

CanNorth

Canada North Environmental Services Limited Partnership
A First Nation Environmental Services Company

Revalidation of the Environmental Risk Assessment for Port Hope Conversion Facility

Final Report

December 2025

Project # 4691-1

Prepared for:
Cameco Corporation
Prepared by:
Canada North Environmental Services

TABLE OF CONTENTS

LIST OF ACRONYMS

COPC	Constituents of Potential Concern
CNL	Canadian Nuclear Laboratories
CNSC	Canadian Nuclear Safety Commission
CORMIX	Cornell Mixing Zone Expert System
EcoRA	Ecological Risk Assessment
EPP	Environmental Protection Program
EPC	Exposure Point Concentration
ERA	Environmental Risk Assessment
HHRA	Human Health Risk Assessment
IEMP	Independent Environmental Monitoring Program
LEL	Lower Exposure Limit
LTWMF	Long-Term Waste Management Facility
MECP	Ontario Ministry of Environment, Conservation and Parks
MPH	Municipality of Port Hope
PHAI	Port Hope Area Initiative
PHCF	Port Hope Conversion Facility
PWQO	Provincial Water Quality Objectives
STP	Sewage Treatment Plant
VIM	Vision in Motion

LIST OF FIGURES

LIST OF TABLES

1.0 INTRODUCTION

In accordance with its licence requirements, the Port Hope Conversion Facility (PHCF) maintains an environmental risk assessment (ERA) in accordance with the standardized requirements of CSA N288.6-22: Environment Risk Assessments at Class 1 Nuclear Facilities and Uranium Mines and Mills (CSA 2022). The ERA is a scientific process that identifies and assesses the potential risk posed by contaminants and physical stressors in the environment on human and ecological receptors. The ERA consists of a human health risk assessment (HHRA) and an ecological risk assessment (EcoRA).

In March 2016, an ERA was completed for the PHCF. The results determined that there were negligible risks to human health and the environment from exposure to contaminants associated with activities from the PHCF. A summary of the ERA and a redacted version of the ERA are available on the Cameco community website[1]. Under Clause 11 of N288.6-22 Cameco is required to review the ERA for the PHCF every five years. A review was submitted to CNSC in June 2024 based on additional monitoring carried out between 2015 and 2022. The findings of the review were that concentrations of contaminants had decreased over time and even though there has been changes in toxicity and methodologies over the review period, there were no changes to the 2016 ERA conclusions.

This review uses data from 2023 and 2024 to validate the results of the June 2024 review and the March 2016 ERA.

1.1 Scope of the Revalidation

The scope of the present revalidation is to:

- Identify any changes to the Site ecology or surrounding land use since 2022.
- Identify any changes to the PHCF or to processes at the PHCF that have the potential to change emissions and the resulting risks to receptors.
- Summarize monitoring data collected between 2023 and 2024 and determine the outcomes with respect to the results of the 2016 ERA.
- Determine whether there were changes in regulatory requirements which affect the outcomes of the 2016 ERA.

Under the current operating licence, operations of the PHCF include the Vision in Motion (VIM) project which represents Cameco's plan to clean up and renew the PHCF. The current revalidation recognizes that during the ongoing execution of the VIM project, changes and improvements are continually being made at the Site. These improvements are expected to result in lower emissions to the environment and thus reduce risks associated with PHCF. This revalidation discusses improvements that occurred in 2023 and 2024 at the PHCF. As agreed by CNSC staff, once the VIM project is complete, a new ERA will be completed in accordance with N288.6-22 and submitted to the CNSC for review and acceptance. The Environmental Protection Program will in turn be revised in accordance with the new ERA.

[1] https://www.camecofuel.com/media/media-library

1.2 Available Data and Information Sources

The following facility data and information were used in the current revalidation of the ERA:

1. Environmental monitoring data for 2023 and 2024
2. 2024 ERA Review
3. 2016 ERA
4. 2025 Derived Release Limits (DRL) Report
5. 2016 DRL Report
6. Annual compliance reports for 2023 and 2024
7. Annual groundwater and surface water report for 2024
8. CNSC IEMP results for Port Hope
9. Applicable provincial and federal guidelines for environmental protection

1.3 Scope of the Revalidation

This report is structured as follows:

Section 2 discusses Site changes that have occurred in 2023 and 2024 and other potential changes to the surrounding environment.

Section 3 provides a summary of the environmental data from 2023 and 2024 and provides a comparison to previously measured data. The IEMP conducted by CNSC is also discussed in this Section.

Section 4 discusses any changes to regulations that occurred in 2023 and 2024 that would impact the conclusions of the 2016 ERA.

Section 5 provides a summary of the revalidation.

2.0 REVIEW OF SITE CHARACTERIZATION

This section provides a description of the review completed to identify changes that have occurred to site ecology or surrounding land use, changes to the physical facility or facility processes that have the potential to change the nature of the facility effluent(s) and the releases to the environment.

2.1 Site Ecology and Surrounding Land Use

As described in Cameco's 2024 ERA review (Cameco 2024a) and 2025 DRL (CanNorth and IEC 2025). Cameco owns and/or leases 9.6 hectares on which the secured area of the PHCF is situated. Since the 2016 ERA, Cameco permanently terminated its licensed activities on the Centre Pier property, which involved the transfer of stored wastes to the Long-Term Waste Management Facility (LTWMF) in Port Hope, demolition of the Centre Pier buildings and transfer of the demolition debris to the LTWMF. The care and control of the property was transferred to Canadian Nuclear Laboratories (CNL) in July 2019.

In the immediate area of the PHCF, CNL has isolated access to the Port Hope harbour. The Centre Pier has been used as a staging area for CNL's ongoing harbour remediation work and associated harbour wall upgrades.

In the surrounding area, the Port Hope Area Initiative (PHAI) has continued the clean-up of low-level radioactive waste within the Municipality of Port Hope (MPH), including remediation of the former waterworks properties and West Beach to the west of the facility, residential properties and a former industrial site to the north of the facility, the viaducts northeast of the facility, and the Centre Pier east of the facility. The PHCF is located in a general employment zoned area with floodplain overlay zoning along the east property boundary.

2.2 Changes to the Physical Facility and Facility Processes

2.2.1 Soil Monitoring

As of 2023, location 2 (background monitoring location) for the soil monitoring program was no longer sampled as it had been impacted by the CNL remediation work zone established at the West Beach to the west of the municipal water treatment facility (Cameco 2024b). Therefore, in 2023 and 2024, there were only two soil monitoring locations beyond the facility fence line, with one of the locations within a 0 to 500 m radius zone from the facility and the other location within the 1000 to 1500 m radius zone. Following the completion of the PHAI project, Cameco will modify the soil monitoring program locations as appropriate, including consideration of CNL clean fill placements.

2.2.2 Cooling Water

The uranium dioxide (UO_2) plant transitioned to a closed loop cooling system in 2022. The production facility cooling water return last operated on July 27, 2022, and is permanently inactive.

The uranium hexafluoride (UF_6) plant subsequently transitioned to a closed loop cooling system in 2023. The production facility cooling water return, which included a municipal water component, last operated on July 13, 2023, and is permanently inactive. In relation, the former harbour water intake and pumphouse facilities have since been decommissioned. The uranium concentrations measured in the harbour water intake and UF_6 plant cooling water return during the January to July 2023 time period were elevated (i.e., above typical background) caused by the CNL remedial work with the inner harbour dredge activities (Cameco 2024b). Therefore, since the uranium concentrations in the cooling water measured during the 2023 monitoring period (January to July) are due to the remedial work and not typical of the facility, these results are not included in this revalidation.

2.3 Releases to the Environment

As described in Cameco's 2024 ERA review (Cameco 2024a), the primary air emissions associated with the PHCF are uranium, fluorides, ammonia and nitrogen oxides. These contaminant emissions are measured using source monitoring and/or estimated using available monitoring data. The main process stacks in the UF_6 plant and UO_2 plant are continuously sampled during operations. In the UF_6 main stack, fluoride and uranium emissions are monitored and in the UO_2 main stack, ammonia and uranium emissions are monitored. All other stacks and discharge points are sampled on an occasional or as requested basis.

The municipal sewage treatment plant processes the sanitary sewer discharges from the PHCF. Daily composite samples are collected from the combined sanitary sewer discharge for uranium and pH. The facility discharge primarily consists of contributions from sanitary facilities, showering facilities, Powerhouse effluent (i.e. boiler blowdown, compressor cooling water, softener regeneration effluent) and condensates, among other items.

3.0 REVIEW OF ENVIRONMENTAL MONITORING DATA

This section provides a description of the review of the environmental monitoring data collected in 2023 and 2024 at the PHCF as well as off-site data collected by the CNSC.

3.1 Overview of Available Data

The Environmental Protection Program (EPP) for PHCF describes the effluent and environmental monitoring programs. The following discharge data and environmental monitoring data are obtained from the documentation associated with this program.

3.1.1 Air Quality Data

Uranium emissions from the UF_6 main stack are sampled nearly continuously during operations using a TSI sampler and analyzed in the site laboratory. Fluoride emissions are continuously monitored by three stack monitors on the main stack of the UF_6 plant. The monitors continuously withdraw a sample of gas from the main stack and then measure the fluoride concentration in the impingement solution.

Uranium and ammonia emissions from the UO_2 main stack are sampled nearly continuously through a filter and impingement train and analyzed in the site laboratory.

During depleted uranium dioxide production runs, NO_x and ammonia emissions are monitored using a continuous emission monitor. Third-party stack sampling has also been used during depleted production runs.

Monitoring data from the process stacks is summarized in the quarterly and annual compliance monitoring and operational performance reports which are available on the Cameco community website[2]. This air quality data is provided in Table 3-1.

Table 3-1 Comparison of 2016 ERA air quality data with 2015 – 2024 data

Constituent	Unit	2016 ERA		2015 - 2022				2023[a]		2024[b]	
		2014 Avg	2014 Max	7- Year Avg	Range of Annual Averages		7-Year Max	Avg	Max	Avg	Max
					Min	Max					
UF_6 Main Stack - Uranium	g/h	1.2	6.3	1.9	1.1	2.7	44.7	2.4	10.7	2.2	9.3
UF_6 Main Stack - Fluoride	g/h	13	99	21.6	10	30	273	12	197	15	226
UO_2 Main Stack - Uranium	g/h	1.2	3.9	0.7	0.5	1.2	5.2	0.8	2.9	0.6	1.7
UO_2 Main Stack - Ammonia	kg/h	2.2	5.4	2.0	1.4	2.4	7.7	2.0	4.6	1.9	3.7

Note : [a] - Cameco (Cameco 2024b).
[b] - Cameco (2025).

[2] www.camecofuel.com/library/media-library

The 2023 and 2024 air quality data provided in Table 3-1 shows that all emissions were below the regulatory limits, corresponding action levels and is similar to that used in the 2016 ERA. The average uranium concentration from the UF_6 main stack is higher in 2023 and 2024 than the average uranium concentration used in the 2016 ERA; however, both of these average concentrations are within the range of annual averages from 2015 to 2022 that were used in the updated air quality modelling (Cameco 2024b). Therefore, the 2023 and 2024 air quality data are consistent with the conclusions of the 2024 ERA review.

3.1.2 Water Quality Data

Waterborne effluents from the PHCF currently consist of the discharge to the sanitary sewer system. However, previously the PHCF also had waterborne effluent discharges associated with the facility cooling water system operations (refer to Section 2.2). Monitoring data from the waterborne discharges is summarized in the quarterly and annual compliance monitoring and operational performance reports which are available on the Cameco community website[3].The water quality data is provided in Table 3-2.

[3] www.camecofuel.com/library/media-library

Table 3-2 Comparison of 2016 ERA water quality data with 2015 – 2024 data

Sampling Location	Constituent	Unit	2016 ERA		2015 - 2022				2023[a]		2024[b]	
			2014 Avg	2014 Max	5-Year Avg	Range of Annual Averages Min	Range of Annual Averages Max	5-Year Max	Avg	Max	Avg	Max
Sanitary Sewer	Uranium	mg/L	0.017	0.25	0.039	0.013	0.044	3.0	0.021	0.22	0.0046	0.053
UF_6 Plant Cooling Water Return	Uranium	mg/L	0.003	0.007	0.025	0.025	0.11	0.52	-[c]	-[c]	-[e]	-[e]
	Fluoride	mg/L	0.13	4.3	0.13	0.07	0.19	0.76	-[c]	-[c]	-[e]	-[e]
	Ammonia	mg/L as N	0.13	0.34	0.09	0.02	0.16	0.84	-[c]	-[c]	-[e]	-[e]
	Nitrate	mg/L as N	0.80	1.4	0.90	0.78	1.0	2.2	-[c]	-[c]	-[e]	-[e]
	TSS	mg/L	14	91	15	8.2	20	150	-[c]	-[c]	-[e]	-[e]
	Arsenic	µg/L	1.2	2.0	7.2	1.1	30	100	-[c]	-[c]	-[e]	-[e]
	Copper	µg/L	3.5	13	3.5	2.5	4.5	12	-[c]	-[c]	-[e]	-[e]
	Lead	µg/L	0.5	3.7	0.84	0.33	1.8	8.4	-[c]	-[c]	-[e]	-[e]
	Nickel	µg/L	2.8	6.0	2.5	1.5	4.0	20	-[c]	-[c]	-[e]	-[e]
	Zinc	µg/L	2.0	15	2.2	1.5	2.8	25	-[c]	-[c]	-[e]	-[e]
UO_2 Plant Cooling Water Return	Uranium	mg/L	0.003	0.008	0.02	0.0026	0.078	0.54	-[d]	-[d]	-[e]	-[e]
	Ammonia	mg/L as N	0.2	1.1	0.08	0.01	0.18	8.8	-[d]	-[d]	-[e]	-[e]
	Nitrate	mg/L as N	0.85	1.4	0.89	0.4	1.1	2.2	-[d]	-[d]	-[e]	-[e]
	TSS	mg/L	15	98	17	9.6	22	290	-[d]	-[d]	-[e]	-[e]

Note: [a] 2023 – Environmental Monthly Data.xls (provided by Cameco) from annual compliance report.
[b] 2024 – Environmental Monthly Data.xls (provided by Cameco) from annual compliance report.
[c] UF_6 plant cooling water return ceased operations in July 2023 and available data January -June not typical of the facility and excluded from assessment (see Section 2.2 for details)
[d] UO_2 plant cooling water return was not operational in 2023 (see Section 2.2 for details)
[e] - No data available since the full transition to closed loop cooling systems was completed in 2023 (see Section 2.2 for details).

The 2023 and 2024 discharges to the sanitary sewer are similar to those reported in both 2014 and 2015 to 2022. Similar to the 2024 ERA Review (Cameco 2024a), an assessment of the discharge to the sanitary sewer is completed and is provided in Section 3.2.2. As indicated in Section 2.2, the transition of production facilities to closed loop cooling systems took place between 2022 and 2023, so once-through cooling water return data was only available for the period January to July 2023. As reported by Cameco in their annual compliance reports, this data was influenced by the CNL's remedial work in the harbour and other factors and was therefore not included in this revalidation.

3.1.3 Off Site Environmental Monitoring Data – CNSC IEMP

CNSC conducts an independent environmental monitoring program (IEMP) for the PHCF. The results and conclusions of this IEMP are available online[4]. The 2024 IEMP sampling plan for the

[4] https://www.cnsc-ccsn.gc.ca/eng/resources/maps-of-nuclear-facilities/iemp/port-hope/ (accessed 20Oct25).

PHCF focused on hazardous substances and a site-specific sampling plan that was developed based on Cameco's approved environmental monitoring program and CNSC's regulatory experience with the Site.

The most recent IEMP was conducted in May 2024, and included the collection of air, water, soil and food samples in publicly accessible areas outside the perimeter of the PHCF. In addition to the 2024 IEMP, the CNSC has also conducted similar monitoring in 2014, 2015, 2017 and 2020. Therefore, monitoring data for all years available has been reviewed as part of this revalidation. The following data has been reviewed and analyzed:

- Uranium in air measurements (Figure 3-1),
- Uranium in soil measurements (Figure 3-2),
- Uranium in vegetation measurements (Figure 3-3),
- Uranium in food sample measurements (only 2024; Figure 3-3)
- Uranium in surface water measurements (Figure 3-4),
- Nitrate in surface water measurements (Figure 3-5),
- Fluoride in surface water measurements (Figure 3-6); and,
- Ammonia in surface water measurements (No Figure as only 1 measurement).

Figure 3-1 Uranium in air measurements

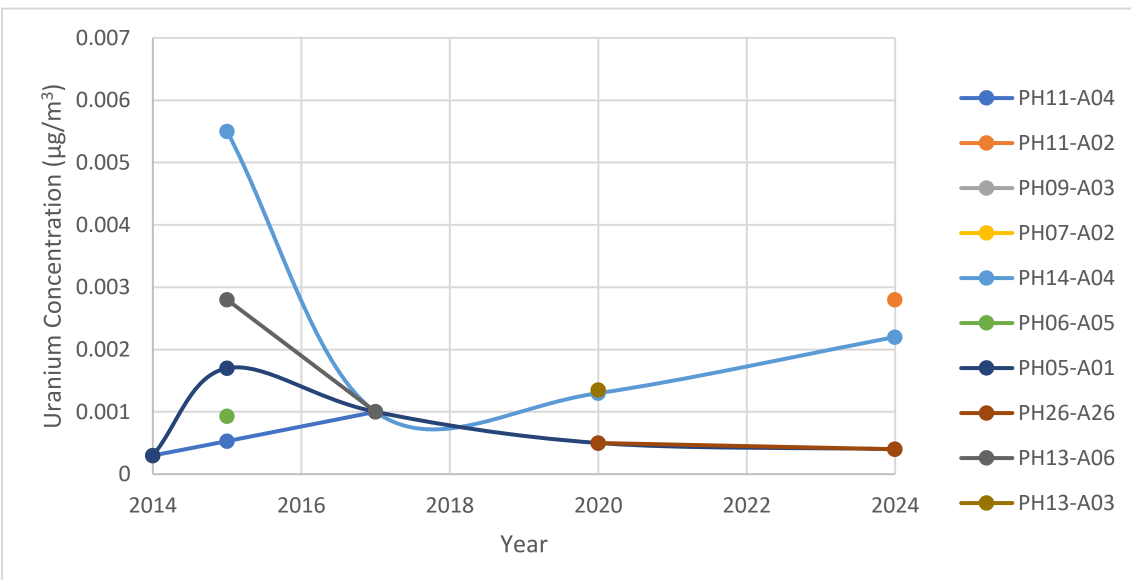


Figure 3-2 Uranium in soil (0 – 5 cm) measurements

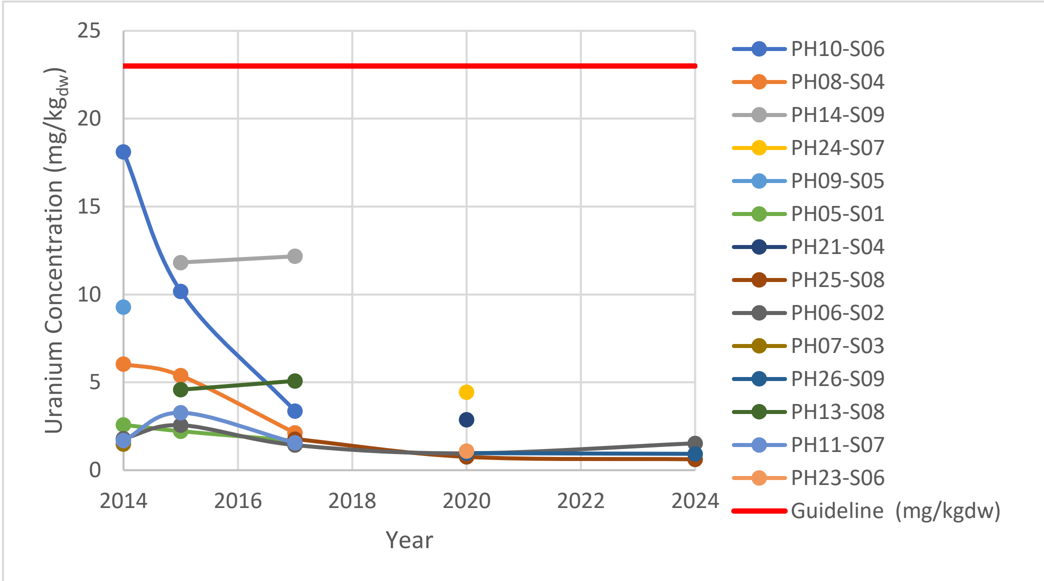
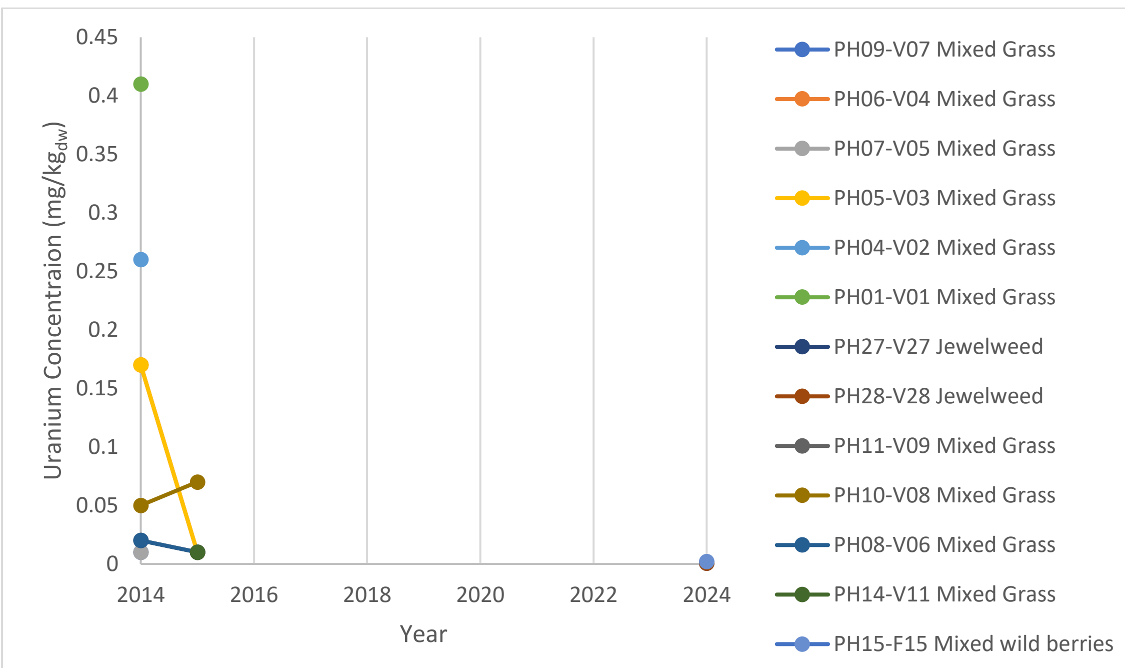


Figure 3-3 Uranium in vegetation measurements[1]



[1]Jewelweed and mixed wild berries data (2024 only) are all <0.01mg/kg$_{dw}$

Figure 3-4 Uranium in surface water measurements

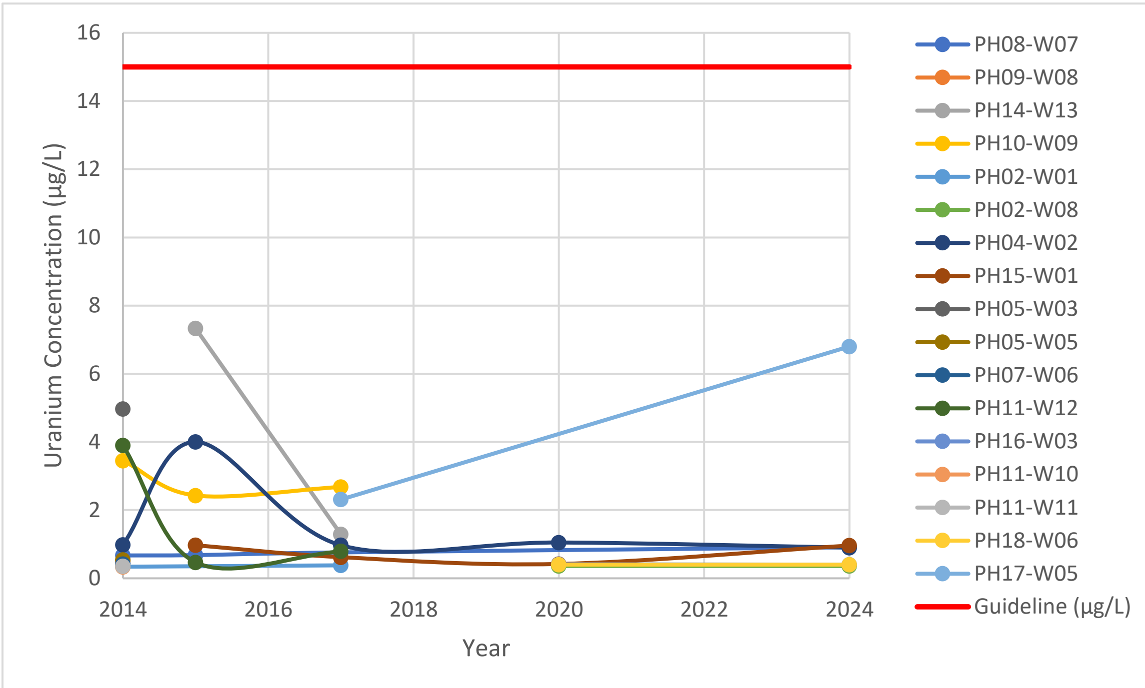


Figure 3-5 Nitrate in surface water measurements

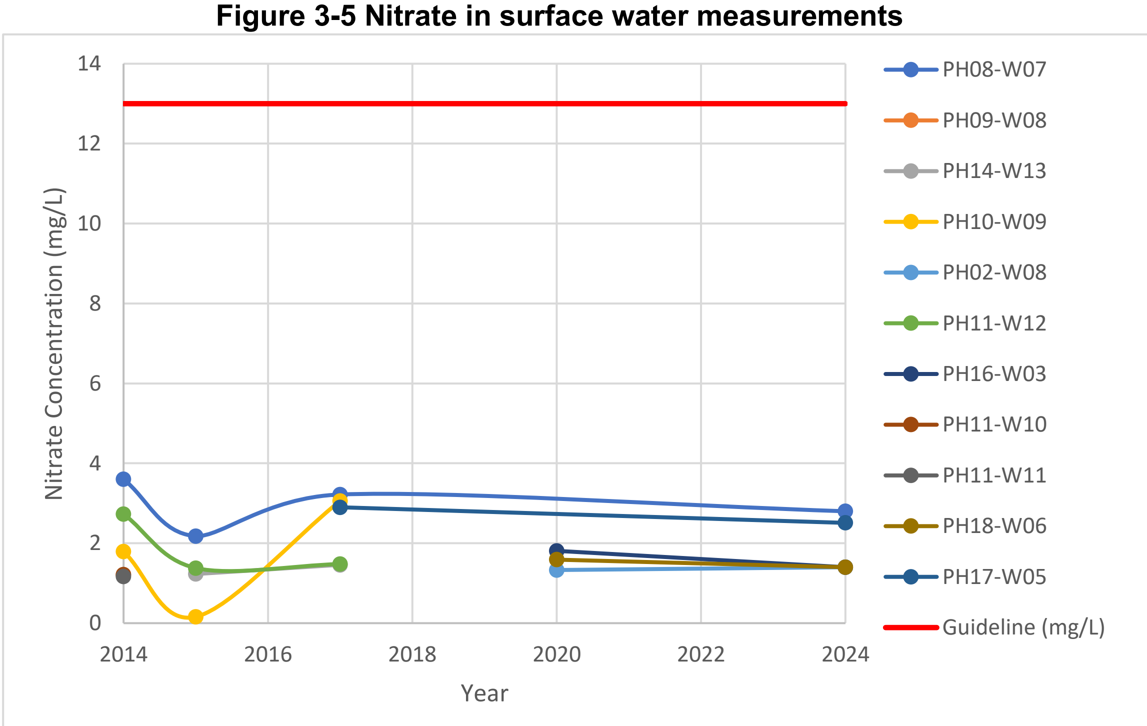
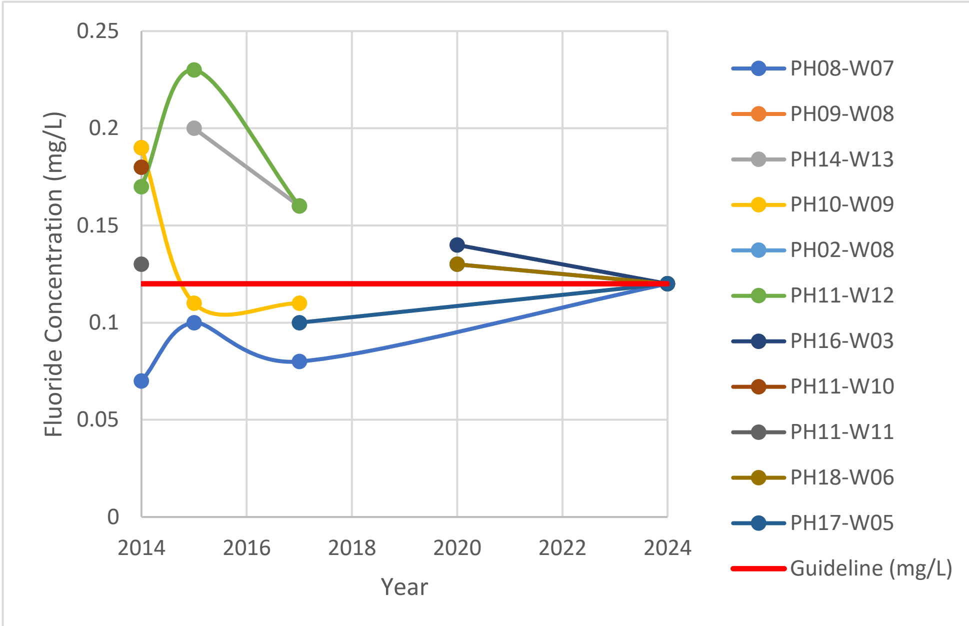


Figure 3-6 Fluoride in surface water measurements



As shown in Figure 3-1, the uranium in air measurements collected since 2014 are all well below the 0.03 µg/m^3 air quality criteria for uranium (MECP 2023). Furthermore, as shown in Figure 3-2, Figure 3-4 and Figure 3-5, all the measurements from 2014 to 2024 for uranium in soil, uranium in surface water and nitrate in surface water, respectively, are also all below the corresponding guidelines. There is no guideline to compare the uranium in vegetation measurements; however, as shown in Figure 3-3 the uranium concentrations in vegetation samples remain low in the available data.

The only measurements in the CNSC IEMP that exceeded the corresponding guideline were the fluoride in surface water measurements. As shown in Figure 3-6, fluoride concentrations in surface water over the years have been measured both below and above the CCME guideline of 0.12 mg/L for the protection of aquatic life (CCME 2002). This guideline was derived in 2001 and was based on a LC_{50} value for caddisflies of 11.5 mg/L with a safety factor of 100 applied to that value. CNSC concluded that adverse effects are not expected because the CCME freshwater quality guidelines were derived on the basis of conservative assumptions and with the goal of protecting the most sensitive species over the long term. Since the CCME guideline was derived, additional toxicity data has become available. McPherson et al (2014) developed a chronic effects benchmark for fluoride based on a SSD approach, with a value of 1.94 mg/L F derived for fluoride. Therefore, if concentrations of fluoride exceed the WQG, a secondary step can be implemented to compare the measured concentrations to a value of 1.94 mg/L F. Based on this comparison, all measured fluoride concentrations are below the chronic effects benchmark. It is also noted that the measured fluoride concentrations are below the Health Canada drinking water guideline of 1.5 mg/L. Based on this, CNSC concluded that adverse effects to human health and aquatic life, including fish and benthic invertebrates, are not likely to occur at these levels of fluoride in surface water (CNSC 2025).

Overall, CNSC concluded that the IEMP results for the monitored years (2014, 2015, 2017, 2020 and 2024) add to the evidence that people and the environment in the vicinity of the PHCF are protected and that there are no anticipated adverse effects from the operation of the PHCF. These conclusions are consistent with those contained in the 2016 ERA.

3.2 Updated Modelling

3.2.1 Air Dispersion Modelling

As part of the 2024 review of the ERA (Cameco 2024a), updated air dispersion modelling was completed for uranium (IEC 2021a) using emissions data and model setup files from the 2020 Consolidated ESDM Report (IEC 2021b). The site-specific meteorological data set used in the ESDM Report was prepared from 2013-2017 data at the Cobourg surface by the Ontario Ministry of Environment, Conservation and Parks (MECP) using AERMET. The wind data used in the updated dispersion modelling was considered representative of long-term climate in the region, and of the current local wind conditions at the Site.

The results of the 2020 air dispersion modelling showed that predicted uranium concentrations are comparable to the results from modelling completed as part of the 2016 ERA. The summary of monitoring data on uranium deposition from the period 2016-2020 indicates lower deposition rates in comparison to the PHCF 2014 monitoring data.

Overall, the results of the updated air dispersion modelling in 2020 showed no significant changes in the air pathway that might affect the conclusions of the 2016 ERA. Based on this finding, and that air monitoring data is consistent with the data included in the 2024 ERA review, no additional air dispersion modelling was carried out for the 2023/2024 time period and the conclusion from the 2016 ERA that uranium in air is not a concern for off-site receptors remains valid.

3.2.2 Liquid Effluent Release Modelling

Liquid effluent release modelling was completed as part of the 2016 DRL (ARCADIS 2016a) based on sanitary sewer quality data from 2014. The PHCF monitors the uranium released to the sanitary sewer which is processed at the municipal sewage treatment plant (STP). Following the processing in the STP, the treated water is released to Lake Ontario, via a diffuser located east of the PHCF and harbour.

In order to develop a dilution factor that accounts for dispersion between the STP outfall and the harbour, dispersion calculations were completed using the Cornell Mixing Zone Expert System (CORMIX). The CORMIX modelling demonstrated that a dilution of approximately 2090x is achieved between the STP diffuser and the Port Hope Harbour (ARCADIS 2016a) which results in a contribution of 0.0014 µg U/L from the discharge of the STP at the Port Hope harbour.

The CORMIX model was updated for the Port Hope STP outfall for work supporting the 2021 DRL for CFM (ARCADIS 2021). The 2021 modelling assessed concentrations are from the STP outfall at the public beach in Port Hope (1.5 km west of the STP outfall), the municipal drinking water intake (2.9 km west of the STP outfall) and at the STP outfall (ARCADIS 2021). The dilution factors from the CORMIX modelling are 2,260 times at the east beach, 4,219 times at the municipal drinking water intake and no dilution at the STP outfall (ARCADIS 2021). The 2021 CORMIX modelling is used in this review.

Since the PHCF sanitary discharge is released to the STP, this volume of wastewater is treated at the STP and needs to be considered. The derivation of the lowest dilution factor (8.8) to be used for the assessment of the impact of uranium discharges from the PHCF to the sanitary sewer is provided in Table 3-3. It is noted that the dilution factor derived from the 2024 data is lower than the dilution factors derived from 2017-2022.

Table 3-3 PHCF effluent dilution with municipal sewage

Year	PHCF Effluent		STP Effluent		Dilution Factor
	Concentration (µg/L)	Volume (m^3)	Volume (m^3)	Concentration (µg/L)	
2017	44	138,012	2,163,874	2.8	16
2018	37	131,589	1,857,391	2.6	14
2019	33	161,938	1,912,776	2.8	12
2020	13	140,029	1,665,680	1.1	12
2021	23[a]	121,476[b]	1,513,921[b]	1.9[d]	12[e]
2022	39[a]	154,543[b c]	1,535,762[b]	3.9[d]	10[e]
2023	21[a]	-[c]	1,607,097[b]	-	-
2024	4.6[a]	162,765[b c]	1,437,877[b]	0.52[d]	8.8[e]

Note [a] - Corresponding spreadsheet provided by Cameco (2021/2022/2023/2024 – Environmental Monthly Data.xls) from Annual compliance reports.
[b]- Sum of daily effluents in spreadsheet provided by Cameco (PHCF sewage and MPH WTP and STP data – 2020 to 2024.xls) from annual compliance reports.
[c]- Data from December 2022 to February 2024 was skewed high due to equipment failures. Therefore, all of 2023 PHCF effluent data is excluded, and the December 2022, January 2024 and February 2024 are skewed high (email from R. Fournier to R. Peters, July 23, 2025).
[d]- Calculated by dividing the concentration at PHCF by the corresponding dilution factor.
[e]- Calculated by dividing total STP effluent by total PHCF effluent.

For conservative purposes and for consistency with the 2024 ERA review (Cameco 2024a), the maximum PHCF contribution to the STP effluent was calculated by using the minimum dilution factor (8.8) for the PHCF to the STP effluent and the maximum annual PHCF effluent concentration from 2017 to 2024 (44 µg/L). The maximum effluent concentration occurred in 2017. The predicted uranium concentrations at each of the receiving locations are provided in Table 3-4.

Table 3-4 Predicted concentrations of uranium from PHCF discharge to sanitary sewer

Receiving Location	PHCF Contribution to STP Effluent (µg/L)[a]	Dilution Factor from CORMIX	Predicted Concentration (µg/L)[b]
STP Outfall	5	1	5
Public Beach	5	2,260	0.0022
Drinking Water Intake	5	4,419	0.0011

Note [a] Calculated by dividing the maximum PHCF effluent concentration (44 µg/L) by the minimum dilution factor (8.8).
[b] Calculated by dividing PHCF contribution to STP effluent by dilution factor from CORMIX.

It is noted that this is a very conservative evaluation, since the maximum annual PHCF concentrations have been decreasing since 2017 and the CORMIX modelling is dated.

In summary, the predicted concentrations provided for each receiving location in Table 3-4 represent negligible contributions at all receptor locations and are well below the federal guideline of 33 µg/L for short term exposure and 15 µg/L for chronic exposure (CCME 2025). It is recommended that when the ERA is updated after Vision in Motion is completed, that the CORMIX model be updated so that it provides a more accurate representation of the dilution factors occurring at the various receptor locations.

3.3 COPC Screening

The environmental monitoring data collected since the 2024 review (Cameco 2024a) were reviewed to determine whether additional constituents of potential concern (COPC) need to be considered.

Overall, the 2023 and 2024 data have not changed the results of the COPC screening since the 2024 ERA review, as detailed below in the following subsections.

3.3.1 Air

COPC screening for air was completed as part of the emission summary and dispersion modelling report completed in 2023 (IEC 2023), as summarized in the 2024 review. This screening only identified uranium as a COPC due to its relevance to current site operations. No additional screening for air has been completed as uranium is still considered to be the only COPC from an air perspective. The 2023 and 2024 air quality results are consistent with the data presented in the 2024 ERA review (Section 3.1.1), indicating that the air quality is consistent with the air quality modelling presented in the 2024 review (Cameco 2024a).

3.3.2 Soil

The 2024 ERA review included an updated soil screening from the 2016 ERA and is reproduced in Table 3-5.

Table 3-5 Soil: Screening presented in 2024 ERA review

Constituent	Units	Screening Criteria MECP Table 3	2016 ERA Max Value	2016-2022 Data Max Value	2016 ERA COPC?	Updated COPC?	Comments
Aluminum	µg/g	NA	36300	No data	**Yes**	No	Not associated with PHCF operations
Antimony	µg/g	40	166	12	**Yes**	No	Below screening criteria
Arsenic	µg/g	18	1790	160	**Yes**	**Yes**	
Barium	µg/g	670	2020	3500	**Yes**	No	Not associated with PHCF operations
Beryllium	µg/g	8	1.6	1.1	No	No	
Bismuth	µg/g	NA	55	No data	No	No	No toxicity data
Boron (total)	µg/g	120	1790	13	**Yes**	No	Below screening criteria
Calcium	µg/g	NA	316000	No data	No	No	Part of Earth's crust
Cadmium	µg/g	1.9	9.8	0.24	**Yes**	No	Below screening criteria
Chromium	µg/g	160	114	0.35	No	No	
Cobalt	µg/g	80	2730	70	**Yes**	No	Below screening criteria
Copper	µg/g	230	8830	730	**Yes**	No	Not associated with PHCF operations
Iron	µg/g	NA	180000	No data	**Yes**	No	Part of Earth's crust
Lead	µg/g	120	30000	4000	**Yes**	No	Not associated with PHCF operations
Magnesium	µg/g	NA	84300	No data	**Yes**	No	Part of Earth's crust
Manganese	µg/g	NA	3600	No data	**Yes**	No	Not associated with PHCF operations
Molybdenum	µg/g	40	15	1	No	No	
Nickel	µg/g	270	5690	51	**Yes**	No	Below screening criteria
Phosphorus	µg/g	NA	44900	No data	No	No	Part of Earth's crust
Potassium	µg/g	NA	45000	No data	**Yes**	No	Part of Earth's crust
Selenium	µg/g	5.5	16	<0.5	**Yes**	No	Below screening criteria
Silicon	µg/g	NA	5800	No data	No	No	Part of Earth's crust
Silver	µg/g	40	40	67	No	No	Above screening criteria; recent data max from beneath a contaminated floor slab and does not represent an exposure pathway
Sodium	µg/g	NA	10000	No data	No	No	Part of Earth's crust
Strontium	µg/g	NA	3000	No data	**Yes**	No	Not associated with PHCF operations
Thallium	µg/g	3.3	0.94	0.22	No	No	

Constituent	Units	Screening Criteria MECP Table 3	2016 ERA Max Value	2016-2022 Data Max Value	2016 ERA COPC?	Updated COPC?	Comments
Titanium	µg/g	NA	2100	No data	No	No	Part of Earth's crust
Uranium	µg/g	33	16800	1900	**Yes**	**Yes**	Above screening criteria; recent data max from beneath a contaminated floor slab and does not represent an exposure pathway
Vanadium	µg/g	86	150	55	**Yes**	No	Below screening criteria
Zinc	µg/g	340	5500	97	**Yes**	No	Below screening criteria
Radium-226	Bq/g	NA	32	No data	**Yes**	**Yes**	
Benzene	µg/g	0.32	<0.002	0.022	No	No	
Ethylbenzene	µg/g	9.5	0.012	0.021	No	No	
Toluene	µg/g	68	0.028	0.11	No	No	
Xylene (total)	µg/g	26	0.212	0.55	No	No	
Bromodichloromethane	µg/g	18	<0.002	<0.04	No	No	
Bromoform	µg/g	0.61	<0.002	<0.04	No	No	
Bromomethane	µg/g	0.05	<0.009	<0.04	No	No	
Carbon tetrachloride	µg/g	0.21	<0.002	<0.04	No	No	
Chlorobenzene	µg/g	2.4	<0.002	<0.04	No	No	
Chloroform	µg/g	0.47	<0.003	0.36	No	No	
Dibromochloromethane	µg/g	13	<0.002	<0.04	No	No	
1,1-Dichloroethane	µg/g	17	<0.002	<0.04	No	No	
1,2-Dichloroethane	µg/g	0.05	<0.002	<0.049	No	No	
1,1-Dichloroethylene	µg/g	0.064	<0.002	<0.04	No	No	
cis-1,2-Dichloroethylene	µg/g	55	0.003	<0.04	No	No	
trans-1,2-Dichloroethylene	µg/g	1.3	<0.004	<0.04	No	No	
1,2-Dichloropropane	µg/g	0.16	<0.002	<0.04	No	No	
cis-1,3-Dichloropropene	µg/g	0.18	<0.002	<0.03	No	No	
trans-1,3-Dichloropropene	µg/g	0.18	<0.002	<0.04	No	No	
Ethylenedibromide	µg/g	0.05	<0.002	0.021	No	No	
Dichloromethane	µg/g	1.6	0.021	<0.049	No	No	
1,1,1,2-Tetrachloroethane	µg/g	0.087	<0.002	<0.04	No	No	
1,1,2,2-Tetrachloroethane	µg/g	0.05	<0.004	<0.04	No	No	
Tetrachloroethylene	µg/g	4.5	<0.002	0.086	No	No	
1,2,4-Trichlorobenzene	µg/g	3.2	0.004	No data	No	No	
1,1,1-Trichloroethane	µg/g	6.1	<0.003	<0.04	No	No	
1,1,2-Trichloroethane	µg/g	0.05	<0.002	<0.04	No	No	
Trichloroethylene	µg/g	0.91	0.188	1	No	No	Above screening criteria; recent data max from beneath a contaminated

Constituent	Units	Screening Criteria MECP Table 3	2016 ERA Max Value	2016-2022 Data Max Value	2016 ERA COPC?	Updated COPC?	Comments
							floor slab and does not represent an exposure pathway
Vinyl Chloride	µg/g	0.032	<0.003	<0.019	No	No	
1,2-Dichlorobenzene	µg/g	6.8	<0.002	<0.04	No	No	
1,3-Dichlorobenzene	µg/g	9.6	0.005	<0.04	No	No	
1,4-Dichlorobenzene	µg/g	0.2	0.002	<0.04	No	No	
Trichlorofluoromethane	µg/g	4	<0.002	<0.04	No	No	
Dichlorodifluoromethane	µg/g	16	<0.002	<0.04	No	No	

Note: Reproduced from Table 11 (Cameco 2024a).
Recent data is based on November 2020 borehole sampling and annual off-site soil sampling for uranium from 2015-2022. Not all parameters considered in the 2016 ERA screening Table 4.2 were included here and constituents are limited to those included in recent data and/or relevant for assessment. The 2016 ERA used data from SENES (2013), as well as data from the 2014 off-site soil monitoring program for uranium.

The 2024 ERA review (Cameco 2024a) generally concluded that the concentrations of COPC were lower in the 2016-2022 dataset than the maximum concentrations considered in the 2016 ERA. Additional context for the maximum values in Table 3-5 for the 2016-2022 period was included in the assessment of the available on-site data. In this period there was not a comprehensive onsite characterization for soil. The available onsite data was collected in 2020 for planning purposes from beneath the floor of an on-site building which was known to have subsurface contamination and these samples do not represent an exposure pathway. The maximum uranium value of 1,900 µg/g in 2020 is much lower than the maximum value of 16,800 µg/g in the 2016 ERA.

Specific to off-site soil monitoring completed as part of the annual soil monitoring program, the 2024 ERA review also noted that the PHCF monitoring program had undergone changes since the completion of the 2016 ERA. The soil sampling approach was modified in 2015 to focus on the sampling of 15 cm cores and the collection of 0-5 cm, 5-10 cm and 10-15 cm core segments for compositing. Since 2018, samples have been submitted to a contract laboratory, and analytical requests have been focused on uranium analysis. Due to impacts from PHAI remedial activities, active monitoring program locations have also been reduced from five to two locations since the 2016 ERA. The 2024 ERA review reported that the maximum uranium measured in off-site soil from all depths was 15 µg/g. This 2016 result was at a location on the former Waterworks property west of the main PHCF parking lot which was last sampled in 2017. The maximum uranium concentrations measured in off-site soil from all depths for 2023 and 2024 were 5.9 µg/g and 5.1 µg/g, respectively (Cameco 2024b, 2025). All offsite uranium in soil results are well below the CCME guideline of 23 µg/g for residential/park land use and therefore, no COPC are identified for soil for human health.

For the ecological assessment, the 2024 ERA review completed a secondary screening for soil which was presented in Table 12 of that report. This table has not been updated as there are no changes to the identified COPC of uranium and radium-226, which was supported by the 2023/24 dataset.

3.3.3 Groundwater

The 2024 ERA review included an updated groundwater screening, which is reproduced in Table 3-6. Groundwater concentrations in 2023 and 2024 are also provided in the table (WSP 2025).

Table 3-6 Groundwater: COPC screening

Constituent	Units	Screening Criteria	2016 ERA Max Value	2017 - 2022 Data Max Value	2023 Max Value[a]	2024 Max Value[a]	2016 ERA COPC?
Fluoride	mg/L	NA	75	100	16	7	**Yes**
Ammonia	mg-N/L	NA	150	400	80	67	**Yes**
Calcium	mg/L	NA	12200	23200	25100	15300	**Yes**
Chloride	mg/L	1800	82000	130000	85000	85000	**Yes**
Magnesium	mg/L	NA	5190	5716	***8290***	***5720***	**Yes**
Nitrite	mg-N/L	NA	<0.3	0.32	0.31	***8***	No
Nitrate	mg-N/L	NA	115	140	30	17	**Yes**
Potassium	mg/L	NA	1080	1000	723	652	**Yes**
Sodium	mg/L	1800	23700	24200	29200	23200	**Yes**
Sulphate	mg/L	NA	1200	1500	350	880	**Yes**
Aluminum	µg/L	NA	220	6710	***6530***	147	**Yes**
Antimony	µg/L	16000	30	13.1	***104***	4	No
Arsenic	µg/L	1500	1150	1690	***1750***	303	**Yes**
Barium	µg/L	23000	6540	7320	***9370***	***6680***	No
Beryllium	µg/L	53	<0.007	0.3	0.03	0.02	No
Boron	µg/L	36000	1470	1360	***8610***	1240	No
Bismuth	µg/L	NA	<0.007	2.7	0.09	0.11	No
Cadmium	µg/L	2.1	<0.003	0.003	***0.15***	***0.11***	No
Cobalt	µg/L	52	20	17.3	***23***	10	No
Chromium	µg/L	640	20	68.4	***31***	16	No
Copper	µg/L	69	290	114	14.6	8	**Yes**
Iron	µg/L	NA	36700	32000	***43500***	***41700***	**Yes**
Lead	µg/L	20	20	15	1.62	1.1	No
Manganese	µg/L	NA	2600	2810	2290	***8470***	**Yes**
Molybdenum	µg/L	7300	230	572	36	72.9	No
Nickel	µg/L	390	100	54	19	44.2	No
Selenium	µg/L	50	538	608	100	7.28	**Yes**
Silicon	µg/L	NA	20400	21400	***22200***	***54300***	No
Silver	µg/L	1.2	30	22.6	0.22	0.28	**Yes**
Strontium	µg/L	NA	1090000	1300000	1525000	1160000	**Yes**
Thallium	µg/L	400	<0.005	3.2	***10***	0.028	No
Titanium	µg/L	NA	20	29.7	1.81	7.3	No
Uranium	µg/L	330	21000	21100	11700	13200	**Yes**
Vanadium	µg/L	200	20	64	20	6.45	No
Zinc	µg/L	890	2220	534	57	233	**Yes**
Radium-226	Bq/L	NA	0.89	12	***6.7***	***4.7***	**Yes**
Benzene	µg/L	44	277	277	279	282	**Yes**
Ethylbenzene	µg/L	1800	21.3	26	24	23.3	No
Toluene	µg/L	14000	275	286	***290***	***291***	No
Xylene (Total)	µg/L	3300	192	218	***208***	***205***	No

Constituent	Units	Screening Criteria	2016 ERA Max Value	2017 - 2022 Data Max Value	2023 Max Value[a]	2024 Max Value[a]	2016 ERA COPC?
Bromodichloromethane	µg/L	67000	2	<0.5	***3.9***	***0.9***	No
Bromoform	µg/L	29000	1	<0.5	< 0.5	< 0.5	No
Bromomethane	µg/L	5.8	<0.5	<0.5	< 0.5	< 0.5	No
Carbon tetrachloride	µg/L	0.35	1.2	<0.2	< 0.2	< 0.2	**Yes**
Chlorobenzene	µg/L	500	<0.5	1	< 0.5	< 0.5	No
Chloroform	µg/L	240	17	1.3	***54.9***	***45.8***	No
Dibromochloromethane	µg/L	65000	0.59	<0.5	1	< 0.5	No
1,1-Dichloroethane	µg/L	320	31.7	21	6.7	4.7	No
1,2-Dichloroethane	µg/L	1.6	<0.5	0.9	***279***	***282***	No
1,1-Dichloroethylene	µg/L	1.6	20.8	7.6	***24***	***23.3***	**Yes**
cis-1,2-Dichloroethene	µg/L	1.6	1020	1080	290	291	**Yes**
trans-1,2-Dichloroethene	µg/L	1.6	28.6	10.8	***208***	***205***	**Yes**
1,2-Dichloropropane	µg/L	16	<0.5	<0.5	***3.9***	***0.9***	No
cis-1,3-Dichloropropene	µg/L	5.2	<0.5	<0.5	< 0.5	< 0.5	No
trans-1,3-Dichloropropene	µg/L	5.2	<0.5	<0.5	< 0.5	< 0.5	No
Ethylenedibromide	µg/L	0.25	<1	<0.2	< 0.2	< 0.2	**Yes**
Dichloromethane	µg/L	1400	2	<0.5	< 0.5	< 0.5	No
1,1,1,2-Tetrachloroethane	µg/L	3.3	<0.5	<0.5	< 0.5	< 0.5	No
1,1,2,2-Tetrachloroethane	µg/L	3.2	0.25	<0.5	< 0.5	< 0.5	No
Tetrachloroethylene (perchloroethylene)	µg/L	1.6	1.4	<0.5	< 0.5	< 0.5	No
1,2,4-Trichlorobenzene	µg/L	180	0.25	0.8	< 0.5	***0.8***	No
1,1,1-Trichloroethane	µg/L	640	15.1	3.9	11.5	14.2	No
1,1,2-Trichloroethane	µg/L	4.7	<1.2	1.2	0.6	1.2	No
Trichloroethylene	µg/L	1.5	1800	207	459	134	**Yes**
Vinyl Chloride	µg/L	0.5	613	911	233	186	**Yes**
1,2-Dichlorobenzene	µg/L	4600	<0.5	<0.5	< 0.5	< 0.5	No
1,3-Dichlorobenzene	µg/L	7600	<0.5	0.9	< 0.5	< 0.5	No
1,4-Dichlorobenzene	µg/L	8	0.6	1.4	< 0.5	0.8	No
Trichlorofluoromethane	µg/L	2000	<5	<5	< 5	< 5	No
Dichlorodifluoromethane	µg/L	3500	2.3	4.1	**3.2**	**4.7**	No

Note: NA – not available. For simplicity, not all constituents considered in the 2016 ERA screening Table 4.1 were included here (i.e., pH, conductivity, hardness and some general chemistry constituents like phosphorus and TDS). Data for PHCs and PCBs from 2009 considered in the 2016 ERA is not included in the comparison, because no recent data are available and data from 2009 are over 10 years old and no longer representative of concentrations at the site. The identification of maximum concentrations considered data from 2018 through 2020 for organic constituents.

a – Data obtained from WSP (WSP 2025).

Bold and italics – indicates maximum concentrations in 2023 and 2024 that are above the 2016 maximum concentration used in the 2016 ERA.

Underline – indicates maximum concentrations in 2023 and 2024 that are below the 2016 maximum concentration used in the 2016 ERA.

Generally, the 2024 ERA review concluded that the groundwater concentrations considered in the 2016 ERA are similar to the maximum values from the more recent data (2015 – 2020), with one notable difference for Ra-226. The 2016 ERA considered a concentration of 0.89 Bq/L, while the maximum concentration in the 2015 – 2020 data was 12 Bq/L. The 2024 ERA review noted that both of these Ra-226 concentrations were measured from the same location (HW-18D), with the concentrations ranging from <0.01 Bq/L (2010) to 12 Bq/L (2017). It is noted that the Ra-226 concentration reported in 2020 was 0.02 Bq/L. Table 3-6 indicates that the Ra-226 concentration was 6.7 Bq/L in 2023 and 4.7 Bq/L in 2024 which is in the range of previous measured data. The variability in Ra-226 concentrations demonstrates that the concentrations are not increasing over time.

Table 3-6 provides the maximum measured groundwater concentrations in 2023 and 2024. It is noted that the maximum concentrations in each year do not occur at the same well location and do not occur at the same well in the 2016 ERA. Concentrations that are higher than ones used in the 2016 ERA are in bold and italics. The table shows that in 2023, there were a number of constituents with maximum concentrations higher than the ones used in the 2016 ERA but that the screening remains unchanged. Nitrite and some VOC concentrations are quite a bit higher than what was used in the 2016 ERA. The occurrences of these increased concentrations are at pumping wells or monitoring wells adjacent to pumping wells and therefore within the zone of capture of the pump and treat system. These changes may be attributed to redistribution of these COPC in the plume as a consequence of the influence of groundwater extraction by the pumping wells. Additionally, these maximum results occurred in bedrock wells, where there is no identified exposure pathway. Concentrations of some constituents in groundwater were lower than what was used in the 2016 ERA. These were underlined in the table. Arsenic, selenium, silver and zinc concentrations in groundwater are lower than what was used in the 2016 ERA and are also below guidelines and would not be considered to be COPC in future risk assessments.

The 2016 ERA completed a secondary screening for groundwater for both humans and ecological receptors. However, as indicated in the 2024 ERA review due to the recent data (2015 – 2020) and changes in approach outlined in the 2024 ERA review, human receptors have no contact with groundwater and a secondary screen for human health was not necessary.

Based on the 2024 ERA review, it was recommended that arsenic should also be added to the groundwater COPC list for the ecological risk assessment as concentrations had increased and were above guidelines. It is noted that in 2024, the arsenic concentration has decreased below guidelines indicating that arsenic may not be identified as a COPC in future assessments.

3.3.4 Harbour Water – Inferred from Groundwater and Stormwater

The 2024 review (Cameco 2024a) compared the mass loadings used in the 2016 ERA (based on 2014 data) with mass loadings from 2016, 2018 and 2024 and found that the mass loadings to the harbour generally decreased. These decreases were attributed to the sustained operation of pumping wells resulting in the gradual decrease of COPC in groundwater. The most recent groundwater mass loadings from 2024 are compared to the previous groundwater mass loadings and site-specific performance objectives (SENES 2009) in Table 3-7.

Table 3-7 Comparison of estimated groundwater mass loading to Port Hope harbour

Constituent	Estimated Mass Discharge to Harbour (kg/yr[a])						Risk-Based Performance Objective (kg/yr)[c]
	2014	2016	2018	2020	2022	2024	
Arsenic	2.0	1.7	1.3	2.7	2.5	0.19	7.19
Fluoride	15	9.4	11	11	6.5	6.0	518
Ammonia (Total)	95	116	66	42	30	47	866
Nitrate	3.8	3.4	2.0	2.3	1.2	1.8	N/A
Radium-226[b]	657[b]	1,216[b]	1,812[b]	1,829[b]	1,345[b]	1,047[b]	18,700[b]
Uranium	5.1	4.2	3.9	3.2	2.6	1.5	262
cis-1,2-Dichloroethene	0.02	0.02	0.01	0.04	0.03	0.02	N/A
Trichloroethylene	0.01	0.01	0.01	0.01	0.01	0.01	N/A
Vinyl Chloride	0.03	0.01	0.01	0.05	0.01	0.02	N/A

Note: Based on average pumping scenario from Table 7 of Golder (2021), WSP (2023) and WSP (WSP 2025).
[a] – As specified in Table 7 of Golder (2021), WSP (WSP 2023) and WSP (WSP 2025). Represents the average pumping rate condition.
[b] – Radium-226 is reported in kBq/yr
[c] – As specified in SENES (2009)

As seen in Table 3-7, the 2024 loadings have decreased for arsenic, fluoride, radium-226, and uranium compared to 2022 loadings. Loadings of ammonia and nitrate have increased between 2022 and 2024, however, remain within the range of loadings for these parameters since 2014. Trichloroethylene, vinyl chloride and cis-1,2-dichloroethylene loadings are similar between 2022 and 2024 and are within the range of estimated loadings since 2014. All loadings are below the site-specific risk-based performance objectives for discharges to the Port Hope harbour, where available.

The most recent stormwater concentrations (2023 and 2024) are provided in Table 3-8 for comparison with previous years, including the stormwater concentrations used in the 2016 ERA (based on 2010 data).

As shown in Table 3-8, the concentrations considered for stormwater in the 2016 ERA modelling are generally similar to the 2023 and 2024 average stormwater concentrations with the exception of ammonia in 2023. However, as noted by Cameco in the 2023 Annual Compliance report (Cameco 2024b), storm water quality is routinely highly variable and influenced by factors such as precipitation event duration and intensity, infrastructure deficiencies and biological sources. Maximum ammonia concentrations recorded between 2023 to 2024 were from Outlet 13. Waste droppings from gulls, and to a lesser extent geese, influence Outlet 13 water quality. Despite reported variances in stormwater quality for selected constituents, the individual grab samples generally passed their respective *Daphnia magna* and rainbow trout single concentration toxicity tests.

Table 3-8 Comparison of stormwater concentrations

Year	Stormwater Concentration					
	Uranium (mg/L)	Fluoride (mg/L)	Ammonia (mg/L)	Arsenic (mg/L)	Radium (Bq/L)	Zinc (mg/L)
2010 (2016 ERA)	0.195	0.69	0.38	0.067	0.09	0.24
2015-2020 Min	0.02	<0.06	No data	0.0002	<0.01	0.04
2015-2020 Avg	0.19	0.22	No data	0.01	0.08	0.28
2015-2020 Max	1.5	0.63	No data	0.11	0.73	0.95
2022 Average	0.05	0.14	0.45	0.003	0.021	0.1
2022 Max	0.15	0.32	2.4	0.01	0.064	0.2
2023 Average[a]	0.28	0.54	3.8	0.052	0.1	0.61
2023 Max[b]	0.56	1.12	29.1[c]	0.53	0.85	1.7
2024 Average[a]	0.16	0.36	0.95	0.0084	0.15	0.37
2024 Max[b]	0.36	0.86	7.9	0.03	1.3[d]	0.91

Note: [a] - Calculated using data from “Combined stormwater – 2016 – 2024.xls” from annual compliance report and didn’t include duplicate samples.
[b] - Extracted from “Combined stormwater – 2016 – 2024.xls” from annual compliance report and didn’t include duplicate samples.
[c] - Location where this sample was collected is influenced by gull and geese droppings which impact ammonia concentration and biological activity
[d] - Result from a location that is typically dry during stormwater events, there is limited data for comparison at this location

The exposure point concentrations (EPCs) for surface water were primarily based on measured data in the 2016 ERA. The results of the harbour surface water modelling, which incorporated stormwater and groundwater loadings, were only considered in the 2016 ERA for the calculation of incremental concentration for arsenic, uranium and radium-226. Therefore, based on the groundwater mass loading and stormwater concentrations comparisons, which includes the 2023 and 2024 data, the modelling for the 2016 ERA remains valid and likely is an overestimation.

3.3.5 Surface Water

At the time of the 2016 ERA, the surface water sampling program consisted of thirteen sampling locations distributed along the perimeter of the Port Hope harbour turning basin and approach channel. However, this sampling program was suspended in August 2018 due to the CNL’s harbour remediation work; sampling will resume when remediation work is complete. Therefore, the COPC presented in the 2024 review (Cameco 2024a) are unchanged and are arsenic, uranium and radium-226. As concluded in the 2024 ERA review, once the harbour remediation and VIM project are completed, monitoring and remodelling will be required for the new Site conditions. It is recommended that prior to re-establishing a surface water monitoring program, that a review of the monitoring locations be completed to ensure their appropriateness given the substantial changes at the Site (e.g. transition to closed-loop cooling, changes to the harbour walls and turning basin by CNL, changes to PHCF’s stormwater outlets).

3.3.6 Sediments

As discussed in the 2024 ERA review (Cameco 2024a), the potential for future re-contamination of sediments from stormwater and groundwater loadings was assessed in 2010. Based on the hydro-geochemical model predictions, dredging of sediments will result in improved water and sediment quality even with continued groundwater and stormwater loadings into the Harbour. Based on 2010 stormwater quality, dredging the sediment would result in the Harbour water meeting Provincial Water Quality Objectives (PWQOs) and sediment quality meeting Lower Exposure Limits (LELs) for the COPC. Implementation of VIM remedial work will further improve both surface water and sediment quality and further reduce the discharges to the harbour which will contribute to sediment loading in the future (SENES 2010). These assumptions will be validated in the ERA to be completed after the VIM project.

3.3.7 Comparison of EMP with 2016 ERA Predictions

The 2023 and 2024 data demonstrate that concentrations and loadings from activities at the PHCF seem to be generally decreasing in comparison to those utilized in the 2016 assessment. Therefore, the 2016 ERA represents a conservative estimate of risks from the PHCF.

4.0 REVIEW OF CHANGES TO SCIENTIFIC AND REGULATORY INFORMATION

A review of potential changes to the scientific and regulatory frameworks was undertaken to determine if there were any substantial changes since the 2024 review (Cameco 2024a).

4.1 Scientific Advances

Since the 2024 review, guidelines provided by the federal and/or provincial agencies have not changed and thus the results of the 2016 ERA remain valid and are over-estimated.

4.2 Regulatory Requirements

Similarly, there have been no significant changes to environmental legislation applicable to PHCF operations since the 2016 ERA. Therefore, the 2016 ERA still adheres to regulatory requirements.

4.3 Concordance with N288.6-22

The 2016 ERA was completed in accordance with CSA N288.6-12. Since the 2024 review was submitted to the CNSC, N288.6 was updated in 2022. This section compares the 2016 ERA (ARCADIS 2016b) to the revised N288.6 (CSA 2022), as detailed in Table 4-1. Standard N288.6 addresses the design, implementation, and management of an environmental risk assessment program at nuclear facilities and uranium mines and mills. N288.6 defines ERA as environmental risk assessment, which include a HHRA and an EcoRA. In general, the 2016 ERA is in agreement with N288.6-22. Additional receptors will be considered in the future ERA, as well as updated modelling and toxicity values.

Table 4-1 Aspects of comparison with N288.6-22

N288.6		Comment
Clause	**Component**	
Introduction		
0.1.1	Environmental risk assessment (ERA)	The 2016 assessment included a human health risk assessment and an ecological risk assessment.
0.1.2	Need for an ERA	The 2016 assessment has been completed under N288.6 for the purpose of risk-based environmental management and serves as an update to the 2009 ERA, taking into account operational changes.
0.1.3	Human health risk assessment (HHRA)	The 2016 assessment included a HHRA.
0.1.4	Ecological risk assessment (EcoRA)	The 2016 assessment included an EcoRA
0.1.5	Risk-based recommendations	The 2016 assessment recommends addressing the contamination in the grass patch along the Harbour walls in coordination with VIM and the PHAI due to exposure to earthworms. However, the results of the assessment determined that earthworm populations were not at risk. Shallow/risk-based soil remediation is planned between the Cameco fence line and the harbour to 0.5 m.

N288.6		Comment
Clause	Component	
0.2	Levels of complexity	The 2016 assessment builds on the database of environmental and operations data, while also, to the extent possible and where appropriate, maintaining consistency with past assessments.
0.3.1	Radiation dose limits	The assessment used dose limits set by the Canadian Nuclear Safety Commission (CNSC) for people and UNSCEAR for ecological receptors.
0.3.2	Benchmark values	The assessment followed the guidance for benchmark values. See Clause 6.4.4 and Clause 7.4.3 for more details.
0.3.3	Receptors	The assessment followed the guidance for receptors. See Clause 6.2.3 and Clause 7.2.3 for more details.
0.3.4	Conceptual models	Conceptual models were provided for the HHRA and EcoRA.
0.3.5	Assessment and measurement endpoints	The assessment used the appropriate assessment and measurement endpoints.
Scope		
1.1.1	Types of facilities	The facility considered in the current assessment is described in the 2016 assessment
1.1.2	Facility lifecycle	The 2016 assessment was completed for the current operations at the PHCF.
1.2	Operating conditions	The 2016 assessment considered the release of low-level emissions of nuclear and hazardous substances to the environment for the normal operations at the facility.
1.3	Releases	The 2016 assessment was completed for routine releases expected for the current operating conditions.
1.4	Fate and transport	The air dispersion model, the soil deposition and leaching model, the groundwater and stormwater discharge model, and the gamma model used in the 2016 assessment incorporated fate and transport concepts. Fate and transport of contaminants in the environment were addressed by calculations of estimated exposure concentrations using transfer-factors from literatures.
1.5	Contaminants and physical stressors	Non-radioactive contaminants and radioactive contaminants were considered in the 2016 assessment.
1.6	Receptors	Human and non-human biota were considered in the 2016t assessment.
1.7	Risk management	The 2016 assessment was carried out to identify potential risks from current operations of the facility and provided recommendations to address the risks.
1.8	Reporting	N/A
1.9	Terminology	N/A
Reference Publications		
2.	Reference publications	N/A
Definitions and abbreviations		
3.	Definitions and abbreviations	N/A

N288.6		Comment
Clause	Component	
Environmental Risk Assessment Objectives and Report Format		
4.1	Environmental risk assessment objectives	The assessment was completed for the purpose of evaluating potential risks from the PHCF, within the context of the potential impacts and estimated exposures to human health and ecological receptors.
4.2	Environmental risk assessment report format	The 2016 report included the results of both the HHRA and the EcoRA. This report uses a different table of contents from Annex A of N288.6; however, the topics included in the suggested table of contents in Annex A of N288.6 are all covered in the 2016 report.
Environmental Risk Assessment Framework, Tiers, and Timelines		
5.1	Types of ERAs	The 2016 assessment evaluated the current conditions and used an extensive record of existing monitoring information.
5.1	Framework	The 2016 assessment included the suggested technical components.
5.2	Tiers of the assessment	The 2016 assessment incorporated Tier 1 and Tier 2 assessments, which builds on the database of environmental and operations data, while also, to the extent possible and where appropriate, maintaining consistency with past assessments.
5.3	Risk assessment updates	This assessment was completed for the purpose of evaluating potential risks related to effluent discharge and air emissions from the PHCF.
Human Health Risk Assessments		
6.1	General	The HHRA presented in the 2016 assessment included the suggested components.
6.2.1	Problem formulation, General	The problem formulation for the 2016 HHRA included the suggested components.
6.2.2	Site characterization	Section 2 provided the site characterization, including detailed description of existing site and its operations.
6.2.3	Receptor selection and characterization	Section 5.1.1 provided descriptions of the receptor selection and characterization. Specific aspects relevant to N288.6 are discussed within the text.
6.2.4	Assessment and measurement endpoints	The assessment was based on the protection (no meaningful health risks) of individual human receptors.
6.2.5	Selection of chemical, radiological and other stressors	Section 4 and 5.1.2 provided the selection of COPC included in the assessment.
6.2.6	Selection of exposure pathways	Section 5.1.2 described the various pathways of exposure considered in the assessment. Specific aspects relevant to N288.6 are discussed within the text.
6.2.7	Human health conceptual model	Section 5.1.4 provided the conceptual model for the HHRA.
6.3.1	Exposure assessment, General	Section 5.2 presented the exposure assessment for the HHRA.

N288.6		Comment
Clause	**Component**	
6.3.2	Exposure locations	Section 5.2.1 presented the exposure locations assumed for the HHRA.
6.3.3	Exposure frequency, duration, and averaging	Section 5.2.2 presented the exposure frequency, duration, and averaging factors assumed for the HHRA. A more conservative approach that what is recommended by N288.6 was used.
6.3.4	Dose calculation methods	The calculation approach was provided in Section 5.2.4 and Section 5.2.5.
6.3.5	Transfer factors, exposure factors, and dose coefficients	Transfer factors were provided in Table 6.24, exposure factors were provided in Section 5.2.2, and dose coefficients were provided in Section 5.2.6.
6.3.6	Modelled versus measured exposure concentrations	The assessment was completed using measured exposure concentrations from the site. Air concentrations at exposure locations were estimated using the air dispersion model, encompassing emissions data from the site. It is uncertain how some of the modelling was used in the evaluation.
6.3.7	Models	The 2016 assessment used the air dispersion model AERMOD for air quality and transport through the site as well as for the pathways assessment and ecological and human health risk assessments. Details of the air modelling are presented in Appendix A. Off-site soil concentrations of uranium were predicted using the Arcadis soil deposition and leaching model, which is presented in Appendix B. Influences of the stormwater and groundwater discharges were predicted through the Port Hope Harbour model. Details of the stormwater and groundwater modelling are included in Appendix C. Influences of gamma radiation on human receptors were predicted through the MicroShield modeling as detailed in Appendix D.
6.3.8	Exposure point concentrations and doses	Sections 5.2.3 and 5.4.3 provide the exposure point concentrations (EPCs) and the doses calculated for the HHRA. Multiple tiers of assessment were used to address the over conservatism in the EPCs
6.4.1	Toxicity assessment, General	The toxicity data used as the basis for the toxicity assessment were provided in Section 5.3.
6.4.2	Radiological toxicity assessments	The dose limit selected for the toxicity assessment was provided in Section 5.3.2
6.4.3	Non-radiological toxicity assessments	The evaluation of non-radiological COPC for toxicological action is presented in Section 5.3.1.
6.4.4	Reference concentrations, reference doses, and slope factors (non-radiological)	Section 5.3 presented the TRVs selected for use in the HHRA.
6.4.5	Radiation dose limits and targets	The radiological HHRA considered the Government of Canada's *Radiation Protection Regulations* for effective dose limits.

N288.6		Comment
Clause	Component	
6.4.6	Other criteria (air quality and noise)	Air quality was assessed using the available benchmarks presented in Section 5.3.1. A noise assessment was also completed as part of the 2016 assessment.
6.5.1	Risk characterization, general	The results of the risk characterization for the HHRA are provided in Section 5.4.
6.5.2	Risk estimation	The results of the risk estimates for the HHRA are provided in Section 5.4.3.
6.5.3	Other lines of evidence	The 2016 assessment referred to an arsenic risk study done during the 2010 follow-up assessment for comparison with the results.
Ecological Risk Assessments		
7.1	Ecological risk assessments, General	The EcoRA presented in the 2016 assessment included the suggested components.
7.2.1	Problem formulation, General	Section 2 provided the characterization of the site, Section 6.1.1 identified the ecological receptors for the assessment, Section 6.1.2 provided the endpoints for the assessment, Sections 4 and 6.1.3 identified the environmental stressors as COPC for the assessment, and Section 6.1.5 provided the conceptual model.
7.2.2	Site characterization	Section 2 provides the site characterization, including detailed description of existing site and its operations.
7.2.3	Receptor selection and characterization	Section 6.1.1 identified the ecological receptors considered in the assessment. Receptors were based on previous assessments.
7.2.4	Assessment and measurement endpoints	Section 6.1.2 provided the endpoints for the assessment. Specific aspects relevant to N288.6 are discussed within the text.
7.2.5	Selection of chemical, radiological, and other stressors	Section 4 and Section 6.1.3 provided the selection process for COPC included in the assessment. Specific aspects relevant to N288.6 are discussed within the text.
7.2.6	Selection of exposure pathways	The pathways of exposure for ecological receptors were identified in Section 6.1.
7.2.7	Ecological conceptual model	The conceptual model for the EcoRA was provided in Section 6.1.5.
7.3.1	Exposure assessment, General	Sections 6.2.4 and 6.4.5 provided the exposure point concentrations for soil, water, groundwater and sediment, as well as the gamma doses. Concentrations for other environmental compartments (e.g. aquatic invertebrates, aquatic plants) were not provided.
7.3.2	Exposure points/locations	Section 6.2.1 provided the exposure points and locations considered for the assessment.
7.3.3	Exposure frequency, duration, and averaging	Section 6.2.3 presented the exposure frequency, duration, and averaging factors assumed for the EcoRA.
7.3.4	Dose calculation methods	Dose calculations were provided in Sections 6.2.5 and 6.2.6. Specific aspects relevant to N288.6 are discussed within the text.

N288.6		Comment
Clause	Component	
7.3.5	Transfer factors, exposure factors, and dose coefficients	Transfer factors were in Section 6.2.7, exposure factors were provided in Table 6.8, and dose coefficients are provided in Section 6.2.6.4.
7.3.6	Modelled versus measured exposure concentrations	The 2016 assessment was completed using measured exposure concentrations from the site. Air concentrations at exposure locations were estimated using the air dispersion model, encompassing emissions data from the site. The updated 2016 ERA provided additional discussion in Section 3.3.1.1 to address CNSC comments on lack of calibration and validation for the groundwater model.
7.3.7	Models	The 2016 assessment used the air dispersion model AERMOD for air quality and transport through the site as well as for the pathways assessment and ecological and human health risk assessments. Details of the air modelling were presented in Appendix A. Off-site soil concentrations of uranium were predicted using the Arcadis soil deposition and leaching model, which was presented in Appendix B. Influences of the stormwater and groundwater discharges were predicted through the Port Hope harbour model. Details of the stormwater and groundwater modelling were included in Appendix C. Influences of gamma radiation on human receptors were predicted through the MicroShield modeling as detailed in Appendix D.
7.3.8	Exposure point concentrations and doses	Sections 6.2.4 and 6.4.5 provided the exposure point concentrations for soil, water, groundwater and sediment, as well as the gamma doses Concentrations for other environmental compartments (e.g., aquatic invertebrates, aquatic plants) were not provided. Section 6.2.8 provided the external gamma radiation dose.
7.4.1	Effects assessment, General	Sections 6.3.1 and 6.3.2 provided the benchmarks used for the effects assessment.
7.4.2	Radiological benchmarks	The radiological benchmarks were provided in Section 6.3.2. The assessment used dose limits set by UNSCEAR for ecological receptors (Table 6.30).
7.4.3	Toxicological benchmarks	The benchmarks for non-radiological COPC were provided in Section 6.3.1. Specific aspects relevant to N288.6 are discussed within the text.
7.4.4	Thermal benchmarks	Section 7.2 discussed thermal effects on fish and how thermal benchmarks were derived.
7.5.1	Risk characterization	The results of the risk characterization for the EcoRA were provided in Section 6.4.
7.5.2	Risk estimation	The results of the risk estimation for the EcoRA are provided in Section 6.4.
7.5.3	Other lines of evidence	Summaries were provided for previous studies. Toxicity tests and field survey results completed following the 2009 ERA were referred to in the discussion.

N288.6		Comment
Clause	**Component**	
7.5.4	Thermal effects	Section 7.2 discusses the thermal effects on fish.
7.5.5	Wildlife-vehicle and bird-structure mortalities effects	Not applicable to the 2016 assessment; roadkill and bird strikes were not components of the scenarios being assessed.
Evaluation of Uncertainty		
8.1	Evaluation of uncertainty	Uncertainties present in the assessment were identified in Sections 5.5 and 6.5.
8.2	Identifying and evaluating uncertainty	Uncertainties in the assessment were identified in Sections 5.5 and 6.5.
8.3	Probabilistic risk assessment	The 2016 assessment was not a probabilistic assessment. However different Tiers of assessment were evaluated.
Risk-based Recommendations		
9.1	Risk-based recommendations	The information in the assessment can be used for risk-based decisions.
9.2	Recommendations for monitoring	The information in the assessment can be used for further monitoring decisions.
9.3	Recommendations for risk management or remediation	The information in the assessment can be used for risk-management or remediation.
Quality Assurance and Quality Control		
10.	Quality assurance and quality control	All data used in the assessment are from Cameco's EMP and were subject to their data quality requirements.
Periodic Review of the ERA		
11.	Periodic review of the ERA	A review was completed and submitted to CNSC in 2024.

5.0 CONCLUSION

The 2016 ERA was completed pursuant to CSA N288.6-12 using the available toxicity information at that time. The assessment was extremely conservative. In addition, the approach to the evaluation of aquatic receptors has evolved and some toxicity values have changed.

Since the completion of the 2016 ERA, additional monitoring has been completed and the most recent 2023/2024 data continue to demonstrate that, in general, concentrations of COPC continue to decrease. The changes in monitoring data, together with changes in toxicity values and approaches to evaluation of aquatic receptors are likely to result in lower risks than were predicted in the 2016 ERA, confirming that the 2016 ERA still represents a conservative estimation of risk associated with the PHCF operations.

Physical changes underway at the site as part of ongoing operations and the VIM project will continue to reduce or eliminate potential risks identified in the 2016 ERA. For example, the migration to production facility closed loop cooling systems and remediation of subsurface infrastructure and contamination would result in a reduction of exposure and consequently risks. These changes have improved environmental performance and reduced the overall impact of PHCF operations on the environment.

The results of the 2016 ERA indicated that there were negligible risks to human health and the environment from exposure to contaminants associated with activities from the PHCF. These results are validated by IEMP results from the CNSC for the monitored years (2014, 2015, 2017, 2020 and 2024) which indicate that people and the environment in the vicinity of the PHCF are protected and that there are no anticipated adverse effects from the operation of the PHCF.

5.1 Recommendations

Based on this review completed in accordance with Clause 11.1 of N288.6-22, there are no identified risks that have emerged since the 2024 ERA review. In fact, the 2023/2024 data indicate that conditions are improving at the site resulting in several potential risks becoming less significant. The changes under the VIM project will require a full update of the ERA to establish a new baseline of environmental performance on which to revise the site Environmental Protection Program. It is important that this full update be undertaken once the site remediation and harbour remediation are largely complete and there are no remaining activities such as building demolition or soil excavation which could skew the operational monitoring data required for the ERA update. As part of this update, CORMIX modelling and Air Quality modelling will also need to be conducted.

6.0 LITERATURE CITED

ARCADIS. 2016a. PHCF Derived Release Limit and Operating Release Level Reports. February.

ARCADIS. 2016b. Environmental Risk Assessment for the Cameco Port Hope Conversion Facility. Prepared for Cameco Port Hope Conversion Facility, Proj. No. 351146, March.

ARCADIS. 2021. Derived release limits for the Cameco Fuel Manufacturing Facility. Project No. 351431. Prepared for Cameco Corporation, Final, February.

Cameco. 2024a. Review of the Environmental Risk Assessment for Port Hope Conversion Facility: Fuel Facility Operating Licence FFOL-3631.00/2027. Revision 1, June.

Cameco. 2024b. 2023 Annual Compliance Monitoring & Operational Performance Report. Reporting Period January 1 – December 31, 2023. March 26.

Cameco. 2025. 2024 Annual Compliance Monitoring & Operational Performance Report. Reporting Period January 1 – December 31, 2024. March 29.

CanNorth and IEC. 2025. Update of derived release limits for the Port Hope Conversion Facility. Prepared by Canada North Environmental Services (CanNorth) and Independent Environmental Consultants (IEC) for Cameco Corporation. September.

CCME. 2002. Canadian Water Quality Guidelines for the Protection of Aquatic Life: Inorganic Fluorides. In: Canadian environmental quality guidelines, 1999, Canadian Council of Ministers of the Environment, Winnipeg.

CCME. 2025. Canadian Environmental Quality Guidelines summary table. Website: https://ccme.ca/en/summary-table.

CNSC. 2025. Independent Environmental Monitoring Program: Port Hope Conversion Facility and Cameco Fuel Manufacturing. Modified March 24.

CSA. 2022. N288.6-22 Environmental risk assessments at nuclear facilities and uranium mines and mills. February.

Golder. 2021. Annual groundwater and surface water review report, Cameco Corporation Port Hope Conversion Facility. Project No. 20447601, March.

IEC. 2021a. Port Hope Conversion Facility Review of Environmental Risk Assessment – Air. August.

IEC. 2021b. Emission Summary and Dispersion Modelling Report for the Cameco Port Hope Conversion Facility. May.

IEC. 2023. Emission Summary and Dispersion Modelling Report for the Cameco Port Hope Conversion Facility. March.

McPherson, C.A., D.H.Y. Lee, and P.M. Chapman. 2014. Development of a fluoride chronic effects benchmark for aquatic life in freshwater. Environmental Toxicology and Chemistry 33(11):2621–2627.

MECP. 2023. Ontario's Ambient Air Quality Criteria - Sorted by Contaminant Name. https://www.ontario.ca/page/ontarios-ambient-air-quality-criteria#section-4.

SENES. 2009. Risk-Based Performance Objectives (Update of SWRA Section 5). SENES

Report 34653-2, prepared for Cameco Corporation. December.

SENES. 2010. 2010 Follow-Up Port Hope Conversion Facility Site-Wide Risk Assessment: Human Health and Ecological Risk Assessment. Prepared for Cameco Corporation, December.

SENES. 2013. Risk Assessment Port Hope Conversion Facility Fence-Line Shift. Prepared for Cameco Corporation, October.

WSP. 2023. Annual groundwater and surface water review report, Cameco Corporation Port Hope Conversion Facility. March.

WSP. 2025. Annual Groundwater and Surface Water Report. Port Hope Conversion Facility. March.