do not support piscivorous species that would show contaminant bioaccumulation
	Lake vegetation (shoreline and littoral zone) – biomass species richness, diversity	Not indicative of early change; not needed as complementary data
	Lake aquatic invertebrates (zooplankton) – diversity, abundance	Highly variable; not indicative of early change; difficult to measure; not needed as complementary data
Vegetation	Tree growth – width of tree rings located on strings	No baseline data available to assess its efficacy as an indicator; not indicative of early change; invasive to measure repeatedly
	Shrubs – distribution width on each side of strings	Highly variable; not indicative of early change; difficult to measure; not needed as complementary data; no baseline data available to assess its efficacy as an indicator
	Vegetation structure (vascular plants) – mean height	No baseline data available to assess its efficacy as an indicator.
	Rare and sensitive species – abundance and distribution	Highly variable; not indicative of early change; difficult to measure; not needed as complementary data
Wildlife Health	Samples of tissue of species that are hunted, trapped (moose, beaver, waterfowl feathers) and plants harvested (contamination)	Highly variable; not indicative of early change; difficult to measure; not needed as complementary data

PAH = polycyclic aromatic hydrocarbons.

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ABBREVIATIONS, ACRONYMS, AND UNITS

Abbreviations and Acronyms

Abbreviation/Acronym	Definition
AAG	Aboriginal Advisory Group
CWR	Comprehensive Wildlife Report
DO	dissolved oxygen
DOC	dissolved organic carbon
e.g.,	for example
EPEA	Alberta *Environmental Protection and Enhancement Act*
Fort Hills Project	Fort Hills Oil Sands Project
FHEC	Fort Hills Energy Corporation
FHELP	Fort Hills Energy LP
FHUC	Fort Hills Upland Complex
i.e.,	that is
ITK	Indigenous Traditional Knowledge
MLWC	McClelland Lake Wetland Complex
MRV	measured range of variability
NRV	natural range of variability
OP	Operational Plan
OSCA	*Oil Sands Conservation Act*
PAH	polycyclic aromatic hydrocarbons
RAMP	Regional Aquatics Monitoring Program
SC	Sustainability Committee
ESCT indicators	Environmental, social, cultural, and traditional economic values and land use indicators
TAG	Technical Advisory Group
TDS	total dissolved solids
TOC	total organic carbon
TSS	total suspended solids
WMMP	Wildlife Mitigation and Monitoring Plan