FOCUSED STUDY ACTIVITY WORK PLAN

General Information

***Decision Pool C: Activity paused.** * Activity paused pending a meeting to be informed by the Oil Sands Monitoring Program Secretariat on high resolution imagery, remote sensing, LIDAR, geospatial analysis application and directions for the OSM Program overall. This includes improved understanding of leverage sources for the same or similar data. * Funding in 2018/19 and beyond is dependent upon the findings of the meeting.	
Work Plan Unique Identifier:	*Internal use only*
Focused Study Activity Title:	**Acquisition of Aerial High-Resolution Digital Ground Terrain Information in the Peace Athabasca Delta for Wetland Monitoring**
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***)**	Peace Athabasca Delta | Choose an item.
Monitoring Site(s) Coordinates *(latitude and longitude)*	The centroid of the study area is, as follows, covering an area of approximately 4000 km^2. 58.6384N | 111.59653W
Project Leader:	Daniel Peters and Donald Baird
Organization and contact information:	Environment and Climate Change Canada Water Science and Technology Directorate daniel.peters@canada.ca donald.baird@canada.ca
Date Study initiated:	New study
Monitoring Category: *(From OSM long-term plan; choose from drop-down menu)*	Wetland Ecosystem Monitoring
Strategic Objective of Focused Study: *(From OSM long-term plan; choose from drop-down menu)*	Objective WE1: Detect and report changes in wetland ecosystem in relation to Oil Sands Developments and related Point and Non-point source emissions

Hypotheses: *(Briefly outline the specific hypotheses that your focused study is aiming to address)*	**The rationale for the study arose from two sources:** • 2012-2017 JOSM funded studies of the hydro-ecology of the Peace Athabasca Delta region has revealed fundamental gaps and deficiencies in understanding of how changes in river discharge and lake levels affect hydrological connectivity of wetlands in large extents of the delta (B1-2-2-1617: Peace-Athabasca Delta Ecosystem Health Study). • In October 2016 the Oil Sands Planning Coordination identified the need to integrate wetland focal studies funding proposals. This task was directed to Dr. Danielle Cobbaert (Environmental Monitoring and Science Division, Alberta Environment and Parks; EMSD, AEP). Subsequent meetings between AEP and ECCC highlighted that substantial gaps remained in high-resolution ground terrain coverage (LiDAR, hyperspectral and digital imagery) in the Peace Athabasca Delta (PAD) region, which needs to be resolved through an OSM Focused study. **Specific Hypotheses:** • High resolution ground terrain information (LiDAR, hyperspectral and digital air photos) provide the means to assess surface water connectivity and habitat conditions in wetland environments. • Hydrological connectivity plays a central role in the transport, deposition and processing of contaminants in wetlands in the Peace Athabasca Delta region. • Variance in the transport of contaminants and nutrients explains variation in the structure and function of biological communities in wetlands and contaminants burdens in various biotic components of delta wetlands. • Aerial remote sensing to obtain high resolution digital terrain information provides the means to link to and develop a satellite remote sensing framework/approach to monitor wetland conditions in the oil sands region.
Deliverables: *What tangible goal (s) and/or product(s) will the monitoring produce and when?*	• We will use newly acquired state-of-the-art high resolution aerial imagery products (LiDAR, hyperspectral and digital air photos) to: • Establish baseline environmental measurements for long-term modelling of habitat structure and hydrological connectivity; • Link ground observations to aerial (drone and airplane platforms) to satellite remote sensing products to develop an enhanced long-term monitoring methodology for key wetland metrics in the direct Oil Sands (OS) and in the PAD regions.

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:

Wetlands, delta, habitat, surface water connectivity, contaminant pathways, ecohydrology

Study Outline

Rationale Logic Flow

- The ability to understand how changes in river discharge and lake levels affects hydrological connectivity of wetlands in the PAD requires a high-resolution digital elevation model that can identify very small differences in elevation (i.e. 10 cm vertical resolution) across a low gradient landscape.
- The ability to understand vegetation structure and composition, a key wetland habitat component, requires high resolution hyperspectral and digital imagery of the landscape.
- Currently, the suite of high-resolution digital terrain information coverage is only available for about 25% of the PAD (delta areas comprise total extent of about 4,000 km^2).
- Current gaps in high-resolution ground terrain imagery of the PAD compromise the ability to develop stressor-response relationships for biological understanding in the delta, to understand the potential environmental effects of existing and future loadings.
- The objective of the current proposal is to acquire approximately 3000 km^2 of high resolution digital terrain information coverage in the delta to fill this data gap. This unique imagery is obtained from a suite of three separate sensors (high resolution LiDAR, Hyperspectral and digital aerial photography).
- Although restricted to smaller areas, a drone based remote sensing approach will also be employed to test a lower cost follow-up approach for wetland monitoring/assessment at select sites identified to have potentially undergone change due to natural and/or anthropogenic change.

Specific and broader utility of acquiring high resolution digital terrain data for the PAD

Obtaining a high resolution digital terrain suite of information (LiDAR, Hyperspectral and digital imagery) will improve our ability to:

- Describe natural variation in the biological structure of wetlands in the PAD and how this is driven by surface hydrological and/or atmospheric connections.
- Use the high-quality digital terrain product to develop and calibrate habitat classification (e.g. open water, emergent vegetation / willow cover) to establish quantitative baseline conditions for future satellite-based long-term monitoring. Defining baseline conditions in this way will support future adoption of satellite-based monitoring at significantly lower cost with greater spatio-temporal coverage, which can then be expanded beyond the PAD and into upstream OS regions (Peace and Athabasca Basins).
- Develop predictive models of atmospheric and riverine-derived contaminant and nutrient loadings to wetlands in the PAD.
- Understand how changes in regional climate and upstream development are affecting hydrological connectivity in the PAD.
- Predict how changes in water level/depth could affect the ability of key species (e.g. fish, wildlife) to access critical habitat in the PAD.
- Acquisition of the aerial ground terrain information can provide understanding which can be applied to wetlands in all three oil sands deposits, and throughout the province of Alberta.
- High-resolution digital terrain information, when combined with hydrometric gauging station

information from central Lakes Athabasca, Mamawi and Claire and perimeter delta connecting channels will support greater understanding of water movement and establishment of aboriginal baseflows via the future development of a 2-D hydraulic/dispersion model.
- The high-resolution digital elevation product generated will support understanding of water balance (wetting-drying cycles) and critical chemical processing (e.g. nutrient flux, mercury methylation).

Describe how you will test your hypothesis:

- ECCC has prior experience and an understanding of the potential of the proposed state-of-the-art aerial remote sensing information acquisition, as well as the expertise to address the outlined objectives, hypotheses and delivery of a viable product(s).

- The hypotheses that were formulated based on the existing ECCC remote sensing data acquisition in 2012 and 2013 will be tested via various statistical and spatial terrain analytical approaches. Furthermore, we will capitalize on the 6 years of geo-bio-physical data collected by the PAD Deltaic Ecosystem Health OS study (B1-2-2-1617) and parallel ECCC studies to test the hypotheses, such as:
  - High resolution ground terrain information (LiDAR, hyperspectral and digital air photos) provide the means to assess surface connectivity and habitat conditions in wetland environments.
  - Hydrological connectivity plays a central role in the transport, deposition and processing of contaminants in wetlands in the Peace Athabasca Delta region.
  - Variance in the transport of contaminants and nutrients explains variation in the structure and function of biological communities in wetlands and contaminants burdens in various biotic components of delta wetlands.
- The final hypotheses will be tested via a prototype application and demonstration that aerial remote sensing provides the means to link to and develop a satellite remote sensing framework/approach to monitor wetland conditions in the oil sands region. For example, the Surface Water and Ocean Topography (SWOT) satellite to be launched in 2021 is predicted to provide the mean to routinely measure surface water elevations from space – the PAD is a test study site for this novel product as part of Canadian Space Agency SWOT project.

Assumptions and Constraints behind the hypothesis and the testing method:

Assumption: Timely availability of funds to conduct the work – Paperwork for contract to be submitted to Public Works by May 1st

Assumption: Timely processing and award of contracts for i) acquisition of high resolution remote sensing data and ii) for related external analysis aerial survey data

Assumption: Ability to hire a Casual/Term PC-02 and NSERC Visiting Fellow to contribute to the development of satellite based remote sensing framework and contribute to aerial high resolution integration of various geophysical data and report/manuscript writing

Constraint: Acquisition of high resolution terrain information is influenced by weather conditions.

References:

Data Management

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

Deliverables	Timeframe
Data Collection Period: *Field work: aerial surveys and ground surveys in August/September 2018, with collection of additional ground based data summer of 2018 once data gaps identified* *Acquisition of relevant geo-bio-physical data from Parks Canada and parallel Oil Sands studies in the region*	Start : 2018-04-02 End: 2019-10-31
Data Analysis Period: *Laboratory/office analysis of field and aerial remote sensing and satellite remote sensing data via contractors, ECCC interns and ECCC staff*	Start : 2018-10-01 End: 2020-09-30
Data Release Date: *High resolution data produced by this study will be too large to upload to JOSM portal – strategy will be to upload metadata with samples of products and data can be provided by ECCC upon request*	2020-12-31

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
Acquisition of High resolution digital terrain report :Phase 1	Report provided by contractor(s) outlining the acquisition of LiDAR, hyperspectral and digital aerial photo data, and initial LiDAR processing	2019
Acquisition of High resolution digital terrain report :Phase 2	Report provided by contractor(s) outlining the processing of LiDAR, hyperspectral and digital aerial photo data	2020

Acquisition of high-resolution ground terrain information in the Peace Athabasca Delta	Final report produced by ECCC outlining the products produced by the study and testing of hypotheses	2020
Development of a satellite remote sensing framework for monitoring wetlands environments: A case study of the Peace-Athabasca Delta	A manuscript assessing the hypothesis – Aerial remote sensing for high resolution digital terrain information provides the means to link to and develop a satellite remote sensing framework/approach to monitor wetland conditions in the oil sands region.	2020-21
The role of hydrological connectivity on wetland health in the Peace-Athabasca Delta	A manuscript assessing the hypothesis - Hydrological connectivity plays a central role in the transport, deposition and processing of contaminants in wetlands in the Peace Athabasca Delta region.	2020-21

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
Co-lead, study design, fieldwork and contract planning, co-ordination of and contribute to remote sensing and hydrological analyses, and lead report and manuscripts	ECCC
Co-lead, study design, project planning, contribution to assessment hydrological connectivity role in potential transport, deposition/processing of wetland contaminants contribute to report and manuscript writing.	ECCC
Contribution to assessment hydro-ecological linkages and contribute to report and manuscript writing.	ECCC
Technical scientific support, fieldwork, data processing and contribute to report production	ECCC
Technical scientific support, fieldwork, data processing and contribute to report production	ECCC
Technical scientific support, remote sensing data processing and contribute to report production	ECCC
Contribute to remote sensing and hydrological analyses, and report and manuscript writing.	ECCC

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
April to June 2018: i) Project design and planning meetings to identify data gaps and new areas to survey based on stitching together existing high resolution ; ii) Write up and secure contract for acquisition of high resolution digital terrain information for about 3000 km^2 of the PAD.
April to June 2018: Secure research permits for Wood Buffalo National Park. Engage with WBNP, who is already engaged in supporting OSM B1-2-2-1617: Peace-Athabasca Delta Ecosystem Health Study via vegetation and muskrat monitoring and remote sensing information and logistical support to obtain logistical support.
Q2 – July to September
July to September 2018: ECCC identify areas for ground-truthing and conduct fieldwork in support of aerial remote sensing work (e.g., GPS acquired elevations and vegetation information)
July to September 2018: Integration meeting with Parks Canada and EMSD (AEP) in Fort Chipewyan AB or Fort Smith NT to establish common goals of information requirements in all three oil sand deposits.
August to September 2018: Contractor collects high resolution digital terrain information (LiDAR, hyperspectral and digital aerial photos) at a date that will maximise data quality.
July to August 2018: Staffing - hire a Casual PC-02 and NSERC Visiting Fellow at W-CIRC.
Q3 – October to December
October to December 2018: Contractor processes acquired LiDAR as first product to deliver to ECCC by end fiscal year
October to December 2018: ECCC staff initiates processing of acquired field data in support of the remote sensing.
Q4 – January to March

January to March 2019: ECCC staff continues to process acquired field data.
January to March 2019: Wetlands Integration and Planning working session with ECCC and AEP in Victoria BC.
February 2019: Transfer of knowledge - Engage with First Nations and present initial findings to Annual Peace-Athabasca Delta Ecological Monitoring Program (PADEMP) Forum in Fort Chipewyan AB.
March 2019: i) Contractor delivers a report to ECCC and Phase 1 processed LiDAR data files; ii) Contractor delivers the raw hyperspectral and digital aerial imagery for processing by another group next fiscal year.
March 2019: Phase 1 Technical summary report quantifying the acquisition of the suite of high resolution digital terrain information and its current state of processing. Posting of technical report on Oil sands portal scheduled for April 2018 following integration of reviewer's comments.

Detailed Financial Breakdown – Year 1 of 2 (2018-2019)

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 for aerial remote sensing acquisition (see contract below) and fieldwork	**$ 40,000**	**$**
Field Costs – shipping	**$3,000**	**$**
Field Consumable Materials & Supplies	**$3,000**	**$**
NSERC Visiting Fellow (0.5 PY)	**$28,000**	
Hire local field assistant (10 days)	**$3,000**	
Other mandatory O&M costs from spreadsheet	**$0**	
Sub-Total	**$197,000**	**$**
O&M - Travel		
Field Work	**$13,500**	**$**
Conferences (2017 American Geophysical Union) with fees	**$0**	**$**
Program Travel - Meetings with AEP, UofA and WBNP scientist	**$7,000**	**$**
Sub-Total	**$23,500**	**$**
O&M - External Contracts :		
Contract for mobilization and aerial imagery acquisition (LiDAR, digital aerial photography, hyperspectral) in PAD for about 3000 km2 and initiate processing for LiDAR data	**$449,000**	**$**
Sub-Total	**$328,000**	**$**
Salaries:		
New Project Support Casual and/or Term PC-02 and SE-RES-02	**$47,576**	**$**
Over Time	**$8,000**	
Sub-Total	**$55,576**	**$**
Total Salaries	**$55,576**	**$**
Total O&M	**$546,500**	**$**

Budget requirements – List areas that require budget expenditures: (ADD OR DELETE BUDGET CATEGORIES AS REQUIRED)	OS Funding	External Funding (*outside JOSM*)
2017-2018 GRAND TOTAL (before other related costs)	**$602,076**	**$**

Appendix A – Approvals

Project Submitted by:		
Name: Daniel Peters and Donald Baird		
Organization: ECCC	Signature:	Date:

Project Approved by:		
Fred Wrona		**David Boerner**
Signature		Signature
Date		Date

Activity Planning Review and Evaluation

To be completed by OSM Administration

Date Completed	**Review type**	**Validated by** (insert name and title)
	Program Management review completed	

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

Budget requirements	Year 1 (2018- 2019)		Year 2 (2019- 2020)		Year 3 (201X- 201Y)	
	Cash	In-kind	Cash	In-kind	Cash	In-kind
1) Salaries and benefits						
a) Investigators	$0		$0			
b) Technical Support	$0		$0			
c) Overtime	$8,000		$4,000			
d) New Project Technical/Scientific Support Casual/Term PC-02 & SE-RES-02	$47,576		$89,830			
2) Operations and maintenance						
a) Helicopter Costs for aerial remote sensing acquisition (see contract below) and fieldwork	$40,000		$40,000			
b) NSERC Visiting Fellow	$28,000		$56,000			
c) Local hire for fieldwork	$3,000					
d) Co-Op/FSWEP Student			12,000			
e) Field work shipping	$3,000		$1,000			
f) Conference fee	$0		$500			
3) Consumable Materials and supplies						
a) Field supplies	$3,000		$1,500			
b)						
4) Travel						

a) Conferences and meetings (AGU)	$0		$4,000			
b) Field work	$13,500		$10,000			
c) Project-related travel	$7,000		$5,000			
5) Dissemination & Engagement						
a) Publications/Reports			$2,000			
b) Translation (if required)						
c) Communications						
d) Stakeholder Engagement PADEMP Annual Forum			$2,500			
e) Indigenous Peoples Engagement						
6) External Contracts						
Phase 1: Contract for mobilization and aerial imagery acquisition (LiDAR, digital aerial photography, hyperspectral) in PAD for about 3000 km2 and initiate processing for LiDAR data	$449,000					
Phase 2: Contract for processing 3000 km2 of 2018 hyperspectral, digital aerial photography, fuse LiDAR and hyperspectral data and development of vegetation structure model.			$285,000			
Grand Total (before other related costs)	$602,076		$513,330			

*Total Salary for ECCC ($55,576) in 2018-19 with other related costs is $76,428. Total O&M for ECCC ($546,500) in 2018-19 is $576,131. The Grand Total for ECCC ($602,076) in 2018-19 with other related costs is $652,559.

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 (2019- 2020)
Deliverable(s) (please provide enough information to support status reporting)
Q1 – April to June
April – June 2019: ii) Write up and secure contract for processing of hyperspectral, aerial digital photo, and merging of LiDAR and hyperspectral data, development of vegetation structure model for the 3000 km^2 of the PAD.
April – June 2019: Continue processing field data
April – June 2019: Staffing - Hire a Co-Op student and Term PC-1 to support data processing of ground and remote sensing data
April – June 2019: ECCC identify knowledge gaps
Q2 – July to September
July-September 2019: ECCC addresses knowledge gaps and conduct fieldwork to complete ground trothing and bathymetric surveys.
July-September 2019: Contractor processes remote sensing info.
July-September 2019: ECCC continues to process acquired field data and remote assesses available satellite remote sensing data for linkage to aerial remote sensing.
Q3 – October to December
October – December 2019: Contractor continues to processes aerial remote sensing info.
July-September 2019: ECCC continues to process acquired field data and remote sensing data.
December 2019: Knowledge transfer – Presentation of aerial and satellite -based remote sensing based wetland monitoring approach at the annual American Geophysical Union conference for critical review by international experts
October-December 2019: Integration meeting with AEP in Edmonton
Q4 – January to March
January to March 2018: ECCC staff continues to process acquired field data and remote sensing data.
February 2018: Transfer of knowledge - Engage with First Nations and present initial findings to Annual

PADEMP Forum in Fort Chipewyan AB.
March 2020: Contractor delivers high resolution remote sensing products to ECCC.
March 2020: Phase 2 Technical summary report outlining the suite of high resolution digital terrain information, its current state, and availability. Posting of technical report on Oil sands portal scheduled for April-June 2020 following integration of reviewer's comments.