Review Comment Table

Board:	SLWB
Review Item:	2019 Annual Water Licence Report and AEMP Report
File(s):	S13L1-007
Proponent:	Imperial Oil Resources
Document(s):	2019 Annual Water Licence Report and AEMP Report (27 MB)
Item For Review Distributed On:	Apr 28 at 12:53 Distribution List June 2 at 15:30 Distribution List
Reviewer Comments Due By:	June 16, 2020
Proponent Responses Due By:	Sep 18, 2020
Item Description:	**Note: New date for submission of review comments extended until June 16, 2020 to permit additional time for reviewers to comment on Annual Report and AEMP Report.** Imperial Oil Resources (NWT) Ltd. submitted 2019 Annual Water Licence Report on March 30, 2020. This report is required by Water Licence S13L1-007, Part B, condition 13 and Schedule 1. This report also includes summary water quality data for the Aquatic Effects Monitoring Program Annual Report required under Part I, condition 3. Although formal approval of the Annual Report is not required under the Licence, the Board must be satisfied that the Licensee has met the requirements of the Licence. Formal Board approval is required for the Aquatic Effects Monitoring Program Annual Report. **Using the Online Review System (ORS), reviewers are invited to submit comments and recommendations on the documents linked below by the review comment deadline specified. Reviewers may also wish to consider providing an overarching recommendation regarding whether the Board should approve the submission, to provide context for the comments and recommendations and assist the Board with its decision. If reviewers seek clarification on the submission, they are encouraged to correspond directly with the Applicant prior to submitting comments and recommendations.**
General Reviewer Information:	All documents that have been uploaded to this review are also available on our public Registry. If you have any questions or comments about the ORS or this review, please contact Bonnie Bergsma at (867) 496-2778 or email

	bonnie.bergsma@slwb.com, or Board staff indicated below.
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Comment Summary

Environment and Climate Change Canada: Eva Walker				
ID	**Topic**	**Reviewer Comment/Recommendation**	**Proponent Response**	**Board Response**
1	General File	**Comment** (doc) Environment and Climate Change Canada cover letter **Recommendation**		
2	2019 AEMP Annual Report Monitoring Locations	**Comment** Table A provides a summary of the aquatic effects monitoring plan (AEMP) sampling locations, separated out by those that require boat access and those that are wading sampling stations. Sampling locations include two main waterbodies: Bosworth Creek and the Mackenzie River. However, all sampling locations are lumped in together instead of being organized by waterbody. In addition, although there are brief descriptions of the sampling locations, it is not entirely clear which locations are intended for use as reference (unimpacted by site activities) and those which have the potential to be impacted by site activities. **Recommendation** Environment and Climate Change Canada (ECCC) recommends updating Table A to organize sampling locations by water body, and to clearly state which sampling locations	**Aug 19:** In addition to the location information shown on Figure 1 of the Norman Wells Operations Aquatic Effects Monitoring Program Report (dated March 10, 2020). Imperial agrees that updating Table A to provide the additional information requested (sampling location by waterbody, clarification on reference locations) would improve clarity. Imperial proposes to address this recommendation in future annual AEMP reports.	Agreed. Table A to be revised in future AR.

		are intended to be reference or unimpacted sampling locations.		
3	2019 AEMP Annual Report Seasonal Trends	**Comment** Figure A depicts the concentration of aluminum at various AEMP stations by month. However, although it is stated that "successive years were superimposed by day of year", it is unclear in the figure which data points correspond to which sampling year. Combining all sampling years onto one figure without indication of sampling year makes interpretation of the figure difficult. In addition, AEMP stations for both the Mackenzie River Stations and Bosworth Creek Stations are combined onto one figure. In the discussion the proponent notes that the aluminum concentration in these two waterbodies behaves differently. Given the potential for different trends in these two water bodies, we recommend that they be presented separately, or that they be clearly identified in order to aid in interpretation. **Recommendation** ECCC recommends that figures depicting seasonal trends be updated to depict year of sampling for each data point. ECCC also recommends that figures clearly identify which AEMP locations correspond to which water body.	**Aug 19:** Imperial agrees that adding sampling year for each data point and better labelling of the AEMP locations would provide clarity and aid with interpretation. Imperial proposes to address these recommendations in future annual AEMP reports.	Agreed. Figures to be revised
4	2019 AEMP Annual Report Seasonal and Spatial Trends	**Comment** The body of the AEMP annual report only includes a discussion of aluminum seasonal and spatial	**Aug 19:** For ease of review, aluminum was used as an example in the body of the report for	Agreed. Imperial to address recommendati

		trends and directs the reviewer to Appendix C where figures for the other parameters are provided. It is not sufficient to only provide figures and tables with concentrations. **Recommendation** ECCC recommends that the Proponent provide a discussion of seasonal and spatial trends for other analyzed water quality variables. ECCC also recommends that a discussion be provided on all other parameters analyzed, and on the conclusions presented based on the analyses provided.	discussion, the same analysis discussed within the body of the report was conducted for other parameters (as shown in Appendix C). Please note that the conclusions outlined in Section 4.0 "Summary" are based on analysis of not only aluminum, but also the other parameters outlined in Appendix C. Imperial agrees that providing only one example may not be sufficient. Going forward, Imperial proposes to include metals of interest in this section of the report. These would include metals exceeding CCME guidelines or showing statistical trends. Imperial proposes to address these recommendations in future annual AEMP reports	ons in future report.
5	2019 AEMP Annual Report Spatial Trends	**Comment** Figure D presents concentrations of total aluminum related to distance downstream with sampling points ranging from 0 m to 18,000 m, with the majority of sampling points located between approximately 7000 m and 10,000 m downstream. The Proponent indicates that, "Figure D has six relatively flat lines indicative of no change in total aluminum concentration as water flows downstream". The Proponent also indicates that "the lack of difference between the extremes of upstream and downstream suggest that the	**Aug 19:** On Figure D (and figures shown in Appendix E), distance 0 (x-axis) corresponds to location AEMP-10 (Upstream), distance 18 000 m (x-axis) corresponds to AEMP-11 (Downstream). Other data points between 6000 m and 12000 m correspond to the remaining AEMP sampling locations nearby NW Operation. Imperial agrees that additional labelling on the figures would provide clarity and will update these figures in future annual AEMP reports. As outlined in	Agreed. Figures to be revised and additional statistical analysis to be conducted.

		variability near operations represent at most only localized effects." Based on these statements, it is unclear which distance points relate to which AEMP sampling locations, because no sampling station numbers have been provided, and no explanation has been provided as to whether the 0 m relates to an upstream location or the primary point of discharge. The x-axis title suggests distance downstream from impact. However this is inconsistent with the statements provided from the proponent. Finally, although the report has indicated that there may be local effects, these have not been elaborated on or further discussed. Given the 18 km distance between the 0 m (stated as upstream in the discussion) and 18,000 m downstream station, it would be assumed that any project impacts would be attenuated at the far downstream sampling location and therefore the local impacts would be of primary importance and interpretation. **Recommendation** ECCC recommends that the Proponent: 1. clarify the sampling locations that correspond to each data point; 2. provide clarification on the x-axis; specifically, whether 0 m constitutes an upstream location and which samples represent the local receiving environment; 3. provide a discussion on localized impacts in the immediate	Section 4.0 of the Annual Water Use Report, no significant increasing trends for any parameters were identified between upstream background (AEMP-10) and downstream (AEMP-11) locations. Variability in concentrations observed near the operation are likely due to sampling density. As outlined in the responses to the comments received, Imperial plans conduct additional statistical analysis as part of future annual reporting, which will help identify the potential for localized impacts.	

		receiving environment in relation to upstream water quality		
6	2019 AEMP Annual Report Temporal Trends	**Comment** Overall the AEMP annual report provides a brief discussion of seasonal trends and spatial trends. However, no discussion is provided on temporal trends (i.e. how concentrations have changed from 2017 to 2019). **Recommendation** ECCC recommends that the proponent provide a discussion of temporal trends over the three year sampling period presented in the annual report.	**Aug 19:** In the AEMP Version 3.0, Imperial committed to "comparing change over year at each site". Imperial agrees that temporal trends are an important component of the annual AEMP reports. Because Norman Wells was not operating during the 2017 and 2018 AEMP sampling seasons, data collected in these years could serve as a "non-operational baseline" and is useful for comparison as more annual data becomes available. Because the 2020 data will be available in the near term, and because temporal analysis will be more valuable with an additional year worth of data, Imperial is proposing to include additional discussion of temporal trends in the upcoming (i.e. 2020) annual AEMP report.	See HESL TR
7	2019 AEMP Annual Report Figure 1	**Comment** Figure 1 provided outlines the AEMP sampling locations. However, it does not depict site infrastructure and discharge points that may be relevant to the locations of the AEMP monitoring locations. In addition, AEMP sampling locations 12 and 13 are not depicted on the figure. **Recommendation** ECCC recommends that Figure 1 be updated to include site	**Aug 19:** In addition, on the local information outlined in Table A of the Norman Wells Operations Aquatic Effects Monitoring Program Report (dated March 10, 2020), Imperial agrees that including relevant site infrastructure on Figure 1 would improve clarity. Imperial proposes to address this	Agreed. Figures to be revised.

		infrastructure that is relevant to AEMP monitoring results (for example, discharge locations), and that figures that depict locations of AEMP stations 12 and 13 be provided.	recommendation in future AEMP annual reports (along with ensuring sampling locations AEMP-12 and AEMP-13 be added to Figure 1).	
8	2019 AEMP Annual Report Guideline Exceedances	**Comment** The surface water results tables as well as figures depicting concentration indicate several exceedances of the CCME Water Quality Guidelines for Protection of Aquatic Life. However, no discussion is provided in the body of the report on these exceedances of guidelines (i.e. natural background, historical contamination, project impacts). **Recommendation** ECCC recommends that the Proponent provide a discussion on any exceedances of guidelines.	**Aug 19:** Imperial agrees that CCME guidelines exceedances for metals is an important topic for discussion in the body of the report. The majority of the exceedances are for total metals. Aluminum, iron, copper and lead consistently exceeded guidelines, whereas zinc and cadmium exhibited sporadic guideline exceedances. This "pattern" of guideline exceedances is also observed at the upstream location (AEMP-10), suggesting that these exceedances are likely not associated with the Norman Wells Operation. Arsenic and chromium (total) only exceed guideline at sampling location AEMP-07. This one time guideline exceedance is associated with elevated total suspended solids. Imperial plans to refine the statistical analyses completed in the 2020 AEMP Annual report. A broader discussion regarding these guidelines exceedances in relation to the Norman Wells Operation will be provided at that time. If this	See HESL TR

			additional analysis indicates the potential for these exceedances to be associated with the Operation, Imperial will take steps to further characterize the potential sources including an investigation of cause. If data analysis confirmed impacts to the aquatic environment were a result of Imperial's Operation, the option of changing activity to reduce stress would be evaluated.	
Fisheries and Oceans Canada: Nicholas Wasilik				
ID	**Topic**	**Reviewer Comment/Recommendation**	**Proponent Response**	**Board Response**
1	2019 Annual Water Licence Report and AEMP Report	**Comment** Fisheries and Oceans Canada has reviewed the report and has no comments at this time. **Recommendation** Fisheries and Oceans Canada has no recommendations at this time.	**Aug 19:** No recommendation provided.	
GNWT - ENR - EAM (Environmental Assessment and Monitoring): Central Email GNWT				
ID	**Topic**	**Reviewer Comment/Recommendation**	**Proponent Response**	**Board Response**
16	General File	**Comment** (doc) ENR Letter with Comments, Recommendations and Attachment **Recommendation**		Letter attached
17	General File	**Comment** (doc) Attachment: Zajdlik & Associates Inc. - May 28, 2020 - Imperial Oil Resources (NWT) Limited Aquatic Effects Monitoring Program Analysis Review **Recommendation**		Report Attached
1	Topic: Table A-4: Four	**Comment** Table A-4: Four Week Rolling Average	**Aug 19:** Table A-4 should read Max. Average Limit	Agreed. Corrections to

	Week Rolling Average (S13L1-007-02)	(S13L1-007-02), lists the maximum average limit for phenols as 0.014 mg/L; however, the Water Licence outlines that effluent quality criteria (EQC) for phenols include a maximum average concentration of 0.07 mg/L and a maximum grab concentration of 0.14 mg/L. As well, Table A-4 lists the maximum average limit for total petroleum hydrocarbons (TPH) is 5 mg/L whereas the Water Licence limit is 3.0 mg/L. Table A-4 outlines in December 1-31 TPH and phenols had an average concentration of<0.0015 mg/L and <2.0 mg/L respectively. Based on the data presented in Table A-1 it appears as though these two values have been switched. **Recommendation** 1) ENR recommends IORL amend Table A-4 to the correct Water Licence limits and correct values of TPH and phenols in December.	value of 3 mg/L for TPH and 0.07 mg/L for phenols (S12L1-007 Maximum Average Concentration Criteria). As noted, Dec 1-23 value for TPH and phenols should be < 2.0 mg/L and >0.0015 mg/L, respectively. These administrative efforts in the Water Licence limits in Table A-4 will be corrected in future Annual Water Use Reports.	be made.
2	Topic: Table A-7: Quarterly Outlet Data	**Comment** Table A-7: Quarterly Outlet Data, lists that this data is from SNP S13L1-007 (inlet); however, the data appears to correspond with the title of the table (i.e. the outlet). **Recommendation** 1) ENR recommends Table A-7 be fixed to reference the correct SNP station.	**Aug 19:** Table A-7 should reference SNP S13L1-007-2 (Outlet) not SNP S13L1-007-1 (Inlet). This administrative error in Table A-7 will be corrected in future Annual Water Use Reports.	Agreed. Corrections to be made
3	Topic: Contingency Wells	**Comment** Section 7: SNP - Groundwater, states well BI-13-3-4.5 was damaged in September 2019 and was	**Aug 19:** In the future, Imperial intends to continue sampling B1-13-1-4 in place of BI-13-3-4.5	Response acceptable

		replaced by contingency well BI-13-1-4. As well, Section 4 of Appendix C: SNP - Groundwater, explains that in 2018 well GIP 09-1-4 was abandoned and reinstalled as GIP 09-1-4-R and in 2019 well BIBG-10-1-4 was sampled instead of primary SNP well BIBG-12-1-7 which was damaged. ENR notes it isn't clear if IORL intends to keep sampling wells BI-13-1-4 and BIBG-10-1-4 going forward instead of wells BI-13-3-4.5 and BIBG-12-1-7. **Recommendation** 1) ENR recommends IORL clarify which wells they intend to continue sampling in the future.	and BIBG-10-1-4 in place of BIBG-12-1-7, based on the similar spatial coverage provided by these alternate wells.	
4	None	**Comment** None **Recommendation** 2) ENR recommends that should IORL intend to sample from different wells than those currently listed in the SNP in the future, IORL should apply to amend the SNP and update the Groundwater Monitoring Plan accordingly.	**Aug 19:** The Groundwater Management Plan discusses sampling from contingency wells (Section 3.1.1) and indicates that efforts will be made to repair groundwater wells as soon as reasonably possible and that the SLWB will be notified during the annual reporting of any changes to the groundwater monitoring network or sampling frequency at a specific location. Imperial provided information on alternate contingency monitoring wells (as summarized in the above comment) in the 2019 Annual Water Use Report and confirmed that it intends to continue to sample these contingency wells in place of the	Agreed. As part of the next annual review of the Groundwater Management Plan, updates will be made to reflect the use of contingency monitoring wells in place of damaged wells.

			damaged wells (based the similar spatial coverage provided). As part of the next annual review of the Groundwater Management Plan, updates will be made to reflect the use of contingency monitoring wells in place of damaged wells.	
5	Topic: Surface Water Background	**Comment** Page 116 of 498 of the report includes Table 10: Surface water background geochemical statistical summary (2009-2016). ENR notes yellow shading indicates parameters above the most restrictive guidelines selected. In the first table, the maximum background - Goose Island - W-CAT-8 has a pH of 9.1 but is not shaded despite being outside the listed guideline of 6.5 to 9. **Recommendation** 1) ENR recommends Imperial clarify the error noted above.	**Aug 19:** Imperial has reviewed this comment and agrees that pH should have been shaded. This error will be corrected in future annual reporting.	Agreed. Corrections to be made
6	Topic: AEMP Report – General	**Comment** ENR requested, following direction from the SLWB, IORL provide the raw data for Tables 1-4 in the 2019 AEMP Report. This raw data was needed in order to complete our analysis. ENR would like to thank IORL for providing this information, in a timely manner. ENR retained Zajdlik & Associates Inc. to conduct spatial and temporal statistical analyses on 2017-2019 data presented in the 2019 AEMP Report. ENR has extracted and summarized the comments and recommendations from the	**Aug 19:** Imperial would like to thank ENR for the thorough review and providing the Memorandum for additional background and context.	Report attached

		memorandum and provided them below. ENR has also included the memorandum which provides additional background for the Board's information. **Recommendation** 1) ENR recommends the Board refer to the attached memorandum for additional background and context supporting ENR's comments and recommendations.		
7	Topic: AEMP Report – Action Levels	**Comment** The AEMP Version 2 states that "the magnitude of the effect that should be detectable by the AEMP program is determined by what is relevant ecologically" and that "In the absence of mechanistic understanding of what critical effect size matters, these may be defined somewhat arbitrarily in terms of percentage changes in value of the indicator or values in excess of several standard deviations of historical values" (IORL, 2019). While this is correct, the magnitude of effect that should be detectable reflects the level of unacceptable change, i.e. the significance threshold. This threshold should allow for the development of action levels that if triggered, require management actions to ensure the significance threshold is not reached. The AEMP should then be designed so that the statistical power is sufficient to reliably detect the degree of change associated with the low action level for each measurement endpoint.	**Aug 19:** Imperial agrees with ENR's recommendation and agrees that development of significance thresholds is important. Imperial will work toward developing significance threshold values for incorporation into future annual reporting.	Agreed. Imperial to develop significance thresholds. see also HESL TR.

		Recommendation 1) ENR recommends IORL consider addressing the question: What is an unacceptable degree of change (i.e. significance threshold) for each measurement endpoint? Once that change is defined, low action levels may be derived such that the significance threshold is never reached.		
8	Topic: AEMP Report – Effect Sizes	**Comment** The effect size presented in the 2019 AEMP Report is estimated from the data and not pre-defined. This is not an issue in the early stages of an AEMP where interest focuses on the question "What effect size can be detected?" (Note that this should eventually lead to an AEMP that can reliably detect changes representing low action levels). However, in the report, there is no linkage between the effect size used (a ratio of the coefficient of determination and its complement) and changes in the water quality analytes. The AEMP report does state that the: "effect size is a function of both the slope and residual variability" but no link between changes in upstream/downstream water quality is provided. **Recommendation** 1) ENR recommends effect sizes, presented in the report, be expressed in a clearer manner for reviewers to understand the measurement endpoints. For example, the method in which IORL has presented the effect size used does not clearly	**Aug 19:** Imperial agrees with this great recommendation and will take into consideration for future annual AEMP reports.	Agreed. Imperial to improve clarity of effect sizes. see also HESL TR.

		articulate what is the size of the difference in upstream-downstream water quality concentrations that the AEMP is able to detect. The effect size used should be presented in terms of the rate of change in water quality concentrations over distance. If an upstream/downstream comparison were conducted, an effect size should be expressed in terms of a percent change in downstream concentrations relative to upstream concentrations.		
9	Topic: AEMP Report - Hypothesis Testing	**Comment** IORL should include all p-values for hypothesis testing rather than indicating "significant" or "not" based on the selected cut-off value of 5%. For example, the p-value for the slope coefficient for seasonal changes in total Al at location AEMP-01 is only marginally insignificant using the selected criterion. However, the p-value (0.0788) is certainly suggestive of a negative trend in Al concentrations from spring to fall. **Recommendation** 1) ENR recommends that p-values for hypothesis testing be included rather than indicating significant or not based on the selected cut-off value of 5%.	**Aug 19:** Imperial agrees that adding p-values would be of value and will take this recommendation into consideration for future annual AEMP reports.	Agreed. Imperial to add p-values.
10	Topic: AEMP Report – Spatial Water Quality Analyses	**Comment** The spatial water quality analyses conducted to date suggest no upstream versus downstream differences and states: "There is variability in water quality adjacent to	**Aug 19:** As part of the 2002-2006 AEMP, Imperial conducted a dye tracer study and an effluent dispersion model to predict the mixing and	See also HESL TR for an upstream - downstream approach.

		operations, but any higher concentration do not manifest in increases downstream and any effects may be highly localized". IORL should confirm that the distance from operations to the downstream locations reflects the spatial extent in which elevations of water quality analytes attributable to operations is of interest. If yes, subject to additional confirmation for several years, and in the absence of operational changes that could affect water quality, a reduction in the AEMP (for water quality analytes only) may be warranted. If no, additional downstream locations may be warranted. **Recommendation** 1) ENR recommends the IORL confirm the distance from operations to downstream locations reflect the spatial extent in which elevations of water quality analytes attributable to operations is of interest.	concentrations of the CPF effluent at various locations downstream under a variety of river flow conditions. Results suggest that the effluent from the Central Processing Facility discharge stream undergoes very slow dispersion in the Mackenzie River and travels over a long distance downstream. The dilution of the effluent to 0.1% of the initial concentration is predicted to be over 8 km downstream and past Rader Island. The current downstream location reflects the spatial extent in which elevations of water quality impacts attributable to the Norman Wells Operation may be detected.	
11	Topic: AEMP Report – Seasonal and Spatial Trend Analyses	**Comment** The estimation of statistical power relies on a series of assumptions regarding the data-power analysis combination used. As noted in the AEMP version 2: "Water quality data, unlike water quantity data and data generated from measurement of other natural phenomena is not normally distributed. Instead, data is often right skewed, and often contains measurements which lie below a specified detection limit. For this reason, non-parametric statistical methods are used to	**Aug 19:** Imperial proposes to address this comment in future annual AEMP reports. Compared to conducting this analysis with only three years' worth of data, having an additional year of data will make the test for normality more powerful.	Agreed. However, Imperial did not combine the following year data into the statistical analysis. See HESL TR.

		analyze water quality data" (IORL, 2019). The seasonal and spatial trend analyses presented in the AEMP Annual Report uses parametric methods which in itself is not problematic when estimating coefficients. However, it may be problematic when estimating statistical distribution-related quantities such as p-values and statistical power. **Recommendation** 1) ENR recommends IORL test the assumptions for the parametric models used and provide the results to ensure that inferences based on p-values and estimates of statistical power are well founded.		
12	Topic: AEMP Report – Figure 1: AEMP Monitoring Locations	**Comment** ENR notes that in Figure 1 of the 2019 AEMP Report, AEMP 12 and AEMP 13 monitoring locations are not identified. **Recommendation** 1) ENR recommends the location of the AEMP-12 and AEMP-13 monitoring sites be identified in Figure 1.	**Aug 19:** AEMP-02, 03, and 04 are located in Bosworth Creek. The sulphate concentrations at these locations are above 100 mg/L, which is the y-axis maximum. This is why the locations are not displayed on the chart. Not extending the y-axis maximum was an error by Imperial and will be corrected in future annual AEMP reports.	Agreed. Imperial to make correction.
13	Topic: AEMP Report, Appendix C - Figure C-12	**Comment** ENR notes data for AEMP-02, 03 and 04 do not appear to be plotted in Figure C-12 despite results of data analysis for these sites being listed in Table C-12. **Recommendation** 1) ENR recommends Imperial clarify why AEMP stations 02, 03 and 04 are not plotted in Figure C-	**Aug 19:** AEMP-02, 03, and 04 are located in Bosworth Creek. The sulphate concentrations at these locations are above 100 mg/L, w hich is the y-axis maximum. This is why the locations are not displayed on the chart. Not extending the y-axis	Agreed. Imperial to make correction.

		12.	maximum was an error by Imperial and will be corrected in future annual AEMP reports.	
14	Topic: AEMP Design	**Comment** The AEMP Version 2 states: "Data from the AEMP will be compared to aspects of the SNP and the GNWT Community Based Water Quality Monitoring Program where appropriate" (IORL, 2019). ENR notes the AEMP Annual Report does not make reference to the data from the SNP nor GNWT Community Based Water Quality Monitoring Program and it is therefore not clear how these programs will be applied to the AEMP. **Recommendation** 1) ENR recommends IORL clarify in what circumstances the SNP or GNWT Community Based Water Quality Monitoring Program will be used for comparison to AEMP data.	**Aug 19:** Data from the SNP provides an additional dataset to explain local variations observed in the AEMP data. Data from the GNWT CBWQP could be used to explain similarities between local and regional observations. Imperial acknowledges that these data were not used in the 2019 AEMP annual report, will consider if there is value in incorporating more discussion around these datasets in subsequent AEMP annual reports.	See also HESL: TR for info. on the GNWT CBWQP.
15	Topic: References	**Comment** The following references is provided in support of ENR review comments. References: IORL (Imperial Oil Resources Limited). 2019. Norman Wells Operations Aquatic Effects Monitoring Plan, October 2019. Zajdlik & Associates Inc. - May 28, 2020 - Imperial Oil Resources (NWT) Limited Aquatic Effects Monitoring Program Analysis Review **Recommendation** None.	**Aug 19:** No recommendation provided.	
Sahtu Renewable Resource Board: Colin Macdonald				
ID	**Topic**	**Reviewer Comment/Recommendation**	**Proponent Response**	**Board Response**

1	General Report	**Comment** Overall, the summary report and the report of the background sites are good and they summarise the data from the SNP program and the background sites well. Interpretation is lacking, which makes it difficult to understand why some elements are elevated (e.g., chloride) even though HCs remain low. The rationalisation of the background sites for soil and groundwater on the Lease Area and distributed in the operations are is hard to understand. Given the long history of activity (i.e. 100 years) it seems likely that contamination is more widely distributed than present day infrastructure and activities. **Recommendation** None but some recommendations and requests for clarifications are below.	**Aug 19:** No recommendation provided.	
2	Page 4-12	**Comment** This section is required under the conditions of the Water Permit and all the values are consistent with reporting requirements. **Recommendation** None.	**Aug 19:** No recommendation provided.	
3	Table A-2	**Comment** Total suspended solids (TSS) are below detection in the Inlet stream to the CPF but well above detection (up to 4 or 5 times higher) at the outlet. No other parameters (e.g., pH or Total EC) have changed. What is the source of the solids if the water has a direct path through the cooling loop? **Recommendation** Provide a	**Aug 19:** The TSS concentrations at the inlet are generally higher or similar to the concentrations at the outlet. There are some exceptions in May and June. Although in some cases, the TSS concentration in the outlet is higher than the concentration in the inlet,	Response acceptable.

		brief explanation of why TSS is higher in the outlet than inlet. Also, has the chemical composition of TSS and TDS been determined?	the overall concentration remains low and not of ecological concern. As there is no source of TSS within the fresh water loop, these exceptions could potentiall be an artifact from the sample collection process (composite) and lag time through the plant. The chemical composition of the water quality is analysed on a quarterly basis (Table A-6 and A-7). This quarterly sampling shows that the yearly average TSS concentration at the inlet is higher than the outlet.	
4	Appendix C	**Comment** Good description of the statistics and sampling/analytical methods. Good references for trend analysis. **Recommendation** Trends are mentioned in the summary of results the trends should also be shown graphically for emphasis.	**Aug 19:** Imperial appreciates this suggestion and will take into consideration for future annual reporting.	Agreed. Imperial to show graphic results.
5	App C. Page 13	**Comment** There is no description of how the groundwater sampling sites were selected. Were the sites selected because of known sources of contamination? **Recommendation** Briefly describe the selection process for the groundwater sampling sites.	**Aug 19:** The process for selection of groundwater sampling sites can be found within the Norman Wells Operations Groundwater Management Plan (Section 3.1).	Agreed.
6	Section 6.2.1	**Comment** Eight monitoring wells had dissolved chloride concentrations higher than background (location TF03-1203). Does this indicate	**Aug 19:** With the exception of one location (i.e., TF 03-12-3) the concentrations of chloride are slightly above what is	Response acceptable

		contamination from operations? What is the significance of high chloride levels? **Recommendation** Briefly describe the importance of the presence of elevated chloride in terms of sources (specifically, what industrial activities cause high Cl and why HCs are not detectable at the same sites) and what the potential impacts might be. Also, what are the implications of the Cl increasing trend at BIBG-10-1-4 and GIBG-10-2-3 after 2016?	defined as background and not in concentration of ecological concern (significantly less than applicable guidelines). Additionally, the chloride concentration at most these locations have been stable over time, below guideline, and within the observed historical range reflected by the Upper Control Limit (UCL) suggesting no new source of influence. At the CPF 97-7-5 location, the latest chloride result appears to be an outlier. 2020 sampling will confirm if it is in fact an outlier or a step change in concentration. The chlorides observed at TF 03-12-3 are elevated due to anthropogenic impacts, as discussed in the 2019 Annual Water Use Report. This area is risk managed through the Interim Closure and Reclamation Plan. The chloride concentrations observed in 2019 are below the CCME CEQG guideline for freshwater aquatic life. Increasing chloride were observed at BIBG-10-1-4 and GIBG-10-2-3. At BIBG-10-1-4 the concentrations have been stable since 2016 and remain within the range of natural variability and below guideline. These concentrations are not of	

			ecological importance and do not trigger an investigation of cause at this point. At GIBG-10-2-3, Although there is a visual trend, this trend is not currently statistically significant and the concentration remains with the historical range and below guideline.	
7	General Report	**Comment** In the 2015 Closure and Reclamation Report (Page 10), IORL reports pumping hydrocarbons out of groundwater near the Refinery Bank. What is the relationship between that site and the groundwater sites in this report? **Recommendation** Please clarify where the contaminated groundwater is relative to the sites mentioned in this report.	**Aug 19:** Information on the location of contaminated groundwater relative to the sites mentioned in this report can be found by referring to the most recent 2019 Annual Closure and Reclamation Report: Cover Letter; 2019 Annual Closure and Reclamation Report; Figures Part 1; Figures Part 2; Appendix 3 and 4; Appendix 5; Appendix 6 and 7; Appendix 8; Appendix 9; Appendix 10 and 11; Appendix 12 and 13	Agreed. Refer to GWMP. Also see HESL TR.

8	Appendix B	**Comment** 1.2.2. Groundwater - Selection of Sites **Recommendation** Provide more detail on the selection of the location of the testing sites. Figure 3 indicates that the "background" sites are distributed throughout the Lease Area and are probably impacted by local operations. Similarly, the "background" soil stations (Figure 2) are distributed through the operations area. Can these be considered to be "backgrounds"given the 100 year operations in the area?	**Aug 19:** Background data was collected through specific environmental site assessments and site specific conditions and comparisons would have been considered to classify as suitable "background" locations. As mentioned in Section 1.2.1, only data from those background locations considered to have minimal or no potential industrial impact were included in the background assessment.	Agreed. Refer to GWMP. Also see HESL TR.
9	1.3.3 Statistical Analysis of Data	**Comment** Values below detection were assigned the detection limit, and not half the DL, which is the usual approach for treating data. This will inflate the background values higher than they should be. **Recommendation** Report data as one-half the detection limit.	**Aug 19:** Imperial is in agreement that half the detection limit should have been used in the analysis and will take this recommendation into consideration during future background assessments. When analysing the SNP groundwater data, more weight is given to intra-well data analysis to identify data departures from historical variabilty than to the background assessment. Background concentrations are used to	Agreed. Also see HESL TR.

			provide additional context. In the case of chloride, using the detection (1 mg/L) limit versus half the detection limit (0.5 mg/L) is not expected to be of significance as chloride are usually above the detection limit.	
10	Section 2 – Summary of Findings	**Comment** Some elements exceed CCME guidelines in soils, groundwater and surface water. It will be very difficult to detect impacts of IORL operations on the local environment with contamination present already. Also, the groundwater near the operations should show the same pattern of elevated elements (they are characteristic of background groundwater), plus any contamination from operations. **Recommendation** Propose a method by which IORL can separate the impact of its operations from natural variability (and a better selection of "background" sites) and the natural seeps. Provide an area map of plumes of contamination of groundwater and soils from seeps and in relation to historic and present-day operations.	**Aug 19:** Imperial has selected key indicator parameters (hydrocarbons and chloride) based on potential sources from the Norman Wells Operation. Statistical analysis such as trending and control limits are conducted on a yearly basis to identify changes in the groundwater quality. If a statistically significant change is detected, Imperial would investigate the cause and evaluate potential sources nearby such as historical contamination and natural seeps. Additional parameters such as salinity and dissolved metals would be considered in the investigation. As outlined in Section 1.4 of Norman Wells Operations Groundwater Management Plan, wells included within the SNP Groundwater Program are intended for the early identification of changes near active facilities. Evaluation of plumes of contamination of groundwater and soils from seeps and in relation of historic and present-day	Agreed. Refer to GWMP. Also see HESL TR.

			operations is outside the scope of the SNP Groundwater program. Additional information on impacts from historic operations can be found by referring to the most recent Annual Closure and Reclamation Report: 2019	
11	Appendix D – Aquatic Effects Monitoring Program Report	**Comment** This report summarises work conducted as part of IORL's Aquatic Effects Monitoring Program (AEMP)	**Aug 19:** No comment from Imperial.	Agreed. AEMP Annual Report must be a stand-alone document.

		which has been running for 3 years. The AEMP work described here is very limited and there is no effort to test for biological effects (e.g., sample fish, benthic or planktonic organisms, sediments, etc.). In general: -This report is Appendix D of the current document and is supposed to be on Page 37 but is hidden after data submission and data sheets from water sampling and starts somewhere around page 410. It should be published on its own so that reviewers can comment directly on the work and its conclusions, -the report discusses monitoring "effects" (which usually implies changes to the biotic community), however only reports water sampling data, -provides statistical analysis of elements that have not been shown to be correlated with IORL operations in any way. Advisian uses statistical analysis that is inappropriate for its intended goal, and mixes comparisons by year and seasons with distance downstream from the NW Lease Area and has not accounted for background variability **Recommendation** The SLWB needs to lay out a minimum amount of work that is reported in the AEMP report if it is released as part of the water monitoring report. If other work		

		(e.g., fisheries) is conducted at the NW site then it should all be presented in the context of accomplishing the AEMP goals.		
12	Appendix D – Executive Summary	**Comment** The objectives of the study are stated in 3 areas, none of which provide a strong rationale for this sampling program. Stating a set of clear objectives gives a reviewer some idea of how well the study has been conducted. Exec. Summary: "Water quality samples were collected to discern potential impacts due to ongoing Norman Wells operations and/ or presence of legacy contaminants." There is no clear definition of "impacts". Scope: "Collect surface water samples at AEMP locations for laboratory analysis" and Provide a summary report and The scope of this work is to simply identify any irregular or notable results and to provide a detailed record of the work. The objective here is to collect samples and write a report. AEMP Locations: "Obtain data both upstream and downstream" and "Capture the longitudinal nature of these	**Aug 19:** Imperial agrees that a stronger statistical analysis can be used to help detect changes between locations. Imperial will take this comment into consideration for future annual AEMP reporting.	Agree with SRRB. See also HESL TR.

		watercourses" and "Support quantifying seasonal variability to account for it in subsequent analysis". The objective is to obtain data and examine it for seasonal variability. No reason is given for why seasonal variation is important for the AEMP. **Recommendation** The report needs to outline the objectives of the AEMP and how this sampling program fits into that larger program plan. "Effects" should be clearly defined in the context of the AEMP and not simply a change in the concentrations of a few elements that may or may not be associated with Imperial's operations. The water sampling program should be designed to detect changes between locations using strong statistical procedures (ANOVA or ANCOVA, if enough samples are collected), not the linear regression methods used in this report. Most important, IORL needs to rationalise beforehand suitable statistical and sampling procedures to test for specific markers of operations. Also, the analysis needs to take into account background variability, and how locations potentially impacted by IORL operations differ from background.		

13	Appendix D – Page 1	**Comment** "evaluating immediate or long-term significance of potential aquatic effects as required, measuring the effect activities may be having on water, and identifying if steps are needed to prevent serious or permanent damage to aquatic life". **Recommendation** There is no indication that this study will be able to test potential "effects" on aquatic life. With the proper analysis, it might be able to test if the concentrations of elements are different at a few locations in the River and Creek.	**Aug 19:** The addition of a fish sampling program (as outlined in AEMP Version 3.0) will be able to test for potential effects from Norman Wells Operation on aquatic life.	Agree with SRRB. See also HESL TR.
14	Appendix D – Sampling and Methodology	**Comment** Most important analytes related to IORL operations were below detection **Recommendation** Propose different methodology to achieve lower detection limits or concentrating the analyte concentration to detect regional trends. Consider using membrane devices for hydrocarbon monitoring.	**Aug 19:** Because all hydrocarbon results are below detection limits (and also below CCME freshwater aquatic life criteria), there is not a need to lower laboratory detection limits. Regardless of how much below detection limits the criteria are, concentrations are well below applicable criteria and are not of ecological significance.	Agree with SRRB. See also HESL TR.
15	Appendix D – Results	**Comment** IORL uses statistics on all analytes that are above detection, but no rationale as to which analyte might be associated with operations, or natural seeps. **Recommendation** Provide a	**Aug 19:** The data analysis program is designed to first detect a change in water quality and then, if a change is detected, to conduct a cause investigation to	Agree with SRRB. See also HESL TR.

		rationale for specific markers of IORL operations at the locations and accept or reject hypotheses on that basis.	understand the source and, the significance of the change and then if mitigation measures are warranted.	
16	Appendix D - Seasonal trends (Page 6)	**Comment** This section is very unclear as to what is being tested and Figure A doesn't help. IORL uses regression to test whether total aluminum varies by season which is not an appropriate method given the non-normality of the data. This method conflates seasonal, location and annual variability for an element (Al) which might not have anything to do with IORL operations. **Recommendation** IORL needs to develop a sampling design that will allow more appropriate statistical analysis with some statistical confidence, such as ANOVA or ANCOVA.	**Aug 19:** Imperial agrees that a stronger statistical analysis can be used to help detect changes between locations. Imperial will take this comment into consideration for future annual AEMP reporting.	Agree with SRRB. See also HESL TR.
17	Appendix D - Page 7	**Comment** Again, it's unclear what is being tested using the "power statistics". "Effect" tested appears to be due to season, but it's unclear why this being tested, as the AEMP program should be testing for differences in concentration by location (near operations versus remote from operations, or upstream versus downstream). **Recommendation** IORL needs to decide before sampling what will be analysed to achieve its objectives. Effects size needs to be determined beforehand,	**Aug 19:** Imperial agrees that a stronger statistical analysis can be used to help detect changes between locations. Imperial will take this comment into consideration for future annual AEMP reporting.	Agree with SRRB. See also HESL TR.

		however this analysis will not provide any answers because of the interactions between season, annual variation, water chemistry, water flow, upstream activity (slumps into the Mackenzie) and a lot of other factors.		
18	Appendix D - Figure C	**Comment** What is being illustrated here is unclear. The data are not normally distributed, giving more weight to the two endpoints. The title mentions "seasonal total copper" which suggests that each data point is a different season (?). The slopes are probably not significant but shouldn't be determined given the non-normal distribution of the data. Copper probably has variability in the background which is independent of the IORL operations. **Recommendation** See above comments. IORL needs to rethink their strategy of determining "effects" even at the water quality level. This analysis is just looking for correlations with no clear objectives.	**Aug 19:** Imperial agrees that a stronger statistical analysis can be used to help detect changes between locations. Imperial will take this comment into consideration for future annual AEMP reporting.	Agree with SRRB. See also HESL TR.
19	Appendix D - Page 11	**Comment "**the lack of difference between the extremes of upstream and downstream suggests that the variability near operations represents at most only localized effects." So the analysis indicates that local effects are possible? I doubt it, but IORL should	**Aug 19:** Imperial plans to review and improve the statistical approach used in the upcoming annual AEMP report. The revised statistical analysis combined with an additional year's worth of data will be more powerful at identifying	Agree with SRRB. See also HESL TR.

		explain further. **Recommendation** Explain why the analysis might indicate local "effects" and the steps taken to confirm or follow-up the observation.	potential local effects. If such local effect are identified, the next steps would be to launch a cause investigation to understand the source and determine the ecological significance of the local effect.	
SLWB: Bonnie Bergsma				
ID	**Topic**	**Reviewer Comment/Recommendation**	**Proponent Response**	**Board Response**
1	AEMP Report	**Comment** The AEMP report summarizes water quality data for the sampling periods of 2017, 2018 amd 2019. All data is pooled and evaluated for trends. However; the Report does not take into account that the Imperial Oil Norman Wells Operation was in a shut-down due to the Enbridge Line 21 failure from the period beginning March 7, 2017 until after all repairs were completed on October 13, 2018. In effect, all water quality sampling completed in 2017 and 2018 reflect a baseline condition when there were no operational discharges to the Mackenzie River. The 2019 sampling period represents normal operational conditions. **Recommendation** The AEMP report must clearly separate the data trend analyses and summaries of background concentrations of parameters measured during non-operational periods (2017 and 2018 when Imperial was shutdown) from the data collected in 2019 when Imperial had resumed	**Aug 19:** Going forward, the two years of data from when the Norman Wells Operation was not in operation can serve as "non-operational baseline" data, and be compared with operational data as a method to identify changes. This analysis will be incorporated into future annual AEMP reports. At this time, additional operational data will be available (i.e. more than one year worth of data), improving the ability to conduct statistical analysis and detect potential changes. The summary of 2017-2019 surface water AEMP data included as Attachment B distinguishes between non-operating (2017 and 2018) and operating (2019) years.	See HESL TR

		operations.		
2	Figure - AEMP Sampling Locations	**Comment** The Figure of AEMP Sampling Locations is missing a location downstream of the CPF Effluent Discharge. The Table of Sampling Locations in AEMP Version 1.0 (conditionally approved by the Board in order to begin WQ sampling) describes this location as where the effluent enters the Mackenzie River and potential stressors being water use and water return. The accompanying figure did not show this location, but did include a sampling location upstream of the CPF Effluent Discharge. Reviewer comments recommended including coordinates for sample locations to ensure accuracy. The AEMP version 2.0 that was not approved by the Board includes the same figure - title,date, and figure number - and correctly identifies the sample location downstream of the effluent discharge in addition to the location upstream of the effluent discharge. Advisian used the figure from AEMP version 1.0 and re-described the location as upstream of the CPF Effluent Discharge. This AEMP is to detect changes in water quality from operations. Why was this error of omission not confirmed by the consultants conducting the sampling when this location is perhaps one of the most important locations to be	**Aug 19:** The location of AEMP-09 was incorrectly listed in Table A and incorrectly shown on Figure 1 of the Norman Wells Operations Aquatic Effects Monitoring Program Report (March 10, 2020). AEMP-09 is located downstream of the CPF Effluent Discharge (not upstream) at the location shown on the figure below. These errors will be corrected in future AEMP annual report submissions.	See HESL TR.

		sampling for potential impacts to water quality? Imperial did not submit annual AEMP reports as required by Part E, condition 3 of :Licence S13L1-007; therefore this error in sampling was not able to be detected. **Recommendation** Imperial is to provide to the consultants conducting the sampling a correct version of the AEMP sample location map (Figure 9 in AEMP version 2.0 - includes a location immediately downstream of the CPF Effluent Discharge) and coordinates of these locations must be included in all AEMP Annual Reports. Sampling of this location must begin in 2020.		
3	Appendix C - Seasonal Trends in Water Quality graphs	**Comment** The seasonal trend graphs need to separate out the water quality data collected during Imperial shutdown in 2017 and 2018 (non-operational years) from water quality data collected after the facility became operational again (fall 2018). The date of the water quality sampling in fall of 2018 coincides with the date of the final repair to the Enbridge Line 21 pipeline. Confirm whether the data from fall 2018 sampling was collected prior to or subsequent to the startup of the Norman Wells Operations.. **Recommendation** Seasonal Trends graphs must distinguish between water quality data collected during operational	**Aug 19:** Imperial agrees with this recommendation and will take this comment into consideration for future annual AEMP reporting. At this time, additional operational data will be available (i.e. more than one year worth of data), improving the ability to conduct statistical analysis and detect potential changes. The summary of 2017-2019 surface water AEMP data included as Attachment B distinguishes between non-operating (2017 and 2018) and operating (2019) years.	See HESL TR.

		shutdown period and data collected after operations resumed.		
4	Appendix D - Regression Slopes across sampling locations	**Comment** Similar to comment above, the sampling results cannot be combined from non-operational and operational years. **Recommendation** Regression slopes graphs must be recalculated to distinguish between water quality samples collected during period of shutdown and those samples collected after operations resumed.	**Aug 19:** Imperial agrees with this recommendation and will take this comment into consideration for future annual AEMP reporting. At this time, additional operational data will be available (i.e. more than one year worth of data), improving the ability to conduct statistical analysis and detect potential changes. The summary of 2017-2019 surface water AEMP data included as Attachment B distinguishes between non-operating (2017 and 2018) and operating (2019) years.	See HESL TR.
5	Appendix E - Spatial Trends in Water Quality and section 3.2	**Comment** The AEMP sampling locations need to be identified along the x-axis to understand where the start of the measurement for distance downstream begins. It should also distinguish between control versus impact locations. The data analysis shows that the two extreme data points upstream and downstream are not very different. This would be expected as the upstream is a control and the downstream is far enough away from the immediate range of influence of the facility that dispersion in water of any contaminants would negate any differences observed at the midpoint	**Aug 19:** Imperial agrees with this recommendation and will take this comment into consideration for future annual AEMP reporting. At this time, additional operational data will be available (i.e. more than one year worth of data), improving the ability to conduct statistical analysis and detect potential changes. The summary of 2017-2019 surface water AEMP data included as Attachment B distinguishes between non-operating (2017 and 2018) and operating (2019) years.	See HESL TR.

		nearest the operations. A variation is shown in the middle cluster of points, however, Advisian suggests that this variation limits the statistical power to detect trends and the variability near operations represents at most only localized effects. What are these localized effects? Comments about these graphs follow the preceding two comments about combining the dataset collected during the period of shutdown (2017-2018) with the data collected after operations resumed in late fall 2018,. In viewing the scatter of points in the midpoint of these graphs, most have at least one data point that is elevated well above the others especially during the Fall of 2019 and 2018 and to a lesser degree in Spring of 2019 , There appears to be limited data points for summer 2019. These trends were observed for Aluminum , Copper, Iron, Magnesium, Manganese, Molybdenum, Nickel, Strontium, Titanium, Uranium, Sulphate. The higher points in Fall 2018 suggest that the operations may have resumed prior to Fall sampling in 2018 (operations resumed October 13, 2018; AEMP sampling occurred October 18, 2018). Chloride would not be expected to be elevated as the use of chloride in the cooling water has been and remains offline		

		since the shutdown in 2017. **Recommendation** The spatial trends in water quality graphs and regression curves need to take into consideration the water quality data collected during the operational shutdown period versus the water quality data collected after operations resumed.		
6	2019 Annual Report - section 4.0	**Comment** The report recommends that changes are not required to tthe AEMP Surface Water Sampling Proigram (number of sampling locations and frequency of sampling) based on data collected between 2017 and 2019. The Board's Decision Letter for the AEMP version 2.0, dated May 30, 2018 directed Imperial that "in order to increase the ability of the AEMP to detect potential changes in the aquatic environment and set low action levels, the Board has recommended that the sampling frequency be increased to at least six times per year (two sampling events each during high, medium and low water periods). The Board has also requested that Imperial ensure sufficient sampling locations are identified at Bear and Goose Islands". Furthermore, the results of the 2017-2019 sampling analyses are inconclusive due to combining water quality data collected during shutdown period (non-operational) and	**Aug 19:** Imperial agrees with the recommendations provided and is proposing to incorporate these changes into the upcoming annual AEMP report, when an additional years' worth of operational data is available (improving the ability to conduct statistical analysis and detect potential changes between operational and non-operational periods).	See HESL TR.

		startup (operational) - see comments above, and also combining data collected from Bosworth Creek with data collected from the Mackenzie River (see comments from ECCC and ENR). Finally, as per comment above regarding the Figure of AEMP Sample Locations. a key location for sampling is missing from the map - immediately downstream of the CPF Effluent Discharge. **Recommendation** The recommendations that no changes are required to sample locations and frequency of sampling must be reconsidered following resubmission and review of AEMP 2017-2019 Annual Reports. The resubmission of the AEMP Annual Reports must 1. separate water quality data analysis collected from Bosworth Creek from the data collected from the Mackenzie River; 2. Conduct all trend analyses and regression analyses on water quality data collected during shutdown period (2017 - Summer 2018) from data collected after operations resumed (Fall 2018 - Fall 2019); 3. add the AEMP sample location at the CPF Effluent Discharge as described in the AEMP version 1.0 report.		

June 2, 2020

Bonnie Bergsma
Regulatory Specialist
Sahtu Land and Water Board
Box 1,
Fort Good Hope, NT
X0E 0H0

Dear Ms. Bergsma,

Re: Imperial Oil Resources NWT Ltd. (IORL)
Water Licence – S13L1-007
2019 Annual Water Licence Report
Request for Comment

The Department of Environment and Natural Resources (ENR), Government of the Northwest Territories has reviewed the report at reference based on its mandated responsibilities under the *Environmental Protection Act,* the *Forest Management Act*, the *Forest Protection Act, the Species at Risk (NWT) Act, the Waters Act* and the *Wildlife Act* and provides the following comments and recommendations for the consideration of the Board.

Topic 1: Table A-4: Four Week Rolling Average (S13L1-007-02)

Comment(s):

Table A-4: Four Week Rolling Average (S13L1-007-02), lists the maximum average limit for phenols as 0.014 mg/L; however, the Water Licence outlines that effluent quality criteria (EQC) for phenols include a maximum average concentration of 0.07 mg/L and a maximum grab concentration of 0.14 mg/L. As well, Table A-4 lists the maximum average limit for total petroleum hydrocarbons (TPH) is 5 mg/L whereas the Water Licence limit is 3.0 mg/L.

Table A-4 outlines in December 1-31 TPH and phenols had an average concentration of<0.0015 mg/L and <2.0 mg/L respectively. Based on the data presented in Table A-1 it appears as though these two values have been switched.

Recommendation(s):

1) ENR recommends IORL amend Table A-4 to the correct Water Licence limits and correct values of TPH and phenols in December.

Topic 2: Table A-7: Quarterly Outlet Data

Comment(s):

Table A-7: Quarterly Outlet Data, lists that this data is from SNP S13L1-007 (inlet); however, the data appears to correspond with the title of the table (i.e. the outlet).

Recommendation(s):

1) ENR recommends Table A-7 be fixed to reference the correct SNP station.

Topic 3: Contingency Wells

Comment(s):

Section 7: SNP – Groundwater, states well BI-13-3-4.5 was damaged in September 2019 and was replaced by contingency well BI-13-1-4.

As well, Section 4 of Appendix C: SNP – Groundwater, explains that in 2018 well GIP 09-1-4 was abandoned and reinstalled as GIP 09-1-4-R and in 2019 well BIBG-10-1-4 was sampled instead of primary SNP well BIBG-12-1-7 which was damaged.

ENR notes it isn't clear if IORL intends to keep sampling wells BI-13-1-4 and BIBG-10-1-4 going forward instead of wells BI-13-3-4.5 and BIBG-12-1-7.

Recommendation(s):

1) ENR recommends IORL clarify which wells they intend to continue sampling in the future.

2) ENR recommends that should IORL intend to sample from different wells than those currently listed in the SNP in the future, IORL should apply to amend the SNP and update the Groundwater Monitoring Plan accordingly.

Topic 4: Surface Water Background

Comment(s):

Page 116 of 498 of the report includes Table 10: Surface water background geochemical statistical summary (2009-2016). ENR notes yellow shading indicates parameters above the most restrictive guidelines selected. In the first table, the maximum background – Goose Island – W-CAT-8 has a pH of 9.1 but is not shaded despite being outside the listed guideline of 6.5 to 9.

Recommendation(s):

1) ENR recommends Imperial clarify the error noted above.

Topic 5: AEMP Report – General

Comment(s):

ENR requested, following direction from the SLWB, IORL provide the raw data for Tables 1-4 in the 2019 AEMP Report. This raw data was needed in order to complete our analysis. ENR would like to thank IORL for providing this information, in a timely manner.

ENR retained Zajdlik & Associates Inc. to conduct spatial and temporal statistical analyses on 2017-2019 data presented in the 2019 AEMP Report. ENR has extracted and summarized the comments and recommendations from the memorandum and provided them below. ENR has also included the memorandum which provides additional background for the Board's information.

Recommendation(s):

1) ENR recommends the Board refer to the attached memorandum for additional background and context supporting ENR's comments and recommendations.

Topic 6: AEMP Report – Action Levels

Comment(s):

The AEMP Version 2 states that "the magnitude of the effect that should be detectable by the AEMP program is determined by what is relevant ecologically" and that "In the absence of mechanistic understanding of what critical effect size matters, these may be defined somewhat arbitrarily in terms of percentage changes in value of the indicator or values in excess of several standard deviations of historical values" (IORL, 2019). While this is correct, the magnitude of effect that should be detectable reflects the level of unacceptable change, i.e. the significance

threshold. This threshold should allow for the development of action levels that if triggered, require management actions to ensure the significance threshold is not reached. The AEMP should then be designed so that the statistical power is sufficient to reliably detect the degree of change associated with the low action level for each measurement endpoint.

Recommendation(s):

1) ENR recommends IORL consider addressing the question: What is an unacceptable degree of change (i.e. significance threshold) for each measurement endpoint? Once that change is defined, low action levels may be derived such that the significance threshold is never reached.

Topic 7: AEMP Report – Effect Sizes

Comment(s):

The effect size presented in the 2019 AEMP Report is estimated from the data and not pre-defined. This is not an issue in the early stages of an AEMP where interest focuses on the question "What effect size can be detected?" (Note that this should eventually lead to an AEMP that can reliably detect changes representing low action levels). However, in the report, there is no linkage between the effect size used (a ratio of the coefficient of determination and its complement) and changes in the water quality analytes. The AEMP report does state that the: "effect size is a function of both the slope and residual variability" but no link between changes in upstream/downstream water quality is provided.

Recommendation(s):

1) ENR recommends effect sizes, presented in the report, be expressed in a clearer manner for reviewers to understand the measurement endpoints. For example, the method in which IORL has presented the effect size used does not clearly articulate what is the size of the difference in upstream-downstream water quality concentrations that the AEMP is able to detect. The effect size used should be presented in terms of the rate of change in water quality concentrations over distance. If an upstream/downstream comparison were conducted, an effect size should be expressed in terms of a percent change in downstream concentrations relative to upstream concentrations.

Topic 8: AEMP Report - Hypothesis Testing

Comment(s):

IORL should include all p-values for hypothesis testing rather than indicating "significant" or "not" based on the selected cut-off value of 5%. For example, the p-value for the slope coefficient for seasonal changes in total Al at location AEMP-01 is only marginally insignificant using the selected criterion. However, the p-value (0.0788) is certainly suggestive of a negative trend in Al concentrations from spring to fall.

Recommendation(s):

1) ENR recommends that's p-values for hypothesis testing be included rather than indicating "significant" or "not" based on the selected cut-off value of 5%.

Topic 9: AEMP Report – Spatial Water Quality Analyses

Comment(s):

The spatial water quality analyses conducted to date suggest no upstream versus downstream differences and states: "There is variability in water quality adjacent to operations, but any higher concentration do not manifest in increases downstream and any effects may be highly localized". IORL should confirm that the distance from operations to the downstream locations reflects the spatial extent in which elevations of water quality analytes attributable to operations is of interest. If yes, subject to additional confirmation for several years, and in the absence of operational changes that could affect water quality, a reduction in the AEMP (for water quality analytes only) may be warranted. If no, additional downstream locations may be warranted.

Recommendation(s):

1) ENR recommends the IORL confirm the distance from operations to downstream locations reflect the spatial extent in which elevations of water quality analytes attributable to operations is of interest.

Topic 10: AEMP Report – Seasonal and Spatial Trend Analyses

Comment(s):

The estimation of statistical power relies on a series of assumptions regarding the data-power analysis combination used. As noted in the AEMP version 2: "Water quality data, unlike water quantity data and data generated from measurement of

other natural phenomena is not normally distributed. Instead, data is often right skewed, and often contains measurements which lie below a specified detection limit. For this reason, non-parametric statistical methods are used to analyze water quality data" (IORL, 2019). The seasonal and spatial trend analyses presented in the AEMP Annual Report uses parametric methods which in itself is not problematic when estimating coefficients. However, it may be problematic when estimating statistical distribution-related quantities such as p-values and statistical power.

Recommendation(s):

1) ENR recommends IORL test the assumptions for the parametric models used and provide the results to ensure that inferences based on p-values and estimates of statistical power are well founded.

Topic 11: AEMP Report – Figure 1: AEMP Monitoring Locations

Comment(s):

ENR notes that in Figure 1 of the 2019 AEMP Report, AEMP 12 and AEMP 13 monitoring locations are not identified.

Recommendation(s):

1) ENR recommends the location of the AEMP-12 and AEMP-13 monitoring sites be identified in Figure 1.

Topic 12: AEMP Report, Appendix C - Figure C-12

Comment(s):

ENR notes data for AEMP-02, 03 and 04 do not appear to be plotted in Figure C-12 despite results of data analysis for these sites being listed in Table C-12.

Recommendation(s):

1) ENR recommends Imperial clarify why AEMP stations 02, 03 and 04 are not plotted in Figure C-12.

Topic 13: AEMP Design

Comment(s):

The AEMP Version 2 states: "Data from the AEMP will be compared to aspects of the SNP and the GNWT Community Based Water Quality Monitoring Program where appropriate" (IORL, 2019).

ENR notes the AEMP Annual Report does not make reference to the data from the SNP nor GNWT Community Based Water Quality Monitoring Program and it is therefore not clear how these programs will be applied to the AEMP.

Recommendation(s):

1) ENR recommends IORL clarify in what circumstances the SNP or GNWT Community Based Water Quality Monitoring Program will be used for comparison to AEMP data.

Topic 14: References

Comment(s):

The following references is provided in support of ENR review comments.

References:

IORL (Imperial Oil Resources Limited). 2019. Norman Wells Operations Aquatic Effects Monitoring Plan, October 2019.

Zajdlik & Associates Inc. – May 28, 2020 - Imperial Oil Resources (NWT) Limited Aquatic Effects Monitoring Program Analysis Review

Recommendation(s):

None

Comments and recommendations were provided by ENR technical experts in the Water Management and Monitoring Division and the Sahtu Region and were coordinated and collated by the Environmental Assessment and Monitoring Section (EAM), Environmental Stewardship and Climate Change Division.

Should you have any questions or concerns, please do not hesitate to contact Patrick Clancy, Environmental Regulatory Analyst at (867) 767-9233 Ext: 53096 or email patrick_clancy@gov.nt.ca.

Sincerely,

Patrick Clancy
Environmental Regulatory Analyst
Environmental Assessment and Monitoring Section
Environmental Stewardship and Climate Change Division
Department of Environment and Natural Resources
Government of the Northwest Territories

Att: Zajdlik & Associates Inc. – May 28, 2020 - Imperial Oil Resources (NWT) Limited Aquatic Effects Monitoring Program Analysis Review

Imperial Oil Resources (NWT) Limited Aquatic Effects Monitoring Program Analysis Review

Prepared for:

L. Vician
Government of the Northwest Territories
Environment and Natural Resources

Prepared by:

Zajdlik & Associates Inc.

May 28th, 2020

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Table 1-1: Acronym Definitions i

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AEMP	aquatic effects monitoring program
EEM	environmental effects monitoring program
GNWT ENR	Government of the Northwest Territories Environment and Natural Resources
INAC	Indian and Northern Affairs Canada
IORL	Imperial Oil Resources (NWT) Limited
SLWB	Sahtu Land and Water Board

1 Introduction

Zajdlik & Associates Inc. was retained by the Government of the Northwest Territories, Environment and Natural Resources (GNWT ENR) to review spatial and temporal statistical analyses on data collected between 2017-2019. The analyses are presented in the most recent aquatic effects monitoring program (AEMP) report:

Advisian. 2020. Norman Wells Operations Aquatic Effects Monitoring Program Report. Imperial Norman Wells Operations, 10 March 2020.

2 Methods Review

IORL (2019 §4.7.1) states that "the magnitude of the effect that should be detectable by the AEMP program is determined by what is relevant ecologically". IORL (2019) goes on to state that: "In the absence of mechanistic understanding of what critical effect size matters, these may be defined somewhat arbitrarily in terms of percentage changes in value of the indicator or values in excess of several standard deviations of historical values". While that statement is correct, it is also correct that the magnitude of effect that should be detectable, reflects the degree of unacceptable change. The degree of unacceptable change is, in the parlance of Northern AEMPs, the significance threshold. An AEMP should be able to reliably detect changes associated with management actions. Again, in the parlance of Northern AEMPs, action levels trigger various management actions such that the significance threshold is never reached. A useful AEMP would be designed so that changes in a measurement endpoint commensurate with a low action level[1] may be reliably detected. A recommendation on this topic is presented in §3. Consistent with usage in Federal environmental effects programs (Environment Canada, 2011) and Northern AEMP guidance (INAC, 2009), the adverb "reliably" is defined as a statistical power greater than 80% with, the Type I error = Type II error. The latter provision ensures that

[1] This topic is not new. In the context of fish and with respect to AEMP version 2.0, SLWB (2018) stated that: "The AEMP must document how the proposed sampling program (i.e. sampling frequency, location, number of samples, analytes) will, at a minimum, allow exceedances of the Low Action Levels to be detected"

risk, as defined by the risk of making an incorrect conclusion, is the same for the Proponent and the environment.

The effect size presented in Advisian (2020) is estimated from the data and not pre-defined. In itself, that is not an issue in the early stages of an AEMP where interest focuses on the question "What effect size can be detected?" (Note that this should eventually lead to an AEMP that can reliably detect changes representing low action levels). However, there is no linkage between the effect size used (a ratio of the coefficient of determination and it's complement) and changes in the water quality analytes. Advisian (2020) does state that the: "effect size is a function of both the slope and residual variability" but no link between changes in upstream/downstream water quality is provided. A recommendation on this wording presented in §3.

The power analyses presented in Advisian (2020 §3.1) speak to the ability of the AEMP program to detect changes over seasons. The ability to do so, while interesting, does not inform stakeholders of the ability of the AEMP to detect upstream/downstream changes in water quality. Advisian (2020) notes that "any differences among the lines in Figure A (*Total Aluminum Concentration, AEMP 2017 – 2019*) could be interpreted as effects on water quality if the seasonal pattern is different depending on location". This statement speaks to the ability to detect differences in seasonal slopes among the various locations. The power analyses conducted reflect that comparison and not the more important comparison namely; the ability to detect changes upstream and downstream of IORL which is the primary intent of the AEMP. That topic is addressed in Advisian (2020 §3.2).

In that section, the variability of water quality analyte concentrations near operations is said to reflect "at most only localized effects". The variability is associated a distance of approximately 3 km for total Al (Advisian 2020, Figure D). Because of this large local variability, the power of the spatial analyses conducted is abysmal. The regression analyses are (correctly) summarized by Advisian as "There is variability in water quality adjacent to operations, but any higher concentration do not manifest in increases downstream and any effects may be highly localized".

The conclusion may be regarded as highly satisfactory if the spatial scale reflects the AEMP working groups definition of acceptable scale of change. A recommendation on this topic is presented in §3.

3 Recommendations

The following recommendations are provided in no particular order.

- The AEMP working group should address the question: What is an unacceptable degree of change (i.e. significance threshold) for each measurement endpoint? Once that change is defined, low action levels may be derived such that the significance threshold is never reached. The AEMP should be designed so that the statistical power is sufficient to reliably detect the degree of change associated with the low action level for each measurement endpoint. As noted by IORL (2019) the low action level could be associated with a relevant ecological change (as long as that degree of change does comprise serious ecological harm) or, some valuation statement regarding the measurement endpoint or group of measurement endpoints. As an example only, a valuation statement regarding water quality is that water quality remains substantively unaltered (Tłı̨chǫ Government, 2003). In this case, the low action level would be some measure representing a degree of change from the "natural" or background water quality and the AEMP would be designed with sufficient statistical power to detect such a change.

- IORL should explicitly express any effect sizes used, in terms of the measurement endpoints. For example, with respect to the spatial trend analyses of water quality analytes, the effect size used should be couched in terms of the rate of change in water quality concentrations over distance. If an upstream / downstream comparison were conducted, an effect size should be expressed in terms of a percent change in downstream concentrations relative to upstream concentrations.

- IORL should include all p-values for hypothesis testing rather than indicating "significant" or "not" based on the selected cut-off value of 5%. For example, the p-value for the slope coefficient for seasonal changes in total Al at location AEMP-01 is only marginally insignificant using the selected criterion. However, the p-value (0.0788) is certainly suggestive of a negative trend in Al concentrations over season.

- The spatial water quality analyses conducted to date suggest no upstream downstream differences. The AEMP working group should confirm that the distance from operations to the downstream locations reflects the spatial extent in which elevations of water quality analytes attributable to operations are of interest. If yes, subject to additional confirmation for several years, and in the absence of operational changes that could affect water quality, a reduction in the AEMP (for water quality analytes only) may be warranted. If no, additional downstream locations may be warranted.

- The estimation of statistical power relies on a series of assumptions regarding the data-power analysis combination used. As noted by IORL (2019): "Water quality data, unlike water quantity data and data generated from measurement of other natural phenomena is not normally distributed. Instead, data is often right skewed, and often contains measurements which lie below a specified detection limit. For this reason, non-parametric statistical methods are used to analyze water quality data". The seasonal and spatial trend analyses presented in Advisian use parametric methods which in itself is not problematic when estimating coefficients. However, it may be problematic when estimating statistical distribution-related quantities such as p-values and statistical power. IORL should test the requisite assumptions for the parametric models used and present the results to ensure that inferences based on p-values and estimates of statistical power are well founded.

4 References

Advisian. 2020. Norman Wells Operations Aquatic Effects Monitoring Program Report. Imperial Norman Wells Operations, 10 March 2020.

Environment Canada. 2011. Metal Mining EEM Guidance Document.

INAC (Indian and Northern Affairs Canada). 2009. Guidelines for designing and implementing aquatic effects monitoring programs for development projects in the Northwest Territories: Overview Report and Technical Guidance Documents Volumes 1 to 6. Prepared by MacDonald Environmental Sciences Ltd. and Zajdlik and Associates Inc., in association with the Water Resources Division. Yellowknife, NT.

IORL (Imperial Oil Resources Limited). 2019. Norman Wells Operations Aquatic Effects Monitoring Plan, October 2019.

SLWB (Sahtu Land and Water Board). 2018. Board Decision Letter for AEMP Version 2.0, May 28, 2018.

Tłı̨chǫ Government. 2003. Land Claims and Self-Government Agreement among the Tłı̨chǫ and the Government of the Northwest Territories and the Government of Canada.