

ERA 2022

ENVIRONMENTAL RISK ASSESSMENT POINT LEPREAU NUCLEAR GENERATING STATION SUMMARY

JANUARY 2022



Énergie NB Power

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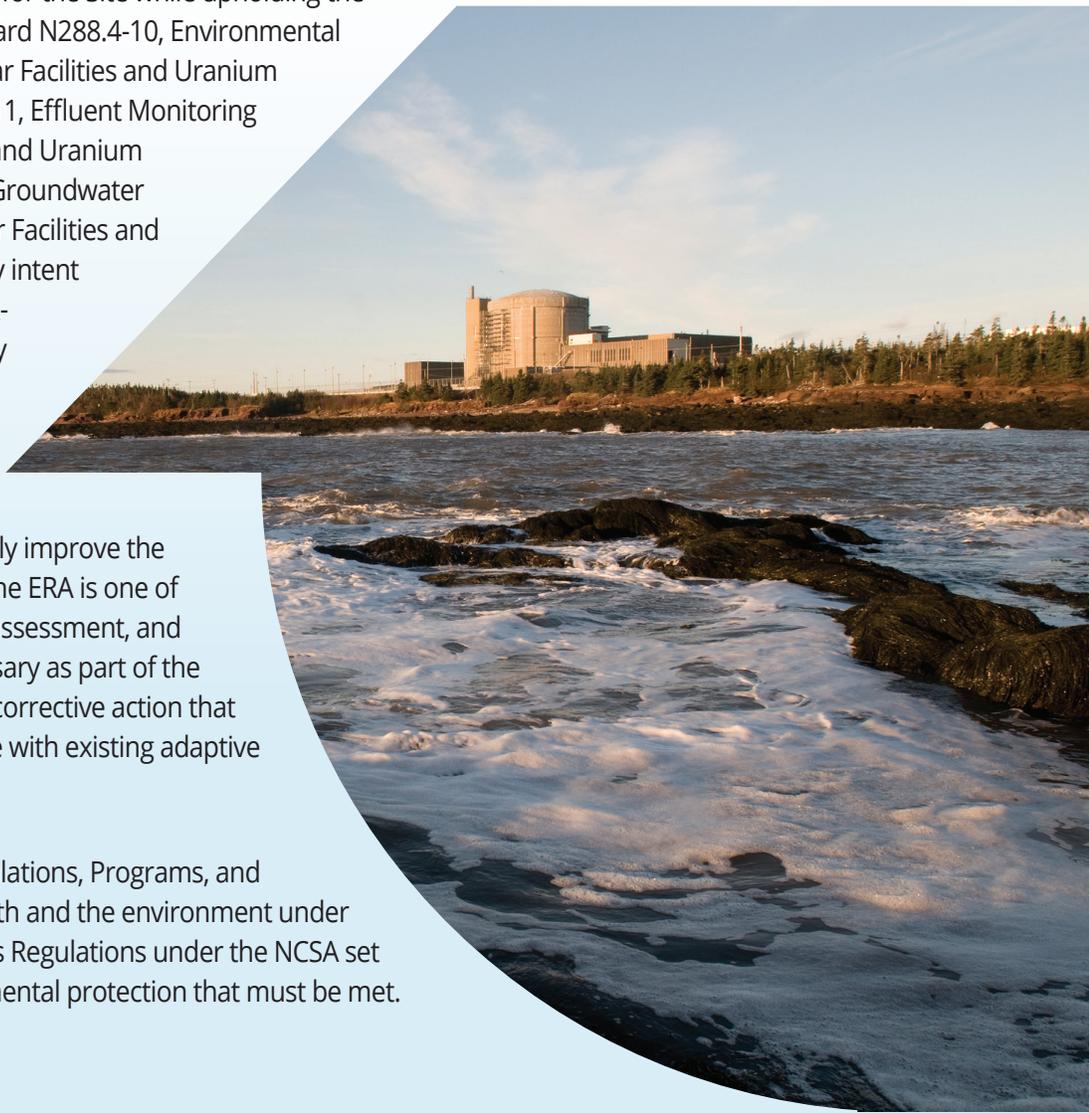
1.0 BACKGROUND

New Brunswick Power (NB Power) owns and is licensed by the Canadian Nuclear Safety Commission (CNSC) to operate the Point Lepreau Nuclear Generating Station (PLNGS) located on the Lepreau Peninsula on the Bay of Fundy approximately 45 km west of the city of Saint John, New Brunswick. The CNSC regulates the use of nuclear energy in Canada in compliance with the stipulations in the Nuclear Safety and Control Act (NSCA). Nuclear Power Plants (NPPs) undergo regular operating license renewals whereby operating performance is evaluated by the CNSC across several areas including Safety and Environmental Protection.

Comprehensive environmental monitoring programs associated with PLNGS have been in place for over 45 years, including the pre-construction phases in the early 1970s. This monitoring has continued throughout construction and operation phases to present day with several comprehensive assessments having been conducted over the years to ensure ongoing protection of environmental and human health both on and surrounding the site.

The purpose of the ERA is to systematically identify potential risks to either human health or the environment as a result of historical and ongoing operations at the Site (i.e., those from the Nuclear Facility). This includes a determination of the magnitude and extent of the potential effects associated with the Site. The ERA considers potential modifications to the current monitoring commitments for the Site while upholding the requirements described in CSA Standard N288.4-10, Environmental Monitoring Programs at Class I Nuclear Facilities and Uranium Mines and Mills, CSA Standard 288.5-11, Effluent Monitoring Programs at Class I Nuclear Facilities and Uranium Mines and Mills, and CSA N288.7-15, Groundwater Protection Programs at Class I Nuclear Facilities and Uranium Mines and Mills. The primary intent of this examination is to provide a risk-based rationale for the relative priority of monitoring for effects or sampling specific media for analysis as part of Environmental Monitoring. As per its Environmental Management System, NB Power strives to continually improve the Environmental Protection Program. The ERA is one of the inputs to this routine review and assessment, and therefore will be considered as necessary as part of the review and assessment process. Any corrective action that is identified is managed in accordance with existing adaptive management procedures at Site.

NB Power complies with Federal Regulations, Programs, and Standards, which protect human health and the environment under the NCSA. The Class I Nuclear Facilities Regulations under the NCSA set out requirements related to environmental protection that must be met.



The General Nuclear Safety and Control Regulations require every licensee to take all reasonable precautions to protect the environment and to control release of radioactive nuclear substances or hazardous substances within the Site and into the environment as a result of the licensed activity. Monitoring is undertaken to fulfill regulatory requirements on environmental protection in accordance with the Power Reactor Operating Licence. Monitoring encompasses the following specific areas:

effluent and emissions control (releases), an Environmental Management System (EMS), and provisions for protection of the public and the natural environment, which is commensurate with risk evaluated in the ERA.

Radiological and non-radiological emissions from the site are within permitted federal and/or provincial regulatory limits established to protect the public and environment. With respect to radiological airborne emissions and liquid releases, derived release limits (DRLs) have been developed by NB Power to ensure release limits to the environment will not exceed the annual regulatory public dose limit of 1 mSv.

The CNSC, when considering relicensing, has an obligation through the NCSA to consider whether an applicant will, in carrying out that activity, make adequate provision for the protection of the environment and the health and safety of people. As outlined in CNSC REGDOC-2.9.1, ver. 1.2, Environmental Protection Policies, Programs and Procedures, the following environmental protection regulatory documents and CSA standards are relevant to the CNSC's regulatory framework for environmental compliance:

- CAN/CSA ISO 14001 Environmental Management Systems – Requirements with Guidance for Use
- CSA N288.1-14 Guidelines for calculating derived release limits for radioactive material in airborne and liquid effluents for normal operation of Nuclear Facilities
- CSA N288.4-10, Environmental Monitoring Program at Class I Nuclear Facilities and Uranium Mines and Mills
- CSA N288.5-11, Effluent monitoring programs at Class I Nuclear Facilities and Uranium Mines and Mills
- CSA N288.6-12, Environmental Risk Assessments at Class I Nuclear Facilities and Uranium Mines and Mills
- CSA N288.7-15, Groundwater Protection Programs at Class I nuclear facilities and Uranium Mines and Mills



2.0 ENVIRONMENTAL RISK ASSESSMENT (ERA)

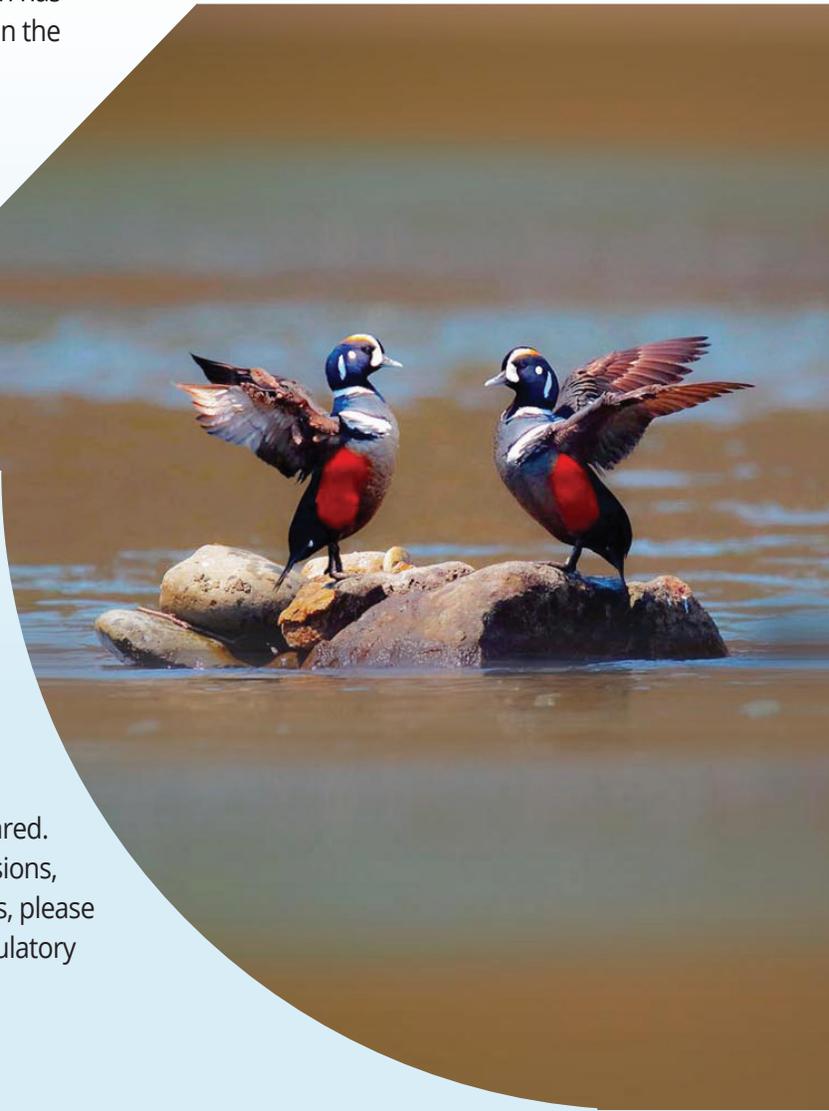
The ERA is completed per CSA N288.6-12, Environmental Risk Assessments at Class I nuclear facilities and uranium mines and mills and identifies environmental protection measures being implemented and maintained at nuclear facilities. Based on periodic review requirements from the CSA Standard, PLNGS is required to review and update its ERA every 5 years to ensure that the document remains current and appropriately reflects the current facility and operations. It is one of several documents reviewed by the CNSC to support PLNGS operation and relicensing. The most recent ERA completed for PLNGS reflects data reviewed and assessed up to February 2019.

The ERA involved a site-wide study that investigated media (e.g., soil, groundwater, surface water (freshwater and seawater), and air) both on and surrounding the PLNGS Site. The ERA consisted of site characterization, human health risk assessment (HHRA), which investigates radiological, chemical exposure and risk to nearby residents and members of the public; ecological risk assessment (EcoRA), which investigates radiological, chemical and physical exposure and risk to flora and fauna at and surrounding the PLNGS site, conclusions, and recommendations for specific additional study and/or on-going monitoring. It reflects the data and parameters available at the time of the risk assessment investigation and report.

The ERA was conducted by Arcadis Canada Inc. The quality assurance / quality control (QA/QC) requirements of CSA N288.6 are captured within the Arcadis Quality System, which has been certified to the ISO 9001:2008, and was implemented in the preparation of the ERA. The main updates in this ERA are:

- Alignment with CSA Standard N288.6-12 (CSA 2012), which was reaffirmed in 2017, for risk assessment approach and contents;
- Updated site characterization information (e.g., addition of the fire-fighting training area)
- Updated environmental concentration and release data
- New reference studies (e.g., thermal effects assessment);
- Updated risk assessment calculation parameters (including transfer factors, dose coefficients and toxicity benchmarks); and,
- Modifications made to address CNSC comments on the 2016 ERA.

To facilitate review, this summary of the ERA has been prepared. The summary describes methods used, approaches, conclusions, and recommendations of the ERA. If you have any questions, please contact the Manager of Community Affairs and Nuclear Regulatory Protocol, PLNGS.



3.0 ERA APPROACH

The study was initiated in February 2019, using the past five (5) years of environmental data. The study areas considered in the ERA included:

- Groundwater across the entire site and surrounding area;
- Soil across the entire site and surrounding area;
- Surface water (freshwater) in puddles, brooks or tributaries, and ponds across the entire site and in the surrounding area;
- Surface water (seawater) and sediment in the Bay of Fundy;
- Air across the entire site and surrounding area.

3.1 SITE CHARACTERIZATION

The site characterization included a review of numerous on-site locations, structures, and facilities to identify those with potential releases. Overall, the review identified the following areas as potential sources:

- The Station, which includes air stack emissions and the Condenser Cooling Water (CCW) discharge which returns cooling water and water-borne effluents to Duck Cove;
- Auxiliary boiler and standby diesel generators, which include air stack emissions;
- Solid Radioactive Waste Management Facility (SRWMF) which includes release of tritium vapour and liquid stormwater runoff to Duck Cove and an adjacent wooded area;
- Inactive (i.e., decommissioned) landfill which includes releases of liquid effluent to adjacent wetlands;
- Sewage Treatment Plant (STP) which discharges liquid effluent to Indian Cove; and,
- Industrial wastewater lagoons which are directed to the CCW discharge.

A review was then undertaken to characterize the potential or actual releases associated with each of these source areas. The review identified chemical (non-radiological) and radionuclide Contaminants of Potential Concern (COPCs). Following the tiered ERA approach, a screening process was employed to determine which COPCs required further investigation. The screening process resulted in a refined list of radionuclides and non-radiological chemicals as COPCs to be retained for further investigation. This step also involved development of a Conceptual Site Model (CSM), outlining the relevant pathways and receptors for assessment.

3.2 HUMAN HEALTH RISK ASSESSMENT (HHRA)

ACCORDING TO CSA N288.6 (2012):

[A] Human health risk assessment (HHRA) focuses on the identification, quantification, and characterization of the risks to individual human receptors resulting from exposure to contaminants and physical stressors released into the environment throughout the lifecycle of a nuclear facility. An HHRA can be completed as a component of an ERA or as a stand-alone assessment.

The objectives of an HHRA are to evaluate the risks to relevant human receptors resulting from exposure to contaminants and stressors related to a Site and its activities. Based on the results of the HHRA, further assessment and possible further action might be deemed necessary.

The requirement for, approach to, and scope of the HHRA is based on a fundamental understanding of: site conditions, including the nature, extent and distribution of the radiological and chemical hazards; the potential exposure pathways; and opportunities for human receptors that will frequent, use, or populate the site. These concepts are integrated into the CSM. The objective of the HHRA component of the ERA is to complete a HHRA based on surface water, groundwater, soil, sediment, and air quality at and surrounding the site. This HHRA examined the potential health risks to people that may be exposed to contaminants. Conservative assumptions were used to identify combinations of receptors and contaminants that require further investigation. Due to the conservative nature of the calculations, if the calculations are below the generally accepted benchmarks, then health effects are not expected.

Data received up to February 2019 have been included in the ERA. A three (3) phase approach is used to evaluate the data and assess potential risk. Potential concerns addressed in an earlier phase do not require further evaluation in a subsequent phase. The first phase, referred to as a screening-level risk assessment (also called Tier 1) was carried out for all the human receptors in the ERA and involved conservative assumptions about environmental concentrations, exposure time and hazard assessment parameters. A second phase or Tier 2 assessment was used in some cases and applied site-specific data and less conservative assumptions to assess receptors and contaminants for which benchmarks were exceeded in the screening-level assessment.



The HHRA comprises an exposure assessment covering both radiological and non-radiological aspects. For the radiological pathways analysis, internal and external pathways of exposure were considered. These pathways were analyzed using dose coefficients that convert environmental concentrations and intakes into doses to human receptors. For non-radiological contaminants, available information on receptor behaviour, potential routes of exposure, and locations of contaminants were reviewed to gain an understanding of potential exposure pathways.

3.3 ECOLOGICAL RISK ASSESSMENT (ECORA)

The Ecological Risk Assessment (EcoRA) examines the potential population effects to terrestrial, freshwater and marine ecological receptors that may be exposed to contaminants. An EcoRA uses conservative assumptions to identify combinations of receptors and contaminants that require further investigation. Due to the conservative nature of the calculations, if the calculations are below the generally accepted toxicity benchmarks, then it is concluded, as per the HHRA, that impacts on ecological receptors are not expected.

A discussion of the ecological receptors that may be exposed is provided below. The EcoRA has been carried out to represent conditions that were current at the time of reporting. Data received up to February 2019 have been included in the EcoRA.

As in the HHRA, a phased approach is used to evaluate the data and assess potential risk. The first phase, referred to as a screening-level (also called Tier 1) EcoRA was carried out for all biota included in the EcoRA. This involved conservative assumptions about environmental concentrations, ecological receptor exposure time and hazard assessment parameters.

The radiological Tier I EcoRA exposure assessment relied on maximum contaminant concentrations in environmental media. A second phase or Tier 2 assessment was used in some cases and applied site-specific data and less conservative assumptions to assess receptors and contaminants for which benchmarks were exceeded in the Tier 1 assessment.

A representative selection of ecological receptors was made and exposure pathways for the CSM were summarized. The ERA calculations consider various study areas, with exposure to various media. These are:

- On the Site itself;
- Surrounding terrestrial area (including ponds, puddles, and brooks or tributaries); and
- The Bay of Fundy.



Ecological receptors were selected for the ERA based on knowledge of the site (including accessibility) and previous PLNGS studies. The selected receptors cover a variety of trophic levels (i.e., the position an organism occupies in the food chain) and are assumed to be representative of the biota (i.e., animal and plant life) expected to be found in the study area. Ecological profiles were developed for each receptor. These profiles specify parameters such as food intake rate, time in area, diet composition, etc. Examples of some of the ecological receptors included in the ERA are: various terrestrial and marine bird species, fox, moose, Black bear, earthworms, aquatic plants, and fish.

Information from NB Power's monitoring programs and reports was used to characterize the site, develop a conceptual site model of the various exposures, and develop a list of chemical and radiological stressors, or Contaminants of Potential Concern (COPCs).

When data was not available, gaps were filled using conservative assumptions, e.g., about where animals spend their time and obtain their food, how COPCs are transported through the food chain, and how much dilution occurs in the Bay of Fundy. Conservative assumptions ensure that the risk is not underestimated.

The HHRA and EcoRA were conducted by selecting receptors: groups of humans or floral/faunal species that are present at and around the site and may be affected by PLNGS activities. The receptors included species listed under the Species at Risk Act.



4.0 SUMMARY

The ERA concludes:

- For human health there are no radiological or non-radiological risks to members of the public
- For ecological health, there are no radiological or non-radiological risks to wildlife or the environment
- All activities and potential concerns were resolved within the bounds of the second phase or Tier 2 assessment and do not require further assessment
- No interactions were identified that pose a risk to humans or the environment
- Potential impacts of future activities are anticipated to be similar to those of existing and predicted operations and as a result would not cause any significant adverse environmental impact
- Current environmental monitoring programs are sufficient and will be maintained
- The impacts of PLNGS operations and associated activities are very well understood through several well-documented reviews. Overall, the impacts of the site on the surrounding environment are very low and do not cause any significant adverse environmental impact as concluded in this ERA and past reviews. By demonstrating the minimal impacts of the facility and meeting other requirements associated with safe operation, PLNGS has been granted Licences to operate by the Canadian Nuclear Safety Commission (CNSC).

To access the full report: <https://www.nbpower.com/media/1491299/era-2020.pdf>

4.1 RISK CHARACTERIZATION AND RESULTS

- The radiological dose estimates for all human receptors are below the 1 mSv/y dose limit set by the CNSC for members of the public, therefore, no adverse effects are expected, based on the available data.
- For non-radiological contaminants, there are no exceedances of the non-carcinogenic benchmarks and no exceedances of the carcinogenic risk threshold. No undue risk to human receptors is expected, based on the available data and assumptions made.
- The doses estimated in the radiological HHRA and EcoRA are all below the dose limits / benchmarks. The results indicate that no undue radiological risk is expected to humans, plants or animals from exposure to releases from the PLNGS under its current operations.

The HHRA and EcoRA also assessed risk from exposure to chemical COPCs, based on the available data and assumptions made. The HHRA results determined that exposure to chemical COPCs released from PLNGS operations is not expected to pose undue health risk to members of the public in the off-site and marine areas.

- The EcoRA results indicate that for most of the receptors assessed, no undue effects are expected from chemical COPC exposure. Some further investigation is required for small mammals, earthworms, terrestrial plants and aquatic species from exposure to one or more metals present in the on-site and/or decommissioned landfill study areas. These results are driven by soil and water concentrations that are elevated but are often within the typical North American range. The elevated concentrations may be attributable to background levels, rather than associated with PLNGS operations.

4.2 RESULTS: PHYSICAL STRESSORS

THERMAL EFFECTS

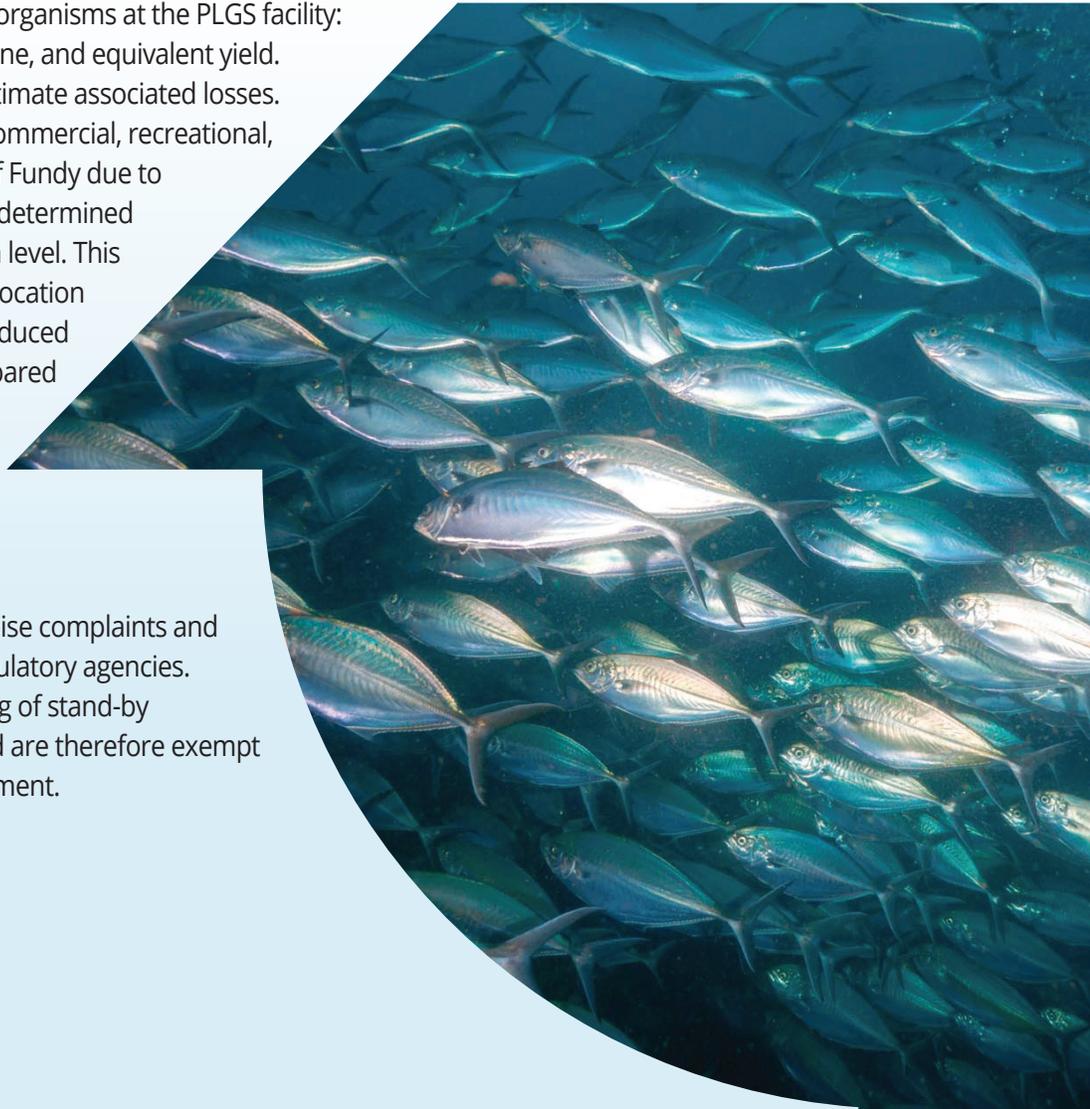
The PLNGS draws in seawater to use as cooling water and releases it back to the Bay of Fundy at a slightly higher temperature (typically less than 1°C above ambient seawater temperatures). PLNGS recently undertook a study to better understand how the plume of warm water (“thermal plume”) mixes with the Bay of Fundy water, and the potential effects on ecological receptors that spend time near the discharge. Based on the known thermal tolerances of the receptors and the thermal plume characteristics determined in the NB Power study, it is expected that the receptors will be able to tolerate the temperature changes (over time and over space) associated with the return of cooling water to the Bay of Fundy.

IMPINGEMENT & ENTRAINMENT

Impingement and entrainment are known to occur at facilities with a cooling water system. Between 2013 and 2015, PLNGS completed studies to quantify the impingement and entrainment resulting from operation of the cooling water system. The studies used three (3) models to evaluate impingement and entrainment losses of individual organisms at the PLGS facility: age-1 equivalence, production foregone, and equivalent yield. Using multiple different models to estimate associated losses. Overall, the estimated losses to the commercial, recreational, and Indigenous fisheries in the Bay of Fundy due to impingement and entrainment were determined not to be significant at the population level. This finding suggests that the design and location of the PLNGS intake contributes to reduced impingement and entrainment compared to other facilities with conventional shoreline intakes.

ACOUSTIC EFFECTS

The PLNGS facility has received no noise complaints and has no noise issues with the local regulatory agencies. Testing of the PA systems and running of stand-by generators are safety procedures and are therefore exempt from the need for an acoustic assessment.



5.0 CONCLUSIONS

The ERA draws the following conclusions and explains limits of uncertainty, as applicable:

- No potential exceedances were identified, and no further assessment is required.
- Radiological and non-radiological emissions from the site are within regulatory limits and requirements, which are set to protect the public and environment.
- With respect to non-radiological emissions, PLNGS is in compliance with applicable Provincial regulations, approvals, and permits.
- Based on measured metals concentrations in the industrial wastewater lagoons, conservatively diluted into the CCW and the Bay of Fundy, non-carcinogenic Hazard Quotients (HQs) are below the screening limit of 1. Carcinogenic risk values are below the acceptable risk level of 1×10^{-5} . Based on these conservative assessments, no undue risk to human receptors is anticipated and no further assessment is required.
- For marine receptors, no potential exceedances were identified, and no further assessment is required.

6.0 RECOMMENDATIONS

The ERA resulted in the following recommendations:

1. In order to better characterize soil concentrations and estimate receptor exposure more accurately, it is recommended that NB Power conduct additional non-radiological soil sampling across the site (rather than only in the firing range area) and at background locations. The analysis should include metals, in particular aluminum, iron, lead, manganese and vanadium. Data from background locations can be used to confirm whether the observed elevated metal concentrations are within the range of local background.
2. It is recommended that NB Power conduct a desktop study of metal levels in surface water, such as typical ranges in reference locations (if these data are available), in order to establish background levels. Publicly-available provincial reports provide background ranges that can be used to provide context for the measured levels.
3. To address the potential for multi-stressor effects to biota from non-radiological contamination, it is recommended that NB Power undertake toxicity testing of surface water samples. It is recommended that NB Power collect samples and conduct toxicity testing at certain sampling locations. Appropriate reference locations must also be sampled and tested. The results are to be included in the next ERA as a line of evidence related to potential for multi-stressor effects.
4. It is recommended that NB Power collect and analyze water and sediment data from the drainage ditch prior to the next ERA update. These data will serve multiple purposes:
 - (i) Provide characterization data so that NB Power can consider adding the ditch as a potential habitat for aquatic plants and benthic invertebrates in the next ERA update;

- (ii) Understand the background concentration levels of hydrocarbon compounds in the ditch during normal operating conditions ; and
- (iii) The ditch concentration data can be used to improve the estimated marine concentrations (based on discharge from the ditch), in future ERA calculations.

The water and sediment in the ditch should be sampled for non-radionuclides expected to be present in the STP effluent and lagoon bypass, including hydrocarbon compounds, and radionuclides.

- 5. It is recommended that NB Power conduct a one-time confirmatory non-radiological sampling event in Indian Cove to confirm that the water quality is below guideline levels associated with the Sewage Treatment Plant (STP). Analytes should include non-radionuclides that may be present in the STP effluent and lagoon bypass, as well as hydrocarbon compounds.
- 6. It is recommended that NB Power conduct a one-time sampling event (for radionuclides and hydrocarbon compounds) in Brook 2 surface water and sediment, to confirm that the potential contributions from the Fire Fighting Training Area and SRWMF collection areas have not resulted in contaminant levels that exceed guidelines.
- 7. It is recommended that the exposure of amphibians to contaminants in soil and sediment is considered in future iterations of the EcoRA, particularly if any new toxicity data is published in reputable literature sources, and if additional on-site soil and sediment data are available.
- 8. It is recommended that NB Power record and trend seal presence and entrapment in the forebay to identify requirements for mitigation measures to reduce seal ingress.



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