5- YEAR LONG-TERM MONITORING OR OPERATIONAL ACTIVITY WORK PLAN

Changes to this Work Plan are only accepted via an Approved Addendum.

General Information		
Monitoring Category: *(From OSM long-term plan; choose from drop-down menu)*	Atmospheric Monitoring	
Strategic Monitoring Objective: *(From OSM long-term plan; choose from drop-down menu)*	Objective: Detect and report levels and trends of oil sands related chemical substances being deposited from the atmosphere	
Work Plan Unique Identifier:	*A-LTM-S-3-1718*	
Monitoring Activity Title:	Atmospheric Pollutant Deposition Monitoring Network – to Forest Ecosystems	
Geographic Location (*choose from drop-down menu, if Project Location is in more than one area choose from second drop-down***)**	Athabasca Oil Sands Region	
Monitoring Site(s) Coordinates *(latitude and longitude)*	See Appendix I	
Monitoring Organization and Responsible Manager:	Wood Buffalo Environmental Association	Bob Myrick Sanjay Prasad
Date Monitoring initiated:	**2012**	
Specific Monitoring Objective: *(State the monitoring objective addressed through this monitoring)*	Monitor the levels and trends of atmospheric dry deposition for specific atmospheric pollutants (O_3, SO_2, NH_3, HNO_3, NO_2, $PM_{2.5}$) that pose a potential risk for ecosystem health (forests, wetlands and lakes). This long-term monitoring project will provide data to evaluate the effects of atmospheric deposition on the health of forests, wetlands and aquatic ecosystems.	
Deliverables (Annual): *What Data Reports will be produced and when?*	(1) Air pollutant concentration data (used to calculate dry deposition) should be available at www.wbea.org. (2) Data is summarized in annual reports provided to the regulator by March 31st for the previous year of data collection. (3) WBEA also produces annual interpretive data reports that are publicly available. (4) This program will be included in a synthesis report developed following the intensive forest health monitoring program. The synthesis report is scheduled to be delivered at the end of 2019.	

Monitoring Plan Summary: *Please summarize the monitoring including relevant information such as background, objectives, monitoring area, methods/monitoring design, assumptions, outcomes, and references. These should align with the information provided in Appendix 1: Annual Monitoring Schedule.*

The dry deposition of acidifying species (SO_2, HNO_3), nitrogen species (NH_3, HNO_3, NO_2) and ozone can negatively impact forest, wetland and aquatic ecosystems. Dry deposition has been shown to dominate over wet deposition for nitrogen (N) and sulphur (S) species in the Athabasca oil sands region. A recent WBEA report on Forest Health Monitoring showed that deposition of N and base cations could exceed the forest's critical load at some Forest Health Monitoring (FHM) sites (WBEA, 2015). Despite the risk posed by N and base cation deposition, the quantity and quality (speciation of N compounds and base cations) of deposition is poorly understood throughout the region.

The Athabasca Oil Sands Dry Deposition Monitoring Program includes:

(1) Monitoring for ozone (O_3), sulphur dioxide (SO_2), nitrogen dioxide (NO_2), ammonia (NH_3) and nitric acid (HNO_3) concentrations using passive samplers at 30 sites throughout the Athabasca Oil Sands region. The sampling regime for the passive samplers was changed to bi-monthly in 2015-16 due to budget constraints.
(2) Active measurements of O_3 as well as NH_3, HNO_3 and $PM_{2.5}$ composition at 3 sites and 4 sites, respectively. These active techniques provide more frequent sampling intervals than passive samplers as well as more reliable (higher precision) measurements. The active techniques were previously validated in separate focused studies (A1-1-6-1617 Remote Ozone Monitoring, and A2-1-3-1617 Athabasca Oil Sands Dry Deposition) and are ready for incorporation into a long-term monitoring network.
(3) Passive ion exchange resins (IER) to measure bulk deposition at several dozen forest health monitoring sites. These are recovered and deployed in spring and fall and measure the transfer of substances derived from both natural and industrial sources from air to soil. The IER deposition sample sites measure bulk deposition (sum of wet deposition and some unpredictable fraction of dry deposition). Measurements can be related to site soil properties and contribute to validation of critical loads mapping/modelling exercises.

These three projects were identified in individual project plans in 2016-17:

- **A1-2-1-1617 – Ambient Air Passive Monitoring: Athabasca Oil Sands (LTM) (funded at $1,314,000 in 2016-17);**
- **A1-1-6-1617 – Remote Ozone Monitoring (FS) (funded at $80,600 in 2016-17); and**
- **A2-1-3-1617 – Athabasca Oil Sands Dry Deposition (FS) (funded at $263,000 in 2016-17).**

The total funding for these activities in 2016-17 was 1,657,600. The required funding in 2017-18 is $1,634,050.

The current atmospheric deposition monitoring program is primarily based on looking at deposition to forest and fen ecosystems. A separate project (*indicate project plan #)* is aimed at looking at opportunities for integrating all of the deposition monitoring programs in the oil sands region. Also, activity *(indicate project plan #)* will evaluate the current Forest Health Monitoring (FHM) program and recommend changes that will likely impact the future atmospheric deposition monitoring program. Figure 1 shows the locations of the FHM sites (green and blue circles), passive monitoring sites (red circles), portable ozone monitoring sites (purple circles) and long-term meteorological towers (yellow circles, see A-LTM-S-4-1718).

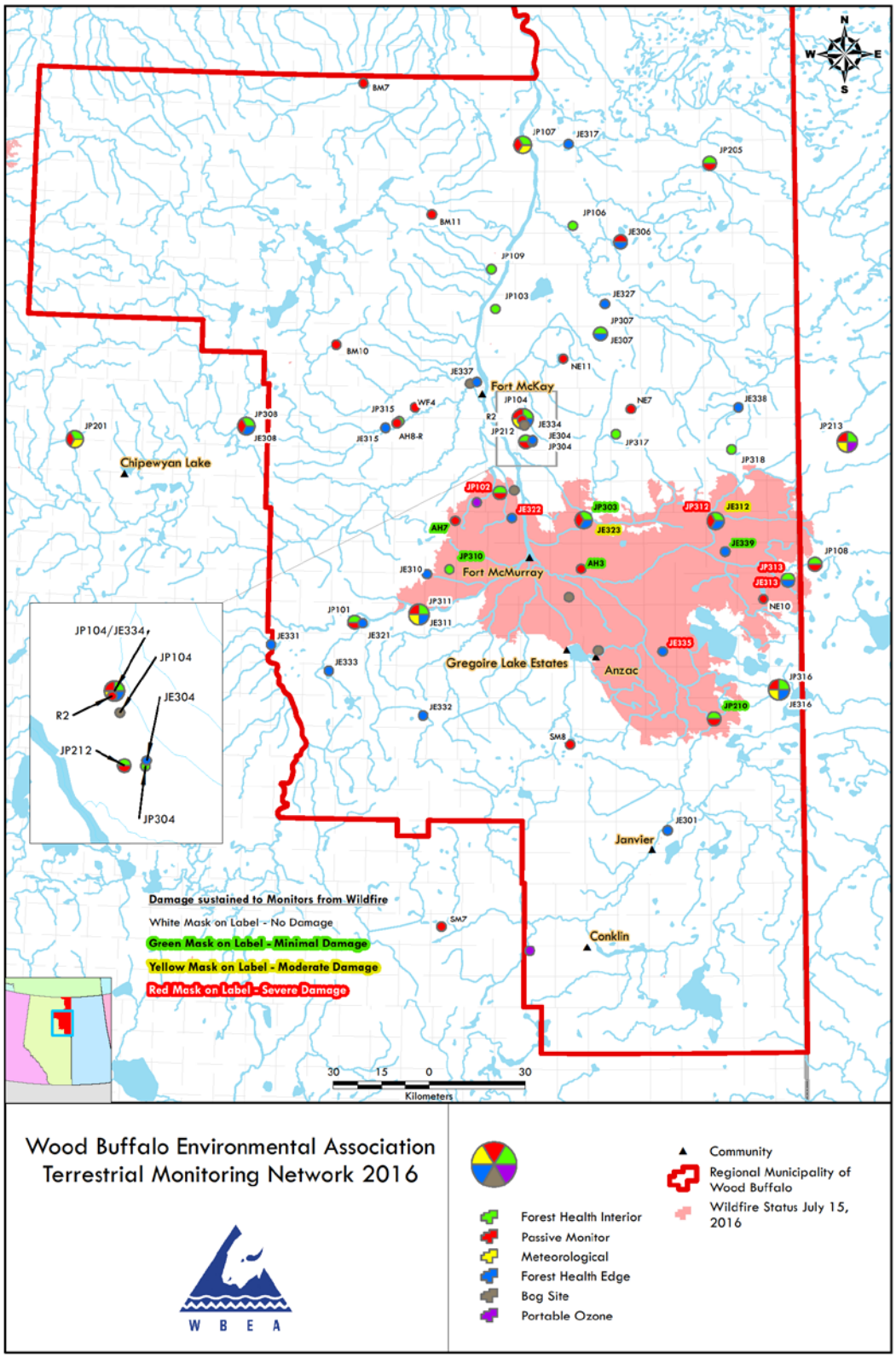

Figure 1 WBEA Terrestrial Monitoring Network (2016) with the 2016 wildfire boundary and the wildfire affected stations. Sites with passive monitoring (red), meteorological towers (yellow) and portable ozone measurements (purple) are shown. Annular denuder sites are JP104, JP107, JP201 and JP213. Figure is taken from the WBEA 1st Quarter 2016/17 Work Plan Progress Report.

Monitoring Objectives

The monitoring objectives of the oil sands dry deposition monitoring program are:

(1) Provide ambient air quality data that will be used, along with meteorological tower data (A-LTM-S-4-1718), to calculate dry deposition in support of determining effects on forest health;
(2) Understand the spatial variation of atmospheric dry deposition across the Athabasca oil sands region;
(3) Determine long-term trends in dry deposition over a large geographical area;
(4) Address gaps in dry deposition monitoring for the oil sands region;
(5) Understand seasonal variations of dry deposition over a large geographical area; and
(6) Assess the impact of AOSR activities on dry deposition and evaluate if critical loads are being exceeded.

Monitoring Area

The real extent of the dry deposition monitoring program includes the Athabasca oil sands region. The extent of the monitoring is concentrated within close proximity of oil sands facilities and monitoring gaps may exist in the areas between each facility and also upwind and downwind of the oil sands deposits.

Methods/Monitoring Design

Passive sampling methods involve installation of a sampler that contains a sorbent that is specifically formulated to adsorb the pollutant of interest (e.g. SO_2, NO_2, O_3, NH_3, HNO_3). The samplers have no moving parts and require no power. Concentrations of pollutants are calculated based on the sampling rate of the chemical of interest onto the sorbent, which is estimated using meteorological conditions (wind speed, ambient temperature and relative humidity).

Active sampling methods use a pump to actively pull air through a denuder (for collection and subsequent analysis in the lab) or the portable ozone monitoring system (for near real-time analysis). These samplers have been designed to operate with minimal power requirements and can be run using solar panels. Active samplers provide several advantages over passive samplers: 1) higher precision because of known flow rate, 2) shorter sampling interval, and 3) ability to measure $PM_{2.5}$ composition (annular denuder system only).

Passive samplers are implemented in the field for two month time periods whereas active samplers are deployed for one month (annular denuder systems) or continuously (portable ozone monitoring system) with periodic maintenance annually or as required.

Assumptions

The Athabasca oil sands dry deposition monitoring network was designed primarily to provide ambient air concentration data that can be used to calculate atmospheric deposition of specific pollutants (O_3, SO_2, NO_2, NH_3, HNO_3) relevant to terrestrial ecosystem health. The network is/will be evaluated through the network optimization project (*indicate project plan #*) and Forest Health Monitoring activity *(indicate project plan #)*. Changes to this network will likely be recommended for implementation in 2018-19. The current thinking is that the number of passive monitoring sites can be reduced substantially following the introduction of more active samplers (annular denuder systems and portable ozone monitoring systems) at selected sites, including the current instrumented meteorological towers.

The five-year budget indicated in this project plan does not reflect current thinking regarding future changes to dry deposition monitoring for the Athabasca oil sands region. It is expected that the savings from reducing the number of passive monitoring sites will be offset by increased costs from additional active samplers for ozone

and $NH_3/HNO_3/PM_{2.5}$ (annular denuder systems) added to some sites.

The future long-term dry deposition monitoring programs are expected to change notionally as follows:

- The removal of some passive monitoring sites.
- The addition of active portable ozone monitoring systems and denuder sampling systems at some remaining sites.
- All of the above assumptions are subject to a scientific assessment prior to making a recommendation.
- It is assumed that most long-term ambient air monitoring will still be contracted to airsheds.

Outcomes

(1) The appropriate ambient air quality data will be available to assess dry deposition of O_3, NO_2, NH_3, HNO_3, SO_2 and certain $PM_{2.5}$ components in the Athabasca Oil Sands Region.
(2) The appropriate long-term dry deposition data sets will be available for terrestrial environmental health assessment through the Forest Health Monitoring activity.

Contribution OSM component areas:

Ambient concentration data from this project contributes directly to the assessment of forest health (B-PD-12-1718). Also meteorological data from A-LTM-S-4-1718 are required to calculate atmospheric deposition using data collected from this project.

References

Alberta Environment and Parks. 2016. http://aep.alberta.ca/air/legislation/air-monitoring-directive/.

Wood Buffalo Environmental Association. 2015. Assessing Forest Health in the Athabasca Oil Sands Region. http://wbea.org/resources/reports-and-publications/terrestrial-monitoring-reports.

Wood Buffalo Environmental Association. 2016. Environmental Monitoring Services First Quarter 2016/17 Work Plan Progress Report (internal document).

Appendix 1 – Annual Monitoring Schedule

(Please provide detailed information on the specifics of your monitoring schedule including – **locations, schedule, methods, SOPs, QA/QC data release, references**)

Sampling Locations/Sites	**Sampling Schedule** (*timing/frequency*)	**Compounds to be Analyzed**	**SOPs to be Consulted** (*hyperlinks accepted*)	**QA/QC Complete & Date Data to be Released**
WBEA Passive Sampling Sites – JP101, JP102, JP104, JP107, JP108, JP201, JP205, JP210, JP212, JP213, JP311, JP316, AH3, AH7, AH8-R, BM7, BM10, BM11, NE7, NE10, NE11, R2, SM7, SM8, WF4, AMS01, AMS02, AMS06, AMS08, AMS14	Bi-monthly averages	SO_2, NO_2, O_3, NH_3 and HNO_3	Still needs to be developed (or made public) by the airsheds and implemented by July 2017 (as per the Air Monitoring Directive)	By March 31st for the previous year
Annular Denuder System Sites – JP104, JP107, JP204, JP213	Monthly averages	NH_3, HNO_3, and $PM_{2.5}$ composition (Mg^{2+}, Na^+, Cl^-, Ca^{2+}, K^+, NO_3^-, NH_4^+, SO_4^{2-}, U, Sm, Be, Pr, Nb, Tl, Th, Cs, Bi, W, La, Ag, Nd, Sb, Ce, Co, Cd, Sn, As, Se, Sr, Mo, Cr, Rb, Pb, Ni, Ca, Li, Cu, Mn, V, Ti, Zn, Mg, Na, Ca, Fe, Al, K, Si)	Still needs to be developed (or made public) by the airsheds and implemented by July 2017 (as per the Air Monitoring Directive)	By March 31st for the previous year
Portable Ozone Monitoring Systems Sites – JP213, Conklin, Beaver River	15 minute averages	O_3	Still needs to be developed (or made public) by the airsheds and implemented by July 2017 (as per the Air Monitoring Directive)	By March 31st for the previous year
Ion Exchange Resin Sites – to be determined	Six month averages	NO_3^- and NH_4^+ bulk deposition	Still needs to be developed (or made public) by the airsheds and implemented by July 2017 (as per the Air Monitoring Directive)	By March 31st for the previous year

References:

Appendix 2 – Detailed Multi-Year Financial Breakdown: if changes are to be made then an Addendum must be Complete and Approved.

(Complete the following detailed financial breakdown; add or delete categories as required)

Budget requirements	Year 1 (2017- 2018)		Year 2 (2018- 2019)		Year 3 (2019- 2020)		Year 4 (2020- 2021)		Year 5 (2021- 2022)	
	OSM Funding	External Funding	OSM Funding	External Funding	OSM Funding	External Funding	OSM Funding	External Funding	OSM Funding	External Funding
1) Salaries and benefits										
a) Appendix 3 – Totals	0.05 FTE ($5000)		0.05 FTE ($5000)		0.05 FTE ($5000)		0.05 FTE ($5000)		0.05 FTE ($5000)	
2) Operations and Maintenance										
a) Vehicles and Transportation										
b) Helicopter										
c) Lab analysis										
d) Data management										
e) Field work										
3) Consumable Materials and supplies										
a) (*Describe Consumable Supply*)										
4) Travel										
a) Conferences and meetings (*identify conference/meeting*)										
b) Field work – travel										

c) Project-related travel										
5) External Contracts										
a) *(WBEA – See Appendix 5)*	$1,629,050									
Grand Total	$1,634,050	$0	$1,923,676	$0	$2,019,610	$0	$2,120,340	$0	$2,226,107	$0

Appendix 3 – Staffing Plan

(Complete the following detailed staffing plan; add or delete categories as required)

	Year 1 – Budget Allocation		Year 2 – Budget Allocation		Year 3 – Budget Allocation		Year 4 – Budget Allocation		Year 5 – Budget Allocation	
Responsible Role	OSM Funding	External Funding	OSM Funding	External Funding	OSM Funding	External Funding	OSM Funding	External Funding	OSM Funding	External Funding
Science Expertise	0.05 FTE ($5000)		0.05 FTE ($5000)		0.05 FTE ($5000)		0.05 FTE ($5000)		0.05 FTE ($5000)	
Technical/Field Staff										
Administrative and Program Coordination										
Grand Total (*inserted into Appendix 2*)	**0.05 FTE ($5000)**	**$**	**0.05 FTE ($5000)**	**$**	**0.05 FTE ($5000)**	**$**	**0.05 FTE ($5000)**	**$**	**0.05 FTE ($5000)**	**$**

Appendix 4 - Approvals

Project Submitted by:		
Name:		
Organization:	Signature:	Date:

Project Approved by:		
Dr. Monique Dubé (AEP)		**Dr. Kevin Cash (ECCC)**
Signature 		Signature 
Date		Date

Appendix 5 – Detailed Budget for External Contractor (WBEA)

Budget requirements	Description	Year 1 (2017- 2018)	
		OSM Funding	External Funding
1) Salaries and benefits			
a) Technical and Field Staff	4 Full time Technical and 1 Summer Student	$417,874	
b) Administrative and Program Coordination	Portion of 7 Administration staff and 2 contracts	$135,629	
c) Science Expertise	Science and Technical consultation		
2) Operations and Maintenance			
a) Vehicles and Transportation	Leased vehicles, repairs, insurance, gas	$22,604	
b) Helicopter	Flight costs + landing fees	$385,370	
c) Lab analysis	Lab analysis of semi-continuous parameters and shipping (Passives, IER, PRS, Denuders)	$316,000	
d) Data management	Data reporting, QAQC validation, Data Translation, Software License, IT infrastructure and support services, website reporting, rss feeds AQHI, emergency response, data backups, data security, data hosting and publications	$44,834	
e) Station and Site Maintenance	Station infrastructure and site access repairs	$23,537	
f) Data Telemetry and cell phone costs	Station modems, data plans, cell phone and satellite phone plans, emergency response data feeds	$13,012	
g) Station and Facilities Expenses	Station Insurance, Tower Lease, Land Agreements, Utilities, Office Equipment Lease and expenses	$7,311	
h) Building Leases and Occupancy Costs	Taiganova bays lease and occupancy costs	$48,910	
i) Quality Assurance	Data Audits, Documentation Management, QAP, Site Documentation -AMD)		

j) Safety	Site Access training, PPE, general safety training, Certificate of Recognition (COR), Health and Safety Policies	$15,678	
k) Shipping	General shipping fees, brokerage fees, freight charges		
l) Emergent Items	Unplanned emergency items that needs to be resolved within fiscal year. Requires special resolution and approval to be spent.	$17,322	
3) Consumable Materials and supplies			
a) Support Gases	Reference standards, calibration gases, support gases		
b) Materials and Consumables	Critical parts, spare parts, pump rebuild kits, pumps, scrubbing materials, tubing, inlet filters, tools, sample lines, electrical wires, etc.	$56,224	
4) Travel			
a) Field work – travel	Fort Chipewyan - air travel, accommodation and vehicle rental, per diems		
b) Program work - travel		$13,727	
c) Conferences, training and meetings	Staff Development, Presentations, Deposition-specific workshops, conferences	$13,669	
5) External Contracts			
a) External Professional Fees	External Contract fees for Technical Specialists, Software License, Alarm Monitoring, Data Analysis Level 3 QA, University Research contracts for post graduate work	$76,520	
b) Stakeholder Honorariums	Honorariums for Indigenous and ENGO involvement	$12,169	
c) Financial Audit and Legal	Perform financial audits and legal reviews of contracts and human resource matters	$6,114	
6) Capital Expense			
a) Capital - Spare Parts	Critical and Spare parts over $1000 in value		

b) Capital - Equipment	Equipment Replacement and new Inventory		
c) Capital - Support Equipment	Computers, modems, data loggers, IT related		
d) Capital - Office Equipment	Office Equipment - Program related	$2,547	
Grand Total		$1,629,050	