# An Introduction and Overview of DRAFT CSA Standard N288.7 Groundwater Protection at Class I Nuclear Facilities and Uranium Mines and Mills

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**Abstract**

The DRAFT CSA Standard N288.7 entitled Groundwater Protection at Class I Nuclear Facilities and Uranium Mines and Mills is currently under development and is anticipated to publish in June of 2015. This draft standard identifies a process for the protection and monitoring of groundwater at nuclear facilities but may also be used at any facility (i.e. nuclear facilities that are not Class I or non-nuclear facilities). The paper discusses the background to the draft standard, the formalized methodology described in the draft standard and provides some input on implementation. The paper is intended for people that have responsibilities related to groundwater protection at facilities that may need to comply with the draft standard or any site/facility that has some form of groundwater monitoring program.

## 1. Introduction

The DRAFT CSA Standard N288.7 entitled Groundwater Protection at Class I Nuclear Facilities and Uranium Mines and Mills (the Draft Standard) is currently under development and is anticipated to publish in June of 2015. Compliance with this Draft Standard, when finalized, will likely become part of license requirements for Class I Nuclear Facilities and Uranium Mines and Mills in Canada. The Draft Standard can be used by any nuclear or non-nuclear facility[1] or organization to ensure groundwater is being protected in a systematic method that is consistent with industry best practice. This paper describes the development of the Draft Standard and provides a discussion of its key elements. The paper is meant as an introduction to the Draft Standard and presents an overview only. The Draft Standard, or the final Standard, when issued, should be referenced for specifics. It is realized that the Standard is in draft and that changes may occur prior to it being finalized.

[1] In this paper (and the Standard ) the term 'nuclear facilities' refers to any Class 1 nuclear facility or Uranium Mine or Mill.

## 2. Standard Development

The Draft Standard has been under development since 2013 through a CSA process, with funding provided by the CANDU Owner's Group (COG). COG provided funding for a consultant team to investigate the background for the Draft Standard, develop the initial draft, and assist with edits. The consultant team consisted of Canadian Nuclear Laboratories, EcoMetrix Incorporated, Golder Associates Ltd., and SENES Consultants. A CSA technical subcommittee provided the majority of comments and edits to the Draft Standard. The technical subcommittee included representatives from federal and provincial regulators, power producers, mining companies, a national research laboratory, and industry consultants.

The process of establishing Canadian guidance specific to groundwater protection began in 2012 when the Canadian Nuclear Safety Commission issued a discussion document on groundwater protection [1]. The discussion document noted that while most nuclear facilities have measures in place to protect groundwater from contamination by nuclear or hazardous substances there were differences and gaps in such programs and there was a need to clarify and formalize requirements related to groundwater protection. Consultation on this document drew comment from numerous stakeholders. Based on this discussion, and with the support of the Canadian Nuclear Safety Commission staff, it was decided to prepare a standard for this topic.

The initial task in the development of the Draft Standard was a search for relevant literature on groundwater protection in general and groundwater protection at nuclear facilities in particular. Applicable documents were reviewed for their relevance to the development of the Draft Standard and for particular aspects that could be used in the development of the Draft Standard. The outcome of this review was a COG discussion paper, along with a proposed outline for the Draft Standard and a list of issues that the consultant team felt should be addressed as part of the Draft Standard development. Most of the documents reviewed were overly technical for use in the Draft Standard and provided guidance on topics such as well construction and sample collection. However, several Electric Power Research Institute documents contained useful information, including a review of groundwater protection programs at various US facilities.

COG held a workshop with the CSA technical subcommittee to review the COG discussion paper. This workshop helped to express the stakeholders' concerns and issues, and provided information that the consultant team could use to develop the initial draft.

The initial version of the Draft Standard went through five reviews and revisions before it was submitted for public review in June 2014. Over 100 public review comments were received, and all comments were reviewed and addressed by the technical subcommittee. The Draft Standard has completed review by the CSA editors and a final draft is to be approved in mid-2015. The Standard will then be available for use by the public.

## 3. Overview of the Draft Standard

The Standard is intended to assist facilities in protecting groundwater for its users. The protection applies to both the quality and quantity of groundwater. It provides a framework for consistent, and industry standard, implementation of a Groundwater Protection Program (GWPP). The Standard is intended to provide the user with flexibility in the implementation of their specific GWPP. In particular each GWPP is intended to be site specific with the level of complexity commensurate with the operations of the facility and the risks to the environment.

The Draft Standard provides for cost–efficiencies by encouraging the use of information from other environmental or facility programs. For example, if a Conceptual Site Model (CSM) is developed as part of an environmental assessment conducted under the *Canadian Environmental Assessment Act* and/or as part of an Environmental Risk Assessment (ERA) that CMS can be referenced without the need to develop a separate CMS under the Draft Standard.

The Draft Standard presents four broad components:

- Introduction – a discussion of the interaction of the Draft Standard with other CSA standards or environmental programs, a discussion of the scope of the Draft Standard, definitions and references, and a discussion of when the Draft Standard may, or may not, be applicable for a facility;

- Groundwater Protection Program (GWPP) – goal setting, CSM development, control of potential releases, and development of the Groundwater Monitoring Program (GWMP) and other associated programs;

- GWMP development and implementation – development of a systematic process for GWMP design, monitoring strategies, interpretation of data, and other technical components required to support the GWMP; and

- Supporting clauses – reporting requirements, requirements to review and audit the programs, training, and others.

This paper reviews each of these components to provide an overview of the Draft Standard and to provide information that may assist with implementation of a GWPP.

## 4. The Draft Standard's Introductory Sections

The GWPP should build on previous work rather than requiring duplication of effort. The Draft Standard is clear, for example, that groundwater that enters an effluent stream (i.e., that discharges into a pipe or effluent channel) is considered to be effluent at the point of discharge to the effluent and is no longer groundwater. Therefore, contaminants in this water are considered part of a facility's effluent monitoring program and not part of the GWMP. As

a further example, ERA findings can be used to develop specific groundwater protection program goals and groundwater evaluation criteria. If the ERA has defined critical receptors (i.e., end-users) and acceptable activities or concentrations, there is no need to reproduce this evaluation.

Assessments and programs that may provide a foundation for the GWPP include:

- environmental assessments conducted under the *Canadian Environmental Assessment Act* or for other purposes;
- human health and ecological risk assessments conducted for compliance to CSA N288.6 [2] or for other purposes;
- environmental monitoring programs conducted for compliance to CSA N288.4 [3] or for other purposes;
- effluent monitoring programs conducted for compliance to CSA N288.5 [4] or for other purposes;
- buried and underground piping and tank programs;
- facility decommissioning plans; and
- any other previous groundwater programs, including investigations, remediations, and monitoring.

The Draft Standard identifies limits to its scope. There are two critical limits that warrant mention:

1) The Draft Standard does not address risk management and remediation. Implementation of the Draft Standard may indicate when risk management and/or remediation are required. However, the Draft Standard does not provide guidance on how to conduct these items.

2) The Draft Standard is designed to address normal operating conditions. Normal operating conditions may include spills, but spill response is not part of the Draft Standard. However, many components of the Draft Standard can be used to monitor impacts from spills or other emergencies.

## 5. Groundwater Protection Program

A GWPP is required at most nuclear facilities, but it is not required for those facilities that meet specific criteria. In general, a GWPP is not required at a facility that does not have, or is not likely to have, potential adverse effects on human or ecological receptors from

degradation of groundwater. If a user does not believe a GWPP is required, the reasons for this decision must be documented.

The Draft Standard requires that a facility's GWPP should include the following components and provides guidance on implementing these components:

- groundwater protection goals;
- a CSM;
- a system to control releases to groundwater;
- a GWMP; and
- other programs or processes as required.

The Draft Standard advocates an overall goal of protection of groundwater quality and quantity, and suggests other general goals for consideration, which include:

- to have control measures in place to prevent or minimize releases of nuclear or other hazardous substances;
- to provide monitoring information related to uncontrolled releases, and if uncontrolled releases are identified, to provide the information needed to assess effects on groundwater quality; and
- to protect identified groundwater end-uses that may be affected by releases to groundwater.

Site-specific considerations include the physical environment, regulatory requirements, the facility operation, and the lifecycle stage of the facility. Site-specific protection goals include protection of both human and ecological receptors which may be affected by groundwater impacts.

The CSM does not need to be constrained to the legal site boundary. It can be defined for any portion of the facility where a CMS is deemed necessary or for an area larger than the legally owned site property. A facility may have more than one CSM. The CSM must include these three elements:

- Identification of potential contamination sources and contaminants of potential concern (COPCs) – This should be conducted in a systematic manner to identify relevant of potential contamination sources (i.e. locations, volume of contaminant, activity/concentration of contaminant). The process to evaluate Structures, Systems and Components (SSCs) should include a review of design aspects, historical information, secondary containment, preventative maintenance, work practices, and

the inventory and activity or concentration of COPCs. The review should conclude with a ranked list of potential sources. EPRI 1016099 [5] provides a process for evaluating and ranking potential sources. However, other ranking systems may be developed for a facility.

- Characterization of groundwater flow systems and COPC migration – The physical environment should be understood to the point where groundwater flow and COPC migration can be predicted. To meet this requirement, the geological and hydrogeological aspects of the site need to be studied. A partial list of the items required includes groundwater depth, gradients, hydraulic conductivity, geochemical properties, preferred pathways, and recharge rates and areas. Constructing this element of the CMS is often an iterative process in which available information is collected, gaps are identified, and additional information is collected to fill these gaps. Numerical groundwater modelling may be useful, but it is not required.

- Identification of groundwater end-uses and groundwater vulnerability – Current and future end-uses of the groundwater should be identified and considered in the CSM. End-uses can include human (i.e., drinking water, agriculture, and heating and cooling) and ecological (i.e., aquatic life, vegetation, mammals). Aquifer vulnerability, (i.e. areas with limited overlying geological materials to protect the underlying aquifer), should be assessed in the CSM.

The findings of the CSM can be used to develop programs that prevent or minimize releases to groundwater. These programs should focus on the higher ranked SSCs identified in the evaluation process above. These programs may already exist in a facility. However, by following the above process, good practices already in place will be linked to groundwater protection, and this step will demonstrate continual improvement at the facility. If required mitigation measures are not already in place, they should be incorporated into the existing preventative maintenance process, operating procedures, or they may require specific projects.

The CSM and other studies will allow specific groundwater protection goals to be defined for each facility, such as collecting additional hydrogeological information (e.g., water levels), taking measures to reduce the potential for leaks from SSCs (e.g., improved secondary containment, improved methods of in-facility leak detection), monitoring for natural attenuation parameters, or monitoring to confirm that groundwater in the area of a specific end-user meets groundwater evaluation criteria. Specific groundwater protection goals will often become GWMP objectives.

The necessary elements to protect groundwater should not be limited to groundwater monitoring. The CSM development may indicate that other programs are required, such as a spill prevention program, a training or awareness program, or a buried piping program.

## 6. Groundwater Monitoring Program

The initial focus of the GWMP should be to define the objectives. These objectives will be both general (e.g., comply with regulatory requirements) and specific (e.g., monitor for potential impacts to a drinking-water well, demonstrate that groundwater is acceptable at a specific point; or monitor contaminant migration from an historical spill). The specific objectives are typically obtained from the specific groundwater protection goals.

The GWMP is to be developed using a systematic process. The process proposed in the Draft Standard is adapted from the US EPA Data Quality Objectives Process [6]; however, there is no requirement to use this specific process. The proposed process consists of the following steps:

1) Defining the objectives of the GWMP.

2) Identifying the data required to meet each objective.

3) Defining the area to be monitored.

4) Determining how the data obtained as part of the GWMP will be evaluated to assess whether the defined objectives are met.

5) Specifying the data quality requirements.

6) Developing groundwater evaluation criteria which can be used to interpret groundwater monitoring results.

7) Identifying a process to address exceedances of groundwater evaluation criteria.

8) Reviewing and modifying the GWMP as required - either on a prescribed schedule or as the CSM changes. If the GWMP is acceptable it can be implemented or continue to be implemented. If changes are required, return to Step 1.

Development of groundwater evaluation criteria is presented in an annex to the Draft Standard because these criteria are considered optional. However, it is likely most users will find that groundwater evaluation criteria are needed to effectively implement the overall program. These criteria can be numerical values (i.e., jurisdiction-based standards or risk-assessment-derived values), statistical limits (i.e., a percentage above background or a specified standard deviation from average), or surrogate values (i.e., a physical or chemical parameter that may indicate a release). The annex to the Standard also provides guidance for a process identifying actions that may be required if exceedances of the groundwater evaluation criteria are identified. Actions may require re-sampling a well to verify results, conducting an investigation, or initiating potential risk management actions. The process of developing groundwater evaluation criteria and responses is intended to be adaptive, with reviews and updates conducted as required.

A monitoring plan will be required to meet the identified objectives. This plan may specify the location and depth of sampling, the frequency of sampling, and the contaminants of potential concern. Although data may be collected at a single point, various points will likely be required to meet the objectives. The CSM developed in the GWPP can be used to evaluate the data as a whole.

Several strategies can be used to develop the monitoring plan using existing or new wells. The Draft Standard outlines the following monitoring strategies and their associated requirements:

- Monitoring near a release point – Although monitoring downgradient of a potential source of impact can provide some useful information the Draft Standard is clear that monitoring downgradient of a potential release point is not a preferred method to detect leaks or releases. Leak prevention or monitoring at the source (i.e., moisture detectors within secondary containment) is preferred for various reasons. These include the fact that the earlier a leak is detected the more able an effective response can be made and the fact that groundwater monitoring may miss leaks.

- Monitoring along the downgradient boundary of a site, as defined by the CSM – This strategy may be the best one for evaluating potential discharges to the environment, but it is has limited value when responding to specific leak events within the monitored site.

- Monitoring a contaminant plume – This strategy can be used to evaluate if remedial efforts, including monitored natural attenuation, are having the desired effect. This strategy can also assist with tracking migration of COPCs to specific end-users of the groundwater.

The Draft Standard includes additional guidance for GWMP design, such as the selection of COPCs to be analyzed (including the use of gross parameters, surrogate parameters, and indicator parameters), well design and installation, sampling frequency, maintenance of monitoring wells, and supplementary studies that may be required.

## 7. Supporting Clauses

The Draft Standard includes supporting sections in addition to the main sections on GWPP and GWMP:

- Sampling and analysis procedures – Many other documents provide additional detail on this topic. However, the Draft Standard addresses items such as sampling equipment, sample collection, sample volumes, field measurement, and sample analysis.

- Interpretation of data – Overall the data should be evaluated in to assess whether the quality criteria is met and if the facility is meeting it's GWMP objectives. Some of the additional topics covered in this section are statistical analysis, treatment of outliers, treatment of non-detectable results, hypothesis testing, trend analysis, and significant figures. Numerous contextual considerations for data management are noted.

- Quality assurance and quality control – This section provides requirements and advice on the development of a quality assurance/quality control program, defining roles and responsibilities, performance verification, and record keeping.

- Reporting, reviews and audits – The Draft Standard indicates that annual GWMP reports are to be prepared in addition to the GWMP design document. Facilities using the Draft Standard are required to review their GWPP and GWMPs following changes that may affect these programs (i.e., new regulations, facility changes, changes to site findings) or at a minimum of every 5 years. An assessment, less intensive then a review, of the GWMP is required annually. Audits should also be conducted to confirm that the programs are being implemented as planned. Audits are required at a minimum of every 5 years and more frequently if there are changes at a facility that warrant it.

- Staff qualifications and training – Qualification and training requirements are to be defined and documented.

- Documentation – The Draft Standard requires that both the GWPP and GWMP are documented. The GWMP documentation will likely include an overall document, supported by a detailed sampling and analysis plan that may be revised more frequently than the overall document.

## 8. Conclusion

The CSA, with assistance from COG, has developed a groundwater protection program Draft Standard for use at Class 1 Nuclear Facilities and Uranium Mines and Mills. The Draft Standard describes requirements and guidance for development of a GWPP that identifies risks, develops a conceptual site model, mitigates risks where possible, and defines specific goals. The Draft Standard also describes requirements and guidance for a systematic process to develop a GWMP which, when implemented, will assess whether objectives are met.

The Draft Standard should assist facilities in ensuring their groundwater programs are developed in a defensible and consistent manner. Implementation of the GWPP and GWMP, as laid out in the Draft Standard, should serve to protect the groundwater resources and end-users from potential effects related to a specific facility.

## 9. References

[1] Canadian Nuclear Safety Commission, "Protection of groundwater at nuclear facilities in Canada, Discussion Paper DIS-12-01", Minister of Public Works and Government Services Canada, 17 pp., February 2012.

[2] CSA, "N288.6-12 - Environmental risk assessments at Class I nuclear facilities and uranium mines and mills", 142 pp., 2012.

[3] CSA, "N288.4-10 - Environmental monitoring programs at Class I nuclear facilities and uranium mines and mills", 132 pp., 2010.

[4] CSA, "N288.5-11 - Effluent monitoring programs at Class I nuclear facilities and uranium mines and mills", 128 pp., 2011.

[5] Electrical Power Research Institute, "Groundwater Protection Guidelines for Nuclear Power Plants", EPRI 1016099, 2008 January.

[6] US EPA (United States Environmental Protection Agency), "Guidance on systematic planning using the data quality objectives process (EPA QA/G-4)", Washington, DC, 121 pp., February 2006.