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GOING GREEN WITH WOOD FLOORS



A Practical Approach to Field Water Testing

The Secret to Workplace Soundscaping

Digging In on Below-Grade Waterproofing

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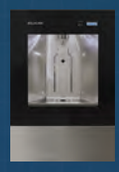

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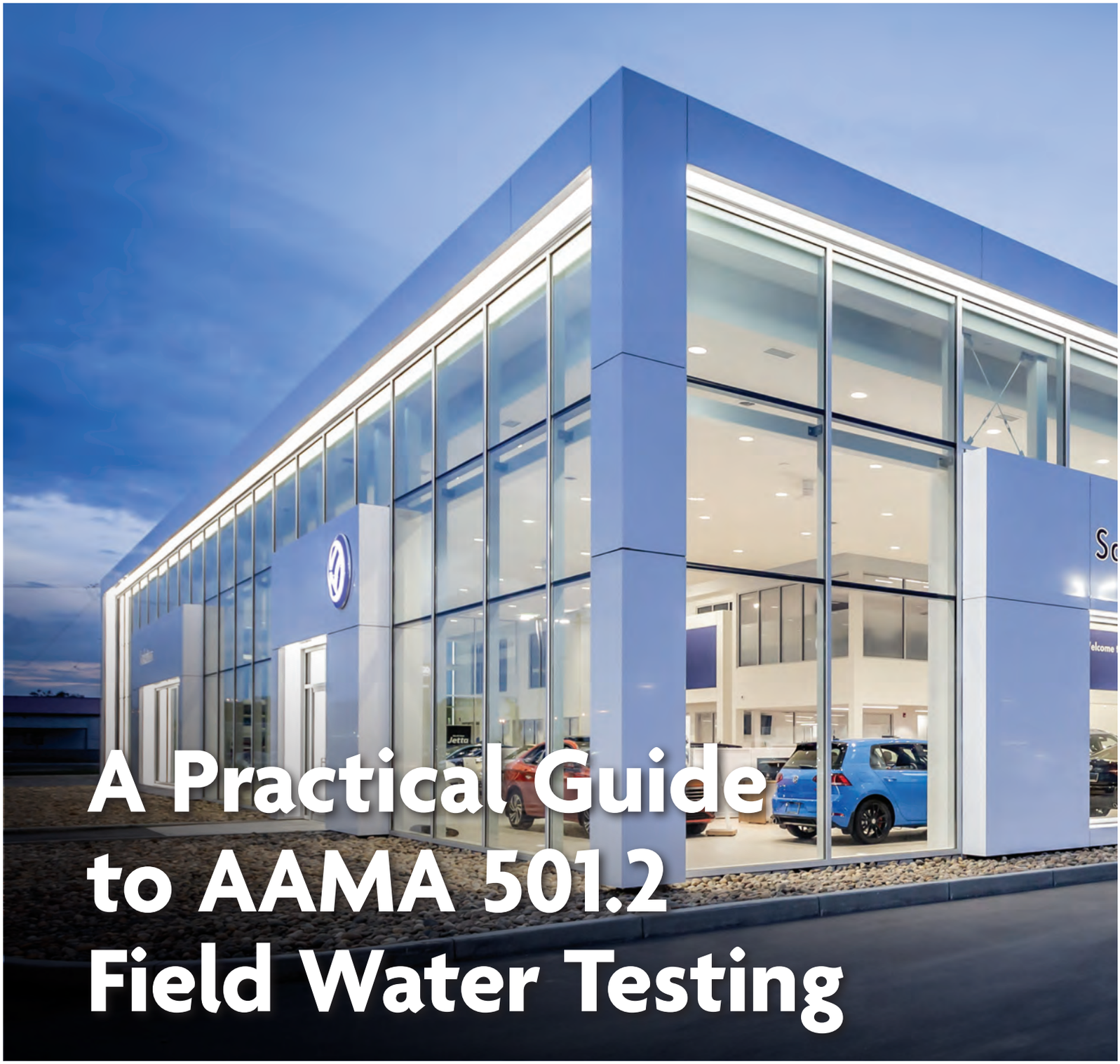

A Practical Guide to AAMA 501.2 Field Water Testing

By Amy Roberts

PHOTO © BOB HOLTSMAN PHOTOGRAPHY/COURTESY VITRUM GLASS GROUP

The Fenestration and Glazing Industry Alliance's (FGIA) AAMA 501.2, *Quality Assurance and Diagnostic Water Leakage Field Check of Installed Storefronts, Curtain Walls and Sloped Glazing Systems*, provides a quality assurance (QA) and diagnostic field water check method for installed storefronts, curtain walls, and sloped glazing systems. It helps specifiers ensure testing is conducted efficiently and consistently by providing guidelines for selecting field test specimens and the test procedures to be used for field water penetration checks. It also details the minimum contents testing agencies or laboratories should include in test reports.

The field check is intended to evaluate the performance of joints, gaskets, and sealants in fenestration products designed to remain permanently closed and watertight and not sealed with weatherstrip or weather seals. This includes a wide variety of products, such as curtain walls, storefronts, sloped glazing,

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fixed windows and doors without a sash or panel, fixed-unit skylights without weatherstrip or weather seals, wall panels, perimeter sealants, and the integration of air and water barriers with the fenestration product. Field checks demonstrate the performance of a building's components and identify areas of weakness. They can also be useful as part of a QA program during building construction or during commissioning. The results of these field checks can identify remedial work and additional items to be included in the punch list for spot-checking throughout continued building construction.

AAMA 501.2 is not the appropriate test protocol to be used to test operable fenestration products (*e.g.,* fixed windows and doors with a sash or panel, entrance systems, integral ventilating systems/devices, and operable unit skylights and roof windows). For those products, refer to AAMA 502, *Voluntary Specification for Field Testing of Newly Installed Fenestration*

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FIGURE 1



This figure shows how the test area should be reviewed prior to testing. In this case, some areas have not been completed, and testing in them would not yield valid results.

PHOTO COURTESY FENESTRATION AND GLAZING INDUSTRY ALLIANCE (FGIA)

Products, which was developed to test the air-leakage and water-penetration resistance of newly installed operable windows and doors. To test the impact of air leakage resistance and water penetration resistance for storefronts, curtain walls, and sloped glazing, specifiers should refer to AAMA 503, *Voluntary Specification for Field Testing of Newly Installed Storefronts, Curtain Walls and Sloped Glazing Systems*.

Once a building has been occupied, AAMA 511, *Voluntary Guideline for Forensic Water Penetration Testing of Fenestration Products*, should be used for such testing. Once walls have been completed, more testing may be required to identify the source of issues, and the entire structure needs to be understood before testing is performed.

Test area preparation

It is important to determine the test specimen before conducting the actual test. AAMA 501.2 recommends using fully glazed units as specimens. They must be located on two typical contiguous floors of the building for testing curtain walls, and on a typical floor



Care needs to be taken to ensure there is a proper water supply and flow. The nozzle and hoses need to be sized to provide a proper water flow. This includes taking precautions to control the water pressure at the nozzle.

PHOTO COURTESY CHRISTOPHER GREY/SIMPSON GUMPERTZ & HEGER

for storefront or sloped glazing systems. For a curtain wall, testing is conducted on two floors to better reflect the range of joint types.

The test area should be a representative sample of the whole building's construction and should not have any outstanding punch list items or other visible defects. It should be ensured that the test area includes perimeter sealant, typical splices, frame intersections, and at least two vision lites and spandrel lites containing intermediate vertical and horizontal members.

Testing must be performed as soon as the curtain wall is installed and sealants are cured, but before the drywall or other interior finishes are applied. On the exterior, allowing sealants to dry prevents water pressure from displacing installed sealant, while on the interior, testing prior to the application of finishes allows for better visual inspection of the test area without removing and reinstalling interior finishes.

The specimen should be protected from extreme conditions, such as high winds, rapid changes in barometric pressure, heavy rain, and severe temperature changes, as these conditions can adversely affect the quality of field testing. If testing is performed under extreme environmental conditions due to unavoidable circumstances, this information should be included in the report.

Running the test

The testing agency needs the appropriate equipment and expertise to run the test in

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To test the impact of air leakage resistance and water penetration resistance of storefronts, curtain walls, and sloped glazing, specifiers should refer to AAMA 503, *Voluntary Specification for Field Testing of Newly Installed Storefronts, Curtain Walls and Sloped Glazing Systems.*

PHOTO © SHUTTERSTOCK/COURTESY FENESTRATION AND GLAZING INDUSTRY ALLIANCE (FGIA)



Testing must be performed as soon as the curtain wall is installed and sealants are cured, but before the drywall or other interior finishes are applied.

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AAMA 501.2 was used during the construction of the Central Presbyterian Church in downtown Vancouver. Designed by Henriquez Partners Architects, the development features a residential tower above a podium that includes the church sanctuary, community areas, and commercial retail space.

PHOTO COURTESY VITRUM GLASS GROUP

accordance with the procedure. According to AAMA 501.2, testing shall be performed by an AAMA-accredited laboratory or field test agency. This does not mean testing cannot be done by someone else, but certification ensures that the proper equipment and knowledge are in place. There are different types of certification: full/lab and field test. Testing staff must ensure there is a proper water supply and flow. The nozzle and hoses need to be sized to provide proper water flow. This includes taking precautions to control the water pressure at the nozzle.

The test is intended to be run at different times on separate portions of the test area. This better identifies any problem areas. The test is performed by wetting the exterior surface sections measuring 1.52-m (5-ft) sections. Each section is wetted for five minutes. The test is performed starting with the lowest framing member and moving to adjacent framing members. Sections are tested from lowest to highest, so any sources of leakage are more easily identified. While one person is wetting the exterior surface, a second person is inside, watching for any water leakage. The observer may use tools such as flashlights, mirrors, borescopes, and water-sensitive paper to help detect water leakage. The water leakage is noted at the location where it occurs.

Water leakage is defined as uncontrolled water that is not contained or drained back to the exterior. Water contained within drained flashings, gutters, and sills is not considered leakage. The collection of up to 14.2 mL (0.5 oz) of water in a five-minute test period on top of an interior stop or stool integral to the system is also permitted under this test.

If water leakage occurs and the source cannot be identified, additional steps should be taken to locate it. These additional steps and tests are needed to isolate the problem area in the building. It is imperative that the exact source is located and remediation is completed. Correcting at the source will help for a long-lasting resolution.

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Random checks for water leaks throughout the remainder of the project, as construction progresses, are also conducted. Keeping in mind that testing once may help identify a problem, it is critical that these checks continue to ensure the remediation was correct and successful.

Final report

The final report should include information regarding the test that was performed. At a minimum, the test report should have the following information about the curtain wall specimen:

- Identification of the testing agency responsible for performing the work.

Checking quality with the AAMA 501 series of standards

Apart from FGIA's AAMA 501.2, *Quality Assurance and Diagnostic Water Leakage Field Check of Installed Storefronts, Curtain Walls and Sloped Glazing Systems*, FGIA has published several documents in the 501 series to help building professionals with their quality checks.

AAMA 501, *Methods of Test for Exterior Walls*
This document provides guidelines on laboratory and field test specifications for metal curtain walls. It includes performance characteristics of curtain walls, instructions on selecting test specimens and apparatus, test methods, and best practices.

AAMA 501.1, *Standard Test Method for Exterior Windows, Curtain Walls and Doors for Water Penetration Using Dynamic Pressure*
This standard establishes the equipment and procedures building professionals need to follow when using dynamic pressure to test exterior windows, curtain walls, and doors for water penetration.

AAMA 501.5, *Test Method for Serviceability of Exterior Fenestration After Thermal Cycling*
This test method provides a standard laboratory procedure that building professionals can use to evaluate the permanent damage caused by thermal cycling to large fenestration components and cladding.

AAMA 501.4 and 501.6, *Recommended Static Testing Method for Evaluating Curtain Wall and Storefront Systems Subjected to Seismic and Wind Induced Interstory Drift*
This test method provides a means to evaluate the performance of curtain wall and storefront wall systems when subjected to horizontal displacements. The method is not intended to test dynamic, torsional, or vertical movements. For that, one should refer to AAMA 501.6, *Recommended Dynamic Test Method for Determining the Seismic Drift Causing Glass Fallout from a Wall System*.

AAMA 501.6
AAMA 501.6 focuses on changes in the serviceability of wall systems (*e.g.,* air and water leakage rates) resulting from racking displacements. This test method is suitable for large curtain walls and storefront mock-ups. This test method describes the apparatus and procedure for horizontally displacing a specimen. Building professionals must have a sufficient understanding of static load applications, deflection measurements, and test fixture design to successfully apply this test.

AAMA 501.7, *Recommended Static Test Method for Evaluating Windows, Window Wall, Curtain Wall and Storefront Systems Subjected to Vertical Inter-Story Movements*
A complement to AAMA 501.4, this test method provides guidelines for evaluating the performance of windows, window walls, curtain walls, and storefront wall systems subjected to vertical displacements.

AAMA 501.8, *Standard Test Method for Determination of Resistance to Human Impact of Window Systems Intended for Use in Behavioral Care Applications*
This document provides a standard laboratory procedure for evaluating human impacts on window systems to be installed in behavioural care hospitals and facilities, as well as in other occupancies with similar concerns.

This test method uses a weighted impact device to apply force, simulating patients hurling themselves into window assemblies. This test method evaluates the effectiveness of the window system to resist such impacts. Caution is advised when applying test results to "in-service" conditions, as other variables, such as maintenance, are not accounted for by this test method.

AAMA 501.9, *Surface Temperature Assessment for Condensation Evaluation of Exterior Wall Systems*
This document provides a standard procedure for measuring surface temperatures when evaluating condensation in exterior wall systems under laboratory conditions. The assessment can be used to determine the potential for winter interior condensation.

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The field check is intended to evaluate the performance of joints, gaskets, and sealants in fenestration products that are designed to remain permanently closed, watertight, and are not sealed using weatherstrip or weather seals.

PHOTO © SHUTTERSTOCK/COURTESY FENESTRATION AND GLAZING INDUSTRY ALLIANCE (FGIA)



A large Tim Hortons location in downtown Calgary, Alta., designed by GEC Architecture, features clear exterior glass over both digitally printed ceramic frit glass and an interior layer of clear glass.

PHOTO COURTESY VITRUM GLASS GROUP

- Information about the fenestration product that was tested, including, if available, manufacturer, model, dimensions, and materials.
- Identification and locations of test specimens on the building.
- Information about the building where the testing was conducted.
- Any meteorological conditions that could have impacted the testing.
- Physical condition of the curtain wall(s).
- A description of modifications, if any, made to the fenestration products.

The report should include all results and any re-evaluations. It should also record all points of water leakage, as well as a compliance statement indicating that the evaluations were conducted in accordance with AAMA 501.2. If there are deviations or meteorological conditions that could have affected the testing, they must also be highlighted in the report.

Successful use case

AAMA 501.2 was used during the construction of the Central Presbyterian Church in downtown Vancouver. Designed by Henriquez Partners Architects, the development features a residential tower above a podium that includes the church sanctuary, community areas, and a commercial retail space. Per the architect, public art designed by Michael Lin of Taiwan envelops the church space and the entire building podium with coloured fritted crosses inkjet-printed on glass. The nearly 2,800 m^2 (30,000 sf) glass building uses the sun to its advantage thanks to its colourful exterior, particularly at sunset.

Conclusion

AAMA 501.2 is one of the most widely used field check methods for verifying the water leakage resistance performance of curtain walls. The test method gives specifiers, design professionals, contractors, and building owners the confidence that critical interfaces, sealants, and drainage paths are functioning correctly. The standard helps project teams reduce risk, improve long-term performance, and deliver curtain walls that meet design intent and occupant expectations. When used alongside related AAMA standards, the test methods help create a comprehensive QA strategy, supporting durable, resilient, and well-integrated curtain wall systems.



Amy Roberts is the Canadian codes and advocacy director for the Fenestration and Glazing Industry Alliance (FGIA). She leads FGIA's Canadian codes and regulatory initiatives with a focus on building and energy codes, standards development, and industry advocacy. In her role, she also supports the FGIA FENBC Region, working closely with stakeholders to represent industry interests at both the regional and national levels. With more than 25 years of experience in glass and insulating manufacturing, as well as residential and commercial window production, Roberts brings deep technical expertise and strategic insight to advancing the Canadian fenestration and glazing industry. She can be reached at aroberts@fgiaonline.org.

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Buried Problems

Rethinking Below-Grade Waterproofing

By Rockford Boyer, B. Arch. Sc., MBSc, BSS

PHOTO COURTESY ELASTOCHEM

Waterproofing is one of those building systems that everyone agrees is important, right up until the moment someone must pay for it. Then, suddenly, value engineering arrives: membranes get thinner, drainage layers disappear, details become "contractor co-ordinated," and somebody decides the soil will magically keep the water away from the building.

Unfortunately, water has never been particularly interested in architectural drawings and specifications, and it certainly does not care how impressive the product data sheet looks or whether the membrane comes with a 20-year warranty. Water follows gravity, pressure, capillary forces, cracks, penetrations, and every imperfect transition left behind. In Canada, there is also snowmelt, saturated soils, freeze-and-thaw cycles, and groundwater conditions that may look very different from what the geotechnical report suggested when the building was designed.

Once a below-grade wall is backfilled, the economics of repair change considerably, because what might have been a relatively simple repair during construction can end up buried behind several metres of soil, landscaping, sidewalks, or even an entire streetscape, and getting back to the membrane may cost substantially more than the waterproofing itself. A warranty is certainly nice to have, but it will not make the excavation any easier. This is why repairability needs to be discussed before the membrane is installed, including how a future leak might be located, what portions of the assembly could realistically be accessed, and whether compatible repair materials and procedures will still be available years down the road.

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A waterproofing membrane is only one part of the assembly, which can also include the concrete, primers, reinforcement, waterstops, protection, drainage, insulation, terminations, and even the final grading around the building. Most have heard the expression that specifiers should design assemblies rather than individual products, but the more useful question for a designer is what each component is expected to do, how they connect to one another, and what happens when one does not perform exactly as intended.

Resilience becomes a much more practical concept when designers are asked whether the design can accommodate the conditions that actually occur on a construction site and throughout a building's life, including movement at joints, temporary ponding, imperfect backfill, a future service penetration, or a drainage outlet that eventually requires maintenance. If the entire waterproofing strategy depends on every trade doing everything perfectly, it should be reconsidered how resilient that strategy really is.

The geotechnical report is a starting point, not a crystal ball. Rainfall, snowmelt, irrigation, perched water, seasonal groundwater, and neighbouring construction can all change the loads on a foundation, which is why designers should document both the observed conditions and the credible conditions that could develop over the building's service life.

Material selection should follow those conditions rather than lead them. Sheet membranes, hot rubberized asphalt, cold liquid-applied systems, bentonite, cementitious coatings, and polyurea each have useful applications, but their limitations differ, particularly due to restricted access, wet substrates, complex geometries, or projects that cannot tolerate leakage. The accompanying comparison is intended as a starting point for specification discussions, not as a substitute for a manufacturer's approved assembly.

Sheet-applied membranes provide a controlled manufactured thickness and established performance characteristics, which can be attractive on relatively regular surfaces, but laps, corners, terminations, and penetrations require disproportionate attention because the membrane field is rarely where the interesting failures occur.



A continuous below-grade waterproofing system at Chalk River Laboratories. Spray-applied polyurea was used to accommodate the foundation geometry while providing a seamless water-control system.

PHOTO COURTESY ELASTOCHEM

Hot rubberized asphalt can form a continuous reinforced waterproofing layer around difficult geometry, although heating requirements, substrate condition, detailing, protection, and sequencing must be addressed in the specification and verified on site. Manufacturers test materials under controlled conditions, but contractors install them in excavations, often while the weather and construction schedule have other ideas.

Polyurea and other rapid-curing, liquid-applied membranes can provide a seamless, tough, and quickly installed system, especially where penetrations and irregular geometry complicate sheet detailing. However, rapid cure does not mean ignoring surface moisture, profile, primer compatibility, adhesion testing, minimum thickness, or the treatment of moving joints. Think of a truck bedliner: the chemistry can be impressive, but the substrate and the preparation still determine whether it stays where it belongs.

This is where construction documents occasionally give a false sense of security. Tensile strength, elongation, crack-bridging, hydrostatic resistance, adhesion, and numerous ASTM test methods can be specified. These factors allow designers to compare waterproofing materials and establish minimum performance requirements; however, laboratory performance does not reflect in-situ assembly performance.

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Advantages, limitations, and design considerations for commonly specified waterproofing technologies

System	Advantages	Limitations/considerations
Sheet-applied membranes	Consistent manufactured thickness; established performance; suited to regular substrates.	Laps, seams, penetrations, and terminations require careful detailing; substrate preparation is critical.
Hot rubberized asphalt	Continuous, conformable membrane; accommodates complex geometry and reinforced transitions.	Specialized equipment, temperature control, application conditions, and protection during construction.
Cold liquid-applied membranes	Seamless application; adaptable to irregular surfaces and penetrations.	Thickness, curing, substrate moisture, and ambient conditions must be controlled.
Bentonite systems	Swelling/self-sealing characteristics; useful for certain blindside and confined appli ations.	Requires appropriate confinement and h dration; groundwater chemistry must be evaluated.
Cementitious waterproofin	Compatible with many concrete substrates; suitable for selected positive- and negative-side applications.	Crack movement, substrate conditions, and hydrostatic resistance depend on the particular system.
Spray-applied polyurea	Rapid curing, seamless, and tough; useful for complex foundation geometry.	Specialized equipment, trained installers, substrate preparation, and verified thickne s are essential.

Author's note: Selection should also consider groundwater conditions, expected movement, repair access, installation sequencing, protection requirements, and the consequences of failure. Product approvals and manufacturer requirements govern suitability.



Waterproofing performance depends on maintaining continuity through complex assemblies. Multiple penetrations, joints, and transitions require careful detailing and co-ordination before they are concealed by subsequent construction.

PHOTO COURTESY ELASTOCHEM

An example is a waterproofing membrane with extraordinary elongation that still fails because the termination was poorly detailed. It can withstand substantial hydrostatic pressure and still leak around existing penetrations, and it can have excellent adhesion qualities yet still be damaged by unprotected backfilling.

A demanding project is not necessarily defined by excavation depth, although that can certainly contribute to the problem. Groundwater at or above the slab, sustained hydrostatic pressure, poorly draining soils, limited discharge options, zero-lot-line construction, numerous tiebacks or penetrations, and limited access for future repairs all increase the level of risk. This is relevant when the space being protected contains occupied areas, critical equipment, or materials that do not respond well to moisture. A relatively shallow foundation next to an electrical room can have consequences that are considerably more serious than a deeper wall enclosing an unfinished parking garage.

Drainage should be designed for a credible water load and a reliable discharge path, with consideration given to filter compatibility, clogging, cleanout access, backflow, pump dependence, and what happens during a power outage. Free-draining backfill and drainage composites can reduce pressure, but they are not an excuse to downgrade a membrane where hydrostatic conditions are reasonably foreseeable.

The rainscreen analogy is useful only up to a point: above-grade walls can often drain and dry, whereas below-grade assemblies may have little opportunity to dry and can remain inaccessible for decades. That difference argues for careful pressure management and verified continuity, not simply another drainage product on the drawings.

A membrane can be installed perfectly and still be damaged by the next trade, which is why specifications should distinguish between

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Torch-applied sheet membranes are a proven waterproofing approach, with performance dependent on proper laps, transitions, terminations, and substrate preparation.

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Rapid-curing polyurea can create a seamless waterproofing membrane that conforms to complex foundation geometry and detailing.

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protection that must remain as part of the completed assembly and the temporary measures a contractor uses during construction. Permanent protection boards or drainage composites should be specified where required to resist backfill damage, maintain drainage, or separate incompatible materials, while the contractor can generally determine the temporary means and methods to protect completed work before those permanent components are installed. The best membrane in the world is not particularly useful if somebody puts a shovel through it and buries it the next day.

Designers need to account for anticipated movement and select compatible waterstops, reinforcement, or flexible transitions accordingly; the drawings should distinguish static cracks from movement joints rather than asking a single generic membrane detail to do both jobs.

Continuity is most difficult at footings, pile caps, elevator pits, slab-to-wall joints, service penetrations, tiebacks, podium edges, and transitions to above-grade control layers. On projects with sustained hydrostatic pressure, extensive below-grade interfaces, zero-lot-line constraints, or costly leakage consequences, a full-scale mock-up extending from the footing or slab interface to the top of the foundation wall can justify costs by testing real sequencing, corner geometry, penetration seals, protection, and trade co-ordination before those conditions are repeated hundreds of times.

Three-dimensional thinking becomes essential because a detail that works beautifully in section may become nearly impossible to construct when it turns a corner, intersects another assembly, or encounters structural members. One of the most valuable exercises during design is simply following the waterproofing line around the entire building, paying particular attention to penetrations, changes in direction, structural joints, and transitions between materials, while asking if the proposed details can be constructed in the anticipated sequence. If the answer is that the contractor will figure it out on site, there is probably more design work to be done.

Repairability should be considered during assembly development, rather than after someone discovers a wet wall 15 years later. Consider where water could travel behind the membrane; whether a leak could be narrowed to a particular joint or area; whether injection ports or other accessible repair locations make sense; and if the manufacturer has compatible materials and documented repair procedures. A warranty may be helpful but is not a repair strategy if nobody knows where the water is getting in or how to reach it.

Quality assurance (QA) must happen while the work is visible. For higher-risk projects, specify a documented pre-cover inspection; substrate and environmental checks; wet- or dry-film thickness measurements, as appropriate; adhesion testing where relevant; inspection of laps and

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terminations; and independent review at critical transitions. Comprehensive leak detection is important for large horizontal areas, high-value equipment, difficult-to-access assemblies, or projects where the cost of locating a defect later is substantial. The chosen method must be compatible with the membrane and assembly, and testing must be completed before protection and concealment prevent meaningful repairs. The manufacturer's technical representative can be a valuable resource, but the project documents should still establish who inspects, what is recorded, and who has authority to accept the work.

A practical risk classification can make these decisions less subjective. Treat it as a project-team decision tool rather than a code-defined rating: evaluate water exposure, leakage consequences, and repair difficulty, then use the highest credible concern to set the level of detailing and verification. Spending more is not automatically better; spending where failure would hurt is.

Practical risk screening

The following are examples of situations that could be considered low-, medium-, or high-risk.

Low-risk

A relatively shallow foundation on a freely draining site, with no credible sustained hydrostatic head, straightforward geometry, limited penetrations, and spaces where an isolated leak would have manageable consequences. There should also be reasonable access for investigation and future repairs. A properly selected waterproofing system, positive grading, dependable drainage, clearly detailed transitions, and documented inspections may provide an appropriate level of protection. Low risk does not mean no risk, and it certainly does not mean the drainage details can be left to someone's imagination.

Medium-risk

Sites with intermittent perched water, seasonal groundwater fluctuations, less reliable drainage, more complicated foundations, multiple service penetrations, or restricted repair access. Finished or occupied spaces can also increase the consequences, even where water exposure appears modest. These projects deserve closer co-ordination among the geotechnical, structural, and enclosure teams; explicit details at joints and penetrations; defined membrane protection; more frequent inspection hold points; and consideration of targeted testing before the work disappears behind backfill.



Even a properly installed waterproofing membrane can be compromised during backfilling, reinforcing the importance of protection and careful construction sequencing.

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Poor site drainage can increase moisture loads and hydrostatic pressure against below-grade assemblies, making drainage an integral part of the overall waterproofing strategy.

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High-risk

Foundations subject to sustained or potentially significant hydrostatic pressure, deep excavations, blindside or zero-lot-line construction, extensive tiebacks, complicated pile caps, movement joints, critical equipment rooms, archives, or other spaces where water intrusion would be disruptive or costly. When exterior excavation becomes impractical or impossible later, repair

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During backfilling, waterproofing can be damaged, making the system more difficult and costly to access and repair.

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difficulty itself becomes a major design driver. The team should consider a documented design basis for groundwater loading, compatible joint and penetration systems, redundancy, full-scale representative mock-ups, a more comprehensive inspection and testing program, and a realistic leak-localization and repair strategy before concrete is placed or the membrane is concealed.

Author's note: These are proposed project screening categories, not classifications established by the building code.

Future conditions deserve the same attention as present ones. Use Environment and Climate Change Canada's climate data resources and the Canadian Centre for Climate Services (CCCS), including ClimateData.ca, to review projected temperature and precipitation changes across plausible emissions scenarios, while local intensity-duration-frequency (IDF) data and municipal stormwater guidance help frame rainfall and drainage design. Groundwater projections are less straightforward: a climate projection is not a site-specific groundwater forecast, so geotechnical and hydrogeological specialists should evaluate seasonal monitoring, perched water, adjacent construction, pumping restrictions, and credible high-water scenarios over the intended service life. Record the assumptions and revisit them when site conditions change.

The architect, geotechnical specialist, enclosure consultant, structural engineer, manufacturer, and contractor each hold part of the answer, and the useful conversations happen before the project is full of people waiting for a decision. Different members understand groundwater, joint movement, other product limits, and whether the proposed detail can be installed without standing on the membrane.

Manufacturers have made great progress with sheet membranes, hot-fluid materials, and liquid-applied technologies, including rapid-curing polyurea, but better chemistry cannot eliminate an uncoordinated penetration, an inaccessible drain, or a missed inspection hold point.

Specifications should connect the identified risk to clear acceptance criteria: the anticipated water load, required membrane and joint performance, permanent protection, drainage discharge, mock-up requirements, inspection hold points, test methods, and repair documentation. That is more useful to the next person reviewing the drawings than a longer list of impressive laboratory numbers.

Perhaps the best question is not, "What membrane should we specify?" Instead, ask, "How is this building going to manage water for the next 75 years, and what are we going to do when one part of that strategy stops working?" That question shifts the conversation from the cost of a product hidden somewhere to the long-term performance of a building that people will still use long after everyone involved in the original project has moved on.



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The Secret to Effective Workplace Soundscaping



By Niklas Moeller

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Sound greatly affects people's experience of the built environment, including how they feel and behave within it. As appreciation of this grows, so does interest in actively managing the workplace "soundscape" to promote health, well-being, and productivity. Coined in the early 1960s and popularized by the work of composer and naturalist R. Murray Schafer, the meaning of this term varies from discipline to discipline, but according to the International Organization for Standardization (ISO), it can generally be defined as the "acoustic environment as perceived or experienced and/or understood by a person or people, in context."

When it comes to offices, soundscaping involves measures to add, preserve, and enhance sounds that support occupants, while reducing the impact of sounds that could cause harm or hinder work. While formulating a plan, it is essential to look at the entire "sonic ecosystem," taking into consideration sounds that are "organically" present in the facility from indoor (*e.g.,* occupants, equipment) and outdoor sources (*e.g.,* traffic), the types of sound (*e.g.,* masking, music, biophilic) that can contribute to the goals (*e.g.,* focus, collaboration, relaxation) set for particular spaces, as well as factors related to humans (*e.g.,* etiquette) and design (*e.g.,* layout, materials) that support desired outcomes and prevent unintended consequences.

As someone who has spent decades in the field of acoustics and often witnessed this key indoor environmental quality (IEQ) parameter pushed to the sidelines in favour of a particular visual esthetic or budgetary constraints, it is relieving to see auditory needs finally receiving at least some of the attention they deserve. But before

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getting into the types of sounds generating all the buzz, the topic of noise must be addressed, as well as an acoustical quality many people assume is its opposite, but is often its partner in crime: silence.

Partners in crime

While the decibel levels known to cause hearing damage are not typically a concern in offices, evidence of the non-auditory health impacts, such as increased stress hormones, heart rate, and blood pressure, of the lower-level noises routinely encountered in these environments is mounting. Further, studies such as those conducted by Szalma and Hancock (2011)[1] and Radun et al. (2022),[2] along with many studies investigating the effects of traffic noise, identify intermittent and/or impulsive noises as the main culprits; basically, relatively silent periods punctuated by random, unpredictable noises that rapidly increase and decrease in level.



The average background sound level in most offices is similar to that of a library. Within such "silent" environments, occupants experience many noises as loud and impulsive, causing distraction, irritation, and fatigue.

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Whether occupants are trying to concentrate on a task or taking a moment to relax, noise that starts and stops causes more physiological and psychological distress than either steady-state sound at the same A-weighted, equivalent continuous level or "quieter" sounds closer to the low ambient levels characteristic of the built environment. Human beings are hardwired to respond to such acoustical disruptions. As Atkinson and Rogers point out in "Developing Your Office's Music Strategy,"[3] these disruptions "unnerve us precisely because the body's survival mechanisms have evolved to recognize them as a source of potential danger, triggering the release of cortisol to prime us for a fight-or-flight scenario." However, in this case, it is not a twig snapping as a predator approaches, but rather people talking, walking, typing, a door closing, HVAC turning on, a truck driving by, and so on. People do not need to be on high alert, but cannot simply switch off an evolutionary trait that took thousands of years to develop.

Notably, Atkinson and Rogers[3] go on to state that, in between such noises, occupants experience "moments of deafening silence." As psychologist Tom Stafford explains, a deafening silence is unlike other silences: the absence of sound is especially noticeable because it comes right after a period of intense noise.[4]

Although many consider noise and silence opposite ends of an acoustical spectrum, when it comes to disturbing occupants, they are related. Both noise and silence are perceived as changes in the surrounding acoustic conditions.

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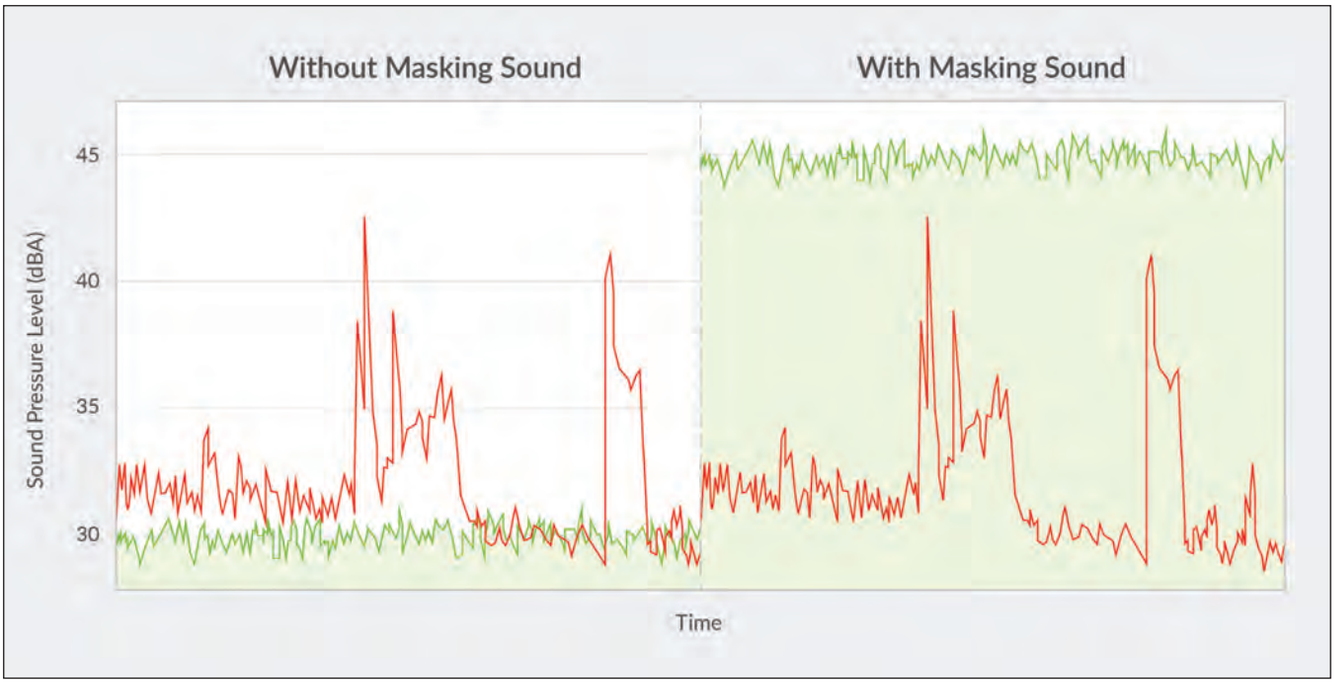

Fortunately, occupants perceive a space with a higher continuous background sound level as quieter, provided the sound is precisely tuned to an effective masking spectrum and level. The masking sound (in green on the right-hand side) covers many noises (in red) and minimizes the disruptive impact of others by reducing the extent of change they cause in the space.

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The greater the difference between them, the more noticeable it is. And the more frequently these changes occur, the more annoyed, interrupted, and startled people become.

Often ignored during acoustical planning—or even placed on a pedestal—silence deserves attention when discussing potential problems. For example, the longer it continues, the more uncomfortable it can become. Studies such as that by Acun and Yilmazer (2018)[5] reveal that occupants are concerned about their level of acoustical privacy in "too quiet" spaces. Due to feelings of exposure, they tend to whisper and rely more heavily on electronic communication. These are just a few of the reasons why researchers such as Schweitzer, Gilpin, and Frampton (2004)[6] concluded that an environment that seems "too quiet" is just as tension-inducing as one perceived as too loud.

Both noise and silence have serious implications for three goals occupants consistently identify as top workplace priorities: acoustical privacy, focus, and collaboration.[a] Therefore, to strategically add sound to the built environment to support them, the first step is to address these extremes. However, there is a tendency to target only the first part of this equation—the noise—and particularly its "loudness," which is usually approached in terms of its decibel level. After taking steps to reduce noise using blocking strategies and absorptive treatments, it is perplexing when it remains a problem. The typical conclusion is that the offending sounds must be unusually loud, or the materials used are somehow insufficient or deficient. But the key is human perception.

Perception is key

Although rock concert-level noise followed by anechoic chamber-level silence does not plague offices, their minimum background sound level is typically akin to that of a library. Within such an environment, occupants experience many loud, impulsive sounds, even when the decibel levels are quite low. Noises can easily—and often—be heard, and, therefore, people are easily and often disrupted. As Atkinson and Rogers[3] state, "the lack of sound makes any workplace noise (particularly conversation) that much louder." Of course, it only seems louder. Fortunately, the flipside of this coin is that human beings can perceive a space with a higher continuous background sound level as quieter.

The question then becomes: what type of sound is best equipped to provide this background? While the ability of sound to move, soothe, and motivate people has many talking about the role music, birdsong, and binaural beats can play within the workplace, striking the right balance between noise and silence involves establishing a comfortable and effective "sonic base" using a particular type of sound rarely discussed: random, non-informational sound spread over a broad frequency range. Because people are not typically conscious of this type of sound unless

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it reaches a level that interferes with sounds they want to hear (*e.g.,* a conversational partner within the hum of a busy restaurant), many members of the general public and even the professional building community are not aware of the positive role it plays in creating effective indoor acoustics. This oversight is compounded by the belief that buildings are constructed in a way that reduces noise and conversation to the point that they will not be heard.

Introducing this type of sound presents both the need and opportunity to perfect it as much as possible; in other words, to ensure it meets occupants' specific requirements as human beings. Studies such as those conducted by Veitch (2012)[7] and Srinivasan et al. (2023)[8] show the ideal level for a comfortable and functional open workplace is 45 to 50 dBA. Levels above 55 dBA are irritating and raise stress levels, while levels below 45 dBA also cause stress because they are "too quiet" to prevent distraction. However, many factors besides decibel level also influence whether sounds are experienced positively or negatively, including their spectral (*e.g.,* rumbly, buzzy, hissy), temporal (*e.g.,* constant, fluctuating, surging, intermittent), and spatial (*e.g.,* overhead, adjacent, throughout a space) characteristics.

Although distributing a non-informational background sound might not seem like a complex task, it must tick many boxes to be successful.

Getting it right

Because it is meant to improve comfort and minimize the amount of change occupants experience in their acoustical conditions—not add to them—the sound cannot significantly fluctuate in volume or spectrum, contain certain frequencies at levels that are too high or too low, or include perceptible patterns.

The electronics generating the sound, as well as the physical positioning and capabilities of the loudspeakers distributing it, bear some of the burden. Still, just like any other sound produced within the space, it is subject to physical forces exerted by the facility's interior, including the materials used and items placed within it; in other words, as Blesser and Salter describe in "Spaces Speak, Are You Listening?" (2007),[9] when a sound is introduced, "the environment responds as if it were a partner in an auditory dialogue," and the "listener is immersed in the space's aural response."



Unlike masking sound, incidental, unpredictable sounds (*e.g.,* HVAC) and informational, variable sounds (*e.g.,* water, birds, music) cannot be relied on to provide consistent noise control or speech privacy.

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To ensure the masking sound that ultimately exists in the space actually "hits all the right notes," a trained technician must use a professional-grade (*i.e.,* Class 1) sound level meter to measure its levels and frequencies post-installation and adjust each zone's settings as needed. Each zone should only cover a small area, maximizing the ability to finely adjust the sound to consistently meet the target masking level and spectrum across all treated spaces. Masking sound delivery can only be considered complete if it conforms to specified tolerances, preferably using testing procedures that meet or exceed the requirements of ASTM E1573-22, *Standard Test Method for Measurement and Reporting of Masking Sound Levels Using A-Weighted and One-Third-Octave-Band Sound Pressure Levels.*

Those requirements are the reasons why incidental, unpredictable sounds (*e.g.,* the noise generated by HVAC equipment) and informational, variable sounds (*e.g.,* lapping waves, chirping birds, any genre of music) cannot be relied on to provide the "sonic base" for a facility, even if they may—erratically, temporarily, and to some unmeasurable degree—cover up noise and speech. The former are merely byproducts of a process completely unrelated to acoustics. The latter not only exhibit volatile levels and frequencies but are subject to personal preference and also trigger thoughts, feelings, and emotions because, as Siebein (2011)[10] states, they have "content, meaning, and symbol in addition

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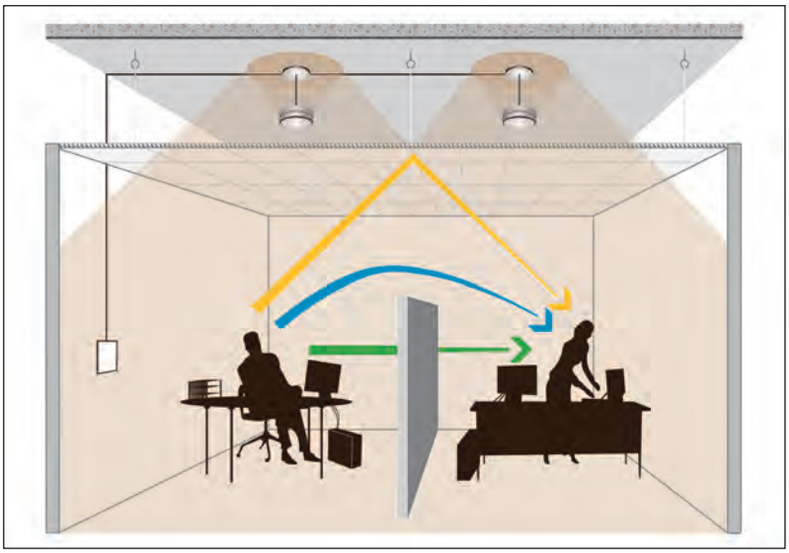

When formulating a soundscaping plan, it is crucial not to lose sight of the fact that masking sound is one of three pillars of effective acoustical design: cover, the 'C' in the 'ABC Rule,' which involves absorbing, blocking, and covering noise.

IMAGE COURTESY K.R. MOELLER ASSOCIATES LTD.

to level and other quantitative properties that are important in the experience of a soundscape in a building."

The aforementioned quality makes writing about sound masking in an article about soundscaping challenging. On the one hand, its inclusion makes sense; after all, it is a "designed" sound introduced to influence occupants' auditory experience within the built environment. On the other hand, there is a tendency to be captivated and inspired by sound's ability to affect emotions. To be clear, this is not the role of masking.

To do its job properly, the sound must essentially disappear from the occupants' consciousness. However, few publications provide details about what this implementation involves—specifics further obscured by indiscriminate use of terms such as "white noise" and "pink noise," social media posts touting the virtues of various sonic hues (*e.g.,* pink, violet), and studies that do not provide details regarding the masking spectrum, levels, and/or type of system tested. This can lead readers (and even some researchers) to flawed conclusions.[b] Omitting specifics also reinforces the erroneous notion that all masking systems produce the same sound and results.

The 'C' in ABC

When formulating a soundscaping plan, it is also crucial not to lose sight of the fact that masking is actually one of the three pillars of effective acoustical design: the "C" (cover) in the "ABC Rule."

As such, this sound is not only a subjective parameter (*i.e.,* occupants will perceive treated areas as quieter), but a critical objective (*i.e.,* measurable) feature of the acoustic environment. When tuned to a specific level and spectrum (*e.g.,* the National Research Council [NRC] Optimum Masking Spectrum), it not only provides a reliable sonic foundation for key occupant needs and workplace activities, but also for speech privacy calculation and, therefore, improved specification and more cost-efficient selection of the materials used for "A" (absorb) and "B" (block). Once this strong acoustical foundation is laid, curated sound and music experiences can be strategically added, as Atkinson and Rogers[3] suggest, in smaller, select areas, such as reception, social, and wellness spaces, to achieve specific aims. The use of masking does not negate their addition; in fact, many systems can simultaneously distribute other sounds through the same loudspeakers.

Together with absorption and blocking, masking also helps prevent those other sounds from being heard in areas where their effect is not required or desired. As stated by Abdulkarim (2009),[11] people "hear further than we can see," so introducing aural experiences in spaces requires careful control of their boundaries and the acoustic conditions within them. Control is not only crucial to the success of these "sonic zones" (*e.g.,* a relaxing room featuring forest ambiance is far less effective if pop music is playing next door), but it also permits occupants to form a cognitive map of their sonic environment, not just their visual one. Sound—like wall colour, seating type, lighting temperature, and technologies—helps communicate the intended emotional and behavioural experience within a given space; ideally, all the sensory elements come together to support its primary purpose.

Focus on focus

Of course, most of a facility needs to be acoustically supportive of the work it houses. According to numerous studies, office occupants spend most of their time on focused work, which they also identify as the most strategically important aspect of their jobs. They also frequently shift between concentrating on a task

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The majority of a facility needs to be acoustically supportive of much of the work done within it. Office occupants spend most of their time on focused work, which they also identify as the most strategically important aspect of their jobs.

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and collaborating with others, which typically involves just a quick, spontaneous discussion with someone at their workspace, online, or on the phone. With an acoustically well-designed space, those tasks are supported, and most of a person's day can be spent in one location, without feeling the need to escape elsewhere. Moving is a choice; they seek change when needed, not to flee a poor environment.

Relaxation, meditation, or napping rooms are excellent candidates for running water, birdsong, or other sounds that some find calming. As employees have little control over the soundscape in most offices, allowing an occupant to decide what plays in this smaller, separate space can also provide a sense of agency, which is particularly important for those experiencing mental stress. When entering a relaxation room, the occupant could select from a menu of biophilic recordings, binaural beats, singing bowls, music, and other "calming" sounds to help differentiate this space from the work soundscape and improve the user's ability to relax and recharge. Research shows that biophilic sounds are more restorative when paired with imagery of their source, helping occupants, for example, equate water sounds with a babbling brook rather than a leaky pipe. Studies indicate people tend to find small rooms more pleasant, calmer, and safer than large rooms; however, this effect disappears when a threatening sound is overheard. Yet another reason for good control of intruding noise.

Many other types of sounds can be worked into the office soundscape. Music, for example, can be used to create a brand-consistent vibe (*e.g.,* playful, trendy, mature) in areas such as lobbies, cafes, and other spaces where, as Atkinson and Rogers[3] point out, "productivity is less critical than relationship." Inviting employees to help build playlists for use in these spaces or at specific events can support relationship building as they hopefully bond over shared tastes. Recorded nature sounds—such as those from the local area—can also be played in such public spaces, strengthening the office's regional ties and establishing a memorable sense of place that helps occupants feel more personally connected to the workplace. Because it provides a sense of community and a lively acoustic setting, some people also find others' chatter inspirational while working on creative tasks. Cafe-like spaces provide an environment for those who desire a louder, busier soundscape, without disrupting those trying to focus.

In their work, Atkinson and Rogers[3] also found that sound can "invite the use of underutilized spaces like corridors and stairwells, encouraging people to walk, climb steps, and generally exercise more" or "simply provide moments of delight." As Blesser and Salter[9] state, "Devoid of acoustic features, a space is as sterile and boring as barren, gray walls. Just as visual embellishments can make a space esthetically pleasing to the eye, so aural embellishments can do so for the ear, by adding aural richness to the space." When doing so, it is again important to be mindful of how sound and space interact to ensure the resulting auditory experience is as desired. As Blesser and Salter[9] point out, familiar sounds do not have the same personality when transported to an environment with a different aural architecture; for example, "[m]oved to a forest, a symphony concert would not have the aural impact, intimacy, and immediacy of a concert hall."

Lastly, not every office is large enough to offer, for example, a relaxation room. In these cases, one can consider allowing employees to use a personal audio system (PAS) with earbuds or headphones for a few minutes at a time throughout the day. To help reduce the risk of hearing loss among users of such products, recommend they follow ITU-T H.870 (03/2022), *Guidelines for safe listening devices/systems.* Of course, these devices should not be used as a band-aid solution for poor acoustical design, as they raise numerous issues that run contrary to key workplace goals. For example, studies show

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that PAS can have an isolating effect within group settings. Others in the office may resent having to tap the wearer on the shoulder to get their attention. "Leaking" headphones and earbuds can also irritate nearby colleagues and prevent users from participating in conversations and benefiting from informal learning opportunities.

In conclusion

It is wonderful to see increasing interest in crafting occupants' aural experience within the built environment—one that facilitates concentration, socialization, tranquility, and esthetic pleasure rather than (albeit inadvertently) causing anxiety, isolation, and frustration. When formulating an acoustical plan, it is key to consider how the objective and subjective parameters inform one another and contribute to occupants' experience, as Eduardo Souza makes clear in "What Is Soundscape and What Does It Have to Do with Architecture?"[12] Environmental noise control and soundscape are not antagonistic approaches. On the contrary, they are complementary, as both influence occupants' holistic assessment of the acoustical environment. Because masking sound straddles both domains, it requires particularly careful specification and implementation.

Author notes

[a]While the ramifications of noise and lack of speech privacy—such as reduced concentration, accuracy, and productivity—have been relatively well studied and reported, research continues to reveal the true extent of their reach. Studies by Ayoko et al. (2023),[13] for example, show that higher levels of perceived office noise are linked to more negative moods, which can, in turn, be tied to greater employee withdrawal and task conflict, as well as to people marking their physical territories.[b] Despite product or app claims, what someone hears from their computer, cellphone, or bedside device is not any colour of noise; it is a "mix" of whatever sound the source generates electronically, altered by the physical capabilities of the loudspeaker, and further impacted by the listening space. Perception is even affected by the person's beliefs regarding the origin and effects of the sound. For example, a 2016 study by Haga et al.[14] suggests that the restorative effect of nature sounds is in part due to people's learned positive associations with nature rather than to people "biologically" finding their characteristics pleasing. The researchers asked participants to perform cognitively challenging tasks, with a short break in between, during which they were exposed to a pseudorandom sound. Participants had previously been split into three groups. Though the sound was identical for all groups, one was told it was a waterfall, another that it was mechanical ventilation, and the last that there was no source. The first found the sound more restorative than the group who believed it was from a mechanical source. The last group also found the sound restorative.



A long-term, real-world study using water-based sound in an open-plan office revealed that occupants associated it with a leaking pipe, fish tank, running bath, toilet, fan, and even rain on a tin roof. They also described the sound as distracting, unpleasant, and awful, and indicated it did not mask noise or conversation.

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Personal audio systems (PAS) should not be used as a band-aid solution for poor acoustical design because they raise numerous issues that run contrary to key workplace goals.

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Notes

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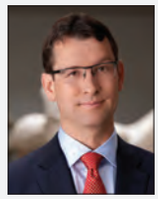

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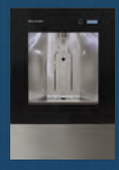

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A More Holistic Approach to Sustainable Wood Flooring

By Dr. Georg Vetter

PHOTOS COURTESY IQ OFFICES

When architects and specifiers evaluate the sustainability of wood flooring, the conversation often begins with questions on responsible sourcing. Is the timber certified by the Forest Stewardship Council (FSC) or Programme for the Endorsement of Forest Certification (PEFC)? Does the manufacturer maintain a chain-of-custody certification? Can the origin of the wood be verified? These are important questions that should remain fundamental to any specification process.

However, for an industry increasingly focused on embodied carbon, lifecycle assessment, and resource efficiency, responsible sourcing alone is not enough. If the Canadian AEC community is serious about reducing the environmental footprint of buildings, it must consider a broader question: how effectively are natural resources being transformed into long-lasting building materials?

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Ultimately, sustainability is about ensuring that forests are responsibly managed and that every tree harvested delivers as much long-term value as possible.

Measuring resource efficiency

The construction industry has made significant progress in understanding the importance of responsible forestry. Certification schemes have helped establish clear standards for forest management, biodiversity protection, and supply-chain transparency. But a certified tree is still a finite natural resource. The sustainability challenge does not end when that tree leaves the forest. In many ways, that is where it begins.

What matters next is how efficiently that resource is utilized, how much waste is generated during production, how long the final product lasts, and how much additional material will be needed to replace it during the building's life.

These factors are often overlooked in flooring specification discussions, despite having a major influence on a product's overall environmental impact. Technological advances are helping to address this by enabling more efficient use of the raw material.

Delivering the greatest value

For decades, the flooring industry has largely operated on a simple model: harvest timber, manufacture flooring, and sell volume. But as resource pressures increase and sustainability expectations grow, a different question becomes more relevant: How much flooring can be produced from a single log?

Traditionally, wood flooring manufacturing has relied on relatively thick wood wear layers and sawing processes that generate significant material loss. Valuable timber can become sawdust before it ever reaches a building.

This is one of the industry's biggest sustainability opportunities. One approach[1] uses a thin slice of real wood combined with a moisture-resistant wood core, allowing significantly more flooring to be produced from the same amount of timber than conventional methods. Manufacturers taking this whole-log approach aim to maximize the usable surface area from each log.

For specifiers, this raises an important consideration. If one floor delivers comparable

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A floor that lasts twice as long does not simply reduce maintenance costs; it may also reduce the environmental burden associated with replacement.



For decades, the flooring industry has largely operated on a simple model: harvest timber, manufacture flooring, and sell volume.

esthetics and performance while requiring substantially less hardwood per square metre, should that influence sustainability assessments? Increasingly, the answer should be yes.

Durability is often a missing sustainability metric

The building industry frequently associates sustainability with recycled content, certifications, and carbon reporting. Less attention is often given to the question: how long will the product remain in use? This is an important sustainability question.

Every floor replacement carries environmental consequences. New raw materials must be harvested. New products must be manufactured and transported. Existing materials must be removed and disposed of.

A floor that lasts twice as long does not simply reduce maintenance costs; it may also reduce the environmental burden associated with replacement. This is particularly relevant in commercial, institutional, and multi-residential projects where lifecycle costs and operational impacts play a significant role in material selection.

Therefore, durability should not be viewed as a performance benefit alone. It should be viewed as a sustainability strategy. This connection between durability and sustainability should be central to product development. A product that remains functional and attractive for longer ultimately extracts more value from every resource invested in its production.

The lifecycle thinking gap

Another area where the industry can evolve is how products are compared. Too often, specifications focus on isolated sustainability attributes. One product may promote certified wood. Another

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It is important for specifiers to consider whether the timber they use is certified by the Forest Stewardship Council (FSC) or Programme for the Endorsement of Forest Certification (PEFC).

PHOTO COURTESY BJELIN

may highlight recycled content. A third may emphasize low CO2 emissions.

While all are valuable considerations, they rarely present the whole picture.

Architects increasingly have access to Environmental Product Declarations (EPDs), which provide a broader assessment of environmental impacts across a product's lifecycle. However, even with EPDs, it is important to ensure that comparisons are made on a like-for-like basis. Differences in product categories, declared units, system boundaries, and assumptions can make it difficult to compare results directly, creating a risk of comparing apples and pears.

The industry's challenge is to make greater use of these tools and move sustainability discussions from individual product attributes toward whole-life environmental performance.

What should specifiers be asking?

As sustainability requirements continue to evolve across Canada, architects and specifiers may benefit from expanding the questions they ask manufacturers.

First, they should ask whether the timber is responsibly sourced. But they should also ask: How efficiently is the raw material utilized? How much waste is generated during production? Is the product supported by an EPD? What maintenance is required over its lifespan? How durable is the surface in real-world conditions? And what service life can reasonably be expected?

The future of sustainable flooring

Responsible sourcing will always remain essential. No sustainability discussion should begin without it. But the next chapter of sustainable specification will be defined by something broader: resource efficiency, durability, and lifecycle performance.

Ultimately, sustainability is about ensuring that forests are responsibly managed and that every tree harvested delivers as much long-term value as possible. This is done through intelligent product design, innovative technology, efficient manufacturing, and durable performance.

The Canadian AEC industry has an opportunity to lead this shift. By looking beyond responsible sourcing and embracing whole-life thinking, architects and specifiers can make decisions that not only protect forests but also maximize the benefit derived from the resources those forests provide.

Notes

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Dr. Georg Vetter is head of sustainability at Bjelin, a Swedish wood flooring manufacturer. He has a background in forestry and wood technology, with extensive experience in wood-related R&D and sustainability. Bjelin is working with FSC-certified material (FSC-C140725).

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Fortress Architecture Is Ending

Integrating Security Into Public Space Design

By Danny Zanchi

PHOTO COURTESY ÄNNT BOLLARDS

For years, many public spaces have been approaching security in highly visible ways. Concrete barriers, rows of bollards, and temporary barricades became common features around civic buildings, transit hubs, cultural institutions, and public spaces.

The intent was protection. The result, too often, was something that felt defensive rather than welcoming.

This is the central challenge now facing architects, planners, and security professionals. The buildings and spaces needing the most protection are often the same ones expected to project openness: city halls, post-secondary institutions, event venues, mixed-use developments, and transportation hubs. These environments must support public access, pedestrian movement, accessibility, maintenance, emergency response, and civic life. They must also face a changing threat landscape where vehicle mitigation is a critical consideration in design.

The old model treated security as something added after a project was complete. A building opened, a risk was identified, and barriers were installed afterward. That approach may solve a technical problem, but it almost always creates a design problem. The more visible and reactive the intervention is, the more likely it is to undermine the experience of the space.

A better approach is emerging. Rather than treating perimeter protection as a separate layer, design teams are increasingly integrating it into the site from the beginning. When done well, security becomes part of the landscape, circulation strategy, material palette, and operational plan. It

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protects the public without turning public space into a fortress.

A different threat landscape

The pressure to rethink perimeter security is not theoretical. Since the early 2000s, vehicle-ramming attacks have become a defining security concern for crowded public environments.

Compared with more complex threat scenarios, vehicle-ramming incidents can be low-cost, are difficult to detect in advance, and cause mass casualties in a very short period of time. This places significant pressure on the physical design of streets, plazas, entrances, and pedestrian zones.

In Canada, the issue gained widespread public attention following the fatal 2018 Toronto van attack on Yonge Street. More recently, a vehicle drove into crowds attending Vancouver's Lapu Lapu Day block party on April 26, 2025, killing 11 people and injuring many others. The tragedy led the City of Vancouver and the Vancouver Police Department to undertake a joint review of outdoor special-event planning and safety, including vehicle mitigation strategies.

Many municipalities and institutions have responded by introducing emergency barriers around event sites, adding bollards at building entrances, and installing temporary measures where permanent plans did not yet exist. In many cases, these interventions were necessary. However, they also revealed a common problem: public spaces had often been designed without vehicle mitigation in mind.

These experiences also showed that when protection is considered late, the available options narrow. Barriers must be fitted around existing grades, drainage, utilities, paving, accessibility routes, tree pits, and vehicle access points. The result is often more expensive, more visible, and less elegant than if security had been part of the original site strategy.

Increasingly, the practical question for design teams is how early vehicle mitigation should be considered, what level of protection is appropriate, and how that protection can be integrated without compromising the space's public purpose.

Understanding the spectrum of protection

One of the most common misconceptions in perimeter security is that anything large, heavy, or visually robust provides meaningful protection. In practice, protective elements exist on a spectrum.

Decorative elements, such as planters, low walls, benches, or landscape features, can help define space and guide movement. They may discourage casual vehicle intrusion and contribute to a sense of order, but they are not necessarily engineered to stop an intentional impact.

Deterrent systems occupy the middle ground. They can discourage unauthorized access and may provide some physical resistance, depending on construction, anchoring, and site conditions.

However, they should not be assumed to provide certified protection unless they have been tested and specified accordingly.

Crash-rated systems are different. These products are engineered and tested to recognized standards, such as ASTM F2656, *Standard Test*

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As vehicle mitigation continues to grow in public realm design, the most successful projects will be those that address security, accessibility, operations, and esthetics together.

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Method for Crash Testing of Vehicle Security Barriers, to stop a vehicle of a defined weight travelling at a defined speed under impact conditions. This distinction matters because an obstacle may appear substantial yet offer little protection in a determined vehicle-attack scenario. Conversely, specifying crash-rated systems where deterrence would be sufficient can introduce unnecessary cost, engineering complexity, and design constraints.

Effective design begins with a clear understanding of risk. Project teams should consider occupancy type, pedestrian density, adjacent road geometry, event programming, symbolic value, emergency access, and the likely speed and angle of vehicle approach. The appropriate solution may be a crash-rated bollard, reinforced planter, grade change, removable barrier system, or a combination of several measures.

Landscape as infrastructure

Landscape architecture has an important role to play in this shift. Across Canada and internationally, site features are increasingly designed to serve multiple functions. A raised planting bed can introduce greenery, shape circulation, and contribute to vehicle mitigation. A seat wall can support social gatherings while helping define a protected pedestrian zone. A grade change, water feature, berm, or narrowed approach can reduce vehicle speeds and limit intrusion routes while standing out as part of the public realm rather than solely serving as security devices.



Security design also needs to consider how a space feels and functions once people are using it.

This integration is especially valuable in civic and cultural settings, where overt fortification can conflict with the place's intended character. A city hall plaza, for example, needs to feel accessible and democratic. A university campus needs to support openness, movement, and gathering. A mixed-use development needs to protect pedestrians without making retail frontages or residential entries feel guarded.

However, landscape integration is not a shortcut around engineering. Appearance does not guarantee performance. A site feature that looks protective may fail under impact if it has not been designed, reinforced, and anchored for that purpose. Where certified protection is required, collaboration among landscape architects, structural and civil engineers, security consultants, and manufacturers is essential.

The opportunity is to design protective elements that belong to the site. The risk is assuming that anything that looks substantial is protective. Good integration requires both design sensitivity and technical clarity.

Geometry as the first line of defence

Before any defensive system is placed, the site layout can do significant security work.

Vehicle speed is one of the most important factors in hostile vehicle mitigation. The faster a

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Following a series of security incidents in 2022 that revealed vulnerabilities in pedestrian areas, city officials in Ottawa undertook a comprehensive perimeter assessment.

vehicle can travel before reaching a protected area, the more energy any barrier must absorb. Site geometry directly affects that risk. A long, straight approach to a building entrance can create an acceleration corridor. A curved approach, offset alignment, narrowed access point, or strategically placed turn can reduce speeds before a vehicle reaches a pedestrian zone.

This is why perimeter security should be discussed during early site planning, not only during product selection. Decisions about drop-off zones, service access, parking layouts, curb cuts, roadway alignments, and plaza edges can all influence the level of protection required later.

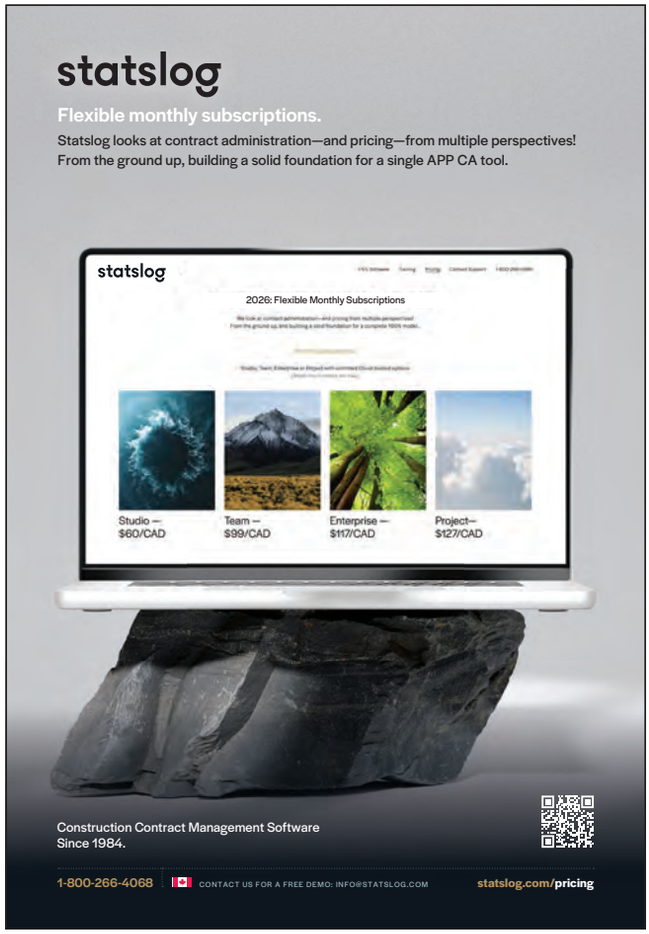
For designers, this can create tension. Legibility, convenience, and ease of movement are important public realm objectives. Routes should not be needlessly confusing or restrictive.

However, subtle changes in alignment can often reduce vehicle risk without compromising pedestrian experience. In some cases, a modest adjustment to circulation can reduce the need for heavier visible infrastructure.

Design considerations for vehicle mitigation projects

For architects, engineers, and owners, the most useful security conversations often begin with a set of practical questions. These should be addressed early, ideally during schematic design or site planning:

- Which pedestrian areas, entrances, gathering zones, or event spaces require protection?
- What vehicle approach routes exist today, and what new routes might be created by the design?
- What speeds could a vehicle realistically reach before entering a pedestrian area?
- Is the goal to discourage casual intrusion, manage access, or provide certified crash-rated protection?
- Are there locations where landscape, grading, site furnishings, or circulation design can reduce risk?
- Will emergency, maintenance, delivery, or service vehicles require periodic access?
- Should some protective elements be fixed, while others are removable or deployable?
- How will bollard spacing, barrier placement, and grade changes affect accessibility?
- Are there underground utilities, drainage requirements, or structural constraints that affect installation?
- Who will operate, store, inspect, and maintain removable or deployable systems?



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These questions help move the conversation away from simply asking, "Where do we put the bollards?" and toward a more integrated design process.

They also help avoid over-specification. Not every edge of a site requires the same level of protection. A high-risk approach beside a major pedestrian gathering area may require a crash-rated system. A low-speed maintenance route may call for a different solution. A landscaped edge may help protect while supporting other public realm objectives.

CPTED and the limits of visible fortification

Security design also needs to consider how a space feels and functions once people are using it. The principles of crime prevention through environmental design (CPTED) have long emphasized that safety is influenced by sightlines, lighting, activity, ownership, and natural surveillance.

These principles matter in perimeter security because highly defensive spaces can produce unintended effects. Opaque barriers can create blind spots, poorly placed infrastructure can disrupt pedestrian movement, and a plaza surrounded by heavy visible defences may feel less like a civic space and more like a controlled zone. When people feel uncomfortable, they may spend less time there, reducing the regular presence that helps make public areas feel safe.

This does not mean physical protection is unnecessary. It means protection should support the broader safety strategy. Clear sightlines, active frontages, accessible paths, appropriate lighting, and well-integrated barriers can work together. A protected space should still invite public use.

Flexibility and operational reality

Not every security need is permanent. Many public spaces operate differently depending on the time of day, season, event, or threat level.

A downtown street may carry regular traffic during the week and become a pedestrian market on weekends. A civic plaza may host a small public gathering one day and a high-profile political event the next. A university campus may have different access needs during normal academic periods, convocation, concerts, or major sporting events.

This is where removable and deployable vehicle mitigation systems can play an important role. A removable crash-rated bollard can allow maintenance or emergency vehicles through when needed, then be locked in place during an event. Deployable systems can provide temporary protection for festivals, parades, construction zones, and public gatherings without permanently closing streets or service routes.

Of course, flexibility only works if operations are planned realistically. Removable systems require staff training, storage, inspection, and clear deployment procedures. They must be practical to install and remove and easy to maintain. A system that meets the technical requirements but is too cumbersome to use consistently may fail in practice.

For owners and municipalities, operational planning should be part of the specification process. Things to consider include who has the authority to deploy the system, how long the installation takes, where removable components

Ottawa City Hall: Calibrated protection at a civic landmark

Ottawa City Hall occupies a highly visible civic site in the heart of Canada's capital. Following a series of security incidents in 2022 that revealed vulnerabilities in pedestrian areas, city officials undertook a comprehensive perimeter assessment.

Any solution would have to provide a high level of vehicle mitigation while preserving accessibility, civic character, and visual compatibility with the site's contemporary architecture.

A fortress-like intervention would have conflicted with the building's role as an open public institution.

The solution, deployed in 2023, used a strategic combination of fixed and removable K12-rated bollards. K12 is one of the highest crash-rating classifications, certifying that a bollard can stop a 6.8-t (7.5-ton) vehicle travelling at 80 km/h (50 mph).

Fixed K12 bollards were installed in the highest-risk pedestrian zones. Removable K12 bollards were used at emergency routes, maintenance corridors, and loading areas, providing the same impact resistance while preserving the operational flexibility required by a working civic facility.

The finish specification was also deliberate. Polished stainless steel coordinates with both the contemporary building elements and the traditional paving palette. The bollards provide protection, but they do not dominate the site.

The result is a civic environment where people can move freely without the visual noise of overt defensive infrastructure.

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The solution at Ottawa City Hall used a strategic combination of fixed and removable K12-rated bollards. K12 is one of the highest crash-rating classifications, certifying that a bollard can stop a 6.8-t (7.5-ton) vehicle travelling at speeds of 80 km/h (50 mph).

are stored, what happens during snow clearing, street cleaning, emergency access, or deliveries, and how often the systems are inspected.

The collaboration imperative

Successful security integration depends on collaboration. Architects, civil and structural engineers, security consultants, accessibility specialists, municipal staff, facility operators, and manufacturers each bring different expertise to the process.

When these conversations begin early, teams can co-ordinate protective performance with grading, drainage, utilities, paving, planting, circulation, accessibility, and architectural intent. Protective elements can be aligned with the site's material language. Access points can be planned rather than improvised. Removable systems can be located where they support operations rather than interfere with them.

When security is treated as a late-stage procurement item, it not only reduces available options; it often increases costs, creates accessibility conflicts, and complicates maintenance.

Accessibility deserves particular attention. Improper bollard spacing, for example, can create barriers for wheelchairs, strollers, and mobility devices. Poorly placed systems can interfere with emergency egress or create pinch points in high-volume pedestrian areas. Clearances, tactile cues, turning radii, and desire lines must be considered alongside impact ratings and access control.

Any protection strategy must also comply with applicable municipal and provincial accessibility requirements, which should be considered from the earliest stages of design and specification.

Toward invisible protection

Security infrastructure is likely to become more common in Canadian public spaces, not less. The challenge for design and construction professionals is to integrate it with enough care that protection does not dominate the experience of the place.

That requires the right level of protection in the right locations. It requires early risk assessment, thoughtful use of site geometry, careful co-ordination with landscape and infrastructure, realistic planning for operations and maintenance, and restraint. A well-protected public space should still feel public. People should be able to move and gather without feeling surrounded by defensive infrastructure. In many cases, the measure of success is that users do not notice the security at all.

As vehicle mitigation continues to grow in public realm design, the most successful projects will be those that address security, accessibility, operations, and esthetics together. The goal is not simply to stop vehicles; it is to create public spaces that remain open, functional, and welcoming while meeting evolving security requirements. The aim is not fortress architecture, but something quieter, smarter, and ultimately more humane.



Danny Zanchi is the co-founder and CEO at ännT Bollards. He works with architects, planners, municipalities, and security professionals to design and implement vehicle mitigation strategies for public spaces across North America.

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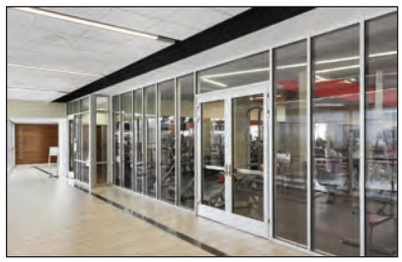

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Abigail MacEachern, Architect, RSW, LEED AP, CDT

Outlook for 2027

As we look ahead to 2027, there is a lot to be excited about. Construction Specifications Canada (CSC) continues to build on a strong foundation of education and member engagement while embracing new opportunities to grow and evolve. From enhancing our educational programs and expanding learning opportunities to strengthening our connections with industry partners and technical resources, we are positioning our organization for a bright future. Guided by the passion and dedication of our volunteers, members, and leaders, I am optimistic about what we can accomplish together in the year ahead.

Education remains at the heart of what we do. With Michelle Chalupa's onboarding as an external educational development consultant, we are finalizing updates to the Principles of Construction Documentation (PCD) course in early 2027. Afterward, our focus will shift to the ongoing, holistic improvement of our educational offerings. This includes developing a more structured, effective process for course reviews, expanding our education portfolio, and adapting our delivery methods.

Our Technical Studies portfolio also remains an important point of connection between CSC and the broader industry. CSC continues to monitor and engage with key initiatives that affect construction documentation and specifications across Canada. This includes collaborating on updates to Canadian Construction Documents Committee (CCDC) publications and to MasterFormat, UniFormat, OmniClass, and PageFormat/SectionFormat. While CSC contributes to the ongoing review and updating of content associated with CSI standards, it is not involved in the development, management, or operation of the CSI Dynamic Standards platform.

Looking ahead, I encourage everyone to mark their calendars for CSC Conference 2027, taking place May 26 to 30 in London, Ont. This year's theme, Rooted in Education, reflects the foundation on which CSC was built and underscores the importance of lifelong learning in our industry. The conference promises learning, networking, good food, and fun.

Finally, I would like to thank our treasurer for leading several key operational initiatives, including the transition to new banking systems, the enhancement of reporting processes for directors, and the continued stewardship of CSC's financial health.

I am excited to jump into 2027 and see all the amazing things we will accomplish together.

Perspectives pour 2027

Alors que nous nous tournons vers 2027, il y a beaucoup de raisons d'être enthousiastes. Devis de construction Canada (DCC) continue de bâtir sur une solide base d'éducation et d'engagement des membres tout en saisissant de nouvelles occasions de croissance et d'évolution. Qu'il s'agisse d'améliorer nos programmes de formation, d'élargir les possibilités d'apprentissage ou de renforcer nos liens avec des partenaires de l'industrie et des ressources techniques, nous positionnons notre organisation pour un avenir prometteur. Guidée par la passion et le dévouement de nos bénévoles, membres et dirigeants, je suis optimiste quant à ce que nous pouvons accomplir ensemble dans l'année qui vient.

L'éducation reste au cœur de ce que nous faisons. Avec l'intégration de Michelle Chalupa en tant que consultante externe en développement éducatif, nous finalisons les mises à jour du cours sur les principes de la documentation de construction (PDC) au début de 2027. Par la suite, notre attention se portera sur l'amélioration continue et holistique de nos offres éducatives. Cela comprend l'élaboration d'un processus plus structuré et efficace pour la révision des cours, l'expansion de notre portefeuille de formation et l'adaptation de nos méthodes de prestation. Nous avons la chance d'avoir des bénévoles talentueux et des responsables de l'éducation.

Notre portefeuille d'études techniques reste également un point de connexion important entre DCC et l'ensemble de l'industrie. DCC continue de surveiller et de participer à des initiatives clés qui touchent la documentation et les spécifications en matière de construction partout au Canada. Cela comprend la collaboration sur les mises à jour des publications du Comité canadien des documents de construction (CCDC) et de MasterFormat, UniFormat, OmniClass et PageFormat/SectionFormat. Bien que DCC contribue à l'examen et à la mise à jour continus du contenu associé aux normes de l'ICS, il n'est pas impliqué dans le développement, la gestion ou l'exploitation de la plateforme des normes dynamiques de l'ICS.

Pour l'avenir, j'encourage tout le monde à noter dans son agenda la conférence DCC 2027, qui se tiendra du 26 au 30 mai à London, en Ontario. Le thème de cette année, Enraciné dans l'éducation, reflète les fondements sur lesquels DCC a été construit et souligne l'importance de l'apprentissage continu dans notre industrie. La conférence promet formation, réseautage et plaisir.

Enfin, je tiens à remercier notre trésorier d'avoir dirigé plusieurs initiatives opérationnelles clés, notamment la transition vers de nouveaux systèmes bancaires, l'amélioration des processus de déclaration pour les administrateurs et la gestion continue de la santé financière de DCC.

Je suis enthousiaste à l'idée de commencer 2027 et de voir toutes les choses incroyables que nous accomplirons ensemble.

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