Engineers Canada paper on environmental engineering

Engineers Canada paper on environmental engineering - October 2019

Notice

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About this Engineers Canada paper
This national Engineers Canada paper was prepared by the Canadian Engineering Qualifications Board (CEQB) and provides guidance to regulators in consultation with them. Readers are encouraged to consult their regulators' related engineering acts, regulations, and bylaws in conjunction with this Engineers Canada paper.

About Engineers Canada
Engineers Canada is the national organization of the provincial and territorial associations that regulate the practice of engineering in Canada and license the country's 295,000 members of the engineering profession.

About the Canadian Engineering Qualifications Board
CEQB is a committee of the Engineers Canada Board and is a volunteer-based organization that provides national leadership and recommendations to regulators on the practice of engineering in Canada. CEQB develops guidelines and Engineers Canada papers for regulators and the public that enable the assessment of engineering qualifications, facilitate the mobility of engineers, and foster excellence in engineering practice and regulation.

About Equity, Diversity, and Inclusion
By its nature, engineering is a collaborative profession. Engineers collaborate with individuals from diverse backgrounds to fulfil their duties, tasks, and professional responsibilities. Although we collectively hold the responsibility of culture change, engineers are not expected to tackle these issues independently. Engineers can, and are encouraged to, seek out the expertise of Equity, Diversity, and Inclusion (EDI) professionals, as well as individuals who have expertise in culture change and justice.

Abstract

This Engineers Canada paper on environmental engineering provides information and guidance to provincial and territorial engineering regulators, as well as engineering practitioners, as to what constitutes the "practice of environmental engineering,". In consideration of the national definition of engineering, this position paper is intended to provide a tool for engineering regulators, particularly discipline and enforcement officials, that can help them better identify conduct that must be regulated and better identify where enforcement action needs to be taken.

The Engineers Canada paper describes the scope of environmental engineering practice and distinguishes between three categories of work, namely environmental engineering, work that can be performed by engineers and other persons, and work that is performed by non-engineers. The paper also sets out and discusses the constituent elements of the definition of environmental engineering, namely the application of engineering principles and the safeguarding of the environment

Finally, the paper provides examples, which are representative areas of practice in environmental engineering, in four appendices that respectively cover land, air, water, and waste. These examples of environmental engineering work do not constitute an exhaustive list of what exclusively constitutes engineering within specific fields. Expert advice should be sought on a case-by-case basis.

1.0 Introduction

Growing public attention on environmental and habitat preservation and new government environmental regulations are continually evolving the ways engineering projects are planned, implemented, monitored, and maintained. By designing and working on infrastructure and managing risks to ensure environmental protection and public safety, engineering licence holders play a crucial role in serving public interest. In fact, the *Public Guideline on the Code of Ethics* requires licence holders to “hold paramount the safety, health and welfare of the public and the protection of the environment and promote health and safety within the workplace”.[1]

This Engineers Canada paper is a position paper, and its purpose is to define and describe the “practice of environmental engineering”. The intended outcome is that regulators and practitioners have a document that helps them identify environmental engineering – which can only be performed by an engineering licence holder. On a related note, this paper can help identify when enforcement activities or reporting to engineering regulators should be undertaken to enforce against the misuse of the engineering title and the unlicensed practice of environmental engineering.

In Canada, the profession of engineering is self-regulated by engineering regulators (hereinafter referred to as “regulators”) pursuant to a statutory mandate set out in provincial and territorial engineering legislation. In fulfilling this mandate, regulators have an overarching duty to promote and protect the public interest in two ways:

» Regulating the practice of engineering[2] and governing engineering licence holders.

» Enforcing engineering legislation, including by acting against persons who are falsely presenting themselves as engineering licence holders, illegally using the restricted title of engineer, or engaging in the practice of engineering without a licence or proper supervision.

As discussed above, engineering licence holders possess a corresponding legal responsibility to protect public health and the environment through several means:

» The delivery of competent services, based on accepted standards of practice, knowledge, and skill.

» The delivery of professional and ethical services based on professional conduct regulations and codes of ethics.

» Accountability for the services provided.

» The delivery of a work product that is safe and can be relied upon.

In the context of environmental engineering, engineering licence holders and their work must also comply with international, federal, provincial/territorial, and municipal environmental regulations, as applicable. In some instances, work can be conducted by overlapping professions, as regulated by joint boards. However, per Engineers Canada’s White Paper on Qualified Persons, demand-side legislation must not permit persons other than engineering licence holders to perform or take responsibility for engineering work.[3]

This Engineers Canada paper also provides examples of the application of environmental engineering in four environmental practice areas. These are discussed in four separate and linked appendices to this document, as set out below:

» Appendix A - site assessment and site remediation.

» Appendix B - water management.

» Appendix C - air quality management.

» Appendix D - solid waste management.

These examples do not describe the entire scope and depth of environmental engineering, but rather provide an explanation as to how environmental engineering applies to these four different areas of practice. Expert advice should always be sought to provide guidance on a case-by-case basis, where required.

2.0 Scope of environmental engineering practice

Several organizations award “environmental professional” certifications to applicants who meet certain base-level requirements that the granting organization has established. The types of certifications are not profession-specific, but are rather awarded to persons from a wide array of educational and occupational backgrounds. Possession of an “environmental professional” certification does *not* authorize an individual to engage in the practice of environmental engineering. Although a regulated professional, such as an engineering licence holder, may possess this type of certification, it can also be possessed by an unregulated person. Regulators, in fulfilling their role to protect the public interest, must carefully monitor several issues:

» That organizations awarding “environmental professional” certifications do not falsely represent the possession of that certification as authorizing a person to engage in the practice of engineering.

» That non-engineers, including those who possess “environmental professional” certifications, are not unlawfully engaging in the practice of engineering.

» That demand-side legislation does not authorize non-engineers to perform environmental engineering.

Regulators must ensure that terminology used in “environmental professional” certifications does not include the words “engineer” or “engineering,” and that environmental engineering services are not being offered by unauthorized persons.

On the one hand, an engineering licence is authorized by statute and accountability of the practice is maintained through engineering regulators. On the other hand, professional certification is a statement of qualification that has little or no accountability to serve the public interest, is not authorized by statute, and is not governed by a regulatory body.

In this Engineers Canada paper, environmental work is divided into three categories:

- »Non-engineering work, which includes the range of natural sciences (biology, chemistry, toxicology, hydrology, geology, etc.), that strictly follows established procedures, or that involves the performance of construction or manual labour.
- »Work that is “shared”, in that it can be performed by both environmental engineers and other persons (depending on the legislation, regulations, joint boards, etc.) such as environmental auditors, lawyers, accountants, architects, or certified environmental practitioners. Where work is performed by persons who are not regulated professionals, professional responsibility cannot be assumed, required, or assured.
- »Work that can only be performed by an environmental engineer (i.e. an engineering licence holder), based on accepted standards of practice, knowledge, and skill.

Initially a subset of traditional engineering disciplines, environmental engineering is now widely recognized as a distinct engineering discipline[4] that focuses primarily on environmental and public health protection. In a constant state of evolution, engineering licence holders in this discipline develop solutions to address existing environmental issues and anticipate future ones, recognizing that current frameworks and approaches must be continuously evaluated and modified as necessary.

Environmental engineering deals with various issues including, but not limited to, the safeguarding, stewardship, and proper management of soil, air, and water systems; the provision of safe drinking water; the safeguarding, stewardship, and proper management of natural resources; wastewater treatment and water management; habitat protection, including flora and fauna; solid, liquid, and hazardous waste management; and assessment of risks to the environment (soil, air, and water), including climate risk and other environmental issues.

Given its interdisciplinary nature, environmental engineering draws upon other areas of engineering and the contributions of non-engineers working in the environmental sector, including environmental scientists and other environmental practitioners (i.e. biologists, hydrologists, microbiologists, limnologists, chemists, agronomists, etc.), and other professionals such as accountants, lawyers, architects, planners and sociologists that help define the wishes of the population.

Only persons licensed with an engineering regulator may take responsibility for environmental engineering, except in instances where certain types of work are regulated by other professional bodies as defined in demand-side legislation. Engineering regulators will not take enforcement against work performed by other professionals so long as their work falls under the jurisdiction of a self-regulated profession whose mandate is to protect the public.

Defining what constitutes environmental engineering provides the public with a clearer sense of its scope. It also conveys that only engineering licence holders can practise or take responsibility for engineering work.

3.0 Definition of environmental engineering

So as to promote a consistent application of provincial and territorial engineering legislation, the definition of the “practice of environmental engineering” is based on the definition of the “practice of engineering”, as set out in the *National Guideline on the Practice of Engineering in Canada*[5]

In this regard, the “practice of environmental engineering” is defined as:

“any act of planning, designing, composing, evaluating, advising, reporting, directing, or supervising, or managing any of the foregoing, that requires the application of engineering principles and concerns the safeguarding the environment and affected habitats“.[6]

The definition has three elements:

- »the existence of certain conceptual activities or combinations of them;
- »the application of engineering principles; and
- »safeguarding the environment[7] and affected habitats.

A particular work is not considered to be the practice of environmental engineering unless all three elements are present.

Each of these three elements will now be discussed.

3.1 Safeguarding of the environment needs to be construed broadly

The safeguarding of the environment is to be construed broadly to recognize that it must account for numerous factors:

- It includes environmental protection, mitigation, restoration, and improvement to protect the public and natural ecosystems, and meet engineering standards and regulatory requirements.
- It is not limited to addressing current environmental issues and includes anticipating future environmental issues over the life cycle of engineered work.
- It is accountable for impacts on habitats of people and wildlife, including impacts on property.
- It acknowledges that environmental issues are constantly evolving, both in nature and degree, as is our understanding and approach to these issues.
- It incorporates the concept of "sustainable development," which has been defined as "development that meets the social, economic and environmental needs of the present without compromising the ability of future generations to meet their needs."[8]
- It recognizes that engineers have a stewardship role in environmental matters that include mitigation and prevention methods for reducing environmental impacts and improving resilience to incidents and natural disasters that include extreme weather events and adapting to future climate changes.

3.2 Environmental engineering requires particular conceptual activities or combinations of them

Another element of the definition of environmental engineering is that the work in question must involve certain types of conceptual activities, namely planning, designing, composing, evaluating, assessing, interpreting, advising, reporting, directing, or supervising (or the managing of any such act), as opposed to supporting activities such as assisting, copying, following, using, etc. If particular work does not involve at least one of the conceptual activities referenced above, or a synonymous work, it does not constitute environmental engineering.

3.3 Environmental engineering requires the application of engineering principles

The final element of the above definition is that the work in question requires the application of engineering principles. In determining the existence of engineering principles, it is necessary to look at the *process* (i.e. how the engineered work was designed and implemented, or whether the processes continue to function properly) and to recognize that environmental engineering focuses on the design and implementation of solutions to environmental issues. In this regard, one or more of the following indicators suggest that the work involves the application of engineering principles:

The engineered work has a known purpose or scope, which is to address an environmental issue; and one or more of the following:

- The engineered work involves the development and application of designs and practices to address an environmental issue.
- The development of the engineered work involves the selection and use of proven defined processes, which must be based on the application of engineering principles (i.e. supported by engineering analysis and optimization of desired outcomes).
- The engineered work can involve innovation and the development and application of innovative technologies or methodologies.
- The development of the engineered work involves validation and verification of work at critical stages.
- Current and anticipated future environmental risks are assessed, analyzed, and managed throughout the development of the engineered work.
- The engineered work is developed to ensure reliability and repeatability.
- The development of the engineered work is interdisciplinary (i.e. it normally includes other disciplines of engineering and the natural sciences).

» The engineered work may relate to or interface with other environmental issues that require environmental engineering.

» The engineered work includes consideration of “Factors of Safety”.[9]

In considering whether engineering principles have been applied in respect of work, it is also instructive to assess the characteristics of the engineered work and its interactions with other, sometimes multiple, engineered works, which includes numerous examples:

» The uniqueness of the engineered work that can only be addressed by the application of the principles of engineering.

» The complexity of the engineered work that requires high-level conceptual activities in the engineering approach to address and resolve.

» The applicable demand-side legislation and regulation that requires engineers to review and approve the environmental compliance of the work or the engineered work (i.e. government, regulatory bodies, etc.).

4.0 Environmental engineers protect public interest

Through provincial and territorial legislation and the regulators’ codes of ethics, engineering licence holders are responsible for protecting the public interest. They are also accountable for only practising in their areas of competence and maintaining their knowledge, skills, and abilities throughout their careers. These requirements are what distinguish engineering licence holders from environmental practitioners, who might be either unregulated or only regulated through demand-side legislation.

5.0 Conclusion

The environmental field is broad, and it would be impossible to list all types of work that constitutes environmental engineering. The appendices to this paper provide representative examples of how environmental engineering applies in different specialized areas of environmental practice. The intention of this paper is to present a foundation for the scope and definition of environmental engineering, so that regulators can use this information to inform their enforcement practices. Moreover, the hope in providing this document is that individuals may draw on it to inform their practises and identify activities that require an engineering licence to perform.

Appendix A: environmental engineering in site assessment and remediation

This appendix provides a definition of site assessment, site remediation, and the practice of environmental engineering within this area. It also provides an overview of the role of the engineering licence holders in protecting the public interest, which is defined as to "hold paramount the safety, health and welfare of the public and the protection of the environment and promote health and safety within the workplace".[10]

A.1 Definition of Site Assessment

Site assessment can be defined as "A systematic due diligence process that includes studies, services and investigations to plan, manage and direct assessment, decommissioning and cleanup actions".[11]

A.2 Definition of Site Remediation

Site remediation can be defined as "The improvement of a contaminated site to prevent, minimize or mitigate damage to human health or the environment. Remediation involves the development and application of a planned approach that removes, destroys, contains or otherwise reduces the availability of contaminants to receptors of concern."[12]

A.3 Definition of Site Assessment and Remediation Work

Site assessment and site investigation(s) are pre-requisites to site remediation. These provide a sufficiently complete and essential description and characterization of local hydrogeologic and geologic conditions (provided by a geoscientist), and they clarify the type, distribution and level of contaminants (lateral and vertical delineation) to assist in planning and implementing site remediation. They include the determination of a site's physical conditions, where the nature, concentration, mobility, and spatial distribution of contaminants are evaluated for their effects on human health, the environment, and habitat.

Phase 1 Environmental Site Assessment (ESA) involves the historical review of a site's past use and identifies areas of environmental concern. Phase 2 ESA involves intrusive investigations that collect original samples of soil, groundwater, or building materials to determine the location and concentration of contaminants in the soil or water in, on, or under a site.

Site remediation work restores land use, addresses any public health and safety impacts, and protects the environment. It includes the completion and/or review of reports and plans that pertain to the planning, design, execution, and auditing of site remediation work that follows the completion of a site assessment. The work includes site assessment, handover, and assessment of site information, as well as the design and execution of the site remediation plan. This concludes with reporting and obtaining the approvals and sign-offs as required by regulation and the client.

Site remediation work requires complementary skills and knowledge that may be required for certain sites and/or stages in the remediation work. These include but are not restricted to project management; biological, toxicology, or chemical sampling and analysis; or completion of Phase 2 and 3 ESAs, as required by legislation (including sampling plan development, data analysis, and recommendations). It may also include consultation with an appropriate science or engineering expert such as an agronomist if soil is re-cultivated, a forestry engineer for reforestation or a fish farming expert if retransforming land into a pond.

Some types of work, such as certain tasks in Phase 1 ESAs, may be conducted by non-engineering professionals. Engineering licence holders and/or other professions may also be engaged in this work with some overlapping areas of practice.

A.4 Definition of Environmental Engineering in Site Assessment and Remediation

Phase 1 ESAs may be undertaken by environmental engineers or others. Site interpretation and characterization is an overlapping area of work between engineers and non-engineers. The planning, design, execution, and reporting of Phase 2 ESAs are the responsibility of environmental engineers, whose work is informed by certain tasks (such as sampling) performed by non-engineers.

Environmental engineering of systems for soil and groundwater remediation involves performing engineering work that includes the planning, designing, construction, supervision, and optimization of remediation systems. These systems consist of an appropriately designed assemblage of biological, chemical, and/or physical processes to degrade, extract, or treat contaminants. These contaminants are either removed from the site and treated off-site or degraded and treated on-site (i.e. in-situ). The systems are designed, constructed, and operated to meet regulatory criteria for discharge in sewers, designated landfills, surface water, or the atmosphere and must be safe for workers and the public. The safe design of excavation and ground work is also part of environmental engineering.

The engineering design process is multi-disciplinary, involving other professionals and disciplines at certain stages. Environmental engineers coordinate with other engineering disciplines such as civil, chemical, and mechanical engineering, as well as with geoscientists, chemists, and biologists, to develop preliminary design concepts and to support costing exercises that require the application of engineering principles. Design of site remedial systems involves the use of chemical, physical, and biological processes.

A.5 Role of Environmental Engineering Licence Holders in Regulations and Protection of Public Interest

The environmental engineer’s roles for receiving site assessment reports is to ensure that there is a sufficiently complete description of local hydrogeologic and geologic conditions and to clarify the type and distribution of contaminants (lateral and vertical delineation). The environmental engineer determines if the site assessment reports are adequate for designing and executing a suitable site remediation program to meet remediation targets. These targets are defined by regulations, by-laws, and standards that serve the public interest, as well as the needs of the client.

Site remediation is highly regulated through federal, territorial, provincial, and municipal legislation, regulation, policy, and guidelines. Permitting processes, approval requirements, and compliance issues vary depending on the site location and the remediation technology employed. Site remediation planning and execution address the environmental protection and restoration of a site to meet a regulation/standard through the development of technical solutions.

Environmental engineering licence holders provide their expertise and professional judgement to mitigate or prevent future adverse impacts, to address off-site issues associated with migration of contamination to neighboring properties, and to reduce human health and ecological risks to acceptable levels.

Environmental engineering remediation work balances engineering feasibility, financial viability, and stakeholder acceptance (public, regulators, and clients). Defining and justifying a site remediation program is the responsibility of an environmental engineering licence holder, as this requires the application of professional engineering judgment. Environmental engineering licence holders have a responsibility to inform site owners of the environmental and societal consequences. They also certify compliance with local by-laws and regulations, as well as provincial/territorial policies and procedures that govern this work.

Environmental engineering in site remediation includes the development of site-specific conceptual designs and remedial options based on the application of technologies and approaches to address each of the areas of environmental concern. Selecting remedial options includes the evaluation of how effective each option is at minimizing risk and evaluating other areas such as ease of implementation, stakeholder acceptance, and capital/operating and maintenance costs. Each factor ultimately contributes to the selection of the preferred remediation option. Site remediation preserves, restores, or improves a site for healthy and safe economic or societal use.

These outcomes require the application of engineering principles that safeguard the public interest. They also entail taking professional responsibility through approvals or sign-offs as required by demand-side legislation. At the same time, elements of site remediation work require the skills and knowledge of natural scientists, the professional services of other professions, and the work of non-engineering environmental practitioners who contribute to and collaborate with engineers to achieve the stated goals of the remediation process.

Appendix B: Environmental engineering in water management

This appendix provides a definition of water management within the context of environmental engineering and an overview of the roles of engineering licence holders in protecting the public interest, which is defined as to “hold paramount the safety, health and welfare of the public and the protection of the environment and promote health and safety within the workplace”.[13]

B.1 Definition of Water Management

Water management is concerned with the administration of water resources for residential, commercial, institutional, and industrial use, as well as in natural habitats, including water courses and water bodies. It is about appropriately balancing public demands with the needs of the environment.

B.2 Definition of Water Management Work

Water management work includes the assessment of water quality, quantity, and geographic distribution; preservation of source water supply (surface and groundwater); treatment of water for human consumption and industrial processes (including hydropower); treatment of wastewater (including grey water); the collection, conveyance and control of stormwater; and the protection, preservation, or enhancement of water in the environment.

Water management work includes the planning, design, construction, permitting, and operation of stormwater and drinking water systems, as well as wastewater collection, treatment, conveyance, control, and storage facilities. It involves assessing and reducing risks associated with high and low volume flows, as well as contamination that may affect public health, safety, and the environment. This work involves a combination of engineering work (i.e. installation of controls), awareness (i.e. public consultation, warnings, or restrictions), and administrative controls (i.e. inspections).

It includes the characterization of environmental water-source quality and quantity parameters, as well as factors that may affect those parameters; the determination of water demand or use requirements; and the design of engineered systems to sustainably alter or manage both water quality and quantity to bridge supply and demand.

Water management work is multi-disciplinary and requires various engineering disciplines and other professionals, including natural scientists, throughout the various stages of a project. It requires complementary skills and knowledge in assessing water resources and environmental factors affecting water quality, quantity, and availability; the qualitative and quantitative assessment of objectives to meet societal and environmental needs; and the design, construction, and operation of engineering works to treat, store, conserve, and manage water resources in a sustainable manner. A single practitioner would not have all the necessary skills to address all these imperatives, although the environmental engineer’s background may incorporate knowledge of ancillary engineering and science disciplines.

Problems are identified based on overall assessments of existing conditions and constraints, as they relate to standard engineering practice. Environmental engineers apply their knowledge and experience in the assessment of hydrology (i.e. watershed mapping supported by GIS), hydrogeology (in the case of groundwater), river hydraulics, fluid dynamics, contaminant transport, unit treatment processes, aquatic impacts, and regulatory interpretation. The environmental engineer leads or is part of a team that evaluates these factors and devises solutions based on the available information; on the application of knowledge regarding chemistry, biology, and physics; and on professional judgment.

Non-engineering work in this field includes, for example, land use planning, terrestrial and aquatic fauna and infauna impact assessment, and toxicology. Water quality sampling and testing of raw and treated water may be carried out as non-engineering work. However, where such activities are carried out for quantitative and qualitative characterization essential to engineering design, it is expected that the environmental engineer will have a wide breadth of knowledge of appropriate chemical, biological, and statistical analyses to be able to interpret the monitoring and assessment data. This is for determining appropriate engineering systems to sustainably manage water systems. Assessment of actual or anticipated impacts on aquatic life and habitats, as well as archaeological investigation, are typically performed by other specialists.

B.3 Definition of Environmental Engineering in Water Management

Environmental engineering in water management involves the development and application of designs and practices to address an environmental issue related to protection, restoration, or enhancement of water in urban, rural, and natural settings. It includes validation and verification of work at critical stages, including approvals, ‘sign-offs,’ and environmental compliance.

In urban and rural environments, environmental engineering includes forensic flood investigations, flood risk assessment, low flow management to support fisheries assets, infrastructure capacity assessment, engineering (wet weather) asset management, hydrologic and hydraulic analysis and modelling, the development of conceptual engineering solutions, the planning and designing of mitigation solutions (including for flooding), the management of engineering projects, and the supervision of engineering work.

Environmental engineering work is focused on preserving and restoring water quality in the environment for human use and support of natural habitat that includes flora, fauna and wetlands. This work includes the design, operation, and maintenance of assets that divert, treat, store and manage water resources and the collection, treatment and environmental release of water following use into the environment; the treatment and the delivery of potable water to the public; and wastewater collection, conveyance, and treatment prior to discharge into the natural environment. This includes engineering of systems required to treat and deliver water for human consumption, health services, and/or industrial processes in compliance with codes and standards, government policies and procedures, and other regulatory instruments.

Environmental engineering principles in water management apply in several ways:

» They support the protection and conservation of source water.

» They assess the capacity of natural water systems to provide water supply for human consumption and natural habitats including flora, fauna, and wetlands.

» They are relied upon in the upgrading of existing water and wastewater treatment works.

» They are important in the design, construction, and operation of new collection, conveyance, and treatment works.

» They inform the rationale and methods for ongoing review and updating of the regulatory regimes that govern work in this area.

Environmental engineering involves design of new works or practices, or the upgrading/rehabilitation of existing works to protect, restore, or enhance assets to manage risk to public health and safety and mitigate environmental impact. Environmental engineering may also involve selection of improvements in treatment processes or the implementation of new, improved, or additional technologies with the purpose of meeting new regulations, improving cost effectiveness, or improving system efficiency.

Examples include treatment plant commissioning and troubleshooting, design and modelling of stormwater systems including low-impact design, modelling of water distribution systems, and

management of process water in oil and gas industries.

Environmental engineering knowledge and principles are applied to a wide variety of interdisciplinary water and wastewater management projects, programs, and systems:

» environmental assessments and monitoring programs

» environmental and health risk assessments

» impact assessments and modelling within marine and freshwater environments

» quality management systems

» the analysis of physical, chemical, biological, and toxicological data

» quality assurance/quality control

» reporting and other administrative controls

The application of environmental engineering principles includes the interpretation and application of multi-disciplinary environmental data (biological, chemical, physical, and toxicological) to guide design and/or operational recommendations and decisions. Engineering principles are also foundational in assuring compliance with federal and provincial environmental legislation and regulations; environmental quality objectives; codes of practice; and standard engineering (and related) guidelines and best practices.

Understanding the impacts of wastewater system operations on living systems and habitats requires the application of engineering and scientific principles (including physics, chemistry, and biology), as well as a solid understanding of regulatory requirements. Relevant engineering principles relate to hydrodynamics and hydrogeology, amongst others, and inform design of wastewater collection, conveyance, and treatment systems; unit processes; and contaminant transport. This holistic understanding informs development of programs to monitor performance of the wastewater system with respect to impacts on human health and the environment, as well as with respect to regulatory compliance.

Assessing the social impact of water management services is a practice shared with other professionals, such as sociologists and urban planners. Non-engineering work includes using research, data collection, surveys, and other means to obtain answers to questions posed by the environmental engineer. Non-engineering professionals may also analyze financial consequences or societal impacts so that the needs and requirements of the public are better understood. The environmental engineer interprets the findings through economic and life-cycle assessment and adds this perspective as necessary to the planning, design, and operation of water-related engineered works.

Other examples of non-engineering work which may be performed include consultation and public engagement, contract management and procurement, proposal preparation, equipment set-up and calibration, field data collection, data processing, and modelling (including hydraulic and/or water balance calculations). The subsequent environmental engineering work considers the needs and requirements of the public and the environment by protecting and preserving property and the environment from loss or damage through precautionary measures, protective stipulation (i.e. through regulatory compliance or contract), procedures, or engineered solutions that account for the societal impacts as defined by other professionals.

Environmental engineering licence holders coordinate with other engineering disciplines such as civil, structural, geotechnical, chemical, and mechanical engineering; they often have academic training, awareness, and/or experience in these or other disciplines. Environmental engineering licence holders also work with geoscientists and natural scientists to conduct environmental assessments, including assessment of impacts related to water extraction or discharge to the environment.

Environmental engineering licence holders design new water and wastewater treatment systems to standards and guidelines that consider and prioritize functionality, operability, safety of the operator and the public, and compliance with codes and regulations. For example, for safety purposes, a new sewage pump station would be expected to require services by other engineering disciplines, including but not limited to geotechnical assessment of foundation subgrade soil, structural design and code review, hydraulic assessment, and HVAC and electrical assessment. The environmental engineer is often the coordinator of these services, which may fall outside of the environmental engineer’s field of competency but are necessary to assure a properly designed facility, the operation of which can comply with governing environmental regulations over its design life.

Engineered systems that include stormwater management or water control structures such as dams, sluice gates, channels, and other means of open channel water conveyance are normally considered to be within the domain of civil engineering in the field of water resources. The delivery of large quantities of potable water for human use and consumption is a practice shared with civil engineering and is not exclusive to environmental engineering.

B.4 Role of Environmental Engineering Licence Holders in Regulations and Protection of Public Interest

The engineering assessment, planning, and designing of water and wastewater servicing infrastructure is needed to support population growth as well as commercial and industrial development that contributes to economic growth and quality of life.

Water supply is directly related to public health. Proper disinfection of water in water treatment plants and safe delivery of drinking water in both quality and quantity is vital to human health and safety. Protecting water at the source is the first step to ensure that a sustainable supply of clean drinking water is available. Establishing average and peak flows and design the reserves is necessary to mitigate drinking water demand peaks. Professional judgment is required in prioritizing water resources in that needs must be aligned with quality e.g. high quality water is used for drinking water, and low quality water for park irrigation.

Water quality and wastewater effluent are regulated through federal, territorial, provincial, and municipal government legislation, regulations, policies, codes, standards, and guidelines, each of which apply within the jurisdiction in which the water is located, extracted, or discharged. Environmental engineers are responsible for fulfilling permitting processes and seeking approval for engineering works that collect, convey, and treat water, as well as for overseeing operational compliance issues that vary depending on the site location and the treatment technology being employed. The scope of environmental engineering includes evaluating the effectiveness of treatment options at the design stage, as well as evaluating and selecting new or additional treatment alternatives to meet new, and often stricter, regulations that arise after a water treatment plant is in operation.

Like other engineering works, the design of water and wastewater treatment infrastructure and processes includes consideration of “Factors of Safety” to address risk, protect human health, and minimize environmental and habitat impact. An environmental engineer specializing in this field may work with a team of professionals, including sociologists, to determine the societal level of risk acceptance when making recommendations to permitting authorities/government regarding the minimum required Factors of Safety.

The application of professional judgment is an integral part of design of engineering works for water and wastewater treatment. This judgment applies to ensuring regulatory compliance, reporting, required documentation, permitting, and registration. Taking responsibility for these actions through review, approval, and ‘sign-off’ of documents, as required by governments, is a key element of environmental engineering in this field.

The appropriate planning and design of new and upgraded water collection, conveyance, storage, and treatment systems are paramount to the protection of public health and safety. Society relies on environmental engineering licence holders to employ their knowledge, experience, and ethics to design safe, reliable, and fiscally responsible treatment systems that comply with regulatory requirements, including the implementation of appropriate Factors of Safety. The environmental engineering licence holder serves the public interest by taking professional responsibility through approvals and ‘sign-offs’, such as Assurance Statements, which verify that all regulatory requirements are fulfilled. They assure that the systems when constructed, operated, and maintained as designed will be safe and will not negatively impact public health or the environment.

Codes and standards for water management serve the public interest. Environmental engineers read, interpret, and consider codes, standards, and best practices in their practice. They contribute their knowledge and experience towards the creation and updating of codes, standards, and best practices, but this work is not exclusive to them, as other professionals are involved.

Appendix C: Environmental engineering in air quality management

This appendix provides a definition of air quality management and environmental engineering within this area. It also provides an overview on the role of the engineering licence holders in protecting the public interest, which is defined as to “hold paramount the safety, health and welfare of the public and the protection of the environment and promote health and safety within the workplace”[14].

C.1 Definition of Air Quality Management

Air quality management protects human health and the environment from the impacts and harmful effects of all forms of air pollution (i.e. criteria air contaminants, air toxins, smog, acid rain and the greenhouse effect). It also includes work managing greenhouse gas (GHG) emissions with the goal of reducing the emission of those pollutants that contribute to our changing climate. The goals of air quality management are to maintain good air quality where it exists, to improve areas with air quality problems, and to ensure that air emissions do not negatively impact natural and built habitats.

Outdoor noise, which travels through an air pathway, is also a key environmental concern. While not typically considered to be an air pollutant, outdoor noise and vibration have been included in this discussion.

C.2 Definition of Air Quality Management Work

The scope of air quality management work focuses on outdoor air quality, which entails emissions control and contaminant removal. Priorities are to reduce emissions through the proper design, operation, and maintenance of manufacturing and combustion processes, product formulations, and material handling/transportation initiatives (i.e. advanced transportation technologies, proper vehicle maintenance, specific initiatives targeting in-use diesel vehicles and engines, and the “greening” of fleets). Emissions from vehicle exhausts, such as nitrogen oxides, particulate matter, sulphur dioxide, volatile organic compounds, and organic acids are some of the key areas of focus for transportation systems.

Managing outdoor air quality includes pollution from “stationary” and “mobile” sources. A “stationary source” means a fixed emitter of air pollutants, such as fossil fuel-fired electrical power plants, petroleum refineries, and other industrial sources. Generally, it is any source of an air pollutant except those emissions resulting directly from an internal combustion engine for transportation purposes or from a non-road engine or vehicle. “Mobile sources” are primarily from the transportation sector and include all forms of moving vehicles that generate gases sounds or vibrations considered to be air pollutants (i.e. automobiles, trucks, ships, trains, aircraft, etc.).

Air quality management also extends to address broader ecological problems, such as smog, acid rain, ozone layer depletion, and climate change. Efforts include identifying and categorizing air pollutant emissions, meeting acceptable emission levels or ambient air quality criteria, and specifying, designing, or implementing appropriate mitigation technologies. The evolving nature of government regulations for air quality and emissions requires planning and adhering to comprehensive monitoring, testing, emissions control, record keeping, and reporting requirements.

The issuance of environmental permits by federal, provincial, territorial, and/or municipal governments can involve emission and noise estimation, best available control technology evaluations, stack design reviews, and air dispersion modelling. The engineering principles of mathematics, chemistry, and physics are used to define and minimize potential impacts on air quality, human health, and the environment. The review of an application for an environmental permit first involves a review of the technical completeness of the application, which requires researching the industrial process in question to assess whether all the emission sources and all possible air contaminants have been included. The technical evaluation of the application includes an evaluation of the emission estimates, a review of the air dispersion modelling results to assess the potential impacts of the emissions, and the synthesis of all this information to provide recommendations for conditions to include in the environmental permit.

Municipalities and land-use planning authorities also typically require an assessment of the environmental noise and vibration impact from both stationary and transportation sources. Stationary sources for outdoor noise include HVAC and other ventilation/stack systems. Further, municipal noise by-laws often require interpretation by an environmental engineer to determine compliance.

Air emission estimation makes use of the principles of mass balance, stoichiometry, as well as measured emission factors and activity levels, which are shared competencies with environmental science. Mathematics, chemistry, meteorology, and physics are used to calculate the concentration of airborne contaminants over a specified period through air-dispersion modelling or noise propagation estimations.

Understanding and documenting atmospheric processes for air quality management involves working with meteorologists and atmospheric scientists. Once these processes are understood, environmental engineering determines solutions to reduce pollutants and improve air quality based on the scientific understanding. The measurement and documenting of the improvements again fall into the purview of the atmospheric scientist and meteorologist.

Work is shared with other professions such as accountants and environmental lawyers in GHG emissions measurement and reporting. Environmental engineers verify the GHG emission monitoring or estimation methodology, while accountants validate that the proper reporting procedures for estimating GHG emissions were followed. In such cases of shared practice, joint practice boards between professions have been established in some jurisdictions. Another example of shared practice is the protection of a facility's economic interests by assisting the facility (i.e. an industrial manufacturing facility) owner to gain its environmental permit. This could also entail protecting the company against claims of negligence by conducting due diligence studies of their air quality impacts. This practice area would be shared with accountants and lawyers.

One outcome of the permitting process can be the need to design appropriate emission mitigation measures and monitoring programs for soil, air, noise, vibration and odour in accordance with provincial, territorial, and/or local regulations. Air quality work performed by non-engineers such as technicians includes the field work for air quality measurements, including installing, operating, and maintaining monitoring equipment, as well as laboratory analysis of samples and data entry. Environmental engineers or scientists can undertake the analysis and reporting of monitoring results, report writing, and correspondence with clients and contractors. Engineering-related work performed by EITs or other professionals but under the supervision of an engineering licence holder may be considered within this category. It does not include an assessment of the impacts of air quality on human health or the environment, which is the purview of toxicologists, epidemiologists, or ecological-impact experts.

C.3 Environmental Engineering in Air Quality Management Work

Air quality assessment involves the identification and assessment of air contaminant emissions, appropriate modelling of the airborne dispersion of those contaminants, and the quantification of the resultant impacts of those emissions on air quality. Measurement of air quality can also be used to assess the impacts. Air quality management is the practise of environmental engineering because it involves the application of engineering principles (the application of the principles of mathematics, chemistry, physics, or any related applied subject to the practice area) in the environmental assessment of air quality impacts. These assessments are required to protect the public interest.

Environmental engineering for stationary sources of air pollution encompasses monitoring, compiling of emission inventories, and assessing and reporting on air quality for existing industrial, commercial, civil infrastructure-related, or institutional engineered works to assess and assure regulatory compliance. It also includes designing and implementing engineered solutions that may include adopting new technologies and processes, as well as changes in operation and maintenance, to reduce emissions to meet regulatory requirements. For mobile sources, measuring and assessing the range and level of air pollutants emitted from all forms of transportation is within the scope of environmental engineering.

Similarly, environmental engineering contributes to the design and construction of new engineered stationary works that will release pollutants into the atmosphere. Additional work includes the preparation and review of designs, which may be shared with other engineering disciplines, and submission of the environmental assessment documentation needed to secure the required environmental permits pertaining to air quality that enable construction and operation.

Environmental engineering extends to reviewing environmental assessments for proposed industrial, institutional, and municipal projects, and to making recommendations for meeting air quality criteria. These reviews can include assessing the condition and efficiency of air pollution control equipment, evaluating source and ambient air-monitoring test results, and preparing engineering reports, including recommendations for changes to the project. The latter may include air pollution control equipment requirements, as well as abatement strategies.

Environmental engineers specializing in air quality often work closely with civil, mechanical, and chemical engineers in the design of engineered works. For example, stack heights for an industrial facility are established as a compromise between pollutant dispersion potential and pollutant control needs, as required to meet air quality requirements. These may include meeting external noise and vibration restrictions. Mechanical engineers are regularly consulted on silencer design for HVAC equipment or stacks, as well as for pressure drop constraints in ventilation systems and fan sizing. Chemical engineers are involved because of their understanding of the industrial processes at a facility and their knowledge of air pollutants that are released from these processes.

C.4 Role of Environmental Engineering License Holders in Regulations and Protection of Public Interest

Legislation relating to air quality governs the emission of pollutants into the atmosphere and encompasses all forms of regulatory instruments (i.e. codes, standards, regulations, and other mechanisms). Air quality laws are designed specifically to protect human health and/or the ecosystem by limiting or eliminating airborne pollutants.

Federally, the Canadian Ambient Air Quality Standards (CAAQS) are standards issued by the Canada Council of Ministers of Environment (CCME) and are a driver for air quality management activities across Canada.[15] The previous National Ambient Air Quality Objectives were voluntary. The CAAQS are not—all jurisdictions are responsible for meeting these standards and reporting on their progress if they are not in compliance.

Maximum allowable levels of air contaminants in the environment are also governed by provincial or territorial legislation. In addition, many jurisdictions, including the federal government, have set sector-based technology requirements that govern the release of air contaminants. Knowledge of the applicable laws and regulations is an essential element of air quality management.

Environmental engineers ensure the health of the public and the natural environment through air pollution control design and evaluation of the efficacy of these designs. Whether caused by the transformation, conversion, or combination with other air pollutants, the effects of ambient air pollutants on human health and the environment include, but are not limited to, effects on soils, water, crops, vegetation, manmade materials, animals, wildlife, weather, visibility, climate, property, and transportation, as well as effects on economic values and on personal comfort and well-being.[16]This describes the breadth of public welfare considered in the practice of environmental engineering.

The range of outdoor air pollutants to be managed is very broad. According to the Government of Canada, "air pollutant" is grouped into four general categories: criteria air contaminants (i.e. sulphur dioxide, nitrogen oxides), persistent organic pollutants, heavy metals, and toxic pollutants.[17] These are normally regulated at the provincial/territorial level. Radioactive material is regulated at the federal level only.

While the main driver for air quality management is to protect human health from degraded air quality, poor air quality (i.e. acid rain, smog) also affects vegetation, wildlife, and structures. It can also result in visibility impairment, which has been directly linked to a negative economic impact on tourism. When applying for and issuing environmental permits, a balance must be struck between the economic benefits realized from businesses that release air contaminants (i.e. jobs, products such as fuel for vehicles and homes, and cement for building housing) and maintaining good air quality by meeting ambient air quality criteria included in guidelines, standards, objectives, and so forth.

Appendix D: Environmental engineering in municipal solid waste management

This appendix provides an example of environmental engineering for solid waste management in the municipal context. It also provides an overview on the role of the engineering licence holders in protecting the public interest, which is defined as to "hold paramount the safety, health and welfare of the public and the protection of the environment and promote health and safety within the workplace".[18]

D.1 Definition of Municipal Solid Waste Management

Municipal solid waste management refers to all types of waste from creation to final disposal. In the municipal context, solid waste typically originates from the residential, commercial, and institutional sectors, and includes waste from construction/demolition activities. This includes household hazardous wastes that are usually managed by municipalities. It also includes biosolids and sludge that are produced from wastewater treatment facilities managed by, and subject to further processing by, municipalities.

Other specialized medical, biohazard, agricultural, and radioactive waste streams, and high-volume waste streams from industries, are beyond the scope of this example. The associated environmental engineering considerations are likewise not discussed.

D.2 Definition of Municipal Solid Waste Management Work

Municipal solid waste management work includes collection, transport, storage, processing, treatment, and disposal of solid waste, together with policy development, regulation, monitoring, and reporting. Practices include prevention and reduction, diversion, recovery, and disposal. It includes the treatment, recycling, storage, disposal, or destruction of solid waste, or the recovery of reusable resources, including energy potential, from solid waste, according to the following hierarchy: waste prevention, preparation for re-use, recycling/composting, other forms of recovery and disposal. It encompasses compliance with the legal and regulatory frameworks that govern the various types of solid waste and their sources. The work includes monitoring and reporting for regulatory purposes.

The primary goal of municipal solid waste reduction is to address both current and future environmental issues associated with the materials produced by the constituency served by the municipality. By reducing the amount of materials generated, the extent of air, water, and land impacted by their production is diminished. In the case of recycling, by using existing materials rather than raw materials, environmental impacts caused by primary resource extraction are reduced. The persistence of specific materials in the environment, such as plastic and microplastics from municipal use, negatively impacts land and oceans and reduction is urgently needed to reduce further impacts. In landfills, the persistence of waste materials increases the risks of leachate migration into ground or surface water sources. For items like food waste, the greenhouse gas emissions produced from decomposition in landfills contribute to climate change. Their environmental impact can be minimized by reducing or recycling plastics, textiles, single-use items, construction and demolition waste, and various other material types.

All municipal solid waste management work must address the requirements of provincial/territorial laws and local municipal regulations. Solid waste standards and practices for all types of wastes are defined in provincial/territorial legislation, which authorize the release or disposal of solid waste into the environment subject to requirements for its protection. Municipalities form their own bylaws and policies surrounding solid waste management by enacting bylaws pertaining to waste disposal, by passing regulations through local health boards (particularly regarding hazardous waste), and by developing zoning bylaws for the siting of waste disposal and handling facilities.[19]

Municipal solid waste management work includes siting, planning and construction, as well as the operation of facilities for the treatment, recycling, storage, disposal, and destruction of various types of recyclable materials or wastes. Within these facilities, machinery, equipment and operating procedures are required for receiving, sorting, and reducing the solid wastes. The siting, planning, construction, and operation of landfills is a widely used method for local waste disposal. In both instances the construction of new facilities and landfills requires extensive site investigation and characterization, as well as public support secured through consultation.

Municipal solid waste management work includes the collection and transportation of wastes from various sources. Water and wastewater treatment plants require a biosolid and sludge waste disposal system, which includes transport and disposal of these wastes in another location, normally a landfill.

Municipal solid waste management includes auditing waste facilities, policies, processes, and procedures, as required by regulatory authorities. It also includes the preparation, review, and approval of supporting documentation. Measuring and the collection of data to support and inform audits and support reporting requirements are essential elements of proper management. It includes the work involved to secure and maintain the appropriate permits to construct and operate municipal solid waste management facilities. This entails securing permits for repairing, altering, removing, improving, or adding to the engineered work and the construction of new works according to permit plans and specifications.

Municipal solid waste management in general is interdisciplinary, and civil, mechanical, and chemical engineers are also involved in various aspects when looking at solid waste infrastructure or processes such as composting.

Education of the public served by the municipality is a key component of municipal solid waste management. Public consultation during the feasibility, design, and operation phases for solid waste management facilities, disclosed in an open and transparent manner and with technically correct proposals and solutions to social and environmental issues, supports public welfare.

D.3 Definition of Environmental Engineering in Municipal Solid Waste Management Work

Municipal solid waste management originated due to the need to prevent diseases caused by improper management of waste and the vectors that are attracted to it. In that regard, it is a combination of solutions through environmental engineering planning, design, and implementation that reduces the risk of disease exposure and protection of public health.

The siting of municipal waste management plants and landfills requires extensive site investigation and characterization to establish the feasibility of the location from the perspective of economic, social, and environmental impacts. The planning, design, and execution of these studies fall within environmental engineering, in that they require the application of mathematics, biology, chemistry, and physics principles, and in some cases engineering models. These principles and/or models are used to select appropriate methods, technologies, and analyses, which help assure the public that the location meets their health and safety needs. Reporting to the public and to regulatory authorities keeps them informed while ensuring compliance with regulatory requirements.

The selection and installation of machinery, technologies, and equipment within facilities designed to receive, process, separate, and treat incoming waste for reuse, recycling, and disposal requires careful consideration of regulatory requirements as well as cost effectiveness and operational safety. The operation and maintenance of the equipment is performed by non-engineers, such as operators, technicians, and technologists, but are under the supervision of an engineer (who may or may not be an environmental engineer). However, the monitoring and performance of the equipment and its overall operation to meet regulatory requirements is environmental engineering. This includes measuring and reporting on impacts of the facility and its operation, regarding the local environment. Through approvals and signing documents, monitoring and reporting compliance with the requirements of the facility or landfill operating permit constitutes the taking of professional responsibility.

Environmental engineering includes designing and managing programs and studies to evaluate effectiveness of current facilities, analyzing and reporting municipal solid waste data for various requests, and reviewing and providing engineering input to applicable regulations that impact waste diversion and material management in a municipality. The development and application of designs and practices, such as applying conceptual designs for new solid waste management facilities and developing regional best practices of composting, are used to address waste issues. Validation and verification of work at critical stages is used throughout consulting projects, whether for feasibility studies for facilities, studies to evaluate effectiveness of existing facilities, or the development of a municipal disaster debris management plan.

Factors of Safety are involved when developing models of solid waste and when making assumptions to account for unknowns such as solid waste from outside the jurisdiction of the municipality. These are also involved when providing reasonable estimates of diversion rate or waste flows, which allow the system to accommodate higher than anticipated levels. Examples of environmental engineering in technical work include developing scope; supervising and analyzing/interpreting results of waste composition studies; creating, revising, and running a model for solid waste flows and projecting these for future infrastructure scenarios; energy recovery from solid waste; evaluating GHG emissions from solid waste for various scenarios; and recommending composting best practices.

Environmental and climate risks are evaluated when assessing GHG emissions from solid waste, when analyzing the current and future solid waste stream that will have to be managed, and when looking at future waste disposal scenarios.

In designing, planning, and managing construction and demolition projects, risks are also considered to prevent substances from causing damage to persons, animals, or plants, and/or from polluting air, water, or land.

Other environmental issues, most notably air quality, GHG emissions, and leachate, are factored in throughout municipal solid waste projects. Environmental engineering leads in developing scope, in supervising and reviewing feasibility studies for municipal solid waste management facilities, and in the resulting capital and/or operations/maintenance projects. Other engineering disciplines, including chemical, civil, mechanical, and electrical will contribute to the design, construction, and operation to varying degrees depending on the type of facility and its function.

Programmatic elements within environmental engineering include program development for safe disposal of household hazardous waste from the residential/commercial/institutional sectors; safety planning and implementation; and emergency response planning, design, and execution, as well as regulatory filings. Although the task of providing information is not necessarily engineering, an environmental engineer is often responsible for ensuring that the correct information is available to members of the public to safely use transfer stations, recycling depots, landfills, and other solid waste management facilities that are open for public use. This is an area of shared practice, where an environmental engineer prepares the correct technical information and then communicates it to decision-makers and the public via other professionals or officials who are not necessarily engineers.

Non-engineering work within municipal solid waste management includes several types of work:

- the operation and maintenance functions for facilities, plants, and landfills
- financial and human resource administration
- the transport of hazardous, biomedical, or other specified classes of waste (often these people are licenced separately)
- field measurements
- collecting data from municipalities and private facilities to feed into the municipal solid waste model
- presenting solid waste information to various municipal government committees
- researching emerging solid waste programs and policies in other jurisdictions
- researching environmental impacts and management methods for specific materials

D.4 Role of Environmental Engineering Licence Holders in Regulations and Protection of Public Interest

Proper municipal solid waste management is an essential part of public health and the protection of the environment for the constituency served by the municipality. Like other areas of environmental engineering, municipal solid waste management is highly regulated with respect to the location, design, operation, and management of facilities, plants, and landfills. Provincial codes and standards and local municipal by-laws define performance requirements, in keeping with regulatory requirements.

Environmental engineering licence holders must provide evidence-based advice to policy makers to enable the public to follow best practices in municipal solid waste management that are consistent with the goals of environmental protection and sustainability. These goals are achieved through the design of facilities, programs, and schedules to minimize risks and maximize compliance with policies, regulations, and governing legislation.

This extends to specific items in the waste stream, such as gypsum and other materials shown to contain asbestos, which require the application of specialized handling techniques and processes to assure proper management and compliance with health and safety regulatory codes. These techniques are required to avoid occupational disease among workers and to protect the health of the public.

An essential component of environmental engineering for solid waste management is designing, implementing, and overseeing safe work procedures. Doing so allows workers to avoid exposure to potentially risky activities and substances that are present in solid waste management facilities, plants, and landfills. If this is not completely possible, then a combination of active and passive safety measures to mitigate or reduce risks to a tolerable level becomes the risk management alternative.

In all solid waste management facility planning, designing, and operation, the impact on surrounding natural habitats and water bodies must be duly considered and accounted for to eliminate negative impacts or reduce to a level of tolerable risk. The environmental engineer is qualified to assess, make, and communicate appropriate recommendations.

In summary, environmental engineering in municipal solid waste management deals with the planning, construction, operation, and management of facilities, plants, and landfills that divert or dispose of solid waste. These engineered works must comply with local and provincial laws and regulations to secure and sustain operating permits. Environmental engineering works with other disciplines of engineering, notably civil geotechnical and chemical engineers, to manage certain elements of these facilities. Coordination with scientists for studies, monitoring, and reporting are common practices. Non-engineering work is related to the physical and administrative elements of facility operations, maintenance, and administration, in addition to site monitoring, measurement, and reporting.

Appendix E: Codes and standards relevant to environmental engineering

(Last updated as of July 2019)

Please note that the items in the list below are only meant examples of applicable codes and standards and the list is not exhaustive. Individuals are encouraged to seek additional information, within their own jurisdictions and specific areas of work.

SITE ASSESSMENT AND REMEDIATION

ISO

ISO/IEC 17025:2005 – General requirements for the competence of testing and calibration laboratories

CSA

Z768-01 (R2016) – Phase I Environmental Site Assessment

Z769-00 (R2018) – Phase II Environmental Site Assessment

Other

ASTM E1465-08a – Standard Practice for Radon Control Options for the Design and Construction of New Low-Rise Residential Buildings

ASTM E2121-03 – Standard Practice for Installing Radon Mitigation Systems in Existing Low-Rise Residential Buildings

EPA/625/R-92/016 – 1994 Radon Prevention in the Design and Construction of Schools and Other Large Buildings, Provincial Building Codes

Standards and Guidelines proposed under the Federal Contaminated Site Action Program (FCSAP) and by the Canadian Council of Ministers of the Environment (CCME)

Federal Decision-Making Framework (FDMF) 10 Step Process and related Guidance Documents

various ASTM standards for material specifications

Preferred Operating Practices (a combination of industry standards and proprietary practices)

CCME guidance manuals Environmental Site Characterization (Phase II and III ESAs) and Risk Management

WATER MANAGEMENT

ISO

ISO 20419:2018 – Treated wastewater reuse for irrigation -- Guidelines for the adaptation of irrigation systems and practices to treated wastewater

ISO 16075-1:2015 – Guidelines for treated wastewater use for irrigation projects -- Part 1: The basis of a reuse project for irrigation

ISO 16075-2:2015 – Guidelines for treated wastewater use for irrigation projects -- Part 2: Development of the project

ISO 16075-3:2015 – Guidelines for treated wastewater use for irrigation projects -- Part 3: Components of a reuse project for irrigation

ISO 16075-4:2016 – Guidelines for treated wastewater use for irrigation projects -- Part 4: Monitoring

ISO 24521:2016 – Activities relating to drinking water and wastewater services -- Guidelines for the management of basic on-site domestic wastewater

ISO 21630:2007 – Pumps -- Testing -- Submersible mixers for wastewater and similar applications

ISO 24512:2007 – Activities relating to drinking water and wastewater services -- Guidelines for the management of drinking water utilities and for the assessment of drinking water services

ISO 24523:2017 – Service activities relating to drinking water supply systems and wastewater systems -- Guidelines for benchmarking of water utilities

ISO 14000 Series – Environmental Management

ISO 14001:2015 – Environmental Management Systems – Requirements with guidance for use

ISO 14004:2016 – Environmental management systems - General guidelines on implementation

ISO 14005:2010 – Environmental management systems - Guidelines for the phased implementation of an environmental management system, including the use of environmental performance evaluation

ISO 14006:2011 – Environmental management systems - Guidelines for incorporating ecodesign

ISO ICS 13 – Environmental Health and Safety

01 - Generalities. Terminology. Standardization. Documentation

ISO ICS 13.030.20 – Liquid wastes. Sludge

ISO ICS 13.060 – Water quality (Including toxicity, biodegradability, protection against pollution, related installations and equipment)

13.060.01 – Water quality in general

13.060.20 – Drinking water

13.060.25 – Water for industrial use

ISO 5667-7:2015 – Water quality -- Sampling -- Part 7: Guidance on sampling of water and steam in boiler plants

13.060.30 – Sewage water

ISO TC 282 – Water Reuse, developing standards for wastewater reclamation and reuse – currently including the following sub-committees (SC):

SC 1 – Treated wastewater reuse for Irrigation

SC 2 – Water reuse in urban areas

SC 3 – Risk and performance evaluation of water reuse systems

SC 4 – Industrial reuse

ISO 5667-10:1992 – Water quality -- Sampling -- Part 10: Guidance on sampling of waste waters

ISO 11296-1:2018 – Plastics piping systems for renovation of underground non-pressure drainage and sewerage networks

ISO 11298-1:2018 – Plastics piping systems for renovation of underground water supply networks

ISO/IEC 17025 – General requirements for the competence of testing and calibration laboratories

ISO 14001:2015 – Asset Management

CSA

CAN/CSA-B66-00 – Prefabricated Septic Tanks and Sewage Holding Tanks

CAN/BNQ-3680-600 – Onsite Residential Wastewater Treatment Technologies

CAN/CSA-B128.1-06/B128.2-06 (R16) – Design and Installation of Non-Potable Water Systems/Maintenance and Field Testing of Non-Potable Water Systems

CSA B805-18/ICC 805-2018 – Rainwater harvesting systems

CSA S900.1:18 – Climate change adaptation for wastewater treatment plants

CAN/CSA-S503-15 – Community drainage system planning, design, and maintenance in northern communities

CSA C22.2 NO 157.92-CAN/CSA - General requirements - Canadian electrical code, part II

Other

NSF/ANSI 40 – Residential Onsite Systems

NSF/ANSI 245 – Nitrogen Reduction

B128.3-12 – Performance of non-potable water reuse systems

NSF/ANSI 350 and 351-1 – Onsite Water Reuse

CAN/BNQ 0413-400 (2002) – Organic Soil Conditioners - Granulated Municipal Biosolids

NSF/ANSI Standard 60 – Drinking Water Treatment Chemicals – Health Effects

NSF/ANSI 61 – Drinking Water System Components – Health Effects

NSF/ANSI Standard 40

NSF/ANSI 60 – Drinking Water Treatment Chemicals – Health Effects

NSF/ANSI 61 – Drinking Water System Components – Health Effects

British Columbia’s Sewerage System Regulation

US EPA Wastewater Treatment Manuals

10 state standards or Recommended Standards for Wastewater Facilities

Manual on sewerage and sewage treatment – Central Public Health and Environmental Engineering Organization

BS EN 12255 – All volumes

Ex. BS EN 12255-11:2001 – Wastewater treatment plants

BS EN 12255-1:2002 – Wastewater treatment plants. General construction principles

BS 6297:1983 – Code of practice for design and installation of small sewage treatment works and cesspools

Engineering Standards based on EGBC requirements and Project Quality Management System based on ISO 9001 and EGBC’s Organizational Quality Management Program for continuous improvement of Project Management Guidelines, Project Forms and Templates, design standards and construction specifications (including environmental specifications which are currently under review)

Corporate Safety Management System

Corporate Records Management System

BC Environmental Management Act – Site remediation Protocols 1-30 and Procedures 1-16

Canadian Environmental Protection Act (CEPA)– National Pollutant Release Inventory

Yearly guide for reporting to the NPRI

Sector specific tools to calculate emissions:

Reporting guidance for the wastewater sector to the National Pollutant Release Inventory

2003NPRI

NPRI reporting guidance on biosolids

Greenhouse Gas Emission reporting

Western Climate Initiative – Final Essential Requirements of Mandatory Reporting

Environment and Climate Change Canada - Reporting greenhouse gas emissions data: technical guidance

Ontario Ministry of the Environment guidelines

Ontario Building Code

AWWA, USEPA, Ten State Standards, Hydraulic Institute standards

Clean Water Act

Drinking Water Quality Management Standard (DWQMS)

Ontario Safe Drinking Water Act

Div 1 through Div 17 – CSA standards

AIR QUALITY MANAGEMENT

ISO

ISO 9613-2:1996 – Acoustics -- Attenuation of sound during propagation outdoors -- Part 2: General method of calculation

ISO 1996-1:2016 – Acoustics -- Description, measurement and assessment of environmental noise -- Part 1: Basic quantities and assessment procedures

ISO 3744:2010 / ISO 3746 – Acoustics -- Determination of sound power levels and sound energy levels of noise sources using sound pressure -- Engineering methods for an essentially free field over a reflecting plane

ISO/PAS 200065 – Electrically propelled road vehicles -- Magnetic field wireless power transfer -- Safety and interoperability requirements

ISO 3095:2013 – Acoustics -- Railway applications -- Measurement of noise emitted by rail bound vehicles

ISO 2631-1 &2:1997 – Mechanical vibration and shock -- Evaluation of human exposure to whole-body vibration -- Part 1: General requirements

ISO 14001 – Environmental management systems -- Requirements with guidance for use

CSA

CSA-61400-11:13 – Wind turbines - Part 11: Acoustic noise measurement techniques (Adopted IEC 61400-11:2012, third edition, 2012-11) (more commonly referred to as IEC 61400-11)

CSA Z107.56 – Measurement of Noise Exposure - Workplace noise and vibration control

CSA Z94.4 – Use and Care of Respirators - Respiratory protection plans

Other

IEEE C57.12-90 – IEEE Standard Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers

IEC 60076-10 – Power transformers - Part 10: Determination of sound levels

IEEE Std 85 – Test Procedure for Airborne Sound Measurements on Rotating Electric Machinery

AMCA 300 – Reverberant Room Methods for Sound Testing of Fans

ANSI 250 – Laboratory Methods of Testing Jet Tunnel Fans for Performance

ANSI 260 – Sound Rating of Ducted Air Moving and Conditioning Equipment

DIN 4150-3 – Vibrations in buildings - Part 3: Effects on structures

Canadian Ambient Air Quality Standards (CAAQS)

Canadian Council of Ministers of the Environment (CCME) guidelines and other documents on air emissions

Base-level Industrial Emission Requirement (BLIERS), Environment and Climate Change Canada

WASTE MANAGEMENT

ISO

ISO 14001 (Environmental Management systems)

ISO 50001 (Energy Management standards)

CSA

CSA-Z809-08 – Sustainable Forest Management (for wood construction items)

CSA Z760 – Life Cycle Assessment (for caulking sealant materials)

Other

ASTMD6400

Solid Waste Association of North America certifications, training, best practices, etc.

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"White paper on qualified persons in demand-side legislation." Engineers Canada, https://engineerscanada.ca/publications/white-paper-on-qualified-persons-in-demand-side-legislation

"White paper on professional practice in software engineering." Engineers Canada, https://engineerscanada.ca/publications/white-paper-on-professional-practice-in-software-engineering

Endnotes

[1] Engineers Canada, Public Guideline on the Code of Ethics, https://engineerscanada.ca/publications/public-guideline-on-the-code-of-ethics

[2] This includes but is not limited to developing and maintaining standards of qualification for entry into the profession; developing and maintaining standards of knowledge and skill to ensure continued competence; and ensuring that only persons who adhere to the standards of professionalism and ethics can practice the profession.

[3] “White paper on qualified persons in demand-side legislation,” Engineers Canada, December 2018, https://engineerscanada.ca/publications/white-paper-on-qualified-persons-in-demand-side-legislation

[4] The reader is referred to the curricula of Canadian Engineering Accreditation Board’s accredited environmental engineering programs as well as the Canadian Engineering Qualifications Board Environmental Engineering Syllabus.

[5] See definition of “engineering” in *National Guideline on the Practice of Engineering in Canada,* Engineers Canada, February 2012.

[6] Refers to people, property, and wildlife affected by mitigation activities such as remediation and management.

[7] See definition of “environment” in *National Guideline on Sustainable Development and Environmental Stewardship*, Engineers Canada, September 2016:

“The natural and built components of the earth and includes:

- »air, land and water;
- »all layers of the atmosphere and oceans;
- »all organic and inorganic matter, and all living organisms; and
- »the interacting natural systems that include components referred in subclauses (i), (ii), (iii)

The human built environment exists within the natural environment”.

[8] See definition of “sustainable development” in *National Guideline on Sustainable Development and Environmental Stewardship for Professional Engineers*, Engineers Canada, 2016

[9] Andrews, Gordon, *Canadian Professional Engineering and Geoscience: Practice and Ethics, Fifth Edition* (Toronto: Nelson Education, 2014), p. 39.

[10] Engineers Canada, Public Guideline on the Code of Ethics, https://engineerscanada.ca/publications/public-guideline-on-the-code-of-ethics

[11] National Energy Board, Remediation Process Guide, online, https://www.neb-one.gc.ca/sftnvrnmnt/nvrnmnt/rmdtnprcssgd/index-eng.html#s12, 2018

[12] National Energy Board, Remediation Process Guide, online, https://www.neb-one.gc.ca/sftnvrnmnt/nvrnmnt/rmdtnprcssgd/index-eng.html#s12, 2018

[13] Engineers Canada, Public Guideline on the Code of Ethics, https://engineerscanada.ca/publications/public-guideline-on-the-code-of-ethics

[14] Engineers Canada, Public Guideline on the Code of Ethics, https://engineerscanada.ca/publications/public-guideline-on-the-code-of-ethics

[15] https://www.ccme.ca/en/current_priorities/air/caaqs.html

[16] **42 U.S.C.** United States Code, 2013 Edition Title 42 - THE PUBLIC HEALTH AND WELFARE CHAPTER 85 - AIR POLLUTION PREVENTION AND CONTROL SUBCHAPTER III - GENERAL PROVISIONS Sec. 7602(h) - Definitions

[17] “Air pollutants overview,” Government of Canada, 2017, https://www.canada.ca/en/environment-climate-change/services/air-pollution/pollutants/overview.html

[18] Engineers Canada, Public Guideline on the Code of Ethics, https://engineerscanada.ca/publications/public-guideline-on-the-code-of-ethics

[19] Meakin, S. (1992). Hazardous waste management: Canadian directions. Government of Canada:

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