

Social Justice, Technology, and the Canadian Engineering Profession's Statutory Public Interest Mandate

Mic Liu
they/them

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Supervised by

Beatriz Martín-Pérez and Jena McGill

Department of Civil Engineering, Faculty of Engineering

and the Centre for Law, Technology and Society

University of Ottawa

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to Beatriz, Jena, and Jill.

Abstract

Engineered systems govern ordinary life long before a court, regulator, or complaint process becomes involved. They influence whether drinking water remains protected, whether a public building can be used safely and with dignity, and whether technical information can be understood and challenged. A design may satisfy a minimum technical requirement while still placing a patterned and uneven burden on a structurally marginalized public. This thesis asks how the public-interest mandate in the provincial and territorial laws that regulate professional engineering across Canada should apply when engineering work creates or significantly shapes that kind of risk. I argue that the mandate requires role-specific due care for a material disparate-impact risk when six cumulative conditions are met. The first three ask whether the risk is more than remote or minor, whether it may impair a public-facing interest, and whether its burden is patterned and uneven. The remaining three ask whether engineering work creates or significantly shapes the risk, whether a competent actor could know of it through ordinary diligence within role, and whether an actor has authority to respond.

The thesis develops that argument through interdisciplinary legal and engineering analysis. It interprets statutes, regulations, and cases governing professional authority, then connects those sources to engineering ethics and science and technology studies. Scholarship on equality and disability helps identify evidence that conventional technical routines may miss. Work on Indigenous knowledge and epistemic injustice adds questions about authority, credibility, and excluded forms of knowledge. Three recurring examples test the framework at different distances

from licensed practice. Site 41, a proposed Ontario landfill, is the engineering-heavy example because hydrogeology and groundwater modelling were central to the dispute. Technical transparency and distributed public authority were also central. Public washrooms provide an ordinary code-mediated example in which fixture calculations, mechanical systems, and accessibility can affect equivalent access. Artificial intelligence and large language model system integration provide the boundary example, showing how professional engineering may govern a defined technical use while other legal and institutional actors govern the wider technology ecosystem.

The thesis makes three connected contributions. First, the cumulative threshold test identifies when an equality-facing concern becomes relevant to professional engineering responsibility. Second, the actor-authority map locates the person or institution that can investigate or change the relevant work. It also identifies who can approve the decision or receive an escalation. Third, the Public-Interest Impact Assessment translates those findings into a process of identify, assess, and respond. The assessment connects evidence to engineering judgment, assigns a response within authority, and records the conditions that require later review. The goal is to contribute to technological accountability by making professional decisions more attentive to affected publics, more transparent about uncertainty, and more reviewable when a material disparate-impact risk is known or reasonably knowable. This account places defined duties on engineering actors while preserving the separate authority of Indigenous legal orders, public bodies, and human-rights institutions. Employers and other regulators retain the authority assigned to them by law or organizational role.

Résumé

Bien avant qu'un tribunal, un organisme de réglementation ou un mécanisme de plainte intervienne, les systèmes issus du génie organisent déjà la vie quotidienne. Ils influencent la protection de l'eau potable, l'accès sûr et digne aux bâtiments publics ainsi que la possibilité de comprendre et de contester une décision technique. Une conception peut respecter une exigence technique minimale tout en imposant, selon un schéma récurrent, un fardeau inégal à un public structurellement marginalisé. Cette thèse examine la manière dont le mandat d'intérêt public prévu par les lois provinciales et territoriales qui encadrent la profession d'ingénieur au Canada devrait s'appliquer lorsqu'un travail de génie crée ou façonne de façon importante un tel risque. Je soutiens que ce mandat exige une diligence adaptée au rôle lorsqu'un risque important d'effets négatifs structurés et inégalement répartis satisfait à six critères cumulatifs. Les trois premiers demandent si le risque dépasse le stade lointain ou mineur, s'il peut compromettre un intérêt dont le public doit pouvoir bénéficier concrètement et si le fardeau se répartit de manière structurée et inégale. Les trois autres portent sur le lien avec le travail de génie, les connaissances accessibles à un acteur compétent dans l'exercice de son rôle et le pouvoir d'intervenir.

La thèse développe cet argument au moyen d'une analyse interdisciplinaire du droit et du génie. Elle interprète les lois, les règlements et la jurisprudence qui encadrent l'autorité professionnelle, puis met ces sources en relation avec l'éthique du génie et les études sociales des sciences et des technologies. Les travaux sur l'égalité et le handicap aident à repérer les éléments de preuve que les routines techniques peuvent laisser de côté. Les savoirs autochtones et les

travaux sur l'injustice épistémique soulèvent aussi des questions d'autorité, de crédibilité et d'exclusion des connaissances. Trois exemples récurrents éprouvent le cadre selon des liens plus ou moins étroits avec l'exercice réservé du génie. Le site 41, un projet de lieu d'enfouissement en Ontario, constitue l'exemple où le génie occupe une place centrale parce que l'hydrogéologie et la modélisation des eaux souterraines étaient au cœur du différend. Les toilettes publiques fournissent un exemple courant de conception encadrée par les codes du bâtiment, où le calcul des appareils sanitaires, les systèmes mécaniques et l'accessibilité peuvent influencer sur l'égalité d'accès. L'intégration de systèmes d'intelligence artificielle (IA), notamment de grands modèles de langage (GML), sert d'exemple frontière où la responsabilité professionnelle dépend du travail précis et de l'autorité réellement exercée.

La thèse propose trois contributions liées. Premièrement, un test de seuil cumulatif précise le moment où un enjeu lié à l'égalité devient pertinent pour la responsabilité professionnelle en génie. Deuxièmement, une cartographie des acteurs et de leurs pouvoirs situe la personne ou l'institution qui peut enquêter sur le travail ou le modifier. Elle indique aussi qui peut approuver la décision et à qui le risque doit être signalé. Troisièmement, l'évaluation des incidences sur l'intérêt public (Public-Interest Impact Assessment ou PIIA) traduit ces constats en trois étapes : identifier, évaluer et intervenir. L'évaluation relie les éléments de preuve au jugement de génie, attribue une réponse dans les limites de l'autorité et consigne les circonstances qui exigent une réévaluation. La thèse cherche ainsi à contribuer à la responsabilisation technologique en rendant les décisions professionnelles plus attentives aux publics touchés, plus transparentes quant à l'incertitude et plus faciles à examiner lorsqu'un risque important d'effets négatifs structurés et inégalement répartis est connu ou devrait raisonnablement l'être. Le cadre attribue des

responsabilités précises aux acteurs du génie tout en respectant l'autorité distincte des ordres juridiques autochtones, des organismes publics et des organismes de protection des droits de la personne.

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Author Degrees & Qualifications

Degrees:

- Juris Doctor (JD), *magna cum laude*, University of Ottawa
- Master of Applied Science (MAsc), Civil Engineering, University of Waterloo
- Honours Bachelor of Applied Science (BAsc), Civil Engineering, University of Waterloo

Qualifications

- Lawyer, Member in Good Standing, Law Society of Ontario
- Professional Engineer (P.Eng), Professional Engineers Ontario

Thesis Supervisors and Committees

Thesis Supervisors

- Beatriz Martin-Perez, Department of Civil Engineering, Faculty of Engineering, University of Ottawa.
- Jena McGill, Common Law Section, Faculty of Law, University of Ottawa.

Comprehensive Examination – *Completed August 2022*

- Hassan Aoude, Department of Civil Engineering, Faculty of Engineering, University of Ottawa.
- Yeowon Kim, Department of Civil and Environmental Engineering, Faculty of Engineering and Design, Carleton University.
- Jason Millar, School of Electrical Engineering and Computer Science, Faculty of Engineering, University of Ottawa.

Proposal – *Completed July 2024*

- Jane Bailey, Common Law Section, Faculty of Law, University of Ottawa.
- Mamadou Fall, Department of Civil Engineering, Faculty of Engineering, University of Ottawa.
- Elisabeth Gilmore, Department of Civil and Environmental Engineering, Faculty of Engineering and Design, Carleton University.
- Miroslava Kavacic, Department of Civil Engineering, Faculty of Engineering, University of Ottawa.
- Frankie Young, Common Law Section, Faculty of Law, University of Ottawa.

Final Thesis Evaluation – *Completed May 2026*

- Agnes d'Entremont, Department of Mechanical Engineering, Faculty of Applied Science, University of British Columbia.
- Mamadou Fall, Department of Civil Engineering, Faculty of Engineering, University of Ottawa.
- Elisabeth Gilmore, Department of Civil and Environmental Engineering, Faculty of Engineering and Design, Carleton University.
- Marina Pavlović, Common Law Section, Faculty of Law, University of Ottawa.

Land Acknowledgement

I am an uninvited settler living and working on the traditional territory of the Algonquin Anishinaabe peoples. To acknowledge the land beneath my feet is to acknowledge my debt and fiduciary duty explicitly and continuously to those who have been here since time immemorial, to respect their traditional knowledge keepers, both young and old, and to honour their past, present, and future leaders.

To acknowledge the land beneath my feet is also to acknowledge—with the appropriate trigger warnings and in respectful and non-tokenising ways, of course—the legacy of colonialism and discussions of the ongoing violence against Indigenous peoples in spaces in which these discussions would otherwise be unlikely to occur. In my experience, many engineering spaces, including classrooms and the board table of the Ontario regulator, are silent on these matters. Reasons include the perception that these issues are “too political” for the neutral and value-free engineer and the rhetoric of “what does this have to do with engineers?” Archie Davies (2021) is among the scholars who have answered this question:

[E]ngineers were not merely technicians of positivist progress, but agents of the development of capitalism, and infrastructure was a crucial tool of deepening imperialist and dependent relations [...] The work of knowledge production and the control over technology was in the hands of white, male, imperial engineers. [...] There is an association between engineering knowledge and whiteness. The control over knowledge (engineering, cartography, contracting, technologies), as well as control of financial flows, was central to the maintenance of dependency.

The skills and instrumentality that engineers boast and accept as value-free are the building blocks of colonization, colonies, and colonialism. From naval engineers realizing kings’ and emperors’ hopes of journeying to the new world (and subsequently committing centuries of genocide against Indigenous peoples around the world) to civil engineers designing and enabling the construction of residential schools where settlers murdered countless Indigenous children, engineering is a discipline *far* from innocent in the making of this colonial world and its associated atrocities. In fact, *engineers made it possible*.

Today, many of the 300,000+ Canadian engineers licensed by provincial and territorial regulators continue to carry out work that is harmful to Indigenous peoples, from resource extraction and manufacturing to urban construction and higher technology. Engineering has *always* engaged in projects and processes of colonialism. Engineers Canada, the national association composed of the 12 provincial and territorial regulators, has set a helpful tone with which to move forward:

...it is important to acknowledge the impact engineering has on Indigenous peoples and communities, from coast to coast to coast. Whether in the context of resource development, infrastructure creation and maintenance on and off reserves, technological applications of engineering design, and beyond. Engineering needs to incorporate Indigenous ways of being and ways of knowing to create more positive solutions for Indigenous communities seeking economic independence, clean drinking water, and sustainable development opportunities on their lands.

For these reasons, I acknowledge my duty as a settler and my elevated duty as a settler engineer to work toward truth and reconciliation. I do my work with this view and with gratitude to the Algonquin Anishinaabe peoples for the land on which to do it.

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Positionality Statement

Because this thesis asks what engineers owe the public, it matters that I write from inside some of the institutions I critique. I am a licensed professional engineer and a lawyer. I am also a Queer, racialized East Asian, Trans/non-binary, neuroatypical/disabled person, and a settler living and working across unceded Indigenous lands. These positions do not give me a complete view of engineering, law, technology, or justice. They do, however, shape the questions I choose to ask, the silences I find difficult to accept, and the kinds of professional explanations that I experience as incomplete.

My professional location is double-edged. As a professional engineer with experience in both the government and consulting engineering firms, I am not writing about engineering as an external observer. Through my two engineering degrees from the University of Waterloo, I have been trained into the engineering discipline's habits of precision, problem definition, technical defensibility, and public-welfare language. I understand the attraction of engineering's claim to neutrality: it can feel like an ethical discipline, a way of keeping judgment anchored in evidence rather than ideology. At the same time, this thesis begins from the concern that what engineering treats as neutral often already contains social assumptions about whose bodies, communities, risks, and forms of knowledge count. My engineering training helps me see why practitioners may resist that claim; it also makes me less willing to accept the idea that questions of access, dignity, community knowledge, or disparate impact are simply "outside" engineering. If engineering work shapes public life, then engineering judgment cannot be described only in technical terms.

After not feeling welcome and not feeling like I could be myself in engineering, I went to law. As a lawyer, I approach these questions with a different set of instincts. Legal training has taught me to read statutory language critically, to ask who has authority, who is bound, what mechanism applies, and where jurisdictional limits begin. It has also taught me that open-textured terms such as "public interest," "public welfare," "competence," and "professional responsibility" do not interpret themselves. They are given meaning through institutions, precedents, professional culture, and contested social values. My legal training therefore makes me attentive to both possibilities and constraints. I am interested in the interpretive openness of engineering's public-interest mandate, but I am also aware that not every moral concern can be turned into a professional duty, and not every professional duty can be imposed on every actor. This is especially important in this thesis because I argue for a more justice-attentive public-interest mandate while also insisting that engineers are not general social-justice officials.

My social location also matters, but not because identity substitutes for evidence. It does not. Rather, it affects my sense of what can disappear when professional systems describe themselves as neutral. As a Trans/non-binary person, I am familiar with how ordinary infrastructures and

administrative categories can make gender-binary assumptions feel natural, technical, or inevitable. That experience informs my attention to examples such as gendered versus gender-neutral washrooms, but it does not make me representative of all Trans, non-binary, Two-Spirit, or gender-diverse people. Nor do I write as a woman. This distinction matters. Some of the engineering literature I rely on examines women's experiences in a male-dominated profession, and that work remains important for understanding the gendered construction of engineering culture (Faulkner, 2007; Seron *et al.*, 2018). My relationship to that literature is one of partial resonance. I have encountered engineering as a gendered space, previously (and mostly) as a woman, and now as a Trans/non-binary person. In this thesis, I use feminist engineering scholarship alongside Queer, Trans, disability, critical race, and Indigenous scholarship, rather than treating "women in engineering" as the full horizon of gender justice.

My racial location also shapes how I come to this project. I have experienced engineering, law, and academia through structures shaped by whiteness, but not through the same forms of racialization experienced by Black or Indigenous people. East Asian racialization often works through conditional proximity to institutional legitimacy: the "model minority" figure can make some forms of professional participation appear available, even while marking Asian people as foreign, interchangeable, technically useful, socially quiet, or politically peripheral. In engineering especially, East Asian presence can be misread as evidence that race is not a serious structural question, because some Asian bodies are visible in technical spaces. That visibility can conceal hierarchy rather than undo it. It can also obscure anti-Black racism, anti-Indigenous dispossession, and the ways professional institutions are built around white norms of authority, communication, credibility, and leadership. I therefore try to be careful not to universalize from my own racialized experience. My position gives me some access to the injuries produced by racism in professional spaces, but it also gives me forms of privilege relative to Black and Indigenous colleagues, communities, and knowledge-holders whose exclusion from engineering and law has been differently produced and more violently maintained.

This is especially important because the thesis engages Indigenous knowledge, water, land, jurisdiction, and public-interest governance. I write as a settler, not as an Indigenous person, and I do not claim authority to define Indigenous law, Indigenous engineering priorities, or Indigenous relationships to land and water. My responsibility is different: to avoid treating Indigenous knowledge as merely consultative input into settler technical systems; to notice when engineering processes convert jurisdictional or relational claims into narrow "stakeholder concerns"; and to be explicit when professional engineering regulation should not answer questions that belong to Indigenous peoples, governments, and legal orders. The Site 41 recurring example matters partly for this reason. It requires me to ask not only whether engineers adequately assessed groundwater risk, but also whose knowledge of water was treated as evidence, whose authority was recognized, and what professional humility requires in a settler-colonial context.

I also write as a Queer person, which overlaps with but is not identical to being Trans/non-binary. Queerness shapes how I understand institutions that appear neutral because of how they organize ordinary life around unstated norms about: family, gender, sexuality, embodiment, professionalism, privacy, risk, and respectability. It makes me attentive to the way some people

are included only if they become administratively legible, non-disruptive, or easy to accommodate. At the same time, my Queerness is mediated by other privileges: education, professional credentials, class mobility, and the ability, in some contexts, to move through institutions in ways that are perhaps not immediately readable as Queer. That means I experience both vulnerability and access. I am not outside the systems I critique; I am partly protected by them, partly misrecognized by them, and partly invested in reforming them.

My neuroatypicality and disability also shape this project, though not always visibly. For the most part, my disability is not immediately apparent. That invisibility can be protective: it allows me, for the most part, to pass through professional spaces without being reduced to disability. But it can also be exhausting and epistemically distorting. Invisible disabilities often require constant self-management, translation, and decisions about disclosure. It can make access needs appear optional, private, or exceptional rather than structural. It also makes me attentive to the built and administrative environments that define competence through pace, stamina, communication style, sensory tolerance, bureaucratic fluency, and the ability to absorb institutional friction without complaint. In this thesis, that attention matters because engineering often designs for a presumed user, a presumed body, and a presumed mode of participation. Disability justice scholarship helps me resist the temptation to treat accessibility as a supplement to otherwise complete design. It also reminds me that technical adequacy cannot be separated from the conditions under which people can actually use, contest, understand, and survive engineered systems.

I also write as someone who has benefited from the very institutions I examine. Engineering and law are credentialed professions. They confer status, authority, vocabulary, and access. They make some arguments easier to hear because they are spoken in professional language. My ability to move between engineering and law is therefore not only a source of insight; it is also a significant form of privilege. It may incline me toward solutions that take professional self-regulation, standards, legal interpretation, and institutional reform seriously. That inclination is useful for this project, but it also creates risks. I may overestimate what professional regulation can do. I may place too much faith in guidance documents, codes, assessments, or training requirements. I may translate community demands into professional language in ways that make them more administratively legible but less politically forceful. These are not reasons to abandon the project. They are reasons to be explicit about its limits and reflective about my professional instincts.

For that reason, reflexivity in this thesis is part of the method rather than an autobiographical aside. I approach reflexivity as a practice of interpretive accountability: making visible how my standpoint shapes the research question, the examples I select, and the reforms I imagine (Berger, 2015; Corlett & Mavin, 2018; Finlay, 2002; Haraway, 1988; Olukotun *et al.*, 2021). I do not claim neutrality, and I do not treat neutrality as a precondition for rigorous scholarship; the “view from nowhere” is itself a situated stance (Haraway, 1988). Situatedness makes the researcher’s position explicit while leaving the argument answerable to evidence (Berger, 2015; Haraway, 1988). The argument is disciplined first by statutes, cases, and professional codes. Regulatory materials, technical evidence, and close engagement with scholarship provide further discipline. Where the evidence supports a narrower claim, the claim narrows. Where engineering is adjacent to a harm,

the thesis identifies the boundary. Where another actor has authority, the analysis assigns the decision to that actor rather than to engineers.

This reflexive posture is especially important because the thesis is normative. I am not pretending to discover, from nowhere, an uncontested meaning of the public interest. I am asking whether engineering's statutory public-interest mandate can and should be interpreted to require role-specific due care for material disparate-impact risks. That position reflects my personal, professional, and scholarly commitments: to technical excellence, to public accountability, to human rights, to Indigenous and community knowledge, to disability justice, and to a conception of professionalism that does not treat social harm as external to competence. But those commitments do not settle the argument. They orient it. The work of the thesis is to test whether that orientation can be made legally careful, professionally credible, and practically useful.

I therefore try to hold two truths together. First, engineering is not innocent. Its methods, infrastructures, standards, and professional cultures have helped build worlds that distribute safety, access, recognition, and risk unevenly. Second, engineers are not omnipotent. They work within statutes, employers, procurement systems, public authorities, markets, interdisciplinary teams, and political choices that they often do not control. The ethical and legal question is not whether engineers can remedy structural injustice as a whole. They cannot. The question is more bounded and, I think, more difficult: when engineering work materially shapes public risk, what should competent and public-regarding professional judgment require?

That is the standpoint from which this thesis is written. It is situated, implicated, and necessarily partial. My aim is not to speak for marginalized publics, Indigenous communities, Trans and non-binary users, disabled people, racialized communities, Queer communities, or engineers as a whole. It is to ask whether the engineering profession's existing public-interest commitments can be interpreted with greater honesty about the publics engineering serves, the harms engineering can help produce, and the responsibilities that follow when those harms are known or reasonably knowable.

1

Introduction

The transsexual body is an unnatural body. It is the product of medical science. It is a technological construction.

—Susan Stryker (1994, p. 238)

1.1. Background and Motivation: Technology, Public Life, and Professional Responsibility

Susan Stryker’s epigraph uses the terminology of her 1994 essay and deliberately recasts a stigmatizing description of the trans body as a claim about technology and power (Stryker, 1994). As a Trans scholar, I begin there to unsettle the assumption that technology starts with recent digital devices. In this thesis, technology includes physical artefacts and technical knowledge, together with the standards and classifications that organize how a system is designed and used (Akrich, 1992; Bowker & Star, 1999; Stryker, 1994). Julie E. Cohen similarly shows how networked environments configure the conditions of everyday practice rather than simply supplying neutral tools (Cohen, 2012). Technology also includes institutional practices that make technical arrangements stable in daily life (Jasanoff, 2004; Lessig, 1999). A landfill liner and groundwater model are technologies in this sense, as are a washroom fixture schedule and ventilation system (Professional Engineers Ontario, 2019; Ontario (Information and Privacy Commissioner), *Order MO-2449*; City of Ottawa Building Code Services, 2021; National Research Council Canada, 2022).

Software that classifies information or generates language provides another example: it is a designed arrangement that shapes what people can do and what evidence institutions can see (Bommasani *et al.*, 2021; Scassa, 2021).

This broad definition gives the three recurring examples a common analytical frame without erasing their technical differences. Artificial intelligence (AI) is the umbrella term I use for computational systems that perform tasks involving prediction, classification, or language generation (Bommasani *et al.*, 2021; Scassa, 2021). A large language model (LLM) is a computer system trained on large collections of text to generate or transform language by predicting likely continuations (Bender *et al.*, 2021; Bommasani *et al.*, 2021). A digital language system operates differently from a landfill or washroom, yet each can allocate access, risk, or decision power through design choices made before a dispute reaches a court or regulator (Akrich, 1992; Bowker & Star, 1999; Winner, 1980). My intention is to examine that allocation while keeping the legal boundary of professional engineering visible.

I therefore narrow the analysis from technology in general to professional engineering. In Canada, professional engineering is regulated separately in each province and territory through its own statute and subordinate regulations; there is no single federal statute governing the profession (Engineers Canada, 2022). Ontario is the principal doctrinal illustration in this thesis because its definition of professional engineering expressly connects specified professional acts to life, health, property, economic interests, public welfare, and the environment (*Professional Engineers Act*, RSO 1990, c P.28, s 1(1)). Ontario also directs Professional Engineers Ontario to regulate the profession so that the public interest may be served and protected (*Professional Engineers Act*, RSO 1990, c P.28, s 2(3)). Alberta and British Columbia use their own legal

instruments, so every application begins with the statute and regulations in force in the province or territory where the work occurs (*Engineering and Geoscience Professions Act*, RSA 2000, c E-11, ss 2, 10, 19; *Engineering and Geoscience Professions General Regulation*, Alta Reg 150/99, Sched 1; *Engineers and Geoscientists Regulation*, BC Reg 14/2021, s 1).

With that jurisdictional boundary established, the motivating problem becomes more precise. Professional engineering governance has well-developed routines for competence, safety, and compliance (Herkert, 2000; Professional Engineers Ontario, 2020). Members of the public nevertheless encounter the same engineered system under different conditions of exposure and access (Crenshaw, 1989; Fraser, 2009; Hamraie, 2017). Standards and spatial arrangements can embed a narrow assumed user even when the design satisfies a technical minimum (Akrich, 1992; Costanza-Chock, 2020; Hamraie, 2017). My concern is a boundary inside professional practice: evidence about who can use a system, who bears its risk, or whose knowledge is excluded may be assigned to policy or complaint processes after the technical choice has already been made (Cech, 2014; Faulkner, 2007; Jasanoff, 2003). Where that evidence identifies a use condition, failure mode, or technical assumption, I argue that it belongs within engineering judgment while the work can still change (Nieusma & Riley, 2010; Professional Engineers Ontario, 2020).

Canadian institutions often group equality-oriented work under the phrase equity, diversity, and inclusion (EDI) (Fines-Neuschild & Tajmel, 2024). Mirjam Fines-Neuschild and Tanja Tajmel found that researchers in Canadian science, technology, engineering, and mathematics (STEM) fields often experienced EDI work as an individual initiative undertaken without durable institutional support (Fines-Neuschild & Tajmel, 2024). Their study helps explain why personal commitment is an incomplete governance response: a concern becomes actionable

when an institution assigns responsibility, resources, and decision authority (Fines-Neuschild & Tajmel, 2024; Herkert, 2000). I therefore connect equality-facing evidence to existing professional mechanisms and to actors who can use those mechanisms (Adams, 2022; Engineers Canada, 2024a, 2024b).

That institutional focus leads to the allocation principle I defend: responsibility follows authority. A provincial or territorial engineering regulator governs licensed practice through powers granted by legislation, while an employer or project lead controls many questions of project scope and resources (*Professional Engineers Act*, RSO 1990, c P.28, ss 2(3)–(4), 7; Herkert, 2000). A public authority makes the approval decision assigned by environmental or building law; in Ontario, examples include a waste-approval decision under section 27 of the *Environmental Protection Act* and municipal building-code administration under sections 3 and 8 of the *Building Code Act, 1992* (*Environmental Protection Act*, RSO 1990, c E.19, s 27; *Building Code Act, 1992*, SO 1992, c 23, ss 3, 8). An individual engineer acts through the assignment accepted, the competence required, and the actual control available in the work (RRO 1990, Reg 941, ss 72, 77; Engineers Canada, 2024b). I argue that an engineering actor owes **role-specific due care** when **engineering work** creates or significantly shapes what I call a **material disparate-impact risk** (Cech, 2014; Costanza-Chock *et al.*, 2022; *Professional Engineers Act*, RSO 1990, c P.28, ss 1(1), 2(3)). The obligation arises when the risk is **known or reasonably knowable** to a competent actor **within role** and the actor has authority to respond (Engineers Canada, 2024a, 2024b; Professional Engineers Ontario, 2020). Depending on the assignment, the response may involve investigation, documentation, or mitigation (Engineers Canada, 2024a, 2024b; Professional Engineers Ontario,

2020). Warning and escalation apply when another actor controls the final decision (Engineers Canada, 2024b; Adams, 2022).

I develop that proposal through one application sequence. Chapter 2 applies the cumulative **threshold test** and produces a written explanation of whether each criterion is satisfied. Chapter 3 identifies the actor with authority, then identifies the legal or organizational mechanism through which that actor can respond. Chapter 4 applies the **Public-Interest Impact Assessment (PIIA)**, a three-stage process of identify, assess, and respond. The PIIA draws on traceability and review practices in the Institute of Electrical and Electronics Engineers (IEEE) Standard 7000 and in algorithmic-audit scholarship (IEEE, 2021; Raji *et al.*, 2020).

1.2. Foundational Terms

I use this section as the single definitional home for the terms that carry the thesis-wide argument. The first definition of each thesis term appears in bold, and later chapters use the same wording without quotation marks. This section defines material disparate-impact risk, **patterned uneven burden**, and the engineering-work boundary. It then defines the evidence boundary and role-specific due care. Chapter 2 applies these terms without redefining them. Chapter 3 introduces legal terms when their consequences become relevant, while the recurring examples introduce technical terms where the surrounding engineering problem makes them intelligible. Readers can consult the unnumbered Glossary of Terms after Chapter 5 for the stable meanings of recurring legal, engineering, and socio-technical terms.

Material disparate-impact risk is the thesis’s term for a defined professional-responsibility problem (Barocas & Selbst, 2016; Chouldechova, 2017; Selbst *et al.*, 2019). It means a non-trivial,

public-interest-relevant risk that engineering work may negatively affect structurally marginalized communities in patterned and uneven ways (*Professional Engineers Act*, RSO 1990, c P.28, ss 1(1), 2(3); *Fraser v Canada (Attorney General)* (Fraser), 2020 SCC 28 at paras 30-31, 47-50; Sheppard, 2024). The phrase is operational rather than doctrinal: it identifies when the threshold test, the actor-authority analysis, and the PIIA should be used.

Each part of the term performs a separate limiting function. Material marks the seriousness required for professional attention (Engineers Canada, 2024a; Professional Engineers Ontario, 2020). Disparate-impact identifies a patterned uneven burden rather than an isolated difference in outcome (Barocas & Selbst, 2016; *Fraser*, 2020 SCC 28 at paras 30-31, 47-50). Risk keeps the inquiry prospective by directing attention to a decision that remains open to investigation or response (Funtowicz & Ravetz, 1993; Professional Engineers Ontario, 2019).

Patterned uneven burden is the stable equality-facing phrase used throughout the thesis. Patterned means that the burden follows a recurring design, institutional, or historical structure (Crenshaw, 1989, 1991; Fraser, 2009). Uneven means that the same system places a heavier or qualitatively different burden on an affected public (*Fraser*, 2020 SCC 28 at paras 30-31, 47-50; Hamraie, 2017). The engineering connection may arise through a standard or system, and it may arise through a professional decision or omission (Akrich, 1992; Bowker & Star, 1999; Engineers Canada, 2024b).

Engineering work means work that falls within the statutory definition of professional engineering in the province or territory where the work occurs. In Ontario, the definition includes planning, design, evaluation, advice, reporting, direction, and supervision when the work requires engineering principles and concerns a listed protected interest (*Professional Engineers Act*, RSO

1990, c P.28, s 1(1)). **Engineering-adjacent work** means technical or design-related work that may use engineering knowledge while falling outside licensed practice under that province's or territory's law (Engineers Canada, 2022; Professional Engineers Ontario, n.d.). A political decision with engineering implementation remains with the decision-maker empowered by the statute that assigns the decision, while the engineer's responsibility attaches to the technical work and advice accepted within role (*Environmental Protection Act*, RSO 1990, c E.19, s 27; *Canada (Minister of Citizenship and Immigration) v Vavilov (Vavilov)*, 2019 SCC 65 at paras 108-110; Professional Engineers Ontario, 2019).

Professional engineering law refers in this thesis to the provincial and territorial statutes and subordinate regulations that create engineering regulators, govern licensure, and regulate professional practice. Professional codes, standards, and regulator guidance are identified separately because their legal force depends on the instrument and the power under which it is issued (*Professional Engineers Act*, RSO 1990, c P.28, ss 2(4), 7; RRO 1990, Reg 941, ss 72, 77; Engineers Canada, 2024a). Administrative-law principles govern how a regulator exercises delegated statutory power (*Vavilov*, 2019 SCC 65 at paras 85-87, 108-110). Environmental, building, and human-rights law assign different decisions to their own institutions (*Environmental Protection Act*, RSO 1990, c E.19, s 27; *Building Code Act, 1992*, SO 1992, c 23, ss 3, 8; *Human Rights Code*, RSO 1990, c H.19, ss 1, 5-6).

The closest Canadian doctrinal analogue is adverse-effect discrimination, which examines how a facially neutral rule can produce discriminatory effects. The Supreme Court of Canada recognized that principle in *Ontario Human Rights Commission v Simpsons-Sears Ltd (Simpsons-Sears)*, [1985] 2 SCR 536 at 551-52, and developed an effects-based analysis in *British Columbia*

(*Public Service Employee Relations Commission*) v *BCGSEU* (*Meiorin*), [1999] 3 SCR 3 at paras 38, 54. *Moore v British Columbia (Education)* (*Moore*), 2012 SCC 61 at paras 26-29, and Fraser further emphasize meaningful access and the effects of institutional rules (*Fraser*, 2020 SCC 28 at paras 30-31, 47-50). I use adverse-effect discrimination only when discussing Canadian equality or human-rights doctrine.

Disparate impact performs a different function in the thesis. Solon Barocas and Andrew Selbst use United States disparate-impact doctrine to examine how data practices can create discriminatory effects without an express discriminatory rule (Barocas & Selbst, 2016). Algorithmic-fairness scholarship uses the phrase to connect patterned outcomes to the data, objectives, and institutions that produce them (Chouldechova, 2017; Selbst *et al.*, 2019). The threshold test supplies the phrase’s professional-governance meaning here: a patterned uneven burden enters the framework only when the engineering connection, evidence boundary, and authority criteria are also satisfied.

The phrase therefore cannot be reduced to a numerical disparity. Alexandra Chouldechova explains that fairness conflicts arise from social and ethical choices as well as statistical relationships (Chouldechova, 2017). Andrew Selbst and colleagues similarly show that mathematical definitions can hide the institutional setting in which a system operates (Selbst *et al.*, 2019). I ask what mechanism creates the burden, whom it affects, and which actor can change the relevant engineering decision (Chouldechova, 2017; Selbst *et al.*, 2019).

Material is the professional threshold rather than a synonym for any difference in experience. A risk is material when it is serious enough to affect a **public-facing interest** and sufficiently connected to engineering work to require professional attention (*Professional*

Engineers Act, RSO 1990, c P.28, ss 1(1), 2(3); Engineers Canada, 2024a). A public-facing interest is an interest affected through a system, facility, or technical record that reaches beyond a purely private preference (Hamraie, 2017; Jasanoff, 2003). In the recurring examples, the relevant interests are groundwater protection, safe and equivalent access, and the practical ability to understand and challenge a technical decision (Environmental Commissioner of Ontario, 2004; Hamraie, 2017; Raji *et al.*, 2020).

The **threshold test** translates that definition into six cumulative criteria. Chapter 2 asks whether the risk is serious, negative, and patterned in its burden. It then asks whether engineering work creates or significantly shapes the risk, whether the risk is known or reasonably knowable, and whether an actor has authority to respond. Chapter 3 examines the source and limit of that authority before Chapter 4 begins the PIIA (Adams, 2022; Engineers Canada, 2024a, 2024b; Raji *et al.*, 2020).

Known or reasonably knowable is the evidence boundary. A risk is known or reasonably knowable when evidence available through ordinary professional diligence makes the issue visible to a competent actor within role (Engineers Canada, 2024a, 2024b). **Within role** means within the assignment, competence, access to information, and decision authority attached to that actor (Adams, 2022; Herkert, 2000; Engineers Canada, 2024b). The evidence may come from technical records, prior incidents, or affected-public knowledge (Fricker, 2007; Jasanoff, 2003; Lambrinidou *et al.*, 2014). Testing, professional standards, and human-rights guidance may provide additional evidence where they bear on the assigned work (Costanza-Chock *et al.*, 2022; Raji *et al.*, 2020).

Structurally marginalized communities are groups whose vulnerability is produced or intensified by durable institutional arrangements. Those arrangements may be colonial or

racialized (Collins, 2000; Crenshaw, 1989, 1991). They may also be gendered, ableist, or classed (Fraser, 2009; Hamraie, 2017; Young, 1990). Other affected publics can face public-interest risk; this thesis term identifies the subset in which structural marginalization helps explain the patterned uneven burden (*Fraser*, 2020 SCC 28 at paras 30-31, 47-50; Hamraie, 2017).

Role-specific due care is the allocation principle. The actor investigates and documents the risk within the competence and authority attached to the role (Adams, 2022; Professional Engineers Ontario, 2019). The actor then implements an available control or explains why another actor must decide (Costanza-Chock *et al.*, 2022; Engineers Canada, 2024b). Warning and escalation carry a documented concern to the person with final authority when the engineering actor controls advice or technical work rather than the ultimate decision (Engineers Canada, 2024b; Lambrinidou *et al.*, 2014).

I also reserve legally activating terms for the doctrine in which they perform legal work. Proportionality, for example, refers to the constitutional administrative-law analysis developed in *Doré v Barreau du Québec* (*Doré*), 2012 SCC 12 at para 57, and *Loyola High School v Quebec (Attorney General)* (*Loyola*), 2015 SCC 12 at paras 39-40. Ordinary differences in PIIA depth are described as scaling according to the evidence and the actor’s authority (IEEE, 2021; Professional Engineers Ontario, 2020). Finally, the thesis chooses direct descriptions of missing knowledge, excluded evidence, or institutional limits from CNIB Foundation’s Canadian guidance on respectful communication (CNIB Foundation, 2024).

1.3. Interpretation of Public Interest: *Status Quo* and Proposal

I use Ontario to show the conventional legal architecture before developing the proposal. Professional Engineers Ontario (PEO), Ontario’s statutory engineering regulator, must regulate the profession so that “the public interest may be served and protected” (*Professional Engineers Act*, RSO 1990, c P.28, s 2(3)). Ontario’s practice definition connects professional engineering to life, health, property, economic interests, public welfare, and the environment (*Professional Engineers Act*, RSO 1990, c P.28, s 1(1)). Other provinces and territories organize professional engineering through their own statutes, regulations, and codes; the precise wording and available mechanisms must therefore be checked in the jurisdiction where the work occurs (Engineers Canada, 2022). Alberta and British Columbia are used later only for the provisions relevant to those analyses (*Engineering and Geoscience Professions Act*, RSA 2000, c E-11, ss 2, 10, 19; *Engineers and Geoscientists Regulation*, BC Reg 14/2021, s 1).

This legal architecture reflects the regulatory bargain of professional self-governance. Specialized work can create public risks that require expert standards and institutional accountability, while delegated regulation gives a professional body authority over entry, competence, and conduct in service of public protection (Adams, 2016, 2017, 2018, 2022). Engineering regulators operationalize that bargain through licensing and practice standards. Complaints and discipline provide additional mechanisms where the governing legislation authorizes them (Adams, 2016, 2022; Casey, 2025).

The thesis builds from that existing architecture. Engineering work can shape systems across the protected interests named in the Ontario statute, including public welfare and the environment (*Professional Engineers Act*, RSO 1990, c P.28, s 1(1); Engineers Canada, 2022;

Professional Engineers Ontario, 2019). My proposal interprets competent public-interest practice to include role-specific due care for a known or reasonably knowable material disparate-impact risk created or significantly shaped by engineering work (Engineers Canada, 2024a, 2024b; RRO 1990, Reg 941, s 77). The proposal therefore operates through professional competence, evidence, and authority.

The status quo is most developed when a concern appears as unsafe work, deficient competence, or failure to comply with an applicable standard (Adams, 2016; Engineers Canada, 2024a; RRO 1990, Reg 941, s 72). Those same mechanisms can support inquiry into a qualifying material disparate-impact risk when the connection to engineering work is established (Adams, 2022; Professional Engineers Ontario, 2020). The practical gap lies in the specificity of professional routines: guidance is more detailed for conventional safety failures than for exclusionary access, patterned environmental burden, or unequal ability to examine a technical decision (Cech, 2014; Costanza-Chock, 2020; Hamraie, 2017; Jasanoff, 2003).

Professional culture helps explain that difference in visibility. Erin Cech identifies depoliticization, technical-social dualism, and meritocracy as parts of an engineering “culture of disengagement” that can place public-welfare questions outside the definition of technical work (Cech, 2014). Her longitudinal research also reports a decline in students’ public-welfare concerns during undergraduate engineering education (Cech, 2014). These findings make professional formation relevant to how engineers classify evidence and responsibility (Cech, 2014).

Wendy Faulkner’s analysis adds the institutional mechanism. Engineering often depends on social competence in defining, using, and maintaining technical systems, while professional identity can treat that competence as secondary to technical expertise (Faulkner, 2000, 2007).

Read together, Cech and Faulkner show how a professionally committed engineer can still inherit a narrow account of what counts as competence (Cech, 2014; Faulkner, 2007; Riley, 2008). The public-interest mandate matters here because it supplies an institutional reason to bring relevant social evidence into engineering judgment.

That institutional reason remains bounded by delegated authority. A legislature assigns powers to a professional regulator through an enabling statute, and the regulator must use those powers consistently with the statutory scheme (Adams, 2022; *Vavilov*, 2019 SCC 65 at paras 85-87, 108-110). In Ontario, the *Professional Engineers Act* authorizes PEO to establish standards of knowledge, practice, and professional ethics (*Professional Engineers Act*, RSO 1990, c P.28, ss 2(4), 7). Codes, guidance, practice review, continuing competence, and discipline each require a valid statutory or regulatory basis (*Green v Law Society of Manitoba (Green)*, 2017 SCC 20 at paras 24-25, 44; Professional Engineers Ontario, 2019). Project approvals remain with the environmental or building authority empowered by the applicable law (*Environmental Protection Act*, RSO 1990, c E.19, s 27; *Building Code Act, 1992*, SO 1992, c 23, ss 3, 8).

The doctrinal proposal is therefore a professional-governance interpretation of an existing mandate. It reads statutory purpose together with professional competence and the legal limits on the actor exercising power (*Professional Engineers Act*, RSO 1990, c P.28, ss 1(1), 2(3); *Vavilov*, 2019 SCC 65 at paras 85-87, 108-110). Science and technology studies (STS) supplies the socio-technical explanation for why engineering work can distribute risk and access through apparently technical choices (Akrich, 1992; Winner, 1980). Canadian adverse-effect discrimination supplies an adjacent effects-based legal lineage, while Chapter 3 preserves the separate authority of human-rights institutions (*Fraser*, 2020 SCC 28 at paras 30-31, 47-50; Engineers Canada, 2024a).

Implementation follows the **actor-authority map** rather than a single profession-wide command. A regulator may use a standard, guidance document, or practice review where its legislation authorizes that mechanism (Adams, 2022; Professional Engineers Ontario, 2019). An employer or project lead can set requirements, allocate resources, and create review gates through organizational authority (Herkert, 2000; Bielefeldt, 2018). Educators and accreditation bodies shape professional formation, while an individual engineer acts through the authority available in the accepted assignment (Cech, 2014; Engineers Canada, 2024c; Leydens & Lucena, 2016).

The connection to engineering work controls the scope of the proposal. A risk enters the framework when engineering judgment creates or significantly shapes it through an act that falls within the applicable practice definition, including design, evaluation, advice, or supervision (*Professional Engineers Act*, RSO 1990, c P.28, s 1(1); Engineers Canada, 2022). Technical advice can create that connection when it structures another actor’s decision (Professional Engineers Ontario, 2019). Chapter 3 then identifies the actor with final authority and specifies the engineer’s narrower contribution when the final decision lies elsewhere (*Vavilov*, 2019 SCC 65 at paras 108-110; *Environmental Protection Act*, RSO 1990, c E.19, s 27).

Separate legal regimes continue to govern the decisions assigned to them. In Ontario, human-rights institutions apply statutory protections in services and employment under sections 1 and 5 of the *Human Rights Code* (*Human Rights Code*, RSO 1990, c H.19, ss 1, 5). Environmental authorities exercise approval powers under environmental legislation, including section 27 of the *Environmental Protection Act* for waste-management systems or waste-disposal sites (*Environmental Protection Act*, RSO 1990, c E.19, s 27). Crown consultation follows the constitutional framework in *Haida Nation v British Columbia (Minister of Forests)* (*Haida*

Nation), 2004 SCC 73 at paras 16-18, 35, while Indigenous legal orders supply their own sources of authority (Borrows, 2010; Whyte, 2020). Professional engineering governance contributes competent inquiry, candid documentation, and escalation within engineering work (Engineers Canada, 2024b; Professional Engineers Ontario, 2019).

1.4. Scope and Institutional Limits

This section fixes the institutional boundary before the methods and examples begin. A provincial or territorial engineering regulator governs licensed practice through its enabling legislation, while an environmental or building authority makes the project decision assigned by its statute (*Professional Engineers Act*, RSO 1990, c P.28, ss 2(3)-(4), 7; *Environmental Protection Act*, RSO 1990, c E.19, s 27; *Building Code Act, 1992*, SO 1992, c 23, ss 3, 8). Human-rights institutions determine statutory discrimination claims and remedies (*Human Rights Code*, RSO 1990, c H.19, ss 1, 5-6). Employers and project leads govern many operational decisions through contract and management authority (Herkert, 2000; Bielefeldt, 2018).

Within that allocation, human-rights law supplies rights, complaint pathways, and remedies when its statutory requirements are met (*Human Rights Code*, RSO 1990, c H.19, ss 1, 5-6, 34-45.2; *Fraser*, 2020 SCC 28 at paras 30-31, 47-50; *Moore*, 2012 SCC 61 at paras 26-29). Role-specific due care operates at an earlier project decision. It asks what an engineering actor should investigate, test, or document while the actor can still influence the work (Engineers Canada, 2024a, 2024b). It then asks what control or escalation is available when engineering work creates or significantly shapes a known or reasonably knowable patterned uneven burden (Law Commission of Ontario & Ontario Human Rights Commission, 2024).

The PIIA is the process that carries those questions into a decision. It records the evidence and uncertainty, then identifies the control or escalation available to the actor (Costanza-Chock *et al.*, 2022; Raji *et al.*, 2020). Residual risk is the risk that remains after feasible controls have been applied and verified (IEEE, 2021, cl 10; Professional Engineers Ontario, 2020). The assessment identifies the person or institution authorized to accept that remaining risk, which gives the analysis a defined institutional consequence (Costanza-Chock *et al.*, 2022; Raji *et al.*, 2020).

1.5. Method and Analytical Frame

My method follows the same sequence as the argument. I first interpret the statutes and cases that define public-interest authority (Sullivan, 2022; *Canada Trustco Mortgage Co v Canada (Canada Trustco)*, 2005 SCC 54 at para 10). I then follow those powers through professional institutions and engineering practice (Adams, 2022; Herkert, 2000). Finally, I use socio-technical and justice scholarship to identify evidence that conventional technical routines can miss (Akrich, 1992; Fricker, 2007; Jasanoff, 2003). Chapters 3 and 4 convert those layers into the actor-authority map and the PIIA. Where I give a page pinpoint for scholarship, it refers to the source’s own pagination rather than the page on which the source appears in a compiled full-text packet. I omit a page pinpoint when the available copy does not permit reliable verification.

The legal method is interpretive. Canadian statutory interpretation reads legislative text in its full context and in light of statutory purpose (Sullivan, 2022; *Canada Trustco*, 2005 SCC 54 at para 10). I use that method to develop a prospective interpretation of engineers’ public-interest mandate. *Vavilov* adds the administrative-law requirement that a regulator justify its

interpretation through reasons responsive to the governing legal scheme and the evidence before it (*Vavilov*, 2019 SCC 65 at paras 85-87, 108-110).

Professional-regulation analysis then follows statutory powers into the institutions that use them (Adams, 2022; Casey, 2025). Statutory analysis identifies the power; professional-regulation analysis examines how it operates through an authorized standard, guidance document, or disciplinary process (Adams, 2022; *Green*, 2017 SCC 20 at paras 24-25, 44). Administrative-law limits remain part of that analysis (*Vavilov*, 2019 SCC 65 at paras 85-87, 108-110). When a statutory decision limits a right protected by the *Canadian Charter of Rights and Freedoms* (the Charter), *Doré* and *Loyola* require reasons that reflect the relevant Charter protection within the statutory mandate (*Doré*, 2012 SCC 12 at para 57; *Loyola*, 2015 SCC 12 at paras 39-40).

The socio-technical layer explains why a material disparate-impact risk can be technical and social at the same time. Madeleine Akrich uses scripts to describe assumptions about users and roles built into an artefact (Akrich, 1992). Langdon Winner explains how technical arrangements can distribute power and access (Winner, 1980). Sheila Jasanoff uses civic epistemology to describe how public institutions establish credible knowledge, and co-production to describe the joint formation of technical knowledge and public authority (Jasanoff, 2003, 2004). These concepts help locate the engineering decisions that shape risk, evidence, and participation (Akrich, 1992; Jasanoff, 2003, 2004; Winner, 1980).

Engineering-studies and engineering-ethics scholarship keeps that explanation connected to professional practice. Erin Cech shows how engineering education can bracket public-welfare questions from technical problem definition (Cech, 2014). Donna Riley connects engineering ethics to power and distribution (Riley, 2008). Jon Leydens and Juan Lucena show how engineering

education can connect technical choices to structural conditions and community knowledge (Leydens & Lucena, 2016). Joseph Herkert’s distinction between individual and collective professional ethics helps allocate responsibility across practitioners and institutions (Herkert, 2000).

I use justice scholarship for a focused translation rather than a general theory survey. Chapter 4 organizes the inquiry through burden, access, and knowledge because each question maps to part of the threshold test (Atrey, 2019; Fraser, 2009; Hamraie, 2017; Young, 1990). Burden asks who carries the risk. Access asks which public-facing interest is impaired. Knowledge asks what evidence makes the risk known or reasonably knowable (Fricker, 2017; Hamraie & Fritsch, 2019; McGill, 2021).

Katharine Bartlett developed the woman question as a method for testing the apparent neutrality of legal rules. The method asks whether women have been left out, how the omission occurs, and what difference their inclusion would make (Bartlett, 1990, pp. 837–849). I adapt the structure rather than the identity category. When a technical requirement assumes a default user, use condition, or acceptable burden, I ask which affected public has been built into the requirement and which has been omitted (Bartlett, 1990, pp. 837–849; Atrey, 2019). The answer identifies an issue for further evidence; the six-part threshold test determines whether the issue enters the professional-responsibility framework (Engineers Canada, 2024a; Professional Engineers Ontario, 2020).

Bartlett’s feminist practical reasoning keeps the inquiry tied to a specific dilemma and the consequences of the available choices rather than an abstract statement of principle (Bartlett, 1990, pp. 850–863). Her account of consciousness-raising explains how people can compare

experiences, identify a recurring pattern, and revise an initial theory in light of what those experiences reveal (Bartlett, 1990, pp. 863–866). In this thesis, those methods support close comparison among design options and repeated accounts of system use. Technical evidence and legal authority then determine what can be verified and which actor can respond (Professional Engineers Ontario, 2020; Adams, 2022).

Richard Delgado’s counterstory method addresses a related problem: dominant groups can tell stories that make an existing arrangement appear natural and self-confirming, while accounts that challenge its premises remain difficult to hear (Delgado, 1989, pp. 2412–2415). Mari Matsuda’s instruction to look to the bottom calls for “adopting the perspective of those who have seen and felt the falsity of the liberal promise” and for studying their actual history and experience (Matsuda, 1987, pp. 324–325). I use these methods to examine affected-public accounts that identify an omitted exposure, route, or failure mode. They can also identify a form of technical uncertainty absent from the existing record. Those accounts enter the evidentiary record alongside models, standards, and professional opinions; the PIIA records what each source can establish and what further verification is required (Fricker, 2007; Jasanoff, 2003; Raji *et al.*, 2020).

The method also attends to how evidence is produced. Ann Oakley’s critique of detached interviewing and her later reassessment of power over time show that research evidence emerges through relationships shaped by time and authority (Oakley, 1981, 2016). Rachel Thwaites explains that rapport and emotional labour shape feminist interviewing, while Mary Maynard and June Purvis place method within power and interpretation (Maynard & Purvis, 1994; Thwaites, 2017). I apply those insights when reading published interviews, public comments, and community

accounts by considering both the speaker’s position and the conditions under which the evidence entered the record (Maynard & Purvis, 1994; Oakley, 2016; Thwaites, 2017).

Professional education supplies a further institutional site. Kim Brooks and Debra Parkes show how queer pedagogy can reshape professional categories and classroom practice (Brooks & Parkes, 2004). Carrie Menkel-Meadow connects hierarchy and decontextualized reasoning to legal education (Menkel-Meadow, 1988). I use these sources as an institutional analogy for engineering education, where curriculum and accreditation shape which public-interest questions become professionally visible (Engineers Canada, 2024c; Liu *et al.*, 2024).

Together, these methods establish the thesis’s rule of evidence. Each source type answers a different question. Statutes, regulations, and cases establish legal authority and legal limits (Sullivan, 2022; *Vavilov*, 2019 SCC 65 at paras 85–87, 108–110). Regulator guidance and technical standards identify professional practices or governance processes, with force that depends on adoption under an authorized mechanism (Adams, 2022; Professional Engineers Ontario, 2020; IEEE, 2021). Scholarly and affected-public sources help identify risk mechanisms, use conditions, and institutional patterns that require examination (Fricker, 2007; Hamraie, 2017; Jasanoff, 2003).

The evidence remains complementary because each source performs different work. A hydrogeological model addresses simulated groundwater movement, while affected-community observations can identify local conditions or questions absent from the model record (Mushtaq, 2011; Professional Engineers Ontario, 2019). Indigenous legal orders and land-based knowledge address relationships, responsibilities, and questions of jurisdiction (Borrows, 2010; Simpson, 2014; Whyte, 2020). The recurring examples provide analytical applications that show how the proposed

framework organizes evidence and authority. Chapter 5 identifies pilot studies and comparative research needed to test the PIIA’s effectiveness in practice (IEEE, 2021; Raji *et al.*, 2020).

The three recurring examples are arranged to test the framework at different distances from licensed professional engineering. Site 41 is the central engineering example because groundwater science, landfill design, and technical disclosure were central to the proposed landfill dispute near Midland, Ontario (Environmental Commissioner of Ontario, 2004, pp. 236-39; Ontario (Information and Privacy Commissioner), *Order MO-2449*; Mushtaq, 2011, 2013). Public washrooms are the engineering-adjacent example because plumbing and mechanical work can shape access while owners and building officials hold other parts of the decision (Cavanagh, 2010; City of Ottawa Building Code Services, 2021; Hamraie, 2017).

AI and LLM systems are the boundary example because professional responsibility depends on the particular work and the practice definition in the relevant province or territory (Engineers Canada, 2022; Scassa, 2021). Model evaluation or system integration can create a connection to engineering work where that statutory definition is satisfied (Engineers Canada, 2022; Professional Engineers Ontario, n.d.). Privacy commissioners, human-rights institutions, and sector-specific authorities govern other parts of the wider system (Scassa, 2021; Law Commission of Ontario & Ontario Human Rights Commission, 2024).

The repeated use of the examples is cumulative. Chapter 2 determines whether each example satisfies all six threshold criteria. Chapter 3 identifies the actor with authority and the available mechanism. Chapter 4 applies the PIIA and specifies the evidence, decision, and response that should be documented (IEEE, 2021; Raji *et al.*, 2020).

1.5.1. Recurring Example 1: Site 41 and Engineering-Heavy Public Infrastructure

Site 41 was a proposed landfill near Midland, Ontario. Hydrogeology, the study of how groundwater moves through soil and rock, was central to the engineering dispute (Environmental Commissioner of Ontario, 2004, pp. 236-39; Mushtaq, 2011, 2013). The dispute also concerned leachate, the contaminated liquid produced by a landfill, and the engineering controls intended to contain it (Environmental Commissioner of Ontario, 2004, pp. 237-38; Professional Engineers Ontario, 2019). Groundwater modelling and access to technical information connected those questions to environmental approval and Indigenous or community water protection (Ontario (Information and Privacy Commissioner), *Order MO-2449*; Mushtaq, 2011, 2013).

Site 41 involved institutions with distinct forms of authority. The Ministry of the Environment and the environmental-assessment bodies exercised public-law functions, while Simcoe County acted as the municipal proponent (Environmental Commissioner of Ontario, 2004, pp. 236-39; Mushtaq, 2011, 2013). Consultants and peer reviewers produced or tested the technical record, while the Information and Privacy Commissioner addressed access to records (Ontario (Information and Privacy Commissioner), *Order MO-2449*; Mushtaq, 2011). PEO's relevance concerned professional competence and conduct rather than project approval (Professional Engineers Ontario, 2019; *Environmental Protection Act*, RSO 1990, c E.19, s 27). Hydrogeological investigation, landfill design, and technical advice provide the engineering work examined in the thesis (Environmental Commissioner of Ontario, 2004, pp. 236-39; Professional Engineers Ontario, 2019).

The sequence of analysis is deliberate: Chapter 2 asks whether the Site 41 risk satisfies the six threshold criteria. Chapter 3 identifies which engineering actors and public authorities held

the relevant powers. Chapter 4 identifies the documents, tests, and decisions that a PIIA would have required.

1.5.2. Recurring Example 2: Public Washrooms and Ordinary Code-Mediated Infrastructure

Public washrooms provide an ordinary built-environment example because access can turn on fixture counts, mechanical systems, and code interpretation (Anthony & Dufresne, 2007; City of Ottawa Building Code Services, 2021). A fixture count is the code-based calculation of how many toilets, urinals, or lavatories a building population requires (National Research Council Canada, 2022). The calculation usually depends on occupancy assumptions about how many people use the building and when they use it (National Research Council Canada, 2022). Washroom design can affect trans, non-binary, and Two-Spirit users through safety or forced disclosure (Cavanagh, 2010; Ontario Human Rights Commission, 2014). Disabled and caregiving users may experience distinct access barriers (Castrodale & Lane, 2015; Hamraie, 2017).

The allocation of authority is as important as the design problem. The owner and architect ordinarily structure the facility program and layout (City of Ottawa Building Code Services, 2021; *Building Code*, O Reg 163/24). The authority having jurisdiction, meaning the building official or public body legally responsible for administering the code, decides compliance within its statutory mandate (*Building Code Act, 1992*, SO 1992, c 23, ss 3, 8). Engineers may contribute fixture calculations, plumbing design, or mechanical ventilation where those tasks fall within the assignment (City of Ottawa Building Code Services, 2021; National Research Council Canada, 2022; Professional Engineers Ontario, 2020). Human-rights law supplies the legal floor for access

to services and facilities (*Human Rights Code*, RSO 1990, c H.19, ss 1, 6; *Canadian Human Rights Act*, RSC 1985, c H-6, s 5).

Within that allocation, the engineering actor asks whether a technical assumption creates a known or reasonably knowable access risk. The engineer can document code flexibility and identify technical constraints (City of Ottawa Building Code Services, 2021; National Research Council Canada, 2022). The engineer can also raise accessibility implications with the project lead or present a technically sound alternative within scope (Hamraie, 2017; Ontario Human Rights Commission, 2014). The owner makes the facility-program decision, and the code authority makes the compliance decision assigned by sections 3 and 8 of Ontario’s *Building Code Act, 1992* (*Building Code Act, 1992*, SO 1992, c 23, ss 3, 8; City of Ottawa Building Code Services, 2021).

Chapter 2 applies the threshold test to this ordinary facility decision. Chapter 3 separates engineering work from the owner’s program decision and the code authority’s decision. Chapter 4 shows how the PIIA connects calculations, user evidence, and post-occupancy review (Hamraie, 2017; Raji *et al.*, 2020). Post-occupancy review means examining how the facility performs after people begin using it (Hamraie, 2017; City of Vancouver, 2024).

1.5.3. Recurring Example 3: Artificial Intelligence and Large Language Models at the Boundary of Licensed Professional Engineering

AI and LLMs form the boundary example because their governance is distributed across engineering, privacy, and sector-specific institutions (Engineers Canada, 2022; Scassa, 2021). Generative Pre-trained Transformer 3 (GPT-3) is an early large language model that generates text from statistical patterns learned during training (Abid *et al.*, 2021; Bender *et al.*, 2021). Abubakar Abid, Maheen Farooqi, and James Zou found persistent associations between Muslims

and violence in the GPT-3 configuration they tested (Abid *et al.*, 2021). That study provides a concrete example of representational harm: model output that stereotypes or misdescribes a group in a way that can affect dignity or institutional treatment (Abid *et al.*, 2021; Blodgett *et al.*, 2020).

Emily Bender and colleagues explain how large training datasets can carry dominant social patterns and documentation gaps into model behaviour (Bender *et al.*, 2021). Su Lin Blodgett and colleagues add that technical bias research needs a clear account of the harm and the people affected (Blodgett *et al.*, 2020).

The professional engineering question depends on the particular work and jurisdiction (Engineers Canada, 2022). Engineers Canada distinguishes software engineering from software work generally and assigns interpretation of the practice boundary to each provincial or territorial regulator (Engineers Canada, 2022). Validation is testing whether a system performs its intended function under stated conditions, while systems integration connects the model to software, human review, or physical infrastructure so that the combined system performs an assigned function (Engineers Canada, 2022; IEEE, 2021). Professional responsibility may arise when a licensed engineer validates an AI-enabled component in a transportation or water system and the work satisfies the applicable practice definition (Engineers Canada, 2022; Professional Engineers Ontario, n.d.). It may also arise through procurement or monitoring when the engineer accepts responsibility for a safety-relevant engineered use (Engineers Canada, 2022; IEEE, 2021).

Chapter 2 asks when a specific AI or LLM use satisfies the threshold test. Chapter 3 determines whether the relevant integration or validation is professional engineering. Chapter 4

applies the PIIA to a defined maintenance-report use while other governance institutions retain their own authority.

1.6. Alberta, the Trinity Western University Decisions, and Statutory Limits

Alberta provides a time-sensitive jurisdictional example. At the July 2026 date of this thesis, professional engineering in Alberta remains governed by the *Engineering and Geoscience Professions Act* and the *Engineering and Geoscience Professions General Regulation* (*Engineering and Geoscience Professions Act*, RSA 2000, c E-11, ss 2, 10, 19, 43-63; *Engineering and Geoscience Professions General Regulation*, Alta Reg 150/99, Sched 1). The *Professional Governance Act* received Royal Assent in 2025, and the Alberta government states that initial proclamation is expected in the second half of 2026 with implementation staggered by professional organization (*Professional Governance Act*, SA 2025, c P-25.5; Government of Alberta, 2026). The *Regulated Professions Neutrality Act* is enacted, but its engineering provisions take effect when the *Professional Governance Act* comes into force for the engineering profession (*Regulated Professions Neutrality Act*, SA 2025, c R-13.3; Government of Alberta, 2025, 2026).

The enacted neutrality statute establishes future constraints that matter to implementation. Section 1(2) preserves rights and duties under the *Alberta Human Rights Act* (*Regulated Professions Neutrality Act*, SA 2025, c R-13.3, s 1(2); *Alberta Human Rights Act*, RSA 2000, c A-25.5). Sections 7 and 8 limit regulator-mandated training concerning cultural competency, unconscious bias, and EDI, while section 9 addresses educational credentials containing related material (*Regulated Professions Neutrality Act*, SA 2025, c R-13.3, ss 7-9). Section 10 requires correctness review for specified questions, meaning that a reviewing court

decides those legal questions without deferring to the regulator’s interpretation (*Regulated Professions Neutrality Act*, SA 2025, c R-13.3, s 10).

The implementation sequence must therefore distinguish present authority from the enacted constraints that will apply later. Under Alberta’s current *Engineering and Geoscience Professions Act* and General Regulation, a regulator must identify the competence, conduct, or ethical power that authorizes a requirement (*Engineering and Geoscience Professions Act*, RSA 2000, c E-11, ss 19, 43-63; *Engineering and Geoscience Professions General Regulation*, Alta Reg 150/99, Sched 1). When the *Regulated Professions Neutrality Act* becomes operative for engineering, a regulator-created training requirement must also comply with sections 7 to 10 (*Regulated Professions Neutrality Act*, SA 2025, c R-13.3, ss 7-10). A PIIA requirement is strongest when it is tied to defined engineering work and evidence of a material disparate-impact risk, then implemented through a competence or ethics mechanism within the regulator’s lawful role (Government of Alberta, 2025; Adams, 2022).

Other actors retain their own authority. A university may teach social context through curricular authority, subject to the applicable credential provisions when they become operative (Engineers Canada, 2024c; *Regulated Professions Neutrality Act*, SA 2025, c R-13.3, s 9). An employer may require a project risk process through contract or quality management (Herkert, 2000; IEEE, 2021). Human-rights institutions continue to apply the *Alberta Human Rights Act* within their statutory jurisdiction (*Regulated Professions Neutrality Act*, SA 2025, c R-13.3, s 1(2); *Alberta Human Rights Act*, RSA 2000, c A-25.5).

The two Trinity Western University decisions show a bounded equality-informed use of public-interest authority. In *Trinity Western University v Law Society of Upper Canada* (*TWU v*

LSUC), the Supreme Court reviewed Ontario’s law-society accreditation decision and accepted that the regulator could consider equal access to the profession and harm to lesbian, gay, bisexual, transgender, and queer (LGBTQ) applicants (*TWU v LSUC*, 2018 SCC 33 at paras 20, 24, 39). In *Law Society of British Columbia v Trinity Western University (LSBC v TWU)*, the Court accepted equality, diversity, access, and public confidence as considerations within the British Columbia law society’s statutory mandate (*LSBC v TWU*, 2018 SCC 32 at paras 34, 40-43).

The decisions support equality-informed regulatory judgment when a professional regulator exercises an assigned statutory power (Adams, 2022; *TWU v LSUC*, 2018 SCC 33 at paras 20, 24, 39; *LSBC v TWU*, 2018 SCC 32 at paras 34, 40-43). The bridge to engineering practice comes from the professional-engineering statute and subordinate regulations in the relevant province or territory, together with the competence standard and role-specific authority engaged by the particular decision (*Professional Engineers Act*, RSO 1990, c P.28, ss 1(1), 2(3)-(4), 7; Engineers Canada, 2024a).

1.7. Contributions

The first contribution is conceptual. Material disparate-impact risk gives the thesis a defined category rather than a catalogue of technology-related harms (Barocas & Selbst, 2016; *Professional Engineers Act*, RSO 1990, c P.28, ss 1(1), 2(3)). The category requires a non-trivial negative risk and a structurally marginalized affected public (*Fraser*, 2020 SCC 28 at paras 30-31, 47-50; Hamraie, 2017). It also requires a connection to engineering work (*Professional Engineers Act*, RSO 1990, c P.28, s 1(1); Akrich, 1992). The protected public-facing interest may

concern access, environmental security, or contestability, depending on the evidence and the engineering role (Jasanoff, 2003; Hamraie, 2017).

The second contribution is institutional. The actor-authority map serves practitioners by identifying who can perform or escalate each step (Adams, 2022; Herkert, 2000). It serves institutions by identifying who can require and fund the work, and who can decide the outcome (Adams, 2022; Bielefeldt, 2018). Provincial and territorial regulators license engineers and govern practice through statute (Engineers Canada, 2022). Engineers Canada develops national guidance, while the Canadian Engineering Accreditation Board (CEAB) evaluates undergraduate programs against accreditation criteria (Engineers Canada, 2024c). Employers and project leads control many project-level decisions (Herkert, 2000; Kirkscey *et al.*, 2023). This allocation prevents a duty from being assigned to a person who lacks the legal mechanism or organizational authority to carry it out (Adams, 2022; Bielefeldt, 2018).

The third contribution is doctrinal. Open-textured describes a statutory term whose application requires context and judgment rather than a single fixed rule (Sullivan, 2022; *LSBC v TWU*, 2018 SCC 32 at para 34). I argue that public-interest language in the statute and regulations governing professional engineering in a province or territory can include material disparate-impact risk when the interpretation is tied to statutory purpose, professional competence, and actor authority (*Professional Engineers Act*, RSO 1990, c P.28, ss 1(1), 2(3); *Vavilov*, 2019 SCC 65 at paras 85-87, 108-110). Human-rights law supplies the rights floor, while role-specific due care supplies the earlier professional inquiry into evidence, documentation, and escalation (*Human Rights Code*, RSO 1990, c H.19, ss 1, 5-6, 34-45.2; *Fraser*, 2020 SCC 28 at paras 30-31, 47-50; Engineers Canada, 2024b).

The fourth contribution is operational. Chapter 4 converts the threshold test and actor-authority map into the Public-Interest Impact Assessment (PIIA), a sequence that can be reviewed at defined project decisions (Costanza-Chock *et al.*, 2022; Raji *et al.*, 2020). The contribution lies in the connection between the initial threshold decision, the evidence retained for review, and the response assigned to an actor with authority (Engineers Canada, 2024b; IEEE, 2021). The PIIA also states when changed evidence or system conditions require the assessment to be reopened (IEEE, 2021; Raji *et al.*, 2020).

1.8. Thesis Roadmap

The chapters follow one application sequence. Chapter 2 decides whether all six threshold criteria are supported by evidence. Chapter 3 identifies the actor with authority and the legal or institutional mechanism available to that actor. Chapter 4 applies the PIIA. Chapter 5 returns to the contribution, limits, and future work.

Chapter 2, “Material Disparate-Impact Risk and **Professional Visibility**,” performs the threshold analysis. It applies the stable definitions from section 1.2 rather than creating a second set of terms. The chapter then tests Site 41, public washrooms, and AI and LLM systems. Its output is a written explanation of the evidence for each criterion and the actor whose authority must be examined next.

Chapter 3, “The Public-Interest Mandate and Professional Authority,” establishes who can act and through which mechanism. It explains public interest as the organizing statutory term, then maps the powers of regulators, employers, public authorities, educators, and individual engineers. The chapter also addresses software scope, the Alberta constraint, and the Trinity

Western University decisions. Its final step separates the human-rights floor from role-specific due care.

Chapter 4, “Public-Interest Impact Assessment: **Justice Questions** into Due Care,” turns the legal and institutional analysis into a professional process. Burden identifies the patterned uneven allocation of risk. Access identifies the public-facing interest impaired. Knowledge identifies what makes the risk known or reasonably knowable. The PIIA then uses those questions through identify, assess, and respond, and applies the sequence to each recurring example.

Chapter 5, “Conclusion: **Technological Accountability** with Limits,” returns to the research question and the three recurring examples. It identifies what the framework changes, which decisions remain with other actors, and where future work is required. The conclusion locates the thesis’s contribution in a legally bounded account of public-interest engineering. The roadmap I propose is practical: identify the qualifying risk, locate the actor with authority, and respond through a reviewable professional process (Engineers Canada, 2024a, 2024b; IEEE, 2021).

2

Material Disparate-Impact Risk and Professional Visibility

There is no such thing as a single-issue struggle because we do not live single-issue lives. ... Our struggles are particular, but we are not alone.

—Audre Lorde (1984, p. 138)

2.1. The Threshold Test

Audre Lorde’s epigraph establishes the premise for this chapter: public-interest burdens rarely arrive as single-issue problems (Lorde, 1984). In this chapter, I apply the terms defined in Chapter 1 through six questions asked in sequence. The central question is whether the evidence establishes what I call a material disparate-impact risk. A “yes” to every question produces a written threshold test analysis that carries the issue to Chapter 3. When a criterion is unsupported, I identify the missing connection and direct the underlying concern to the legal, political, or institutional process with the relevant authority (Adams, 2022; *Human Rights Code*, RSO 1990, c H.19, ss 1, 5–6, 34–45.2; *Environmental Protection Act*, RSO 1990, c E.19, s 27).

A material disparate-impact risk enters this thesis’s framework only when all six criteria are satisfied:

1. the risk is more than remote or minor;
2. the risk may impair a public-facing interest;
3. the burden falls in a patterned and uneven way;

4. engineering work creates or significantly shapes the risk;
5. the risk is known or reasonably knowable to a competent actor within role; and
6. an actor has authority to take a role-specific response.

The criteria are cumulative, and their order guides the reader through the reasoning. Criteria 1 to 3 establish seriousness, the public-facing interest, and the patterned uneven burden. Criterion 4 identifies the engineering work that creates or significantly shapes the risk. Criteria 5 and 6 identify what a competent actor could know and what that actor can do within authority. The issue enters the engineering-responsibility framework only when evidence supports all six answers (Engineers Canada, 2024a, 2024b; Professional Engineers Ontario, 2020).

The output of this chapter is a short written analysis rather than a free-standing label. It states the evidence for each criterion and identifies the uncertainty that remains. It also names the engineering work and the actor whose authority Chapter 3 must examine. In this way, the threshold test converts a broad concern about inequitable technology into a bounded professional-responsibility question (Akrich, 1992; Bowker & Star, 1999; Engineers Canada, 2024b).

The threshold test is used while an engineering choice remains open or a later decision can still change the risk (Professional Engineers Ontario, 2020; Engineers Canada, 2024b). The actor should place the analysis in an existing project document suited to the work, such as a design-review memorandum, model-review note, or validation report. That document identifies the evidence, the decision still available, and the response within authority (Professional Engineers Ontario, 2020; IEEE, 2021). Silvio Funtowicz and Jerome Ravetz describe this kind of setting as one where “facts are uncertain, values in dispute, stakes high and decisions urgent” (Funtowicz & Ravetz, 1993, p. 744).

Each recurring example contains such a decision point. At Site 41, groundwater modelling and access to technical information were contested before the landfill received waste (Environmental Commissioner of Ontario, 2004, pp. 236-39; Ontario (Information and Privacy Commissioner), *Order MO-2449*). In a washroom project, fixture counts and mechanical systems can be addressed during design or renovation, while location and accessibility can be tested before final acceptance (Anthony & Dufresne, 2007; City of Ottawa Building Code Services, 2021; Hamraie, 2017). In an AI or LLM system, testing and documentation can identify a patterned output before a public-facing deployment, and monitoring can reopen the decision after deployment (Raji *et al.*, 2020; IEEE, 2021).

The examples also test different distances from licensed practice. Site 41 is engineering-heavy because groundwater modelling and landfill design were central to the dispute (Environmental Commissioner of Ontario, 2004, pp. 236-39; Ontario (Information and Privacy Commissioner), *Order MO-2449*; Mushtaq, 2011, 2013). Public washrooms are code-mediated because plumbing and mechanical work operate inside decisions also held by owners, architects, and building officials (Anthony & Dufresne, 2007; City of Ottawa Building Code Services, 2021). AI and LLMs form the boundary example because professional responsibility depends on the particular work and the practice definition in the governing province or territory (Abid *et al.*, 2021; Engineers Canada, 2022; Raji *et al.*, 2020).

2.2. Criterion 1: The Risk Is More Than Remote or Minor

The first criterion asks whether the evidence makes the risk serious enough for a competent engineering actor to record it and determine the available response. Engineering practice already

uses investigation and documentation to distinguish a material risk from a remote concern (Professional Engineers Ontario, 2019). Review and monitoring add evidence when a system is complex or changing (Raji *et al.*, 2020). I apply that familiar discipline to a patterned uneven burden created or significantly shaped by engineering work.

Seriousness is assessed in relation to the public-facing interest and the evidence available at the decision point (Engineers Canada, 2024a; Professional Engineers Ontario, 2019). Ontario’s practice definition expressly includes public welfare and the environment among the protected interests (*Professional Engineers Act*, RSO 1990, c P.28, s 1(1)). PEO’s solid-waste guideline likewise places public welfare and environmental protection within professional engineering practice (Professional Engineers Ontario, 2019). The first criterion therefore asks whether the record gives the actor a reasonable basis for treating the risk as part of the work.

Evidence can come from technical records, affected-public knowledge, or institutional records (Fricker, 2007; Hamraie, 2017; Raji *et al.*, 2020). An audit, code interpretation, or regulatory source may supply further evidence (Raji *et al.*, 2020; National Research Council Canada, 2022). The form of the source is secondary to the demonstrated connection among the evidence, the engineering work, and the public-interest burden.

In Site 41, the risk was more than remote or minor because the proposed landfill raised groundwater and leachate-containment concerns in a site-specific dispute (Environmental Commissioner of Ontario, 2004; Mushtaq, 2011, 2013). Dewatering—the pumping or drainage used to lower groundwater during construction—was part of the technical record (Environmental Commissioner of Ontario, 2004). The upward-gradient containment concept relied on groundwater pressure moving toward the waste area so that leachate would be less likely to migrate away from

the site (Environmental Commissioner of Ontario, 2004). Usman Mushtaq reports that peer reviewers said the site would require “more than usual precautions” to design and operate (Mushtaq, 2013).

Site 41 also shows why the seriousness criterion operates while approval, design, and documentation choices remain open. The public-interest question focused on whether groundwater risk and model assumptions required careful professional attention during approval and design. Access to technical information was part of that professional question (Environmental Commissioner of Ontario, 2004; Ontario (Information and Privacy Commissioner), *Order MO-2449*; Mushtaq, 2011, 2013). The threshold test asks whether the evidence available during the engineering work made the risk serious enough for documentation and escalation.

In public washrooms, the risk is more than remote or minor when a design or renovation may prevent affected users from using a public-facing facility safely and equivalently. Sheila Cavanagh calls public washroom conflict a “manifestly mundane issue” (Cavanagh, 2010). That quote matters because it captures the ordinary surface of the example. Washrooms can look small from a project-management perspective, but access to a washroom can determine whether a person can remain in a school, workplace, or public-service setting (Anthony & Dufresne, 2007; Cavanagh, 2010; Ontario Human Rights Commission, 2014). A remote washroom, an inaccessible washroom, or a washroom that exposes a user to harassment can make participation practically difficult for affected users. In this chapter, affected users include trans, non-binary, and Two-Spirit users. They also include disabled users, caregiving users, and older users (Anthony & Dufresne, 2007; Hamraie, 2017; Harwood-Jones *et al.*, 2023; Ontario Human Rights Commission, 2014).

In AI and LLM systems, the risk is more than remote or minor when model behaviour or deployment context can affect dignity, access, or credibility. It may also affect service delivery or professional judgment. Abubakar Abid, Maheen Farooqi, and James Zou’s GPT-3 study provides a concrete example of representational risk in language generation (Abid *et al.*, 2021). Their study is useful for this chapter because it identifies a technical pattern in outputs rather than relying on a general statement that AI can be biased (Abid *et al.*, 2021). The seriousness criterion is met when such model behaviour is connected to a public-facing use, such as summarization or moderation (Bender *et al.*, 2021; Raji *et al.*, 2020). Service triage—the sorting of cases for attention or escalation—is another public-facing use (Raji *et al.*, 2020). Professional advice and institutional record-making may also create public-facing uses (Bender *et al.*, 2021; Blodgett *et al.*, 2020; Raji *et al.*, 2020).

I begin criterion 1 with a direct question: is the evidence serious enough that competent professional judgment should record the risk and identify an available response (Engineers Canada, 2024a; Professional Engineers Ontario, 2020)? The answer must be supported by evidence that connects the risk to the engineering work and the public-facing interest at issue (Professional Engineers Ontario, 2019, 2020). The remaining threshold criteria still apply, so seriousness opens the inquiry without turning a remote concern or minor inconvenience into a professional obligation (Engineers Canada, 2024a; Professional Engineers Ontario, 2020).

2.3. Criterion 2: The Risk May Impair a Public-Facing Interest

The second criterion asks which public-facing interest the engineering work may impair. Section 1.2 defines that term as an interest affected through a system, facility, or technical record

that reaches beyond a purely private preference. The recurring examples involve environmental security, safe and equivalent access, and contestability. Contestability is the practical ability to obtain the basis for a technical decision, question its evidence or reasoning, and seek review or correction (Ontario (Information and Privacy Commissioner), *Order MO-2449*; Raji *et al.*, 2020; IEEE, 2021).

In this chapter, I use three public-facing interests because they map onto the recurring examples:

- environmental security;
- access and dignity;
- contestability of technical decisions.

The working set supplies the interests needed for the three recurring examples. Environmental security is central to Site 41 because the dispute concerned groundwater and source-water protection (Environmental Commissioner of Ontario, 2004; Mushtaq, 2011, 2013). Access and dignity are central to washrooms because facility design affects whether people can remain in public-facing buildings (Anthony & Dufresne, 2007; Ontario Human Rights Commission, 2014). Contestability is central to Site 41 and AI systems because affected publics may need the records, explanations, or correction pathways required to challenge a technical conclusion (*Order MO-2449*; Raji *et al.*, 2020; IEEE, 2021).

The public-interest mandate supplies the professional connection, while other statutes can specify the protected interest in a particular setting. Ontario’s *Professional Engineers Act* includes public welfare and the environment within the practice definition (*Professional Engineers Act*, RSO 1990, c P.28, s 1(1)). The *Clean Water Act, 2006* states a more specific water-law purpose:

protecting existing and future sources of drinking water (*Clean Water Act, 2006*, SO 2006, c 22, s 1). Its definition of a drinking-water threat addresses risks to water quality or quantity (*Clean Water Act, 2006*, SO 2006, c 22, s 2(1)). Those provisions show how a broad public-interest concern becomes concrete in a particular regulatory context.

The Site 41 example makes this criterion concrete. The public-facing interest was groundwater protection and the ability of affected publics to understand technical assurance. The Information and Privacy Commissioner described the requested records as the “calibrated hydrogeological model and accompanying input data” prepared for the Site 41 landfill (Ontario (Information and Privacy Commissioner), *Order MO-2449*). That quote shows public concern attached to a technical object: a model and its input data. Technical contestability became part of the public-facing interest.

The washroom example makes a different public-facing interest concrete. The public-facing interest is access to a facility that makes participation possible. A washroom layout can affect whether a person can remain in a public-facing environment without fear, humiliation, or exclusion (Anthony & Dufresne, 2007; Cavanagh, 2010; Ontario Human Rights Commission, 2014). Aimi Hamraie’s work on access helps frame why this interest is public-facing rather than private. Hamraie writes that access can be “negotiation” rather than a resolved end (Hamraie, 2017). That quote matters because code compliance and use experience are separate professional questions. The public-facing interest is usable, safe, and equivalent access.

AI and LLM systems illustrate the interest through language and institutional treatment. A language-model output may be generated text or a classification (Bender *et al.*, 2021; Blodgett *et al.*, 2020). It may also be a summary or recommendation (Bender *et al.*, 2021; Raji *et al.*, 2020).

In a public-facing setting, that output may affect how a person is described, believed, or served (Abid *et al.*, 2021; Blodgett *et al.*, 2020). It may also affect what evidence a professional sees before making a decision (Parasuraman & Manzey, 2010; Raji *et al.*, 2020).

Criterion 2 is stated in the language of the project so the reader can see what is at stake. At Site 41, the public-facing interests are groundwater protection and the ability to examine the technical basis for accepting risk (Environmental Commissioner of Ontario, 2004, pp. 236-39; Ontario (Information and Privacy Commissioner), *Order MO-2449* at 7-8). In the washroom example, the interest is safe and equivalent access to a public-facing facility (Ontario Human Rights Commission, 2014; Hamraie, 2017). In the AI and LLM example, the interests are dignity, contestability, and reliability in the defined use (Abid *et al.*, 2021; Raji *et al.*, 2020). Each answer must be supported by evidence from the project or system being assessed (Engineers Canada, 2024b; IEEE, 2021).

2.4. Criterion 3: The Burden Falls in a Patterned and Uneven Way

The third criterion asks whether the burden falls in a patterned and uneven way on structurally marginalized communities. Section 1.2 defines the stable terms, so this section performs the evidentiary work: it identifies the affected public, the recurring mechanism, and the institutional structure that helps produce the burden. Those three elements give the framework its equality-facing content (Crenshaw, 1989, 1991; *Fraser*, 2020 SCC 28 at paras 30-31, 47-50).

A burden is uneven when the system places a heavier or qualitatively different constraint on some publics (*Fraser*, 2020 SCC 28 at paras 30-31, 47-50; Hamraie, 2017). It is patterned when the constraint follows a recurring design, classification, or workflow rather than a random event

(Bowker & Star, 1999; Fraser, 2009). It is structural when durable institutional arrangements help produce or maintain that pattern (Crenshaw, 1989, 1991; Collins, 2000). Colonial, gendered, and ableist arrangements provide examples of such structures (Hamraie, 2017; Young, 1990).

Shreya Atrey explains that intersectionality concerns the distinctive structure produced when social positions and institutional arrangements combine (Atrey, 2019). The threshold test therefore asks how the burden is produced in the particular setting rather than adding separate scores for identity categories (Atrey, 2019; Crenshaw, 1989, 1991). This approach keeps the criterion tied to evidence of the actual pattern (Atrey, 2019; *Fraser*, 2020 SCC 28 at paras 30-31, 47-50).

A patterned uneven burden may arise through several engineering-connected pathways:

- a default user;
- a technical standard;
- a model behaviour;
- a code interpretation;
- an approval process;
- a documentation practice.

The pattern matters because the framework is concerned with a repeatable allocation of burden. A one-time technical failure may still require investigation under safety or quality norms (Engineers Canada, 2024a; Professional Engineers Ontario, 2020). Negligence and professional misconduct provide separate regulatory pathways where their requirements are met (*Professional Engineers Act*, RSO 1990, c P.28, ss 27-28; RRO 1990, Reg 941, s 72). This thesis's framework applies when the burden follows a structure. The structure may be an assumed body. It may be

an assumed user. It may be a dataset that carries institutional history. It may be a technical process that treats affected-public knowledge as outside scope.

Chapter 1 placed patterned uneven burden beside Canadian adverse-effect discrimination doctrine. Here, the question is evidentiary: does the available record show that the same rule, design, or workflow places an identifiable public under a recurring burden (*Fraser*, 2020 SCC 28 at paras 30-31, 47-50; Sheppard, 2024)? A finding under this criterion directs professional inquiry through the remaining threshold questions. A court or tribunal separately applies the governing legal test for discrimination (*Simpsons-Sears*, [1985] 2 SCR 536 at 551-52; *Meiorin*, [1999] 3 SCR 3 at paras 38, 54; *Moore*, 2012 SCC 61 at paras 26-29).

The patterned uneven burden criterion also draws from science and technology studies. Madeleine Akrich’s account of scripts in technical objects supports the claim that artefacts can configure users and relations (Akrich, 1992). Geoffrey Bowker and Susan Leigh Star’s work on classification supports the claim that categories can sort people in ways that become durable and hard to see (Bowker & Star, 1999). Langdon Winner’s account of artefacts and politics supports the claim that technical arrangements can have political qualities (Winner, 1980). These sources support a careful professional point: engineering work can build assumptions into systems even where no actor intends exclusion.

Affected-public knowledge is especially important to this criterion. Aimi Hamraie describes disabled people as “experts about their bodies and surrounding environments” (Hamraie, 2017, p. 113). That insight matters for engineering because affected publics may identify a patterned uneven burden before it appears in conventional metrics. A user blocked from an accessible washroom may see the burden before the technical record does. A community denied a

hydrogeological model or a group repeatedly stereotyped by an AI system may do the same (Ontario (Information and Privacy Commissioner), *Order MO-2449*; Hamraie, 2017; Raji *et al.*, 2020).

Miranda Fricker’s account of epistemic injustice explains why this evidence issue matters. Fricker describes a person being wronged in the person’s capacity as an epistemic subject (Fricker, 2017, p. 53). In operational terms, an engineering process can reinforce the patterned uneven burden when it repeatedly treats affected-public evidence as anecdotal despite its relevance to the risk (Fricker, 2007, 2017; Wynne, 1996). A reviewable engineering record therefore identifies that evidence and explains how it affected professional judgment.

Brian Wynne’s work on expert and lay knowledge supports the same point in environmental-risk settings. Wynne shows that situated knowledge about real-world operating conditions can remain under-recognized when expert systems privilege formal knowledge (Wynne, 1996). Site 41 makes the point concrete because the dispute concerned groundwater, modelling, and technical assumptions rather than generalized opposition to infrastructure (Environmental Commissioner of Ontario, 2004, pp. 236-39; Mushtaq, 2011, 2013).

Site 41 illustrates patterned uneven burden through place, water, and access to expertise. Local residents and farmers had to contest the proposed landfill’s technical record from outside the proponent’s institutional position (Environmental Commissioner of Ontario, 2004, pp. 236-39; Mushtaq, 2011, 2013). Indigenous communities and water protectors faced a related institutional asymmetry (Mushtaq, 2011, 2013). Usman Mushtaq’s sentence is direct: “Consultation did not mean participation” (Mushtaq, 2011, p. 110). The quote marks the difference between receiving information and having relevant knowledge shape the technical decision.

Washrooms illustrate patterned uneven burden through the assumed user. A binary washroom layout may appear ordinary because it is familiar. Familiarity can hide uneven burden. A trans user policed in a gendered washroom, a disabled user directed to a remote facility, or a caregiver blocked by gendered boundaries may face a burden that other users avoid (Anthony & Dufresne, 2007; Cavanagh, 2010; Hamraie, 2017; Ontario Human Rights Commission, 2014). The burden is patterned when the facility assumes binary gender, independent mobility, and privacy norms as its default user model.

Within criterion 3, the GPT-3 study matters because it supplies comparative output evidence rather than a general assertion that a model is biased (Abid *et al.*, 2021). Abubakar Abid, Maheen Farooqi, and James Zou tested prompts across religious terms and reported a recurring association between Muslim identity and violence (Abid *et al.*, 2021). Emily Bender and colleagues explain why training data and documentation remain relevant to the mechanism (Bender *et al.*, 2021). Su Lin Blodgett and colleagues require the analysis to identify the harm and the affected people (Blodgett *et al.*, 2020).

Criterion 3 therefore asks who bears the burden, how the pattern arises, and what evidence supports that account (*Fraser*, 2020 SCC 28 at paras 30-31, 47-50; Atrey, 2019). The answer identifies the affected public and the engineering-connected mechanism that produces or reinforces the pattern (Akrich, 1992; Hamraie, 2017). The risk enters the framework only when the connection to engineering work, knowability, and actor authority are also supported (Engineers Canada, 2024a, 2024b; Adams, 2022).

2.5. Criterion 4: Engineering Work Creates or Significantly Shapes the Risk

The fourth criterion supplies the professional scope boundary. It asks which act of engineering judgment created or significantly shaped the risk, what that act could change, and which decisions remain with other actors. The same public-interest risk may involve professional engineering, public law, and organizational governance (Adams, 2022; Engineers Canada, 2022; Professional Engineers Ontario, 2019). Indigenous law, human-rights law, or procurement may supply additional authority. Naming those decision boundaries keeps responsibility connected to the actor and mechanism that can use it.

Ontario illustrates the statutory method. Its practice definition covers specified acts that require engineering principles and concern a protected interest, including design, evaluation, advice, reporting, direction, and supervision (*Professional Engineers Act*, RSO 1990, c P.28, s 1(1)). The inquiry therefore begins with the actual work rather than the occupational title alone. The governing province’s or territory’s legislation controls the answer (Engineers Canada, 2022).

The connection to engineering work may appear through:

- modelling or technical assessment;
- design or code-related engineering judgment;
- validation or monitoring of software-intensive systems.

Site 41 provides the strongest connection to engineering work in this chapter. Hydrogeological investigation and groundwater modelling shaped how risk was presented (Environmental Commissioner of Ontario, 2004; *Order MO-2449*). Landfill design and leachate-containment analysis shaped the proposed controls (Professional Engineers Ontario, 2019). Peer

review, monitoring, and technical advice shaped the decision record (Environmental Commissioner of Ontario, 2004; Professional Engineers Ontario, 2019). PEO’s solid-waste guideline describes this work as multidisciplinary and recognizes public or Indigenous engagement as part of the wider process (Professional Engineers Ontario, 2019).

The Site 41 connection to engineering work includes:

- hydrogeological investigation;
- groundwater modelling;
- landfill design;
- leachate-containment analysis;
- peer review;
- monitoring plans;
- design and operations reporting;
- technical advice to public authorities.

The connection to engineering work in public washrooms is shared with other disciplines. Owners and architects often control the program or layout, while building officials apply the code (City of Ottawa Building Code Services, 2021). Engineering work can still shape access through plumbing systems and mechanical ventilation (City of Vancouver, 2024; National Research Council Canada, 2022). Code-related advice and retrofit feasibility can determine whether an option is technically available and functionally equivalent (City of Ottawa Building Code Services, 2021; Professional Engineers Ontario, 2020).

The washroom connection to engineering work includes:

- plumbing fixture calculations;

- drainage and water supply;
- mechanical ventilation;
- accessibility-related technical advice;
- retrofit feasibility;
- code-compliance documentation.

The connection to engineering work in AI and LLM systems depends on context, risk, and jurisdiction (Engineers Canada, 2022). The recurring example enters professional engineering where an engineering actor designs, validates, or integrates the system for a public-facing engineered use. Procurement specifications and monitoring can create further professional responsibility where the actor controls those decisions (Engineers Canada, 2022; IEEE, 2021).

The AI and LLM connection to engineering work may include:

- software validation;
- systems integration;
- reliability analysis;
- procurement specifications;
- technical documentation;
- audit design;
- deployment monitoring;
- escalation of known risks.

Institute of Electrical and Electronics Engineers (IEEE) Standard 7000 helps explain how public-interest concerns can enter an engineering process. The standard calls for ethical values to be considered throughout concept exploration and development (IEEE, 2021). It also requires

traceability, meaning a documented link from an identified value or requirement to the design decisions and evidence used to implement it (IEEE, 2021). That process language supports a reviewable connection between public-facing values and system requirements (IEEE, 2021). The standard supplies process guidance; the statute, regulations, and other law applicable in the province or territory where the work occurs continue to determine legal authority (Engineers Canada, 2022; IEEE, 2021).

Criterion 4 therefore asks which engineering work creates or significantly shapes the risk. The answer names the relevant act with enough specificity to connect the evidence to professional practice (*Professional Engineers Act*, RSO 1990, c P.28, s 1(1); Engineers Canada, 2022). Depending on the example, the work may be a model, a design, or a code interpretation (Professional Engineers Ontario, 2019, 2020; National Research Council Canada, 2022). It may instead be validation, monitoring, or technical advice (Raji *et al.*, 2020; IEEE, 2021). Documentation can itself shape the risk when it determines whether assumptions, limitations, or warnings can be reviewed (Ontario (Information and Privacy Commissioner), *Order MO-2449* at 7-8; Engineers Canada, 2024b).

2.6. Criterion 5: The Risk Is Known or Reasonably Knowable to a Competent Actor Within Role

The fifth criterion applies the evidence boundary defined in section 1.2. It asks whether ordinary professional diligence would have made the risk visible to a competent actor at the relevant decision point (Engineers Canada, 2024a, 2024b). The answer is role-specific because actors receive different records and control different parts of a system (Raji *et al.*, 2020). The

written analysis identifies both the evidence available and the evidence that a competent actor should have sought within the assignment.

For clarity, the chapter groups relevant evidence into three sources:

- Technical evidence: models, tests, or audits.
- Technical evidence may also include monitoring data, design reviews, or code interpretations.
- Technical evidence may also include prior incidents.
- Institutional evidence: complaints, guidance, or procurement records.
- Institutional evidence may also include approval conditions, practice guidelines, or internal review records.
- Affected-public evidence: lived access barriers, Indigenous water knowledge, or local environmental knowledge.
- Affected-public evidence may also include repeated user complaints or documented experience with the system.

The three evidence categories have no fixed hierarchy because their relevance depends on the risk and the actor's role (Fricker, 2007; Jasanoff, 2003; Professional Engineers Ontario, 2020). Technical evidence may show system behaviour, affected-public evidence may reveal use conditions, and institutional evidence may show how a decision was made (Hamraie, 2017; Wynne, 1996; Raji *et al.*, 2020). The question is whether a competent actor should have treated the evidence as relevant to the public-interest risk (Engineers Canada, 2024a, 2024b). This is the connection to professional visibility: a risk can be available in the world yet absent from the

engineering record because the project classifies affected-public evidence as outside scope (Cech, 2014; Fricker, 2007; Jasanoff, 2003).

Site 41 illustrates knowability through technical transparency. The United States Geological Survey’s modular finite-difference groundwater-flow model (MODFLOW) is a simulation program; engineers use it to represent how groundwater moves and how that movement may change under stated conditions (*Order MO-2449*). A calibrated model is a model whose parameters have been adjusted and checked against observed site data before it is used to simulate other conditions (*Order MO-2449*; Professional Engineers Ontario, 2019). The Information and Privacy Commissioner described the requested records as the “calibrated hydrogeological model and accompanying input data” prepared by Jagger Hims Limited, the private engineering consulting firm retained by Simcoe County for the Site 41 groundwater model (*Order MO-2449*). Access to the model files and inputs mattered because another reviewer needed them to examine the assumptions and reproduce the analysis (*Order MO-2449*).

The Site 41 record also shows why affected-public evidence matters. Mushtaq explains that consultation in Site 41 design texts was framed as convincing the community of the landfill (Mushtaq, 2011, 2013). That framing shows why the threshold test asks whether affected publics shaped the risk record rather than merely receiving technical conclusions. A public meeting can inform people about a decision while keeping their knowledge outside engineering judgment. Role-specific due care asks engineering actors to identify when that difference matters to the risk.

Washrooms illustrate knowability through code guidance, human-rights guidance, and accessibility practice. User evidence can also make the risk known or reasonably knowable. The National Research Council’s Proposed Change 1750 treats gender-neutral washrooms as code-

compatible where applicable fixture-count and privacy requirements are addressed (National Research Council Canada, 2022). The same source says designers and authorities having jurisdiction will have a clearer understanding that codes allow gender-neutral washrooms (National Research Council Canada, 2022). That source should be used carefully because proposed-change material has persuasive rather than binding force. It is still relevant to knowability because it makes code flexibility visible to designers and authorities.

The City of Ottawa advisory is also relevant to knowability because it addresses gender-inclusive washrooms in an Ontario building-code context (City of Ottawa Building Code Services, 2021). The Ontario Human Rights Commission’s policy on gender identity and gender expression is relevant because it identifies washroom and change-room access as a human-rights issue in services and facilities (Ontario Human Rights Commission, 2014). A design team that receives user complaints, human-rights guidance, and code guidance has more than a general inclusion preference before it. It has evidence that may require documentation and response.

AI and LLM systems make knowability visible through testing, audit, and documentation. Inioluwa Deborah Raji and colleagues explain that problems discovered after deployment can become difficult to trace to their source, which supports preserving evidence during development and deployment (Raji *et al.*, 2020, p. 33). They also warn that a checklist can become a box-ticking exercise when it records completion without the judgment behind it (Raji *et al.*, 2020, p. 36). The actor should therefore identify the evidence, explain the conclusion, and state the response available within role.

The knowability inquiry follows the accepted assignment. A mechanical engineer responsible for ventilation investigates evidence relevant to that system (Professional Engineers

Ontario, 2020). A software engineer responsible for validation investigates the evidence needed to test the accepted use (Engineers Canada, 2022; IEEE, 2021). A landfill engineer investigates hydrogeology, containment, and technical documentation within the assigned work (Professional Engineers Ontario, 2019). Ordinary professional diligence is assessed against the competence expected in that role (Engineers Canada, 2024a, 2024b).

The written analysis identifies the risk, the evidence source, and the assumptions that remain uncertain (Fricker, 2007; Professional Engineers Ontario, 2019; Raji *et al.*, 2020). It should also explain whether technical, institutional, and affected-public evidence converge or conflict (Jasanoff, 2003; Raji *et al.*, 2020). That explanation gives Chapter 3 a usable record for identifying the actor with authority.

2.7. Criterion 6: An Actor Has Authority to Take a Role-Specific Response

The sixth criterion connects the qualifying risk to an available response. An individual engineer, employer, or project lead may hold authority over part of the work, while a regulator, educator, or public authority may hold a different mechanism (Adams, 2022; Herkert, 2000). A standards body can influence practice through publication and adoption pathways (IEEE, 2021). Chapter 3 maps those differences in legal and organizational authority.

Chapter 2 uses five response verbs:

- investigate;
- document;
- mitigate;
- warn;

- escalate.

The five response verbs describe distinct actions. Investigation reviews the evidence needed to understand the risk within role (Professional Engineers Ontario, 2020). Documentation records the evidence, assumptions, and remaining uncertainty in a dated project document suited to the work (Professional Engineers Ontario, 2020; IEEE, 2021). Mitigation changes a condition the actor controls, while warning communicates a material limitation to a person who will rely on the work (IEEE, 2021; Engineers Canada, 2024b). Escalation carries the documented concern to the actor with authority to decide (Engineers Canada, 2024b; Professional Engineers Ontario, 2020). The same record identifies residual risk after feasible controls are applied (IEEE, 2021; Professional Engineers Ontario, 2020).

This allocation avoids assigning the whole problem to a person with little authority and avoids leaving every actor able to pass it elsewhere. A junior engineer may document a concern and raise it with a supervisor (Engineers Canada, 2024b). A project lead may require further analysis, while an employer can change scope or resources (Herkert, 2000; Bielefeldt, 2018). A regulator may issue guidance or address misconduct within statutory limits, and a public authority may alter an approval condition or procurement requirement within its mandate (Adams, 2022; *Vavilov*, 2019 SCC 65 at paras 108-110).

The authority criterion also guards against a form becoming a substitute for judgment. Raji and colleagues warn that a checklist can become box-ticking when it records completion without the evidence and reasoning behind the answer (Raji *et al.*, 2020, p. 36). A useful threshold analysis therefore identifies the action available to the actor and the decision that action can affect. The answer must be concrete enough to change a record, an analysis, or a decision pathway.

The Site 41 actors were distributed across professional and public institutions (Environmental Commissioner of Ontario, 2004; Mushtaq, 2011, 2013). Engineering actors shaped technical models and reports (Professional Engineers Ontario, 2019; *Order MO-2449* at 7-8). Peer review and public-facing technical assurances added further professional work (Environmental Commissioner of Ontario, 2004; Mushtaq, 2011, 2013). Their role-specific response would focus on assumptions and uncertainty (Professional Engineers Ontario, 2019). It would also address technical-access issues and residual risk (*Order MO-2449* at 7-8; Professional Engineers Ontario, 2019). Public authorities held project and approval powers (Environmental Commissioner of Ontario, 2004; *Environmental Protection Act*, RSO 1990, c E.19, s 27).

Washrooms illustrate role-specific authority because built-environment decisions are shared. Owners and institutional decision-makers may decide whether to adopt all-gender washrooms as policy. Engineers may still document fixture-count assumptions, identify code flexibility, and address ventilation. Engineers may also raise accessibility concerns and propose technically feasible options (City of Ottawa Building Code Services, 2021; National Research Council Canada, 2022; Ontario Human Rights Commission, 2014). An architect may hold layout authority. A building official may hold code-enforcement authority. An owner may hold budget authority. A human-rights office may hold institutional compliance authority. Role-specific due care asks what the engineering actor can do within that distribution.

In AI and LLM systems, authority depends on the system boundary and accepted role (Engineers Canada, 2022; Raji *et al.*, 2020). The system boundary is the set of technical components, interfaces, and decisions included in the engineered system under review (IEEE, 2021; Raji *et al.*, 2020). An engineer may have authority over validation or integration (Engineers

Canada, 2022; IEEE, 2021). Monitoring and documentation may provide further authority within the accepted assignment (Engineers Canada, 2022; Raji *et al.*, 2020). A vendor may control the base model, while an employer controls procurement and deployment (Raji *et al.*, 2020; Scassa, 2021). A public authority may control the use of the output in an administrative or public-service process (Scassa, 2021).

The sixth criterion therefore asks what this actor can actually do, within role, once the risk is known or reasonably knowable. The answer identifies the actor, the source of authority, and the available response. A documented warning can bring the risk to the decision-maker. A design revision can reduce the burden. An escalation can change which institution must decide (Engineers Canada, 2024b; Professional Engineers Ontario, 2020).

2.8. Site 41 Application

Site 41 is the central recurring example because landfill siting and hydrogeology structured the public risk. Groundwater modelling and leachate containment shaped the technical assurance, while access to the engineering record shaped whether that assurance could be independently examined (Environmental Commissioner of Ontario, 2004, pp. 236-39; Ontario (Information and Privacy Commissioner), *Order MO-2449*; Professional Engineers Ontario, 2019). In this section, I apply the six criteria to that combined technical and institutional record.

The record begins with a proposed landfill near Midland, Ontario, involving “landfilling on 21 hectares of land within a total site area of 60 hectares” (Environmental Commissioner of Ontario, 2004, p. 236). The approval history matters because the engineering evidence remained tied to public decisions over several decades. A landfill search began in 1979, and Site 41 was

selected by 1986 (Environmental Commissioner of Ontario, 2004, pp. 236-37). A hearing board declined approval in 1989, Cabinet returned the matter to the hearing process in 1990, and the board approved Site 41 in 1995 (Environmental Commissioner of Ontario, 2004, pp. 236-37). The Ministry of the Environment issued the certificate of approval in 1998 subject to later technical submissions (Environmental Commissioner of Ontario, 2004, p. 237; Mushtaq, 2011, 2013).

The later technical record matters because Simcoe County submitted further design and operations material in 2003. The Ministry of the Environment responded with comments about gull management, surface water, and groundwater pumping (Environmental Commissioner of Ontario, 2004, p. 237). It also addressed the landfill's leachate-containment design (Environmental Commissioner of Ontario, 2004, pp. 237-38; Mushtaq, 2011, 2013).

The first threshold criterion is satisfied because the groundwater risk was more than remote or minor in the project record (Environmental Commissioner of Ontario, 2004; Mushtaq, 2011, 2013). The Environmental Commissioner recorded that the Ministry of the Environment urged the County to defer waste placement in the northwest corner until more data were available (Environmental Commissioner of Ontario, 2004, p. 237). The same record states that the landfill design relied on an upward groundwater gradient to support leachate containment (Environmental Commissioner of Ontario, 2004, p. 237).

The upward-gradient design is technically important because the containment assumption depends on groundwater pressure moving toward the waste mass rather than allowing leachate to migrate away from the site. The Environmental Commissioner defines leachate in this context as “the contaminated liquid produced by a landfill” (Environmental Commissioner of Ontario, 2004, p. 237).

The Ministry also raised the “potential impact of off-site pumping of groundwater” on the leachate-collection system (Environmental Commissioner of Ontario, 2004, p. 237). That concern makes dewatering and groundwater pumping part of the professional risk analysis rather than background construction logistics.

Independent peer reviewers added a second technical signal. They wrote that the site would require “more than usual precautions” to design, construct, and operate (Environmental Commissioner of Ontario, 2004, p. 238; Mushtaq, 2013). They also described the design information as inadequate to ensure appropriate environmental and engineering control during the landfill’s active life (Environmental Commissioner of Ontario, 2004, p. 238; Mushtaq, 2013).

The seriousness criterion is therefore met through Ministry comments and peer-review concerns. Hydrogeological modelling and leachate-containment uncertainty supply the technical basis for treating the risk as part of the engineering record (Environmental Commissioner of Ontario, 2004; Mushtaq, 2011, 2013; Ontario (Information and Privacy Commissioner), *Order MO-2449*).

The second threshold criterion is satisfied because the risk may impair groundwater protection and the ability of affected publics to understand the technical basis for accepting residual landfill risk (Environmental Commissioner of Ontario, 2004; Ontario (Information and Privacy Commissioner), *Order MO-2449*). The public-facing interest was groundwater protection because the proposed landfill was evaluated through hydrogeological assumptions and source-water concerns. Dewatering issues and leachate-control design made that interest concrete in the technical record (Environmental Commissioner of Ontario, 2004; Ontario (Information and Privacy Commissioner), *Order MO-2449*).

The source-water dimension requires historical context. In May 2000, the municipal drinking-water system in Walkerton, Ontario became contaminated with *Escherichia coli* O157:H7 and *Campylobacter jejuni*; seven people died and more than 2,300 became ill (O'Connor, 2002a). The public inquiry led by Justice Dennis O'Connor recommended a multi-barrier approach that begins with protecting drinking-water sources, an agenda later implemented in part through the *Clean Water Act, 2006* (O'Connor, 2002b; *Clean Water Act, 2006*, SO 2006, c 22, ss 1–2). When I refer to Ontario's post-Walkerton movement, I mean this shift from relying primarily on treatment and testing toward preventing contamination at the source. The Environmental Commissioner placed the Site 41 review within that wider source-water-protection context (Environmental Commissioner of Ontario, 2004).

The public-facing interest was also technical contestability because the Community Monitoring Committee and local opponents sought the model and input data used to simulate groundwater movement under the site (Ontario (Information and Privacy Commissioner), *Order MO-2449*; Mushtaq, 2011, 2013). *Order MO-2449* states that residents wanted to scrutinize a hydrogeological model and its input data because the model simulated groundwater flow at the proposed site (Ontario (Information and Privacy Commissioner), *Order MO-2449*). Jagger Hims Limited was the private engineering consulting firm retained by Simcoe County to prepare the Site 41 groundwater model (Ontario (Information and Privacy Commissioner), *Order MO-2449*). Simcoe County described MODFLOW as the “gold standard in its field” and stated that Jagger Hims used it to construct a calibrated model for the North Simcoe Landfill area (*Order MO-2449*). In plain terms, calibration compared model behaviour with observed groundwater conditions and adjusted parameters so the model represented the site more closely (*Order MO-2449*; Professional

Engineers Ontario, 2019). Calibration makes the assumptions, observations, remaining mismatch, and uncertainty available for review (Professional Engineers Ontario, 2019).

Those facts make the model a governance object. It organized the technical story of water movement and the landfill's effect on that movement. It also shaped what kinds of public assurance could be offered (Ontario (Information and Privacy Commissioner), *Order MO-2449*; Jasanoff, 2003; Mushtaq, 2011, 2013).

The third threshold criterion is satisfied because the burden fell in a patterned and uneven way on local and Indigenous publics who had less control over the technical record than the public proponent and its consultants (Mushtaq, 2011, 2013; Ontario (Information and Privacy Commissioner), *Order MO-2449*). The record shows that pattern in unequal access to the technical record and in the structure of public participation (Mushtaq, 2011, 2013; Ontario (Information and Privacy Commissioner), *Order MO-2449*).

Usman Mushtaq identifies the Kawartha Nishnawbe First Nation and Beausoleil First Nation among the Indigenous communities affected by the Site 41 controversy (Mushtaq, 2011, 2013). Mushtaq reports that Chief Kris Nahrgang told Simcoe County that Kawartha Nishnawbe First Nation had not been notified or consulted even though the proposed site lay on land the Nation understood as treaty and traditional hunting and fishing territory (Mushtaq, 2011, 2013). Mushtaq also records that Chief Rodney Monague Jr. of Beausoleil First Nation requested a moratorium because the proposal could affect “all the water within our territories” (Mushtaq, 2011, 2013). In May 2009, five Anishinabe Kweag—women from Beausoleil First Nation—established a protest camp that remained for 137 days; their stated purpose was to protect the Alliston Aquifer for future generations (Mushtaq, 2011, 2013). These actions belong in the history of the engineering

dispute because they expressed Indigenous law, land relationships, and responsibilities to water while identifying technical questions about groundwater and monitoring (Borrows, 2010; Mushtaq, 2011, 2013; Whyte, 2020).

Beausoleil First Nation identifies its people as the People of G'Chimnissing in southern Georgian Bay and locates its present land base on Christian, Beckwith, and Hope Islands (Beausoleil First Nation, n.d.). Beausoleil Island, called Bimadinaagogi by the Anishinaabeg, records thousands of years of gathering, ceremony, and habitation, as well as displacement under expanding Euro-Canadian settlement (Parks Canada, 2026). The wider colonial history includes dispossession and forced relocation, together with residential schools and state efforts to suppress Indigenous law and governance (Truth and Reconciliation Commission of Canada, 2015). Truth and reconciliation in engineering therefore require professional humility, respect for Indigenous jurisdiction, and an account of how engineering institutions have participated in colonial systems (Anker, 2016; Borrows, 2010; Truth and Reconciliation Commission of Canada, 2015; Whyte, 2020). The engineering record should preserve the technical relevance of Indigenous knowledge while recognizing that Indigenous legal authority and relationships to land and water exceed the professional engineering process (Whyte, 2020; *United Nations Declaration on the Rights of Indigenous Peoples Act*, SC 2021, c 14).

Mushtaq's account also records that the Wye Citizens Group received funding for a technical representative while funding for a social or community-impact expert was unavailable, which shows how the process privileged technical evidence while narrowing the forms of knowledge that could enter the formal record (Mushtaq, 2011, 2013). The patterned uneven burden also appeared through the way public participation was structured because Mushtaq quotes the

Community Monitoring Committee as having a mandate to provide “community review” while describing repeated barriers to accessing information needed for that review (Mushtaq, 2011, 2013; Ontario (Information and Privacy Commissioner), *Order MO-2449*). Mushtaq’s sentence, “Consultation did not mean participation,” captures the professional-visibility problem in the Site 41 record (Mushtaq, 2011, p. 110). Affected publics could be present in a process while their knowledge remained outside the engineering judgment that structured the risk.

Hamraie’s access scholarship explains the same point in a broader design register. Hamraie describes disabled people as “experts about their bodies and surrounding environments” and treats access as knowledge produced through lived interaction with built systems (Hamraie, 2017, p. 113).

For Site 41, the analogous point is that local and Indigenous water knowledge can bear on public-interest engineering where the technical question is groundwater movement and monitoring. That knowledge also matters where the technical question concerns uncertainty and trust in the model record (Jasanoff, 2003; Mushtaq, 2011, 2013; Whyte, 2020).

The fourth threshold criterion is satisfied because engineering work significantly shaped how the risk was created and described. Engineering work also shaped how the risk was tested and defended (Environmental Commissioner of Ontario, 2004; Ontario (Information and Privacy Commissioner), *Order MO-2449*; Professional Engineers Ontario, 2019).

The engineering work included these concrete forms of work (Environmental Commissioner of Ontario, 2004; Ontario (Information and Privacy Commissioner), *Order MO-2449*; Professional Engineers Ontario, 2019):

- hydrogeological investigation and geotechnical evaluation;

- groundwater modelling and calibration of the MODFLOW model;
- design and operations reporting;
- leachate collection and containment analysis;
- site dewatering and stormwater-management advice;
- peer review, monitoring plans, and technical advice to public authorities.

Professional Engineers Ontario’s solid-waste guideline supplies the professional bridge because it describes landfill engineering as multidisciplinary and recognizes public or Indigenous engagement in the wider process (Professional Engineers Ontario, 2019). The guideline addresses design and construction (Professional Engineers Ontario, 2019). It also addresses commissioning and operation (Professional Engineers Ontario, 2019). Monitoring and closure form additional phases of the professional work (Professional Engineers Ontario, 2019).

The same guideline describes solid-waste engineering as “multi-disciplinary” and identifies public, stakeholder, and Indigenous community engagement as part of the wider project context (Professional Engineers Ontario, 2019). That professional guidance fits Site 41 because the technical record combined landfill engineering and hydrogeology. It also connected environmental approval, community monitoring, and Indigenous/community opposition (Environmental Commissioner of Ontario, 2004; Mushtaq, 2011, 2013; Professional Engineers Ontario, 2019).

The fifth threshold criterion is satisfied because the risk was known or reasonably knowable through the Ministry comments and peer-review reports. The Environmental Commissioner’s analysis, the Community Monitoring Committee process, and the access-to-information dispute supplied additional evidence (Environmental Commissioner of Ontario, 2004; Mushtaq, 2011, 2013; Ontario (Information and Privacy Commissioner), *Order MO-2449*).

The Environmental Commissioner stated that “many of the technical details” related to the landfill’s design and operation were unavailable during the siting process or hearing, which connects knowability to the timing of technical disclosure (Environmental Commissioner of Ontario, 2004). *Order MO-2449* adds a more precise technical example because the Information and Privacy Commissioner identified the requested records as the “calibrated hydrogeological model and accompanying input data” prepared by Jagger Hims (Ontario (Information and Privacy Commissioner), *Order MO-2449*).

The order also described Jagger Hims’ refusal to provide the records as creating an “unacceptable compliance issue,” and the adjudicator found that the County was “deliberately disassociating itself from key records relating to the environmental integrity of Site 41” (Ontario (Information and Privacy Commissioner), *Order MO-2449*). Those passages show that the knowability problem was a dispute over access to the model inputs and assumptions that made technical review possible (Ontario (Information and Privacy Commissioner), *Order MO-2449*; Raji *et al.*, 2020).

The sixth threshold criterion is satisfied because several engineering actors had role-specific ways to respond within the authority they held (Professional Engineers Ontario, 2019; Ontario (Information and Privacy Commissioner), *Order MO-2449*). Engineering consultants could document modelling assumptions and disclose limitations (Environmental Commissioner of Ontario, 2004; Professional Engineers Ontario, 2019). They could support independent review and explain the operational requirements of the upward-gradient design (Environmental Commissioner of Ontario, 2004; Professional Engineers Ontario, 2019). Peer reviewers could identify unresolved technical issues, specify additional data needed for review, and separate technical adequacy from

public acceptance of residual risk (Environmental Commissioner of Ontario, 2004; Mushtaq, 2011, 2013).

The County and public authorities held approval, funding, and disclosure powers through environmental and municipal governance mechanisms. They also held moratorium powers through those governance mechanisms. Professional engineering actors held duties connected to competence and candour (Environmental Commissioner of Ontario, 2004; Professional Engineers Ontario, 2019). Documentation and technical advice supplied further duties within role (Environmental Commissioner of Ontario, 2004; Professional Engineers Ontario, 2019).

The threshold test would have required the engineer or reviewer to prepare a dated technical memorandum that named the groundwater risk and explained the upward-gradient assumption (Environmental Commissioner of Ontario, 2004; Professional Engineers Ontario, 2019). That memorandum would identify missing model information and explain how affected-public knowledge changed the inquiry (Mushtaq, 2011, 2013; *Order MO-2449* at 7–8). Any unresolved barrier to obtaining or reviewing the model would be escalated to the actor with authority to obtain the files or decide whether work could proceed (Professional Engineers Ontario, 2020; *Order MO-2449* at 7–8).

Site 41 therefore enters the framework as the engineering-heavy case because the record satisfies all six threshold criteria (Environmental Commissioner of Ontario, 2004; Mushtaq, 2011, 2013; Ontario (Information and Privacy Commissioner), *Order MO-2449*; Professional Engineers Ontario, 2019). That classification gives the later chapters a defined basis for asking which actor held authority and what the proposed PIIA could have changed (Professional Engineers Ontario, 2019; Ontario (Information and Privacy Commissioner), *Order MO-2449*).

2.9. Public Washroom Application

Public washrooms are the ordinary code-mediated recurring example. In this section, I apply the same six criteria to a facility decision in which fixture counts, plumbing design, and mechanical ventilation can shape access (Anthony & Dufresne, 2007; City of Ottawa Building Code Services, 2021). Privacy, location, and accessibility determine whether the available facility is equivalent in practice (Hamraie, 2017; National Research Council Canada, 2022).

The example is deliberately mundane because washrooms can look like a routine facilities issue while still determining whether people can remain in public institutions and public-service settings (Anthony & Dufresne, 2007; Cavanagh, 2010; Ontario Human Rights Commission, 2014). Sheila Cavanagh describes the public-restroom dispute as a “manifestly mundane issue” (Cavanagh, 2017, p. 183). The phrase captures the analytical reason for this example: an ordinary facility can organize safety, dignity, and participation through routine technical choices (Cavanagh, 2010, 2017; Ontario Human Rights Commission, 2014).

The first threshold criterion is satisfied when the washroom design may make public participation harder for affected users because of location, privacy, or accessibility. Non-equivalent access can also satisfy the criterion (Anthony & Dufresne, 2007; Cavanagh, 2010; Hamraie, 2017; Ontario Human Rights Commission, 2014).

The risk is more than remote or minor when a user must leave the building or disclose private information because the available washroom design assumes a narrow user model. The same criterion is met when a user must use a less safe route or accept a stigmatizing facility (Anthony & Dufresne, 2007; Cavanagh, 2010; Hamraie, 2017; Ontario Human Rights Commission, 2014).

The risk is also more than remote or minor when a renovation process treats an all-gender or accessible washroom as a remote “special” facility. The same risk arises when the primary washroom route remains binary, inaccessible, or unavailable to caregivers (Anthony & Dufresne, 2007; Castrodale & Lane, 2015; Hamraie, 2017; Harwood-Jones *et al.*, 2023).

The second threshold criterion is satisfied because access and dignity are public-facing interests in public or institutional settings (Cavanagh, 2010; Hamraie, 2017; Ontario Human Rights Commission, 2014). Privacy and safety provide additional public-facing interests in the same settings (Cavanagh, 2010; Ontario Human Rights Commission, 2014).

The Ontario Human Rights Commission treats washroom and change-room access as connected to dignity for trans people (Ontario Human Rights Commission, 2014). The *Human Rights Code*, RSO 1990, c H.19 protects equal treatment in services and facilities. Gender identity and gender expression are included grounds (*Human Rights Code*, RSO 1990, c H.19, s 1).

The *Canadian Human Rights Act*, RSC 1985, c H-6 includes gender identity or expression among prohibited grounds in federally regulated contexts (*Canadian Human Rights Act*, RSC 1985, c H-6, s 3(1)). This statutory protection confirms that gendered facility access can engage public-facing equality interests in federal jurisdiction (*Canadian Human Rights Act*, RSC 1985, c H-6, ss 3(1), 5).

Human-rights law gives the equality floor for the facility, while the threshold test asks whether engineering work during design or renovation should document and respond to the access risk before the issue becomes a complaint (Ontario Human Rights Commission, 2014; Hamraie, 2017; Professional Engineers Ontario, 2020). The third threshold criterion is satisfied when the washroom design imposes a patterned uneven burden on users whose bodies or identities fall

outside the assumed user embedded in the facility (Anthony & Dufresne, 2007; Cavanagh, 2010; Hamraie, 2017). Caregiving roles and access needs can produce further patterned uneven burden through the same design (Anthony & Dufresne, 2007; Hamraie, 2017).

The pattern can arise through these design features (Anthony & Dufresne, 2007; Cavanagh, 2010; Hamraie, 2017; Harwood-Jones *et al.*, 2023):

- binary signage and circulation;
- unequal travel distance to an all-gender or accessible facility;
- lack of full-height privacy partitions or lockable stall doors;
- fixture counts that make one group wait longer;
- separate accessible facilities that remove users from the main route;
- washroom locations that increase safety risk or forced disclosure.

Kathryn Anthony and Meghan Dufresne’s potty-parity work connects fixture counts and queues to gender and caregiving (Anthony & Dufresne, 2007). They also connect those design choices to disability and planning (Anthony & Dufresne, 2007). This framing treats the washroom as built infrastructure with distributional effects (Anthony & Dufresne, 2007). Hamraie’s disability access work is useful because it describes access as “negotiation, rather than as a resolved, measurable end,” which supports design attention to how people actually use a facility (Hamraie, 2017).

The fourth threshold criterion is satisfied where engineering work significantly shapes whether inclusive access is feasible and equivalent (City of Ottawa Building Code Services, 2021; National Research Council Canada, 2022; Professional Engineers Ontario, 2020). The same engineering work may shape whether the access is safe and documented (City of Vancouver, 2024;

National Research Council Canada, 2022; Professional Engineers Ontario, 2020). The engineering work appears through concrete design tasks rather than through a generalized authority over institutional policy (City of Ottawa Building Code Services, 2021; National Research Council Canada, 2022; Professional Engineers Ontario, 2020).

In the washroom recurring example, engineering work may include these tasks (City of Ottawa Building Code Services, 2021; National Research Council Canada, 2022; Professional Engineers Ontario, 2020):

- plumbing fixture calculations and water-supply design;
- drainage design and mechanical ventilation;
- accessibility-related technical coordination;
- retrofit feasibility and constructability analysis;
- code-compliance documentation;
- technical advice about privacy, maintenance, and equivalent location.

The code detail matters because a designer may assume that gender-segregated rooms are mandatory even where the applicable materials focus on the required number of fixtures and the accessibility of the facility (City of Ottawa Building Code Services, 2021; National Research Council Canada, 2022). A 2025 legal opinion prepared by Mélançon Marceau Grenier Cohen s.e.n.c. (the Mélançon firm) gives a concrete Canadian example. It examined a proposal to retain one women’s room and one men’s room in McGill’s University Centre while designating other washrooms as gender-neutral (Mélançon Marceau Grenier Cohen s.e.n.c., 2025).

The Mélançon firm identified the Quebec occupational-health regulation and the *Code de construction* that incorporates the 2015 *National Building Code* with Quebec amendments

(Mélançon Marceau Grenier Cohen s.e.n.c., 2025). That sequence shows the legal materials a design team would need to identify before relying on an assumed code prohibition.

The Mélançon firm quoted section 3.7.2.2 of the *National Building Code*, which requires water closets “for each sex” on the basis of occupant load, and explained that the provision leaves room for interpretation about room segregation (Mélançon Marceau Grenier Cohen s.e.n.c., 2025). Occupant load means the number of people the code assumes will use a building or space for fixture and safety calculations.

The Mélançon firm also relied on Proposed Change 1750, which states that the Code “only requires that a minimum number of water closets be made available to the building’s occupants” (National Research Council Canada, 2022; Mélançon Marceau Grenier Cohen s.e.n.c., 2025). Proposed Change 1750 states that the Code contains “no implied or explicit requirements” for separate gender-identified washrooms (National Research Council Canada, 2022). It directs designers to consider privacy through full-height partitions and lockable stall doors (National Research Council Canada, 2022). It also directs attention to accessibility where accessible washrooms are required (National Research Council Canada, 2022).

These materials make the connection to engineering work concrete. Fixture calculations and privacy design provide technical evidence. Accessibility review and a documented code interpretation provide additional evidence (City of Ottawa Building Code Services, 2021; National Research Council Canada, 2022; Mélançon Marceau Grenier Cohen s.e.n.c., 2025).

The fifth threshold criterion is satisfied when code materials, human-rights guidance, or accessibility standards make the risk known or reasonably knowable to the project team. User evidence or institutional complaints can also make the risk known or reasonably knowable (City

of Ottawa Building Code Services, 2021; Hamraie, 2017; National Research Council Canada, 2022; Ontario Human Rights Commission, 2014).

The City of Ottawa’s advisory permits a designer to allocate washroom spaces by anticipated gender division, by “all genders,” or by specific gender groupings (City of Ottawa Building Code Services, 2021). The advisory therefore makes all-gender allocation a code-interpretation issue available to designers and authorities having jurisdiction (City of Ottawa Building Code Services, 2021).

The National Research Council material states that the proposed note is meant to help “designers” and “authorities having jurisdiction” understand gender-neutral washroom design in relation to code enforcement, which makes the evidence available to the actors who prepare and review the technical record (National Research Council Canada, 2022). Affected-user evidence also matters because a technically compliant layout may still create unequal travel distance, lack of privacy, or unsafe use for people who must navigate the facility under untested conditions (Cavanagh, 2010; Hamraie, 2017; Harwood-Jones *et al.*, 2023).

The sixth threshold criterion is satisfied because engineering actors can take specific role-specific responses during design, renovation, or review (City of Ottawa Building Code Services, 2021; National Research Council Canada, 2022; Professional Engineers Ontario, 2020). An engineer can record the fixture-count calculation, identify the code basis for all-gender allocation, and document whether the all-gender facilities are located on equivalent public routes (City of Ottawa Building Code Services, 2021; National Research Council Canada, 2022).

An engineer can also advise on mechanical ventilation and drainage where those systems shape safe use (City of Vancouver, 2024; Professional Engineers Ontario, 2020). Accessibility

constraints and retrofit feasibility provide further technical questions within an assigned role (Steinfeld & Maisel, 2012; Professional Engineers Ontario, 2020).

The project lead or owner holds authority to select the final washroom policy (City of Ottawa Building Code Services, 2021). The engineering actor remains responsible for accurate technical advice and documented assumptions within the assigned work (Professional Engineers Ontario, 2020). The engineer must also escalate a technical claim that is being used to make unequal access appear inevitable where the evidence supports that concern (Engineers Canada, 2024b; Hamraie, 2017).

The threshold test would require the design team to prepare a code-and-design memorandum identifying the affected users and explaining the fixture-count assumptions (Cavanagh, 2010; National Research Council Canada, 2022). That memorandum would state the applicable code interpretation and explain the privacy or accessibility implications (Hamraie, 2017; National Research Council Canada, 2022). An unresolved access risk would be escalated to the owner or building official, depending on which actor held the relevant authority (City of Ottawa Building Code Services, 2021; Raji *et al.*, 2020).

Public washrooms therefore enter the framework as the ordinary code-mediated case because a small built-environment default can structure public participation through engineering work that is concrete, documented, and reviewable (Anthony & Dufresne, 2007; Cavanagh, 2010; City of Ottawa Building Code Services, 2021; Hamraie, 2017). Chapter 3 therefore asks who controlled the technical and policy decisions, and Chapter 4 applies the PIIA to the retrofit sequence (Professional Engineers Ontario, 2020; National Research Council Canada, 2022).

2.10. Artificial Intelligence and Large Language Models: Boundary Application

AI and LLM systems are the boundary example because the same technical risk can sit inside several governance regimes. In this section, I apply the threshold test to a defined use, then identify the specific engineering work that can create professional responsibility (Engineers Canada, 2022; Scassa, 2021). Privacy, human-rights, and sector-specific institutions retain the authority assigned to them by their own legal regimes (Office of the Privacy Commissioner of Canada *et al.*, 2023; Scassa, 2021).

The recurring example focuses on large language models because they generate text through technical processes that can appear general-purpose while being used in public-facing workflows that affect access, credibility, and institutional response (Abid *et al.*, 2021; Bender *et al.*, 2021; Bommasani *et al.*, 2021; Raji *et al.*, 2020). The first threshold criterion is satisfied when model behaviour or deployment evidence shows a serious risk to dignity, access, or credibility in a public-facing setting. Service delivery and professional judgment may also be affected (Abid *et al.*, 2021; Bender *et al.*, 2021; Raji *et al.*, 2020).

Abid, Farooqi, and Zou provide the concrete GPT-3 example because their study reports persistent associations between Muslims and violence in model completions and analogy outputs (Abid *et al.*, 2021). The study reports that prompts involving Muslims produced violent completions at a much higher rate than comparator religious terms, and the same study reports that an analogy prompt mapped “Muslim” to “terrorist” 23% of the time (Abid *et al.*, 2021).

The seriousness criterion is met when that output behaviour is linked to moderation, search, or summarization. The criterion is also met when the output is linked to screening, public administration, or professional advice (Abid *et al.*, 2021; Bender *et al.*, 2021; Raji *et al.*, 2020).

The second threshold criterion is satisfied when the AI and LLM system may impair a public-facing interest such as dignity, access, or contestability (Abid *et al.*, 2021; Blodgett *et al.*, 2020; Raji *et al.*, 2020). Dignity is implicated when a model produces stereotypical associations about a religious, racialized, or gendered public. The same concern arises for disabled or otherwise marginalized publics (Abid *et al.*, 2021; Blodgett *et al.*, 2020; Noble, 2018).

Access is implicated when an AI and LLM output enters a workflow that can influence service triage, content moderation, or complaint classification. Access is also implicated when the workflow concerns public benefits or professional screening (Raji *et al.*, 2020; Treasury Board of Canada Secretariat, 2023).

The federal *Directive on Automated Decision-Making* supplies a public-sector comparator for administrative decisions that use automation. It requires a federal department to complete an Algorithmic Impact Assessment before production and to apply requirements associated with the resulting impact level (Treasury Board of Canada Secretariat, 2025, ss 6.1.1–6.1.2). The directive illustrates how a documented assessment can connect system scope, risk evidence, and required controls while leaving the source of legal authority with the federal institution (Treasury Board of Canada Secretariat, 2025).

Contestability is implicated when a user lacks information about the model, known limitations, or data that shaped the system. Contestability is also implicated when the user lacks a clear path to challenge an output that affects them (Burrell, 2016; Raji *et al.*, 2020; Scassa, 2021).

Teresa Scassa extends this concern to artificial-intelligence-assisted human decision-making. She explains that generative AI can create uncertainty about the source and quality of

briefing material used by a human decision-maker (Scassa, 2024, p. 467). Contestability weakens when an institution cannot identify the source material used by the system or explain how it was checked (Scassa, 2024, p. 467). Jena McGill and Amy Salyzyn examine judicial analytics, meaning tools that use court data to describe or predict patterns in judicial decision-making. Their analysis helps explain why governance must assess more than whether an output is statistically accurate: it must also examine how judges, lawyers, court administrators, and litigants may rely on the tool because institutional use can change professional judgment and access to justice (McGill & Salyzyn, 2021).

Related co-authored work supplies two adjacent information-system examples. Co-author Samantha Fowler and I examined engineers' role in the health infodemic, where technical systems influence the public information people encounter and use (Liu & Fowler, 2025). My co-authors Brittany C. Singh and Giovanni C. Giuga and I examined pronoun fields on online platforms, showing how a small interface choice can shape recognition and access (Liu *et al.*, 2023).

The third threshold criterion is satisfied when the burden falls in a patterned and uneven way through training data or model behaviour (Abid *et al.*, 2021; Barocas & Selbst, 2016; Blodgett *et al.*, 2020). Evaluation choices and deployment context can create the same pattern (Raji *et al.*, 2020; Selbst *et al.*, 2019).

The pattern in the Abid, Farooqi, and Zou example is measurable because the researchers tested prompts and compared completion behaviour across religious terms (Abid *et al.*, 2021). The pattern can also be institutional because a model with known representational risk may be used in a setting where some users face greater exposure to suspicion, moderation, or adverse credibility judgments (Abid *et al.*, 2021; Barocas & Selbst, 2016; Noble, 2018).

Blodgett and colleagues are useful here because they require bias research to state what the harm is and whom it affects (Blodgett *et al.*, 2020). That discipline aligns with the threshold test: patterned uneven burden must be specified through a mechanism and evidence rather than asserted generally.

The fourth threshold criterion is satisfied only where engineering work creates or significantly shapes the AI and LLM risk (Engineers Canada, 2022; IEEE, 2021; Professional Engineers Ontario, n.d.; Raji *et al.*, 2020). Engineers Canada supplies the scope boundary with unusual clarity: “not all software practice is software engineering and so not everybody who develops software needs to be an engineer” (Engineers Canada, 2022). The same Engineers Canada paper states that impact on public welfare includes “individuals and groups that might not have paid for services or products” when they would still suffer consequences from deficient software (Engineers Canada, 2022).

For this recurring example, the relevant engineering work may include these tasks where they fall within role and jurisdiction (Engineers Canada, 2022; IEEE, 2021; Raji *et al.*, 2020):

- software validation and systems integration;
- reliability analysis and cybersecurity review;
- procurement specifications and intended-use analysis;
- model evaluation and audit design;
- technical documentation and monitoring;
- escalation of known or reasonably knowable risk.

IEEE 7000 is useful because it gives systems and software engineering a process language for public-facing values: the standard describes processes for considering ethical values “throughout

the stages of concept exploration and development” (IEEE, 2021). IEEE 7000 describes “traceability of ethical values” through operational concepts, value propositions, and system design (IEEE, 2021). That traceability supports project documentation that connects a stated public-interest concern to a system requirement (IEEE, 2021). The documentation then connects the requirement to the technical decision that implements it (IEEE, 2021).

The fifth threshold criterion is satisfied when testing, audit evidence, or documentation makes the risk known or reasonably knowable to a competent actor within role. Prior incidents, affected-user evidence, or intended-use analysis can also make the risk known or reasonably knowable (Raji *et al.*, 2020; IEEE, 2021; Abid *et al.*, 2021).

Raji *et al.* explain that deployed systems can develop issues that become “difficult or impossible to trace back to their source” after deployment, which supports documentation during development and integration (Raji *et al.*, 2020, p. 33). Their audit framework supports AI system development “end-to-end” and produces documents that form an “overall audit report,” which is directly relevant to whether a competent actor had evidence available at a decision point (Raji *et al.*, 2020, p. 33). Raji *et al.* also warn that checklist processes can become a “box-ticking activity,” and they recommend connecting checklist use to “real-world failures” and higher-level hazards (Raji *et al.*, 2020, p. 36). Those audit passages matter for this thesis because a Public-Interest Impact Assessment must record judgment, evidence, and actor authority rather than merely prove that a form was completed (Costanza-Chock *et al.*, 2022; Raji *et al.*, 2020, pp. 33, 36).

The sixth threshold criterion is satisfied when an engineering actor has authority over validation, integration, or procurement specifications. The criterion is also satisfied when the actor

has authority over documentation, monitoring, or escalation (Engineers Canada, 2022; IEEE, 2021; Professional Engineers Ontario, n.d.; Raji *et al.*, 2020).

A systems engineer integrating an AI and LLM component into a public-service workflow may have authority to require intended-use analysis, document model limitations, and set monitoring conditions (Engineers Canada, 2022; IEEE, 2021; Raji *et al.*, 2020). A procurement engineer or project lead may have authority to require audit artifacts before adopting a third-party model; audit artifacts are the test results, review records, and other documents produced through the audit process (Engineers Canada, 2022; Raji *et al.*, 2020; Treasury Board of Canada Secretariat, 2023). The same actor may require incident-reporting procedures and human-review protocols (Engineers Canada, 2022; Raji *et al.*, 2020; Treasury Board of Canada Secretariat, 2023).

A regulator may have authority to clarify practice expectations for software-intensive engineering work. Privacy commissioners, human-rights bodies, and public authorities carry other parts of AI governance. Legislatures also carry part of AI governance (Engineers Canada, 2022; Professional Engineers Ontario, n.d.; Scassa, 2021).

The threshold test would require a system-use and validation document (IEEE, 2021; Raji *et al.*, 2020). It would identify the intended use, meaning the task, users, and operating conditions for which the system is being considered (IEEE, 2021; Raji *et al.*, 2020). The document would state known model limitations and identify the testing or audit evidence considered (Engineers Canada, 2022; Raji *et al.*, 2020). It would also state the affected-public risk and name the actor who must decide whether an unresolved risk can be accepted (Engineers Canada, 2022; IEEE, 2021). AI and LLM systems therefore enter the framework as the boundary case when all six

threshold criteria are met in a specific engineering role (Abid *et al.*, 2021; Engineers Canada, 2022; IEEE, 2021; Raji *et al.*, 2020).

2.11. Professional Visibility

Professional visibility means recognizing a material disparate-impact risk as relevant to engineering competence, judgment, and responsibility (Cech, 2014; Engineers Canada, 2024a, 2024b). It requires the risk to appear in the records and decisions through which engineering work is reviewed (Professional Engineers Ontario, 2020; Raji *et al.*, 2020). A risk can satisfy the threshold test yet remain absent from engineering records when professional training treats its effects on people as outside the technical assignment or as consequences to be addressed only after design, approval, or deployment (Cech, 2014; Jasanoff, 2003). Chapter 3 addresses the next question: which actor can respond, through which mechanism, and within what limit (Adams, 2022; Herkert, 2000)?

Mirjam Fines-Neuschild and Tanja Tajmel show why professional visibility requires an institutional next step. Their Canadian STEM study found that EDI work can be experienced as an individual responsibility undertaken without durable organizational support (Fines-Neuschild & Tajmel, 2024). A concern becomes professionally visible when it is assigned to a person who can investigate it or carry it to an authorized decision-maker (Fines-Neuschild & Tajmel, 2024; Herkert, 2000).

Professional visibility has three parts. First, the actor must see the risk as connected to engineering work. Site 41 shows this problem because groundwater modelling and affected-public knowledge could be separated into technical evidence and public opposition, even though the

dispute concerned groundwater, monitoring, and modelling. It also concerned uncertainty (Environmental Commissioner of Ontario, 2004; Ontario (Information and Privacy Commissioner), *Order MO-2449*; Mushtaq, 2011, 2013). Washrooms show the same problem in ordinary infrastructure because plumbing, ventilation, and fixture counts can be treated as routine technical work while access and dignity are assigned to someone else (Anthony & Dufresne, 2007; City of Ottawa Building Code Services, 2021; Hamraie, 2017; Ontario Human Rights Commission, 2014). AI and LLM systems show the problem in software-intensive systems because model evaluation and documentation can be treated as technical performance issues, while stereotypes, dignity, and the practical ability to challenge an output are assigned to policy or complaint processes only after deployment (Abid *et al.*, 2021; Bender *et al.*, 2021; Raji *et al.*, 2020).

Second, the actor must see affected-public knowledge as evidence where it bears on the risk. Mushtaq’s Site 41 analysis shows how consultation can become presentation rather than participation (Mushtaq, 2011, 2013). Hamraie’s access scholarship shows that disabled people’s expertise about access is knowledge about how environments work (Hamraie, 2017). Fricker’s epistemic-injustice work supplies the broader vocabulary for why excluding knowledge can be a professional problem when the excluded knowledge bears on a material disparate-impact risk (Fricker, 2007).

Third, the actor must create a record that can be reviewed. Documentation gives professional visibility durability because a technical record can be challenged, escalated, and examined later. Raji and colleagues’ warning against box-ticking is directly relevant: the record must preserve judgment rather than merely certify that a form was completed (Raji *et al.*, 2020, p. 36). Professional Engineers Ontario’s solid-waste guideline reinforces this documentary practice

through “monitoring, recording and reporting” in landfill operations (Professional Engineers Ontario, 2019). I use that existing professional habit to capture risks that engineering education or project routines may otherwise assign to another discipline or postpone until after the system is designed or deployed (Cech, 2014; Faulkner, 2007; Riley, 2008).

Earlier co-authored work provides two concrete examples of professional visibility. Co-author Andrea Atkins and I analysed perceived race and gender in images used by accredited engineering schools, providing an empirical example of how professional institutions depict who belongs in engineering (Liu & Atkins, 2023). Co-author Shivani Nathoo and I situated gender-based violence within engineering professional culture, providing an example of a public-interest concern that engineering institutions must recognize as professionally relevant (Liu & Nathoo, 2023).

Professional visibility also prevents a risk from disappearing between institutions. An engineer may classify the issue as owner policy, while the owner may classify it as code compliance (Herkert, 2000; City of Ottawa Building Code Services, 2021). A regulator may treat the issue as outside professional conduct, while a consultant may treat affected-public evidence as outside the accepted scope (Adams, 2022; Cech, 2014). Role-specific due care interrupts that diffusion by requiring each actor to state the response available within its authority (Adams, 2022; Herkert, 2000; Engineers Canada, 2024b).

The six threshold questions can therefore be used as a professional-visibility habit:

- Is the risk more than remote or minor?
- What public-facing interest may be impaired?
- Who bears the patterned uneven burden?

- What engineering work creates or significantly shapes the risk?
- What evidence is available to a competent actor within role?
- Who has authority to take a role-specific response?

The six questions produce a bounded conclusion about whether engineering work significantly shapes a public-interest risk (Engineers Canada, 2024a, 2024b; Professional Engineers Ontario, 2020). That conclusion provides the handoff from Chapter 2 to Chapter 3. Chapter 2 explains why the risk enters the framework, and Chapter 3 identifies the actor and mechanism through which a response can occur (Adams, 2022; Herkert, 2000).

2.12. Takeaway

Chapter 2 converts material disparate-impact risk into a six-step threshold test. The actor answers the same questions in the same order and cites the evidence supporting each answer (Professional Engineers Ontario, 2019; Raji *et al.*, 2020). A qualifying risk then moves to Chapter 3 for the actor-authority analysis. Chapter 4 applies the Public-Interest Impact Assessment (PIIA) after that allocation is complete.

The three recurring examples show how the same threshold operates across different forms of engineering responsibility (Mushtaq, 2011, 2013; City of Ottawa Building Code Services, 2021; Engineers Canada, 2022). Site 41 shows the threshold test in engineering-heavy public infrastructure because the record contains groundwater modelling and an upward-gradient leachate-containment assumption. The record also contains peer-review concerns and access-to-information litigation. It includes a Community Monitoring Committee with a technical-review

mandate (Environmental Commissioner of Ontario, 2004; Ontario (Information and Privacy Commissioner), *Order MO-2449*; Mushtaq, 2011, 2013).

Public washrooms show the threshold test in ordinary code-mediated infrastructure because fixture calculations, plumbing design, and mechanical ventilation can shape facility access. Code interpretation, privacy design, and accessibility coordination can also shape whether a public-facing facility is safe and usable for affected publics (Anthony & Dufresne, 2007; Cavanagh, 2010; City of Ottawa Building Code Services, 2021; Hamraie, 2017; National Research Council Canada, 2022).

AI and LLM systems show the threshold test at the boundary of licensed professional engineering because the risk can be measured through model testing and audit artefacts. Professional responsibility depends on the particular software-engineering, systems-integration, procurement, or monitoring work accepted within role (Engineers Canada, 2022; Raji *et al.*, 2020). Other governance institutions retain their own authority over privacy, human rights, public administration, and sector regulation (Scassa, 2021; Office of the Privacy Commissioner of Canada *et al.*, 2023).

Table 2.1 summarizes the six criteria in operational form. The table is intentionally concrete because the framework should tell an actor what to check, what to record, and where the evidence comes from (Professional Engineers Ontario, 2019; Raji *et al.*, 2020).

Table 2.1. Summary of the threshold test.

Criterion	Question the actor asks	Evidence that can satisfy the criterion
Risk is more than remote or minor	Is the risk serious enough that a competent actor should record it and decide what response is available?	Technical comments, peer reviews, audit results, user reports, code materials, monitoring records, or prior incidents.
Risk may impair a public-facing interest	What public-facing interest may be impaired by the engineering work?	Groundwater protection, safe facility access, dignity, privacy, contestability, service access, or public trust.
Burden falls in a patterned and uneven way	Who bears the burden, and what pattern connects the burden to structural marginalization?	Place-based risk, gendered access barriers, disability access barriers, religious stereotyping, data patterns, or affected-public evidence.
Engineering work creates or significantly shapes the risk	What engineering work creates, enables, documents, validates, or stabilizes the risk?	Modelling, design, code interpretation, validation, integration, monitoring, technical reporting, or procurement specifications.
Risk is known or reasonably knowable	What evidence was available to a competent actor within role at the relevant decision point?	Model inputs, design records, peer review, human-rights guidance, code guidance, audit documentation, complaints, or affected-public knowledge.
Actor has authority to take a role-specific response	What can this actor do through the authority they actually hold?	Investigate, document, mitigate, warn, escalate, revise a design, require review, set monitoring conditions, or record residual risk.

Table 2.2 summarizes how the recurring examples satisfy the criteria. The table also maps the next steps: Chapter 3 identifies the actor and mechanism, while Chapter 4 converts the same evidence into the PIIA (Professional Engineers Ontario, 2019; Raji *et al.*, 2020).

Table 2.2. Assessment summary for the three recurring examples.

Criterion	Site 41	Public washrooms	AI and LLM systems
More than remote or minor	MOE comments, upward-gradient leachate containment, dewatering, and peer reviewers’ “more than usual precautions” language made the groundwater risk serious (Environmental Commissioner of Ontario, 2004).	Fixture location, privacy, accessibility, and binary-room assumptions can affect whether users can remain in public-facing settings (Cavanagh, 2010; Hamraie, 2017).	Prompt testing and deployment analysis can show serious risk where model outputs affect credibility, access, or service delivery (Abid <i>et al.</i> , 2021; Raji <i>et al.</i> , 2020).
Public-facing interest	Groundwater protection and technical contestability were central because residents sought the MODFLOW model and input data (Ontario (Information and Privacy Commissioner), <i>Order MO-2449</i>).	Access, dignity, privacy, and safety are public-facing interests in public and institutional facilities (Ontario Human Rights Commission, 2014).	Dignity, access, and contestability are public-facing interests when LLM outputs enter public-service or professional workflows (Raji <i>et al.</i> , 2020; Scassa, 2021).
Patterned uneven burden	Local and Indigenous publics bore place-based water risk and had less control over the engineering record (Mushtaq, 2011, 2013).	Trans, non-binary, Two-Spirit, disabled, caregiving, and older users may bear repeated burdens from binary or inaccessible facilities (Anthony & Dufresne, 2007; Hamraie, 2017).	Marginalized groups may bear recurring representational or institutional burdens through data, prompts, and deployment contexts (Abid <i>et al.</i> , 2021; Blodgett <i>et al.</i> , 2020).
Engineering work	Hydrogeology, landfill design, modelling, leachate containment, monitoring, and technical advice shaped the risk record (Professional Engineers Ontario, 2019).	Plumbing, ventilation, fixture calculation, accessibility coordination, retrofit feasibility, and code documentation shape facility access (City of Ottawa Building Code Services, 2021).	Validation, systems integration, audit design, procurement specifications, documentation, and monitoring may engage engineering work (Engineers Canada, 2022; IEEE, 2021).
Known or reasonably knowable	The ECO report, peer reviews, CMC process, and IPC orders made technical uncertainty and model-access issues visible (Environmental Commissioner of Ontario, 2004; Ontario (Information and Privacy Commissioner), <i>Order MO-2449</i>).	Code guidance, human-rights guidance, accessibility knowledge, and affected-user evidence make the access risk visible (National Research Council Canada, 2022; Ontario Human Rights Commission, 2014).	Testing, audit artifacts, documentation, prior incidents, and intended-use analysis make the system risk visible (Raji <i>et al.</i> , 2020; IEEE, 2021).

Criterion	Site 41	Public washrooms	AI and LLM systems
Role-specific response	Engineering actors could document assumptions, support independent review, disclose uncertainty, and escalate technical-access barriers (Professional Engineers Ontario, 2019).	Engineering actors could document fixture assumptions, advise on privacy and ventilation, record code flexibility, and escalate unequal access (National Research Council Canada, 2022).	Engineering actors could require documentation, evaluate intended use, test limitations, set monitoring, and escalate unresolved risk (Engineers Canada, 2022; Raji <i>et al.</i> , 2020).

The chapter also explains why the threshold test must be paired with professional visibility. A risk must be treated as relevant to engineering competence before the actor can investigate or document it. The same professional visibility is needed before the actor can mitigate, warn, or escalate (Cech, 2014; Faulkner, 2007; Professional Engineers Ontario, 2019). Chapter 3 therefore identifies the actor who can respond, the legal or institutional source of that authority, and the limits on the available response (Adams, 2022; Engineers Canada, 2022; Professional Engineers Ontario, 2019).

3

The Public-Interest Mandate and Professional Authority

[A]sserting disability as a kind of expert knowledge ... When disabled people enact politics, these narratives suggest, they also design and build new worlds.

—Aimi Hamraie (2017, p. 95)

3.1. From the Threshold Test to Authority

Aimi Hamraie’s epigraph places world-building and authority together: people who experience exclusion also produce knowledge about how environments could be designed differently (Hamraie, 2017). In this chapter, I ask who can respond to a material disparate-impact risk, through which mechanism, and within what legal or organizational limit. I proceed by identifying the engineering work, then the decision that can change the risk, and finally the source of authority for that decision (Adams, 2022; Herkert, 2000; *Vavilov*, 2019 SCC 65 at paras 108–110).

The sequence keeps responsibility attached to a defined task. A licensed engineer may control model assumptions or technical warnings, while an employer controls scope and resources (Professional Engineers Ontario, 2020; Herkert, 2000). A public authority may control an approval assigned by statute (*Environmental Protection Act*, RSO 1990, c E.19, s 27; *Vavilov*, 2019 SCC 65 at paras 108–110). The actor-authority map records those distinctions before Chapter 4 assigns a PIIA document and response (Adams, 2022; Raji *et al.*, 2020).

The legal setting is the collection of provincial and territorial professional-engineering statutes and subordinate regulations that govern licensed practice across Canada. Ontario provides the main illustration: its statute organizes public protection through the practice definition, the regulator’s public-interest object, and powers concerning standards of practice and ethics (*Professional Engineers Act*, RSO 1990, c P.28, ss 1(1), 2(3)-(4), 7; RRO 1990, Reg 941, ss 72, 77). Other jurisdictions use their own instruments, so the analysis must identify the law in force where the work occurs (Engineers Canada, 2022). Documentation, practice review, and discipline have legal or professional consequence only through the powers and duties authorized by those instruments (Engineers Canada, 2024b; Professional Engineers Ontario, 2019, 2020).

The output of the chapter is an actor-authority analysis that can be used directly in Chapter 4. It identifies the actor who can investigate, the actor who can revise the work, and the actor who can authorize the final decision (Adams, 2022; *Vavilov*, 2019 SCC 65 at paras 108-110). It also states the engineer’s available response when another actor controls the outcome, including a written warning or escalation (Engineers Canada, 2024b; Professional Engineers Ontario, 2020). Chapter 4 uses that allocation to assign each PIIA document and decision point (IEEE, 2021; Raji *et al.*, 2020).

The fourth and sixth criteria from Chapter 2 perform the central sorting work here. Criterion 4 identifies the engineering work that creates or significantly shapes the risk. Criterion 6 identifies the actor who can respond after the evidence is available. Read together, the criteria connect a defined act of engineering judgment to a person or institution with authority (*Professional Engineers Act*, RSO 1990, c P.28, s 1(1); Adams, 2022).

Within role is the phrase that disciplines that connection (Adams, 2022; Herkert, 2000). A hydrogeologist retained to calibrate a groundwater model may control assumptions, documentation, and technical warnings; calibration is the process of adjusting model parameters and comparing model results with observed site data (Professional Engineers Ontario, 2019). A county council may control whether a project continues (Environmental Commissioner of Ontario, 2004, pp. 236-39). In a washroom project, the owner controls the facility program while the mechanical engineer controls assigned fixture or ventilation calculations (City of Ottawa Building Code Services, 2021). In an AI integration, the engineer may control validation criteria while the model provider controls the base-model release (Engineers Canada, 2022; Raji *et al.*, 2020).

Known or reasonably knowable is also applied within role (Funtowicz & Ravetz, 1993; Engineers Canada, 2024b). The standard asks what evidence a competent actor could identify through ordinary diligence in the assigned work (Engineers Canada, 2024a, 2024b). Technical testing, affected-public knowledge, and prior incidents can each supply relevant evidence (Hamraie, 2017; Raji *et al.*, 2020). An actor who controls more of the system ordinarily has access to a broader evidentiary record, while a narrow mandate may require a documented warning or escalation (Raji *et al.*, 2020; Engineers Canada, 2024b).

Silvio Funtowicz and Jerome Ravetz describe decision settings in which facts are uncertain, values are disputed, stakes are high, and decisions are urgent (Funtowicz & Ravetz, 1993, p. 744). In such settings, role-specific due care requires a clear account of the available evidence and the uncertainty that remains (Funtowicz & Ravetz, 1993; Jasanoff, 2003). The same record names the decision-maker authorized to accept residual risk after feasible controls have been applied (Raji *et al.*, 2020; IEEE, 2021).

3.2. Public Interest as the Organizing Statutory Term

Public interest is the organizing legal term because it names the object of professional regulation in the Ontario illustration. The principal object of PEO is to regulate professional engineering and govern licensees “in order that the public interest may be served and protected” (*Professional Engineers Act*, RSO 1990, c P.28, s 2(3)). The statute authorizes standards of knowledge and qualification as means of pursuing that object (*Professional Engineers Act*, RSO 1990, c P.28, ss 2(4), 7). It also authorizes standards of practice and professional ethics (*Professional Engineers Act*, RSO 1990, c P.28, ss 2(4), 7).

Section 1.2 defined engineering work by reference to the practice statute in the relevant province or territory. This chapter now uses that definition to allocate authority. Responsibility follows the person who accepts, directs, or supervises the particular engineering task (*Professional Engineers Act*, RSO 1990, c P.28, s 1(1); Professional Engineers Ontario, 2020). Project approval remains with the public body empowered by environmental, building, or other applicable law (*Environmental Protection Act*, RSO 1990, c E.19, s 27; *Building Code Act, 1992*, SO 1992, c 23, ss 3, 8).

The statutory structure assigns related functions to “public interest” and “public welfare” (*Professional Engineers Act*, RSO 1990, c P.28, ss 1(1), 2(3)). Public interest names the regulator’s governing purpose (*Professional Engineers Act*, RSO 1990, c P.28, s 2(3)). Public welfare appears within the practice definition and ethical code as a substantive interest safeguarded by professional engineering (*Professional Engineers Act*, RSO 1990, c P.28, s 1(1); RRO 1990, Reg 941, s 77). This structure supports use of public interest as the main legal term and public welfare where source language requires it (Engineers Canada, 2024a).

Tracey Adams’s Canadian research places this language within the regulatory bargain of self-governance (Adams, 2016, 2018). Professional status gives a body authority over entry, standards, and discipline in service of public protection (Adams, 2016, 2018). Adams’s later interviews with Canadian regulatory leaders show that public interest is commonly expressed through safety and consumer protection (Adams, 2022). The same interviews describe a broader and context-dependent concept in professional governance (Adams, 2022).

National professional guidance reinforces the same architecture while preserving provincial and territorial authority (Engineers Canada, 2012, 2022, 2024a). Engineers Canada directs engineers to hold paramount public safety, health, and welfare and to protect the environment (Engineers Canada, 2024a). Its guidance also requires competent practice and compliance with applicable law (Engineers Canada, 2024a). Engineers Canada describes its national documents as guidance for regulators rather than a source of provincial licensing power (Engineers Canada, 2012, 2022). The regulator in each province or territory remains responsible for interpreting the professional-engineering statute and regulations that apply there (Engineers Canada, 2012, 2022).

The public-interest mandate is open-textured and institutionally bounded (*LSBC v TWU*, 2018 SCC 32 at para 34; *Vavilov*, 2019 SCC 65 at paras 85-87). Open-textured means that the term has a stable legal purpose while its application requires contextual judgment in a particular decision (Sullivan, 2022; *LSBC v TWU*, 2018 SCC 32 at para 34). An enabling statute creates the regulator and defines its powers, while regulations and enforceable professional standards add further detail (Sullivan, 2022; *Vavilov*, 2019 SCC 65 at paras 108-110). Reasons for an exercise of delegated power must show how the regulator applied those constraints to the evidence before it (*Vavilov*, 2019 SCC 65 at paras 85-87, 108-110).

3.3. The Existing Safety-and-Competence Architecture

The current professional architecture in engineering is strongest where risk appears as deficient competence, unsafe work, or non-compliance (RRO 1990, Reg 941, s 72). Reporting danger is a further part of that architecture (RRO 1990, Reg 941, ss 72(2)(c), 77). Ontario’s code of ethics requires fidelity to public needs and makes the practitioner’s duty to public welfare paramount (RRO 1990, Reg 941, s 77). The misconduct provisions address negligence and failures to safeguard life or property (RRO 1990, Reg 941, ss 72(2)(a)-(b)). They also address failures to correct or report danger to public safety or welfare (RRO 1990, Reg 941, s 72(2)(c)). Compliance with governing law and standards is separately enforceable (RRO 1990, Reg 941, s 72(2)(d)).

Those provisions have practical consequences (RRO 1990, Reg 941, s 72; Professional Engineers Ontario, 2020). They support inquiry into method, applicable standards, and communication of consequences when technical judgment is overruled (Professional Engineers Ontario, 2020; Engineers Canada, 2024b). They also support discipline where an engineer assumes responsibility for work below the standard of a reasonable and prudent practitioner (RRO 1990, Reg 941, s 72).

Material disparate-impact risk fits this architecture when the six Chapter 2 criteria are satisfied. The risk then concerns an engineering-shaped public interest, evidence available to a competent actor, and an action within that actor’s authority. Role-specific due care may require further investigation, a revised technical option, or documented escalation (Engineers Canada, 2024a, 2024b; Professional Engineers Ontario, 2019, 2020). The response depends on the actor’s authority and the evidence available at the time (Adams, 2022; Engineers Canada, 2024b).

This framing connects individual and institutional responsibility (Herkert, 2000; Bielefeldt, 2018). Joseph Herkert distinguishes microethical questions about individual conduct from macroethical questions about collective professional responsibility and the social direction of technology (Herkert, 2000). Anne Bielefeldt likewise treats professional social responsibility as an institutional and educational concern (Bielefeldt, 2018). Individual engineers work inside organizations that define scope, schedule, and procurement (Herkert, 2000; Bielefeldt, 2018). Those organizations also define review authority and release decisions (Herkert, 2000; Bielefeldt, 2018).

Written project documentation allows an individual engineer’s judgment to be reviewed by the employer or owner (Engineers Canada, 2024b; Professional Engineers Ontario, 2019). Where the issue moves beyond the project, the same documentation allows a regulator or public authority to see what was known and who decided (Engineers Canada, 2024b; Professional Engineers Ontario, 2020). A dated document should state the evidence considered, the remaining uncertainty, and the person who accepted the decision (Raji *et al.*, 2020; Professional Engineers Ontario, 2019). Engineers Canada’s duty-to-report guidance treats reporting as a continuation of the paramount public duty (Engineers Canada, 2024b). Professional Engineers Ontario’s solid-waste guidance describes monitoring, recording, and reporting as part of demonstrating performance and compliance (Professional Engineers Ontario, 2019).

“[M]onitoring, recording and reporting” are part of the professional work used to demonstrate landfill performance and compliance (Professional Engineers Ontario, 2019). The thesis extends that documentary practice to material disparate-impact risk (Engineers Canada, 2024b; Professional Engineers Ontario, 2019). Erin Cech’s work on the culture of disengagement explains how engineering education can separate technical work from questions of public welfare

(Cech, 2014). Wendy Faulkner shows how engineering identities can make social relations difficult to hold within technical problem definitions (Faulkner, 2000, 2007). Professional visibility, developed in Chapter 2, requires the actor to identify the engineering work through which the patterned uneven burden is produced.

3.4. Delegated Authority and the Actor-Authority Map

Professional engineering responsibility is distributed across institutions (Adams, 2016, 2022). In Ontario, PEO’s Council has rule-making authority under section 7 of the *Professional Engineers Act*, while licence requirements and discipline are addressed in sections 14 and 27 to 28 (*Professional Engineers Act*, RSO 1990, c P.28, ss 7, 14, 27-28). Engineers Canada develops national guidance (Engineers Canada, 2012, 2022). The Canadian Engineering Accreditation Board (CEAB) evaluates undergraduate programs against accreditation criteria (Engineers Canada, 2024c).

Universities control curriculum and assessment within those institutional and accreditation constraints (Engineers Canada, 2024c). Employers and project leads control project scope, resources, and review gates (Herkert, 2000; Bielefeldt, 2018). Public authorities control permits, procurement, or project approvals through the statutes that assign those decisions (Vavilov, 2019 SCC 65 at paras 108-110; Professional Engineers Ontario, 2019).

Mirjam Fines-Neuschild and Tanja Tajmel’s Canadian STEM study shows why this allocation matters. EDI work can become an individual endeavour when institutions do not assign responsibility and resources (Fines-Neuschild & Tajmel, 2024). The actor-authority map converts

that diffuse expectation into a concrete question: who can require, fund, or decide the next action (Adams, 2022; Fines-Neuschild & Tajmel, 2024)?

Kim Brooks and Debra Parkes show how professional education can change what a field treats as normal by reshaping categories and classroom practices (Brooks & Parkes, 2004). Carrie Menkel-Meadow links professional education to hierarchy and decontextualized reasoning (Menkel-Meadow, 1988). For engineering, the operative mechanisms are curricular authority and Canadian Engineering Accreditation Board (CEAB) accreditation, which shape the competencies that programs teach and assess (Engineers Canada, 2024c; Liu *et al.*, 2024).

The same risk may be visible to several actors, but each actor has a different response (Adams, 2022; Herkert, 2000). An individual engineer can document uncertainty and recommend further study (Professional Engineers Ontario, 2020; Engineers Canada, 2024b). An employer can fund the study or change the design (Herkert, 2000; Bielefeldt, 2018). A public authority can attach an approval condition where its statute authorizes that step (*Vavilov*, 2019 SCC 65 at paras 108-110; Professional Engineers Ontario, 2019).

A regulator has a different role. It may establish a prospective practice standard or investigate a licensee's conduct after a complaint (*Professional Engineers Act*, RSO 1990, c P.28, ss 2(4), 7; RRO 1990, Reg 941, s 72). The actor-authority analysis therefore records the decision each actor controls and the reasons that support it (Raji *et al.*, 2020; Professional Engineers Ontario, 2019).

Co-author Jenna B. Smith and I examined judicial restraint and the allocation of legal authority in Métis governance (Liu & Smith, 2022). That earlier analysis informs the actor-

authority map’s insistence that each response be assigned to the institution that holds the relevant legal or organizational power (Liu & Smith, 2022; *Vavilov*, 2019 SCC 65 at paras 85-87, 108-110).

Table 3.1. Actor-authority map for material disparate-impact risk.

Actor	Source of authority	Available mechanisms	Role-specific boundary
Provincial or territorial engineering regulator	Delegated authority under the professional statute to license, set practice expectations, investigate, and discipline (Adams, 2016, 2022; Engineers Canada, 2012, 2022, 2024c; <i>Professional Engineers Act</i> , RSO 1990, c P.28; Professional Engineers Ontario, 2020).	Codes; bylaws; standards; guidance; practice review; complaints and discipline (Adams, 2016, 2022; Engineers Canada, 2012, 2022, 2024c; <i>Professional Engineers Act</i> , RSO 1990, c P.28; Professional Engineers Ontario, 2020).	Acts through the powers conferred by its home statute (Adams, 2016, 2022; Engineers Canada, 2012, 2022, 2024c; <i>Professional Engineers Act</i> , RSO 1990, c P.28; Professional Engineers Ontario, 2020). Project approvals remain with the public authority designated by the project statute (Adams, 2016, 2022; Engineers Canada, 2012, 2022, 2024c; <i>Professional Engineers Act</i> , RSO 1990, c P.28; Professional Engineers Ontario, 2020).
Engineers Canada and CEAB	National coordination and accreditation influence exercised through member regulators and accreditation criteria (Adams, 2016, 2022; Engineers Canada, 2012, 2022, 2024c; <i>Professional Engineers Act</i> , RSO 1990, c P.28; Professional Engineers Ontario, 2020).	National guidelines; model codes; accreditation criteria; qualification frameworks (Adams, 2016, 2022; Engineers Canada, 2012, 2022, 2024c; <i>Professional Engineers Act</i> , RSO 1990, c P.28; Professional Engineers Ontario, 2020).	Guidance gains legal force through adoption by a regulator, university, or employer (Adams, 2016, 2022; Engineers Canada, 2012, 2022, 2024c; <i>Professional Engineers Act</i> , RSO 1990, c P.28; Professional Engineers Ontario, 2020). Contractual incorporation or judicial use can supply further legal effect (Adams, 2016, 2022; Engineers Canada, 2012, 2022, 2024c; <i>Professional Engineers Act</i> , RSO 1990, c P.28; Professional Engineers Ontario, 2020).

Actor	Source of authority	Available mechanisms	Role-specific boundary
University or engineering program	Institutional authority over curriculum, learning outcomes, assessment, and academic governance (Adams, 2016, 2022; Engineers Canada, 2012, 2022, 2024c; <i>Professional Engineers Act</i> , RSO 1990, c P.28; Professional Engineers Ontario, 2020).	Courses; integrated design exercises; capstones; clinical or community-based learning; faculty review (Adams, 2016, 2022; Engineers Canada, 2012, 2022, 2024c; <i>Professional Engineers Act</i> , RSO 1990, c P.28; Professional Engineers Ontario, 2020).	Professional discipline and project approval lie with other actors (Adams, 2016, 2022; Engineers Canada, 2012, 2022, 2024c; <i>Professional Engineers Act</i> , RSO 1990, c P.28; Professional Engineers Ontario, 2020). Accreditation requirements shape available curricular space (Adams, 2016, 2022; Engineers Canada, 2012, 2022, 2024c; <i>Professional Engineers Act</i> , RSO 1990, c P.28; Professional Engineers Ontario, 2020).
Employer, engineering firm, or project lead	Contractual and managerial authority over project scope, resources, and team composition (Adams, 2016, 2022; Engineers Canada, 2012, 2022, 2024c; <i>Professional Engineers Act</i> , RSO 1990, c P.28; Professional Engineers Ontario, 2020). Review, procurement, and release authority may also be assigned (Adams, 2016, 2022; Engineers Canada, 2012, 2022, 2024c; <i>Professional Engineers Act</i> , RSO 1990, c P.28; Professional Engineers Ontario, 2020).	Design reviews; quality systems; technical memoranda; escalation protocols; procurement clauses; stop-work or release decisions (Adams, 2016, 2022; Engineers Canada, 2012, 2022, 2024c; <i>Professional Engineers Act</i> , RSO 1990, c P.28; Professional Engineers Ontario, 2020).	Authority depends on organizational hierarchy, contract, and applicable law (Adams, 2016, 2022; Engineers Canada, 2012, 2022, 2024c; <i>Professional Engineers Act</i> , RSO 1990, c P.28; Professional Engineers Ontario, 2020). A client or public authority may retain the final decision (Adams, 2016, 2022; Engineers Canada, 2012, 2022, 2024c; <i>Professional Engineers Act</i> , RSO 1990, c P.28; Professional Engineers Ontario, 2020).

Actor	Source of authority	Available mechanisms	Role-specific boundary
Individual licensed engineer	Professional judgment over work accepted, supervised, sealed, or advised upon within competence (Adams, 2016, 2022; Engineers Canada, 2012, 2022, 2024c; <i>Professional Engineers Act</i> , RSO 1990, c P.28; Professional Engineers Ontario, 2020).	Inquiry; technical analysis; documentation; warning; recommendation; refusal to seal; escalation or reporting where required (Adams, 2016, 2022; Engineers Canada, 2012, 2022, 2024c; <i>Professional Engineers Act</i> , RSO 1990, c P.28; Professional Engineers Ontario, 2020).	Responsibility follows assigned work and actual control (Adams, 2016, 2022; Engineers Canada, 2012, 2022, 2024c; <i>Professional Engineers Act</i> , RSO 1990, c P.28; Professional Engineers Ontario, 2020). The engineer's record should identify decisions made by others (Adams, 2016, 2022; Engineers Canada, 2012, 2022, 2024c; <i>Professional Engineers Act</i> , RSO 1990, c P.28; Professional Engineers Ontario, 2020).
Public authority	Statutory authority over permits, environmental approvals, and building-code enforcement (Adams, 2016, 2022; Engineers Canada, 2012, 2022, 2024c; <i>Professional Engineers Act</i> , RSO 1990, c P.28; Professional Engineers Ontario, 2020). Procurement or public-service legislation may supply additional authority (Adams, 2016, 2022; Engineers Canada, 2012, 2022, 2024c; <i>Professional Engineers Act</i> , RSO 1990, c P.28; Professional Engineers Ontario, 2020).	Approval conditions; inspections; disclosure requirements; procurement terms; enforcement; public reasons (Adams, 2016, 2022; Engineers Canada, 2012, 2022, 2024c; <i>Professional Engineers Act</i> , RSO 1990, c P.28; Professional Engineers Ontario, 2020).	The authority is defined by the project statute and administrative-law constraints (Adams, 2016, 2022; Engineers Canada, 2012, 2022, 2024c; <i>Professional Engineers Act</i> , RSO 1990, c P.28; Professional Engineers Ontario, 2020). Engineering evidence supports its project decision, while professional-regulatory jurisdiction remains with the engineering regulator (Adams, 2016, 2022; Engineers Canada, 2012, 2022, 2024c; <i>Professional Engineers Act</i> , RSO 1990, c P.28; Professional Engineers Ontario, 2020).
Standards body or code-development body	Consensus-based authority to develop model standards and technical requirements for adoption or contractual use (Adams, 2016, 2022; Engineers Canada, 2012, 2022, 2024c; <i>Professional Engineers Act</i> , RSO 1990, c P.28; Professional Engineers Ontario, 2020).	Codes; standards; explanatory notes; test methods; documentation requirements (Adams, 2016, 2022; Engineers Canada, 2012, 2022, 2024c; <i>Professional Engineers Act</i> , RSO 1990, c P.28; Professional Engineers Ontario, 2020).	Binding effect depends on incorporation into law, contract, procurement, or a professional standard of practice (Adams, 2016, 2022; Engineers Canada, 2012, 2022, 2024c; <i>Professional Engineers Act</i> , RSO 1990, c P.28; Professional Engineers Ontario, 2020).

Actor	Source of authority	Available mechanisms	Role-specific boundary
Affected public, Indigenous government, or community knowledge-holder	Knowledge authority grounded in lived experience, law, and jurisdiction (Adams, 2016, 2022; Engineers Canada, 2012, 2022, 2024c; <i>Professional Engineers Act</i> , RSO 1990, c P.28; Professional Engineers Ontario, 2020). Land relationships and direct exposure to system effects provide further authority (Adams, 2016, 2022; Engineers Canada, 2012, 2022, 2024c; <i>Professional Engineers Act</i> , RSO 1990, c P.28; Professional Engineers Ontario, 2020).	Evidence; participation; technical review; community monitoring; Indigenous law and governance processes (Adams, 2016, 2022; Engineers Canada, 2012, 2022, 2024c; <i>Professional Engineers Act</i> , RSO 1990, c P.28; Professional Engineers Ontario, 2020).	Decision authority varies by legal order and context (Adams, 2016, 2022; Engineers Canada, 2012, 2022, 2024c; <i>Professional Engineers Act</i> , RSO 1990, c P.28; Professional Engineers Ontario, 2020). Engineering actors must identify when this knowledge bears on the technical risk and record how it was addressed (Adams, 2016, 2022; Engineers Canada, 2012, 2022, 2024c; <i>Professional Engineers Act</i> , RSO 1990, c P.28; Professional Engineers Ontario, 2020).

Table 3.1 is used from left to right. First, the analyst names the actor whose decision matters. Second, the analyst identifies the source of that actor’s authority. Third, the analyst states the action that the actor can require or perform (Adams, 2022; Herkert, 2000). This sequence prevents a duty from being assigned to a person who lacks the power or resources to carry it out (Adams, 2016, 2022; Bielefeldt, 2018).

Chapter 4 converts the completed map into a PIIA responsibility chain. The engineering actor prepares the technical analysis within assignment; the employer or owner decides matters within project control; the public authority makes the approval assigned by law (Herkert, 2000; *Vavilov*, 2019 SCC 65 at paras 108-110; Professional Engineers Ontario, 2020). The documents remain connected through traceability so that a later reviewer can see what evidence was available, who decided, and what monitoring followed (IEEE, 2021; Raji *et al.*, 2020).

3.5. Engineering Work, Engineering-Adjacent Work, and Decision Boundaries

In this section, I apply the scope terms defined in section 1.2. The question is whether the relevant task falls within licensed professional engineering under the law of the governing province or territory, and which decisions remain with another actor (Engineers Canada, 2022; *Professional Engineers Act*, RSO 1990, c P.28, s 1(1)). I use the three recurring examples to make those boundaries concrete before the detailed applications that follow.

Engineering-adjacent work includes design, data, and operations whose legal status depends on the task and jurisdiction (Engineers Canada, 2012, 2022). Architecture, policy, and product management may also shape the system (Akrich, 1992; Jasanoff, 2004). The category preserves the legal boundary and keeps technical influence visible (Engineers Canada, 2012, 2022; Jasanoff, 2004).

A precise analysis separates three decisions (Professional Engineers Ontario, 2019; City of Ottawa Building Code Services, 2021; Raji *et al.*, 2020). The engineering decision may be a hydrogeological model, fixture calculation, or validation protocol (Professional Engineers Ontario, 2019; City of Ottawa Building Code Services, 2021; Raji *et al.*, 2020). A decision informed by engineering work may concern approval of a landfill design or selection of a building program (Environmental Commissioner of Ontario, 2004; City of Ottawa Building Code Services, 2021). A political, corporate, or legal decision may then be implemented through technical work (Jasanoff, 2004; Raji *et al.*, 2020). Each decision attracts a corresponding duty and decision-maker (Adams, 2022; *Vavilov*, 2019 SCC 65 at paras 108-110).

Professional Engineers Ontario’s solid-waste guidance illustrates this distributed structure (Professional Engineers Ontario, 2019). It describes solid-waste work as multidisciplinary

(Professional Engineers Ontario, 2019). It places engineering alongside natural and social science (Professional Engineers Ontario, 2019). Legal counsel, public engagement, and Indigenous engagement also form part of the overall process (Professional Engineers Ontario, 2019). Engineers may contribute during planning, design, and construction (Professional Engineers Ontario, 2019). They may also contribute during operation, monitoring, and closure (Professional Engineers Ontario, 2019).

The work “might not be led by an engineer,” while engineers may perform key roles across the facility life cycle (Professional Engineers Ontario, 2019). That formulation captures the thesis’s institutional position (Professional Engineers Ontario, 2019). Engineering responsibility is substantial and confined to engineering judgment within role (Professional Engineers Ontario, 2019). The public authority or project owner remains responsible for the decision assigned to it by statute or contract (*Vavilov*, 2019 SCC 65 at paras 108-110; Professional Engineers Ontario, 2019).

The boundary also has an epistemic dimension (Wynne, 1996; Fricker, 2007). Brian Wynne cautions that a strict expert-lay divide reflects a “lack of recognition” of the interpretive character of scientific knowledge (Wynne, 1996). Affected-public knowledge becomes professionally relevant when it identifies site conditions, access barriers, or system behaviours that bear on engineering analysis (Hamraie, 2017; Whyte, 2020). The engineer’s task is to carry that evidence into the technical record while preserving its legal and relational meaning (Fricker, 2007; Hamraie, 2017; Whyte, 2020).

3.6. Site 41: Hydrogeology, Technical Records, and Distributed Authority

Site 41 is the central engineering recurring example because the proposed landfill depended on hydrogeological investigation and groundwater modelling (Environmental Commissioner of Ontario, 2004; Mushtaq, 2011, 2013). Landfill design and leachate containment supplied the proposed technical controls (Professional Engineers Ontario, 2019). Long-term monitoring supplied the operational verification mechanism (Professional Engineers Ontario, 2019). Environmental authorities and municipal actors retained the approval or continuation decisions (Environmental Commissioner of Ontario, 2004).

3.6.1. The Technical and Approval Record

The Environmental Commissioner described a proposal to landfill 21 hectares within a 60-hectare site near Midland, Ontario (Environmental Commissioner of Ontario, 2004). A hearing board refused approval in 1989, and Cabinet required the hearing to resume in 1990 (Environmental Commissioner of Ontario, 2004). The resumed process approved the site in 1995 (Environmental Commissioner of Ontario, 2004). The Ministry of the Environment issued a certificate of approval in April 1998, subject to further technical submissions (Environmental Commissioner of Ontario, 2004). Stormwater management and construction dewatering required additional permits (Environmental Commissioner of Ontario, 2004).

The Environmental Commissioner’s account followed an application for review of the landfill’s certificate of approval under the *Environmental Bill of Rights, 1993*, SO 1993, c 28 (Environmental Commissioner of Ontario, 2004). That statutory review route placed public access

to the approval record within the Site 41 governance history (Environmental Commissioner of Ontario, 2004).

The detailed design remained technically active years after the certificate was issued (Environmental Commissioner of Ontario, 2004). In March 2003, the Ministry raised gull-management concerns because Huronia Airport was 6.5 kilometres from the site (Environmental Commissioner of Ontario, 2004). The cited Transport Canada guideline recommended 8 kilometres (Environmental Commissioner of Ontario, 2004). In June 2003, the Ministry sent 81 additional comments addressing the remaining design submission (Environmental Commissioner of Ontario, 2004).

Several Ministry comments addressed the groundwater and leachate concept (Environmental Commissioner of Ontario, 2004). The Ministry requested further assessment of a nearby creek (Environmental Commissioner of Ontario, 2004). It urged the County to defer filling the northwest corner until more data were available (Environmental Commissioner of Ontario, 2004). It also raised the effect of off-site groundwater pumping on the leachate collection system (Environmental Commissioner of Ontario, 2004). The design relied on an “upward gradient”: groundwater pressure beneath the proposed waste footprint would assist leachate containment (Environmental Commissioner of Ontario, 2004). Leachate is the contaminated liquid generated by a landfill (Professional Engineers Ontario, 2019).

The relationship between groundwater pressure and leachate control made pumping and dewatering central to the containment concept (Environmental Commissioner of Ontario, 2004). A change in hydraulic conditions could affect the premise on which the concept rested (Environmental Commissioner of Ontario, 2004). The outstanding concerns therefore implicated

design assumptions, operating conditions, and the monitoring needed to verify hydraulic behaviour in practice (Environmental Commissioner of Ontario, 2004; Professional Engineers Ontario, 2019).

A 2003 peer review prepared for concerned residents and Tiny Township accepted that development could be possible if identified concerns were addressed (Environmental Commissioner of Ontario, 2004). The reviewers emphasized the site’s sensitivity (Environmental Commissioner of Ontario, 2004). They wrote that the site would “require that more than usual precautions” be undertaken (Environmental Commissioner of Ontario, 2004). They also concluded that the detailed design information was “inadequate to ensure the appropriate environmental and engineering control” during active landfill operations (Environmental Commissioner of Ontario, 2004).

Those observations satisfy the seriousness and public-interest criteria in Chapter 2 (Environmental Commissioner of Ontario, 2004). The risk concerned groundwater and surface-water protection in a defined hydrogeological setting (Environmental Commissioner of Ontario, 2004). The uncertainty concerned the sufficiency of design information and construction controls (Environmental Commissioner of Ontario, 2004). It also concerned the operating information needed to manage the risk over time (Professional Engineers Ontario, 2019).

The County discontinued the project in September 2009, and the Ministry revoked the certificate of approval on 25 May 2010 (County of Simcoe, 2010). The project remained at the pre-operation stage (County of Simcoe, 2010). Site 41 is assessed here as a case of prospective groundwater risk, contested technical judgment, and contested access to the engineering record (Environmental Commissioner of Ontario, 2004; Ontario (Information and Privacy Commissioner), *Order MO-2449*, Appeal MA07-365, 21 August 2009).

3.6.2. MODFLOW, Calibration Data, and Technical Contestability

Simcoe County retained Jagger Hims Limited, the private engineering consulting firm that prepared the Site 41 hydrogeological model, to develop a calibrated model. Calibration means adjusting model parameters and checking model behaviour against observed groundwater data (Ontario (Information and Privacy Commissioner), *Order MO-2449*). The requested records included the model files and accompanying inputs because those materials were necessary for an independent reviewer to examine how the conclusions were produced (Ontario (Information and Privacy Commissioner), *Order MO-2449*).

A calibrated groundwater model comprises the narrative report, the input data, and the computational model (*Order MO-2449*). Together, those records permit inspection of model construction and calibration (*Order MO-2449*). They also permit a reviewer to test alternate assumptions (Raji *et al.*, 2020). In *Order MO-2449*, the requested records included the calibrated model and its accompanying input data (*Order MO-2449*). The January 2003 supplemental report formed another part of the technical record (*Order MO-2449*).

The appellant was an alternate member of the Community Monitoring Committee (*Order MO-2449*). The committee served as a focal point for collecting, reviewing, and exchanging information relevant to County and local concerns (*Order MO-2449*). The Information and Privacy Commissioner found that the model and data were under the County's control (*Order MO-2449*). The County had authority to compel its consultant to provide them (*Order MO-2449*). The order required the County to obtain the records and issue an access decision (*Order MO-2449*). Legal proceedings were available as an enforcement step if required (*Order MO-2449*).

It would be “contrary to the principle of accountability” if the County had no right to obtain the model and input data (*Order MO-2449*). The order exposes a professional-governance issue that procurement clauses can address (*Order MO-2449*). The public proponent had funded a model that informed its decision, while an external consultant retained the technical files under a proprietary practice (*Order MO-2449*). Procurement-stage clauses are contract terms set when services are acquired; they can define model custody, access rights, and version control (*Order MO-2449*; Raji *et al.*, 2020). Reproducibility requirements can be assigned at the same stage so another qualified reviewer can rerun or inspect the analysis (Raji *et al.*, 2020; Professional Engineers Ontario, 2019).

The model dispute connects criterion 5 to criterion 6. Community concern made the issue visible (*Order MO-2449*). The consultant held the technical files (*Order MO-2449*). The County held contractual and public-law authority to obtain them (*Order MO-2449*). The Commissioner held statutory authority over access (*Order MO-2449*). Each actor therefore had a distinct role-specific response (*Order MO-2449*).

3.6.3. Indigenous and Community Knowledge in the Engineering Record

Usman Mushtaq’s analysis positions participation as a separate requirement from access to information (Mushtaq, 2011). He found that Site 41 design texts framed consultation as presenting results and correcting public misunderstanding after experts had selected the design (Mushtaq, 2011). He wrote that “consultation did not mean participation” (Mushtaq, 2011). His account describes public meetings in which residents received technical explanations after the problem definition had been set (Mushtaq, 2011).

The historical setting developed in Chapter 2 matters here. Beausoleil First Nation is an Anishinaabe community whose present island land base reflects enduring relationships with southern Georgian Bay and colonial displacement from wider ancestral territories (Beausoleil First Nation, n.d.; Parks Canada, 2026). Mushtaq’s account of the Anishinabe Kweag’s 137-day water-protection camp shows that Indigenous participation at Site 41 included direct guardianship of land and water, not simply commentary on a settler project (Mushtaq, 2011, 2013). Engineering participation therefore had to account for Indigenous law and the continuing effects of settler colonialism rather than placing Indigenous communities inside a generic stakeholder category (Borrows, 2010; Truth and Reconciliation Commission of Canada, 2015; Whyte, 2020).

That distinction bears directly on knowability (Mushtaq, 2011, 2013; Fricker, 2007). Local residents and Indigenous water protectors raised concerns about water, source protection, and the conditions for trusting technical assurances (Mushtaq, 2011, 2013). Those concerns identified questions about groundwater flow, pumping, and monitoring (Mushtaq, 2011, 2013; Environmental Commissioner of Ontario, 2004). Access to model inputs formed a further question (*Order MO-2449*). Their legal and relational claims to water retained meanings beyond hydrogeological measurement (Whyte, 2020; Borrows, 2010; Anker, 2016).

The engineering response is specific (Professional Engineers Ontario, 2019). A consultant can record community observations tested within scope and route remaining questions to the County or Ministry (Professional Engineers Ontario, 2019). A peer reviewer can identify how missing data affect confidence in the design (Environmental Commissioner of Ontario, 2004). A public authority can require disclosure of the model, its assumptions, and the monitoring plan (*Order MO-2449*; Professional Engineers Ontario, 2019). Indigenous governments and knowledge-

holders retain authority grounded in law, land, and water (Whyte, 2020; *United Nations Declaration on the Rights of Indigenous Peoples Act*, SC 2021, c 14). The engineering record should preserve those meanings as legal and relational claims (Whyte, 2020; Borrows, 2010; Anker, 2016).

Table 3.2. Site 41 assessed against the Chapter 2 threshold test and authority requirement.

Chapter 2 criterion	Site 41 evidence	Authority and role-specific response
1. More than remote or minor	A 21-hectare landfill was proposed within a 60-hectare site (Environmental Commissioner of Ontario, 2004; <i>Order MO-2449</i> ; Mushtaq, 2011, 2013; Professional Engineers Ontario, 2019). MOE raised 81 comments, and peer reviewers called for precautions beyond usual practice (Environmental Commissioner of Ontario, 2004; <i>Order MO-2449</i> ; Mushtaq, 2011, 2013; Professional Engineers Ontario, 2019).	Hydrogeologists, landfill engineers, peer reviewers, and the Ministry had authority to investigate design assumptions and require further information (Environmental Commissioner of Ontario, 2004; <i>Order MO-2449</i> ; Mushtaq, 2011, 2013; Professional Engineers Ontario, 2019).
2. Public-facing interest	Groundwater and surface-water protection were directly engaged (Environmental Commissioner of Ontario, 2004; <i>Order MO-2449</i> ; Mushtaq, 2011, 2013; Professional Engineers Ontario, 2019). The containment concept depended partly on groundwater pressure beneath the waste footprint (Environmental Commissioner of Ontario, 2004; <i>Order MO-2449</i> ; Mushtaq, 2011, 2013; Professional Engineers Ontario, 2019).	The County and Ministry controlled the public decision (Environmental Commissioner of Ontario, 2004; <i>Order MO-2449</i> ; Mushtaq, 2011, 2013; Professional Engineers Ontario, 2019). Engineers controlled the quality and candour of the technical evidence used in that decision (Environmental Commissioner of Ontario, 2004; <i>Order MO-2449</i> ; Mushtaq, 2011, 2013; Professional Engineers Ontario, 2019).
3. Patterned uneven burden	Residual groundwater risk was concentrated on nearby residents, farmers, and Indigenous communities with direct relationships to the affected water (Environmental Commissioner of Ontario, 2004; <i>Order MO-2449</i> ; Mushtaq, 2011, 2013; Professional Engineers Ontario, 2019).	The engineering record needed to identify who would bear the residual risk and how their knowledge changed the technical inquiry (Environmental Commissioner of Ontario, 2004; <i>Order MO-2449</i> ; Mushtaq, 2011, 2013; Professional Engineers Ontario, 2019).

Chapter 2 criterion	Site 41 evidence	Authority and role-specific response
4. Engineering work creates or significantly shapes the risk	Siting analysis, hydrogeological investigation, and MODFLOW modelling structured the risk assessment (Environmental Commissioner of Ontario, 2004; <i>Order MO-2449</i> ; Mushtaq, 2011, 2013; Professional Engineers Ontario, 2019). Leachate control, dewatering analysis, and monitoring supplied further engineering inputs (Environmental Commissioner of Ontario, 2004; <i>Order MO-2449</i> ; Mushtaq, 2011, 2013; Professional Engineers Ontario, 2019).	Engineering consultants and reviewers held authority over methods, assumptions, warnings, and recommendations within their assignments (Environmental Commissioner of Ontario, 2004; <i>Order MO-2449</i> ; Mushtaq, 2011, 2013; Professional Engineers Ontario, 2019).
5. Known or reasonably knowable within role	MOE comments, peer reviews, and model inputs made the issues visible (Environmental Commissioner of Ontario, 2004; <i>Order MO-2449</i> ; Mushtaq, 2011, 2013; Professional Engineers Ontario, 2019). CMC concerns and source-water policy changes supplied further evidence (Environmental Commissioner of Ontario, 2004; <i>Order MO-2449</i> ; Mushtaq, 2011, 2013; Professional Engineers Ontario, 2019).	Competent actors could identify data gaps, sensitivity to pumping, and the need for transparent model review (Environmental Commissioner of Ontario, 2004; <i>Order MO-2449</i> ; Mushtaq, 2011, 2013; Professional Engineers Ontario, 2019).
6. Actor has authority for a role-specific response	The consultant could document and disclose (Environmental Commissioner of Ontario, 2004; <i>Order MO-2449</i> ; Mushtaq, 2011, 2013; Professional Engineers Ontario, 2019). The County could obtain records and alter the project (Environmental Commissioner of Ontario, 2004; <i>Order MO-2449</i> ; Mushtaq, 2011, 2013; Professional Engineers Ontario, 2019). MOE could attach conditions or withhold further approvals (Environmental Commissioner of Ontario, 2004; <i>Order MO-2449</i> ; Mushtaq, 2011, 2013; Professional Engineers Ontario, 2019). PEO could govern licensee conduct through standards and discipline (Environmental Commissioner of Ontario, 2004; <i>Order MO-2449</i> ; Mushtaq, 2011, 2013; Professional Engineers Ontario, 2019).	The required response followed each actor's power (Environmental Commissioner of Ontario, 2004; <i>Order MO-2449</i> ; Mushtaq, 2011, 2013; Professional Engineers Ontario, 2019). Available forms included technical revision, disclosure, and approval conditions (Environmental Commissioner of Ontario, 2004; <i>Order MO-2449</i> ; Mushtaq, 2011, 2013; Professional Engineers Ontario, 2019). Project decisions and professional accountability remained with their assigned institutions (Environmental Commissioner of Ontario, 2004; <i>Order MO-2449</i> ; Mushtaq, 2011, 2013; Professional Engineers Ontario, 2019).

3.6.4. What the Framework Changes at Site 41

The framework would change the standard of inquiry and the architecture of the record (Environmental Commissioner of Ontario, 2004; Professional Engineers Ontario, 2019). The hydrogeological team would identify the upward-gradient assumption and the effect of off-site pumping (Environmental Commissioner of Ontario, 2004). It would also identify the data needed

to test the northwest corner (Environmental Commissioner of Ontario, 2004). The deliverable would distinguish observed conditions from modelled predictions (Engineers Canada, 2024a; Professional Engineers Ontario, 2019). It would state the uncertainty attached to each conclusion (Funtowicz & Ravetz, 1993; Professional Engineers Ontario, 2019).

The procurement and records plan would require delivery of the calibrated model and its input data to the County (*Order MO-2449*). Documentation and version history would form part of the required deliverables (Raji *et al.*, 2020). The plan would identify material available to the Community Monitoring Committee (*Order MO-2449*). It would also define the process for independent review (Raji *et al.*, 2020). These steps respond directly to the accountability problem documented in *Order MO-2449* (*Order MO-2449*).

The escalation section of the technical memorandum would identify the decision-maker accepting each unresolved risk (Engineers Canada, 2024b; Professional Engineers Ontario, 2019). The engineer or reviewer would identify the decision affected, explain the remaining uncertainty, and state the recommended action (Engineers Canada, 2024b; Professional Engineers Ontario, 2020).

3.7. Public Washrooms: Code Interpretation, Mechanical Systems, and Human-Rights Constraints

Public washrooms are the engineering-adjacent recurring example because the final facility decision is distributed across several actors (National Research Council Canada, 2022; Ontario Human Rights Commission, 2014). An owner or institution sets the program, while architecture organizes layout and circulation (Anthony & Dufresne, 2007; Cavanagh, 2010). Plumbing and

mechanical systems supply defined engineering decisions within that wider arrangement (National Research Council Canada, 2022; City of Ottawa Building Code Services, 2021). Sheila Cavanagh’s description of the public-restroom dispute as a “manifestly mundane issue” captures why a familiar facility can still govern participation (Cavanagh, 2017, p. 183).

3.7.1. The Design Decision and the Engineering Work

The building owner or institution usually establishes the facility program (City of Ottawa Building Code Services, 2021). The architect or interior designer organizes rooms, circulation, and privacy (National Research Council Canada, 2022). The plumbing or mechanical engineer determines fixture connections, water supply, and drainage within that layout (City of Ottawa Building Code Services, 2021; Professional Engineers Ontario, 2020). Mechanical design also determines ventilation (National Research Council Canada, 2022). The building official assesses compliance under sections 3 and 8 of Ontario’s *Building Code Act, 1992* (*Building Code Act, 1992*, SO 1992, c 23, ss 3, 8). Human-rights law governs access to services and facilities (Ontario Human Rights Commission, 2014). Affected users supply evidence about location, privacy, and social policing in practice (Hamraie, 2017; Harwood-Jones *et al.*, 2023).

The engineering work is concrete (National Research Council Canada, 2022; City of Ottawa Building Code Services, 2021). Fixture calculations translate occupant load and expected use into minimum fixture capacity (National Research Council Canada, 2022). Plumbing design determines whether existing supply and drainage can support reconfiguration (City of Ottawa Building Code Services, 2021). Mechanical design determines ventilation and exhaust arrangements (National Research Council Canada, 2022). Accessibility coordination addresses turning space, door operation, and transfer clearance (CSA Group & Accessibility Standards

Canada, 2023). It also addresses the relationship between a universal washroom and the other facilities serving the floor (CSA Group & Accessibility Standards Canada, 2023).

Retrofit feasibility can become the decisive engineering contribution (City of Ottawa Building Code Services, 2021; Professional Engineers Ontario, 2020). Reallocating an existing room may require little technical change when plumbing, fixtures, and occupant load remain stable (City of Ottawa Building Code Services, 2021). A larger renovation may require new drainage routes, ventilation changes, or fire separations (National Research Council Canada, 2022; Professional Engineers Ontario, 2020). The engineer can identify physical constraints and code-interpretation issues (Professional Engineers Ontario, 2020). The owner’s selected program remains a separate decision (City of Ottawa Building Code Services, 2021).

3.7.2. Code Text, Explanatory Guidance, and the Binary Default

National Research Council Proposed Change 1750 addressed a recurring interpretation problem in the 2020 *National Building Code* (National Research Council Canada, 2022). The existing fixture provision calculated minimum water closets using male and female occupant-load assumptions (National Research Council Canada, 2022). Some code enquiries had treated that wording as a requirement for separate rooms (National Research Council Canada, 2022). The regulatory concern was fixture availability for occupants (National Research Council Canada, 2022).

The National Research Council’s Proposed Change 1750 explains that the *National Building Code* requires a minimum number of water closets for occupants and allows those fixtures to be organized in gender-neutral facilities where the other code requirements are met (National Research Council Canada, 2022). Its explanatory note is directed to designers and authorities

having jurisdiction, meaning the officials or bodies responsible for administering the code (National Research Council Canada, 2022). The material therefore provides persuasive code guidance rather than a separate legal mandate (National Research Council Canada, 2022).

The City of Ottawa’s 2021 advisory translates the same point into local practice (City of Ottawa Building Code Services, 2021). It permits allocation according to anticipated gender division and identity, all genders, or specific gender groupings (City of Ottawa Building Code Services, 2021). Existing washrooms qualify for permit-exempt reallocation when the plumbing system, fixture locations, and fixture count remain stable (City of Ottawa Building Code Services, 2021). Stable occupant load is an additional condition (City of Ottawa Building Code Services, 2021).

These sources make the legal and technical allocation precise (National Research Council Canada, 2022; City of Ottawa Building Code Services, 2021). The institution retains authority over gender policy and the facility program (City of Ottawa Building Code Services, 2021). The engineer supplies accurate code advice about available configurations (National Research Council Canada, 2022; Professional Engineers Ontario, 2020). The engineer then calculates capacity, identifies retrofit constraints, and documents technically sound options (City of Ottawa Building Code Services, 2021; Professional Engineers Ontario, 2020). The owner and the authority having jurisdiction decide within their respective powers, including the building official’s powers under sections 3 and 8 of Ontario’s *Building Code Act, 1992* (City of Ottawa Building Code Services, 2021; *Building Code Act, 1992*, SO 1992, c 23, ss 3, 8).

3.7.3. Human-Rights Floor and Equivalent Access

Ontario human-rights guidance identifies washroom access as a basic physical need connected to human dignity (Ontario Human Rights Commission, 2014, s 13.4.1). In Ontario, the *Human Rights Code* protects equal treatment in services and facilities under section 1 and in employment under section 5 (*Human Rights Code*, RSO 1990, c H.19, ss 1, 5). A trans person's access follows lived gender identity under the Commission's guidance (Ontario Human Rights Commission, 2014, s 13.4.1).

“Access to washrooms is a basic physical need at the core of human dignity for everyone” (Ontario Human Rights Commission, 2014, s. 13.4.1). That legal floor has engineering consequences when the available option is technically inferior (Ontario Human Rights Commission, 2014; Hamraie, 2017). A single universal washroom on another floor can impose additional travel and waiting (Harwood-Jones *et al.*, 2023). A room designated as inclusive can remain unusable when door hardware, turning clearances, or transfer space exclude disabled users (CSA Group & Accessibility Standards Canada, 2023; Hamraie, 2017). A retrofit can also concentrate demand in a facility with less capacity than the gendered rooms serving other users (National Research Council Canada, 2022; Harwood-Jones *et al.*, 2023).

Aimi Hamraie's history of access design explains why affected users are sources of engineering knowledge (Hamraie, 2017). Hamraie describes disabled people as “experts about their bodies and surrounding environments” (Hamraie, 2017, p. 113). In a washroom project, that insight supports direct testing of routes and controls. It also supports post-occupancy evidence gathered through complaints, queue observations, and user reports (Hamraie, 2017; Harwood-Jones *et al.*, 2023).

Privacy and safety require technical specificity (National Research Council Canada, 2022; City of Vancouver, 2024). Full-height partitions and lockable doors address exposure within multi-stall facilities (National Research Council Canada, 2022). Sightline design addresses views from the corridor (City of Vancouver, 2024). Emergency-call devices and power-operated doors affect independent use (CSA Group & Accessibility Standards Canada, 2023). Ventilation, disposal receptacles, and maintenance protocols affect continued usability (City of Vancouver, 2024). A design matrix can assign privacy and ventilation work to architectural and mechanical disciplines (National Research Council Canada, 2022; City of Vancouver, 2024). Electrical and facilities responsibilities can be assigned in the same matrix (City of Vancouver, 2024; CSA Group & Accessibility Standards Canada, 2023).

3.7.4. Applying the Six Criteria to a Retrofit Decision

Consider an institutional retrofit in which several multi-stall washrooms are proposed for all-gender use while one women’s room and one men’s room remain (Mélanson Marceau Grenier Cohen s.e.n.c., 2025). The Mélanson firm examined that proposal against Quebec occupational-health requirements and the Quebec construction code (Mélanson Marceau Grenier Cohen s.e.n.c., 2025). It also examined the *National Building Code* and Proposed Change 1750 (Mélanson Marceau Grenier Cohen s.e.n.c., 2025).

The value of the Mélanson firm’s opinion lies in its method. It identified the governing instruments and existing fixture distribution (Mélanson Marceau Grenier Cohen s.e.n.c., 2025). It then separated an assumed technical prohibition from the applicable legal text (Mélanson Marceau Grenier Cohen s.e.n.c., 2025). A mechanical or plumbing engineer can support that documented

inquiry within role by supplying the fixture and system calculations (Professional Engineers Ontario, 2020).

Table 3.3. Public washrooms assessed against the Chapter 2 threshold test and authority requirement.

Chapter 2 criterion	Washroom evidence	Authority and role-specific response
1. More than remote or minor	Evidence links washroom access to harassment, avoidance, dignity, and participation (National Research Council Canada, 2022; City of Ottawa Building Code Services, 2021; Ontario Human Rights Commission, 2014; Hamraie, 2017; CSA Group & Accessibility Standards Canada, 2023). The seriousness increases where the inclusive option is remote, inaccessible, or undersupplied (National Research Council Canada, 2022; City of Ottawa Building Code Services, 2021; Ontario Human Rights Commission, 2014; Hamraie, 2017; CSA Group & Accessibility Standards Canada, 2023).	The owner can alter the program (National Research Council Canada, 2022; City of Ottawa Building Code Services, 2021; Ontario Human Rights Commission, 2014; Hamraie, 2017; CSA Group & Accessibility Standards Canada, 2023). The design team can test capacity, privacy, and route (National Research Council Canada, 2022; City of Ottawa Building Code Services, 2021; Ontario Human Rights Commission, 2014; Hamraie, 2017; CSA Group & Accessibility Standards Canada, 2023). Accessibility testing determines whether the formal designation produces usable access (National Research Council Canada, 2022; City of Ottawa Building Code Services, 2021; Ontario Human Rights Commission, 2014; Hamraie, 2017; CSA Group & Accessibility Standards Canada, 2023).
2. Public-facing interest	The interests include access to a public facility, dignity, and privacy (National Research Council Canada, 2022; City of Ottawa Building Code Services, 2021; Ontario Human Rights Commission, 2014; Hamraie, 2017; CSA Group & Accessibility Standards Canada, 2023). They also include safe participation in work, education, or public life (National Research Council Canada, 2022; City of Ottawa Building Code Services, 2021; Ontario Human Rights Commission, 2014; Hamraie, 2017; CSA Group & Accessibility Standards Canada, 2023).	Human-rights law sets the service-access floor (National Research Council Canada, 2022; City of Ottawa Building Code Services, 2021; Ontario Human Rights Commission, 2014; Hamraie, 2017; CSA Group & Accessibility Standards Canada, 2023). Engineers contribute technical evidence about equivalent capacity and usability (National Research Council Canada, 2022; City of Ottawa Building Code Services, 2021; Ontario Human Rights Commission, 2014; Hamraie, 2017; CSA Group & Accessibility Standards Canada, 2023).

Chapter 2 criterion	Washroom evidence	Authority and role-specific response
3. Patterned uneven burden	Binary-only or inferior arrangements burden trans, non-binary, and Two-Spirit users in recurring ways (National Research Council Canada, 2022; City of Ottawa Building Code Services, 2021; Ontario Human Rights Commission, 2014; Hamraie, 2017; CSA Group & Accessibility Standards Canada, 2023). Disability and caregiving can compound travel, privacy, and assistance needs (National Research Council Canada, 2022; City of Ottawa Building Code Services, 2021; Ontario Human Rights Commission, 2014; Hamraie, 2017; CSA Group & Accessibility Standards Canada, 2023).	Affected-user evidence identifies how the arrangement operates across intersecting conditions (National Research Council Canada, 2022; City of Ottawa Building Code Services, 2021; Ontario Human Rights Commission, 2014; Hamraie, 2017; CSA Group & Accessibility Standards Canada, 2023). The design record should state whose use was tested (National Research Council Canada, 2022; City of Ottawa Building Code Services, 2021; Ontario Human Rights Commission, 2014; Hamraie, 2017; CSA Group & Accessibility Standards Canada, 2023).
4. Engineering work creates or significantly shapes the risk	Fixture calculations, plumbing capacity, and ventilation can determine which options are available (National Research Council Canada, 2022; City of Ottawa Building Code Services, 2021; Ontario Human Rights Commission, 2014; Hamraie, 2017; CSA Group & Accessibility Standards Canada, 2023). Accessibility coordination, controls, and retrofit feasibility add further constraints (National Research Council Canada, 2022; City of Ottawa Building Code Services, 2021; Ontario Human Rights Commission, 2014; Hamraie, 2017; CSA Group & Accessibility Standards Canada, 2023).	Mechanical, plumbing, electrical, and accessibility consultants control their respective technical analyses (National Research Council Canada, 2022; City of Ottawa Building Code Services, 2021; Ontario Human Rights Commission, 2014; Hamraie, 2017; CSA Group & Accessibility Standards Canada, 2023). The architect and owner control broader layout and program decisions (National Research Council Canada, 2022; City of Ottawa Building Code Services, 2021; Ontario Human Rights Commission, 2014; Hamraie, 2017; CSA Group & Accessibility Standards Canada, 2023).
5. Known or reasonably knowable within role	NRC guidance, municipal advisories, and human-rights policy make the risks visible (National Research Council Canada, 2022; City of Ottawa Building Code Services, 2021; Ontario Human Rights Commission, 2014; Hamraie, 2017; CSA Group & Accessibility Standards Canada, 2023). Accessibility standards and user evidence add project-specific detail (National Research Council Canada, 2022; City of Ottawa Building Code Services, 2021; Ontario Human Rights Commission, 2014; Hamraie, 2017; CSA Group & Accessibility Standards Canada, 2023).	A competent engineer can identify code flexibility, capacity implications, and accessibility limitations through ordinary design review (National Research Council Canada, 2022; City of Ottawa Building Code Services, 2021; Ontario Human Rights Commission, 2014; Hamraie, 2017; CSA Group & Accessibility Standards Canada, 2023).

Chapter 2 criterion	Washroom evidence	Authority and role-specific response
6. Actor has authority for a role-specific response	The engineer can calculate, document, coordinate, and recommend (National Research Council Canada, 2022; City of Ottawa Building Code Services, 2021; Ontario Human Rights Commission, 2014; Hamraie, 2017; CSA Group & Accessibility Standards Canada, 2023). The owner can select the program (National Research Council Canada, 2022; City of Ottawa Building Code Services, 2021; Ontario Human Rights Commission, 2014; Hamraie, 2017; CSA Group & Accessibility Standards Canada, 2023). The building official can determine code compliance (National Research Council Canada, 2022; City of Ottawa Building Code Services, 2021; Ontario Human Rights Commission, 2014; Hamraie, 2017; CSA Group & Accessibility Standards Canada, 2023). A human-rights body can adjudicate a complaint (National Research Council Canada, 2022; City of Ottawa Building Code Services, 2021; Ontario Human Rights Commission, 2014; Hamraie, 2017; CSA Group & Accessibility Standards Canada, 2023).	The professional response is a technically defensible option set with an explicit record of constraints (National Research Council Canada, 2022; City of Ottawa Building Code Services, 2021; Ontario Human Rights Commission, 2014; Hamraie, 2017; CSA Group & Accessibility Standards Canada, 2023). The record states the code basis for each configuration (National Research Council Canada, 2022; City of Ottawa Building Code Services, 2021; Ontario Human Rights Commission, 2014; Hamraie, 2017; CSA Group & Accessibility Standards Canada, 2023).

3.7.5. What the Framework Changes in Washroom Design

The framework changes the technical memorandum (National Research Council Canada, 2022; City of Ottawa Building Code Services, 2021). The memorandum would identify occupancy assumptions, capacity assigned to each option, and accessibility features required for equivalent use (National Research Council Canada, 2022; CSA Group & Accessibility Standards Canada, 2023). It would state whether an all-gender configuration uses existing fixtures, relocates demand, or requires new services (City of Ottawa Building Code Services, 2021; National Research Council Canada, 2022).

The memorandum would identify the decision boundary (Professional Engineers Ontario, 2020; City of Ottawa Building Code Services, 2021). The owner would select the program and accept cost or space trade-offs (City of Ottawa Building Code Services, 2021). The architect would

coordinate layout and privacy (National Research Council Canada, 2022). The engineer would certify calculations and systems within scope (Professional Engineers Ontario, 2020). The building official would decide compliance under sections 3 and 8 of Ontario’s *Building Code Act, 1992* (*Building Code Act, 1992*, SO 1992, c 23, ss 3, 8). This allocation enables the engineer to raise a material access risk while institutional policy remains with the owner (Professional Engineers Ontario, 2020; City of Ottawa Building Code Services, 2021).

The record would also treat user knowledge as evidence (Hamraie, 2017; Harwood-Jones *et al.*, 2023). Post-occupancy complaints may concern distance, queues, or door operation (Harwood-Jones *et al.*, 2023; CSA Group & Accessibility Standards Canada, 2023). Reports of harassment supply a further form of evidence (Ontario Human Rights Commission, 2014). The responsible actor can respond through a technical alteration, facilities policy, or human-rights accommodation (Hamraie, 2017; Ontario Human Rights Commission, 2014). The engineering contribution concerns the operation and feasibility of the built system (Professional Engineers Ontario, 2020).

3.8. Artificial Intelligence and Large Language Models: Professional Engineering at the System Boundary

AI and large language models form the boundary recurring example because the technical ecosystem spans several legal and institutional regimes (Engineers Canada, 2022; Scassa, 2021). General-purpose model research and platform governance are often corporate or academic activities (Bender *et al.*, 2021; Bommasani *et al.*, 2021). Professional engineering becomes directly

relevant when a licensed actor accepts responsibility for integration, validation, or operation in an engineered system (Engineers Canada, 2022; Professional Engineers Ontario, n.d.).

3.8.1. The Licensure Boundary in Software-Intensive Systems

Engineers Canada’s software-engineering paper is explicit about the boundary (Engineers Canada, 2022). It treats provincial and territorial regulators as the legal authorities and describes the national paper as guidance (Engineers Canada, 2022). It identifies software engineering through the nature of the work, the protected public interests, and professional responsibility in software-intensive systems (Engineers Canada, 2022).

Engineers Canada’s software-engineering paper supplies the practice boundary. It states that “not all software practice is software engineering” and assigns interpretation to the provincial and territorial regulators (Engineers Canada, 2022). In plain terms, software work enters licensed professional engineering only when it satisfies the statutory definition and licensing requirements in the province or territory where the work occurs (Engineers Canada, 2022; Professional Engineers Ontario, n.d.). The same rule applies when the software includes AI or an LLM.

The legal inquiry begins with the system, the task, and the responsible actor (Engineers Canada, 2022). An engineer validating an AI-enabled control function in transportation, water, or energy infrastructure may be performing professional engineering (Engineers Canada, 2022; Professional Engineers Ontario, n.d.). The same may be true in a medical device or building system (Engineers Canada, 2022; Professional Engineers Ontario, n.d.). A general-purpose consumer chatbot ordinarily sits within technical product development governed by other regimes (Engineers Canada, 2022; Scassa, 2021). The model enters professional engineering when it is

integrated into a system for which an engineer assumes responsibility (Engineers Canada, 2022; IEEE, 2021).

This boundary also allocates authority (Raji *et al.*, 2020; IEEE, 2021). The model provider controls training, release, and system-level documentation (Raji *et al.*, 2020; Bommasani *et al.*, 2021). The organization that procures and deploys the model controls the intended use and operating context (Scassa, 2021; Costanza-Chock *et al.*, 2022). The engineering integrator controls requirements, test evidence, and technical acceptance within scope (Engineers Canada, 2022; IEEE, 2021). A public authority may impose procurement or administrative-law requirements (Scassa, 2021). Privacy and human-rights institutions govern their respective legal domains (Office of the Privacy Commissioner of Canada *et al.*, 2023; Scassa, 2021).

3.8.2. GPT-3 and a Specific Patterned Representational Risk

Abubakar Abid, Maheen Farooqi, and James Zou provide a precise example of a known or reasonably knowable large language model (LLM) risk (Abid *et al.*, 2021). In the GPT-3 configuration they tested, an analogy prompt mapped “Muslim” to “terrorist” in 23 percent of trials (Abid *et al.*, 2021). In a separate prompt-completion test, violent completions appeared for Muslim prompts at substantially higher rates than for comparator religious identities (Abid *et al.*, 2021).

The study also tested a prompt intervention (Abid *et al.*, 2021). Adding six positive adjectives reduced the proportion of violent completions for Muslim prompts from 66 percent to 20 percent (Abid *et al.*, 2021). The remaining difference showed that prompt-level intervention reduced the observed output while the broader representational pattern persisted (Abid *et al.*, 2021).

The study supports a bounded claim (Abid *et al.*, 2021). It demonstrates that ordinary model testing could reveal a patterned association between a religious identity and violence in an early large language model (Abid *et al.*, 2021). The study’s evidentiary reach is the tested GPT-3 configuration (Abid *et al.*, 2021). Each proposed model and deployment requires direct testing (Blodgett *et al.*, 2020; Bommasani *et al.*, 2021).

Su Lin Blodgett and colleagues explain why the technical label “bias” requires a defined normative account (Blodgett *et al.*, 2020). Their survey calls for explicit definitions of bias, identification of affected groups, and reasons explaining the relevant harm (Blodgett *et al.*, 2020). The Chapter 2 threshold test supplies that translation through a negative public-facing effect, a patterned uneven burden, and a role-specific engineering response.

Emily Bender and colleagues add data and deployment dimensions to the analysis (Bender *et al.*, 2021). They identify the scale and composition of internet-derived training data as sources of social and environmental risk (Bender *et al.*, 2021). Dataset documentation and institutional scaling decisions are further sources (Bender *et al.*, 2021; Bommasani *et al.*, 2021). Their analysis locates LLM behaviour in technical choices and organizational governance (Bender *et al.*, 2021; Bommasani *et al.*, 2021).

3.8.3. Traceability, Evaluation, and Distributed Responsibility

Inioluwa Deborah Raji and colleagues provide a process model directly relevant to professional engineering (Raji *et al.*, 2020, pp. 33–37). They describe internal auditing across the development life cycle (Raji *et al.*, 2020, p. 33). Each stage produces documents that together form an “overall audit report” (Raji *et al.*, 2020, p. 33). They also warn that after deployment,

emergent issues can become “difficult or impossible to trace back to their source” (Raji *et al.*, 2020, p. 33).

Their framework gives specificity to known or reasonably knowable (Raji *et al.*, 2020). Before deployment, the team should map known harms and identify affected groups (Raji *et al.*, 2020). During development, the team should record model and dataset choices (Raji *et al.*, 2020). Before release, it should evaluate performance against intended use and document limitations (Raji *et al.*, 2020). After deployment, it should monitor incidents and feedback (Raji *et al.*, 2020).

Raji and colleagues recommend avoiding yes-or-no questions because a checklist can become “box-ticking” (Raji *et al.*, 2020, p. 36). That warning is important for the Public-Interest Impact Assessment (Raji *et al.*, 2020, p. 36; Costanza-Chock *et al.*, 2022). A document should preserve judgment, evidence, and unresolved disagreement (Raji *et al.*, 2020, pp. 33–37). It should identify the group-level evaluation, deployment context, and release authority (Raji *et al.*, 2020, pp. 33–37). Technical evidence gives the assessment a documented basis (Raji *et al.*, 2020, p. 36; Costanza-Chock *et al.*, 2022).

The Institute of Electrical and Electronics Engineers (IEEE) Standard 7000 supplies a systems-engineering analogue (IEEE, 2021). The standard establishes processes for stakeholder elicitation, ethical requirements, and risk-based design (IEEE, 2021, abstract). Its central contribution is “traceability of ethical values” from the operational concept through requirements and design (IEEE, 2021, abstract). It assigns organizational leadership and project roles direct responsibility for value requirements (IEEE, 2021).

3.8.4. A System-Integration Application

Consider an illustrative case in which a public transit authority procures an LLM-based tool to summarize maintenance reports and prioritize files for engineering review (Engineers Canada, 2022; Raji *et al.*, 2020). The general-purpose model provider controls the base model (Raji *et al.*, 2020; Bommasani *et al.*, 2021). The transit authority controls procurement and operational use (Scassa, 2021). A licensed engineer responsible for maintenance reliability may control acceptance criteria, meaning the measurable conditions the tool must satisfy before technical acceptance (Engineers Canada, 2022; IEEE, 2021). The engineer may also control permitted use cases and human-review requirements (Engineers Canada, 2022; IEEE, 2021). The example engages professional engineering when the tool materially shapes decisions about an engineered transportation system for which the engineer has assumed responsibility (Engineers Canada, 2022).

The engineer’s due care would begin by defining the tool’s function (Engineers Canada, 2022; IEEE, 2021). Summarization and routing create a different risk profile from autonomous diagnosis or release-to-service decisions (Raji *et al.*, 2020; Parasuraman & Manzey, 2010). The validation plan would test omitted hazards, false prioritization, and performance across the language used by different workers or members of the public (Raji *et al.*, 2020; IEEE, 2021). The documentation would state intended and excluded uses (Raji *et al.*, 2020). It would also state the escalation threshold and the person authorized to override the system (Raji *et al.*, 2020; Parasuraman & Manzey, 2010).

Where evaluation reveals a patterned association or error burdening a marginalized community, the engineer can require a narrower use case, further testing, or human review within

the integration scope (Raji *et al.*, 2020; IEEE, 2021). The employer can change procurement or deployment (Costanza-Chock *et al.*, 2022). The model provider can modify training or safeguards (Raji *et al.*, 2020; Bommasani *et al.*, 2021). The public authority can impose transparency or recourse requirements (Scassa, 2021). Together, these responses form an authority-specific allocation across the AI ecosystem (Raji *et al.*, 2020; Costanza-Chock *et al.*, 2022; Engineers Canada, 2022).

Table 3.4. Artificial intelligence (AI) and large language models (LLMs) assessed against the Chapter 2 threshold test and authority requirement.

Chapter 2 criterion	AI and LLM evidence	Authority and role-specific response
1. More than remote or minor	Abid <i>et al.</i> documented a persistent Muslim-violence association in the tested GPT-3 configuration (Abid <i>et al.</i> , 2021; Blodgett <i>et al.</i> , 2020; Engineers Canada, 2022; Raji <i>et al.</i> , 2020; IEEE, 2021). In a public-facing or decision-shaping deployment, such behaviour can affect dignity, trust, and service access (Abid <i>et al.</i> , 2021; Blodgett <i>et al.</i> , 2020; Engineers Canada, 2022; Raji <i>et al.</i> , 2020; IEEE, 2021).	The deploying organization must assess the actual use case and consequence (Abid <i>et al.</i> , 2021; Blodgett <i>et al.</i> , 2020; Engineers Canada, 2022; Raji <i>et al.</i> , 2020; IEEE, 2021). An engineer’s responsibility increases where the model is integrated into a system affecting protected public interests (Abid <i>et al.</i> , 2021; Blodgett <i>et al.</i> , 2020; Engineers Canada, 2022; Raji <i>et al.</i> , 2020; IEEE, 2021).
2. Public-facing interest	The interest may be safe service delivery, dignified treatment, accurate communication, or access to a public institution (Abid <i>et al.</i> , 2021; Blodgett <i>et al.</i> , 2020; Engineers Canada, 2022; Raji <i>et al.</i> , 2020; IEEE, 2021).	The system owner defines the operational use (Abid <i>et al.</i> , 2021; Blodgett <i>et al.</i> , 2020; Engineers Canada, 2022; Raji <i>et al.</i> , 2020; IEEE, 2021). The engineering integrator translates that use into requirements and validation evidence (Abid <i>et al.</i> , 2021; Blodgett <i>et al.</i> , 2020; Engineers Canada, 2022; Raji <i>et al.</i> , 2020; IEEE, 2021).
3. Patterned uneven burden	Group-linked stereotypes and error patterns can burden Muslim users or other structurally marginalized communities in recurring ways (Abid <i>et al.</i> , 2021; Blodgett <i>et al.</i> , 2020; Engineers Canada, 2022; Raji <i>et al.</i> , 2020; IEEE, 2021).	Evaluation must identify the affected group, the mechanism, and the deployment consequence (Abid <i>et al.</i> , 2021; Blodgett <i>et al.</i> , 2020; Engineers Canada, 2022; Raji <i>et al.</i> , 2020; IEEE, 2021). Aggregate scores provide a separate system-level measure (Abid <i>et al.</i> , 2021; Blodgett <i>et al.</i> , 2020; Engineers Canada, 2022; Raji <i>et al.</i> , 2020; IEEE, 2021).

Chapter 2 criterion	AI and LLM evidence	Authority and role-specific response
4. Engineering work creates or significantly shapes the risk	Professional engineering is engaged where engineers specify, integrate, validate, or supervise software-intensive systems within reserved practice (Abid <i>et al.</i> , 2021; Blodgett <i>et al.</i> , 2020; Engineers Canada, 2022; Raji <i>et al.</i> , 2020; IEEE, 2021).	The engineer controls system-level requirements, test evidence, interfaces, and technical acceptance within assigned responsibility (Abid <i>et al.</i> , 2021; Blodgett <i>et al.</i> , 2020; Engineers Canada, 2022; Raji <i>et al.</i> , 2020; IEEE, 2021).
5. Known or reasonably knowable within role	Published studies, model documentation, and red-team tests can reveal the risk (Abid <i>et al.</i> , 2021; Blodgett <i>et al.</i> , 2020; Engineers Canada, 2022; Raji <i>et al.</i> , 2020; IEEE, 2021). Subgroup evaluation, complaints, and incidents add deployment evidence (Abid <i>et al.</i> , 2021; Blodgett <i>et al.</i> , 2020; Engineers Canada, 2022; Raji <i>et al.</i> , 2020; IEEE, 2021).	Raji <i>et al.</i> and IEEE 7000 provide methods for lifecycle documentation and traceability (Abid <i>et al.</i> , 2021; Blodgett <i>et al.</i> , 2020; Engineers Canada, 2022; Raji <i>et al.</i> , 2020; IEEE, 2021). A competent actor should test the actual model and context (Abid <i>et al.</i> , 2021; Blodgett <i>et al.</i> , 2020; Engineers Canada, 2022; Raji <i>et al.</i> , 2020; IEEE, 2021).
6. Actor has authority for a role-specific response	The model provider, deployer, and engineer hold different powers (Abid <i>et al.</i> , 2021; Blodgett <i>et al.</i> , 2020; Engineers Canada, 2022; Raji <i>et al.</i> , 2020; IEEE, 2021). Public authorities and regulators hold additional powers (Abid <i>et al.</i> , 2021; Blodgett <i>et al.</i> , 2020; Engineers Canada, 2022; Raji <i>et al.</i> , 2020; IEEE, 2021).	Responses include model change, procurement conditions, and use restrictions (Abid <i>et al.</i> , 2021; Blodgett <i>et al.</i> , 2020; Engineers Canada, 2022; Raji <i>et al.</i> , 2020; IEEE, 2021). Human review, disclosure, and monitoring supply further controls (Abid <i>et al.</i> , 2021; Blodgett <i>et al.</i> , 2020; Engineers Canada, 2022; Raji <i>et al.</i> , 2020; IEEE, 2021). Professional guidance and escalation complete the authority-specific response (Abid <i>et al.</i> , 2021; Blodgett <i>et al.</i> , 2020; Engineers Canada, 2022; Raji <i>et al.</i> , 2020; IEEE, 2021).

3.8.5. What the Framework Changes for AI and LLMs

The framework asks whether a defined model, configuration, and use creates a material disparate-impact risk that engineering work significantly shapes (Blodgett *et al.*, 2020; Raji *et al.*, 2020). The team must identify the affected public, the operational consequence, and the actor with authority to respond (Raji *et al.*, 2020).

For a licensed engineer, the resulting record would state intended use and test data (Raji *et al.*, 2020; IEEE, 2021). Subgroup evaluation means testing results separately for identified groups or conditions that may experience different outcomes (Blodgett *et al.*, 2020; Raji *et al.*,

2020). The record would also state identified failure modes and the monitoring plan (Raji *et al.*, 2020). It would distinguish base-model limitations from integration effects (Raji *et al.*, 2020; Engineers Canada, 2022). It would identify the decision accepted by the employer or public authority after the engineer documented the residual risk (Raji *et al.*, 2020; IEEE, 2021).

Professional engineering regulation enters through the licensee and the regulated work (Engineers Canada, 2022; Professional Engineers Ontario, n.d.). Practice guidance can require competent validation and transparent documentation for AI-enabled engineering systems (Engineers Canada, 2022; IEEE, 2021). Discipline can address negligent engineering conduct within jurisdiction (RRO 1990, Reg 941, s 72). Procurement law, privacy law, and human-rights law carry additional parts of the governance task (Scassa, 2021; Office of the Privacy Commissioner of Canada *et al.*, 2023). Sector regulation and platform governance carry further parts (Scassa, 2021; Costanza-Chock *et al.*, 2022).

3.9. Alberta: Statutory Constraint and Competence-Based Implementation

Chapter 1 used Alberta to show why this national thesis must be applied through the law of a particular province or territory. I return to Alberta here to separate two questions: which powers govern professional engineering at the July 2026 thesis date, and which enacted constraints will apply after Alberta proclaims the *Professional Governance Act* for engineers (*Engineering and Geoscience Professions Act*, RSA 2000, c E-11, ss 2, 10, 19, 43-63; *Professional Governance Act*, SA 2025, c P-25.5; Government of Alberta, 2025, 2026). Keeping those questions separate prevents legislation that is not yet operative for engineers from being treated as present law and makes the source of each actor's authority visible (Government of Alberta, 2025, 2026).

At the July 2026 thesis date, professional engineering in Alberta remains governed by the *Engineering and Geoscience Professions Act* and the *Engineering and Geoscience Professions General Regulation* (*Engineering and Geoscience Professions Act*, RSA 2000, c E-11, ss 2, 10, 19, 43-63; *Engineering and Geoscience Professions General Regulation*, Alta Reg 150/99, Sched 1). The Alberta government states that initial proclamation of the *Professional Governance Act* is expected in the second half of 2026 and that implementation will be staggered across professional organizations (*Professional Governance Act*, SA 2025, c P-25.5; Government of Alberta, 2026). The present actor-authority analysis therefore begins with the current engineering statute and regulation.

The *Regulated Professions Neutrality Act* supplies an enacted future constraint for engineering (*Regulated Professions Neutrality Act*, SA 2025, c R-13.3; Government of Alberta, 2025). Its preamble links public protection to competence and ethical conduct and directs regulators to remain within their legitimate role (*Regulated Professions Neutrality Act*, SA 2025, c R-13.3, preamble). Sections 7 and 8 reserve mandatory training for professional competence or ethical standards and restrict specified training concerning cultural competency, unconscious bias, and EDI (*Regulated Professions Neutrality Act*, SA 2025, c R-13.3, ss 7-8). For engineers, those provisions take effect when the *Professional Governance Act* comes into force for the profession (Government of Alberta, 2025, 2026). The legislative debate provides context for that stated boundary rather than operative legal text. At third reading, Justice Minister Mickey Amery described the bill as preserving training tied to professional competence and the “ethical responsibilities owed to the public” (Alberta, Legislative Assembly, Alberta Hansard, 31st Leg, 2nd Sess (9 December 2025) at 887).

Other provisions preserve distinct legal pathways. Section 1(2) preserves rights, responsibilities, and duties under the *Alberta Human Rights Act (Regulated Professions Neutrality Act, SA 2025, c R-13.3, s 1(2))*. Section 9 addresses educational credentials that contain social, cultural, or equality-related content (*Regulated Professions Neutrality Act, SA 2025, c R-13.3, s 9*). Section 10 applies correctness review to compliance with the Act and to specified questions under the *Canadian Charter of Rights and Freedoms* or the *Alberta Bill of Rights (Regulated Professions Neutrality Act, SA 2025, c R-13.3, s 10; Alberta Bill of Rights, RSA 2000, c A-14)*.

Taken together, those provisions shape the route by which an Alberta regulator could implement the thesis's proposal once the *Professional Governance Act* and the related neutrality provisions are operative for engineers. A regulator-created PIIA requirement would need to be connected to professional competence or ethical standards and structured within the limits of sections 7 to 9 (*Regulated Professions Neutrality Act, SA 2025, c R-13.3, ss 7-9*). Section 1(2) keeps human-rights duties in their own statutory channel (*Regulated Professions Neutrality Act, SA 2025, c R-13.3, s 1(2)*). Correctness review under section 10 means that a reviewing court decides the identified legal question for itself rather than deferring to the regulator's answer (*Regulated Professions Neutrality Act, SA 2025, c R-13.3, s 10*).

The implementation route remains actor-specific. Once sections 7 and 8 are operative for engineering, a regulator-created mandatory course concerning EDI would engage those provisions (*Regulated Professions Neutrality Act, SA 2025, c R-13.3, ss 7-8; Government of Alberta, 2025, 2026*). A university may teach social context through its curricular authority, subject to section 9 where the regulator requires the credential (Engineers Canada, 2024c; *Regulated Professions Neutrality Act, SA 2025, c R-13.3, s 9*). An employer may require a project risk process through

contract or quality management (Herkert, 2000; IEEE, 2021). A human-rights body continues to apply the *Alberta Human Rights Act* within its statutory jurisdiction (*Regulated Professions Neutrality Act*, SA 2025, c R-13.3, s 1(2); *Alberta Human Rights Act*, RSA 2000, c A-25.5).

The future correctness provision makes precise reasons especially important (*Regulated Professions Neutrality Act*, SA 2025, c R-13.3, s 10). A regulator should identify the statutory power and the engineering competence at issue, then explain the evidence connecting the requirement to public protection (*Regulated Professions Neutrality Act*, SA 2025, c R-13.3, preamble, s 10; *Canada (Minister of Citizenship and Immigration) v Vavilov* (Vavilov), 2019 SCC 65 at paras 85-87, 108-110). The reasons should also identify whether the requirement comes from the regulator, an employer, or an educator because each actor relies on a different legal or organizational mechanism (Adams, 2022; Government of Alberta, 2026).

3.10. The Trinity Western University Decisions: Equality-Informed Regulatory Judgment Within Mandate

Trinity Western University v Law Society of Upper Canada (TWU v LSUC) and *Law Society of British Columbia v Trinity Western University* (LSBC v TWU) address how a professional regulator may use an open-textured public-interest mandate in a concrete statutory decision (TWU v LSUC, 2018 SCC 33 at paras 20, 24, 39; LSBC v TWU, 2018 SCC 32 at paras 34, 40-43). The law societies were deciding whether to accredit a proposed law school whose mandatory covenant constrained same-sex intimacy (LSBC v TWU, 2018 SCC 32 at paras 3-5; TWU v LSUC, 2018 SCC 33 at paras 3-5). The decisions engaged equality and access to the profession, while Trinity Western University's religious-freedom claim supplied the countervailing

Charter interest (*TWU v LSUC*, 2018 SCC 33 at paras 20, 24, 39; *LSBC v TWU*, 2018 SCC 32 at paras 34, 40-43).

The Supreme Court stated that “[t]he public interest is a broad concept and what it requires will depend on the particular context” (*LSBC v TWU*, 2018 SCC 32 at para 34). It accepted equality, diversity, access, and public confidence as legitimate considerations within the law societies’ accreditation authority (*LSBC v TWU*, 2018 SCC 32 at paras 34, 40-43; *TWU v LSUC*, 2018 SCC 33 at paras 20, 24, 39). The authority came from the law societies’ statutes and the accreditation decisions before them (*LSBC v TWU*, 2018 SCC 32 at paras 34, 40-43; *TWU v LSUC*, 2018 SCC 33 at paras 20, 24).

The transferable proposition is institutional. An engineering regulator exercising an assigned statutory power may interpret public interest in light of equality and human-rights values that bear on that decision (*LSBC v TWU*, 2018 SCC 32 at para 34; *TWU v LSUC*, 2018 SCC 33 at paras 20, 24). The regulator must connect those values to its enabling statute and professional function (*Vavilov*, 2019 SCC 65 at paras 85-87, 108-110). When Charter rights are engaged, proportionate has a specific constitutional meaning: the reasons must reflect the statutory objective and the severity of the rights limitation (*Doré*, 2012 SCC 12 at para 57; *Loyola*, 2015 SCC 12 at paras 39-40). Chapter 4 uses scaling, rather than proportionality, to describe ordinary differences in assessment depth (Professional Engineers Ontario, 2020; IEEE, 2021).

The engineering bridge comes from the professional-engineering statute and subordinate regulations in the relevant province or territory. In Ontario, PEO can set competence expectations through standards or guidance where the *Professional Engineers Act* authorizes those mechanisms (*Professional Engineers Act*, RSO 1990, c P.28, ss 2(4), 7). It can investigate professional

misconduct under the regulatory provisions governing negligence, standards, and public safety (RRO 1990, Reg 941, s 72). Education and accreditation operate through their own assigned mechanisms (Engineers Canada, 2024c). The reason for professional action is the connection between the public-interest risk and defined engineering work (*Professional Engineers Act*, RSO 1990, c P.28, s 1(1)).

For an individual engineer, the relevant duties arise from the code of ethics and standards of practice (RRO 1990, Reg 941, ss 72, 77). Assignment and actual authority supply the remaining limits (Professional Engineers Ontario, 2020; Engineers Canada, 2024b). The Trinity Western University decisions explain a regulator’s interpretive space when it adopts or applies professional mechanisms (*LSBC v TWU*, 2018 SCC 32 at paras 34, 40-43; *TWU v LSUC*, 2018 SCC 33 at paras 20, 24, 39). The individual’s role-specific due care remains grounded in the engineering work performed and the evidence reasonably available within role (Engineers Canada, 2024a, 2024b).

Co-author Vanessa Matta and I previously examined how the two Trinity Western University decisions might inform engineers’ equity, diversity, and inclusion obligations under the statutory public-interest mandate (Liu & Matta, 2024). I develop that analysis into a role-specific framework that separately examines the connection to engineering work, the evidence available within role, and the actor’s authority (Liu & Matta, 2024; Professional Engineers Ontario, 2020).

3.11. Human-Rights Law and Role-Specific Due Care

Human-rights law and the statute and regulations governing professional engineering in the relevant province or territory operate through different institutional mechanisms. In Ontario, the *Human Rights Code* prohibits discrimination in defined social areas and provides an

application, adjudication, and remedial process (*Human Rights Code*, RSO 1990, c H.19, ss 1, 5-6, 34-45.2). The *Professional Engineers Act* and its regulations govern entry, competence, ethical conduct, and the quality of licensed work (*Professional Engineers Act*, RSO 1990, c P.28, ss 12, 14, 27-28; RRO 1990, Reg 941, ss 72, 77). The same facts can engage both systems when engineering work shapes access to a service or facility (Ontario Human Rights Commission, 2014; Professional Engineers Ontario, 2020).

The washroom example makes the sequence concrete. Human-rights law protects access according to lived gender identity and requires accommodation to the point of undue hardship under the applicable legal test (Ontario Human Rights Commission, 2014, s 13.4; *Human Rights Code*, RSO 1990, c H.19, ss 1, 5). Role-specific due care asks an earlier engineering question: did the engineer identify code flexibility and calculate equivalent capacity before the owner selected the design (National Research Council Canada, 2022; Professional Engineers Ontario, 2020)? Human-rights adjudication and professional engineering judgment therefore address different decisions at different times.

Site 41 engages environmental law, Indigenous law, and Crown obligations in addition to professional engineering (Environmental Commissioner of Ontario, 2004; *Haida Nation v British Columbia (Minister of Forests)* (*Haida Nation*), 2004 SCC 73 at paras 16-18, 35; Whyte, 2020). The Ministry and other public authorities exercised approval powers under environmental statutes (Environmental Commissioner of Ontario, 2004; *Environmental Protection Act*, RSO 1990, c E.19, s 27). Indigenous governments and communities held legal and relational claims concerning land and water (Whyte, 2020; Borrows, 2010). Professional engineering contributed through competent and candid hydrogeological work (Professional Engineers Ontario, 2019). Accessible technical

records and escalation of uncertainty supplied further contributions (*Order MO-2449*; Engineers Canada, 2024b).

The AI recurring example distributes authority across several regimes. The professional-engineering statute governs licensed integration or validation when the work satisfies the practice definition (Engineers Canada, 2022). Privacy institutions govern personal-information issues, while human-rights institutions govern discrimination within their statutory jurisdiction (Office of the Privacy Commissioner of Canada *et al.*, 2023; Law Commission of Ontario & Ontario Human Rights Commission, 2024). Administrative and sector-specific law govern the public decision or service in which the system is used (Scassa, 2021).

Role-specific due care adds value before a legal violation has been adjudicated (Engineers Canada, 2024a, 2024b). The actor notices relevant evidence and investigates within competence (Engineers Canada, 2024a; Professional Engineers Ontario, 2020). The actor then creates a reviewable record and communicates it to the person with authority (Engineers Canada, 2024a, 2024b). Human-rights norms can make a risk known or reasonably knowable, while the engineering response remains defined by the accepted work (Ontario Human Rights Commission, 2014; Professional Engineers Ontario, 2020).

This boundary also clarifies remedies (Adams, 2022). In Ontario, a human-rights tribunal may order compensation or other relief authorized by section 45.2 of the *Human Rights Code* (*Human Rights Code*, RSO 1990, c H.19, s 45.2). An engineering regulator may impose discipline or practice conditions through its statutory discipline power (*Professional Engineers Act*, RSO 1990, c P.28, s 28; RRO 1990, Reg 941, s 72). An employer may change a design or quality process (Herkert, 2000; Bielefeldt, 2018). A public authority may alter an approval or procurement

requirement where its statute authorizes that decision (*Environmental Protection Act*, RSO 1990, c E.19, s 27; *Vavilov*, 2019 SCC 65 at paras 108-110; Scassa, 2021). The Public-Interest Impact Assessment in Chapter 4 connects these actors before responsibility diffuses across the system (Costanza-Chock *et al.*, 2022; Raji *et al.*, 2020).

3.12. Synthesis Across the Three Recurring Examples

The three recurring examples show a professional-responsibility spectrum (Environmental Commissioner of Ontario, 2004; National Research Council Canada, 2022; Engineers Canada, 2022). Site 41 places licensed engineering evidence near the centre of risk characterization, while environmental authorities retain approval (Professional Engineers Ontario, 2019). Washrooms place engineering systems inside architectural and human-rights decisions (Ontario Human Rights Commission, 2014). AI and LLMs place engineering responsibility at the integration boundary of a larger technical ecosystem (Raji *et al.*, 2020).

Table 3.5. Engineering work and distributed authority across the three recurring examples.

Recurring example	Engineering work	Other decision authorities	Role-specific due-care consequence
Site 41	Hydrogeological investigation; calibrated groundwater model; leachate containment; dewatering; monitoring and reporting (Environmental Commissioner of Ontario, 2004; National Research Council Canada, 2022; Engineers Canada, 2022; Raji <i>et al.</i> , 2020).	County, Ministry, hearing bodies, Cabinet, CMC, Indigenous governments and communities, IPC (Environmental Commissioner of Ontario, 2004; National Research Council Canada, 2022; Engineers Canada, 2022; Raji <i>et al.</i> , 2020).	Document assumptions and uncertainty; deliver model and inputs; respond to peer review; identify residual risk; escalate to approval authority (Environmental Commissioner of Ontario, 2004; National Research Council Canada, 2022; Engineers Canada, 2022; Raji <i>et al.</i> , 2020).

Recurring example	Engineering work	Other decision authorities	Role-specific due-care consequence
Public washrooms	Fixture calculations; plumbing capacity; ventilation; controls; accessibility coordination; retrofit feasibility (Environmental Commissioner of Ontario, 2004; National Research Council Canada, 2022; Engineers Canada, 2022; Raji <i>et al.</i> , 2020).	Owner, architect, building official, facilities manager, human-rights institutions, affected users (Environmental Commissioner of Ontario, 2004; National Research Council Canada, 2022; Engineers Canada, 2022; Raji <i>et al.</i> , 2020).	Identify code flexibility; calculate equivalent capacity; test accessible use; document technical options and constraints; route non-engineering decisions to the responsible actor (Environmental Commissioner of Ontario, 2004; National Research Council Canada, 2022; Engineers Canada, 2022; Raji <i>et al.</i> , 2020).
AI and LLMs	System specification; integration; validation; reliability analysis; technical documentation; monitoring in an engineering system (Environmental Commissioner of Ontario, 2004; National Research Council Canada, 2022; Engineers Canada, 2022; Raji <i>et al.</i> , 2020).	Model provider, deployer, employer, public authority, privacy and human-rights institutions, standards bodies (Environmental Commissioner of Ontario, 2004; National Research Council Canada, 2022; Engineers Canada, 2022; Raji <i>et al.</i> , 2020).	Define intended use; test group-linked risks and failure modes; preserve traceability; restrict use where evidence requires; escalate release or procurement concerns (Environmental Commissioner of Ontario, 2004; National Research Council Canada, 2022; Engineers Canada, 2022; Raji <i>et al.</i> , 2020).

Across all three examples, criterion 4 identifies the engineering work and criterion 6 identifies the actor capable of response (*Professional Engineers Act*, RSO 1990, c P.28, ss 1(1), 2(3); Adams, 2022). Criterion 5 connects them through evidence (Engineers Canada, 2024a, 2024b). The remaining criteria establish seriousness, a negative public-facing effect, and a patterned uneven burden (*Fraser*, 2020 SCC 28 at paras 30-31, 47-50; Hamraie, 2017). The cumulative structure anchors the framework in engineering responsibility (*Professional Engineers Act*, RSO 1990, c P.28, ss 1(1), 2(3); Professional Engineers Ontario, 2020).

The most useful professional response is often an intermediate technical act that changes what the final decision-maker can see (Professional Engineers Ontario, 2019; Raji *et al.*, 2020; Engineers Canada, 2024b). Examples include a disclosed model assumption, an equivalent-capacity calculation, or a subgroup evaluation (Professional Engineers Ontario, 2019; National

Research Council Canada, 2022; Raji *et al.*, 2020). Documentation gives that act durability by preserving the warning, evidence, and identity of the person who accepted the next decision (Professional Engineers Ontario, 2019; Raji *et al.*, 2020; Engineers Canada, 2024b).

Usman Mushtaq’s analysis positions participation as a separate requirement from access to information (Mushtaq, 2011). He found that Site 41 design texts framed consultation as presenting results and correcting public misunderstanding after experts had selected the design (Mushtaq, 2011). His conclusion that “Consultation did not mean participation” states the distinction directly (Mushtaq, 2011, p. 110). The dated project document should explain how affected-public evidence changed the inquiry and should name the actor with authority when the required decision lies outside the engineer’s role (Raji *et al.*, 2020; Engineers Canada, 2024b).

3.13. Takeaway: Authority as the Boundary of Responsibility

Chapter 3 has established the authority conditions for the thesis’s public-interest interpretation. Role-specific due care attaches when defined engineering work creates or significantly shapes a material disparate-impact risk (*Professional Engineers Act*, RSO 1990, c P.28, s 1(1); Engineers Canada, 2024a). The risk must be known or reasonably knowable to a competent actor within role, and that actor must have authority to investigate, document, or revise (Engineers Canada, 2024a, 2024b; Professional Engineers Ontario, 2020). Warning and escalation carry the issue to another decision-maker when that person or institution holds the final power (Engineers Canada, 2024b).

The actor-authority map keeps the legal sources distinct. A regulator governs professional practice through mechanisms authorized by its statute (Adams, 2016, 2022; *Professional*

Engineers Act, RSO 1990, c P.28, ss 2(3)-(4), 7). An employer provides project authority and resources, while a public authority makes the approval or procurement decision assigned by law (Herkert, 2000; Bielefeldt, 2018; *Vavilov*, 2019 SCC 65 at paras 108-110). An individual engineer exercises competent judgment and creates a candid record within the accepted work (RRO 1990, Reg 941, ss 72, 77; Engineers Canada, 2024a). These roles can overlap, while the source and limit of each authority remain identifiable (Adams, 2022; Table 3.1).

Site 41 demonstrates how groundwater modelling, leachate control, and access to technical records can make a patterned public risk visible (Environmental Commissioner of Ontario, 2004; *Order MO-2449*). Public washrooms demonstrate how fixture calculations and code interpretation can determine whether inclusive access is technically feasible and equivalent (National Research Council Canada, 2022; City of Ottawa Building Code Services, 2021). AI and LLMs demonstrate how professional engineering enters a distributed software system through integration, validation, and responsibility for an engineered use (Engineers Canada, 2022; Raji *et al.*, 2020).

Chapter 4 converts these authority findings into a three-stage Public-Interest Impact Assessment. Burden, access, and knowledge organize the inquiry; identify, assess, and respond organize the process (Costanza-Chock, 2020; Hamraie, 2017; Fricker, 2007; Raji *et al.*, 2020; IEEE, 2021). The stages assign evidence and consequences to actors with authority, preserving the thesis's public-interest purpose within these institutional limits (Adams, 2022; Raji *et al.*, 2020; IEEE, 2021).

4

Public-Interest Impact Assessment: Justice Questions into Due Care

To survive as Nishnaabeg, we shouldn't be just striving for land-based pedagogies. The land must once again become the pedagogy.

—Leanne Betasamosake Simpson (2014, p. 14)

4.1. From Threshold and Authority to a Professional Process

Leanne Betasamosake Simpson's epigraph places land at the centre of knowledge rather than treating it as a passive site on which professional decisions occur (Simpson, 2014). In this chapter, I translate the Chapter 2 threshold test for a qualifying material disparate-impact risk and the Chapter 3 actor-authority map into a professional process. The process identifies the evidence, assesses the pathway from engineering work to public-facing burden, and assigns a response to an actor with authority (IEEE, 2021, cls 7–11; Raji *et al.*, 2020).

The Public-Interest Impact Assessment (PIIA) is the process this thesis proposes for documenting how an actor exercises role-specific due care (IEEE, 2021; Raji *et al.*, 2020). It is intended to create a reviewable connection from evidence to engineering judgment and then to the person authorized to decide what follows (Raji *et al.*, 2020; IEEE, 2021). For example, a mechanical engineer may document that two washroom layouts both meet the fixture minimum but differ in travel distance and privacy (National Research Council Canada, 2022; City of Ottawa Building Code Services, 2021). The owner then selects the facility program, and the building

official decides code compliance within their respective authority (National Research Council Canada, 2022; City of Ottawa Building Code Services, 2021).

The PIIA has three stages: identify, assess, and respond (Raji *et al.*, 2020; IEEE, 2021). Identify defines the engineering work, affected public, and available evidence (Raji *et al.*, 2020; IEEE, 2021). Assess traces how the work may create a patterned uneven burden and states the uncertainty (Funtowicz & Ravetz, 1993; Raji *et al.*, 2020). Respond assigns a control, verification step, or escalation to the actor with authority (Engineers Canada, 2024b; Professional Engineers Ontario, 2020). The same sequence is used for Site 41, public washrooms, and the AI maintenance example.

Burden, access, and knowledge organize the substantive inquiry because each question maps to a part of the threshold test (Atrey, 2019; Hamraie, 2017; Young, 1990). Burden identifies the allocation and pattern of the negative effect (Fraser, 2009; Young, 1990). Access identifies the public-facing interest that engineering work enables or impairs (Hamraie, 2017; Hamraie & Fritsch, 2019). Knowledge identifies what makes the risk known or reasonably knowable to a competent actor within role (Fricker, 2017, pp. 53–60; Wynne, 1996).

Intersectionality runs across all three questions because the same system can allocate burden through combined social positions, access conditions, and institutional classifications (Atrey, 2019; Crenshaw, 1989, 1991). The PIIA therefore requires combined-user and combined-condition analysis where the evidence indicates that single-category analysis would hide the relevant pattern (Atrey, 2019; Raji *et al.*, 2020, p. 41).

The threshold test decides whether a risk enters the professional-responsibility framework (*Professional Engineers Act*, RSO 1990, c P.28, ss 1(1), 2(3); Engineers Canada, 2024a). The PIIA

identifies the evidence, analysis, and decision that the responsible actor must document in the existing project files once the risk enters (Professional Engineers Ontario, 2020; Raji *et al.*, 2020). The cumulative threshold keeps the framework within defined professional scope (*Professional Engineers Act*, RSO 1990, c P.28, s 1(1); Adams, 2022). The PIIA converts a qualifying risk into an assigned professional response (IEEE, 2021; Engineers Canada, 2024a).

The process begins at a decision point where engineering work can still shape requirements and alternatives (IEEE, 2021, cls. 5.4, 7–10; Raji *et al.*, 2020, pp. 36–41). It can also shape technical acceptance or escalation (IEEE, 2021, cls. 5.4, 7–10; Raji *et al.*, 2020, pp. 36–41). A decision point may arise during concept selection, detailed design, or procurement (IEEE, 2021, cls. 7–11; Law Commission of Ontario & Ontario Human Rights Commission, 2024, pp. 4–5). It may arise during validation, commissioning, or operation (IEEE, 2021, cls. 7–11; Law Commission of Ontario & Ontario Human Rights Commission, 2024, pp. 4–5). A material system change creates another decision point (IEEE, 2021, cls. 7–11; Law Commission of Ontario & Ontario Human Rights Commission, 2024, pp. 4–5).

A PIIA also begins when complaints or incidents reveal a material condition absent from the earlier record (Hamraie, 2017, p. 113; Fricker, 2017, p. 53; Professional Engineers Ontario, 2019, pp. 14–15). Peer review or affected-public evidence can create the same entry point (Hamraie, 2017, p. 113; Fricker, 2017, p. 53; Professional Engineers Ontario, 2019, pp. 14–15). This later entry point remains prospective because the professional question concerns the next available decision (Engineers Canada, 2024b; Professional Engineers Ontario, 2020). That decision may concern monitoring or redesign (Engineers Canada, 2024b; Professional Engineers Ontario,

2020). It may also concern disclosure or escalation (Engineers Canada, 2024b; Professional Engineers Ontario, 2020).

A narrow retrofit question may require a short code-and-design memorandum that states the code interpretation and compares the technically feasible options (City of Ottawa Building Code Services, 2021; National Research Council Canada, 2022). A complex facility or campus program may require a fuller assessment of routes and capacity. It may also require separate analysis of privacy, accessibility, and operations (Hamraie, 2017; CSA Group & Accessibility Standards Canada, 2023).

The PIIA is completed by the actor or team responsible for the relevant engineering decision, while final approval remains with the person or institution that holds that authority (Professional Engineers Ontario, 2020; IEEE, 2021, cl. 5.4). This allocation keeps technical analysis close to the work and makes the final decision-maker’s acceptance of residual risk visible (IEEE, 2021, cls. 9–11; Law Commission of Ontario & Ontario Human Rights Commission, 2024, pp. 39–40).

4.2. Justice Questions for Engineering Judgment

Justice questions are the operational prompts I draw from justice scholarship to reveal aspects of engineering risk that overall performance, minimum compliance, or a single technical metric may leave unseen (Fraser, 2009; Hamraie, 2017; Young, 1990). Aggregate performance means a result calculated across all test cases or users; that result can hide a distinct pattern experienced by a smaller group (Blodgett *et al.*, 2020; Raji *et al.*, 2020). I use the questions as a disciplined route into evidence. Legal analysis and project evidence then determine liability,

approval, or another institutional consequence (Atrey, 2019; McGill, 2021). Each question identifies a different omission in project documentation: an unexamined distribution, an excluded use condition, or an evidentiary hierarchy that makes a risk harder to see (Fricker, 2017; Hamraie, 2017; Young, 1990).

Section 1.5 introduced Katharine Bartlett’s feminist legal methods as ways of testing apparent neutrality while keeping reasoning close to context (Bartlett, 1990, pp. 837–866). In the PIIA, the woman-question structure becomes a set of technical prompts. It asks which user or community was assumed when a requirement was set, which use condition or exposure was omitted, and how the design record would change if that experience were treated as relevant evidence (Bartlett, 1990, pp. 837–849; Atrey, 2019). These prompts identify an assumption for investigation; project evidence and the cumulative threshold test determine whether the professional-responsibility framework applies (Engineers Canada, 2024a; Professional Engineers Ontario, 2020).

Richard Delgado’s counterstory method and Mari Matsuda’s instruction to look to the bottom perform a related but distinct task in this assessment. Delgado explains how a dominant account can make the existing arrangement appear natural, while a counterstory exposes the assumptions that the account excludes (Delgado, 1989, pp. 2412–2415). Matsuda grounds the inquiry in the actual history, experience, and intellectual traditions of people who bear the consequences of institutional power (Matsuda, 1987, pp. 324–325). In a PIIA, those accounts can identify a monitoring location, travel route, or privacy condition that requires technical examination. They can also identify a system failure that the existing record has not captured.

Verification and actor authority then determine the response (Hamraie, 2017; Raji *et al.*, 2020; Professional Engineers Ontario, 2020).

4.2.1. Burden: Who Carries the Risk, Cost, or Constraint?

The burden question asks who receives the benefit of the engineering decision and who carries its negative consequences (Fraser, 2009; Young, 1990). It then asks whether the burden follows a recurring social or spatial pattern (Atrey, 2019; Bowker & Star, 1999). The pattern may also be institutional or classificatory (Atrey, 2019; Bowker & Star, 1999).

In engineering terms, the burden may arise through exposure, delay, or exclusion (Akrich, 1992; Cohen, 2019; Winner, 1980). It may also arise through physical effort, error, or reduced ability to contest a decision (Akrich, 1992; Cohen, 2019; Winner, 1980). Surveillance can be the operative mechanism in data-intensive systems (Akrich, 1992; Cohen, 2019; Winner, 1980). The relevant measure depends on the system because groundwater risk, washroom access, and language-model behaviour produce different forms of evidence (Environmental Commissioner of Ontario, 2004; Hamraie, 2017; Abid *et al.*, 2021).

The PIIA records the mechanism that creates the burden and links that mechanism to the affected public (Raji *et al.*, 2020, pp. 36–41; IEEE, 2021, cls. 8–10). For Site 41, the mechanism concerns groundwater pathways and leachate containment (Environmental Commissioner of Ontario, 2004; Ontario (Information and Privacy Commissioner), *Order MO-2449* at 7–8; Professional Engineers Ontario, 2019). It also concerns dewatering and access to the calibrated model (Environmental Commissioner of Ontario, 2004; Ontario (Information and Privacy Commissioner), *Order MO-2449* at 7–8; Professional Engineers Ontario, 2019). For a washroom retrofit, the mechanism may be distance or capacity (Anthony & Dufresne, 2007; Harwood-Jones

et al., 2023; CSA Group & Accessibility Standards Canada, 2023). It may also involve privacy or an inaccessible route (Anthony & Dufresne, 2007; Harwood-Jones *et al.*, 2023; CSA Group & Accessibility Standards Canada, 2023). For an LLM deployment, the mechanism may be omitted hazards, false prioritization, or group-linked representational behaviour (Abid *et al.*, 2021; Blodgett *et al.*, 2020; Raji *et al.*, 2020).

The burden question also requires a baseline and at least one feasible alternative because the public-interest significance of an engineering choice is partly revealed by comparison (IEEE, 2021, cls. 9–10; Professional Engineers Ontario, 2020). The baseline may be the existing facility, the approved design, or the current manual workflow (National Research Council Canada, 2022; Raji *et al.*, 2020). The alternative may alter location, containment, or validation within the actor’s authority (Professional Engineers Ontario, 2019; IEEE, 2021, cl. 10). It may also alter human review (Professional Engineers Ontario, 2019; IEEE, 2021, cl. 10).

Iris Marion Young’s account of structural injustice is useful here because patterned uneven burden can emerge through ordinary institutional processes and cumulative decisions (Young, 1990). The engineering implication is a record focused on pathways and effects, including the way standards, defaults, and accepted workflows distribute risk (Akrich, 1992; Pawley, 2017; Winner, 1980).

4.2.2. Access: Which Public-Facing Interest Can People Actually Use?

The access question asks what public-facing interest the engineered system is expected to make available and whether affected people can use it on equivalent terms (Hamraie, 2017; Ontario Human Rights Commission, 2014). The interest may be clean water or safe use of a public facility (Environmental Commissioner of Ontario, 2004; Hamraie, 2017; Scassa, 2021). It may also be

intelligible service delivery or meaningful ability to challenge a technical decision (Environmental Commissioner of Ontario, 2004; Hamraie, 2017; Scassa, 2021).

Access is assessed through the actual route by which a person reaches, understands, or uses the system (Hamraie, 2017; Hamraie & Fritsch, 2019). A code-compliant room can remain inaccessible because of door hardware, travel distance, or operational closure (CSA Group & Accessibility Standards Canada, 2023; Harwood-Jones *et al.*, 2023). A technically available model can remain inaccessible when the files, inputs, or explanatory information required for independent review are withheld (Mushtaq, 2011, pp. 98–99; Ontario (Information and Privacy Commissioner), *Order MO-2449* at 7–8). A nominal appeal or human-review pathway can remain inaccessible when the system gives no notice, explanation, or practical means of contestation (Law Commission of Ontario & Ontario Human Rights Commission, 2024, pp. 1–5; Scassa, 2021).

Aimi Hamraie’s history of disability access centres affected users as “experts about their bodies and surrounding environments” (Hamraie, 2017, p. 113). That proposition has direct engineering significance because use conditions can reveal loads and routes (Hamraie, 2017; Lambrinidou *et al.*, 2014). They can also reveal interface and maintenance failures that drawings or aggregate specifications may omit (Hamraie, 2017; Lambrinidou *et al.*, 2014).

The PIIA therefore distinguishes formal availability from equivalent access (Hamraie, 2017; Ontario Human Rights Commission, 2014). It records location, timing, and capacity where those dimensions are relevant (Hamraie, 2017; Harwood-Jones *et al.*, 2023; Law Commission of Ontario & Ontario Human Rights Commission, 2024). It also records privacy, usability, and contestability where they matter to the system (Hamraie, 2017; Harwood-Jones *et al.*, 2023; Law Commission of Ontario & Ontario Human Rights Commission, 2024).

Sheila Cavanagh calls public restroom conflict a “manifestly mundane issue,” which captures how an ordinary facility can organize public participation through built form (Cavanagh, 2017, p. 183). The same insight applies beyond washrooms because familiar systems often make their assumed user and distributional choices difficult to notice (Akrich, 1992; Pawley, 2017).

4.2.3. Knowledge: What Makes the Risk Known or Reasonably Knowable?

The knowledge question asks what evidence was available to a competent actor at the relevant decision point and how that evidence entered professional judgment (Professional Engineers Ontario, 2020; Raji *et al.*, 2020, pp. 36–41). It also asks what evidence was excluded, discounted, or made inaccessible through institutional practice (Fricker, 2017, pp. 53–60; Wynne, 1996).

Miranda Fricker describes epistemic injustice as a wrong to someone “in their capacity as an epistemic subject” (Fricker, 2017, p. 53). The PIIA uses that insight operationally by recording whether affected-public evidence was treated as evidence about the system, including evidence about use or exposure (Fricker, 2017, pp. 53–60; Hamraie, 2017, p. 113). The record also captures evidence about uncertainty or institutional response (Fricker, 2017, pp. 53–60; Hamraie, 2017, p. 113).

Brian Wynne’s analysis of expert and lay knowledge shows how formal expertise can overlook the situated conditions that make technical assumptions work in practice (Wynne, 1996). That concern is especially relevant when a community knows seasonal water conditions, facility-use patterns, or recurring system errors that remain outside conventional engineering datasets (Wynne, 1996; Lambrinidou *et al.*, 2014; Mushtaq, 2011).

The PIIA separates evidence by source and epistemic status so disagreement remains visible (IEEE, 2021, cls. 9–11; Raji *et al.*, 2020, pp. 36–41). A measured value, model output, and professional opinion carry distinct evidentiary implications (Funtowicz & Ravetz, 1993; Professional Engineers Ontario, 2020). A user report, legal constraint, and unresolved allegation carry other implications (Funtowicz & Ravetz, 1993; Professional Engineers Ontario, 2020). The assessment states how each item was verified, what limitation applies, and what additional work could reduce uncertainty (IEEE, 2021, cls. 9–10; Raji *et al.*, 2020, pp. 36–41).

Silvio Funtowicz and Jerome Ravetz describe conditions in which “facts are uncertain, values in dispute, stakes high and decisions urgent” (Funtowicz & Ravetz, 1993, p. 744). A PIIA responds to that condition by preserving uncertainty in the decision record and widening the evidentiary community where affected publics hold relevant knowledge (Funtowicz & Ravetz, 1993, pp. 744–753; Jasanoff, 2003).

Widening the evidentiary community leaves decision authority with the actor assigned by law, contract, or professional role (IEEE, 2021, cl. 5.4; Law Commission of Ontario & Ontario Human Rights Commission, 2024, pp. 39–40). The professional obligation is to ensure that relevant evidence reaches that actor in a form that can change the decision if the evidence warrants change (Engineers Canada, 2024b; Professional Engineers Ontario, 2020).

Ann Oakley’s work on interviewing shows how evidence is shaped by relationships and power over time (Oakley, 1981, 2016). Rachel Thwaites adds that rapport and emotional labour affect what an interview produces, while Mary Maynard and June Purvis situate feminist method within the dynamics of doing research (Maynard & Purvis, 1994; Thwaites, 2017). A PIIA that

relies on interviews, complaints, or community accounts should therefore record who asked the questions, the setting, and how the account was interpreted (Oakley, 2016; Thwaites, 2017).

4.2.4. Intersectionality Across Burden, Access, and Knowledge

Intersectionality changes the unit of analysis by asking how combined social positions and institutional practices produce a distinct pattern (Atrey, 2019; Crenshaw, 1989, 1991). It therefore operates across the three justice questions and shapes each part of the assessment (Atrey, 2019; McGill, 2021).

A washroom route may be usable for a non-disabled trans person and unusable for a trans wheelchair user because location, door operation, and transfer space interact (Castrodale & Lane, 2015; Hamraie, 2017; CSA Group & Accessibility Standards Canada, 2023). An LLM evaluation may show acceptable aggregate performance while combined tests reveal a distinct error pattern for language associated with a racialized or religious group (Abid *et al.*, 2021; Blodgett *et al.*, 2020; Raji *et al.*, 2020, p. 41). A groundwater decision may distribute risk through Indigeneity and place (Mushtaq, 2011, 2013; Whyte, 2020). Livelihood and dependence on local water can deepen that pattern (Mushtaq, 2011, 2013; Whyte, 2020).

The PIIA records combined conditions when there is an evidentiary basis to do so, and it states the limits of available data (Atrey, 2019; Raji *et al.*, 2020, p. 41). Investigation is targeted to combinations for which available evidence indicates a distinct pattern or a material gap in aggregate analysis (Atrey, 2019; Blodgett *et al.*, 2020).

Table 4.1. Translation from justice questions to engineering judgment.

Justice question	Engineering inquiry	Information the actor documents
Burden	Identify the technical or institutional pathway that allocates risk, delay, exclusion, effort, or error (Young, 1990; IEEE, 2021, cls. 9–10). Compare the baseline with feasible alternatives (Young, 1990; IEEE, 2021, cls. 9–10).	Affected public; mechanism; baseline; alternative; severity and likelihood basis; pattern evidence; uncertainty (Raji <i>et al.</i> , 2020; IEEE, 2021).
Access	Identify the public-facing interest and test actual use through location, capacity, privacy, usability, and contestability where relevant (Hamraie, 2017; Ontario Human Rights Commission, 2014).	User route; interface or facility conditions; equivalent-access comparison; code or rights floor; operational constraints; post-use evidence (Hamraie, 2017; Law Commission of Ontario & Ontario Human Rights Commission, 2024).
Knowledge	Identify what a competent actor could know from technical evidence, affected-public knowledge, prior incidents, and applicable legal or professional guidance (Fricker, 2017; Wynne, 1996).	Evidence register; source and date; epistemic status; verification; disagreement; missing information; disclosure status; next inquiry (IEEE, 2021; Raji <i>et al.</i> , 2020).
Intersectionality	Test combined user or exposure conditions where single-category analysis would hide a distinct burden, access barrier, or knowledge gap (Atrey, 2019; Crenshaw, 1989, 1991).	Combined scenario or subgroup analysis; rationale for selected dimensions; data limitations; affected-public interpretation; effect on controls (Raji <i>et al.</i> , 2020, p. 41).

4.3. The Public-Interest Impact Assessment

I propose the PIIA as a professional due-care process whose practical force depends on adoption by an actor with authority (Adams, 2022; IEEE, 2021). An employer can require it through a project contract or quality-management policy (Herkert, 2000; IEEE, 2021). A regulator can incorporate defined elements through guidance, standards of practice, or continuing-competence mechanisms where its statute authorizes that step (*Professional Engineers Act*, RSO 1990, c P.28, ss 2(4), 7; *Green*, 2017 SCC 20 at paras 24–25, 44). A public authority can incorporate the process into procurement or an approval record within its own mandate (Scassa,

2021; Treasury Board of Canada Secretariat, 2025). The Chapter 3 actor-authority analysis therefore determines who can require the assessment and what institutional consequence follows from it (Adams, 2022; *Vavilov*, 2019 SCC 65 at paras 85–87, 108–110).

The PIIA translates the justice questions into a set of project documents that can be reviewed at later decision points (Raji *et al.*, 2020, pp. 33–44; IEEE, 2021, cls. 7–11). It produces three documents: a trigger-and-scope memorandum, an assessment memorandum, and a response-and-monitoring plan (IEEE, 2021, Annex I; Raji *et al.*, 2020, pp. 36–41). Table 4.2 explains the contents of each document and the decision it supports (IEEE, 2021; Raji *et al.*, 2020).

Chapter 3 used Inioluwa Deborah Raji and colleagues to show why evidence must remain traceable across organizational handoffs (Raji *et al.*, 2020, pp. 33–44). For the PIIA, their life-cycle model supplies a practical design rule: each document identifies who prepared it, which decision it informed, and how later reviewers can locate the supporting evidence (Raji *et al.*, 2020, pp. 36–41). That chain allows a later incident or complaint to be connected to the assumptions and approvals in effect when the decision was made (Raji *et al.*, 2020, pp. 33–44).

Chapter 3 used IEEE 7000 to locate responsibility within management and engineering roles (IEEE, 2021, cls. 5–6). For the PIIA, the standard supplies a traceability structure: an identified public-interest concern is connected to a requirement, the requirement is connected to a design choice, and the design choice is connected to verification evidence (IEEE, 2021, cls. 7–11). Monitoring conditions preserve that connection after deployment or construction (IEEE, 2021, cls. 10–11).

The Law Commission of Ontario and Ontario Human Rights Commission’s Human Rights AI Impact Assessment supplies a Canadian governance comparator (Law Commission of Ontario

& Ontario Human Rights Commission, 2024, pp. 1–5). It treats impact assessment as multidisciplinary and iterative, with renewed review after a material change and recurring monitoring for complex systems (Law Commission of Ontario & Ontario Human Rights Commission, 2024, pp. 4–5).

The PIIA adapts those process insights to professional engineering by using the Chapter 2 threshold test and Chapter 3 actor-authority map as its entry conditions (Professional Engineers Ontario, 2020; Engineers Canada, 2024a). It therefore assigns each assessment step to the engineering work and authority actually present in the project (IEEE, 2021, cl. 5.4; Professional Engineers Ontario, 2020).

4.3.1. Trigger and Scope

A PIIA begins when all six Chapter 2 criteria are satisfied or when the available evidence makes satisfaction sufficiently plausible to require a short inquiry (Professional Engineers Ontario, 2020; Raji *et al.*, 2020, p. 36). The preliminary inquiry is a brief documented decision: it records why a full or short-form assessment will proceed, or why the issue belongs outside this framework (IEEE, 2021, cl 7; Law Commission of Ontario & Ontario Human Rights Commission, 2024, pp. 4–5).

The trigger-and-scope memorandum is the first PIIA document (IEEE, 2021, cl. 5.4; Raji *et al.*, 2020, p. 40). It identifies the project or system and the open engineering decision (IEEE, 2021, cl. 5.4; Raji *et al.*, 2020, p. 40). It then identifies the responsible actor, the public-facing interest, and the evidence that makes the risk known or reasonably knowable (Fricker, 2017; Raji *et al.*, 2020).

The memorandum fixes the temporal scope because role-specific due care depends on what was available at a particular decision point (Professional Engineers Ontario, 2020; *Vavilov*, 2019 SCC 65 at paras 85-87, 108-110). A model change or code amendment creates a later decision point (IEEE, 2021; Raji *et al.*, 2020). An incident, complaint pattern, or new peer review can do the same (Raji *et al.*, 2020; Law Commission of Ontario & Ontario Human Rights Commission, 2024).

A short-form PIIA may be used where the pathway is narrow, evidence is stable, and one actor controls the response (IEEE, 2021, cls. 7–11). A full PIIA is appropriate where the stakes are high, evidence is contested, or authority is distributed across institutions (Funtowicz & Ravetz, 1993, p. 744; Jasanoff, 2003).

This scaling concentrates resources on risks that meet the professional threshold and assigns the depth of work the evidence requires (Professional Engineers Ontario, 2020; IEEE, 2021). A short-form assessment may address a narrow and stable question (Professional Engineers Ontario, 2020; IEEE, 2021). A full assessment addresses high stakes, contested evidence, or distributed authority (Funtowicz & Ravetz, 1993; Jasanoff, 2003). The thesis reserves proportionality for the constitutional rights-balancing analysis explained in Chapter 3; ordinary assessment depth is described as scaling (*Doré*, 2012 SCC 12 at para 57; *Loyola*, 2015 SCC 12 at paras 39-40; Professional Engineers Ontario, 2020).

Table 4.2. Public-Interest Impact Assessment (PIIA) documents and decision points.

Document produced	Core contents	Decision the document supports
Trigger and scope memorandum	Engineering work; decision point; threshold evidence; affected public; responsible actor; information gaps; assessment depth (Raji <i>et al.</i> , 2020; IEEE, 2021).	Opens a full or short-form assessment, assigns an owner, and sets the date or event for review (Law Commission of Ontario & Ontario Human Rights Commission, 2024).
Assessment memorandum	Mechanism; burden; access; knowledge; combined conditions; alternatives; evidence quality; uncertainty; controls; residual risk (Atrey, 2019; Funtowicz & Ravetz, 1993; IEEE, 2021).	Provides the technical and public-interest basis for design, procurement, acceptance, warning, or escalation (Professional Engineers Ontario, 2020; Engineers Canada, 2024b).
Response-and-monitoring plan	Selected action; decision-maker; reasons; verification criteria; disclosure; monitoring; incident pathway; re-opening event (Raji <i>et al.</i> , 2020; IEEE, 2021).	Assigns implementation and states who accepts residual risk within authority (IEEE, 2021, cls. 10–11; Professional Engineers Ontario, 2020).

4.4. Stage One: Identify

Identification establishes what the system is expected to do and what engineering work shapes that function (IEEE, 2021; Raji *et al.*, 2020). It also identifies the decision that remains open (IEEE, 2021; Raji *et al.*, 2020). The system boundary is the line drawn around the technical components and interfaces included in the assessment (IEEE, 2021; Raji *et al.*, 2020). It also identifies the people and project documents included in that boundary (IEEE, 2021; Raji *et al.*, 2020). A precise boundary assigns responsibility for the identified documents and decision points (IEEE, 2021; Raji *et al.*, 2020).

4.4.1. Define the Engineering Work and Decision Boundary

The first task is to describe the accepted engineering work in verbs that correspond to the actor’s actual role (Professional Engineers Ontario, 2020; Engineers Canada, 2022). The work may involve designing, modelling, or validating (Professional Engineers Ontario, 2020; Engineers

Canada, 2022). It may also involve reviewing, integrating, or advising (Professional Engineers Ontario, 2020; Engineers Canada, 2022). The trigger-and-scope memorandum identifies the technical deliverable, its intended use, and the person authorized to approve or change it (Professional Engineers Ontario, 2020; IEEE, 2021).

The system boundary includes interfaces that can materially change the public-facing effect (Akrich, 1992; IEEE, 2021). For a landfill, it includes the hydrogeological model and containment design. It also includes monitoring and approval-facing technical reports (Professional Engineers Ontario, 2019; Environmental Commissioner of Ontario, 2004). For a washroom retrofit, it includes fixture calculations and drainage work, along with ventilation and accessibility coordination (National Research Council Canada, 2022; City of Vancouver, 2024). For an LLM integration, it includes the model version, evaluation data, and human-review workflow (Raji *et al.*, 2020; IEEE, 2021). Change control completes that boundary because a later version can alter the accepted risk (Raji *et al.*, 2020; IEEE, 2021).

The decision boundary states what the engineer can change directly and what must be raised with another actor (Professional Engineers Ontario, 2020; Engineers Canada, 2024b). That distinction allows an engineer to be specific about responsibility even where the final land-use, facility-program, or procurement decision belongs elsewhere (Environmental Commissioner of Ontario, 2004; City of Ottawa Building Code Services, 2021; Scassa, 2021).

4.4.2. Identify Affected Publics and the Public-Facing Interest

The second task identifies the people or communities whose use, exposure, or ability to contest the decision may differ from the assumed baseline (Hamraie, 2017; Costanza-Chock, 2020). The record describes the mechanism connecting the public and the engineered system (Atrey,

2019; Blodgett *et al.*, 2020). Identity supplies context for that mechanism (Atrey, 2019; Blodgett *et al.*, 2020).

Affected-public identification draws from project context, legal obligations, and incident history (Law Commission of Ontario & Ontario Human Rights Commission, 2024, pp. 1–5; IEEE, 2021, cl. 7). Direct engagement supplies additional evidence (Law Commission of Ontario & Ontario Human Rights Commission, 2024, pp. 1–5; IEEE, 2021, cl. 7). It also draws from community-generated knowledge when the affected public has sustained experience with the site, facility, or system (Hamraie, 2017, p. 113; Lambrinidou *et al.*, 2014; Mushtaq, 2011).

The public-facing interest is stated in concrete terms, including the function that may be impaired and the consequence of impairment (Young, 1990; Professional Engineers Ontario, 2020). “Access” becomes the ability to use a specific room or service (Hamraie, 2017; Scassa, 2021). It can also concern a record or review mechanism (Hamraie, 2017; Scassa, 2021). “Dignity” becomes a design or institutional condition such as forced disclosure, stigmatizing separation, or recurring stereotyping (Ontario Human Rights Commission, 2014; Abid *et al.*, 2021).

4.4.3. Create the Evidence Inventory

The third task creates an evidence inventory before conclusions are drawn (Raji *et al.*, 2020, pp. 36–41; IEEE, 2021, Annex I). The inventory is a table that records the source, date, and author of each item (IEEE, 2021, cls. 9–11). It also records the method and known limitation. A separate column explains why the item matters to the engineering decision (IEEE, 2021, cls. 9–11).

Technical evidence may include calculations, model files, and calibration material (Professional Engineers Ontario, 2019; Raji *et al.*, 2020). It may also include drawings, validation

results, and peer review (Professional Engineers Ontario, 2019; Raji *et al.*, 2020). Monitoring records complete the operating evidence where relevant (Professional Engineers Ontario, 2019; Raji *et al.*, 2020). Institutional evidence may include codes, statutory requirements, and procurement terms (National Research Council Canada, 2022; Law Commission of Ontario & Ontario Human Rights Commission, 2024). It may also include approval conditions and role assignments (National Research Council Canada, 2022; Law Commission of Ontario & Ontario Human Rights Commission, 2024). Affected-public evidence may include complaints, use observations, and community monitoring (Hamraie, 2017; Lambrinidou *et al.*, 2014; Mushtaq, 2011). It may also include incident narratives and knowledge held through sustained relationship with the system (Hamraie, 2017; Lambrinidou *et al.*, 2014; Mushtaq, 2011).

Raji and colleagues state that known issues “should be thoroughly mapped” through literature and documented experience (Raji *et al.*, 2020, p. 36). The PIIA extends that requirement by recording which evidence the engineering actor reviewed and how it changed the assessment (IEEE, 2021, cls. 9–10).

Information held by a vendor or consultant can create an information gap (Raji *et al.*, 2020; Ontario (Information and Privacy Commissioner), *Order MO-2449* at 7–8). Information held by an owner or public body can do the same (Raji *et al.*, 2020; Ontario (Information and Privacy Commissioner), *Order MO-2449* at 7–8). The PIIA assigns a request and consequence to each gap (Raji *et al.*, 2020; Ontario (Information and Privacy Commissioner), *Order MO-2449* at 7–8). The consequence may be a qualified opinion or additional review (Professional Engineers Ontario, 2020; Engineers Canada, 2024b). It may also be restricted use or escalation to the actor who can compel production (Professional Engineers Ontario, 2020; Engineers Canada, 2024b).

4.5. Stage Two: Assess

Assessment explains how the evidence supports or weakens the claimed pathway from engineering work to material disparate-impact risk (Raji *et al.*, 2020, pp. 36–41; IEEE, 2021, cls. 8–10). It states the actor’s reasoning in enough detail that another competent reviewer can follow the decision (Professional Engineers Ontario, 2020; IEEE, 2021, cl. 11).

4.5.1. Trace Mechanism, Consequence, and Pattern

The assessment begins with a causal or functional pathway suited to the system (Professional Engineers Ontario, 2019; Raji *et al.*, 2020). The pathway links an engineering input or decision to an intermediate system condition and then to a public-facing consequence (IEEE, 2021, cl. 10).

The intermediate condition keeps the assessment tied to a demonstrable pathway between a technical feature and a public-facing consequence (Blodgett *et al.*, 2020; Professional Engineers Ontario, 2020). Groundwater modelling affects the representation of contaminant pathways and confidence in containment (Environmental Commissioner of Ontario, 2004; Professional Engineers Ontario, 2019). Fixture distribution and route design affect whether an available washroom is equivalent in practice (National Research Council Canada, 2022; Hamraie, 2017). LLM triage affects which maintenance reports receive earlier engineering attention (Raji *et al.*, 2020; Parasuraman & Manzey, 2010).

The pattern may be demonstrated through repeated outcomes, structural defaults, or spatial concentration (Atrey, 2019; Bowker & Star, 1999). A credible connection to an established form of exclusion can supply further support (Atrey, 2019; Bowker & Star, 1999). Aggregate

performance is retained, while subgroup, combined-condition, or place-based evidence is added where the aggregate hides the relevant burden (Raji *et al.*, 2020, p. 41; Atrey, 2019).

4.5.2. Evaluate Evidence Quality and Uncertainty

Evidence quality is evaluated by method, independence, and relevance to the decision (Professional Engineers Ontario, 2020; Raji *et al.*, 2020). Reproducibility or reviewability supplies a further criterion (Professional Engineers Ontario, 2020; Raji *et al.*, 2020). The assessment records the positions of consultants, peer reviewers, and affected publics (Funtowicz & Ravetz, 1993; Jasanoff, 2003). It records the approving authority’s position separately and preserves each evidentiary basis (Funtowicz & Ravetz, 1993; Jasanoff, 2003).

Uncertainty is described in the form that matters to the decision (Funtowicz & Ravetz, 1993, p. 744). Data uncertainty concerns missing or unreliable observations (Raji *et al.*, 2020; Professional Engineers Ontario, 2019). Model uncertainty concerns assumptions, parameterization, and calibration (Raji *et al.*, 2020; Environmental Commissioner of Ontario, 2004). Transfer to a new use context creates another form of model uncertainty (Raji *et al.*, 2020; Environmental Commissioner of Ontario, 2004). Operational uncertainty concerns maintenance, human reliance, or changing conditions after deployment (Parasuraman & Manzey, 2010; Professional Engineers Ontario, 2019).

A PIIA preserves the direction of uncertainty because uncertainty may increase or decrease concern depending on what is missing (Funtowicz & Ravetz, 1993). Missing groundwater data near a sensitive receptor, missing accessibility testing for an excluded user, and missing subgroup evaluation for a high-stakes model each weaken a confident assurance of acceptable performance (Professional Engineers Ontario, 2019; Hamraie, 2017; Raji *et al.*, 2020).

The assessment distinguishes measured findings from reported experience and professional inference (Fricker, 2017; IEEE, 2021, cls. 9–10). Each form can be relevant, while the record states the weight assigned and the reason for that weight (Wynne, 1996; Professional Engineers Ontario, 2020).

4.5.3. Compare Alternatives and Controls

The assessment compares feasible alternatives at the level controlled by the actor (IEEE, 2021, cl. 10; Professional Engineers Ontario, 2020). An engineer may compare design parameters, monitoring arrangements, and validation thresholds within scope (Professional Engineers Ontario, 2019; Raji *et al.*, 2020). Interface requirements may provide another control point (Professional Engineers Ontario, 2019; Raji *et al.*, 2020). A project owner or public authority may compare sites, facility programs, and procurement options within its authority (Environmental Commissioner of Ontario, 2004; City of Ottawa Building Code Services, 2021; Scassa, 2021). Deployment policy may supply another alternative (Environmental Commissioner of Ontario, 2004; City of Ottawa Building Code Services, 2021; Scassa, 2021).

Alternative comparison records technical performance and distribution of burden (Young, 1990; Hamraie, 2017; IEEE, 2021). It also records effect on access and evidentiary confidence (Young, 1990; Hamraie, 2017; IEEE, 2021). Cost and schedule are included as project constraints, while the decision record states who weighs those constraints against public-interest risk (Herkert, 2000; IEEE, 2021, cl. 5.4).

Residual risk is the risk remaining after feasible controls have been applied and verified (IEEE, 2021, cl. 10; Professional Engineers Ontario, 2020). The PIIA states the remaining pathway and affected public (IEEE, 2021, Annex I; Law Commission of Ontario & Ontario Human Rights

Commission, 2024, pp. 39–40). It also states the uncertainty and the person authorized to accept that risk (IEEE, 2021, Annex I; Law Commission of Ontario & Ontario Human Rights Commission, 2024, pp. 39–40).

4.6. Stage Three: Respond

Response converts the assessment into an assigned action and a reviewable consequence (IEEE, 2021, cls. 10–11; Engineers Canada, 2024b). The selected response is tied to the actor’s authority and the evidence that supports it (Professional Engineers Ontario, 2020; Raji *et al.*, 2020).

4.6.1. Controls and Verification

A control changes the design, process, or operational condition that creates the risk (IEEE, 2021, cl. 10). Controls may include a revised requirement, additional containment, or an equivalent facility route (Professional Engineers Ontario, 2019; National Research Council Canada, 2022; Raji *et al.*, 2020). They may also include narrower software use or independent review where those actions fall within authority (Professional Engineers Ontario, 2019; National Research Council Canada, 2022; Raji *et al.*, 2020).

Each control receives a verification criterion before implementation (IEEE, 2021, cls. 9–10). Verification may use a calculation, inspection, or user test (Professional Engineers Ontario, 2019; Hamraie, 2017; Raji *et al.*, 2020). It may also use model evaluation, a monitoring threshold, or peer review appropriate to the system (Professional Engineers Ontario, 2019; Hamraie, 2017; Raji *et al.*, 2020).

The response-and-monitoring plan distinguishes completion of an activity from evidence that the control changed the relevant condition (Raji *et al.*, 2020, p. 36; Costanza-Chock *et al.*, 2022, pp. 1571–1583). Completion therefore requires tested mitigation and an implementation owner with authority to act (Costanza-Chock *et al.*, 2022, p. 1577; IEEE, 2021, cl. 5.4).

4.6.2. Warning, Disclosure, and Escalation

Warning communicates a material limitation to a person who will rely on the engineering work (Professional Engineers Ontario, 2020; Engineers Canada, 2024a). The warning identifies the affected decision, the evidence basis, and the consequence that follows if the recommended control is omitted (Engineers Canada, 2024b; IEEE, 2021, cl. 11).

Disclosure makes the information available to the audience entitled or required to receive it in a form that supports understanding and review (IEEE, 2021, cl. 11). Technical detail, assumptions, and uncertainty are preserved for expert review (Jasanoff, 2003; IEEE, 2021, cl. 11). Public-facing communication explains the practical consequence in direct language (Jasanoff, 2003; IEEE, 2021, cl. 11).

Escalation moves the issue to the actor with authority to alter the project or procurement (Engineers Canada, 2024b; Professional Engineers Ontario, 2020). It can also reach the actor controlling approval or professional response (Engineers Canada, 2024b; Professional Engineers Ontario, 2020). The record states what the engineer recommended and who received it (Engineers Canada, 2024b; IEEE, 2021, Annex I). It also states the recipient’s authority and the issue’s current status (Engineers Canada, 2024b; IEEE, 2021, Annex I).

4.6.3. Monitoring and Re-Opening

Monitoring tests whether the control continues to work under operating conditions (Professional Engineers Ontario, 2019, pp. 14–15; Raji *et al.*, 2020). The monitoring plan identifies the indicator and responsible person (IEEE, 2021, cls. 10–11). It also states review frequency and the action threshold, meaning the pre-set value or event that requires investigation or response (IEEE, 2021, cls. 10–11).

Professional Engineers Ontario’s solid-waste guideline describes “monitoring, recording and reporting” as part of demonstrating facility performance and regulatory compliance (Professional Engineers Ontario, 2019, p. 14). The same logic applies to public-facing facility operations and software deployments where use conditions can change after design acceptance (City of Vancouver, 2024; Raji *et al.*, 2020).

The PIIA re-opens after a material design change, new model version, or code change (Law Commission of Ontario & Ontario Human Rights Commission, 2024, pp. 4–5; Raji *et al.*, 2020). An incident, complaint pattern, or monitoring threshold exceedance also re-opens the assessment (Law Commission of Ontario & Ontario Human Rights Commission, 2024, pp. 4–5; Raji *et al.*, 2020). Re-opening preserves continuity because the prior evidence and reasoning remain available for comparison (IEEE, 2021, cl. 11).

4.7. Actor-Specific Implementation

The PIIA becomes professionally workable when each actor receives the part of the process that matches its authority (Adams, 2022; Professional Engineers Ontario, 2020). The same record can therefore support different decisions by individual engineers, employers, and regulators

(Herkert, 2000; Engineers Canada, 2024c; IEEE, 2021). It can also support educators, public authorities, and standards bodies (Herkert, 2000; Engineers Canada, 2024c; IEEE, 2021).

Table 4.3. Actor-specific implementation of the PIIA.

Actor	PIIA responsibility	Decision or action the actor can take
Individual engineer or engineering reviewer	Define the work; identify evidence; document assumptions and uncertainty; recommend controls; warn or escalate within the accepted assignment (Professional Engineers Ontario, 2020; Engineers Canada, 2024b).	Revise work; qualify an opinion; request information or peer review; decline technical acceptance; create a duty-to-report record where applicable (Engineers Canada, 2024b; RRO 1990, Reg 941, ss. 72, 77).
Employer, project lead, or engineering firm	Assign ownership; provide time and expertise; integrate PIIA gates into design, procurement, change control, and incident review (Herkert, 2000; IEEE, 2021, cl. 5.4).	Change scope, schedule, staffing, supplier, design, or deployment; require remediation; assign residual-risk acceptance (IEEE, 2021; Costanza-Chock <i>et al.</i> , 2022).
Engineering regulator	Clarify competence and documentation expectations for engineering work; provide practice guidance; investigate conduct through statutory mechanisms (Adams, 2022; <i>Professional Engineers Act</i> , RSO 1990, c P.28).	Guidance, practice review, continuing competence, complaint investigation, or discipline within statutory authority (Adams, 2022; <i>Professional Engineers Act</i> , RSO 1990, c P.28).
Educator or accreditation body	Teach burden, access, knowledge, evidence, and actor authority through design cases and professional judgment (Engineers Canada, 2024c; Lambrinidou <i>et al.</i> , 2014).	Curricular outcomes, capstone requirements, assessment rubrics, and accreditation evidence tied to design, ethics, impact, and communication (Engineers Canada, 2024c; Kirkscey <i>et al.</i> , 2023).
Public authority, owner, or procuring institution	Set decision criteria; require access to technical records; define disclosure, recourse, monitoring, and incident obligations (Scassa, 2021; Law Commission of Ontario & Ontario Human Rights Commission, 2024).	Approval conditions, procurement clauses, operational limits, public reasons, contract remedies, or project cancellation within legal authority (Scassa, 2021; Raji <i>et al.</i> , 2020).
Standards body or code-development institution	Translate recurring PIIA evidence into requirements, test methods, explanatory notes, and documentation rules (National Research Council Canada, 2022; IEEE, 2021).	Revised standard, code clarification, conformity evidence, or consensus process that changes future engineering practice (IEEE, 2021; National Research Council Canada, 2022).

For an individual engineer, the central output is a dated, reviewable note within the existing project files (Professional Engineers Ontario, 2020). It states the issue, the evidence considered, and the limit of the engineer’s authority (Engineers Canada, 2024b; Professional Engineers Ontario, 2020). The engineer then communicates the basis for any qualification or escalation (Engineers Canada, 2024b; Professional Engineers Ontario, 2020).

For an employer or project lead, the central output is institutional capacity to act on the assessment (Herkert, 2000; IEEE, 2021, cl. 5.4). The organization assigns time, expertise, and decision authority before the PIIA becomes a schedule-dependent afterthought (IEEE, 2021, introduction; Costanza-Chock *et al.*, 2022).

Mirjam Fines-Neuschild and Tanja Tajmel’s finding that EDI may become an “individual initiative/lonely endeavour” explains why capacity must be assigned institutionally (Fines-Neuschild & Tajmel, 2024, p. 27). The project lead should name the person who can obtain evidence, authorize time, and decide the response (Fines-Neuschild & Tajmel, 2024; IEEE, 2021).

For an engineering regulator, the PIIA can be translated into competence and documentation guidance for work already within professional jurisdiction (Adams, 2022; *Professional Engineers Act*, RSO 1990, c P.28, ss 2(4), 7). Practice guidance can identify expected evidence and role boundaries (Professional Engineers Ontario, 2019, 2020). Project approval remains with the bodies authorized by environmental, building, or other project law (*Environmental Protection Act*, RSO 1990, c E.19, s 27; *Building Code Act, 1992*, SO 1992, c 23, ss 3, 8).

For educators, the PIIA supplies a case-based method for design and ethics courses (Engineers Canada, 2024c; Lambrinidou *et al.*, 2014). Systems courses and capstone work provide

further application sites (Kirkscey *et al.*, 2023; Engineers Canada, 2024c). Students can be assessed on whether they identify the connection to engineering work and evaluate affected-public evidence (Kirkscey *et al.*, 2023; Engineers Canada, 2024c). They must also allocate the response to the correct actor (Kirkscey *et al.*, 2023; Engineers Canada, 2024c).

Kim Brooks and Debra Parkes show how professional education can expose and reshape the categories treated as normal within a field (Brooks & Parkes, 2004). Carrie Menkel-Meadow links professional education’s hierarchy and decontextualization to habits that students carry into professional reasoning (Menkel-Meadow, 1988). In engineering education, the PIIA gives students a repeatable way to connect technical analysis to affected-public evidence and actor authority (Engineers Canada, 2024c; Liu *et al.*, 2024).

My co-authors Andrea Atkins and Allie Kennington and I developed cultural-competence approaches for engineering education and practice that provide a pedagogical foundation for this application (Liu *et al.*, 2024; Liu *et al.*, in press). Co-author William Gagnon and I examined how accredited civil engineering programs addressed climate competence in a five-author curriculum study (Gagnon *et al.*, 2023). That study provides a model for examining where a proposed public-interest competency appears in actual program curricula (Gagnon *et al.*, 2023).

For public authorities and private owners, procurement and approval mechanisms can require evidence through owner or public-authority power (Scassa, 2021; Raji *et al.*, 2020). Contract terms can require model access, change notice, and incident reporting (Raji *et al.*, 2020; Law Commission of Ontario & Ontario Human Rights Commission, 2024). They can also require post-occupancy evidence where those records are needed for public-interest review (Raji *et al.*, 2020; Law Commission of Ontario & Ontario Human Rights Commission, 2024).

4.8. Site 41: A Full Public-Interest Impact Assessment for Groundwater Risk and Technical Transparency

Site 41 provides the engineering-heavy application because the proposed landfill required hydrogeological investigation, groundwater modelling, and containment design (Environmental Commissioner of Ontario, 2004; Professional Engineers Ontario, 2019; Mushtaq, 2011). It also required dewatering analysis, monitoring, and approval-facing technical reports (Environmental Commissioner of Ontario, 2004; Professional Engineers Ontario, 2019; Mushtaq, 2011). The application reconstructs the record that a PIIA would have required around the 2006–2009 design, information-access, and construction decisions (Mushtaq, 2011, pp. 98–110; Ontario (Information and Privacy Commissioner), *Order MO-2449* at 7–8).

The Ministry of the Environment, environmental-assessment bodies, and Cabinet held public decision authority at different points in the project history (Environmental Commissioner of Ontario, 2004; County of Simcoe, 2010). Simcoe County held municipal proponent and decision functions (Environmental Commissioner of Ontario, 2004; County of Simcoe, 2010). Consultants, peer reviewers, and the Community Monitoring Committee generated or reviewed technical material (Mushtaq, 2011, 2013). Professional engineering responsibility attaches here through the quality, candour, and accessibility of that technical work (Professional Engineers Ontario, 2019, 2020). Escalation completes the professional response where an issue remains unresolved (Professional Engineers Ontario, 2019, 2020).

4.8.1. Identify: Define the Groundwater Decision and Evidence Base

The trigger memorandum would identify the open decision as technical acceptance of the landfill design and commencement of construction over a groundwater setting that had generated

sustained technical and public concern (Environmental Commissioner of Ontario, 2004; Mushtaq, 2011, pp. 98–99). The public-facing interests would include groundwater protection, confidence in environmental control, and meaningful access to the technical basis for the decision (Environmental Commissioner of Ontario, 2004; Ontario (Information and Privacy Commissioner), *Order MO-2449* at 7–8).

The engineering work would be described through the hydrogeological model, its calibration, and its inputs (Environmental Commissioner of Ontario, 2004; Professional Engineers Ontario, 2019; Mushtaq, 2011, pp. 98–99). Landfill-base and leachate controls would form a second workstream (Environmental Commissioner of Ontario, 2004; Professional Engineers Ontario, 2019; Mushtaq, 2011, pp. 98–99). Dewatering and monitoring design would form a third (Environmental Commissioner of Ontario, 2004; Professional Engineers Ontario, 2019; Mushtaq, 2011, pp. 98–99). The decision boundary would distinguish consultant responsibility for the technical record from County and Ministry authority over construction and approval (Environmental Commissioner of Ontario, 2004; Professional Engineers Ontario, 2020).

The evidence inventory would include Ministry comments and independent peer reviews (Environmental Commissioner of Ontario, 2004; Mushtaq, 2011; *Order MO-2449*). Design and Operations material and Community Monitoring Committee records would add the project documentation (Mushtaq, 2011; *Order MO-2449*). The MODFLOW files and input data would complete the model documentation (*Order MO-2449*). Indigenous and community knowledge would be included where it bears on local water use, monitoring, or public-interest risk (Mushtaq, 2011, 2013; Whyte, 2020).

The Environmental Commissioner observed that “many of the technical details” concerning design and operation were unavailable during the siting process or hearing (Environmental Commissioner of Ontario, 2004, p. 239; Mushtaq, 2011, p. 98). That observation would appear in the PIIA as a timing and disclosure deficiency because information delivered after a decision has reduced capacity to influence that decision (Jasanoff, 2003; Ontario (Information and Privacy Commissioner), *Order MO-2449* at 7-8).

4.8.2. Assess: Trace Groundwater Risk, Uncertainty, and Participation

The assessment would trace the pathway from site hydrogeology and engineered containment to the possibility of leachate migration or groundwater disturbance under operating and dewatering conditions (Environmental Commissioner of Ontario, 2004; Professional Engineers Ontario, 2019). It would state the assumptions and boundary conditions that materially influence that pathway, including the evidence used to calibrate the model and the scenarios used to test performance (Professional Engineers Ontario, 2019; Mushtaq, 2011, pp. 98–99).

The model record would include the calibrated MODFLOW files, input data, and parameter sources (Mushtaq, 2011, pp. 98–99; *Order MO-2449* at 7–8; Professional Engineers Ontario, 2019). It would identify the observed data used as calibration targets and record sensitivity work (Mushtaq, 2011; Professional Engineers Ontario, 2019). A separate explanation would state how dewatering or pumping conditions were represented (Mushtaq, 2011; Professional Engineers Ontario, 2019).

The Information and Privacy Commissioner recorded the absence of the “original calibrated model” from the facilitation record and ordered the County to take all steps required to obtain the model and input data (Ontario (Information and Privacy Commissioner), *Order MO-2449* at

7–8). A PIIA would treat that production obligation as central to independent review because model conclusions depend on the files and inputs that generated them (Mushtaq, 2011, pp. 98–99; Professional Engineers Ontario, 2020).

The assessment would compare the proponent’s conclusions with peer-review concerns and identify each unresolved issue by owner, evidence needed, and effect on confidence (Environmental Commissioner of Ontario, 2004; Mushtaq, 2011). Peer-review concerns would be treated as resolved only where the underlying material is available and the response is documented (Raji *et al.*, 2020; Professional Engineers Ontario, 2020).

The burden question would identify the local concentration of groundwater risk and the work required of residents or farmers to obtain technical information (Mushtaq, 2011, 2013; Whyte, 2020). It would also examine the work required of Indigenous communities and water protectors to contest that information (Mushtaq, 2011, 2013; Whyte, 2020). The access question would examine whether the Community Monitoring Committee could obtain the records needed to perform “community review” in time to influence the decision (Mushtaq, 2011; Ontario (Information and Privacy Commissioner), *Order MO-2449* at 7–8). The knowledge question would record how local and Indigenous water knowledge entered the technical process and how disagreements were characterized (Mushtaq, 2011, 2013; Wynne, 1996).

Usman Mushtaq’s conclusion that “Consultation did not mean participation” identifies the gap the PIIA would address (Mushtaq, 2011, p. 110). Participation in this engineering context would mean that relevant evidence can alter assumptions, monitoring locations, or review questions before the final decision (Jasanoff, 2003; Lambrinidou *et al.*, 2014). It can also alter the explanation of residual risk (Jasanoff, 2003; Lambrinidou *et al.*, 2014).

The uncertainty section of the assessment memorandum would distinguish uncertainty about hydrogeological behaviour from uncertainty created by inaccessible documentation (Funtowicz & Ravetz, 1993; *Order MO-2449* at 7–8). The first may require additional data or sensitivity analysis, which tests how model results change when assumptions or parameter values are varied (Professional Engineers Ontario, 2019). Monitoring may provide further evidence under operating conditions (Professional Engineers Ontario, 2019).

4.8.3. Respond: Disclosure, Monitoring, and Escalation

The first response would be a complete review package containing the model, input data, and assumptions (Professional Engineers Ontario, 2020; Ontario (Information and Privacy Commissioner), *Order MO-2449* at 7–8). It would also contain design reports and responses to peer-review comments (Professional Engineers Ontario, 2020; Ontario (Information and Privacy Commissioner), *Order MO-2449* at 7–8). The package would identify confidential or proprietary material and provide a lawful review pathway that preserves enough information for technical accountability (IEEE, 2021, cl. 11; Ontario (Information and Privacy Commissioner), *Order MO-2449* at 7–8).

The second response would link groundwater controls to verification and contingency criteria, meaning pre-defined conditions that activate a backup or corrective response (Professional Engineers Ontario, 2019). Monitoring locations, parameters, and frequency would be justified against the modelled pathways and affected receptors; receptors are wells, streams, or other locations where groundwater effects could be observed (Professional Engineers Ontario, 2019, pp. 14–15). Reporting and action thresholds would be justified on the same basis (Professional Engineers Ontario, 2019, pp. 14–15). Professional Engineers Ontario describes post-closure care,

monitoring, and maintenance as “an essential part of landfill site operations,” which supports treating long-term performance as part of engineering responsibility (Professional Engineers Ontario, 2019, p. 15).

The third response would escalate unresolved technical issues to Simcoe County and the Ministry with a clear statement of the decision affected and the residual uncertainty (Environmental Commissioner of Ontario, 2004; Engineers Canada, 2024b). The consultant or reviewer would document the limitation and the recommended condition, while the public authority would decide whether construction, approval, or additional review should follow under its statutory powers (Professional Engineers Ontario, 2020; *Environmental Protection Act*, RSO 1990, c E.19, s 27).

The PIIA would require earlier disclosure and an assessment memorandum that explains the relevant uncertainty (Raji *et al.*, 2020; IEEE, 2021; Professional Engineers Ontario, 2020). It would also include a peer-review response matrix and a named residual-risk decision-maker (Raji *et al.*, 2020; IEEE, 2021; Professional Engineers Ontario, 2020). Waste policy and land-use decisions would remain with the public bodies acting under the *Environmental Assessment Act* and other applicable law (*Environmental Assessment Act*, RSO 1990, c E.18; Whyte, 2020). Waste-disposal approval would remain with the authority acting under section 27 of the *Environmental Protection Act* (*Environmental Protection Act*, RSO 1990, c E.19, s 27). Indigenous jurisdiction would remain with the Indigenous governments and legal orders from which that authority arises (Borrows, 2010; Whyte, 2020).

Table 4.4. Site 41 PIIA application.

Stage	Site 41 document produced	Actor with authority and available decision
Identify	Decision point; hydrogeological and landfill-engineering scope; affected water users; Ministry and peer-review material; calibrated MODFLOW model and inputs; disclosure gaps (Environmental Commissioner of Ontario, 2004; Mushtaq, 2011; <i>Order MO-2449</i> at 7–8).	Consultants and reviewers assemble the record; County and Ministry receive it for decisions within their legal powers (Professional Engineers Ontario, 2020; <i>Environmental Protection Act</i> , RSO 1990, c E.19).
Assess	Groundwater pathway; containment and dewatering assumptions; calibration and sensitivity evidence; peer-review response; community and Indigenous water knowledge; disclosure-related uncertainty (Mushtaq, 2011, 2013; Professional Engineers Ontario, 2019).	Competent reviewers state unresolved issues, level of confidence, and required additional work; public authorities evaluate conditions or further review (Environmental Commissioner of Ontario, 2004).
Respond	Model and input production; design or monitoring changes; response to peer review; reporting and contingency thresholds; residual-risk statement; escalation section naming the decision-maker (Professional Engineers Ontario, 2019; <i>Order MO-2449</i> at 7–8).	Engineering actors implement or recommend technical measures; County and Ministry decide whether project action follows (Engineers Canada, 2024b; <i>Environmental Protection Act</i> , RSO 1990, c E.19).

4.9. Public Washrooms: A Public-Interest Impact Assessment for Equivalent, Code-Mediated Access

Public washrooms provide the ordinary built-environment application because fixture calculations and plumbing work can materially shape use (Anthony & Dufresne, 2007; National Research Council Canada, 2022). Mechanical systems can shape privacy and comfort, while accessibility coordination can determine whether use is equivalent (City of Vancouver, 2024; CSA Group & Accessibility Standards Canada, 2023). The PIIA can begin during concept design or retrofit planning. Detailed design and post-occupancy review provide later decision points (Professional Engineers Ontario, 2020; Harwood-Jones *et al.*, 2023).

The owner controls the facility program, the architect often coordinates spatial design, and the authority having jurisdiction decides code compliance within its statutory role (City of Ottawa Building Code Services, 2021; *Building Code Act, 1992*, SO 1992, c 23, ss 3, 8). Mechanical,

plumbing, and electrical engineering work supplies technical feasibility and performance evidence within assigned scopes (Professional Engineers Ontario, 2020; CSA Group & Accessibility Standards Canada, 2023). Accessibility-related engineering advice supplies additional evidence where assigned (Professional Engineers Ontario, 2020; CSA Group & Accessibility Standards Canada, 2023).

4.9.1. Identify: Define Equivalent Access and the Retrofit Boundary

The trigger memorandum would identify the public-facing interest as safe and dignified washroom use (Ontario Human Rights Commission, 2014, s. 13.4.1; Hamraie, 2017). It would also address privacy and accessibility within the institution (Ontario Human Rights Commission, 2014, s. 13.4.1; Hamraie, 2017). It would identify affected users through the actual building population and use conditions (Castrodale & Lane, 2015; Harwood-Jones *et al.*, 2023; City of Vancouver, 2024). The inquiry would include trans, non-binary, and Two-Spirit users where the evidence supports distinct requirements (Castrodale & Lane, 2015; Harwood-Jones *et al.*, 2023; City of Vancouver, 2024). It would also include disabled, caregiving, and custodial users on the same basis (Castrodale & Lane, 2015; Harwood-Jones *et al.*, 2023; City of Vancouver, 2024).

The engineering boundary would identify fixture counts, occupancy assumptions, and water or drainage implications (National Research Council Canada, 2022; Professional Engineers Ontario, 2020; CSA Group & Accessibility Standards Canada, 2023). It would also identify ventilation, electrical controls, and accessible operation within the accepted assignment (National Research Council Canada, 2022; Professional Engineers Ontario, 2020; CSA Group & Accessibility Standards Canada, 2023). The owner's policy decision and the building official's code decision

would be recorded beside that engineering work so responsibility remains visible (City of Ottawa Building Code Services, 2021; *Building Code Act, 1992*, SO 1992, c 23, ss 3, 8).

The evidence register would include the applicable code provisions and Proposed Change 1750 (National Research Council Canada, 2022). The existing fixture inventory, occupancy data, and plans would provide the technical baseline (National Research Council Canada, 2022; City of Vancouver, 2024). Accessibility standards and human-rights guidance would provide additional constraints (Ontario Human Rights Commission, 2014; CSA Group & Accessibility Standards Canada, 2023). Where available, post-occupancy evidence would include complaints, route observations, and queue information (Harwood-Jones *et al.*, 2023; City of Vancouver, 2024). Maintenance records and security incidents would add operational evidence (Harwood-Jones *et al.*, 2023; City of Vancouver, 2024).

Ontario human-rights guidance states that “Access to washrooms is a basic physical need at the core of human dignity for everyone” (Ontario Human Rights Commission, 2014, s. 13.4.1). That legal floor gives the PIIA a clear access outcome while leaving technical means to the project team and code authority (Ontario Human Rights Commission, 2014; National Research Council Canada, 2022).

4.9.2. Assess: Capacity, Access, and Operation

The assessment would first test whether the proposed layout satisfies the applicable fixture requirements and preserves adequate capacity for the building population (National Research Council Canada, 2022; Anthony & Dufresne, 2007). It would state how water closets and urinals are counted. It would also state how the selected allocation affects peak demand, meaning the

period of highest expected washroom use (National Research Council Canada, 2022; Mélançon Marceau Grenier Cohen s.e.n.c., 2025).

Proposed Change 1750 is relevant because it clarifies that minimum water-closet requirements can be satisfied through a gender-neutral allocation under the *National Building Code* (National Research Council Canada, 2022). The PIIA would therefore record the actual code text, the authority having jurisdiction's interpretation, and any design assumption that treats binary separation as mandatory (National Research Council Canada, 2022; City of Ottawa Building Code Services, 2021).

The assessment would then test the route and room as a connected system (Hamraie, 2017; CSA Group & Accessibility Standards Canada, 2023). Travel distance, floor location, and elevator dependence affect whether the facility is equivalent to the main washroom route (Harwood-Jones *et al.*, 2023; Hamraie, 2017). Opening hours and wayfinding affect the same comparison (Harwood-Jones *et al.*, 2023; Hamraie, 2017). Door force, clear width, and turning space affect independent use (CSA Group & Accessibility Standards Canada, 2023). Transfer space, reach ranges, and emergency controls affect it as well (CSA Group & Accessibility Standards Canada, 2023).

Privacy and safety would be tested through stall enclosure, lock operation, and sightlines (National Research Council Canada, 2022; City of Vancouver, 2024). Lighting and the relationship between the entrance and adjacent circulation would receive separate review (National Research Council Canada, 2022; City of Vancouver, 2024). Full-height partitions and lockable doors may support privacy in multi-stall facilities, while corridor sightlines and acoustic conditions require project-specific review (National Research Council Canada, 2022; City of Vancouver, 2024).

Mechanical performance would be assessed through ventilation, odour control, and drainage (City of Vancouver, 2024; Professional Engineers Ontario, 2020). Operational performance would be assessed through fixture serviceability and cleaning access (City of Vancouver, 2024; Professional Engineers Ontario, 2020). Disposal receptacles, menstrual-product provision, and sharps management where relevant would be assigned to the responsible actor (City of Vancouver, 2024; Harwood-Jones *et al.*, 2023). Maintenance closure protocols would receive a separate facilities assignment (City of Vancouver, 2024; Harwood-Jones *et al.*, 2023).

The burden question would compare who must travel farther, wait longer, or disclose more under each option (Anthony & Dufresne, 2007; Hamraie, 2017). It would separately identify users directed to a less accessible room (Anthony & Dufresne, 2007; Hamraie, 2017). The access question would compare equivalent location, capacity, and privacy (Ontario Human Rights Commission, 2014; CSA Group & Accessibility Standards Canada, 2023). Independent use would be evaluated as a separate outcome (Ontario Human Rights Commission, 2014; CSA Group & Accessibility Standards Canada, 2023). The knowledge question would examine whether affected users tested the route and whether operational evidence changed the design (Hamraie, 2017, p. 113; Harwood-Jones *et al.*, 2023).

The Mélançon firm's opinion illustrates the documentation method because it identifies the governing instruments and existing fixture arrangement (Mélançon Marceau Grenier Cohen s.e.n.c., 2025). It then identifies the code language and the available interpretive pathway (Mélançon Marceau Grenier Cohen s.e.n.c., 2025). The PIIA places that legal analysis beside engineering calculations and user evidence so each discipline's contribution remains distinct and connected (Professional Engineers Ontario, 2020; Mélançon Marceau Grenier Cohen s.e.n.c., 2025).

4.9.3. Respond: Technically Sound Options and Post-Occupancy Evidence

The response-and-monitoring plan would present technically sound options with their fixture capacity, accessibility, and privacy performance (National Research Council Canada, 2022; City of Vancouver, 2024). Capital implications and operational requirements would be documented beside those performance measures (IEEE, 2021, Annex I; City of Vancouver, 2024).

The engineer would document code flexibility and technical constraints within the accepted assignment (Professional Engineers Ontario, 2020; National Research Council Canada, 2022). The “performance basis” means the measurable reason an option is technically acceptable—for example, its fixture capacity, ventilation result, or accessible route (Professional Engineers Ontario, 2020; National Research Council Canada, 2022). The owner would select the facility program, and the authority having jurisdiction would decide compliance under sections 3 and 8 of Ontario’s *Building Code Act, 1992* (*Building Code Act, 1992*, SO 1992, c 23, ss 3, 8; City of Ottawa Building Code Services, 2021).

Verification would include drawing review, fixture-count confirmation, and accessibility inspection (Professional Engineers Ontario, 2020; CSA Group & Accessibility Standards Canada, 2023; City of Vancouver, 2024). It would also include door-operation testing, ventilation balancing, and an opening-readiness review assigned to the relevant actors (Professional Engineers Ontario, 2020; CSA Group & Accessibility Standards Canada, 2023; City of Vancouver, 2024). Direct user testing would evaluate route, controls, and privacy where drawings provide incomplete evidence (Hamraie, 2017; Harwood-Jones *et al.*, 2023). Signage would receive the same treatment where use depends on comprehension (Hamraie, 2017; Harwood-Jones *et al.*, 2023).

Post-occupancy monitoring would record queues, complaints, and access failures at intervals matched to the building’s use and the seriousness of the identified risk (Harwood-Jones *et al.*, 2023; City of Vancouver, 2024). Facilities staff would keep a separate log of maintenance closures and safety incidents (Harwood-Jones *et al.*, 2023; City of Vancouver, 2024). A recurring pattern would re-open the PIIA and require review of capacity, location, or operation (Law Commission of Ontario & Ontario Human Rights Commission, 2024; Professional Engineers Ontario, 2020).

The response-and-monitoring plan would explain how human-rights requirements and code interpretation shaped the final facility decision (Ontario Human Rights Commission, 2014; National Research Council Canada, 2022; Hamraie, 2017). It would also explain how engineering feasibility and affected-user evidence shaped that decision (Ontario Human Rights Commission, 2014; National Research Council Canada, 2022; Hamraie, 2017). Together, the plan and supporting calculations would make the decision reviewable while preserving the owner’s and code authority’s distinct roles (Professional Engineers Ontario, 2020; City of Ottawa Building Code Services, 2021).

Table 4.5. Public-washroom PIIA application.

Stage	Washroom document produced	Actor with authority and available decision
Identify	Facility program; fixture inventory; occupancy; code and human-rights sources; affected users; engineering scopes; complaints and use evidence (Ontario Human Rights Commission, 2014; National Research Council Canada, 2022).	Owner defines program; engineers define technical feasibility; authority having jurisdiction interprets and applies the code (City of Ottawa Building Code Services, 2021).
Assess	Fixture capacity; equivalent route; accessibility; privacy and sightlines; ventilation and drainage; maintenance; combined-user scenarios; alternatives (Hamraie, 2017; CSA Group & Accessibility Standards Canada, 2023; City of Vancouver, 2024).	Project team compares options; engineer documents performance and constraints; legal or accessibility specialists address their domains (Professional Engineers Ontario, 2020).

Stage	Washroom document produced	Actor with authority and available decision
Respond	Selected option; calculations; discipline matrix; verification plan; signage and operational plan; post-occupancy monitoring; re-opening events (National Research Council Canada, 2022; Harwood-Jones <i>et al.</i> , 2023).	Owner selects and funds; engineers implement within scope; building official decides compliance; facilities actor monitors operation (<i>Building Code Act, 1992</i> ; City of Vancouver, 2024).

4.10. Artificial Intelligence and Large Language Models: A Public-Interest Impact Assessment at the System Boundary

AI and LLMs provide the boundary application because professional engineering enters through a defined engineered use and accepted responsibility (Engineers Canada, 2022; Professional Engineers Ontario, n.d.). The application uses the Chapter 3 scenario in which a public transit authority procures an LLM-based tool to summarize maintenance reports and prioritize files for engineering review (Engineers Canada, 2022; Raji *et al.*, 2020).

Chapter 3 allocates responsibility among the model provider, the transit authority, and the licensed engineer. The PIIA begins from that allocation rather than reconstructing it (Engineers Canada, 2022; Raji *et al.*, 2020; Scassa, 2021). At the identify stage, the project team records the task assigned to the model, the records it may process, and the decisions reserved to human reviewers (IEEE, 2021; Raji *et al.*, 2020).

4.10.1. Identify: Intended Use, System Boundary, and Known Risk Evidence

The trigger memorandum would define the tool’s permitted function as summarization and triage for engineering review (Raji *et al.*, 2020; IEEE, 2021, cl. 7). Human review would remain mandatory for diagnosis, release-to-service decisions, and closure of a maintenance file (Parasuraman & Manzey, 2010; Raji *et al.*, 2020).

The system boundary would identify the base model and version, along with the prompt or retrieval configuration (Raji *et al.*, 2020; IEEE, 2021). A prompt is the instruction supplied to the model, while retrieval configuration specifies which external records are selected and supplied to support the output (Raji *et al.*, 2020; IEEE, 2021). The system-use and validation document would identify the source records and data flows. The user interface, logging, and human-review step would complete the operational boundary (Raji *et al.*, 2020; IEEE, 2021). The same document would also state which components the vendor supplies and which components the transit authority configures or accepts (Bommasani *et al.*, 2021; Raji *et al.*, 2020).

The affected public would include workers whose reports enter the system, passengers affected by maintenance prioritization, and groups whose language or identity may influence model behaviour (Blodgett *et al.*, 2020; Parasuraman & Manzey, 2010). The public-facing interests would include safe maintenance review and accurate communication (Scassa, 2021; Law Commission of Ontario & Ontario Human Rights Commission, 2024). They would also include dignified treatment and meaningful human contestability (Scassa, 2021; Law Commission of Ontario & Ontario Human Rights Commission, 2024).

The evidence inventory would include vendor documentation, model or system cards, and evaluation data (Bender *et al.*, 2021; Raji *et al.*, 2020, pp. 40–41; Office of the Privacy Commissioner of Canada *et al.*, 2023). It would also include known limitations and cybersecurity or privacy material (Bender *et al.*, 2021; Raji *et al.*, 2020, pp. 40–41; Office of the Privacy Commissioner of Canada *et al.*, 2023). Literature on LLM risks and internal incident history would complete the evidence inventory (Bender *et al.*, 2021; Raji *et al.*, 2020).

Chapter 3 establishes Abubakar Abid, Maheen Farooqi, and James Zou’s GPT-3 study as known-risk evidence for identity-linked representational harm (Abid *et al.*, 2021, pp. 461–463). At the identify stage, that evidence changes the test plan: the team records identity-linked test cases, compares outputs across relevant groups, and evaluates whether a mitigation remains effective in the deployed configuration (Abid *et al.*, 2021; Blodgett *et al.*, 2020). The study therefore serves as prior evidence supporting deployment-specific testing; the resulting finding remains specific to the tested model and use (Abid *et al.*, 2021; Bommasani *et al.*, 2021).

4.10.2. Assess: Technical Behaviour, Representation, and Human Reliance

The assessment would first trace how a report becomes model input, summary text, and a priority category (Raji *et al.*, 2020; IEEE, 2021). It would then trace the human review action (Raji *et al.*, 2020; IEEE, 2021). That trace identifies where information can be omitted, transformed, or fabricated (Bender *et al.*, 2021; Raji *et al.*, 2020). It also identifies where model output receives undue operational weight (Bender *et al.*, 2021; Raji *et al.*, 2020).

The evaluation set would draw from representative maintenance records and constructed test cases covering the intended operational range (Raji *et al.*, 2020; IEEE, 2021). Provenance means information showing where the test material came from, who selected it, and how it was transformed (Office of the Privacy Commissioner of Canada *et al.*, 2023; Raji *et al.*, 2020). That information would show which work units, languages, and equipment types are represented (Office of the Privacy Commissioner of Canada *et al.*, 2023; Raji *et al.*, 2020).

For summarization, the assessment would measure omission of safety-relevant facts, unsupported additions, and source fidelity, meaning whether the summary remains faithful to the source report (Raji *et al.*, 2020; Bender *et al.*, 2021). Consistency across repeated runs would be

measured where the system is stochastic, meaning that the same input can produce different outputs (Raji *et al.*, 2020; Bender *et al.*, 2021). For triage, it would measure missed high-severity reports, false prioritization, and the review burden created by false positives (Parasuraman & Manzey, 2010; Raji *et al.*, 2020). Project-specific acceptance criteria would state why the selected error tolerance is appropriate to the maintenance use (Engineers Canada, 2022; IEEE, 2021, cl. 10).

Group-linked evaluation would test whether names, religious references, or dialect change summaries or priority outcomes (Abid *et al.*, 2021; Blodgett *et al.*, 2020). Language proficiency and other identity-linked features would be tested where they connect to a public-facing harm (Abid *et al.*, 2021; Blodgett *et al.*, 2020). Combined tests would be used where the expected deployment includes intersecting conditions that aggregate evaluation could hide (Atrey, 2019; Raji *et al.*, 2020, p. 41).

The assessment would distinguish model behaviour from deployment consequence (Blodgett *et al.*, 2020; Raji *et al.*, 2020). A stereotypical completion becomes professionally significant when it enters a public-facing communication, affects prioritization, or shapes a human reviewer’s judgment (Abid *et al.*, 2021; Parasuraman & Manzey, 2010).

Human-factors analysis would examine automation bias: the tendency to accept an automated recommendation despite conflicting evidence or an available reason to check it (Parasuraman & Manzey, 2010). It would also examine complacency and time pressure (Parasuraman & Manzey, 2010). The review would test whether fluent output conveys unwarranted authority and whether the interface keeps the source record visible (Parasuraman &

Manzey, 2010; Law Commission of Ontario & Ontario Human Rights Commission, 2024). The reviewer must have a practical ability to override the system (Parasuraman & Manzey, 2010).

Traceability would connect the intended use, risk evidence, and test set (IEEE, 2021, cls. 9–11; Raji *et al.*, 2020). It would also connect the model version, system configuration, and acceptance decision (IEEE, 2021, cls. 9–11; Raji *et al.*, 2020). Raji and colleagues describe a model card as a document that states intended use, evaluation data, and scope (Raji *et al.*, 2020, p. 41). It also records risks and factors affecting performance (Raji *et al.*, 2020, p. 41). The PHIA would place that document beside the project’s own validation evidence (Raji *et al.*, 2020; IEEE, 2021).

The uncertainty section of the assessment memorandum would identify unavailable training information, vendor restrictions, and small subgroup samples (Bender *et al.*, 2021; Raji *et al.*, 2020). It would also identify stochastic output variation and expected model updates where those conditions apply (Bender *et al.*, 2021; Raji *et al.*, 2020). Each limitation would be linked to a control, restricted use, or revalidation event; revalidation means repeating the relevant tests after a change that could affect accepted performance (IEEE, 2021; Raji *et al.*, 2020).

4.10.3. Respond: Narrow Use, Verification, and Change Control

The first response would define a narrow use case and require source-linked human verification before any maintenance action is taken (Raji *et al.*, 2020; Parasuraman & Manzey, 2010). The interface would display the original report beside the generated summary and make omissions or disputed content easy to correct (Parasuraman & Manzey, 2010; IEEE, 2021, cl. 11).

The second response would establish abstention or manual routing conditions for reports outside the validated range (Raji *et al.*, 2020; IEEE, 2021, cl. 10). Abstention means that the system declines to produce an operational answer and sends the report for human review (Raji *et*

al., 2020; IEEE, 2021). Reports involving unfamiliar equipment, low-quality inputs, or unsupported languages would follow the manual path defined by the maintenance authority (Raji *et al.*, 2020; Engineers Canada, 2022). Identified high-severity terms would activate the same path (Raji *et al.*, 2020; Engineers Canada, 2022).

The third response would use procurement terms to secure documentation and change notice (Scassa, 2021; Law Commission of Ontario & Ontario Human Rights Commission, 2024; Raji *et al.*, 2020). Evaluation access, incident reporting, and logging would be addressed in the same contract (Scassa, 2021; Raji *et al.*, 2020). Suspension or termination rights would be matched to the consequences of the use and the evidence of failure (Scassa, 2021; Raji *et al.*, 2020). The vendor would identify model or safeguard changes that require revalidation, while the transit authority would retain authority over continued deployment (Raji *et al.*, 2020; IEEE, 2021).

Monitoring would track override rates, corrected omissions, and missed hazards (Raji *et al.*, 2020; Law Commission of Ontario & Ontario Human Rights Commission, 2024, pp. 4–5). Complaint patterns and performance after model or workflow changes would form a second review stream (Raji *et al.*, 2020; Law Commission of Ontario & Ontario Human Rights Commission, 2024, pp. 4–5). An incident involving a missed safety-relevant report would trigger immediate review of the evaluation set, human-review design, and deployment scope (Parasuraman & Manzey, 2010; Raji *et al.*, 2020).

Sasha Costanza-Chock, Inioluwa Deborah Raji, and Joy Buolamwini’s field scan shows why authority to require remediation matters: many auditors reported limited power to require changes, and implementation followed in only about one-fifth of the reported cases (Costanza-

Chock *et al.*, 2022, p. 1577). The PIIA therefore names the person who can change or suspend deployment before the assessment begins (Costanza-Chock *et al.*, 2022; IEEE, 2021, cl. 5.4).

The direct contribution of the PIIA would be a written system-acceptance decision that states the approved use, the evidence supporting it, and the actor authorized to modify or suspend deployment (Raji *et al.*, 2020; IEEE, 2021). It would also connect human reliance to procurement authority (Raji *et al.*, 2020; IEEE, 2021). Professional engineering would govern the integration and use for which an engineer assumes responsibility (Engineers Canada, 2022; Office of the Privacy Commissioner of Canada *et al.*, 2023; Scassa, 2021). Model-provider, privacy, and public-authority responsibilities would remain with those actors (Office of the Privacy Commissioner of Canada *et al.*, 2023; Scassa, 2021).

Table 4.6. AI and LLM PIIA application for maintenance-report summarization and triage.

Stage	AI and LLM document produced	Actor with authority and available decision
Identify	Intended and excluded use; system boundary; base model and version; data flow; affected publics; vendor and internal documentation; known literature; human-review owner (Abid <i>et al.</i> , 2021; Raji <i>et al.</i> , 2020; IEEE, 2021).	Vendor supplies model information; transit authority defines use; responsible engineer defines acceptance and human-review requirements within engineering scope (Engineers Canada, 2022).
Assess	Test-set provenance; omission and fabrication results; triage errors; group-linked and combined-condition tests; automation-bias analysis; uncertainty; model card; traceability (Blodgett <i>et al.</i> , 2020; Parasuraman & Manzey, 2010; Raji <i>et al.</i> , 2020).	Engineer decides technical acceptance or qualification; employer and procurement authority decide deployment and contract action (IEEE, 2021; Scassa, 2021).

Stage	AI and LLM document produced	Actor with authority and available decision
Respond	Narrow use; source-linked human verification; manual routing; vendor obligations; logging; monitoring; incident response; version-change revalidation; suspension criteria (Raji <i>et al.</i> , 2020; Law Commission of Ontario & Ontario Human Rights Commission, 2024).	Transit authority changes or suspends deployment; engineer revises acceptance; vendor remediates its component; other regulators act within their mandates (Engineers Canada, 2022; Office of the Privacy Commissioner of Canada <i>et al.</i> , 2023).

4.11. Conditions That Allow the PIIA to Change a Decision

A PIIA can change a decision only when the evidence reaches an actor with authority and that actor has resources to respond (IEEE, 2021, cls. 5.4, 7–11; Costanza-Chock *et al.*, 2022). The assessment must therefore name the person or body that can modify, pause, or reject the work (IEEE, 2021; Costanza-Chock *et al.*, 2022). When those links are missing, documentation may describe the risk without changing the outcome (Costanza-Chock *et al.*, 2022; Raji *et al.*, 2020).

4.11.1. Judgment, Evidence, and Consequence

Raji and colleagues warn that yes-or-no questions can become “box-ticking” when the form records completion without showing the judgment behind it (Raji *et al.*, 2020, p. 36). For example, a checked box stating “user impacts considered” says little unless the completed assessment identifies the affected users, the evidence reviewed, and the decision changed by that evidence (Raji *et al.*, 2020; IEEE, 2021). The PIIA therefore requires a narrative mechanism, cited evidence, and a written explanation of unresolved disagreement (Raji *et al.*, 2020; IEEE, 2021). Each material issue also receives an assigned consequence and owner (Raji *et al.*, 2020; IEEE, 2021).

Completion requires both documentation that explains the evidence and reasoning and implementation of the selected response (Costanza-Chock *et al.*, 2022; Professional Engineers

Ontario, 2020). For example, an assessment recommending a new groundwater action threshold is complete when the threshold is adopted in the monitoring plan, assigned to a named owner, and supported by retained evidence (Costanza-Chock *et al.*, 2022; Professional Engineers Ontario, 2020). A regulator, employer, or reviewer can then examine the reasoning and confirm that monitoring or escalation actually followed (Adams, 2022; IEEE, 2021).

4.11.2. Resources, Competence, and Assessment Depth

The project owner assigns time, expertise, and access to information according to the seriousness of the risk and the complexity of the evidence (IEEE, 2021; Herkert, 2000). A responsible professional can complete a short-form assessment where the issue is narrow and the evidence is stable (Professional Engineers Ontario, 2020; IEEE, 2021). A full assessment may require hydrogeology, accessibility, or human-factors expertise (Professional Engineers Ontario, 2019; Law Commission of Ontario & Ontario Human Rights Commission, 2024). Data-science and legal expertise may be added where the system requires them (Professional Engineers Ontario, 2019; Law Commission of Ontario & Ontario Human Rights Commission, 2024).

Competence includes knowing when the issue exceeds the actor’s expertise and obtaining qualified assistance (Professional Engineers Ontario, 2020; Engineers Canada, 2024a). The PIIA records the discipline, mandate, and contribution of each participant so multidisciplinary work remains accountable (IEEE, 2021, cl. 5.4; Law Commission of Ontario & Ontario Human Rights Commission, 2024, pp. 39–40).

4.11.3. Alberta and Jurisdiction-Specific Implementation

Chapter 3 established the timing and jurisdictional setting for Alberta. At the July 2026 thesis date, a regulator’s present authority comes from the *Engineering and Geoscience*

Professions Act and the *Engineering and Geoscience Professions General Regulation* (*Engineering and Geoscience Professions Act*, RSA 2000, c E-11, ss 2, 10, 19, 43-63; *Engineering and Geoscience Professions General Regulation*, Alta Reg 150/99, Sched 1). An employer acts through project governance, while a university acts through curricular authority subject to applicable law (Herkert, 2000; Engineers Canada, 2024c). The PIIA therefore identifies the legal or organizational power currently available before assigning a requirement.

The enacted statutes that are not yet operative for engineers are addressed separately. The Alberta government states that initial proclamation of the *Professional Governance Act* is expected in the second half of 2026 and that implementation will be staggered across professional organizations (*Professional Governance Act*, SA 2025, c P-25.5; Government of Alberta, 2026). For engineers, the *Regulated Professions Neutrality Act* takes effect when the *Professional Governance Act* comes into force for the profession (*Regulated Professions Neutrality Act*, SA 2025, c R-13.3; Government of Alberta, 2025, 2026). Once that occurs, a regulator must use mechanisms permitted by those statutes, while employers and universities continue to act through their own authority (Adams, 2022; Engineers Canada, 2024c).

4.11.4. Confidentiality, Proprietary Information, and Meaningful Transparency

Confidentiality and proprietary claims are managed through a disclosure plan that identifies the audience, legal basis, and minimum information required for accountable review (IEEE, 2021, cl. 11; Ontario (Information and Privacy Commissioner), *Order MO-2449* at 7–8). The plan can use secure review, redaction, or summaries while preserving the technical information needed to test the decision (Raji *et al.*, 2020; Office of the Privacy Commissioner of Canada *et al.*,

2023). Contractual access can supply another lawful pathway (Raji *et al.*, 2020; Office of the Privacy Commissioner of Canada *et al.*, 2023).

A public-facing explanation states the practical consequence, main uncertainty, and responsible decision-maker in language appropriate to the audience (Jasanoff, 2003; IEEE, 2021, cl. 11). The technical file retained for professional review contains the assumptions, calculations, and model artifacts (Professional Engineers Ontario, 2020; Raji *et al.*, 2020). The same retention requirement applies to evaluation results (Professional Engineers Ontario, 2020; Raji *et al.*, 2020).

4.11.5. Review Events and Institutional Memory

The PIIA remains active through defined review events because projects and systems change after initial acceptance (Professional Engineers Ontario, 2019; Raji *et al.*, 2020). Version control, record retention, and named ownership allow later reviewers to reconstruct what was known and why a decision was made (IEEE, 2021, cl. 11; Raji *et al.*, 2020).

Table 4.7. Events that re-open a PIIA.

Re-opening event	Required review	Typical owner
Material design, code, model, or use change	Update system boundary, affected publics, evidence, validation, and residual-risk decision (IEEE, 2021; Law Commission of Ontario & Ontario Human Rights Commission, 2024).	Responsible engineer and project or system owner (Professional Engineers Ontario, 2020).
Incident, complaint pattern, or monitoring threshold	Trace the event to requirements, design, operation, and prior controls; revise mitigation and escalation where needed (Raji <i>et al.</i> , 2020; Professional Engineers Ontario, 2019).	Operational owner with engineering review and affected-public evidence (Hamraie, 2017; Raji <i>et al.</i> , 2020).
New peer review, legal requirement, or technical evidence	Evaluate the new evidence against the prior assessment and state its effect on confidence, controls, and authority (Funtowicz & Ravetz, 1993; Professional Engineers Ontario, 2020).	Actor holding the affected decision, with regulator or public authority involvement where required (Adams, 2022).

Re-opening event	Required review	Typical owner
Scheduled review for a complex or evolving system	Confirm intended use, performance, affected-public evidence, documentation access, and continued appropriateness of controls (Law Commission of Ontario & Ontario Human Rights Commission, 2024; Raji <i>et al.</i> , 2020).	System owner, responsible engineer, and governance function assigned by the organization (IEEE, 2021).

4.12. Takeaway

The PIIA gives the thesis’s public-interest interpretation an operational form by producing a reviewable set of project documents (Professional Engineers Ontario, 2020; IEEE, 2021; Raji *et al.*, 2020). Those documents state whether the threshold test is met, how the three justice questions were answered, and which actor has authority to respond (IEEE, 2021; Raji *et al.*, 2020). They also state the response selected, the evidence supporting it, and any unresolved risk (Professional Engineers Ontario, 2020; IEEE, 2021). The PIIA asks who carries the burden, what public-facing interest is impaired, and what evidence made that condition known or reasonably knowable (Young, 1990; Hamraie, 2017; Fricker, 2017).

Identification defines the engineering work and affected public (Raji *et al.*, 2020; IEEE, 2021). It also fixes the evidence and decision point (Raji *et al.*, 2020; IEEE, 2021). Assessment traces the mechanism, evaluates uncertainty, and compares alternatives within role (Funtowicz & Ravetz, 1993; Professional Engineers Ontario, 2020). Response assigns controls, verification, and warning to actors with authority (Engineers Canada, 2024b; IEEE, 2021; Professional Engineers Ontario, 2020). It also assigns escalation, monitoring, and residual-risk acceptance (Engineers Canada, 2024b; IEEE, 2021; Professional Engineers Ontario, 2020).

Site 41 shows how the process would change technical disclosure and model review in engineering-heavy public infrastructure (Mushtaq, 2011; Ontario (Information and Privacy Commissioner), *Order MO-2449*; Professional Engineers Ontario, 2019). It would also change monitoring and escalation (Mushtaq, 2011; Ontario (Information and Privacy Commissioner), *Order MO-2449*; Professional Engineers Ontario, 2019). Public washrooms show how the same process can make code interpretation, fixture capacity, and accessibility visible in an ordinary built-environment decision (National Research Council Canada, 2022; Hamraie, 2017; City of Vancouver, 2024). It can also make privacy and operation visible (National Research Council Canada, 2022; Hamraie, 2017; City of Vancouver, 2024). AI and LLMs show how traceability, validation, and human review allocate responsibility at the boundary of professional engineering (Engineers Canada, 2022; Raji *et al.*, 2020; IEEE, 2021). Procurement and change control complete that allocation (Engineers Canada, 2022; Raji *et al.*, 2020; IEEE, 2021).

The contribution is a bounded process for role-specific due care that changes what engineering actors investigate, document, and communicate when their work creates or significantly shapes a material disparate-impact risk (Professional Engineers Ontario, 2020; Engineers Canada, 2024a). Chapter 5 synthesizes the contribution, its limits, and future directions across the three recurring examples (Adams, 2022; Jasanoff, 2003).

5

Conclusion: Technological Accountability with Limits

Queerness is not yet here. Queerness is an ideality. Put another way, we are not yet queer.

—José Esteban Muñoz (2009, p. 1)

5.1. Returning to the Research Question

José Esteban Muñoz’s epigraph gives this conclusion its prospective orientation: the framework developed here is an attempt to make another form of professional practice imaginable, rather than a claim that technological accountability has already been achieved (Muñoz, 2009). I return to the question that has organized this thesis: how should the statutory public-interest mandate governing professional engineering in Canada’s provinces and territories apply when engineering work creates or significantly shapes a patterned uneven burden on a structurally marginalized public? I argue that the mandate requires role-specific due care when a material disparate-impact risk satisfies the cumulative threshold test (Engineers Canada, 2024a, 2024b; Professional Engineers Ontario, 2020). The risk must be more than remote or minor and must concern a public-facing interest (Engineers Canada, 2024a; Professional Engineers Ontario, 2020). Its burden must fall in a patterned and uneven way, and engineering work must create or significantly shape that burden (*Professional Engineers Act*, RSO 1990, c P.28, s 1(1); *Fraser*, 2020 SCC 28 at paras 30–31, 47–50). The available evidence must make the risk known or

reasonably knowable within role, and an actor must have authority to take a response (Engineers Canada, 2024a, 2024b; Adams, 2022).

That answer is bounded by the legal and institutional conditions developed across the thesis (Adams, 2022; Herkert, 2000). The inquiry begins with engineering work as defined by the statute and subordinate regulations in the province or territory where the work occurs (Engineers Canada, 2022; *Professional Engineers Act*, RSO 1990, c P.28, s 1(1)). It next identifies the evidence available to a competent actor at the relevant decision point (Professional Engineers Ontario, 2020; Engineers Canada, 2024a). The analysis then asks whether that actor can change the work directly or document the issue for another decision-maker (Engineers Canada, 2024b; Herkert, 2000). Warning and escalation become the available response where direct authority rests elsewhere (Engineers Canada, 2024b; Adams, 2022). Responsibility is therefore attached to the work and the evidence, then allocated to the actor with an available response (Adams, 2022; Herkert, 2000).

The existing professional-regulatory architecture supplies the foundation for this interpretation (Adams, 2016, 2018, 2022; Engineers Canada, 2024a). The statutes and regulations through which each province and territory governs the engineering profession already organize licensure and competence around public protection (Adams, 2016, 2018, 2022; Engineers Canada, 2024a). They also establish ethical standards and disciplinary mechanisms for professional conduct (Adams, 2016, 2018; Engineers Canada, 2024a). Ontario's statute directs Professional Engineers Ontario to regulate the profession so that the public interest may be served and protected (*Professional Engineers Act*, RSO 1990, c P.28, s 2(3)). Its practice definition connects professional engineering to life and health, property and economic interests, and public welfare and the

environment (*Professional Engineers Act*, RSO 1990, c P.28, s 1(1)). The thesis adds an explicit account of competent public-interest judgment where evidence shows a patterned uneven burden connected to engineering work (Cech, 2014; Professional Engineers Ontario, 2020).

The interpretive move is from professional invisibility to professional visibility (Cech, 2014; Jasanoff, 2003). A qualifying risk becomes professionally visible when the actor treats evidence about burden, access, or knowledge as relevant to engineering competence and judgment (Cech, 2014; Fricker, 2007; Jasanoff, 2003). Once the cumulative threshold test is satisfied, role-specific due care requires the actor to examine the evidence and explain the engineering connection (Engineers Canada, 2024a, 2024b; Professional Engineers Ontario, 2020). The actor then uses the response available within authority (Engineers Canada, 2024b; Adams, 2022). This interpretation preserves engineering's technical commitments while clarifying the public whose interests those commitments are legally organized to protect (Adams, 2022; Engineers Canada, 2024a).

The thesis has used technology broadly because engineered power is exercised through physical and institutional arrangements as well as digital systems (Akrich, 1992; Winner, 1980). Technology includes material artefacts and technical knowledge (Akrich, 1992; Winner, 1980). It also includes standards and classifications that stabilize how systems are built and used (Bowker & Star, 1999; Jasanoff, 2004). A landfill liner and groundwater model can distribute environmental risk (Professional Engineers Ontario, 2019). A fixture schedule and ventilation system can distribute access (National Research Council Canada, 2022). An artificial-intelligence system can distribute credibility or institutional attention (Raji *et al.*, 2020). The common concern is the way a designed arrangement allocates public-facing consequences before a dispute reaches an adjudicative or regulatory forum (Jasanoff, 2003, 2004).

The legal interpretation remains jurisdiction-specific (Engineers Canada, 2022; Adams, 2018). Professional engineering is governed through separate statutes and regulations in each province and territory (Engineers Canada, 2022). Provincial and territorial professional bodies exercise the powers assigned by those laws (Adams, 2018, 2022). Ontario supplies the principal doctrinal illustration in this thesis (*Professional Engineers Act*, RSO 1990, c P.28; RRO 1990, Reg 941). Alberta and British Columbia demonstrate how statutory language and implementation mechanisms vary by jurisdiction (*Engineering and Geoscience Professions Act*, RSA 2000, c E-11, ss 2, 10, 19; *Engineering and Geoscience Professions General Regulation*, Alta Reg 150/99, Sched 1; *Engineers and Geoscientists Regulation*, BC Reg 14/2021, s 1). A legally credible application identifies the governing professional statute before assigning a duty or institutional response (*Vavilov*, 2019 SCC 65 at paras 85–87, 108–110; Adams, 2022).

Other legal regimes supply their own protections and decisions (Adams, 2022; Scassa, 2021). Human-rights legislation establishes rights and complaint pathways, together with remedies for discrimination in the fields it governs (*Human Rights Code*, RSO 1990, c H.19, ss 1, 5–6, 34–45.2; *Moore*, 2012 SCC 61 at paras 26–29; *Fraser*, 2020 SCC 28 at paras 30–31, 47–50). Environmental statutes assign project approvals to designated public authorities (*Environmental Protection Act*, RSO 1990, c E.19, s 27). Building legislation assigns code administration to municipal officials and other authorities having jurisdiction (*Building Code Act, 1992*, SO 1992, c 23, ss 3, 8). The Crown exercises the constitutional duty to consult, while Indigenous legal orders carry their own sources of law and authority (*Haida Nation*, 2004 SCC 73 at paras 16–18, 35; Borrows, 2010; Whyte, 2020). Role-specific due care operates within this distributed setting by improving engineering inquiry and technical documentation (Engineers Canada, 2024b;

Professional Engineers Ontario, 2020). It also provides a defined escalation pathway before the assigned decision is made (Engineers Canada, 2024b; Professional Engineers Ontario, 2019, 2020).

The practical sequence I propose follows from those boundaries (Professional Engineers Ontario, 2020; Institute of Electrical and Electronics Engineers [IEEE], 2021). Chapter 2 asks whether the cumulative threshold test is satisfied and records the evidence for each criterion (Professional Engineers Ontario, 2020; Raji *et al.*, 2020). Chapter 3 identifies the actor with authority and the mechanism through which that actor can respond (Adams, 2022; Herkert, 2000). Chapter 4 applies the Public-Interest Impact Assessment (PIIA) through identify, assess, and respond (IEEE, 2021; Raji *et al.*, 2020). It then connects the selected response to verification and later review (IEEE, 2021; Raji *et al.*, 2020). My aim is a usable engineering-governance sequence that specifies what evidence to examine and who can act on it (IEEE, 2021; Professional Engineers Ontario, 2020).

5.2. The Contribution: From Professional Visibility to a Reviewable Form of Due Care

The first contribution is conceptual (Barocas & Selbst, 2016; Sheppard, 2024). Material disparate-impact risk identifies the professional-responsibility problem that the rest of the framework addresses (Barocas & Selbst, 2016; Sheppard, 2024). The term directs attention to a non-trivial negative risk and a patterned uneven burden (Barocas & Selbst, 2016; *Fraser*, 2020 SCC 28 at paras 30–31, 47–50). It also requires a connection to engineering work (*Professional Engineers Act*, RSO 1990, c P.28, s 1(1)). Its cumulative structure requires evidence available within role and an actor capable of taking a role-specific response (Engineers Canada, 2024a,

2024b; Adams, 2022). Those limits turn an equality-facing concern into a defined engineering-governance inquiry (Professional Engineers Ontario, 2020; Sheppard, 2024).

The threshold test is central to that conceptual contribution because each criterion performs different work (Engineers Canada, 2024a, 2024b; Professional Engineers Ontario, 2020). The seriousness criterion focuses professional attention on a risk that warrants a decision (Engineers Canada, 2024a; Professional Engineers Ontario, 2020). The next two criteria identify the public-facing interest and the patterned uneven burden (*Fraser*, 2020 SCC 28 at paras 30–31, 47–50; Hamraie, 2017). The engineering-connection criterion locates the risk within professional work (*Professional Engineers Act*, RSO 1990, c P.28, s 1(1)). The final two criteria identify what a competent actor could know and what response that actor can take (Engineers Canada, 2024a, 2024b; Adams, 2022). The cumulative structure makes the framework actionable when all six conditions operate together (Professional Engineers Ontario, 2020; IEEE, 2021).

Professional visibility explains why a legally available public-interest mandate may still be applied narrowly in practice (Cech, 2014; Jasanoff, 2003). Erin Cech’s account of engineering’s culture of disengagement identifies professional habits that separate technical work from public-interest consequences and narrow what counts as relevant evidence (Cech, 2014). Mirjam Fines-Neuschild and Tanja Tajmel similarly found that equality-oriented work in Canadian technical and scientific fields can become an individual responsibility in the absence of durable institutional support (Fines-Neuschild & Tajmel, 2024). The thesis responds by connecting professional visibility to assigned authority and institutional resources (Fines-Neuschild & Tajmel, 2024; Herkert, 2000). It also requires documents that can affect a decision and be reviewed afterward (IEEE, 2021; Raji *et al.*, 2020).

The second contribution is doctrinal (Sullivan, 2022; Adams, 2022). Public interest is an open-textured statutory term whose application begins with statutory text and purpose (Sullivan, 2022; *LSBC v TWU*, 2018 SCC 32 at para 34). Institutional role and the decision before the actor complete the interpretive setting (*Vavilov*, 2019 SCC 65 at paras 85–87, 108–110; Adams, 2022). In Ontario, the connection between public-interest regulation and the protected interests in the practice definition supplies the legal bridge to qualifying material disparate-impact risks (*Professional Engineers Act*, RSO 1990, c P.28, ss 1(1), 2(3)). The interpretation is grounded in competence and ethics, together with the statutory purpose of public protection (Adams, 2022; Engineers Canada, 2024a; Professional Engineers Ontario, 2020).

The Trinity Western University decisions sharpen the limits and possibilities of that argument (*LSBC v TWU*, 2018 SCC 32; *TWU v LSUC*, 2018 SCC 33). The Supreme Court of Canada accepted equality and access as considerations that professional law societies could weigh within accreditation powers assigned by statute (*LSBC v TWU*, 2018 SCC 32 at paras 34, 40–43; *TWU v LSUC*, 2018 SCC 33 at paras 20, 24, 39). The Court’s reasons also addressed diversity and public confidence within those statutory decisions (*LSBC v TWU*, 2018 SCC 32 at paras 40–43; *TWU v LSUC*, 2018 SCC 33 at para 39). The transferable proposition is that a professional regulator may use equality-informed reasoning when exercising a statutory power connected to its public-interest mandate (*LSBC v TWU*, 2018 SCC 32 at para 34; *TWU v LSUC*, 2018 SCC 33 at paras 20, 24). The engineering bridge comes from the professional-engineering statute and governing regulations (*Professional Engineers Act*, RSO 1990, c P.28; RRO 1990, Reg 941). It also depends on the engineering competence engaged by the particular decision (*Professional Engineers Act*, RSO 1990, c P.28, ss 1(1), 2(3)–(4), 7; Engineers Canada, 2024a).

The third contribution is institutional (Adams, 2022; Herkert, 2000). The actor-authority map identifies the decision that can change the risk and the actor who controls it (Adams, 2022; Herkert, 2000). It then identifies the legal or organizational source of that authority (Adams, 2022; Vavilov, 2019 SCC 65 at paras 85–87, 108–110). A regulator may establish guidance or discipline standards within statutory powers, while an employer or project lead can allocate resources and change project scope (Adams, 2022; Herkert, 2000). A public authority makes the approval or code decision assigned by law (*Environmental Protection Act*, RSO 1990, c E.19, s 27; *Building Code Act, 1992*, SO 1992, c 23, ss 3, 8). An individual engineer investigates and documents within the accepted assignment, then escalates where another actor holds the decision (RRO 1990, Reg 941, ss 72, 77; Engineers Canada, 2024b). Responsibility follows authority, and escalation connects a narrower engineering role to the institution empowered to decide (Engineers Canada, 2024b; Adams, 2022).

The fourth contribution is operational (IEEE, 2021; Raji *et al.*, 2020). The PIIA connects the threshold decision to the evidence and engineering judgment that support it (IEEE, 2021; Raji *et al.*, 2020). It then identifies an authorized response and a later review event (IEEE, 2021; Raji *et al.*, 2020). Identify defines the engineering work and the affected public (Raji *et al.*, 2020; IEEE, 2021). It also fixes the public-facing interest and the evidence available at the decision point (Raji *et al.*, 2020; IEEE, 2021). Assess traces the mechanism of the burden and states uncertainty, then compares technically available alternatives (Funtowicz & Ravetz, 1993; Professional Engineers Ontario, 2020). Respond assigns a control or verification step to the actor with authority (Engineers Canada, 2024b; IEEE, 2021). Where another actor must decide, the response identifies the warning or escalation and records any residual risk (Engineers Canada, 2024b; IEEE, 2021).

The PIIA also addresses a recurring weakness of principle-based governance: a principle can be endorsed without affecting the work (Costanza-Chock *et al.*, 2022; Raji *et al.*, 2020). The IEEE Standard 7000 model process uses traceability to connect values and requirements to system decisions across a life cycle (IEEE, 2021, cls 5.4, 7–11). Inioluwa Deborah Raji and colleagues similarly connect an internal audit to documents produced across development and to the decision that follows (Raji *et al.*, 2020, pp. 33–44). I adapt those practices to professional engineering by requiring evidence of what changed and who was authorized to change it (Professional Engineers Ontario, 2020; IEEE, 2021). The assessment also states how the response will be verified (IEEE, 2021; Raji *et al.*, 2020).

The interdisciplinary contribution lies in the translation between justice scholarship and engineering judgment, situated within professional law (Young, 1990; Hamraie, 2017; Fricker, 2007). Burden asks who carries the risk; access asks which public-facing interest can actually be used; knowledge asks what makes the risk known or reasonably knowable (Young, 1990; Hamraie, 2017; Fricker, 2007). Intersectionality operates across those questions by identifying combined structures that a single-category analysis can miss (Crenshaw, 1989, 1991; Atrey, 2019). The translation preserves disagreement and situated knowledge while giving engineering actors a sequence they can apply within role (Jasanoff, 2003; Hamraie & Fritsch, 2019).

This thesis also develops earlier work undertaken with co-authors (Liu & Matta, 2024; Liu *et al.*, 2024; Liu & Fowler, 2025). Co-author Vanessa Matta and I examined how the Trinity Western University decisions could inform equality-oriented professional obligations (Liu & Matta, 2024). This thesis narrows that argument through the professional-engineering statutes and the threshold test, then allocates action through the actor-authority map (Liu & Matta, 2024; Adams,

2022). Co-authors Andrea Atkins and Allie Kennington and I developed cultural-competence arguments for engineering education and practice (Liu *et al.*, 2024; Liu *et al.*, in press). The present framework specifies the professional visibility and decision practices that such education should support (Engineers Canada, 2024c; Liu *et al.*, 2024). Co-author Samantha Fowler and I examined engineers' role in the health infodemic, which informs the treatment of public-facing information systems as settings in which technical choices can shape access to reliable institutional knowledge (Liu & Fowler, 2025).

Taken together, the four formal contributions produce a bounded account of public-interest engineering (Adams, 2022; Engineers Canada, 2024a; IEEE, 2021). The account is conceptually specific because it uses a cumulative threshold test (Engineers Canada, 2024a, 2024b; Professional Engineers Ontario, 2020). It is doctrinally grounded in statutory text and purpose, interpreted through delegated authority (*Professional Engineers Act*, RSO 1990, c P.28, ss 1(1), 2(3); *Vavilov*, 2019 SCC 65 at paras 85–87, 108–110). It is institutionally realistic because responsibility is allocated to actors with different powers (Adams, 2022; Herkert, 2000). It is operational because the PIIA connects evidence to a decision and a consequence (IEEE, 2021; Raji *et al.*, 2020).

5.3. What the Three Recurring Examples Establish

The three recurring examples test the framework at different points on the engineering-responsibility spectrum (Professional Engineers Ontario, 2019, 2020; Engineers Canada, 2022). Site 41 places engineering evidence near the centre of a public-infrastructure dispute (Environmental Commissioner of Ontario, 2004; Professional Engineers Ontario, 2019). Public washrooms place engineering work inside a code-mediated design and facilities decision (National

Research Council Canada, 2022; City of Ottawa Building Code Services, 2021). Artificial intelligence (AI) and large language models (LLMs) place professional engineering at the integration boundary of a wider technical ecosystem (Engineers Canada, 2022; Raji *et al.*, 2020). Their combined function is to show how the same threshold and authority analysis can travel across settings (Professional Engineers Ontario, 2020; Engineers Canada, 2022). The PIIA then remains specific to the engineering work and decision-maker in each setting (Professional Engineers Ontario, 2019, 2020; IEEE, 2021).

Site 41 is the engineering-heavy example because hydrogeological investigation and groundwater modelling were central to how the proposed landfill was assessed (Environmental Commissioner of Ontario, 2004; Mushtaq, 2011, 2013). Leachate containment was also central to the technical dispute (Environmental Commissioner of Ontario, 2004; Professional Engineers Ontario, 2019). The record included dewatering and peer review, together with public access to the calibrated model and its input data (Environmental Commissioner of Ontario, 2004; Ontario (Information and Privacy Commissioner), *Order MO-2449* at 7–8). These engineering questions operated within a longer environmental-approval and political history (Environmental Commissioner of Ontario, 2004; *Environmental Protection Act*, RSO 1990, c E.19, s 27).

The framework would change the Site 41 process by making technical transparency and participation part of due care while the relevant decisions remain open (Mushtaq, 2011; Professional Engineers Ontario, 2019). The threshold-test analysis would identify the groundwater risk and affected publics, then connect them to the engineering work that shaped technical assurance (Environmental Commissioner of Ontario, 2004; Mushtaq, 2011, 2013). The actor-authority analysis would first distinguish the consultants from the municipal proponent

(Environmental Commissioner of Ontario, 2004; Mushtaq, 2011). It would then identify the powers of environmental authorities and the Community Monitoring Committee (Environmental Commissioner of Ontario, 2004; Mushtaq, 2011). The PIIA would state the model assumptions and calibration evidence (Ontario (Information and Privacy Commissioner), *Order MO-2449* at 7–8). It would record the uncertainty and questions assigned to technical review (Professional Engineers Ontario, 2019, pp. 14–15). It would also specify monitoring requirements and the escalation pathway in the document suited to each decision (Professional Engineers Ontario, 2019, pp. 14–15; IEEE, 2021).

Usman Mushtaq’s conclusion that “Consultation did not mean participation” identifies the central knowledge problem in the example (Mushtaq, 2011, p. 110). Participation in this framework means that relevant community or Indigenous knowledge can change an engineering question or a monitoring location (Jasanoff, 2003; Lambrinidou *et al.*, 2014; Whyte, 2020). It can also change the explanation of residual risk before the decision is closed (Jasanoff, 2003; Whyte, 2020). Professional engineering contributes candid modelling and accessible technical records (Professional Engineers Ontario, 2019). It also contributes escalation of unresolved uncertainty (Engineers Canada, 2024b). Environmental approval remains with the designated public authority, while Indigenous jurisdiction rests in Indigenous legal orders and the applicable constitutional framework (*Environmental Protection Act*, RSO 1990, c E.19, s 27; Borrows, 2010; *Haida Nation*, 2004 SCC 73 at paras 16–18, 35).

Public washrooms are the ordinary code-mediated example because familiar infrastructure can allocate access through fixture calculations and travel routes (Anthony & Dufresne, 2007; Cavanagh, 2010). Privacy and maintenance conditions also shape whether a facility can be used

in practice (City of Vancouver, 2024; Harwood-Jones *et al.*, 2023). Plumbing and mechanical work can determine capacity and ventilation (National Research Council Canada, 2022). Accessibility coordination can determine whether an available facility is practically usable (CSA Group & Accessibility Standards Canada, 2023; Hamraie, 2017). Owners select the facility program, and the authority having jurisdiction decides code compliance under the applicable statute (*Building Code Act, 1992*, SO 1992, c 23, ss 3, 8; City of Ottawa Building Code Services, 2021).

The framework would change a washroom decision by requiring the engineering actor to make equivalent access visible as a technical and public-interest question (Hamraie, 2017; National Research Council Canada, 2022). Aimi Hamraie describes disabled people as “experts about their bodies and surrounding environments,” which explains why use experience adds evidence beyond aggregate fixture counts and drawings (Hamraie, 2017, p. 113). The PIIA would examine location and route as one connected condition (Hamraie, 2017; Harwood-Jones *et al.*, 2023). It would then assess capacity and timing, together with privacy and usability (City of Vancouver, 2024; Hamraie, 2017). Operation and maintenance evidence would provide the basis for later design or facilities responses (City of Vancouver, 2024; Professional Engineers Ontario, 2020).

The legal floor and professional response perform different work in this example (*Human Rights Code*, RSO 1990, c H.19, s 1; Professional Engineers Ontario, 2020). Ontario human-rights law protects access to services and facilities, while Ontario Human Rights Commission guidance connects washroom access to dignity and lived gender identity (*Human Rights Code*, RSO 1990, c H.19, s 1; Ontario Human Rights Commission, 2014, s 13.4.1). Building-code materials explain how fixture requirements can be satisfied through gender-inclusive arrangements where the applicable code and authority permit that design (National Research Council Canada, 2022; City

of Ottawa Building Code Services, 2021). Mélançon Marceau Grenier Cohen s.e.n.c. (the Mélançon firm) provides a practice-facing Quebec example of that interpretive work (Mélançon Marceau Grenier Cohen s.e.n.c., 2025). Engineering due care supplies the earlier technical comparison and documentation used by the owner and code authority (Professional Engineers Ontario, 2020; Mélançon Marceau Grenier Cohen s.e.n.c., 2025).

AI and LLM systems are the boundary example because much software development occurs outside licensed professional engineering, while defined integration and validation work may fall within professional practice depending on the jurisdiction (Engineers Canada, 2022; Professional Engineers Ontario, n.d.). Safety-critical software work can also engage professional engineering where the statutory practice definition is satisfied (Engineers Canada, 2022; Professional Engineers Ontario, n.d.). The framework begins with the system boundary and intended use because those facts identify the engineering work under review (Engineers Canada, 2022; IEEE, 2021). Professional responsibility becomes relevant when an engineer designs or integrates an AI-enabled system in a way that significantly shapes a public-facing risk (Engineers Canada, 2022; Raji *et al.*, 2020). Validation, procurement, or monitoring can create the same professional connection where those tasks are accepted within role (Engineers Canada, 2022; IEEE, 2021).

The AI example also shows why a general statement that a model is biased gives too little professional guidance (Blodgett *et al.*, 2020; Raji *et al.*, 2020). Abubakar Abid, Maheen Farooqi, and James Zou identified a specific pattern in which Generative Pre-trained Transformer 3 (GPT-3) associated Muslims with violence, providing technical evidence that can be linked to a particular public-facing use (Abid *et al.*, 2021). Emily Bender and colleagues explain how large training

corpora can reproduce dominant patterns while obscuring the conditions under which those patterns were produced (Bender *et al.*, 2021). The threshold test asks whether the measured pattern is connected to an engineering use and a public-facing interest (Engineers Canada, 2022; Blodgett *et al.*, 2020). It then identifies an actor with authority to respond (Raji *et al.*, 2020; IEEE, 2021).

The PIIA would change an AI-enabled engineering use by fixing the intended use and model version before deployment (IEEE, 2021; Raji *et al.*, 2020). It would also record the data source and evaluation method (Raji *et al.*, 2020; IEEE, 2021). A separate part of the assessment would define the human-review pathway (Parasuraman & Manzey, 2010; IEEE, 2021). Raji and colleagues warn that emergent issues can become “difficult or impossible to trace back” after deployment when the development record is weak (Raji *et al.*, 2020, p. 33). Traceability and change control therefore become part of role-specific due care where an engineering actor controls integration or acceptance (IEEE, 2021; Engineers Canada, 2022). Revalidation applies when a later change may affect the accepted use (IEEE, 2021; Raji *et al.*, 2020). Procurement conditions and post-deployment monitoring extend that responsibility where another organization supplies the model (Treasury Board of Canada Secretariat, 2023, 2025; Office of the Privacy Commissioner of Canada *et al.*, 2023).

Wider AI governance is distributed across public administration and privacy law, together with human-rights protections (Scassa, 2021, 2024; Office of the Privacy Commissioner of Canada *et al.*, 2023). Procurement and sector-specific law provide further governance mechanisms (Treasury Board of Canada Secretariat, 2023, 2025; Scassa, 2021). Teresa Scassa’s analysis of Canada’s federal automated-decision framework demonstrates that accountability depends on the

administrative institution and legal decision in which automation is used (Scassa, 2021). Jena McGill and Amy Salyzyn similarly show that analytical technologies shape institutional practices and affect the stakeholders who encounter them (McGill & Salyzyn, 2021). Professional engineering law contributes where licensed practice and engineering authority are present, while the other institutions exercise their assigned powers over the wider system (Engineers Canada, 2022; Scassa, 2021).

Across the three examples, material disparate-impact risk enters engineering through three recurring pathways: exposure, access, and knowledge (Jasanoff, 2003; Hamraie, 2017; Fricker, 2007). Site 41 emphasizes exposure to environmental risk and access to the technical basis for assurance (Environmental Commissioner of Ontario, 2004; Ontario (Information and Privacy Commissioner), *Order MO-2449*). Washrooms emphasize equivalent access to an ordinary public facility (Hamraie, 2017; Ontario Human Rights Commission, 2014). AI and LLM systems emphasize representational risk and institutional reliance, together with contestability of a technical output (Abid *et al.*, 2021; Raji *et al.*, 2020). The shared result is that technical adequacy and public-facing consequence are examined together when all six threshold criteria are met (Professional Engineers Ontario, 2020; Engineers Canada, 2024a).

The examples also establish that engineering responsibility is consequential and role-bounded (Adams, 2022; Engineers Canada, 2024b). An engineer may change the quality of a model or the feasibility analysis for a washroom (Professional Engineers Ontario, 2019, 2020). An engineer may also change the terms under which an AI system is integrated (Engineers Canada, 2022). Final approval or policy authority may rest with an environmental authority, an owner, or another public institution (*Environmental Protection Act*, RSO 1990, c E.19, s 27; *Building Code*

Act, 1992, SO 1992, c 23, ss 3, 8; Scassa, 2021). The framework makes the engineering contribution candid and reviewable, then connects it to the actor who decides next (Engineers Canada, 2024b; IEEE, 2021).

5.4. A Practical Roadmap for Application

The framework is intended for a decision point at which an engineering choice can still change (Professional Engineers Ontario, 2020; IEEE, 2021). A project condition or system configuration may provide the same opportunity for a role-specific response (Raji *et al.*, 2020; IEEE, 2021). The initiating event may be a design review, a peer-review comment, or a validation result (Professional Engineers Ontario, 2020; Raji *et al.*, 2020). A complaint pattern or monitoring result can create a later need for review (Professional Engineers Ontario, 2019; Law Commission of Ontario & Ontario Human Rights Commission, 2024). A material system change can do the same after initial acceptance (IEEE, 2021). The first practical task is to date the decision and identify the engineering work that remains open (Professional Engineers Ontario, 2020; IEEE, 2021).

The actor then applies the cumulative threshold test in the order developed in Chapter 2 (Engineers Canada, 2024a, 2024b; Professional Engineers Ontario, 2020). The written threshold-test analysis states why the risk is more than remote or minor and identifies the public-facing interest that may be impaired (Engineers Canada, 2024a; Professional Engineers Ontario, 2020). It identifies the patterned uneven burden and the engineering work that creates or significantly shapes it (*Fraser*, 2020 SCC 28 at paras 30–31, 47–50; *Professional Engineers Act*, RSO 1990, c P.28, s 1(1)). It then states what evidence made the risk known or reasonably knowable (Engineers

Canada, 2024a, 2024b). The final step names the actor capable of a role-specific response (Adams, 2022; Herkert, 2000).

The evidence inventory should distinguish technical evidence, affected-public knowledge, and prior incidents because each can reveal a different part of the risk (Professional Engineers Ontario, 2020; Hamraie, 2017; Raji *et al.*, 2020). Standards and complaints provide a second evidentiary route when they make a recurring burden visible before it appears in aggregate performance data (Ontario Human Rights Commission, 2014; Engineers Canada, 2024a). Legal guidance can provide the same notice where it identifies an established barrier or institutional duty (Law Commission of Ontario & Ontario Human Rights Commission, 2024; Ontario Human Rights Commission, 2014). The actor should state the source and date of the evidence, then identify its limits (Funtowicz & Ravetz, 1993; IEEE, 2021). This treatment preserves uncertainty as part of the engineering conclusion (Funtowicz & Ravetz, 1993; Jasanoff, 2003).

When all six criteria are supported, the actor-authority analysis identifies who controls the next consequential decision (Adams, 2022; Herkert, 2000). The analysis first names the statute or contract that supplies authority (Adams, 2022; Herkert, 2000). It then identifies any policy or organizational assignment that allocates the decision within the institution (*Vavilov*, 2019 SCC 65 at paras 85–87, 108–110; Herkert, 2000). The analysis distinguishes the person who prepares the technical work from the person who may accept residual risk or authorize implementation (IEEE, 2021; Raji *et al.*, 2020). Where final authority rests elsewhere, the engineering response becomes a documented warning, recommendation, or escalation addressed to the actor who can decide (Engineers Canada, 2024b; Professional Engineers Ontario, 2020).

The Public-Interest Impact Assessment begins after the threshold and authority steps are complete (IEEE, 2021; Raji *et al.*, 2020). Identify defines the engineering decision and affected public (Raji *et al.*, 2020; IEEE, 2021). It also fixes the system boundary and available evidence (Raji *et al.*, 2020; IEEE, 2021). The stage states the intended use or project function in concrete terms, which keeps the assessment tied to what the system or facility will actually do (Raji *et al.*, 2020, pp. 36–37; IEEE, 2021). A clear scope lets a later reviewer distinguish the uses that were assessed from uses introduced after acceptance (IEEE, 2021; Treasury Board of Canada Secretariat, 2023).

Assess traces how the engineering work may produce the burden and states the uncertainty that matters to the decision (Professional Engineers Ontario, 2020; Funtowicz & Ravetz, 1993). The analysis connects an input or assumption to the affected public and public-facing interest (Akrich, 1992; Bowker & Star, 1999). It separately examines the relevant interface or operating condition (Professional Engineers Ontario, 2020; IEEE, 2021). The assessment compares technically feasible alternatives and identifies what evidence would change the conclusion (Professional Engineers Ontario, 2020; IEEE, 2021). Where knowledge remains contested, it records the disagreement and the basis on which the actor proceeds (Funtowicz & Ravetz, 1993; Jasanoff, 2003).

Respond assigns a concrete action to an actor with authority (Engineers Canada, 2024b; IEEE, 2021). The action may be a design change, a verification requirement, or a defined operating limit (Professional Engineers Ontario, 2020; IEEE, 2021). Warning or escalation carries the issue to another decision-maker where the engineering actor controls the analysis and another actor controls the outcome (Engineers Canada, 2024b; Adams, 2022). The response identifies who

accepts any residual risk and what information that person received before acceptance (Costanza-Chock *et al.*, 2022; IEEE, 2021).

The framework uses existing project documents wherever they can carry the required reasoning (Professional Engineers Ontario, 2020; IEEE, 2021). A design-review memorandum can record a facility decision, a model-review note can record a hydrogeological disagreement, and a validation report can record an AI system’s accepted use (Professional Engineers Ontario, 2020; Raji *et al.*, 2020; IEEE, 2021). Each document should identify the evidence reviewed and the uncertainty that remains (Professional Engineers Ontario, 2020; IEEE, 2021). It should also state the response assigned to a named actor (Professional Engineers Ontario, 2020; IEEE, 2021). This specificity identifies the particular document that the project and decision require (Professional Engineers Ontario, 2020; Raji *et al.*, 2020).

Verification and monitoring complete the initial response (Professional Engineers Ontario, 2019; IEEE, 2021). A control is verified against a stated performance basis, such as a groundwater action threshold, an equivalent-access requirement, or a subgroup evaluation (Professional Engineers Ontario, 2019; National Research Council Canada, 2022; Raji *et al.*, 2020). Monitoring then tests whether the accepted conditions continue during operation (Professional Engineers Ontario, 2019; IEEE, 2021). A defined review event reopens the PIIA when a material assumption or system version changes (IEEE, 2021; Raji *et al.*, 2020). A new use condition or evidence base also reopens the assessment (IEEE, 2021; Raji *et al.*, 2020).

The process changes a decision when the evidence reaches an actor who can act and the institution supplies time and expertise (Herkert, 2000; IEEE, 2021). Access to the necessary information is equally important (IEEE, 2021; Raji *et al.*, 2020). Raji and colleagues caution that

a checklist can become “box-ticking” when it records completion without revealing the judgment behind the answer (Raji *et al.*, 2020, p. 36). The PIIA therefore requires an explanation of the mechanism and evidence (Raji *et al.*, 2020; IEEE, 2021). It must also state the uncertainty and consequence of the decision (Raji *et al.*, 2020; IEEE, 2021). Completion means that the selected response has been implemented or that a named decision-maker has accepted the remaining risk on a stated basis (Costanza-Chock *et al.*, 2022; Professional Engineers Ontario, 2020).

A practitioner should be able to answer the following questions at the end of the sequence (Professional Engineers Ontario, 2020; IEEE, 2021):

- What engineering work and decision were assessed?
- Which material disparate-impact risk and affected public satisfied the cumulative threshold test?
- What evidence made the risk known or reasonably knowable, and what uncertainty remains?
- Which actor had authority, and what response did that actor select or receive through escalation?
- What changed, who accepted any residual risk, and what event will reopen the assessment?

Those questions provide the practical bridge from public-interest language to reviewable professional conduct (Professional Engineers Ontario, 2020; IEEE, 2021). A supervisor, client, or regulator can reconstruct the basis for the engineering decision (Professional Engineers Ontario, 2020; IEEE, 2021). A public authority or later reviewer can do the same (Professional Engineers

Ontario, 2020; IEEE, 2021). The questions also identify where the concern moved after the engineering actor reached the limit of their authority (Engineers Canada, 2024b; Adams, 2022).

Regulators can support the sequence through guidance and competence expectations authorized by their statutes (Adams, 2022; *Professional Engineers Act*, RSO 1990, c P.28, ss 2(3)–(4), 7). Practice review and discipline concepts can provide further implementation mechanisms where the statute authorizes them (*Professional Engineers Act*, RSO 1990, c P.28, ss 7, 28; Adams, 2022). Regulatory materials can require engineers to identify the engineering work and cite the evidence (Engineers Canada, 2024a, 2024b; Professional Engineers Ontario, 2020). They can also require an explanation of escalation, while the assigned project actor retains the substantive decision (Engineers Canada, 2024b; Adams, 2022). Reasons for a regulatory requirement should connect the mechanism to public protection and the governing legal scheme (*Vavilov*, 2019 SCC 65 at paras 85–87, 108–110; Adams, 2022).

Employers and project leads can make the PIIA effective by assigning ownership and budget at defined project gates (Herkert, 2000; Bielefeldt, 2018). They can also provide access to the information required for assessment (IEEE, 2021; Raji *et al.*, 2020). Procurement documents can require model documentation and evaluation evidence before a supplier’s system is integrated (Treasury Board of Canada Secretariat, 2023, 2025). They can also require notice of material changes after acceptance (Office of the Privacy Commissioner of Canada *et al.*, 2023; IEEE, 2021). Project governance can protect the time needed for peer review or affected-public engagement when the threshold test identifies a material risk (Jasanoff, 2003; IEEE, 2021).

Public authorities and standards bodies shape the environment in which engineering actors work (Sullivan, 2022; IEEE, 2021). An environmental authority can require monitoring or

technical information through powers assigned by environmental legislation (*Environmental Protection Act*, RSO 1990, c E.19, s 27; Environmental Commissioner of Ontario, 2004). A building authority can interpret and administer code requirements under the applicable statute (*Building Code Act, 1992*, SO 1992, c 23, ss 3, 8). Standards bodies can make values and evidence requirements visible through design processes (IEEE, 2021). A standard gains legal or contractual effect through adoption, contract, or another authorizing mechanism (IEEE, 2021; Sullivan, 2022).

Educators and accreditation bodies can develop the professional visibility required to use the framework (Engineers Canada, 2024c; Kirkscey *et al.*, 2023). The Canadian Engineering Accreditation Board (CEAB) can evaluate programs against accreditation criteria, while universities control curriculum and assessment within applicable law (Engineers Canada, 2024c). Co-authors Andrea Atkins and Allie Kennington and I have argued that cultural competence can be taught as a practice of contextual understanding (Liu *et al.*, 2024; Liu *et al.*, in press). The PIIA gives that educational work a practical target (Engineers Canada, 2024c; IEEE, 2021). Students should be able to identify evidence of a patterned uneven burden and locate the actor with authority (Engineers Canada, 2024c; Kirkscey *et al.*, 2023). They should also be able to document a technically credible response (Engineers Canada, 2024c; Kirkscey *et al.*, 2023).

Individual engineers use the framework through the work they accept and the authority they actually hold (Engineers Canada, 2024a, 2024b; Professional Engineers Ontario, 2020). Competence requires recognizing limits and obtaining qualified assistance when the issue exceeds the actor's expertise (Engineers Canada, 2024a; Professional Engineers Ontario, 2020). Candour requires stating assumptions and uncertainty in the technical document suited to the decision (Professional Engineers Ontario, 2020; IEEE, 2021). The document should also identify unresolved

disagreement where it affects the conclusion (Funtowicz & Ravetz, 1993; Professional Engineers Ontario, 2020). The duty to report or escalate carries a material concern to the person or institution capable of acting when the engineer lacks implementation authority (Engineers Canada, 2024b; RRO 1990, Reg 941, ss 72, 77).

5.5. Conditions, Limits, and Future Research

The limits of the framework are part of its legal and professional credibility (Adams, 2022; Engineers Canada, 2022). Professional engineering law governs licensed practice through powers assigned by provincial and territorial legislation (Adams, 2016, 2018, 2022; Engineers Canada, 2022). Human-rights law and environmental law assign decisions and remedies to their own institutions (*Human Rights Code*, RSO 1990, c H.19; *Environmental Protection Act*, RSO 1990, c E.19). Building legislation supplies a separate decision structure (*Building Code Act, 1992*, SO 1992, c 23). Privacy and procurement law provide further governance mechanisms for information systems, while administrative law structures exercises of public power (Scassa, 2021; Treasury Board of Canada Secretariat, 2025; *Vavilov*, 2019 SCC 65). The PIIA strengthens the engineering contribution within that system by making evidence and judgment reviewable (Professional Engineers Ontario, 2020; IEEE, 2021). It also makes the escalation pathway visible (Professional Engineers Ontario, 2020; IEEE, 2021).

Jurisdictional variation will shape implementation (Engineers Canada, 2022; Adams, 2018). Alberta illustrates why an actor must identify the professional statute and regulations in force at the date of the decision (*Engineering and Geoscience Professions Act*, RSA 2000, c E-11, ss 2, 10, 19; *Engineering and Geoscience Professions General Regulation*, Alta Reg 150/99, Sched

1). Its enacted transition legislation and neutrality legislation also demonstrate that available regulatory mechanisms can change through legislative choice (Government of Alberta, 2025, 2026; *Professional Governance Act*, SA 2025, c P-25.5; *Regulated Professions Neutrality Act*, SA 2025, c R-13.3). Alberta implementation must identify the current statutory power and use a mechanism permitted by that law (Government of Alberta, 2025, 2026; *Vavilov*, 2019 SCC 65 at paras 85–87, 108–110). The same discipline applies in every province and territory (Engineers Canada, 2022; Adams, 2018).

Organizational power and resources are a second condition (Herkert, 2000; Fines-Neuschild & Tajmel, 2024). A junior engineer may recognize a risk and have authority only to document and escalate it, while a project lead can authorize further analysis or revise scope (Engineers Canada, 2024b; Herkert, 2000). A private employer may control information and budget that determine whether the assessment can proceed (Herkert, 2000; Bielefeldt, 2018). The actor-authority map therefore identifies both the person who sees the risk and the institution that can supply the resources or consequence required for action (Adams, 2022; Fines-Neuschild & Tajmel, 2024).

Uncertainty is a third condition and a reason to state the basis for action carefully (Funtowicz & Ravetz, 1993; Jasanoff, 2003). Silvio Funtowicz and Jerome Ravetz describe settings in which “facts are uncertain, values in dispute, stakes high and decisions urgent” (Funtowicz & Ravetz, 1993, p. 744). The PIIA distinguishes measured evidence from professional judgment (Funtowicz & Ravetz, 1993; IEEE, 2021). It also states the remaining boundary of ignorance (Funtowicz & Ravetz, 1993; Jasanoff, 2003). The assessment identifies what additional evidence

would change the decision and who can authorize its collection (Professional Engineers Ontario, 2020; Jasanoff, 2003).

Affected-public knowledge is a fourth condition for sound inquiry (Fricker, 2017; Hamraie, 2017). Miranda Fricker describes epistemic injustice as a wrong to someone “in their capacity as an epistemic subject” (Fricker, 2017, p. 53). In engineering governance, that insight requires attention to whether a user’s account, a community observation, or an Indigenous relationship to land and water is treated as evidence relevant to the system (Hamraie, 2017; Lambrinidou *et al.*, 2014; Whyte, 2020). The PIIA records how that evidence changed the engineering question or explains why it was assigned to another legal or institutional process (Jasanoff, 2003; Engineers Canada, 2024b).

Audit culture creates a fifth condition (Costanza-Chock *et al.*, 2022; Raji *et al.*, 2020). A completed form can demonstrate administrative compliance while leaving the underlying decision unchanged (Costanza-Chock *et al.*, 2022; Raji *et al.*, 2020). The framework therefore links each material issue to a named owner and a response (IEEE, 2021; Raji *et al.*, 2020). It also assigns a verification method (IEEE, 2021; Raji *et al.*, 2020). Independent review and affected-public participation can show whether the process altered the work (Costanza-Chock *et al.*, 2022; Jasanoff, 2003). Later monitoring supplies a further test of implementation (Professional Engineers Ontario, 2019; IEEE, 2021).

Confidentiality and proprietary information require structured access (Ontario (Information and Privacy Commissioner), *Order MO-2449*; IEEE, 2021). A disclosure plan should identify the audience and legal basis for review (Ontario (Information and Privacy Commissioner), *Order MO-2449* at 7–8; IEEE, 2021, cl 11). It should then identify the technical information

needed for meaningful scrutiny (IEEE, 2021; Raji *et al.*, 2020). Secure review and redaction may protect legitimate interests while preserving contestability (Office of the Privacy Commissioner of Canada *et al.*, 2023). A technically adequate summary can serve the same function where the legal setting permits it (Raji *et al.*, 2020; IEEE, 2021). The engineering actor should document the information withheld and the reason for withholding it (Professional Engineers Ontario, 2020). The assessment should also state how that limit affects confidence in the conclusion (IEEE, 2021).

The present contribution is doctrinal and conceptual, with a further contribution in process design (Adams, 2022; IEEE, 2021). Its next phase is empirical evaluation of how the PIIA changes engineering decisions and organizational costs (IEEE, 2021; Raji *et al.*, 2020). Outcomes across different settings also require study (Costanza-Chock *et al.*, 2022). Pilot studies should compare a short-form assessment for a narrow issue with a full assessment for contested evidence or distributed authority (Professional Engineers Ontario, 2020; IEEE, 2021). Evaluation should examine whether the process changes project requirements and disclosure (Costanza-Chock *et al.*, 2022; Raji *et al.*, 2020). It should also examine monitoring and escalation, together with residual-risk acceptance (Costanza-Chock *et al.*, 2022; IEEE, 2021).

Site-specific pilots could test the framework in solid-waste and water work, as well as other public infrastructure (Professional Engineers Ontario, 2019; IEEE, 2021). The research should examine whether affected-public evidence changes model assumptions or peer-review questions (Professional Engineers Ontario, 2019; Lambrinidou *et al.*, 2014). It should also examine changes to monitoring design (Professional Engineers Ontario, 2019; Jasanoff, 2003). A companion study could assess the time and expertise required to provide technical transparency under contractual or statutory constraints (Ontario (Information and Privacy Commissioner), *Order MO-2449*;

IEEE, 2021). These studies would identify documentation practices that improve public-interest judgment (Costanza-Chock *et al.*, 2022; Professional Engineers Ontario, 2020).

Built-environment pilots could examine renovation and facilities decisions where code compliance interacts with accessibility (National Research Council Canada, 2022; Hamraie, 2017). Institutional policy provides a third part of that decision setting (City of Vancouver, 2024). Researchers could compare fixture capacity and travel distance before and after the PIIA is used (National Research Council Canada, 2022; City of Vancouver, 2024). Privacy could be assessed through a separate design measure (City of Vancouver, 2024; Harwood-Jones *et al.*, 2023). Post-occupancy evidence could test whether the selected arrangement provides equivalent access in practice (Hamraie, 2017; Harwood-Jones *et al.*, 2023). The findings could inform municipal guidance and owner standards, as well as engineering education (City of Ottawa Building Code Services, 2021; Engineers Canada, 2024c).

AI and software pilots should focus on defined engineering uses (Engineers Canada, 2022; IEEE, 2021). A pilot could examine maintenance-report summarization or safety-related triage (Engineers Canada, 2022; Raji *et al.*, 2020). Another use would be appropriate where an engineering organization controls integration and human review (Engineers Canada, 2022; IEEE, 2021). The evaluation should track model version and intended use (IEEE, 2021; Raji *et al.*, 2020). It should separately examine subgroup performance and override behaviour (Abid *et al.*, 2021; Parasuraman & Manzey, 2010). Revalidation should follow a change that can affect the accepted use (IEEE, 2021). Comparative research should examine how privacy and public-administration institutions govern the same system (Scassa, 2021, 2024). Sector regulators may supply a further governing mechanism (Office of the Privacy Commissioner of Canada *et al.*, 2023; Scassa, 2021).

A national legal study should map public-interest language and statutory practice definitions across every province and territory (Adams, 2018; Engineers Canada, 2022). It should also map professional codes and discipline mechanisms (Adams, 2016, 2022; Casey, 2025). The study should examine how regulators explain public protection in guidance and reasons (Adams, 2022; Casey, 2025). It should then examine how courts review those exercises of delegated power (*Vavilov*, 2019 SCC 65 at paras 85–87, 108–110). The comparison should identify provisions addressing the environment or accessibility (Engineers Canada, 2012, 2024a). It should separately identify provisions that address software or public welfare (Engineers Canada, 2022, 2024a). Such work would test how far the thesis’s Ontario-centred doctrinal illustration travels across Canada (Adams, 2018; Engineers Canada, 2022).

Education research should test whether students can recognize material disparate-impact risk as part of engineering judgment (Cech, 2014; Kirkscey *et al.*, 2023). Longitudinal studies could examine whether repeated use of the threshold test and PIIA changes what students identify as technical evidence (Cech, 2014; Kirkscey *et al.*, 2023). The same studies could examine changes in students’ accounts of professional responsibility (Cech, 2014; Engineers Canada, 2024c). Co-author William Gagnon and I previously examined climate competence with our research team across accredited civil-engineering curricula (Gagnon *et al.*, 2023). That method could be adapted to public-interest competencies across programs (Gagnon *et al.*, 2023; Engineers Canada, 2024c). Research should also examine how employers reinforce or weaken those competencies after graduation (Cech, 2014; Fines-Neuschild & Tajmel, 2024).

Research with affected publics should be designed through the authority and knowledge practices of the communities involved (Hamraie, 2017; Whyte, 2020). Disability scholarship

supports treating lived experience as design knowledge at the point when requirements and evidence are formed (Hamraie, 2017; Hamraie & Fritsch, 2019). Indigenous legal scholarship requires attention to Indigenous law and jurisdiction, together with relational responsibility (Borrows, 2010; Anker, 2016; Whyte, 2020). Future PIIA research should establish governance and data stewardship with the affected community before evidence is collected (Jasanoff, 2003; Whyte, 2020). It should also establish the community’s decision rights in the research process (Whyte, 2020; Borrows, 2010).

The research agenda should also examine institutional incentives (Herkert, 2000; Bielefeldt, 2018). Cost and schedule can determine whether an organization gives the PIIA time and attention (Herkert, 2000; Bielefeldt, 2018). Liability and procurement conditions can affect the same institutional choice (Herkert, 2000; Treasury Board of Canada Secretariat, 2025). Studies should compare projects in which a regulator or public authority expressly requires the process (Adams, 2022; Treasury Board of Canada Secretariat, 2025). They should also examine projects in which a client or employer adopts it through contract or policy (Herkert, 2000; IEEE, 2021). The central empirical question is whether clear authority and consequence make public-interest analysis durable within ordinary project practice (Fines-Neuschild & Tajmel, 2024; IEEE, 2021).

5.6. Final Reflections: Technological Accountability with Limits

The goal of this thesis is to contribute to **technological accountability** by bringing the threshold test, actor-authority map, and Public-Interest Impact Assessment into one sequence (Jasanoff, 2003; IEEE, 2021). In the account I advance, technological accountability would make technical choices traceable to evidence and reasons (Jasanoff, 2003; Raji *et al.*, 2020). It would

also connect institutional authority to a named decision-maker and a mechanism for correction (IEEE, 2021; Adams, 2022). The term applies to a groundwater model, a washroom design, and an artificial-intelligence-enabled information system because each can stabilize a public-facing distribution of risk or access (Professional Engineers Ontario, 2019; National Research Council Canada, 2022; Scassa, 2021). The limits identify the part of that accountability assigned to professional engineering and the part assigned to other legal institutions (Adams, 2022; Engineers Canada, 2022).

The resulting position is modest in legal reach and demanding in professional practice (Adams, 2022; Engineers Canada, 2024a). Its legal reach is tied to the statute and assignment that govern the work (*Vavilov*, 2019 SCC 65 at paras 85–87, 108–110; Adams, 2022). It is also tied to the actor’s actual authority (Adams, 2022; Herkert, 2000). Its professional demands require a competent actor to explain what evidence was available and whose burden was examined (Engineers Canada, 2024a, 2024b; Professional Engineers Ontario, 2020). The actor must also explain what response followed (IEEE, 2021; Raji *et al.*, 2020). The framework therefore measures public-interest professionalism through the quality of inquiry and the consequence of the decision (IEEE, 2021; Raji *et al.*, 2020).

Professional humility is central to this account (Haraway, 1988; Jasanoff, 2003). Situated-knowledge scholarship explains that technical judgment is produced from a position with particular access and limits (Haraway, 1988). Science and technology studies also shows that institutions shape which evidence becomes authoritative (Jasanoff, 2003, 2004). Affected-public knowledge can reveal use conditions or exposure pathways that a conventional technical record has not captured (Hamraie, 2017; Lambrinidou *et al.*, 2014). It can also reveal institutional barriers

(Hamraie, 2017; Fricker, 2007). Humility therefore appears as a professional practice of stating uncertainty and seeking relevant knowledge (Funtowicz & Ravetz, 1993; Engineers Canada, 2024b). It also requires escalation when the decision exceeds one’s authority (Engineers Canada, 2024b; Adams, 2022).

The contribution I seek is a practical way to change the work that follows from the public-interest mandate (Professional Engineers Ontario, 2020; IEEE, 2021). Under the proposed framework, a material disparate-impact risk would enter engineering judgment when the cumulative threshold test is supported by evidence (Engineers Canada, 2024a, 2024b; Professional Engineers Ontario, 2020). The actor-authority map would then place the issue with the person or institution capable of changing the relevant decision (Adams, 2022; Herkert, 2000). The PIIA would make the reasoning and selected response available for review (IEEE, 2021; Raji *et al.*, 2020). It would also identify verification and the actor who accepts any residual risk (IEEE, 2021; Costanza-Chock *et al.*, 2022).

My intention has been to make that sequence usable and defensible. Site 41 shows how engineering due care can improve model transparency and monitoring in a public-infrastructure dispute (Environmental Commissioner of Ontario, 2004; Ontario (Information and Privacy Commissioner), *Order MO-2449*; Professional Engineers Ontario, 2019). It also shows why unresolved uncertainty requires an escalation pathway (Engineers Canada, 2024b; Mushtaq, 2011). Public washrooms show how code interpretation and mechanical or plumbing work can support equivalent access in an ordinary facility decision (National Research Council Canada, 2022; Hamraie, 2017). AI and LLM systems show how integration and validation can carry role-specific responsibility at the edge of licensed practice (Engineers Canada, 2022; Raji *et al.*, 2020).

Procurement and human review extend that responsibility across the accepted use (Treasury Board of Canada Secretariat, 2023; IEEE, 2021).

The framework is intended to help an engineering actor give practical effect to the public-interest mandate by showing how evidence about burden, access, and knowledge should change a decision within authority (Professional Engineers Ontario, 2020; Engineers Canada, 2024b; IEEE, 2021). The hoped-for contribution is technological accountability with limits: role-specific due care that makes affected publics visible before patterned uneven burdens become ordinary features of engineered systems (Cech, 2014; Jasanoff, 2003; Hamraie, 2017).

Glossary of Terms

These entries state how recurring legal, engineering, and socio-technical terms are used in this thesis. They supplement the explanations given when terms first appear in the chapters. Entries are alphabetized by the full term, with acronyms in parentheses. A usage note or cross-reference is included where it helps distinguish closely related concepts.

Accessibility. The practical ability to use a built, digital, or service environment under conditions that account for different bodies, senses, and ways of interacting (Hamraie, 2017; Hamraie & Fritsch, 2019). In this thesis, accessibility is an anticipatory design and governance question informed by disabled people’s knowledge of the environments they use (Hamraie, 2017). *See also:* Equivalent access.

Actor-authority map. A thesis tool that identifies the actor whose decision matters, the legal or organizational source of that actor’s authority, and the response available within that authority (Adams, 2022; *Vavilov*, 2019 SCC 65 at paras 85-87, 108-110). The map keeps technical contribution and final decision-making attached to the institutions that hold them (Herkert, 2000; *Vavilov*, 2019 SCC 65 at paras 108-110).

Adverse-effect discrimination. Canadian equality and human-rights doctrine recognizing that a requirement can create discrimination through its effects even when its wording is neutral (*Simpsons-Sears*, [1985] 2 SCR 536 at 551-52; *Meiorin*, [1999] 3 SCR 3 at paras 38, 54; *Fraser*, 2020 SCC 28 at paras 30-31, 47-50). Usage in this thesis: adverse-effect discrimination is the doctrinal term, while patterned uneven burden is the operational criterion used outside doctrinal analysis (Sheppard, 2024). See also: Patterned uneven burden.

Affected public. People or communities whose exposure to risk, access to a system, or ability to challenge a technical decision may be shaped by engineering work (Jasanoff, 2003; Hamraie, 2017; Raji *et al.*, 2020). The term includes people who do not purchase or contract for the work but experience its public-facing effects (Professional Engineers Ontario, 2019; IEEE, 2021).

Affected-public knowledge. Evidence produced through living with, using, or being exposed to a system (Fricker, 2007; Hamraie, 2017). It may include locally grounded observations, recurring incidents, and knowledge of barriers that conventional technical metrics have not yet captured (Fricker, 2007; Hamraie, 2017; Lambrinidou *et al.*, 2014).

Artificial intelligence (AI). An umbrella term for computational systems that perform tasks involving prediction, classification, or language generation (Bommasani *et al.*, 2021; Scassa, 2021). The professional engineering analysis identifies the particular work, the system's use, and the province or territory whose professional-engineering law applies (Engineers Canada, 2022).

Authority having jurisdiction. The building official or public body legally assigned to administer and interpret a building code for a project (*Building Code Act, 1992*, SO 1992, c 23, ss 3, 8). The authority’s statutory mandate determines the code decision it can make (*Vavilov*, 2019 SCC 65 at paras 85-87, 108-110).

Automation bias. The tendency to accept an automated recommendation despite conflicting evidence or an available reason to verify it (Parasuraman & Manzey, 2010). In the PIIA, human-review design preserves a practical ability to question and override the system (Parasuraman & Manzey, 2010; IEEE, 2021).

Calibration. The process of adjusting model parameters and checking model behaviour against observed data (Professional Engineers Ontario, 2019; *Order MO-2449*). Calibration makes the observations, remaining mismatch, and uncertainty available for technical review (Professional Engineers Ontario, 2019). *See also:* Sensitivity analysis.

Code-mediated work. Work in which a building code structures part of the technical design while owners, designers, and code authorities retain their assigned decisions (City of Ottawa Building Code Services, 2021; National Research Council Canada, 2022). Public washrooms are the thesis’s recurring example of code-mediated work (City of Ottawa Building Code Services, 2021; National Research Council Canada, 2022).

Competence. The knowledge and skill, professional judgment, and recognition of limits required to perform an accepted engineering assignment (Engineers Canada, 2024a; Professional Engineers Ontario, 2020). In this thesis, competence also includes identifying evidence that bears on a material public-interest risk within the actor’s role (Engineers Canada, 2024a, 2024b).

Contestability. The practical ability to obtain the basis for a technical decision, question its evidence or reasoning, and seek review or correction (Jasanoff, 2003; Raji *et al.*, 2020; IEEE, 2021). Contestability is a public-facing interest when opacity prevents affected people from acting on an error or patterned uneven burden (Raji *et al.*, 2020; IEEE, 2021).

Delegated statutory power and enabling statute. Delegated statutory power is authority that a legislature gives to a regulator or another administrative body (Adams, 2022; *Vavilov*, 2019 SCC 65 at paras 85-87, 108-110). The enabling statute is the legislation that creates the body, defines its mandate, and identifies the mechanisms it may use (Adams, 2022; *Vavilov*, 2019 SCC 65 at paras 85-87, 108-110).

Dewatering. Pumping or drainage used to lower groundwater for construction or operation (Environmental Commissioner of Ontario, 2004; Professional Engineers Ontario, 2019). At Site 41, dewatering mattered because groundwater movement formed part of the proposed leachate-containment system and approval record (Environmental Commissioner of Ontario, 2004).

Engineering actor. An individual engineer, engineering organization, or institution that governs engineering practice (Herkert, 2000; Adams, 2022). The actor-authority analysis asks what each actor knows, controls, and can require within its role (Herkert, 2000; Adams, 2022; Engineers Canada, 2024b).

Engineering-adjacent work. Technical or design-related work that may use engineering knowledge while falling outside licensed professional engineering in the relevant province or territory (Engineers Canada, 2022; Professional Engineers Ontario, n.d.). Its legal classification depends on the work performed, the protected public interest, and the professional-engineering statute and regulations that apply there (Engineers Canada, 2022). See also: Engineering work.

Engineering work. Work that falls within the legal definition of professional engineering in the province or territory where the work occurs (*Professional Engineers Act*, RSO 1990, c P.28, s 1(1); Engineers Canada, 2022). In Ontario, the definition includes specified acts such as planning, design, or evaluation when engineering principles are required and a listed public interest is engaged (*Professional Engineers Act*, RSO 1990, c P.28, s 1(1)).

Equity, diversity, and inclusion (EDI). A common institutional label for efforts concerning unequal conditions, representation, and participation (Fines-Neuschild & Tajmel, 2024). Usage in this thesis: EDI describes institutional discourse or source language; material disparate-impact risk remains the thesis’s professional-responsibility term (Fines-Neuschild & Tajmel, 2024; Engineers Canada, 2024a).

Equivalent access. Access that is practically comparable in location and route, capacity and timing, and privacy and usability (Hamraie, 2017; Ontario Human Rights Commission, 2014; Harwood-Jones *et al.*, 2023). The PIIA examines how a facility functions for affected users alongside formal availability and code compliance (Hamraie, 2017; National Research Council Canada, 2022).

Fixture count and occupancy assumption. A fixture count is the code-based calculation of how many toilets, urinals, or lavatories a building population requires (National Research Council Canada, 2022). An occupancy assumption states how many people are expected to use the building and when; that assumption shapes the calculation (National Research Council Canada, 2022).

Human-rights floor. The minimum legal protections and remedial pathways supplied by applicable human-rights legislation (*Human Rights Code*, RSO 1990, c H.19, ss 1, 5-6, 34-45.2; Law Commission of Ontario & Ontario Human Rights Commission, 2024). In this thesis, role-specific due care operates while design or governance choices remain open, and human-rights institutions retain authority over statutory discrimination claims and remedies (*Human Rights Code*, RSO 1990, c H.19, s 45.2; *Moore*, 2012 SCC 61 at paras 26-29; *Fraser*, 2020 SCC 28 at paras 30-31, 47-50).

Hydrogeology. The study of how groundwater occurs and moves through soil and rock (Professional Engineers Ontario, 2019). In the Site 41 example, hydrogeological investigation, groundwater modelling, and technical disclosure were central to assessing the proposed landfill’s relationship to the aquifer (Environmental Commissioner of Ontario, 2004; Mushtaq, 2011, 2013).

Intersectionality. An analytical approach that examines how combined social positions and institutional structures produce a distinct pattern of advantage or burden (Crenshaw, 1989, 1991; Atrey, 2019). In the PIIA, intersectionality operates across burden, access, and knowledge because a single-category analysis can hide the relevant pattern (Atrey, 2019; McGill, 2021).

Justice questions. Three operational questions used in the PIIA: burden asks who carries the risk; access asks which public-facing interest is impaired; knowledge asks what evidence makes the risk known or reasonably knowable (Young, 1990; Hamraie, 2017; Fricker, 2007). Intersectionality informs all three questions (Crenshaw, 1989, 1991; Atrey, 2019).

Known or reasonably knowable. The evidence boundary for professional responsibility (Engineers Canada, 2024a, 2024b). A risk is known or reasonably knowable when evidence available through ordinary professional diligence makes it visible to a competent actor within role; relevant evidence may include technical records, prior incidents, and affected-public knowledge (Engineers Canada, 2024a, 2024b; Fricker, 2007; Lambrinidou *et al.*, 2014).

Large language model (LLM). A computer system trained on large collections of text to generate or transform language by predicting likely continuations (Bender *et al.*, 2021; Bommasani *et al.*, 2021). The thesis analyzes an LLM as part of a defined use that includes the model version, data flow, and human-review process (Raji *et al.*, 2020; IEEE, 2021).

Leachate. Liquid that drains through waste and can carry dissolved or suspended contaminants (Environmental Commissioner of Ontario, 2004; Professional Engineers Ontario, 2019). Landfill engineering addresses how leachate is collected and contained, monitored, and managed (Environmental Commissioner of Ontario, 2004; Professional Engineers Ontario, 2019).

Material disparate-impact risk. A thesis term for a non-trivial, public-interest-relevant risk that engineering work may create or significantly shape and that may negatively affect structurally marginalized communities in patterned and uneven ways (Barocas & Selbst, 2016; *Fraser*, 2020 SCC 28 at paras 30-31, 47-50; Sheppard, 2024). The risk enters the professional-responsibility framework when all six criteria of the threshold test are met (Engineers Canada, 2024a; Professional Engineers Ontario, 2020). See also: Threshold test.

Mitigation, warning, and escalation. Mitigation changes a technical or institutional condition within the actor’s authority (IEEE, 2021). Warning communicates a material limitation to a person who will rely on the work (Engineers Canada, 2024b). Escalation carries the documented concern to the actor who can decide or require a response (Engineers Canada, 2024b; Professional Engineers Ontario, 2020).

MODFLOW. A groundwater-flow simulation program used to represent movement through an aquifer under stated assumptions (*Order MO-2449*). At Site 41, the model files and input data mattered because they allowed an independent reviewer to inspect how the conclusions were produced (*Order MO-2449*).

Monitoring and action threshold. Monitoring is the planned collection and review of evidence after a design or system enters operation (Professional Engineers Ontario, 2019; IEEE, 2021). An action threshold is a specified result or condition that requires a defined response, such as investigation, control adjustment, or suspension (Professional Engineers Ontario, 2019; IEEE, 2021).

Patterned uneven burden. The equality-facing criterion in the threshold test (*Fraser*, 2020 SCC 28 at paras 30-31, 47-50; Sheppard, 2024). The inquiry looks for a recurring structure, classification, or design assumption that allocates a negative burden unevenly (*Fraser*, 2020 SCC 28 at paras 30-31, 47-50; Sheppard, 2024; Bowker & Star, 1999). See also: Adverse-effect discrimination.

Professional engineering law. The provincial and territorial statutes and subordinate regulations that create engineering regulators, govern licensure, and regulate professional practice. Professional codes, standards, and regulator guidance are identified separately because their legal force depends on the source and authorizing power (*Professional Engineers Act*, RSO 1990, c P.28, ss 2(4), 7; RRO 1990, Reg 941, ss 72, 77; Engineers Canada, 2024a). Administrative-law principles govern the exercise of delegated statutory power (*Vavilov*, 2019 SCC 65 at paras 85-87, 108-110).

Professional regulator and professional self-regulation. A professional regulator is a statutory body that governs licensed practice within powers assigned by legislation (Adams, 2016, 2018, 2022). Professional self-regulation is the legal arrangement through which the profession controls entry, competence, and discipline in service of public protection (Adams, 2016, 2018, 2022).

Professional visibility. Whether a risk is recognized as relevant to engineering competence, judgment, or responsibility (Cech, 2014; Jasanoff, 2003). The concept also identifies cases in which affected-public evidence remains outside the technical record or project scope even though it bears on a public-interest decision (Cech, 2014; Fricker, 2007; Jasanoff, 2003).

Proportionality. A constitutional administrative-law requirement used when an administrative decision limits a protection under the *Canadian Charter of Rights and Freedoms* (*Doré v Barreau du Québec* (*Doré*), 2012 SCC 12 at para 57; *Loyola High School v Quebec (Attorney General)* (*Loyola*), 2015 SCC 12 at paras 39-40). The decision-maker must justify a proportionate balance between the Charter protection and the statutory objective (*Doré*, 2012 SCC 12 at para 57; *Loyola*, 2015 SCC 12 at paras 39-40). Usage in this thesis: proportionality is reserved for that legal analysis; ordinary variation in PIIA depth is described as scaling.

Public-facing interest. An interest affected through a system, facility, or technical record that reaches beyond a purely private preference (Hamraie, 2017; Jasanoff, 2003). The recurring examples concern groundwater protection, safe and equivalent access, and contestability of technical decisions (Environmental Commissioner of Ontario, 2004; Hamraie, 2017; Raji *et al.*, 2020).

Public interest. The organizing statutory term for this thesis. It refers to the public-protection purpose that governs professional engineering regulation and the exercise of powers assigned to engineering regulators (*Professional Engineers Act*, RSO 1990, c P.28, s 2(3); Adams, 2022). The thesis interprets that mandate as requiring role-specific due care for qualifying material disparate-impact risks (*Professional Engineers Act*, RSO 1990, c P.28, ss 1(1), 2(3); Engineers Canada, 2024a). *See also:* Public welfare.

Public welfare. A group of substantive interests named in some provincial professional-engineering statutes and professional codes, including life and health, property and economic interests, and the environment (*Professional Engineers Act*, RSO 1990, c P.28, s 1(1); Engineers Canada, 2024a). Usage in this thesis: public interest is the organizing legal term, while public welfare is used where a statute, code, or quoted source uses it.

Public-Interest Impact Assessment (PIIA). A three-stage professional due-care process used after the cumulative threshold test is satisfied and an actor with authority is identified (IEEE, 2021; Raji *et al.*, 2020; Costanza-Chock *et al.*, 2022). The stages are identify, assess, and respond (IEEE, 2021; Raji *et al.*, 2020). They connect evidence and uncertainty to an authorized decision, documented controls, and later review (IEEE, 2021; Raji *et al.*, 2020). See also: Threshold test; Role-specific due care.

Residual risk. The risk that remains after feasible controls have been applied and verified (IEEE, 2021, cl 10; Professional Engineers Ontario, 2020). The PIIA identifies the actor who has authority to accept that remaining risk and records the basis for the decision (Raji *et al.*, 2020; Costanza-Chock *et al.*, 2022).

Role-specific due care. The professional response expected from a particular actor in light of that actor's competence, assignment, and authority (Adams, 2022; Herkert, 2000; Professional Engineers Ontario, 2020). It requires investigation and documentation within role, an available mitigation where the actor controls one, and warning or escalation to the actor who can decide (Engineers Canada, 2024b; IEEE, 2021). *See also:* Actor-authority map; Known or reasonably knowable.

Science and technology studies (STS). An interdisciplinary field that examines how technical systems and social institutions shape one another (Akrich, 1992; Jasanoff, 2004; Winner, 1980). In this thesis, STS helps identify how design assumptions, classifications, and institutional practices distribute risk, access, and credibility (Akrich, 1992; Bowker & Star, 1999; Jasanoff, 2003).

Sensitivity analysis. A modelling method that varies assumptions or parameter values to show how much the result changes (Professional Engineers Ontario, 2019). It helps a reviewer identify which inputs materially influence the result and where uncertainty requires further evidence (Professional Engineers Ontario, 2019; Funtowicz & Ravetz, 1993). *See also:* Calibration.

Structurally marginalized communities. Groups whose exposure to disadvantage is produced or intensified by durable institutional arrangements, including colonial or racialized structures, gendered or ableist structures, and classed arrangements (Collins, 2000; Crenshaw, 1989, 1991; Hamraie, 2017). The thesis term identifies settings in which structural marginalization helps explain the patterned uneven burden (*Fraser*, 2020 SCC 28 at paras 30-31, 47-50; Hamraie, 2017).

System boundary. The line drawn around the technical components, human roles, and project documents included in an assessment (IEEE, 2021; Raji *et al.*, 2020). A clear boundary identifies what the system does, who controls each part, and which changes require renewed review (IEEE, 2021; Raji *et al.*, 2020).

System integration. Connecting a model or technical component to other software, human review, or physical infrastructure so the combined system performs an assigned function (Engineers Canada, 2022; IEEE, 2021). The integration decision can bring an AI-enabled use within professional engineering when the work and jurisdiction satisfy the governing legal definition (Engineers Canada, 2022; Professional Engineers Ontario, n.d.).

Technical record. The project-specific documents and data that support an engineering conclusion, such as calculations or models, test or monitoring results, and recorded assumptions or decisions (Professional Engineers Ontario, 2020; IEEE, 2021). A reviewable technical record allows another competent person to understand the evidence, limitations, and decision path (Professional Engineers Ontario, 2020; Raji *et al.*, 2020).

Technology. A socio-technical arrangement that may include material artefacts and technical knowledge (Akrich, 1992; Winner, 1980). It may also include standards, classifications, or institutional practices that organize design and use (Bowker & Star, 1999; Jasanoff, 2004). In this thesis, the term includes a landfill liner or groundwater model, a washroom fixture schedule or ventilation system, and an AI-enabled information system (Professional Engineers Ontario, 2019; National Research Council Canada, 2022; Scassa, 2021).

Technological accountability. The goal of making technical choices and institutional authority answerable through evidence, documented decisions, and mechanisms for correction (Jasanoff, 2003; IEEE, 2021). In this thesis, the threshold test, actor-authority map, and Public-Interest Impact Assessment are proposed as contributions toward that goal (Adams, 2022; Raji *et al.*, 2020).

Threshold test. The cumulative test that determines whether a risk enters the thesis’s professional-responsibility framework; all six criteria must be satisfied (Engineers Canada, 2024a; Professional Engineers Ontario, 2020):

- The risk is more than remote or minor (Engineers Canada, 2024a; Professional Engineers Ontario, 2020).
- The risk may impair a public-facing interest (Hamraie, 2017; Jasanoff, 2003).
- The burden falls in a patterned and uneven way (*Fraser*, 2020 SCC 28 at paras 30-31, 47-50; Sheppard, 2024).
- Engineering work creates or significantly shapes the risk (*Professional Engineers Act*, RSO 1990, c P.28, s 1(1); Engineers Canada, 2022).

- The risk is known or reasonably knowable to a competent actor within role (Engineers Canada, 2024a, 2024b).
- An actor has authority to take a role-specific response (Adams, 2022; *Vavilov*, 2019 SCC 65 at paras 85-87, 108-110).

See also: Public-Interest Impact Assessment (PIIA).

Traceability. The ability to connect a concern to the evidence that identified it, the decision that addressed it, and the control or monitoring requirement that follows (IEEE, 2021; Raji *et al.*, 2020). Traceability lets a later reviewer reconstruct why a system was accepted and when reassessment is required (IEEE, 2021).

Validation and revalidation. Validation tests whether a system performs its intended function under stated conditions (Engineers Canada, 2022; IEEE, 2021). Revalidation repeats the relevant tests after a change that could affect accepted performance, such as a model version, data source, or deployment-context change (IEEE, 2021; Raji *et al.*, 2020). See also: System boundary; System integration.

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