FOCUSED STUDY ACTIVITY WORK PLAN

General Information

Work Plan Unique Identifier:	*W-MD-7-1718*	
Focused Study Activity Title:	Representative Sub-basin Studies – Ells and Steepbank Rivers (REPS)	
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 Oil Sands Region	Athabasca River - Tributaries
Monitoring Site(s) Coordinates *(latitude and longitude)*	EL1: 57°16.826' N,111°42.284' W; EL2: 57°14.676' N,111°44.193' W; EL3: 57°13.665' N,111°57.536' W; EL4: 57°9.083' N,112°10.205' W ST1: 57°01.338' N,111°28.618' W; ST2: 56°59.919' N,111°24.201' W ST3: 56°58.773' N,111°17.914' W; ST4: 56°52.144' N,111°08.606' W	
Project Leader:	Christina Suzanne	
Organization and contact information:	Christina Suzanne Organization: University of Calgary Contact information: Christina.suzanne2@ucalgary.ca, 403-210-8923	
Date Study initiated:	**April 1, 2017**	
Monitoring Category: *(From OSM long-term plan; choose from drop-down menu)*	Watershed Monitoring	
Strategic Objective of Focused Study: *(From OSM long-term plan; choose from drop-down menu)*	Objective W3: Integration and Synthesis	
Hypotheses: *(Briefly outline the specific hypotheses that your focused study is aiming to address)*	*H1*) The sampling program design and related analytical methodologies are not adequate in making the necessary linkages (cause-effect relationships) between abiotic stressors and corresponding changes in the structure and function of watersheds *H2*) Sub-basins within the Lower Athabasca Region differ in environmental conditions and are not comparable due to differences in geomorphology and background conditions	
Deliverables: *What tangible goal (s) and/or*	• Produce multiple scientific articles on multi-year trends in metal and polyaromatic hydrocarbon (PAH) concentrations and food web dynamics in the Ells and Steepbank Rivers	

product(s) will the monitoring produce and when?	(2017-2019) • Produce a scientific article assessing concentrations of algal chlorophyll-a along a gradient of catchment landuse disturbance in a tributary of the Lower Athabasca River (2018) • Produce a special issue of synthesis papers assessing and predicting causal linkages of landuse changes on hydrology and ecology of rivers in the Athabasca Watershed region (2019) • Release of data on December 31, 2018

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:

Cumulative effects, ecological endpoints, metals, sediment, invertebrate, periphyton, watershed monitoring, primary production, environmental disturbance gradient, integrated monitoring

Describe how you will test your hypothesis:

This study builds upon the data obtained from the Joint Oil Sands Monitoring Representative Sub-basin studies (JOSM REPS) (2012 – 2015) project, involving a comparison of two representative sub-basins (Ells and Steepbank Rivers) (see Suzanne 2015, Droppo 2016). These two sub-basins in the Lower Athabasca River differ in non-point source geochemical inputs as a result of landuse disturbance from oil sands (OS) operations. However, both flow through a geological region containing natural hydrocarbon deposits, resulting in challenges discerning the direct and indirect effects on their respective aquatic ecosystems. Suzanne (2015) quantified benthic primary production in addition to metal concentrations in fine sediments, surface water and aquatic invertebrates in the two sub-basins using an environmental disturbance gradient sampling design; with sites 1) outside of OS geological deposit and development, 2) inside OS geological deposit, with no to limited development, and 3) inside OS geological deposit and within development area. The gradient design was to develop a more comprehensive understanding of the responses of chemical/biological/ecological endpoints to catchment/landscape/development-related processes.

Results based on a comprehensive 2012 field campaign involving sampling of depositional bed sediments, macroinvertebrates and chlorophyll-a using novel artificial substrates showed: 1) among-site differences within catchments in metal concentrations and 2) among-site differences in chlorophyll-a concentrations which could both be attributed primarily to natural variation along the environmental disturbance gradient. To obtain a more comprehensive understanding of ecosystem productivity, a complementary stone sampling study was initiated in 2013 to further assess and validate the use of a stratified, stone sampling system developed by Wrona et al. (1986). The system allows the estimation of population densities of organisms which adhere to, or are associated with, stones in both lentic and lotic habitats, using the stones themselves as the primary sampling units as opposed to traditional sampling methods. This system has been applied to a variety of freshwater and marine systems, and has been shown to be more representative of benthic habitats (considers varying stone sizes) and provides a better estimation of total primary production and associated standing crop of autotrophs (periphyton and bryophytes). In tandem, Droppo (2016) also deployed Phillips tube samplers at the same sites as artificial substrates in the Ells River to collect and analyze transport of fine sediments along the environmental disturbance gradient.

This study will process and complete the analysis of archived samples of periphyton chlorophyll-a and benthic invertebrate community structure, as well as metals concentrations in depositional and fine sediments, and benthic invertebrates (2012, 2013, and 2014) from the two sub-basins. It will provide additional information to discriminate and quantify the relative importance of natural fluvial geomorphological processes and trophic food web structure in producing the observed trends in hydrocarbon and metal concentrations. It will also compare the efficacy and efficiency of existing protocols for assessing

benthic primary production in tributaries of the Lower Athabasca River. This study contributes to defining appropriate baseline/reference conditions against which to assess change in environmental endpoints. This study also will inform the development and implementation of a more integrated monitoring design that explicitly incorporates causal mechanisms and interpretable structural and functional ecological endpoints.

Overall, the purpose of Representative Sub-basin studies (REPS) is to conduct necessary focused integrated monitoring, process studies to assess causal linkages of OS operations to observed effects. Ultimately, the goal of having an integrated monitoring framework is to move towards the implementation of an integrated cumulative effects assessment approach. Such an approach reduces the focus from assessing effects (both stressor-specific and cumulative) on a project-specific basis, and instead provides a local, reach-specific, and regional basis for addressing key questions. The REPS project further develops and validates monitoring requirements, and informs adaptive changes to the overall monitoring program. Specifically, the data being analyzed in this study is complimentary to a suite of other measurements and experiments conducted under the REPS program. Upon completing the relevant processing and analysis, the results of this study will be integrated into a holistic synthesis of ecosystem structure and function in the Athabasca Oil Sands Region.

Assumptions and Constraints behind the hypothesis and the testing method:

The Ells and Steepbank River sampling sites were selected along a pre-determined environmental disturbance gradient. Therefore, it was an *a priori* assumption that observed results would follow the pre-selected disturbance categories within the gradient sampling design – this assumption is being explicitly tested.

References:

Wrona, F.J., P. Calow, I. Ford, D.J. Baird, and L. Maltby. 1986. Estimating the Abundance of Stone-dwelling Organisms: A New Method. Canadian Journal of Fisheries and Aquatic Sciences. 43: 2025-2035.

Suzanne, C.L. 2015. Effects of natural and anthropogenic non-point source disturbances on the structure and function of tributary ecosystems in the Athabasca Oil Sands Region. MSc Thesis, Department of Geography, University of Victoria.

Droppo, I.G., and B.G. Krishnappan. 2016. Modeling of hydrophobic cohesive sediment transport in the Ells River Alberta, Canada. Journal of Soils and Sediments. 16: 2753-2765.

Data Management

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

Deliverables	Timeframe
Data Collection Period: *Field work – completed in 2014*	Start : 2012-03-07 End: 2014-10-01
Data Analysis Period: *Laboratory analysis and QA/QC of data*	Start : 2012-11-01 End: 2018-08-31
Data Release Date: *Metadata and data consistent, complete and meet basic standard format for publication in Open Data; on or linked to JOSM portal*	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
Multi-year trends in metal and polyaromatic hydrocarbon (PAH) concentrations and food web dynamics in the Ells and Steepbank Rivers	Multiple publications/reports on longitudinal patterns of metal (including total and methyl mercury) and polyaromatic hydrocarbon (PAH) concentrations in sediments, surface water and invertebrates across multiple years in the Ells and Steepbank Rivers. Also the assessment of algal and invertebrate community structure and nutrient dynamics along the environmental disturbance gradient.	Initial publication: 2017 Others: 2018/19
Concentrations of algal chlorophyll-a along a gradient of catchment	A comparison of the efficacy and efficiency of existing protocols for	2018

landuse disturbance in a tributary of the Lower Athabasca River: A comparison of methods	conventional periphyton sampling, artificial substrates, and stone sampling across two years along an environmental disturbance gradient in the Ells River.	
Assessing and predicting causal linkages of landuse changes on hydrology and ecology of rivers in the Athabasca Watershed region	A special issue of synthesis papers connecting previously collected ecological and biogeochemical data in the Ells and Steepbank River sub-basins to support the implementation of an integrated cumulative effects assessment approach.	2019

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
Frederick Wrona, Project lead	Scientific oversight for entire project. Provides advice on data analysis and how the publications produced from this study will be organized and structured.	University of Calgary (Adjunct Professor); Alberta Environment and Parks
Christina Suzanne, Project lead	Hire and train technical assistants to do laboratory sample processing, data analysis and report writing. Also contributes to data analyses and related publications produced from this study.	University of Calgary
Scientific Contributors	Active and historical principle investigators involved in the REPS program. Contributing data, analyses and writing appropriate scientific evaluations and publications	Environment and Climate Change Canada; Alberta Environment and Parks; Other academic Principle Investigators
Professional and Technical Assistants	Process all archived samples in the laboratory, data analysis and contribute to the publications produced from this study. Aiding in the production of technical reports and publications (eg. Literature reviews, data integration etc.)	University of Calgary; Alberta Environment and Parks; Environment and Climate Change Canada.

Deliverables (Year 1) If your Focus Study is longer than 1 year then complete **Appendix 3** 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
Process periphyton samples (n=27) and send to analytical lab for isotope analysis
Process stone samples (n=60) by removing periphyton/bryophytes and measuring stone surface area
Q2 – July to September
Process stone samples (n=60) by removing periphyton/bryophytes and measuring stone surface area
Process nutrient diffusing substrate samples (n=96) for chlorophyll-a and ash-free dry mass at the University of Calgary Aquatic Ecology Lab
Submission of initial metals manuscript
Q3 – October to December
Process scour pad sediment samples for fine sediments (n=117) and send to analytical labs for metals, mercury and PAH analysis
Process stone samples (n=60) by removing periphyton/bryophytes and measuring stone surface area
Process periphyton/bryophyte samples (n=180) for chlorophyll-a and ash-free dry weight
Q4 – January to March
Process sediment-trap invertebrate samples (n=16) and send to taxonomist for species-level taxonomic identification
Process periphyton algal samples (n=36) and send to taxonomist for species-level taxonomic identification
Process bulk kicknet samples for invertebrates (n=36) to send to analytical labs for mercury and isotope analysis
Process depositional sediment samples (n=63) to send to analytical labs for metals, mercury and PAH analysis

Detailed Financial Breakdown – Year 1 of 2 (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	**$0**	**$0**
Field Costs	**$0**	**$0**
Data Management	**$0**	**$0**
Facilities	**$0**	**$75,000**
Internal Lab Analysis	**$0**	**$14,500**
Consumable Materials & Supplies	**$8,450**	**$8,500**
Equipment	**$4,800**	**$100,100**
Sub-Total	**$13,250**	**$198,100**
O&M - Travel		
Field Work	**$0**	**$0**
Conferences (*identify conference*)	**$0**	**$0**
Meeting (*identify meeting*)	**$0**	**$0**
Sub-Total	**$0**	**$0**
O&M - External Contracts :		
Goods and Services Contract (*describe contractor*)	**$0**	**$0**
External Lab Analysis	**$72,800**	**$0**
Sub-Total	**$72,800**	**$0**
Salaries:		
Principal Investigator	**$0**	**$55,800**
Technical / Professional Assistants	**$154,425**	**$29,500**
Field Staff	**$0**	**$0**
Sub-Total	**$154,425**	**$85,300**
Dissemination & Engagement:		
Publications/Reports	**$1,000**	**$0**
Sub-Total	**$1,000**	**$0**

Budget requirements – List areas that require budget expenditures: (ADD OR DELETE BUDGET CATEGORIES AS REQUIRED)	OS Funding	External Funding* (*outside JOSM*)
Total Salaries	**$154,425**	**$85,300**
Total O&M	**$86,050**	**$198,100**
Total Dissemination & Engagement	**$1,000**	**$0**
University Administrative Costs (Overhead 25%)	**$36,525**	**$0**
2017-2018 GRAND TOTAL	**$278,000**	**$283,400***

***** In-kind contributions related to University of Calgary facilities, equipment and staff salary

Appendix 1 - Approvals

Project Submitted by:		
Name: Fred Wrona		
Organization: University of Calgary; Alberta Environment and Parks	Signature:	Date:

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

Budget requirements	Year 1 (2017- 2018)		Year 2 (2018- 2019)	
	Cash	In-kind	Cash	In-kind
1) Salaries and benefits				
a) Investigators	$0	$55,800	$0	$55,800
b) Technical/professional assistants	$154,425	$29,500	$59,000	$0
c) Field Staff	$0	$0	$0	$0
2) Operations and maintenance				
a) Facilities	$0	$75,000	$0	$75,000
b) Equipment	$4,800	$100,100	$0	$30,000
c) Lab analysis	$0	$14,500	$0	$0
d) Data management	$0	$0	$0	$0
e) Field work	$0	$0	$0	$0
3) Consumable Materials and supplies				
a) Lab Supplies	$8,450	$8,500	$5,500	$2,000
4) Travel				
a) Conferences and meetings	$0	$0	$0	$0
b) Field work	$0	$0	$0	$0
c) Project-related travel	$0	$0	$12,000	$0
5) Dissemination & Engagement				
a) Publications/Reports	$1,000	$0	$3,000	$0
b) Translation (if required)	$0	$0	$0	$0

c) Communications	$0	$0	$0	$0
d) Stakeholder Engagement	$0	$0	$0	$0
e) Indigenous Peoples Engagement	$0	$0	$0	$0
6) External Contracts				
a) External Lab Analysis	$72,800	$0	$39,700	$0
7) University Administrative Costs				
a) University of Calgary (Overhead 25%)	$36,525	$0	$29,800	$0
Grand Total	$278,000	$283,400	$149,000	$162,800

APPENDIX 3 –Years 2 and 3 Deliverables (Complete the following detailed breakdown. Provide a summary of tangible quarterly deliverables. 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
Submit depositional sediment samples (n=63) to analytical labs for metals, mercury and PAH analysis
Submit bulk kicknet samples for invertebrates (n=36) to analytical labs for mercury and isotope analysis
Scientific collaborator meeting
Q2 – July to September
QA/QC data
Data organization and management
Data analysis
Q3 – October to December
Data analysis
Data visualization
Writing manuscripts for publication
Q4 – January to March
Writing manuscripts for publication
Submitting manuscripts and dissemination