FOCUSED STUDY ACTIVITY WORK PLAN

General Information

Work Plan Unique Identifier:	*A-PD-3-1718*	
Focused Study Activity Title:	Ambient Air Monitoring Network Optimization	
Focused Study Category:	Monitoring Design and Method Improvement	
Geographic Location (*choose from drop-down menu. If Project Location is in more than one area choose from second drop-down***)**	Athabasca, Cold Lake and Peace River oil sand regions	
Monitoring Site(s) Coordinates *(latitude and longitude)*		
Project Leader:	Bob Myrick, AEP • Paul Makar, Project Investigator (ECCC) • Long Fu, Project Investigator (AEP)	
Organization and contact information:	Environmental Monitoring and Science Division Alberta Environment and Parks 9th Floor, 9888 Jasper Avenue NW Edmonton, Alberta, T5J 5C6 Bob.Myrick@gov.ab.ca; (780) 229-7290	
Date Study initiated:	Fiscal Year 2016-17	
Monitoring Category: *(From OSM long-term plan; choose from drop-down menu)*	Atmospheric Monitoring	
Strategic Objective of Focused Study: *(From OSM long-term plan; choose from drop-down menu)*	Objective A4: Integration and Synthesis	
Hypotheses: *(Briefly outline the specific hypotheses that your focused study is aiming to address)*	The existing long-term air monitoring networks in the oil sands region can be improved to remove redundancies and fill monitoring gaps to address defined monitoring objectives in the oil sands region. This can be done utilizing new numerical modeling methodologies for objective network design using the creation of optimized network maps that show idealized locations for monitoring stations given specific monitoring objectives, resource constraints and practical realities (e.g. site accessibility, availability of a power source).	
Deliverables: *What tangible goal (s) and/or*	1. A synthesis of knowledge from existing network evaluations with recommendations for changes that optimize the	

product(s) will the monitoring produce and when?	efficiency and effectiveness of the existing networks. 2. New theoretical atmospheric monitoring network designs optimized through numerical simulations to monitor: • Human exposure to: a) AQHI parameters; b) VOCs; c) PACs; and d) odour causing substances, being emitted from known industrial sources in the oil sands development region. • Cumulative biotic exposure to: a) AQHI parameters; b) Acidifying compounds; c) Metals; d) VOCs; and e) PACs, being emitted from known industrial sources in the oil sands development region. • Cumulative deposition of: a) Acidifying compounds; b) Metals; c) VOCs; and d) PACs, being emitted from known industrial sources in the oil sands development region.

Detailed Study Plan

(Please provide detailed information on the specifics of your focused study including – (**keywords, hypothesis and the assumptions and constraints behind your hypothesis**)

Provide a maximum of 10 key words that describe this project. Use commas to separate them:

Ambient air monitoring network, optimization, oil sands region, continuous monitoring, passive monitoring

Describe how you will test your hypothesis:

Develop monitoring questions, objectives and optimization criteria for air and deposition monitoring in the Oil Sands region. These will be used to assess the existing continuous and passive ambient air monitoring networks in the oil sands region. Also, idealized theoretical monitoring network(s) will be produced using numerical modelling. The assessment of the existing networks against the monitoring questions/objectives and the idealized theoretical monitoring network(s) will be used to generate recommendations for optimizing the existing networks operated by the Wood Buffalo Environmental Association (WBEA), Lakeland Industry and Community Association (LICA) and Peace River Area Monitoring Program (PRAMP).

Process and Timelines:

There are four key deliverables for this project that will be developed in a multistep parallel process by Alberta Environment and Parks (AEP) and Environment and Climate Change Canada (ECCC) with consideration of stakeholder input:

(1) Optimization Criteria will be developed by identifying the monitoring needs/objectives (by December 2017) and siting criteria that reflect the realities of the region (e.g., resources, access, power; by June 2018). This deliverable will involve stakeholder consultation and input at the appropriate stages of development.

(2) A knowledge synthesis report that compiles all previous and current network analyses will be completed by June 2018 and will involve stakeholder consultation and input.

(3) A new theoretical monitoring design will be developed using GEM-MACH and information from deliverables (1) and (2). This work will identify specific site locations and parameters for theoretical, idealized networks for the region. The numerical modelling results will be used with other tools, such as GIS analysis, to develop the idealized monitoring network. The anticipated completion date for this work is June 2018.

(4) Recommendations for optimization will be developed by comparing the existing networks to the theoretical networks developed in deliverable (3). It will also incorporate other relevant factors. The work associated with deliverable (4) will not be initiated until deliverables 1 to 3 are complete. The recommendations will be documented in a final report that integrates the knowledge synthesis, optimization criteria, and theoretical networks. The approach is still being finalized but will be completed by fall 2018 and will involve stakeholder input.

Current network analysis being concluded as part of this work plan includes:

(1) Evaluation of monitoring networks using observation data, correlation analyses, removal bias, and model simulations (led by AEP)

In FY2017/18, the project will focus on:

- What is the removal bias for each station in the study area for monitoring the selected parameters (i.e., NO_2, O_3, $PM_{2.5}$, SO_2 and CO)?
- Which of these stations have high correlations among themselves in monitoring the selected air quality parameters?
- Are there opportunities for network optimization at station and parameter levels?

The questions listed above will be addressed by AEP project using station-to-station correlation and removal bias analyses. The Air Mapping Tool and relevant statistical analysis will be applied to accomplish those tasks. Data quality assessment and missing data treatment would be necessary to ensure meaningful results can be generated. The model resolution for removal bias analysis will be in the same scale as work done in 2016-2017 (WBEA stations) for consistency and comparability. Results will be presented in suitable format to depict relevant meta data (e.g., locations, averaging time periods and parameters). If appropriate, maps and images will be generated for data visualization.

(2) Evaluation of monitoring networks using observation data, dissimilarity analysis and air quality model output (led by ECCC)

In FY2017/18, the project will focus on:

- Analysis of model output at observation network station locations, to evaluate the model's ability to mimic the observation-based station analysis.
- Analysis of model-generated fields at all model grid points, in order to create maps showing the most regionally representative locations to place monitoring stations.
- Using the information gained previously, provide summary advice on Alberta monitoring network locations and an overall methodology for the use of air-quality models in monitoring network design.

  The ECCC methodology employed first analyzed station observation data (using time filtering, correlation and hierarchical clustering) to determine potential redundant stations and/or stations which may have instrumentation errors or are heavily influenced by local sources. This was followed by an additional analysis using high resolution air-quality model output both at the station locations and across the Alberta/Saskatchewan region for the same time period as the observation. It is important to note that each of above stages are to be carried out in sequence, and each is dependent on the successful completion of the new methodologies developed in the prior stage in order for the next stage to be carried out.

References:

Makar, P.A., Morrison, H. Use of the high resolution air quality model for monitoring network design, Air CAC Focused Studies Meeting, Edmonton, November 24-25, 2015.

Makar, P.A. et al, Air Theme: Modelling to Integrate Data, Air CAC Focused Studies Meeting, November 24-25, 2015.

Solazzo, E. and Galmarini, S., Comparing apples with apples: Using spatially distributed time series of monitoring data for model evaluation, Atm. Env., 112, pp 234-245, 2015.

Fu, L., Nunifu, T., Yang, Z., "Removal Bias Analysis for an Ambient Air Quality Monitoring Station in the Athabasca Oil Sands Region in Western Canada". Presented at the AWMA Air Quality Measurement, March 15-17, 2016. Chapel Hill, NC.

Fu, L., Spitzer, D., "High Resolution Air Mapping Tool for the Oil Sands Region in Alberta". Presented at Oil Sands Monitoring Symposium, February 24-25, 2015, Edmonton, Alberta.

A-MAPS Environmental Inc. 2014. High Resolution Air Quality and Emission Mapping System for the Oil Sands Region of Alberta. Unpublished report submitted to Alberta Environment and Sustainable Resources Development, 10th Floor Oxbridge Place, 9820 106 Street, Edmonton, Alberta, T5K 2J6. March 2014. 21pp.

Dann, T. and Edgerton, E., 2011. Review of the WBEA Air Monitoring Network. Unpublished report prepared for the Wood Buffalo Environmental Association (WBEA), #100 – 330 Thickwood Boulevard, Fort McMurray, Alberta, T9K 1Y1. 72pp.

US EPA. 2007. Ambient air monitoring network assessment guidance: analytical techniques for technical assessments of ambient air monitoring networks. U.S. Environmental Protection; Agency Office of Air Quality Planning and Standards, Air Quality Assessment Division; Research Triangle Park, North Carolina, February 2007; EPA-454/D-07-001.

Data Management

If this work generates data please summarize your project-level data management plan.

Deliverables	Timeframe
Interim report detailing analysis of data collected at existing monitoring networks using clustering analysis applied by ECCC. Interim report detailing analysis of data collected at existing monitoring networks using removal bias analysis applied by AEP.	Start : 2017-04-01 End: 2017-12-31
Optimization criteria for continuous, integrated and deposition networks.	Start : 2017-09-01 End: 2018-06-30
A synthesis report summarizing existing monitoring network analyses and the results of previous network analyses for the oil sands region. This report will also contain recommendations for changes that optimize the efficiency and effectiveness of the existing networks.	Start : 2018-01-01 End: 2018-06-30
Theoretical atmospheric monitoring network designs optimized through numerical simulations to monitor: (a) continuously human exposure to specific air quality parameters and odour causing substances), (b) cumulative biotic exposure to specific air quality parameters; and (c) cumulative deposition to specific acidifying compounds, metals and PACs).	Start : 2017-09-01 End: 2018-06-30
Final report integrating the above deliverables and providing a practical idealized monitoring network developed with stakeholder input.	2018-12-31

Reporting and Publications

Provide information on the anticipated reports / publications. (Insert additional rows if needed)

Expected Subject/Titles of Publications or Reports	Short Description of Publication or Report	Expected Year of Publication
Technical summary report (ECCC)	Describe the final methodology used, any computational considerations that were required to achieve the objectives, main results of the project.	FY2017/18
Technical summary report (AEP)	Describe the final methodology used, any analysis considerations that were required to achieve the objectives, main results of the project	FY2017/18
Synthesis report (ECCC/AEP)	Integrating the above summary reports by ECCC and AEP into a high-level synthesis report with data analysis informing recommendations on network optimization given in the final report	FY2017/18
Summary paper(s) on the project submitted for journal peer review	ECCC: At least one paper submitted to peer-reviewed journal on the ECCC work AEP: At least one paper submitted to peer-reviewed journal on the AEP work.	FY2018/19
Final report	Report that integrates: (a) a synthesis of knowledge of previous network analyses; (b) optimization criteria; and (c) theoretical design of the "idealized" monitoring network based on numerical modelling. The ultimate result will be a practical idealized monitoring network developed with stakeholder consultation.	Fall 2018

Technical / Professional Roles and Responsibilities

Identify members of the monitoring team/organization, their roles and responsibilities. Identify monitoring organization leads if different from overall monitoring activity lead. (Insert additional rows if needed)

Role	Responsibilities	Resource Name/Organization
Project Lead	Provide overall direction to the network optimization project	AEP
Project Manager	Day-to-day project management	TBD, AEP
Scientific oversight	Optimization criteria identification / synthesis report preparation	AEP
ECCC Network Analysis Lead	Modelling, project oversight	ECCC
ECCC Project Support	Modelling, coding assistance	ECCC
ECCC Project Support	Similarity Analysis	ECCC
ECCC Project Coordination	Oil Sands Senior Support (air)	ECCC
ECCC Project Coordination	Component Lead (air)	ECCC
AEP Network Analysis Lead	Study design, project oversight	AEP
AEP project support	Correlation and removal bias analyses Extended removal bias analysis Data processing and modeling support	AEP

Deliverables (Year 1) If your Focus Study is longer than 1 year then complete **Appendix C** for multi-year deliverables breakdown. Provide a summary of tangible quarterly deliverables. Identify major project areas (deliverables) and results that can be identified as a tangible goal. This could include: field work, lab work/ analysis, evaluation, data, reports, publications, SOPs etc. Do not define process as your Deliverable e.g. 'fly to Ft. McMurray to conduct fieldwork' or 'seek Director approval for report'.

Deliverable(s) (please provide enough information to support status reporting)
Q1 – April to June
First draft of technical report on network assessment of current monitoring data using clustering analysis
Framework document for optimization process
Q2 – July to September
Draft of the overarching air monitoring questions, specific monitoring objectives/questions
Q3 – October to December
Finalize air monitoring questions, specific monitoring objectives/questions with stakeholder input
First draft of technical report on network assessment of current monitoring data using removal bias analysis
Final draft of technical report on network assessment of current monitoring data using clustering analysis
Q4 – January to March
Final draft of technical report on network assessment of current monitoring data using removal bias analysis
Criteria to inform a theoretically "optimized" placement of monitoring sites that respond to objectives and realities (e.g., resources, access, etc.) of the oil sands region based on the monitoring questions/objectives
Stakeholder meeting summarizing results of previous network analyses, oil sands region monitoring objectives/questions and criteria for optimized placement of monitoring sites based on the monitoring objectives/questions

Detailed Financial Breakdown – Year 2 of 3 (2017-2018)

Also complete **Appendix B** for the multi-year financial breakdown

Budget requirements – List areas that require budget expenditures: (ADD OR DELETE BUDGET CATEGORIES AS REQUIRED)	**OS Funding**	**External Funding (*outside JOSM*)**
O&M - Operations and Maintenance:		
Helicopter Costs	**$**	**$**
Field Costs	**$**	**$**
Project Support (PDF – J.S.)	**$73,000 (ECCC)**	**$**
Process support (meetings, workshops)	**$**	**$**
Publications and reports	**$**	**$**
Sub-Total	**$73,000**	**$**
O&M - Travel		
Field Work	**$**	**$**
Stakeholder engagement (meetings and workshop)	**$2,000 (AEP)**	**$**
Sub-Total	**$2,000**	**$**
O&M - External Contracts :		
Goods and Services Contract (*describe contractor*)	**$**	**$**
External Lab Analysis	**$**	**$**
Sub-Total	**$**	**$**
Salaries:		
Principal Investigator / Project Management	**$10,000 (AEP)**	**$24,400 (ECCC)** **$5,000 (AEP)**
Technical / Professional Assistants	**$35,000 (AEP)**	**$30,000 (ECCC)**
Field Staff	**$**	**$**
Sub-Total	**$45,000**	**$54,400 (ECCC)** **$5,000 (AEP)**
Total Salaries	**$45,000**	**$59,400**
Total O&M	**$75,000**	**$**
2017-2018 GRAND TOTAL* (Before other related costs)	**$120,000**	**$**

*This total does not reflect ECCC overhead costs. With consideration of these costs, the grand total is $123,000 (see appendix B).

Appendix A – Approvals

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

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

APPENDIX B – Detailed Multi-year Financial Breakdown (Complete the following detailed financial breakdown; add or delete categories as required)

Budget requirements	Year 1 (2017- 2018)		Year 2 (2018- 2019)		Year 3 (201X- 201Y)	
	Cash	In-kind	Cash	In-kind	Cash	In-kind
1) Salaries and benefits						
a) Investigators		$24,400 (ECCC) $5,000 (AEP)		TBC		
b) Technical/professional assistants/students	$45,000 (AEP)		$30,000 (AEP)			
c) Field Staff						
d) Post-doctoral fellow (O&M)	$73,000 (ECCC)		$32,500 (ECCC)			
2) Operations and maintenance						
a) Process support (meetings and workshop)						
b) Equipment						
c) Lab analysis						
d) Data management						
e) Field work						
3) Consumable Materials and supplies						
a)						
b)						
4) Travel						
a) Conferences and meetings	$2,000 (AEP)		$5,000 (ECCC) $5,000 (AEP)			
b) Field work						

c) Project-related travel						
5) Dissemination & Engagement						
a) Publications/Reports			$8,000 (AEP)			
b) Translation (if required)						
c) Communications						
d) Stakeholder Engagement						
e) Indigenous Peoples Engagement						
6) External Contracts						
a)						
Grand Total * (BEFORE OTHER RELATED COSTS)	$120,000		$80,500			

*Total salary for AEP is $45,000 in 2017-18, and $30,000 in 2018-19. There are no salary costs for ECCC in either year. Total O&M for ECCC ($73,000) in 2017-18 with overhead costs is $75,993; total O&M for AEP is $2,000 in 2017-18. In 2018-19, total O&M for ECCC ($37,500) with overhead costs is $39,038; total O&M for AEP is $13,000. **The Grand Total with overhead costs for ECCC is $75,993 in 2017-18 ($123,000 with the AEP budget) and $39,038 in 2018-19 ($85,038 with AEP budget).**

APPENDIX C –Years 2 and 3 Deliverables (Complete the following detailed breakdown. Provide a summary of tangible quarterly deliverables and your anticipated expenditures. Identify major project areas (deliverables) and results that can be identified as a tangible goal.)

Year 2 (2018- 2019)
Deliverable(s) (please provide enough information to support status reporting)
Q1 – April to June
Draft report synthesizing the above-mentioned network assessments and previous network analyses/assessments
Optimization criteria for continuous, integrated and deposition networks.
A synthesis report summarizing existing monitoring network analyses and the results of previous network analyses for the oil sands region.
Theoretical atmospheric monitoring network designs optimized through numerical simulations.
Q2 – July to September
Final report integrating the above deliverables and providing a practical idealized monitoring network developed with stakeholder input.
Q3 – October to December
Q4 – January to March
Total Annual Budget