Work Plan Application

Project Information	
Project Title:	Integrated Atmospheric Deposition Monitoring
Lead Applicant, Organization, or Community:	Alberta Environment and Protected Areas
Work Plan Identifier Number: If this is an on-going project please fill the identifier number for 24/25 fiscal by adjusting the last four digits: **Example:** D-1-2425 would become D-1-**2425**	A-PD-6-2425
Project Region(s):	Oil Sands Region
Project Start Year: First year funding under the OSM program was received for this project (if applicable)	2019
Project End Year: Last year funding under the OSM program is requested **Example: 2024**	N/A
Total 2024/25 Project Budget: From all sources for the 2024/25 fiscal year	$8,176,613.75
Requested OSM Program Funding: For the 2024/25 fiscal year	$8,176,613.75
Project Type:	Long Term Monitoring
Project Theme:	Air & Deposition
Anticipated Total Duration of Projects (Core and Focused Study (3 years))	-Select One-
Current Year (choose one):	Focused Study -Select One-
	Core Monitoring -Select One-

Contact Information

Lead Applicant/ Principal Investigator: Every work plan application requires one lead applicant. This lead is accountable for the entire work plan and all deliverables.	Greg Wentworth
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Project Summary

In the space below, please provide a summary of the proposed project that includes a brief overview of the project drivers and objectives, the proposed approach/methodology, project deliverables, and how the project will deliver to the OSM Program objectives. The summary should be written in plain language and **should not exceed 300 words**.

Atmospheric deposition is a critical pathway that links stressors to responses. Deposition monitoring data are used by the Oil Sands Monitoring Program to assess responses, and to help determine the source(s) of stressors. The primary objectives for atmospheric deposition long-term monitoring are to:

(1) Determine levels and changes of atmospheric deposition for specific pollutants that pose a likely risk for forest, river, lake, and wetland ecosystem function
(2) Quantify the contribution of OS emissions to deposition of pollutants of concern, particularly at ecological monitoring sites, and provide these data to ecological effects monitoring projects
(3) Improve integration within and across themes, and delivering model outputs and deposition data required by other themes.

This work plan monitors the spatial and temporal changes in deposition of pollutants of concern at relevant ecological monitoring sites, including: acidifying (e.g., nitrogen, sulphur), alkalizing (i.e., base cations) and eutrophying (e.g., nitrogen) pollutants at forest and wetland sites; and contaminants (i.e., polycyclic aromatic compounds (PACs), other organic carbon compounds and trace metals) at forest, wetland, and aquatic sites. This work plan also contains environmental effects monitoring related to deposition, including: soil and forest health indicators, and fen/bog indicators. These effects monitoring activities are co-located with deposition monitoring to allow for an assessment of if/how deposition is affecting the environment.

Source apportionment analyses and chemical transport models can determine the contribution of specific OS and non-OS sources to deposition. Deposition modelling and GIS techniques will support the estimation of deposition at ecological monitoring sites where deposition is not measured and allow for determination of contribution of OS sources. The key modelling tool that will enable the above is GEM-MACH, which is an observation-evaluated tool that simulates emissions, transport, transformation, and deposition, and is used for scenario testing. GEM-MACH has transitioned to a service delivery role (e.g., providing annual deposition maps, scenario-testing, comparison against surface observations), with the intensive model-measurement intercomparison between model output and surface measurements completed in 2023-24. Beyond 2024, GEM-MACH will undergo periodic evaluations and updates as emissions evolve and inputs/ science from focused studies is incorporated.

Supplement Attachment #9 shows how this work fits within an Adaptive Monitoring framework. This work plan continues to employ adaptive monitoring philosophies by updating monitoring considering recent findings. For example, the WBEA's Forest Health Monitoring (FHM) program has begun addressing the 75 recommendations that were generated from their publication project to improve deposition and effects monitoring in the AOSR. These recommendations are based on a comprehensive analysis of ~20 years of data. The FHM program is also hosting the first of a series of multistakeholder workshop in November 2023 to review and adapt the Forest Health Monitoring program before the sampling intensive campaign in Summer 2024 (intensive sampling occurs every six years).

Integration of information (e.g., deposition maps, source attribution) provided by the work described herein within air component activities and across themes is an on-going and iterative process. The focus for 2024/25 will be: (i) model improvement using data from past studies and long-term monitoring, (ii) configuration of the model and its inputs to provide deposition maps and output that fulfills OSMP Objectives and addresses community/stakeholder priorities, (iii) further alignment of deposition monitoring methods and approaches across the OS Regions, and (iv) continued transitioning, as appropriate, to the adaptive monitoring framework including formalizing baseline and limits of change for ambient deposition surveillance monitoring and modelling.

Major changes relative to the 2023-24 work plan include:

• Operation of GEM-MACH to a service delivery will provide up to 12 simulations per year to fulfill OSMP Objectives and address community and stakeholder concerns. The prioritization of and need for simulations will be determined by the Air and Deposition TAC. Model updates and evaluations will continue as emissions evolve and inputs/science improve.

• WBEA's FHM Program intensive sample collection will occur in Summer 2024. The FHM Program has been collecting forest health samples (i.e., soils, vegetation, and lichen) for analysis since the mid-1990s on a six-year cycle. The last collection was in 2018, and sampling sites are primarily co-located with deposition monitoring allowing for a direct assessment of ecological effects from deposition. The WBEA is hosting a multistakeholder 2-day workshop in November 2023 to review and adapt the FHM Program, and to ensure the 2024 sample collection meets stakeholder needs.

• LICA's Acid Deposition Monitoring Program has recently expanded due to stakeholder concerns and recent EPEA approval conditions for operators in the region to participate in a regional acid deposition monitoring network.

• Transition of the Villanova work back to the Wetlands TAC, as per direction from the SIKIC's comments on the 2024-25 Scope of Work document

• Inclusion of focused study to examine the effects of total carbon gas deposition on downwind locations, and to estimate emissions fluxes from tailings ponds making use of pond samples and subsequent laboratory analysis. Initial work (under review) suggested that the OS facilities are a hitherto unsuspected source of emissions of high molecular mass organic gases, which are deposited in sufficient quantities downwind to influence cumulative effects estimates such as critical loads, as well as human health impacts such as oxidative potential. The focused study will obtain surface-based information to better characterize these processes in the air-quality model.

• Speciation and size distribution of fugitive dust has been identified as a key missing factor in current monitoring by the modelling work to date. The need for a focused study at fenceline has been suggested by ECCC as one means for achieving this, though such a focused study is not part of ECCC's 2024-25 work planning. Some discussion with WBEA has suggested that WBEA contractors (e.g. Landis, Edgerton) might be able to undertake this work.

1.0 Merits of the Work Plan

All work plans under the OSM Program must serve the mandate of the program by determining (1) if changes in indicators are occurring in the oil sands region and (2) if the changes are caused by oil sands development activities and (3) the contribution in the context of cumulative effects. In the space below please provide information on the following:

- Describe the key drivers for the project identifying linkages to Adaptive Monitoring framework particularly as it relates to surveillance, confirmation and limits of change (as per OC approved Key Questions).
- Explain the knowledge gap as it relates to the Adaptive Monitoring that is being addressed along with the context and scope of the problem as well as the Source - Pathway - Receptor Conceptual Models .
- Describe how the project meets the mandate of the OSM Program or areas of limited knowledge is the work being designed to answer with consideration for the TAC specific Scope of Work Document (attached) and the Key Questions (attached)?
- Discuss results of previous monitoring/studies/development and what has been achieved to date. Please identify potential linkages to relevant sections of the State of Environment Report.

KEY DRIVERS and LINKAGES TO THE ADAPTIVE MONITORING FRAMEWORK:
The key driver of this work plan is the need for the OSM Program to link stressors and their sources (i.e., pressures) to responses. Supplemental Attachment #9 shows how monitoring activities in this work plan fit within an EEM-style (adaptive monitoring) framework. Ambient deposition surveillance monitoring is conducted through forest health deposition monitoring (i.e., passive air samplers, ion exchange resins, denuder/filter pack samplers, lichen sampling, remote ozone monitors, and meteorological towers), long-term snowpack contaminants sampling, deposition modelling (GEM-MACH), and PACs passive air samplers. GEM-MACH provides a quantitative link between atmospheric emissions from oil sands activities and deposition/exposure, including odour and pollution events.

The deposition surveillance monitoring activities are explicitly linked to on-going effects surveillance monitoring including forest health (soil and vegetative) monitoring, wetland ecosystem health monitoring, health assay measurements, aquatic ecosystem health monitoring, and amphibian health monitoring. GEM-MACH concentration and deposition outputs, combined with observation data and expertise from the OSM Geospatial work plan are leveraged to generate deposition maps. Adaptive monitoring needs are met through the generation of these deposition maps for multiple past years, future-year maps incorporating expected future emissions changes, and short-term event maps which may highlight the need for additional monitoring stations. Adaptive monitoring needs are also met through the post-processing of GEM-MACH output for monitoring network analysis purposes.

These activities are explicitly addressing Key Questions provided by the OSM Program Office: ‘Has deposition of airborne contaminants changed?’, ‘Is there an effect on the receiving environment?’, and ‘What is the extent of deposition of compounds of concern?’, ‘What are regional sources of air contaminants?’, ‘What are pathways and fate of Contaminants?’, ‘What are the pathways and fate of airborne particles?’, ‘Can we use predictive modelling to understand the current state and make predictions?’, and ‘How do management of odours, tailings ponds emissions, mine fleets, and stack emission management affect air quality?’. These activities are also consistent with the original JOSM Implementation Plan 2012 Air Quality Component. The Air and Deposition TAC will continue to develop baseline and limits of change for surveillance monitoring activities using consensus decision-making, including the use of GEM-MACH maps of change associated with oil sands emissions relative to a zero oil sands emissions “baseline” scenario simulations as well as additional scenario simulations discussed at the TAC level.

KNOWLEDGE GAP WITHIN SOURCE-PATHWAY-RECEPTOR MODEL:
Atmospheric deposition is a critical pathway that connects pressures, stressors and responses. This work plan fills the knowledge gap of the deposition pathway by delivering data required by this theme, and others within OSM (i.e., surface aquatics, groundwater, terrestrial biological, and wetland monitoring) to assess responses and to link any changes back to a specific stressor/pressure. Other key drivers include a need to: i) understand contribution of various sources and transformation processes to deposition, ii) provide data for comparison and improvement of air quality models which in turn provide deposition data to other themes, and iii) inform other OSM programs on patterns of stressor exposure/deposition.

FULFILLMENT OF OSM PROGRAM MANDATE:
1) Assess accumulated environmental condition – spatial and temporal patterns of deposition are monitored and modelled, which are used to assess environmental changes both directly (through comparison to critical loads, critical levels, and co-located ecological indicator data) and indirectly (through other OSM themes).
2) Determine relationships between OS-related stressors and effects – deposition monitoring (e.g., lichen samples, PAC passives, snowpack samples) and modelling data are used to quantify contribution of specific OS and non-OS source categories to deposition. Data from both monitoring network and focused studies are also used to evaluate and improve the GEM-MACH model which in turn quantifies source-specific contribution to deposition where monitoring data are not available.
3) Assess cumulative effects – deposition and effects monitoring inherently measures the cumulative impact of all sources on deposition. Information on source attribution (Result #2) and integration with other OSM themes targeting effects provides a programmatic view on the combined effects of OS and non-OS stressors on ecological responses delivered through the deposition pathway .

This work plan provides information in support of sound decision-making by governments as well as stakeholders and on transboundary nature of the issue. It is building on strong collaboration, inclusion and communications between governments, industry, and Indigenous communities. Data and information are shared and publicly available to ensure transparency. Monitoring activities are enhanced science-based and continuously improved and adapted as per OFA to best meet cross-programmatic needs.

KEY RESULTS:
Details and findings have been presented in numerous reviews of atmospheric deposition monitoring and effects in the OS Regions (Davidson et al., 2020; Harner et al. 2018; Horb et al., 2021; Kirk et al., 2018; Wentworth and Zhang, 2018). The following is a high-level summary of key results, and new results since last year's work plan:

•Spatial patterns of atmospheric deposition vary by stressor but are enhanced within <50 km (e.g., base cations, mercury, trace metals, organic carbon, and PACs) and beyond 100 km (e.g., SO_2, NO_2) of the surface mineable area.
•Vegetative changes have been observed at forest and wetland bog sites due to nitrogen and potentially sulphur and base cation deposition.
•Contribution of Oil Sands emissions to deposition varies by stressor, and is better characterized for stressors dominated by point sources for sulphur and nitrogen (e.g., SO_2, NO_x) and area sources for NO_x (off-road mine fleet) relative to other area sources (e.g., base cations, NH_3).
•Tests of GEM-MACH at 250m resolution have shown that the magnitude of H_2S events is better captured at this very high resolution. Very high resolution modelling is being investigated for odour event simulation.
• A strong temperature dependence in coarse mode fugitive dust emissions has been determined from PMF analysis (Landis et al., 2019) and incorporated in GEM-MACH model simulations, with these emissions effectively go to zero when daily average air temperatures fall below -2.8C.
• Reactions between dust and atmospheric gases, from different oil sands sources, have been shown to alter the chemical composition of particulate matter, with airborne base cation particles removing nitric acid resulting from oil sands NO_x emissions being deposited as particulate nitrate. However, the rate at which this process takes place was overestimated in early 2023/2024. Subsequent application of an observation-based conversion rate resulted in significantly improved model performance for NO_2, HNO_3 and particle nitrate.
• Comparison of GEM-MACH model estimates of base cations relative to area observations led to the discovery that emissions of fugitive dust from the Hammerstone Quarry were not reported to the National Pollutant Release Inventory or AEPA – follow-up on this to estimate these emissions is underway in FY2023/2024.
•Maps of area deposition constructed from observations at monitoring stations were shown to sometimes create spurious high and low concentration at locations where no monitoring was taking place, due to

interpolation/extrapolation errors. Comparisons to GEM-MACH simulations were used to determine an optimal map generation procedure (IDW/30% transparency). However, extrapolation of observation station data beyond the available monitoring sites remains an issue, highlighting the need for GEM-MACH as an integration tool for the monitoring network.

• The contribution of the oil sands activities to total deposition of oxidized N species, reduced inorganic N species, and S species at a downwind ecosystem site were 11.9 ± 7.4 %, 5.0 ± 2.7 %, and 8.7 ± 3.6 %, respectively (draft manuscript). The total deposition of N and S were found to be in a similar range to those modelled in the surrounding region (Makar et al., 2018).

This work plan explicitly links to Chapters 3 (State of the Air) and 4 (State of Aquatics) of the State of Environment Report, including: (i) ambient air measurements of PACs and trace elements, (ii) modelled acidifying deposition, (iii) modelled PACs deposition, and (iv) snowpack deposition of trace elements and PACs.

2.0 Objectives of the Work Plan

List in point form the objectives of the 2024/25 work plan below

OSM atmospheric deposition monitoring is a long-term effects-based surveillance program that determines if atmospheric deposition is having an effect on the receiving environment, and if so, to identify the geographic extent, magnitude, frequency, source, and reversibility of the effect(s). Receptors, indicators, and endpoints are based on their suitability for assessing the effects of changes in air quality and atmospheric deposition, with a focus on acidic deposition, nutrient deposition, and contaminant deposition. Some of the effects-based monitoring occurs in other work plans (noted below where applicable).

The following objectives relate to ambient deposition and effects surveillance monitoring (and should not be conflated with the OSM Program Objectives noted previously):

1) Monitor air concentrations and deposition of nitrogen, sulphur, base cations, and ozone at forest sites in the Oil Sands Regions, as well as nitrogen and sulphur deposition at two downwind transboundary sites. These data are directly used with data from Objective #2 for assessing stressor-response links, as well as for model evaluation (see Objective #10).

2) Monitor soil and vegetation parameters in the Athabasca and Cold Lake regions for indicators of vegetative changes and acidification. Soil measurements are integrated with measured and/or modelled deposition data to assess stressor-response linkages.

3) Monitor air concentrations and deposition of PACs at selected forest, wetland, and continuous air quality monitoring sites in all three Oil Sands regions. These data are needed by this TAC, as well as the Terrestrial TAC, for assessing stressor-response links and source attribution. The number of proposed sites has been reduced to adapt to the fact that PAC levels in ambient air have not changed in a statistically significant way since these measurements began in 2012.

4) Monitor wintertime deposition of PACs, mercury, and trace metals in the Athabasca Oil Sands Region at near river and ecologically important sites, and provide samples to the Groundwater work plan for isotopic analysis. These data are needed by the Surface Water, Wetland, and Groundwater TACs to evaluate the impact of contaminant input to ecosystems during snowmelt, as well as to attribute deposition to specific sources. The data needed to calculate deposition and conduct source attribution analysis are collected using snowpack sampling followed by lab analyses.

5) Collect monthly precipitation samples in Fort Chipewyan, Fort McKay, and Maskwa (Cold Lake region) for analysis of isotopes in water. These data are needed by the Groundwater TAC to assess the input of precipitation to groundwater reservoirs. The equipment and analytical costs of this sampling are covered by the Groundwater TAC.

6) Analyze extracts from PACs passive samplers (Objective #4) using chemical health assays, a surrogate for effects of PACs exposure on human health.

7) Monitor temporal and spatial changes in deposition through regional collection of lichen samples for trace metals, PAHs, total nitrogen, and total sulfur. Data derived from this biomonitor provides critical information about the extent of stressors entering ecosystems via the deposition pathway. These data are also necessary for the Groundwater, Surface Water, and Terrestrial TACs to investigate effects and attribute these effects to specific sources.

The following objectives relate to focused studies, model development/comparison, and testing new methodologies:

8) Use a modelling approach developed in FY2021/22 and an updated emission database of PACs developed in FY2023/24 to produce (i) updated concentration maps for PAHs and alkylated-PAHs (a subset of PACs) and (ii) maps of the toxicity from PAH and alkylated-PAHs (making use of the concentration maps from (i) and based on toxic equivalency factor), and (iii) to assess the relative contributions of OS-related and non-OS emissions to the total air concentration, atmospheric deposition, and toxicity of these pollutants in the whole region. NOTE: this is a different model than GEM-MACH, since the current version of GEM-MACH does not yet include alkylated PAHs – an investigation to incorporate alkylated PAHs within GEM-MACH will start in FY2024/2025.

9) Provide estimates of total gas-phase organic carbon and speciated organic emissions from tailing pond samples obtained form across the oil sands facilities, and analyzed via comprehensive chemical characterization in the laboratory (see Supplement #10). Results intend to quantitatively improve TP emissions and speciation within GEM-MACH for a variety of atmospheric conditions (see 13 below).

10) Quantitatively determine through atmospheric oxidation studies in the laboratory, the fate of tailing pond emissions in the atmosphere (see Supplement #10) and their contribution to the observed health assays associated with extracts of passive samples collected in the region (#7 above). Determine the chemical species associated with observed effects in #7 above.

11) Conduct comprehensive analysis of total organic carbon and speciated carbon in snow deposited in the oil sands region (samples provided as part of ongoing project in Surface Water TAC). Results will be used to confirm, quantify and improve the deposition of organic species in GEM-MACH (see Supplement #10).

12) Service delivery reconfiguration of GEM-MACH and its inputs to deliver products to meet OSMP Objectives and address community/stakeholder concerns. Examples of products from these simulations are deposition maps of additional years (aside from the current 2018 simulated year) in the past, future (i.e. projected) simulations, zero-out emissions scenarios to determine source-receptor relationships for net oil sands emissions and for specific oil sands sources. A significant part of this effort will be in the generation of emissions data for use as model inputs. The Air and Deposition TAC will prioritize information needs received from OSMP members (e.g., other TACs, communities). Based on the FY2023/2024 model evaluation, model improvement will focus on emissions updates (e.g., other emissions years, particle size distribution, missing sources of emissions identified through evaluation), specific process updates (e.g., in-plume aqueous chemistry, co-deposition of base cations and SO2, organic aerosol deposition algorithms, H2S and total reduced S odour prediction, 250 m resolution simulations to better resolve high concentration plumes). Supplementary Attachment #10 summarizes recent GEM-MACH improvements resulting from evaluation, and progress over the last few years.

13) Continue operating a monitoring site where all deposition measurement methods are co-located with an existing continuous monitoring station for the purpose of ensuring measurement comparability.

14) Test surrogate surface samplers, a method to quantify fugitive dust deposition, at a subset of air monitoring stations for the spring, summer and fall. If validated, these data will complement the wintertime snowpack measurements allowing for direct year-round quantification of fugitive dust deposition.

15) Create an Indigenous-led air deposition program in the Peace Athabasca Delta and at reserve locations in partnership with WBEA.

16) Build community capacity through training of ACFN and MCFN Personnel for deposition monitoring program operations and maintenance.

The following objectives relate to improving within theme and cross-theme integration, and ensuring this work plan aligns with the priorities of the OSM Program and the Adaptive Monitoring framework:

17) Continue participating in cross-thematic workshops (e.g., TBM contaminants workshop) to ensure deposition maps and related information required by other TACs is being provided, including provision of long-term deposition trends to other theme areas. For example, PACs snowpack deposition data were provided upon request by the OSM fish monitoring leads to study a potential link between PACs exposure and fish health. In addition, continue discussions with the ABMI to align and integrate lichen sampling, and provision of GEM-MACH deposition data to other TACs and stakeholder groups.

18) Develop a shared understanding of regulatory and community expectations for monitoring that will guide the adjustment of the current long-term surveillance program to fit the OSM adaptive monitoring framework. This work will be supported by discussions at the SIKIC and OC on whether specific EPEA requirements are fulfilled by the OSM Program.

19) Continue to formalize baseline and limits of change for deposition surveillance monitoring parameters. This work will be carried out through the Air and Deposition TAC.

20) Contribute to annual State of Environment (SoE) reporting, as required.

21) Develop a draft 5-year proposal for the Integrated Atmospheric Deposition Monitoring program. This work will be led by the Project Team in close collaboration with the Air TAC.

3.0 Scope

Evaluation of Scope Criteria (Information Box Only- No action required)

Your workplan will be evaluated against the criteria below. A successful workplan would:

- Be in scope of the OSM Program (e.g., regional boundaries, specific to oil sands development, within boundaries of the Oil Sands Environmental Monitoring Program Regulation)
- consider the TAC-specific Scope of Work document and the key questions
- integrate western science with Indigenous Community-Based Monitoring)
- address the Adaptive Monitoring particularly as it relates to surveillance, confirmation and limits of change as per approved Key Questions.
- have an experimental design that addresses the Pressure/Stressor, Pathway/Exposure, Response continuum
- produce data/knowledge aligned with OSM Program requirements and is working with Service Alberta
- uses Standard Operating Procedures/ Best Management Practices/ Standard Methods including for Indigenous Community-Based Monitoring

3.1 Theme

Please select the theme(s) your monitoring work plan relates to:

- [x] Air
- [ ] Groundwater
- [ ] Surface Water
- [ ] Wetlands
- [ ] Terrestrial Biology
- [ ] Data Management Analytics & Prediction
- [ ] Cross Cutting

3.2 Core Monitoring, Focused Study or Community Based Monitoring

Please select from the dropdown menu below if the monitoring in the work plan is "core monitoring" and/or a "focused study". Core monitoring are long term monitoring programs that have been in operation for at least 3 years, have been previously designated by the OSM program as core, and will continue to operate into the future. Focused studies are short term projects 1-2 years that address a specific emerging issue.

Long Term Monitoring

Themes

Please select the theme from the options below. Select all that apply.

- [x] Air
- [ ] Groundwater
- [ ] Surface Water
- [ ] Wetland
- [ ] Terrestrial
- [ ] Cross-Cutting

3.3.4 Air Themes

3.3.4.1 Sub Themes

Deposition

3.3.4.2 Air & Deposition - Key Questions:

Explain how your air & deposition monitoring program addresses the key questions below.

Has baseline been established? Have thresholds or limits of change been identified?

There are multiple ways to define 'change', which relies on how 'baseline' or 'background' is defined. Developing a shared understanding between all stakeholders and partners will be crucial for the success of this framework. These terms have not been explicitly defined for air monitoring by the OSM Program, but have been defined by numerous reports, journal articles, and review papers in the literature. In 2024-25, the TAC will continue its work to define 'baseline' for specific deposition parameters through a Sub-Working Group to quantify baseline and develop limits of change. GEM-MACH baseline simulations (with oil sands emissions and all anthropogenic emissions removed) will help identify baseline for the chemicals included in that model. Existing data will be leveraged to help define 'baseline', which considers different time periods and geographical locations. It is likely that each contaminant will require a distinct baseline.

Are changes occurring in air quality? If yes, is there evidence that the observed change is attributable to oil sands development? (Describe source-pathway-receptor and/or conceptual models) and what is the contribution in the context of cumulative effects?

Spatial and temporal changes in deposition as a result of oil sands emissions have been reported in the surface-mineable area. An abundance of monitoring and modelling data show a pattern of increased deposition for nitrogen, sulphur, base cations, total mercury, methylmercury, most PACs, and most trace metals surrounding the surface mines. The extent of change in deposition varies by contaminant and is affected by the relative amount of non-OS emissions (e.g., wildfires, long-range transport). Source attribution and modelling studies have revealed a major contribution of OS emissions to cumulative deposition for some stressors (e.g., sulphur, nitrogen, alkylated-PACs), whereas the contribution for other stressors (e.g., ammonia) is less clear. The GEM-MACH simulations include the relative contributions of all S and N depositing species towards total predicted model deposition – hence the model maps show relative contributions of different species towards these totals. Spatial changes for deposition in the other OS regions (i.e., southern Athabasca, Cold Lake, and Peace River) is less well characterized by observation data than for the surface-mineable region. Model simulations for more current years (2023) will aid in identifying changes in cumulative effects.

Are there unanticipated results in the data? If yes, is there need for investigation of cause studies?

Previous results from this work plan, some of which were unanticipated, are summarized in Section 1.0. The TAC will continue its work to develop baselines for core monitoring parameters to support defining limits of change that can be used to trigger investigation of cause studies. In the meantime, GEM-MACH has transitioned to a service delivery tool to provide desired products (e.g., annual deposition maps, scenario testing) that will fulfill OSMP Objectives and address community/stakeholder concerns. The Air TAC will coordinate the collation and prioritization of information needs to prioritize GEM-MACH product delivery. Specific improvements to GEM-MACH based on past evaluation are expected to continue in parallel to service delivery, to provide improved versions for service delivery. In addition, a 2-year focused lab study to investigate the impacts of increased deposition of N and S from OS emissions on greenhouse gas emissions from bogs and fens will be completed by Q4 2024-25. This focused study stems from the unanticipated result of changes to bog and fen ecological indicators caused by increased N and S deposition. Another unanticipated result in work to date is the unexpectedly large contribution of organic carbon gases towards the total carbon balance and ecosystem acidity, through observations and GEM-MACH modelling. In order to better capture this process in GEM-MACH, focused studies will be conducted to measure organic carbon in precipitation (snow) across the region, and provide improved emissions and fate understanding for tailings ponds (the observed largest source of organic carbon emissions) contributing to the deposition.

Are changes in air quality informing Indigenous key questions and concerns?

Most data generated by this work plan are focused on quantifying spatial and temporal changes in stressor deposition (a pathway for exposure), their effect on ecological indicators, and the contribution from OS emissions. Collectively, these inform Indigenous concerns and health. For example, snowpack data are used to quantify the input of PACs, trace metals, and mercury into streams during spring snowmelt. Nitrogen, sulphur, and base cation deposition data are used to assess changes in forest and wetland ecosystems, as well as berry health. GEM-MACH modelling can identify locations where deposition exceeds ecosystem capacity for both concentration (critical levels) and deposition (critical loads) and be used to predict or forecast change, and will address Indigenous community concerns through their involvement on TACs. The GEM-MACH work also includes model and emissions improvements to predict and provide source attribution for odour events, as well as scenario simulations designed to address Indigenous concerns. This work plan was developed in collaboration with airshed organizations (i.e., WBEA, LICA, and PRAMP) that have Indigenous communities as members. There is also participatory community involvement in the snowpack sampling.

The WBEA's long-term surveillance program was initiated due to concerns expressed by local Indigenous community members about the potential impacts of atmospheric deposition on forest health and they have continued to be key participants in the technical and general membership that oversees this surveillance program.

Are data produced following OSM Program requirements and provided into the OSM Program data management system?

Data are produced following OSM Program requirements and are posted publicly after QA/QC checks have been completed. Data are available on the Alberta Air Data Warehouse (https://www.alberta.ca/alberta-air-data-warehouse.aspx), WBEA website (www.wbea.org) and the WBEA time-integrated data search tool (https://wbea.org/data/time-integrated-data-search/), and the Canada-Alberta Oil Sands data portal (https://www.canada.ca/en/environment-climate-change/services/oil-sands-monitoring.html). The OSM Program data management system also has direct links to these data.

Do methodologies use relevant Standard Operating Procedures/ Best Management Practices/ Standard Methods?

Yes. Standard Operating Procedures and Best Management Practices are available at the above links, or upon request. Unless noted otherwise, the methods used in this work plan are considered standard and commonly used for air and deposition monitoring. Methodologies used in this work plan have also been repeatedly published in the peer-review scientific literature.

How does the monitoring identify integration amongst projects, themes or with communities?

Integration amongst projects and themes is shown in Supplemental Attachment #9, which details existing linkages between monitoring activities within this work plan, between work plans in Air and Deposition, and with other themes. Monitoring data described in this work plan are needed by other projects and themes to support effects surveillance monitoring. Some of the deposition data needs of communities and other TACs were compiled during the June 29, 2023 GEM-MACH workshop in Calgary. The Air TAC will continue to coordinate monitoring activities with Indigenous reps, other TACs, and the ICBMAC to ensure deposition data needs of all OSMP members are met using GEM-MACH and other sources of deposition information.

There is significant integration with the Atmospheric Pollutant Active Monitoring Network work plan (A-LTM-S-1-2425). Continuous and integrated data from A-LTM-S-1-2425 are used to assess forest health effects monitoring and to compare to model output.

There is already substantial integration with other themes through site co-location and clear data uses by other themes (e.g., Wetlands using PACs; Surface Water using snowpack data to estimate snowmelt contaminant input to streams and rivers; Groundwater using precipitation and snow samples for isotopic analysis; Wetlands and Forest Deposition sites requesting vegetation-specific GEM-MACH maps).

Integration with communities is implicitly achieved through community membership with airshed organizations, which collaboratively developed this work plan. Several community members from the Mikisew Cree First Nation also participate in the snowpack sampling every March, and deposition data has been used as part of the Fort McKay Berry Health project.

With consideration for adaptive monitoring, where does the proposed monitoring fit on the conceptual model for the theme area relative to the conceptual model for the OSM Program?

Deposition monitoring is explicitly listed on the theme area conceptual model. It also provides information on stressors as well as atmospheric dispersion/transport. Monitoring data and model simulations are used to quantify the contribution of relevant pressures on stressor air concentrations and deposition. All of these conceptual model components also appear on the OSM Programmatic model, as well as in the Adaptive Monitoring framework. This work will continue to provide necessary data for linking stressors to responses and determine the relative impact of various pressures on deposition and ecosystem responses.

How will this work advance understanding transition towards adaptive monitoring?

See Supplemental Attachment #9 for a graphical description of how monitoring activities described in this work plan fit within the Adaptive Monitoring framework. This work plan will continue to transition to an Adaptive Monitoring framework by continuing to develop baselines and limits of change, via the TAC, for deposition surveillance monitoring. The modelling component of this work plan can provide quantitative answers to Adaptive Monitoring questions such as the extent to which change has occurred, the extent to which change is due to oil sands sources, regions expected to be most sensitive to change for potential monitoring network adaptation, predict the effectiveness of potential mitigation strategies in advance of their implementation, and provide advice on Adaptive Monitoring. For example, post-processing of model simulations was used for input to WBEA’s Monitoring Network Analysis in FY2023/2024.

Is the work plan contributing to Programmatic State of Environment Reporting? If yes, please identify potential linkages to relevant sections of the State of Environment Report.

Yes, monitoring and modelling from previous iterations of this work plan are being used in the Programmatic State of Environment reporting. Project team members from this work plan contributed data, analyses, figures, and text to the SoE report, and will continue to do so as required.

4.0 Mitigation

Evaluation of Mitigation Criteria (Information Box Only- No action required)
Your workplan will be evaluated against the criteria below. A successful workplan would potentially inform:

- efficacy of an existing regulation or policy
- an EPEA approval condition
- a regional framework (i.e., LARP)
- an emerging issue

Explain how your monitoring program informs management, policy and regulatory compliance. As relevant consider adaptive monitoring and the approved Key Questions in your response.

The deposition monitoring program addresses multiple objectives and scientific questions as identified in the EPEA approvals, Acid Deposition Management Framework, 2009 Alberta Ambient Air Monitoring Strategy, 2019-2024 Alberta Science Strategy, and OSM Monitoring Objectives.

Some recent EPEA approvals for some OS facilities require the approval holder to submit a deposition monitoring plan for acid deposition. Monitoring captured under this work plan, specifically the forest health monitoring network in the southern region of the AOSR and the Cold Lake OSR, help fulfill this regulatory requirement. Some EPEA approvals also require snow contaminant monitoring, which might be fulfilled by the snowpack contaminant monitoring in this work plan. Monitoring data are also used to evaluate a provincial deposition model that calculates acid critical load exceedances through the provincial Acid Deposition Management Framework (ADMF). Team members of this work plan will ensure that proponents of the ADMF are kept informed, through the Acid Deposition Assessment Group (ADAG), about results of acidic critical load exceedances work detailed in this work plan and will work together to promote alignment and resolve any differences related to methodology or reporting results.

The vegetative changes linked to deposition recently observed at Jack Pine and wetland bog sites are emerging issues that require on-going monitoring to track changes. Atmospheric deposition monitoring is a key component of the comprehensive provincial ambient air quality management plan as outlined in the 2009 Ambient Air Monitoring Strategy for Alberta. In addition, the monitoring activities in this work plan address the 2019-2024 Alberta's Science Strategy "Priority Area of Environmental Monitoring for Chemical Contaminants and Biological Stressors in the Environment" by producing timely, credible monitoring and reporting of chemical contaminants and/or biological stressors of concern entering the environment in order to assess whether, through exposure, there are potential or observed impacts on human and/or ecosystem health. The deposition and exposure to contaminants (e.g., trace metals, PACs) are also an emerging issue, in the sense they are less well characterized and of concern to communities. GEM-MACH simulations can also be used to compare pre- and post-mitigation deposition, thus providing a quantitative estimate of effectiveness of mitigation, prior to the introduction of the mitigation action itself. The deposition of atmospheric carbon in the gas-phase is an emerging issue identified in FY2023-2024 – this may have implications for critical load exceedance estimates in the area, in addition to ecosystem exposure to potentially hazardous carbon species. Follow-up ground-based monitoring and sample analysis in the laboratory is needed to determine impacts on ecosystems.

Supplement Attachment #9 shows how this monitoring program fits within the Adaptive Monitoring Framework. The approved Key Questions are actively being addressed by the monitoring program.

5.0 Indigenous Issues

Evaluation of Indigenous Issues Criteria (Information Box Only- No action required)

Your workplan will be evaluated against the criteria below. A successful workplan would potentially:

- Investigate Indigenous communities key questions and concerns
- Includes culturally relevant receptor(s) and indicator(s)
- Include or be driven by Indigenous communities (participatory or collaborative)
- Develop capacity in Indigenous communities
- Include a Council Resolution or Letter of Support from one or more Indigenous communities
- Describe how ethics protocols and best practices regarding involvement of Indigenous peoples will be adhered to
- Provide information on how Indigenous Knowledge will be collected, interpreted, validated, and used in a way that meets community Indigenous Knowledge protocols

Explain how your monitoring activities are inclusive and respond to Indigenous key questions and concerns and inform the ability to understand impacts on concerns and inform Section 35 Rights

This work plan monitors a wide range of contaminants (e.g., PACs, trace metals) that are of concern to communities. There are potential impacts of contaminants on wildlife health and human health through consumption of country foods. Deposition monitoring data are also used to assess ecological changes to forests, wetlands, and surface water quality, which are relevant to communities and contain resources of importance. GEM-MACH's capabilities have been assessed regarding predicting odour events, sulphur and nitrogen deposition, and attributing the sources of these events. Human and ecosystem exposure to a range of pollutants can be provided as maps generated from GEM-MACH simulations. Participatory community involvement is undertaken during snowpack sampling and through membership in airshed organizations.

The WBEA's long-term surveillance program was initiated due to concerns expressed by local Indigenous community members about the potential impacts of atmospheric deposition on forest health and they have continued to be key participants in the technical and general membership that oversees this surveillance program. Additionally, the WBEA is working in partnership with ACFN and MCFN to expand deposition monitoring into the Peace Athabasca Delta, in alignment with an ICBM workplan.

Indigenous representatives on the Air and Deposition TAC have requested specific GEM-MACH scenarios designed to examine baseline and source attribution for specific source sectors (e.g. mine fleet, large stacks, settling ponds) on air concentrations and deposition. The GEM-MACH project team will meet with Indigenous representatives to communicate the results of scenario simulations, and work with communities to identify future scenario simulations.

The SLFN focused study embedded within this core work plan directly investigates Indigenous community key questions and concerns and is driven by SLFN. The focused study will first document effects experienced by community members, as well as analyze existing data sets (i.e., GEM-MACH, snowpack, and ambient air data) to assess linkages between OS sources and receptors.

Does this project include an Integrated Community Based Monitoring Component?

No

If YES, please complete the ICBM Abbreviated Work Plan Forms and submit using the link below

ICBM WORK PLAN SUBMISSION LINK

5.1 Alignment with Interim Ethical Guidelines for ICBM in the OSM Program

Are there any community specific protocols that will be followed?

No

Does the work plan involve methods for Indigenous participants to share information or knowledge (e.g. interview, focus group, survey/structured interview), or any other Indigenous participation? If yes, describe how risks and harms will be assessed, and the consent process that will be used.

N/A

Do the activities include any other collecting/sharing, interpreting, or applying Indigenous knowledge? Please describe how these activities will be conducted in alignment with the Interim Ethical Guidelines, and any community-based protocols and/or guidelines that may also apply.

No

Indicate how Indigenous communities / Indigenous knowledge holders will be involved to ensure appropriate analysis, interpretation and application of data and knowledge.

N/A

How are Indigenous communities involved in identifying or confirming the appropriateness of approach, methods, and/or indicators?

N/A

How does this work plan directly benefit Indigenous communities? How does it support building capacity in Indigenous communities?

N/A

How is the information from this work plan going to be reported back to Indigenous communities in a way that is accessible, transparent and easy to understand?

N/A

6.0 Measuring Change

Evaluation of Measuring Change Criteria (Information Box Only- No action required)

Your workplan will be evaluated against the criteria below. A successful workplan would potentially:

- assess changes in environmental conditions compared to baseline (e.g., validation of EIA predictions)
- report uncertainty in estimates and monitoring is of sufficient power to detect change due to oil sands development on reasonable temporal or spatial scales
- include indicators along the spectrum of response (e.g., individual, population, community)
- focus on areas of highest risk (where change is detected, where change is greater than expected, where development is expected to expand collection of baseline).
- measure change along a stressor gradient or a stressor/reference comparison

Explain how your monitoring identifies environmental changes and how can be assessed against a baseline condition. As relevant, consider adaptive monitoring, the TAC specific Scope of Work document and the Key Questions in your response.

This work plan monitors along a spatial gradient of deposition around the surface-mineable region, and can use reference sites to ascertain background deposition. The TAC is formalizing definitions for 'baseline' and 'limits of change' to assess the extent to which change has occurred. Temporal changes have been assessed for some parameters with a sufficiently long historical data set (e.g., SO2 and NO2 passives, Ion Exchange Resins, metals/ions/total suspended sediment/total organic carbon in snowpack samples, and PACs in sediment cores). Source attribution techniques and GEM-MACH modelling scenarios have been used and will continue to be used to delineate change in deposition due to OS and non-OS sources, and the relative contribution of different sources within the OSR towards change. Deposition data (measured and modelled) are also used by other themes to identify environmental changes, such as vegetative changes at wetland bog sites, and PACs loadings in specific biota or ecosystem compartments (e.g., sediments). Deposition monitoring is focused on the surface-mineable region where the change in deposition and risk for ecological response from deposition is the greatest, although has been expanded in the Southern AOSR and the Cold Lake Region as required by recent EPEA approval clauses and to fill previously identified monitoring gaps. Modelling is used for estimating deposition in both the surface mineable region and for ecosystems much further downwind and has suggested impacts may potentially occur in sensitive ecosystems hundreds of kilometres downwind of the sources. Spatial maps of deposition generated by GEM-MACH and/or measurement data (when available) will continue to be used to identify regions of highest risk (e.g., in the in situ regions for acidifying deposition), allowing for adaptive monitoring as defined by the Adaptive Monitoring framework.

7.0 Accounting for Scale

Evaluation of Accounting for Scale Criteria (Information Box Only- No action required)

Your workplan will be evaluated against the criteria below. A successful workplan would potentially be:

- appropriate to the key question and indicator of interest
- relevant to sub-regional and regional questions
- relevant to organism, population and/or community levels of biological organization
- where modelled results are validated with monitored data
- where monitoring informs on environmental processes that occur at a regional scale. e.g. Characterizing individual sources to gain a regional estimate of acid deposition and understand signal from individual contributing sources.

Explain how your monitoring tracks regional and sub-regional state of the environment, including cumulative effects. As relevant, consider adaptive monitoring, the TAC specific Scope of Work document and the Key Questions in your response.

Deposition monitoring at ecological sites where deposition is causing an observed or likely response helps to track sub-regional state of the environment. Hence, monitoring the deposition of key stressors at forest, wetland, and near-river sites are necessary for answering "are changes occurring?" and "are these changes related to OS emissions?". As noted in Objective #9, deposition data are, and will continue to be, used for comparing to modelled data. Monitored and modelled deposition data are also used, and in some cases combined (model-measurement fusion), to create deposition maps which provide a regional perspective to inform environmental processes (e.g., acidification, eutrophication, contaminant exposure). These depositions maps are needed, and currently used, by other work plans and theme areas for informing site selection and understanding contaminant exposure via deposition. GEM-MACH was evaluated against observations in 2022-23 and 2023-24, leading to improvements in model performance – evaluations will continue in the future as a regular core activity as emissions sources change and modelling science improves. Evaluated GEM-MACH deposition maps provide deposition estimates in areas without monitoring stations, thereby allowing Adaptive Monitoring endpoints and cumulative effects to be assessed across the entire oil sands region and impacted regions further downwind. These maps identify regions at greatest risk of environment change, hence feed into the adaptive monitoring concept. The model output has also been used to assist in Network Analysis – determining the degree of similarity between existing monitoring stations, and the best locations for new or re-located monitoring stations.

8.0 Transparency

Evaluation of Transparency Criteria (Information Box Only- No action required)
Your workplan will be evaluated against the criteria below. A successful workplan would potentially include:

- a plan for dissemination of monitoring data, including appropriate timing, format, and aligns with OSM program data management plan
- demonstrated transparency in past performance
- identified an annual progress report as a deliverable
- reporting of monitoring results occurs at timing and format that is appropriate for recipient audience.

Explain how your monitoring generates data and reporting that is accessible, credible and useful. As relevant, consider adaptive monitoring, the TAC specific Scope of Work document and the Key Questions in your response.

Monitoring data, including summary model output maps, are made publicly available on appropriate timescales in appropriate formats at the following websites: https://www.alberta.ca/alberta-air-data-warehouse.aspx, WBEA website (www.wbea.org) and the WBEA time-integrated data search tool (https://wbea.org/data/time-integrated-data-search/), and https://www.canada.ca/en/environment-climate-change/services/oil-sands-monitoring.html. Some data are available within months of collection (e.g., passive gas samplers), whereas other samples (e.g., snowpack, lichen) require extensive lab analysis and QA/QC prior to being posted. Data are also available on the OSM data catalogue. Annual progress reports are delivered by each airshed organization and through this work plan. Project team members listed in this work plan provided data, figures, analyses, and text for the programmatic State of Environment (SoE) report. Data and findings are shared during TAC and other working group meetings as well as publicly available via the oil sands data catalogue. Journal paper drafts will continue to be submitted for information and comment to stakeholders and TACs, as well as through the formal OSM publication review process. List of published journal papers and links to their full text are publicly available at https://www.canada.ca/en/environment-climate-change/services/oil-sands-monitoring/scientific-papers-presentations.html. Deposition maps will be made available through the OSM Data Catalogue in a user-friendly format (e.g., GIS .kml files).

9.0 Efficiency

Evaluation of Efficiency Criteria (Information Box Only- No action required)
Your workplan will be evaluated against the criteria below. A successful workplan would include:

- appropriately addressed a risk-informed allocation of resources
- identified the role and justification for each staff member on the proposed work plan
- identified in-kind and leveraged resources (e.g., resources and approaches are appropriately shared with other OSM projects where possible)
- established partnerships (value-added) and demonstrated examples of coordinated efficiencies (e.g., field, analytical)
- identified co-location of monitoring effort
- demonstrated monitoring activities and information collected are not duplicative
- considered sampling/measurement/methods compatibility to other data sources (e.g., AER)

Explain how your monitoring is integrated with other OSM projects and incorporates community-based participation and/or engagement in proposed monitoring activities. As relevant, consider adaptive monitoring, the TAC specific Scope of Work document and the Key Questions in your response.

The allocation of resources in this work plan is focused on deposition and effects monitoring where evidence for a link between an OS-related stressor and an ecological effect is greatest. Specifically, the majority of the proposed budget is allocated to monitoring and modelling nitrogen, sulphur, and base cation deposition at jack pine, soil, and wetland bog sites, where changes in vegetation as a result of deposition of these stressors has been reported. The next largest allocation of resources is for snowpack and lichen sampling of nitrogen, sulphur, base cations, PACs, trace metals, and mercury, which is used by the Aquatic Ecosystem Health work plan to assess contaminant input into nearby rivers and input of snowmelt into groundwater reservoirs (via a mass balance approach). This work plan is also integrated with the Atmospheric Pollutant Active Monitoring Network work plan (A-LTM-S-1-2324). Data from each program informs the collective understanding of the impact of oil sands development on air quality and atmospheric deposition.

The cost of purchasing, implementing, operating, and maintaining atmospheric deposition monitoring stations is significant and, in many cases, more expensive in the oil sands region because of challenges with power and road access. However, the monitoring sites have multiple monitoring objectives and management frameworks that need to be addressed (EPEA approvals, ADMF, 2009 Alberta Ambient Air Monitoring Strategy, 2019-2024 Alberta Science Strategy, OSM Monitoring Objectives). GEM-MACH model output is in use for Monitoring Network Analysis, with post-processing of model output using hierarchical clustering feeding into monitoring station location decision-making, for more efficient use of resources.

This work includes a significant degree of in-kind and leveraged resources (equivalent to $5,135,870). Through ECCC's participation, the OSM Program accesses a team of over 70 research scientists, as well as additional work by university researchers funded under ECCC's Grant and Contribution Research program. This in-kind contribution includes access to ECCC's continuously upgraded supercomputer systems for the modelling work (currently two Lenovo ThinkSystem Xeon Platinum 8380's, each with 148,000 processors, ranked 85th and 86th in the world), and the analysis laboratories, instrumentation, and infrastructure within the ECCC Processes Research and Measurements and Analyses sections. The in-kind work also includes upgrades to the GEM-MACH model resulting from non-OSM projects within ECCC. The data collected by past focused studies conducted under the OSM program continue to be leveraged in the improvement and application of GEM-MACH for OS simulations.

Specific roles are provided in Section 15, and the specific in-kind contributions from ECCC for equipment and staff time are listed in Section 18. There are coordinated efficiencies between partner organizations on this project, such as coordinated sample change out at sites with multiple types of samplers. Most of the deposition monitoring sites are co-located at ecological effects monitoring sites. Based on previous workshops and reports (i.e., Horb et al., 2021; Wentworth and Zhang, 2018; Swanson 2019a,b), there is little-to-no duplicative deposition monitoring in the OS Regions.

10.0 Work Plan Approach/Methods

List the Key Project Phases and Provide Bullets for Each Major Task under Each Project Phase

Note: these phases occur concurrently

PHASE 1: Ambient Deposition Surveillance Monitoring

Deploy and/or maintain, and analyze/interpret:
- Open and throughfall IERs to calculate wet and total nitrogen, sulphur, and base cation deposition at jack pine sites.
- Annular denuders and filter packs to calculate dry deposition of NH3, HNO3, and particulate matter components at selected WBEA sites.
- Passive gas samplers, co-located with denuders, to calculate dry deposition of SO2, NO2, and O3 at selected WBEA sites.
- Passive gas samplers to calculate dry deposition of SO2, NO2, NH3, HNO3, and O3 at jack pine, Peace River, and Cold Lake soil sites.
- Annular denuders and filter packs to calculate dry deposition of NH3, HNO3, SO2, and particulate matter components at selected WBEA sites.
- Portable ozone monitors to measure dry deposition of O3 at selected WBEA sites. Portable ozone monitors to measure ozone intrusion from the stratosphere to the troposphere in the late spring and understand how that contributes to ozone concentrations in the region
- PACs (and now trace metals too) passive samplers to calculate dry deposition at selected jack pine, wetland, and air quality stations.
- Snowpack samples for PACs, trace metals, nitrogen, sulphur, phosphorous, and speciated mercury to calculate accumulated wintertime deposition across the surface-mineable region. These data are required by the Aquatic Ecosystem Health work plan. Samples are also shared with the Groundwater program for isotopic analysis and with the Air program for organic carbon deposition analysis.
- Continuous nitrogen and sulphur species, combined with existing CAPMoN filter pack and precipitation measurements, to calculate total deposition at two transboundary sites. These two transboundary sites also have base cation and precipitation monitoring that is not funded by the OSM Program. This work will be adapted in 2024/25 and 2026/27 to end enhanced CAPMoN measurements at the Flat Valley site and Pinehouse Lake site, respectively. The Flat Valley site is influenced by local emissions, and 2026/27 will have allowed for sufficient data collection at the Pinehouse Lake site to quantify impacts from OS emissions.
- Collect monthly precipitation samples at three sites for isotopic analysis, on behalf of the Groundwater TAC.
- Analyze and interpret previous collected lichen samples to understand deposition patterns of N, S, base cations, trace metals, and PACs in the Athabasca Oil Sands region.
- Generate deposition maps for snowpack contaminants in collaboration with the Geospatial work plan, and conduct source attribution studies, as required by other themes, and compare these to maps provided by GEM-MACH.

PHASE 2: Effects Surveillance Monitoring

- Collect soil samples for acidification indicators at a soil plot in the Cold Lake region.
- Analyze passive samplers using health assays to assess potential health effects (e.g., oxidative potential) from exposure to PACs and trace metals. Samples will also be analyzed for bioaerosols (environmental DNA) and linked to health assessment, biodiversity and source apportionment.
- Conduct oxidation experiments air emissions of tailings samples and assess potential health effects from exposure to oxidized species and their contribution to ambient passive sample results (see Supplemental Attachment #10).
- Conduct intensive sampling for Forest Health ecological indicators (e.g., soil, foliage, lichen) at jack pine

sites. This work is conducted on a 1-in-6 year cycle, with the summer of 2024 being an intensive sampling campaign.

PHASE 3: Model Development and Comparison to Observations

•Dispersion modeling to improve our understanding of specific emission sources of PACs and associated regional-scale distributions of ambient concentrations, atmospheric deposition, and toxicity.
•GEM-MACH Modelling: GEM-MACH air quality and deposition output is being used as a core component in a 'service delivery' role of the OSM Program from 2023-24 and beyond, such that the model will have been sufficiently evaluated and will be used to provide annual deposition maps and other model scenarios/ forecasts on an on-going basis. Evaluation of the model is expected to continue as an ongoing activity as emissions sources change and modelling science improves. The TAC is prioritizing scenario simulations to run, and the Indigenous TAC reps have indicated that GEM-MACH is a core component of the OSM Program, requesting specific scenarios to help determine baseline and source apportionment by emitting source type (mine fleet versus stack emissions versus tailings ponds)
•During previous fiscal years, the following activities took place (see Supplemental Attachment #10 for more details): (i) comprehensive model evaluation, leading to findings reported in section 1.0 and improvements to model performance, (ii) emissions updates, (iii) model process improvements, (iv) odour event source analysis and forecasting, (v) model-measurement comparison, (vi) stakeholder consultation on desired model scenario runs and forecasts, and (vii) transition of modelling products to a service delivery (core) part of the OSM Program.
•During 2024/25, the following activities will take place: (i) the documentation of model evaluation carried out in 2022/2023 and 2023/2024 will be completed (in the form of a high-level report for the SIKIC and accompanying peer-review paper detailing the results of the model-measurement comparison), (ii) model deposition, concentration, and predicted environmental impacts maps will continue to be provided to stakeholders and other TACS, (iii) Adaptive Monitoring products, such as baseline maps generated from "no oil sands emissions" and maps of changes relative to the baseline, will be generated using model output, (iv) emissions will be updated for ongoing annual deposition maps, to improve odour event forecasts, and in response to evaluation results, (v) model process improvements based on evaluations will continue, (vi) stakeholder consultation via TAC on desired core model scenario runs and forecasts will continue, (vii) requests for special model products such as post-processing analysis for network analysis purposes will continue to be addressed as these needs arise.
•Provide emission factors to GEM-MACH for tailings pond emissions by conducting laboratory analyses of tailing pond sample air emissions and transformation (see Supplemental Attachment #10.
•Provide estimates of organic carbon deposition and chemical deposition in winter for comparison to GEM-MACH by laboratory analysis of snow sample organic carbon deposition (see Supplemental Attachment #10).
•Generate deposition maps for stressors in collaboration with the Geospatial work plan, and conduct source attribution studies, as required by other themes.

PHASE 4: Improving deposition sampling and further aligning with the Adaptive Monitoring framework
•Continue to deploy all deposition monitoring technologies at a single "test site" to continually assess the comparability of data generated by complementary deposition monitoring techniques.
•Continue testing surrogate surface samplers for quantifying and characterizing fugitive dust deposition.
•Ambient PACs levels in air have not changed significantly since 2012. The number of PACs passive air monitoring sites were reduced, and some are being redeployed to the Cold Lake and Peace River OSRs.
In 2024-25 some samplers will be redeployed at community sites to link with the PM Health assessment work.
•Spatial maps of lichen concentrations and snowpack deposition will be integrated to better understand annual deposition rates of fugitive dust, PACs, and trace metals.

•Use model estimates of critical load and critical level exceedances to identify locations most at-risk for change, and hence possible adaptation of surveillance monitoring.
•Continue to develop definitions for “baseline” and “limits of change” for deposition indicators. This will be done through the Air and Deposition TAC.
•Develop a shared understanding of regulatory and community expectations for monitoring that will guide the adjustment of the current long-term surveillance program to fit the OSM adaptive monitoring framework.

Describe how changes in environmental Condition will be assessed

In general, changes in the environment are assessed in three different ways: i) analyzing changes in observed and modelled deposition over time, ii) analyzing changes in observed and modelled deposition over space, and iii) conducting “zero-out” (baseline, no oil sands emissions), past, and projected future year emissions scenarios with models (i.e., setting specific sources in the model to zero and comparing modelled data with and without a specific source). Deposition monitoring sites are primarily set up along a spatial gradient around known emission sources allowing for the detection of change in deposition across the landscape. Modelling is used to identify locations where ecosystem change is most likely to occur or may have occurred in the past, and to help establish likely baseline levels in the absence of oil sands emissions and changes relative to those baselines. Deposition monitoring is used to assess change over time for at least as far back as the monitoring data are available, and in some cases even further (e.g., using tree cores, sediment cores). Changes in deposition are linked to assessing environmental effects indicators through co-location of deposition monitoring at jack pine, and soil sites. Chemical transport and dispersion models, as well as source attribution techniques, are used to quantify changes in deposition based on specific emission sources. The potential for future change is assessed using model and projections of future emissions and/or mitigation activities.

However, “baseline” and “change” have not been formally defined within the context of the OSM Adaptive Monitoring framework. Hence, the TAC will continue to develop baseline and limits of change for deposition indicators.

Are there Benchmarks Being Used to Assess Changes in Environmental Condition? If So, Please Describe, If Not, State "NONE"

There are only a few Alberta-specific benchmarks for deposition: critical loads of acidity (e.g., WBEA, 2015; Makar et al., 2018), and critical levels for annual sulphur dioxide and nitrogen dioxide air concentrations (i.e., Alberta’s Ambient Air Quality Objectives, and Lower Athabasca Regional Plan annual limits/triggers). The CEMA Acid Deposition Management Framework (ADMF) and Interim Nitrogen (Eutrophication) Framework also have some relevant regional thresholds for acidification and eutrophication, respectively. Team members of this work plan will ensure that proponents of the ADMF are kept informed, through the Acid Deposition Assessment Group (ADAG), about results of acidic critical load and level exceedances work detailed in this work plan and will work together to promote alignment and resolve any differences related to methodology or reporting results. Most relevant benchmarks are for concentrations or loadings within the ecosystem after a substance has deposited – these benchmarks are assessed by other themes. Spatial, temporal, and source-specific changes have been assessed against a “background” benchmark, which is what the deposition would be in the absence of anthropogenic emissions and may be quantitatively assessed through model scenario simulations. Change in ecological indicators (i.e., a response) is often assessed by other themes using, in part, deposition monitoring data and/or GEM-MACH modelling. Some effects surveillance monitoring (i.e., soil acidification, vegetation changes, bog effects monitoring, human health assays) is done under this work plan.

(e.g., objectives, tiers, triggers, limits, reference conditions, thresholds, etc.)

Provide a Brief Description of the Western Science or Community-Based Monitoring Indigenous Community-Based Monitoring Methods by Project Phase

PHASE 1: Ambient Deposition Surveillance Monitoring

•Ion Exchange Resin (IER): a precipitation collector that contains resin beads which retain sulphate, ammonium, nitrate, and base cations over a 6-month period. Samples are extracted in a lab and wet or throughfall deposition is calculated.
•Passive Gas Samplers: a diffusive membrane collects a single air pollutant onto a sampling medium over a 1-month, 2-month, or 3-month time period. Samples are extracted in a lab and average air concentrations over the sampling period are calculated. An inferential model (requiring meteorological data) is then used to estimate dry deposition.
•Annual Denuders and Filter Packs: air is actively pumped through an annular denuder to capture gases in the air. Filter packs are located behind the denuder to capture particulate matter. Denuders and filters are collected monthly and provide a more accurate measurement than passive samplers, as well as particulate matter composition. Denuders and filters simultaneously monitor multiple pollutants, including: nitric acid, ammonia, and particulate matter composition, and the WBEA begins to plan trialing sulphur dioxide this year. Samples are extracted in a lab and average air concentrations over the sampling period are calculated. An inferential model (requiring meteorological data) is then used to estimate dry deposition.
•Portable Ozone Monitors: air is actively pulled through a continuous analyzer (using a pump) to monitor 15-minute averaged ozone concentrations. Data are reported in near-real time and the monitors only need to be visited for maintenance and repair (i.e., no lab extraction or analysis is needed). An inferential model (requiring meteorological data) is then used to estimate dry deposition.
•Snowpack Sampling: collect snow samples with members of Mikisew Cree First Nation and quantify PACs, mercury, and trace metals using state-of-the-science techniques described in Kirk et al. (2014). Calculate wintertime deposition using snowpack concentrations, depth, and density. Data are required by the Aquatic Ecosystem Health work plan to calculate contaminant mass balance in rivers and tributaries, and provide background values for metals deposition.
•Meteorological Towers: continuously measure standard meteorological parameters (e.g., temperature, wind speed, wind direction) at heights within and above the canopy. These data are used to calculate dry deposition and to provide input data to dispersion models.
•Wet Deposition Sampling: collect weekly wet-only precipitation samples using an automated collector. Isotopic analysis of precipitation is covered under the Groundwater Monitoring work plan (GW-LTM-S-3-2122).
•Continuous Analyzers: a variety of continuous and integrated air sampling monitors are deployed at the two long-range deposition sites in Saskatchewan. The continuous measurements complement the existing Canadian Air and Precipitation Monitoring Network (CAPMoN) instrumentation at these sites. The integrated sample parameters are monitored through an in-kind contribution from CAPMoN.
•Lichen Sampling: lichen samples are collected from ~180 sites around the Athabasca OSR every 6 years, and at a smaller spatial scale during forest health monitoring sampling campaigns, and analyzed for sulphur, nitrogen, trace elements, and PACs. These data are used to estimate atmospheric deposition patterns and to conduct source apportionment modelling. Activities for this fiscal year are restricted to analysis and results of previously collected samples.

PHASE 2: Effects Surveillance Monitoring
•Soil Sampling: collect soil samples at 7 different depths and a leaf litter sample in the Cold Lake OSR. Analyze samples for indicators of potential acidification (e.g., pH, total C, total N, total S, and cation exchange capacity) using standard analytical techniques.
•Forest Health Monitoring: soil and vegetation sampling occurs every sixth year in the Athabasca OSR. In 2021-22, two new forest health sites were established in the southern area of the Athabasca OSR due to gaps in this area of the network and new requirements of southern operators to participate in a regional deposition program. Activities for this fiscal year are the intensive 1-in-6 forest health indicator sampling, which include soil, foliage, and lichen sampling, as well as vegetation surveys, and tree coring at Forest Health Monitoring plots.
•Health Assays: extracts of PACs, trace metals and PM are taken from air samplers (see Phase 1) and subjected to chemical assays that are a proxy for human health. These data give a relative indication of potential health effects from airborne contaminants.

•Bioaerosols: new methods have been validated and applied to measure bacteria and fungi in air and can be extended in future work to include other forms of environmental DNA (eDNA) with potential to link to assessment of environmental effects, including PM health and tracking biodiversity using ambient air.

PHASE 3: Model Development, Comparison to Observations, and Provision of Model Output to fulfill OSMP Priorities
•Use available measurement data of air concentrations of PAHs and alkylated-PAHs to constrain and update emission databases of these pollutants based on dispersion modeling results. Dispersion modeling sensitivity tests will then be conducted to assess the relative contributions of OS-related and non-OS emissions to the total air concentration, atmospheric deposition, and toxicity of these pollutants in the whole region. This approach is analogous to the approach used for generating trace metals deposition maps for this work plan in previous fiscal years.
•GEM-MACH work will include provision and dissemination of:, (i) high priority model scenario simulations (identified through the TAC) to meet OSMP objectives, (ii) model deposition maps (including model-measurement fusion results) in GIS format for stakeholders and other groups, (iii) model maps aimed at Adaptive Monitoring needs (e.g., from baseline zero-out emissions scenarios and maps showing change relative to this baseline, and from source-specific zero-out or emissions reduction scenarios, to provide maps showing relative impacts associated with different oil sands sources and the potential effects of different levels of emissions reductions) , (iv) odour event and other relevant model products relevant to Indigenous communities, (v) model output post-processing based on stakeholder needs and requests (e.g. for monitoring network analysis).

PHASE 4: Improving deposition sampling and further aligning with the Adaptive Monitoring framework
• Surrogate surface samplers have been developed to quantify and characterize fugitive dust deposition (see Hall et al., 2017). These samplers are being tested at two WBEA sites in the AOSR to verify their efficacy. If validated, these samplers will provide critical complementary information to snowpack and lichen sampling and improve regional estimates of fugitive dust deposition.
•Methodology described above will be co-located at a test site for the purposes of on-going validation to understand the extent of data comparability.
•The review and documentation of the existing monitoring network objectives, as well development of baselines and limits of change, will be done through the Air and Deposition TAC. Consideration will be given to regulatory and Indigenous criteria for monitoring as it is understood by the Project team and TAC members.

List the Key Indicators Measured, If Not Applicable, State N/A

In some cases, deposition data are used directly to assess potential ecological effects (e.g., acid critical loads). However, more often than not, deposition data are used by effects monitoring in this project, or by other projects, to assess causal linkages to changes in biological indicators. The following bullet points detail which stressors are measured and/or modelled:

•Air concentrations of trace gases (i.e., SO2, NO2, HNO3, NH3, O3, and dozens of polycyclic aromatic compounds) and particulate matter composition (sulphate, nitrate, ammonium, calcium, magnesium, potassium, sodium, and dozens of polycyclic aromatic compounds). These air concentrations are used to calculate dry deposition using an inferential model. Air concentrations of most of these parameters are also provided as GEM-MACH maps.
•Quasi-wet (i.e., open) and throughfall deposition of ions in precipitation (i.e., sulphate, nitrate, ammonium, calcium, magnesium, potassium, and sodium) around the surface-mineable area.
•GEM-MACH maps of wet and dry deposition fluxes of sulphur, nitrogen, and base cation species are provided at 2.5km resolution over all of Alberta and Saskatchewan, as well as maps of critical levels and critical load exceedances. These maps will be provided on both a per-grid-cell basis and by the broad ecosystem classifications resolved within the model.
•Total accumulated wintertime deposition of dozens of PACs, trace metals, mercury, and methylmercury

around the surface-mineable area.
•Wet deposition measurements of ions in precipitation (in-kind) at two long-range CAPMoN sites in Saskatchewan, as well as three sites in the OSR used for isotope analysis (covered by the Groundwater TAC).

11.0 Knowledge Translation

In the space below, please provide the following:

- Describe the plan for knowledge transfer and distribution of learnings from the project. This could include workshops, publications, best practice documentation, marketing plan, etc.
- Demonstrate that the knowledge transfer plan is appropriate for the intended end-users.

Knowledge transfer will occur through several means: TAC meetings, an OSM annual report, peer-reviewed publications, contribution to OSM State of Environment (SoE) reporting, and airshed annual reports. It is expected that TAC members will disseminate pertinent information from these meetings to their respective organizations. Peer-review publications listed in Section 14 will transfer knowledge to the OSM Program through internal review processes, as well as the broader scientific community thereby providing a degree of scientific credibility to OS deposition monitoring program. Airshed and project annual reports will contain high-level summaries of data that have been collected.

12.0 External Partners

List by project or project phase each component that will be delivered by an external party (including analytical laboratories) and name the party. Describe and name the associate work plan/grant/contract for these services. * state none if not required

•Airshed organizations (WBEA, LICA, and PRAMP) will deliver components of all four phases. The associated contracts for WBEA, LICA, and PRAMP are 24RSD828, 24RSD829, and 24RSD822, respectively. Airshed organizations are also contracted to swap out passive air samplers and collect precipitation samples on behalf of ECCC and the Groundwater TAC.
•Portions of the modelling component of this proposal (Phase 3) will be delivered through external contractors hired by ECCC. Emissions data for model simulations are gathered with the assistance of AEP and industry sources, as well as ECCC's National Pollutant Release Inventory. Additional collaborators may be identified as the project proceeds.
•Tailings pond sample collection and supporting information will require and will be conducted in collaboration with industry partners.

*To ensure complete work plan proposal submission, all grants and contracts listed in this section should also be captured in Grants & Contracts.

13.0 Data Sharing and Data Management

For 2024-25 the following approach will be taken by the OSM Program related to data sharing.

For all work plans of a **western science** nature funded under the OSM Program, data sharing is a condition of funding and must align with the principle of **"Open by Default"**. In this case, all data is to be shared with the OSM Program as directed by the OSM Program Data Management work plan.

For all work plans involving **Indigenous Knowledge** as defined below and funded under the OSM Program, data sharing is a condition of funding and the Indigenous Knowledge components of the work plan must align with the principle of **"Protected by Default".** In this case, all data as defined as Indigenous Knowledge, are to be retained by the Indigenous community to which the Indigenous Knowledge is held.

Indigenous Knowledge is defined as:

*"*The knowledge held by First Nations, Inuit and Métis peoples, the Aboriginal peoples of Canada. Traditional knowledge is specific to place, usually transmitted orally, and rooted in the experience of multiple generations. It is determined by an Aboriginal community's land, environment, region, culture and language. Traditional knowledge is usually described by Aboriginal peoples as holistic, involving body, mind, feelings and spirit. Knowledge may be expressed in symbols, arts, ceremonial and everyday practices, narratives and, especially, in relationships. The word tradition is not necessarily synonymous with old. Traditional knowledge is held collectively by all members of a community, although some members may have particular responsibility for its transmission. It includes preserved knowledge created by, and received from, past generations and innovations and new knowledge transmitted to subsequent generations. In international or scholarly discourse, the terms traditional knowledge and Indigenous knowledge are sometimes used interchangeably.*"*

This definition was taken from the Canadian Government's Tri-council Policy Statement for Ethical Research involving Humans (Chapter 9, pg. 113) and is an interim definition specific to the Oil Sands Monitoring Program.

13.1 Has there, or will there be, a Data Sharing agreement established through this Project? *

No

13.2 Type of Quantitative Data Variables**:**

Both

13.3 Frequency of Collection:

Other

13.4 Estimated Data Collection Start Date:

1-Apr-2024

13.5 Estimated Data Collection End Date:

31-Mar-2025

13.6 Estimated Timeline For Upload Start Date:

1-Jun-2024

13.7 Estimated Timeline For Upload End Date:

30-Sep-2025

13.8 Will the data include traditional knowledge as defined by and provided by an Indigenous representative, Community or Organization?

No

Table 13.9 Please describe below the Location of Data and Data Type:

Add a Data Source by clicking on the add row on the bottom right side of table

Name of Dataset	Location of Dataset (E.g.:Path, Website, Database, etc.)	Data File Formats (E.g.: csv, txt, API, accdb, xlsx, etc.)	Security Classification
Ion Exchange Resin (WBEA sites)	https://wbea.org/data/time-integrated-data-search/	.csv	Open by Default
GEM-MACH Output, datasets for model-measurement comparison	ECCC OSM data catalogue	GIS shapefiles	Open by Default
Passives (NO2, NH3, HNO3, SO2, and O3)	https://wbea.org/data/time-integrated-data-search/ https://lica.ca/airshed/report-tracking/non-continuous-monitoring-data-reports/ https://prampairshed.ca/air-monitoring/monitoring-reports/	.csv	Open by Default
Denuders and Filter Packs	https://wbea.org/data/time-integrated-data-search/	.csv	Open by Default
Portable ozone monitors	https://wbea.org/data/time-integrated-data-search/	.csv	Open by Default
Enhanced N&S measurements at CAPMoN sites	ECCC OSM data catalogue	.csv	Open by Default
Snowpack Samples	ECCC OSM data catalogue	.csv	Open by Default
PAC Passive Samplers	ECCC OSM data catalogue	.csv	Open by Default
Talings pond Total Organic carbon air emissions	ECCC OSM data catalogue	.csv	Open by Default
Talings pond oxidized VOC emissions	ECCC OSM data catalogue	.csv	Open by Default
Soil Samples	www.lica.ca https://wbea.org/data/time-integrated-data-search/	.csv	Open by Default
Lichen Samples	https://wbea.org/data/time-integrated-data-search/	.csv	Open by Default

14.0 2024/25 Deliverables

Add an additional deliverable by clicking on the add row on the bottom right side of table

Type of Deliverable	Delivery Date	Description
Other (Describe in Description Section)	Q4	On-going sample collection, site maintenance, analysis, and data processing for routine monitoring
OSM Program Annual Progress Report (required)	Q4	OSM Annual Progress Report
Condition of Environment Report	Q4	Contribute to OSM State of Environment report, as required
Other (Describe in Description Section)	Q4	GEM-MACH model products delivered as GIS and csv files to the ECCC OSM Data Catalogue. Maps of deposition, critical load and level exceedances, baseline (oil sands zero-out scenario) and change relative to baseline; adaptive monitoring. Maps and figures comparing model to observations.
Technical Report	Q3	High-level technical report including comparison of two GEM-MACH 15 month simulations against observations, comparisons between baseline (zero-out) and change relative to baseline.
Peer-reviewed Journal Publication	Q4	ECCC-led journal publications from model-measurement evaluation, odour event analysis and prediction, cumulative effects estimation, model science improvements, and focus study measurement data analysis (i.e., aircraft and laboratory derived emissions and transformation). PAC passives: publication comparing PACs in ambient air at in situ mining sites versus open pit mining areas. PM Health: i) first publication evaluating oxidative potential in air at community sampling sites, and ii) proof-of-concept paper on measurement of bioaerosols (bacteria and fungi) using PAC passives, and iii) calibration study of PAC passives for measuring bioaerosols – enhancing quantitation.

Type of Deliverable	Delivery Date	Description
Stakeholder or Community Presentation	Q2	Webinar on GEM-MACH evaluation using monitoring data, and on the use of the model estimate baseline, change relative to baseline, and example source determination.
Key Engagement/Participation Meeting	Q1	Stakeholder / TAC discussion on next steps for modelling: desired maps and Adaptive Monitoring products for delivery in Q3 to Q4 of FY2024/2025
Key Engagement/Participation Meeting	Q4	Continue TEEM program development and collaboration with science advisors and Knowledge Holders. This includes engagement with communities, science advisors, and stakeholders on FHM program findings and path forward.

15.0 Project Team & Partners

In the space below please provide information on the following:

- Describe key members of the project team, including roles, responsibilities and expertise relevant to the proposed project.
- Describe the competency of this team to complete the project.
- Identify any personnel or expertise gaps for successful completion of the project relative to the OSM Program mandate and discuss how these gaps will be addressed.
- Describe the project management approach and the management structure.

Key (lead) members of the project team include:

•Greg Wentworth (Project Lead and Management) – provide co-ordination between team members, as well as facilitate alignment with the OSM Program and integration with other themes; lead the development of the 5-year draft deposition proposal
•Tyler Veness (SIKIC Support) – provide programmatic oversight
•Sanjay Prasad (Component Lead) – complete deliverables linked to the WBEA
•Michael Bisaga (Component Lead) – complete deliverables linked to LICA and PRAMP
•Lily Lin (Component Lead) – complete deliverables linked to LICA and PRAMP
•Tom Harner (Component Lead) – complete deliverables linked to PACs in air and deposition, and PM health assessment
•Jane Kirk (Component Lead) – complete deliverables linked to snowpack sampling
•Leiming Zhang (Component Lead) – complete deliverables linked to inferential deposition modelling and dispersion modelling
•Jason O'Brien (Component Lead) – complete deliverables linked to enhanced N&S measurements at downwind enhanced CAPMoN sites
•Paul Makar (Component Lead) – complete deliverables linked to GEM-MACH modelling
•John Liggio (Component Lead) – complete deliverables linked to emissions, transformation, and fate data analyses used for GEM-MACH improvements
•Samar Moussa (Component Lead) – complete deliverables linked to emissions from tailings ponds and analyses used for GEM-MACH improvements
•Stoyka Netcheva (ECCC) – Project coordination
•Carrie Taylor (Management)

This team consists of experts who possess substantial knowledge and experience monitoring and modelling each component they lead. There are no major gaps in personnel or expertise, although subject matter experts will be brought in, if required, on an as needs basis for specific issues. There is also a risk of expertise gaps developing if suitable postdoctoral personnel are not found and hired.

The Project Lead is primarily a coordination role and leads the development of the work plan as well as deliverables associated with improving integration and further aligning the project with the Adaptive Monitoring framework. Component Leads directly oversee and deliver on specific components of the work plan, due to their expertise and knowledge. Additional personnel are listed in subsequent sections and assist with sample collection, field work, data analysis, data interpretation, and reporting. There are significant in-kind contributions for staffing and capital costs (equivalent to $5,175,870). Most of the ECCC staff, including component leads, are providing their expertise in-kind.

16.0 Project Human Resources & Financing

Section 16.1 Human Resource Estimates

Building off of the competencies listed in the previous section, please complete the table below. Add additional rows as necessary. This table must include **ALL staff involved** in the project, their role and the % of that staff's time allocated to this work plan. The AEPA calculated amount is based on an estimate of $120,000/year for FTEs. This number cannot be changed. The OSM program recognizes that this is an estimate.

Table 16.1.1 AEPA

Add an additional AEPA Staff member by clicking on the add row below the table. The total FTE (Full Time Equivalent) is Auto Summed (in Table 16.2.1) and converted to a dollar amount.

Name (Last, First)	Role	%Time Allocated to Project
Senior Atmospheric Scientist	Project Lead	30

Table 16.1.2 ECCC

Add an additional ECCC Staff member by clicking on the add row below the table. The total FTE (Full Time Equivalent) is Auto Summed (in Table 16.2.2) and converted to a dollar amount.

Name (Last, First)	Role	%Time Allocated to Project
New Hire (Res01 or PC02)	Statistic and GIS for snowpack adaptive monitoring	100
TBD – Post-Doctoral fellow (ECCC)	ECCC focused study support: Tailings air emission laboratory experiments	100
TBD – Post-Doctoral fellow (ECCC)	ECCC focused study support: snow sample analysis and Health assay support	100
Netcheva, Stoyka	Program Coordination	100
Abu, James	ECCC modelling support	100
Fathi, Sepehr	ECCC modelling support – model/ measurement comparison, plumerise expert	100
Miller, Stefan	ECCC inorganic heterogeneous chemistry modelling and surface pH expert	100
Nikiéma, Oumarou	ECCC scenario simulations for baseline and modelling support (ECCC REQA group).	100
Trotechaud, Sandrine	ECCC scenario simulations for baseline and modelling support (ECCC REQA group).	100
New Hire	ECCC scenario simulations for baseline and modelling support (ECCC REQA group).	100
Griffin, Debora	ECCC Inventories Expert	50
TBD, new ECCC staff	ECCC Emissions OSM processing assistant	100
TBD, new ECCC staff	ECCC secondary organic aerosol modelling	100
Post-Doctoral Fellow, ECCC	ECCC Odour modelling expert	100
Post-Doctoral Fellow, ECCC	Ice nucleation and winter chemistry expert	100
Post-Doctoral Fellow, ECCC	PACs modeling	100
PC-03	Communications, products	100
Schuster, Jasmin	ECCC PACs and PAH expert	50

The tables below are the financial tables for Alberta Environment & Protected Areas (AEPA) and Environment & Climate Change Canada. All work plans under the OSM Program require either a government lead or a government coordinator.

Section 16.2 Financing

The OSM Program recognizes that many of these submissions are a result of joint effort and monitoring initiatives. A detailed "PROJECT FINANCE BREAKDOWN" must be provided using the Project Finance Breakdown Template provided, accessible here. Please note that completion of this Project Finance Breakdown Template is mandatory and must be submitted along with each workplan.

PROJECT FINANCE BREAKDOWN TEMPLATE

Table 16.2.1 Funding Requested BY ALBERTA ENVIRONMENT & PROTECTED AREAS

Organization - Alberta Environment & Protected Areas ONLY	Total % time allocated to project for AEPA staff	Total Funding Requested from OSM
Salaries and Benefits (Calculated from Table 16.1.1 above)	30	$36,000.00
Operations and Maintenance		
Consumable materials and supplies		
Conferences and meetings travel		
Project-related travel		$3,000.00
Engagement		
Reporting		
Overhead		
Total All Grants (Calculated from Table 16.4 below)		$0.00
Total All Contracts (Calculated from Table 16.5 below)		$4,549,371.84
Sub-Total (Calculated)		$4,588,371.84
Capital*		
AEPA TOTAL (Calculated)		$4,588,371.84

* The Government of Alberta Financial Policies (*Policy # A600*) requires that all **capital asset** purchases comply with governmental and departmental legislation, policies, procedures, directives and guidelines. **Capital assets** (*Financial Policy # A100*, Government of Alberta, January 2014) are tangible assets that: have economic life greater than one year; are acquired, constructed, or developed for use on a continuing basis; are not held for sale in ordinary course of operations; are recorded and tracked centrally; have a cost greater than $5,000.
Some **examples of capital asset equipment include:** laboratory equipment, appliances, boats, motors, field equipment, ATV's/snowmobiles, stationary equipment (pier/sign/weather), fire/safety equipment, pumps/tanks, heavy equipment, irrigation systems, furniture, trailers, vehicles, etc. (*Financial Policy # A100*, Government of Alberta, January 2014).

Table 16.2.2 Funding Requested BY ENVIRONMENT & CLIMATE CHANGE CANADA

Organization - Environment & Climate Change Canada ONLY	Total % time allocated to project for ECCC staff	Total Funding Requested from OSM
Salaries and Benefits FTE (Please manually provide the number in the space below)		$2,392,846.72
Operations and Maintenance		
Consumable materials and supplies		$754,000.00
Conferences and meetings travel		$80,000.00
Project-related travel		$55,000.00
Engagement		$5,000.00
Reporting		$49,000.00
Overhead		$252,395.20
ECCC TOTAL (Calculated)		$3,588,241.92

* ECCC cannot request capital under the OSM program. Any capital requirements to support long-term monitoring under the OSM program should be procured by Alberta and captured in that budget table.

Table 16.3

Complete ONE table per Grant recipient.

Add a Recipient by clicking on add table below the table. The total of all Grants is Auto Summed in Table 16.2.1

GRANT RECIPIENT - ONLY: Name	
GRANT RECIPIENT - ONLY: Organization	
Category	Total Funding Requested from OSM
Salaries and Benefits FTE	
Operations and Maintenance	
Consumable materials and supplies	
Conferences and meetings travel	
Project-related travel	
Engagement	
Reporting	
Overhead	
GRANT TOTAL (Calculated)	$0.00

Table 16.4

Complete ONE table per Contract recipient.

Add a Recipient by clicking on add row below the table.. This section is only to be completed should the applicant intend to contract components or stages of the project out to external organizations. The total of all Contracts is Auto Summed in Table 16.2.1

CONTRACT RECIPIENT - ONLY: Name	Sanjay Prasad
CONTRACT RECIPIENT - ONLY: Organization	Wood Buffalo Environmental Association
Category	Total Funding Requested from OSM
Salaries and Benefits	$377,925.00
Operations and Maintenance	
Consumable materials and supplies	$3,009,447.00
Conferences and meetings travel	$20,000.00
Project-related travel	
Engagement	$15,515.00
Reporting	$152,629.00
Overhead	$370,247.00
CONTRACT TOTAL (Calculated)	$3,945,763.00
CONTRACT RECIPIENT - ONLY: Name	Michael Bisaga
CONTRACT RECIPIENT - ONLY: Organization	Lakeland Industry and Community Association
Category	Total Funding Requested from OSM
Salaries and Benefits	$26,378.99
Operations and Maintenance	
Consumable materials and supplies	$464,737.22
Conferences and meetings travel	$1,536.98
Project-related travel	$23,922.03
Engagement	
Reporting	$43,176.68
Overhead	$6,306.60
CONTRACT TOTAL (Calculated)	$566,058.50
CONTRACT RECIPIENT - ONLY: Name	Michael Bisaga

CONTRACT RECIPIENT - ONLY: Organization	Peace River Area Monitoring Program
Category	Total Funding Requested from OSM
Salaries and Benefits	$9,671.30
Operations and Maintenance	
Consumable materials and supplies	$26,320.84
Conferences and meetings travel	
Project-related travel	
Engagement	
Reporting	$1,558.20
Overhead	
CONTRACT TOTAL (Calculated)	$37,550.34

Table 16.5 GRAND TOTAL Project Funding Requested from OSM Program

The table below is auto calculated, please do not try to manually manipulate these contents.

Category	Total Funding Requested from OSM
Salaries and Benefits Sums totals for salaries and benefits from AEPA and ECCC ONLY	$2,428,846.72
Operations and Maintenance	
Consumable materials and supplies Sums totals for AEPA and ECCC ONLY	$754,000.00
Conferences and meetings travel Sums totals for AEPA and ECCC ONLY	$80,000.00
Project-related travel Sums totals for AEPA and ECCC ONLY	$58,000.00
Engagement Sums totals for AEPA and ECCC ONLY	$5,000.00
Reporting Sums totals for AEPA and ECCC ONLY	$49,000.00
Overhead Sums totals for AEPA and ECCC ONLY	$252,395.20
Total All Grants (from table 16.2.1 above) **Sums totals for AEPA Tables ONLY**	$0.00
Total All Contracts (from table 16.2.1 above) **Sums totals for AEPA Tables ONLY**	$4,549,371.84
SUB-TOTAL (Calculated)	$8,176,613.76
Capital* **Sums total for AEPA**	
GRAND PROJECT TOTAL	$8,176,613.76

Some **examples of capital asset equipment include:** laboratory equipment, appliances, boats, motors, field equipment, ATV's/snowmobiles, stationary equipment (pier/sign/weather), fire/safety equipment, pumps/tanks, heavy equipment, irrigation systems, furniture, trailers, vehicles, etc. (*Financial Policy # A100*, Government of Alberta, January 2014).

17.0 FINANCIAL MANAGEMENT

The OSM Program reserves the right to reallocate project funding during the current fiscal year on the basis of project performance and financial overspend or underspend.

☑ Please check this box to acknowledge you have read and understand

In the space below please describe the following:

- Discuss how potential cost overruns and cost underruns will be managed.
- If this is a continuing project from last year, identify if this project was overspent or underspent in the previous year and explain why.
- Describe what risks and/or barriers may affect this project.

It is challenging to assess whether this project was overspent or underspent in 2023/24, since Q3 has just started. However, there are no significant budget discrepancies anticipated. Potential risks and barriers include delays in the contract approval process, travel restrictions for government personnel, and delays in hiring new personnel (if applicable).

The proposed budget for this work plan is $8,176,614. This is 22% ($1,488,699) higher than the 2023-24 funded budget ($6,687,915). These budget changes are documented for each organization below:

(1) The WBEA budget has increased due to intensive forest health indicator sampling in summer 2024 that occurs on a 1-in-6 year cycle.
(2) The Villanova work (approved at $163,372) was transitioned to the Wetlands TAC for the 2024/25 work plan, as per direction from the SIKIC in Sept 2023.
(3) The ECCC GEM-MACH and focused study work has increased due to the need for additional focused studies and the transition of GEM-MACH to a service delivery role.

Detailed budgets and other information are available as the following Supplemental Attachments:

•Sup01: Total budget breakdown by sub-project
•Sup02: Detailed WBEA budget
•Sup03: Detailed LICA budget
•Sup04: Detailed PRAMP budget
•Sup05: Detailed ECCC budget for snowpack sampling
•Sup06: Detailed ECCC budget for PACs passives, health assay, dispersion modelling, and transboundary sites
•Sup07: Detailed ECCC budget for GEM-MACH and transformation studies
•Sup08: Field Sampling Schedule
•Sup09: Adaptive Monitoring Framework Schematic
•Sup10: Summary of GEM-MACH progress-to-date

18.0 Alternate Sources of Project Financing - In-Kind Contributions

Table 18.1 In-Kind Contributions

Add an In Kind Contribution by clicking on the table and then clicking on the add row on the bottom right side of table.

Description	Source	Equivalent Amount ($CAD)
De Silva, Amila	Expert on PACs	$10,000.00
Muir, Derek	Expert on Contaminants (Emeri	$0.00
Gleason, Amber	Snowpack field planning and lal	$10,000.00
Lawson, Greg	Snowpack lab analyses	$10,000.00

Description	Source	Equivalent Amount ($CAD)
Wang, Xiaowa	Snowpack Lab Analyses	$10,000.00
O&M - LeNovo ThinkSystem Xeon Platinum 8380 computer systems processing and annual development GEM-MACH	ECCC	$1,892,020.00
Salary	ECCC Staff	$2,875,070.00
Enhanced N&S Instrumentation	ECCC	$43,280.00
N&S CAPMoN Sites (Operators and Infrastructure)	ECCC	$60,000.00
Laboratory Analyses PACs, Aerosols	ECCC	$60,000.00
Data management PACs	ECCC	$5,500.00
Process section instrumentation and infrastructure	ECCC	$200,000.00
	TOTAL	$5,175,870.00

19.0 Consent & Declaration of Completion

Should your application be successful, The OSM Program reserves the right to publish this work plan application. Please check the box below to acknowledge you have read and understand:

☑ I acknowledge and understand.

Lead Applicant Name

Greg Wentworth

Title/Organization

Senior Atmospheric Scientist (Alberta Environment and Protected Areas)

Signature

Greg.Wentworth Digitally signed by Greg.Wentworth
Date: 2023.11.02 15:24:42 -06'00'

Government Lead / Government Coordinator Name (if different from lead applicant)

Title/Organization

Signature

Please save your form and refer to the instructions page for submission link.

Program Office Use Only

Governance Review & Decision Process

this phase follows submission and triggers the Governance Review

TAC Review (Date):

ICBMAC Review (Date):

SIKIC Review (Date):

OC Review (Date):

Final Recommendations:
Decision Pool:

Notes:

Post Decision: Submission Work Plan Revisions Follow-up Process

This phase will only be implemented if the final recommendation requires revisions and follow-up from governance

ICBMAC Review (Date):

SIKIC Review (Date):

OC Review (Date):

Comments:
Decision Pool:

Notes & Additional Actions for Successful Work Plan Implementation:

Signature