Environmental Impact Guide

Underground Stormwater Management Systems

Building Resilient Cities.

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Introduction

Urban expansion and climate change make effective stormwater management crucial for engineers in North America. With over 80% of Canadians and Americans living in cities, there is increasing strain on infrastructure. Aging systems and frequent severe weather events drive the need for innovative solutions that meet regulatory standards and promote sustainable urban development. Additionally, water scarcity affects densely populated regions in North America, specifically the Southwestern United States, highlighting the importance of sustainable water practices.

This guide explores the benefits of underground stormwater management systems in North American cities. These solutions offer significant environmental advantages:

Optimized Land Use & Urban Planning

Underground systems free up surface space for green areas, recreation, and development, promoting denser, more livable cities.

Enhanced Water Quality

Innovative technologies improve runoff and pollution control, enhancing the quality of urban water bodies and supporting healthier ecosystems.

Flood Mitigation & Erosion Control

These systems reduce urban flooding risks during heavy rainfall and extreme weather, protecting property and ensuring community safety.

Optimized Land Use & Urban Planning

Uncontrolled urbanization and development can alter the natural hydrological cycle due to the increase in impervious land coverage and changes in pervious areas. An increase in impervious surfaces can cause:

- Reduced infiltration and evaporation
- Reduced groundwater recharge
- Increased runoff and more frequent/severe flooding events
- Elevated temperatures for stormwater discharges
- Degradation of water quality
- Groundwater depletion

Improper urban planning that does not integrate a sound stormwater management plan is detrimental to the environment and reduces the quality of life for residents.

Project Cost Implications

In addition to environmental consequences, improper urban planning is highly costly. With the cost of land in urban areas and the extreme increase in development and construction costs (at the time this guide was published), developers and municipalities can't afford to waste land or approve a poorly designed stormwater management plan.

> Since 2020, fluctuating residential and non-residential development costs have significantly affected the construction industry, requiring all stakeholders to adapt. Engineers and developers must choose the best materials and products to keep projects on track and under budget.

Maximizing Land Use

Underground stormwater management systems offer a strategic solution to the dual challenges of high land costs and the need for optimized land use in urban construction.

By installing essential water management infrastructure underground, valuable surface land that would otherwise be dedicated to large stormwater ponds or other surface management system can be freed up for more valuable uses, such as public parks, commercial development, or housing.

Modular tanks have a high void ratio (up to 97%), meaning they can store large volumes of stormwater in the smallest footprint. This is particularly advantageous in densely built areas where space is at a premium and project sites have tight spatial constraints.

> In this project, 645 m^3 of water storage was required for a commercial warehouse lot with extremely limited space. A product with high void space was necessary to meet the local stormwater requirements; any other product would have required roughly 33% more space to function properly. The modular tanks selected allowed for the smallest project footprint possible.

Flexibility in Design

Underground systems can be designed and constructed to fit around existing buildings and infrastructure. This flexibility allows for more creative and effective use of space in urban planning and can be adapted as cities grow and change. Additionally, underground stormwater management systems can be easily integrated with Green Infrastructure (GI) or Low Impact Development (LID) techniques.

- **Pervious pavement:** Paving methods for roads, parking lots and walkways that allow the movement of water and air through the paving material.
- **Rain gardens and bioretention systems:** A shallow depression planted with suitable vegetation used to collect stormwater by mimicking the natural process of water absorption.
- **Downspout connections:** A pipe that directs stormwater runoff from the roof of a building to rain barrels, cisterns or permeable areas rather than a storm sewer.
- **Rainwater harvesting:** The collection and storage of rain to reduce runoff and save water for irrigation on site.
- **Bioswales:** Often found along curbs and in parking lots, bioswales use vegetation to slow and filter stormwater flows and provide pollinator habitats.
- **Green parking:** Several GI methods can be integrated into parking lot designs (permeable pavement, rain gardens, bioswales, etc.) which also reduce the heat island effect.

Improved Aesthetics

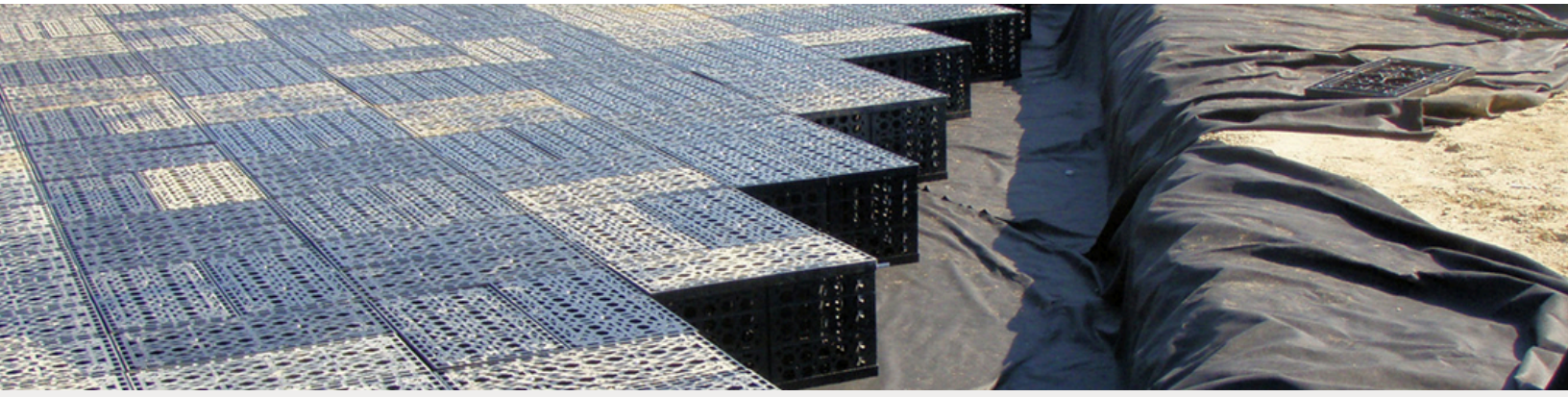
An underground stormwater system can be an attractive feature that enhances the value of a property. The system can be designed to include landscaping features, such as bioswales with grasses and flowers for pollinator habitats. Underground systems reduce the need for clunky ponds and ditches. The system can also be equipped for rainwater harvesting to provide irrigation on site.

Maintenance Cost-Effectiveness

Once a system is installed, it requires very little maintenance beyond occasional inspections to ensure that it's functioning properly. Underground systems reduce the need for expensive flood damage repairs to properties and infrastructure and offer more environmental and aesthetic benefits.

Design Assistance

Stormwater management is site-specific, and no single solution can be recommended. Detail and precision are imperative to the planning, designing, and construction phases. Titan offers various underground stormwater management solutions with design consultation, so your site and investment are protected.



Enhanced Water Quality & Control

Urbanization and development can result in contaminant sources which contribute elevated levels of chemical, physical or biological contaminants to enter downstream receivers.

An underground stormwater system can help to improve water quality by filtering out pollutants and other contaminants from stormwater runoff. The system can be designed to include debris rows and isolator rows for ease of maintenance and higher sediment retention.

> Through water detention, infiltration and drainage, underground stormwater management systems maintain better water quality than alternative surface solutions.

Infiltration & Sediment Capture

When designing an underground system, infiltration and sediment capture is an essential consideration for two main reasons:

- To ensure the system itself doesn't become clogged with sediment.
- To ensure sediment and other contaminants are captured before stormwater is released back into the groundwater/downstream receivers or used for irrigation.

Including areas for sediment capture and removal as part of the system design will eliminate the need to trace the entire system ensuring long-term performance and reducing maintenance.

Debris rows can be installed in the inlet section of modular tank systems to remove sediment, trash, and debris from stormwater and isolate the material for later removal.

Isolator rows can be installed in the inlet section of arch chamber systems to act as a sediment trap. They are completely encased in geotextile filter fabric.

In systems designed for retention or detention, an impermeable geomembrane liner is often incorporated. See page 7 for more details on the difference between infiltration, retention and detention.

Groundwater Recharge

Understanding of seasonal groundwater is essential for developments with deeper underground facilities where intrusion into the groundwater table is likely. Groundwater conditions should be investigated through the completion of site-specific geotechnical or hydrogeological assessments.

Where groundwater intrusion is possible, infiltration systems allow stormwater to percolate through the soil, naturally filtering it and helping to replenish groundwater aquifers. This is particularly important in areas where groundwater supplies are a critical resource for drinking water and agriculture.

Reducing Pollution Caused by Surface Runoff

According to the Environmental Protection Agency (EPA), underground systems can significantly reduce stormwater runoff, by as much as 80%, and decrease the pollutants entering our waterways, making them a crucial component of urban environmental management.

By capturing stormwater and directing it underground, underground systems minimize surface runoff, which can carry pollutants from urban surfaces into water bodies. This reduces the overall pollutant load entering streams, rivers, and lakes.

Flood Mitigation & Erosion Control

Urbanization and development cause increased runoff volume and peak flows due to impervious surfaces. Underground stormwater systems are extremely successful in stormwater runoff management. These systems are intended to capture and store stormwater, where it can gradually infiltrate into the ground. This reduces the quantity of stormwater runoff that enters streams, rivers, and other bodies of water, reducing flooding and erosion.

Enhanced Detention & Infiltration

Modular tanks can be designed to temporarily hold large volumes of stormwater that accumulate during heavy rainfall events. After detaining the stormwater, these systems release it slowly at a controlled rate. Infiltration allows stormwater to percolate into soil, replenish groundwater and reduce the volume of water that needs to be managed on the surface.

Reduction of Surface Runoff

By diverting stormwater underground, these systems reduce the amount of water that flows over the ground surface. This minimizes immediate flood risks and decreases erosion.

Design Flexibility and Scalability

Underground systems can be designed and scaled to meet a location's specific needs, considering local rainfall patterns, topography, and urban layout. This tailored approach ensures that areas prone to flooding are equipped with adequate infrastructure to handle stormwater effectively.

> According to a study prepared for the U.S. Environmental Protection Agency, annual savings in the USA in terms of flood losses avoided in the year 2040 would range from $63 million to $136 million (2011 dollars) if Green Infrastructure practices were more widely adapted on new development and redevelopment where stormwater management costs are part of the project.

Choosing the Correct Underground System

Infiltration, Retention, or Detention?

Underground stormwater systems incorporate either an impermeable geomembrane or a permeable non-woven geotextile depending on if the system is meant for infiltration, retention or detention.

Infiltration-focused applications include non-woven geotextiles around the chamber or tank and the granular stone at the excavation line. This allows the water to be stored in a temporary basin for it to percolate down into the bedding layer and native soils to recharge the groundwater.

Retention-focused systems include an impermeable liner either wrapped around the chamber or tank or wrapped around the granular material. This prevents infiltration for various reasons, including concern over contaminated soil or the presence of groundwater. This method allows for rainwater harvesting to be used for irrigation.

Detention is meant to slow the release of water and reduce peak runoff downstream based on the outlet or orifice sizing. This type of application may or may not include an impermeable geomembrane.

Regulatory Compliance & Maintenance

In addition to several environmental benefits, underground stormwater management systems can help engineers meet regulatory requirements where they're required:

- Water quality standards
- Reduction of runoff volume requirements
- Erosion and sediment control regulations
- Green infrastructure or low-impact requirements
- Flood management regulations
- Sustainable sites initiatives or certifications

Underground stormwater systems require less maintenance and repair than conventional stormwater management systems such as retention ponds and swales.

Maintenance Methods

Conduct regular inspections:
Regular inspections of the underground stormwater system can help to determine the appropriate removal frequency.

Clean out sediment and debris:
Over time, sediment and debris can accumulate in the underground stormwater system, which can reduce its effectiveness. Cleaning out sediment and debris on a regular basis can help to ensure that the system continues to function properly, and the storage volume is optimized.

Additional Design Factors

When choosing a system, load rating, buoyancy, lateral load and potential dead loads are important factors. These parameters help ensure the stormwater system is designed to match the site requirements for long-term performance.

StormTank® Modules

Modular tank systems are comprised of strong PVC and polypropylene boxes, assembled side by side to create a subsurface tank. They're applied in conjunction with geotextiles, clear stone and geomembranes (if applicable).

Key Benefits and Features:

- Suitable for major commercial construction and smaller residential applications.
- Can reduce stone backfill by 40-60%, on average.
- Largest void space of any subsurface stormwater management system – up to 97% (minimal granular stone required for installation, allowing for maximum volume of water).
- Uniform load distribution and strength.
- Used for infiltration, retention, rainwater harvesting, and runoff reduction.
- Designed to ASTM & AASHTO specifications.
- System stack ability and variable column height to accommodate site constraints.
- Can be used in submerged groundwater conditions.

Arch Chambers

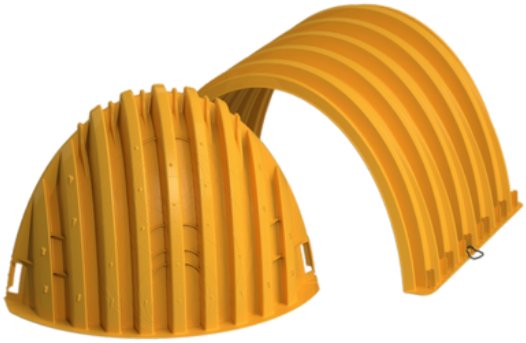
Arch chambers are made of polypropylene and feature an open bottom. They're placed in parallel rows in conjunction with geotextiles, clear stone and geomembranes (if applicable).

Key Benefits and Features:

- Suitable for major commercial construction and smaller residential applications.
- Structurally durable; 75-year design life.
- Used for infiltration, retention, rainwater harvesting, and runoff reduction.
- Designed to ASTM & AASHTO specifications.
- Stormwater quality through patented isolator row (TSS, TP and TPH removal).
- Reduction of thermal impacts.

Applications for Modular Tanks and Arch Chambers:

- Stormwater runoff reduction
- Water sustainability
- Rainwater detention
- Underground stormwater retention
- Underground stormwater infiltration
- Rainwater harvesting
- Flood mitigation



About Titan Environmental

High Performing Products Backed by Comprehensive Service

Whether you are a water resources engineer working on a stormwater project or a civil contractor bidding on a project, Titan can help you. We offer underground stormwater management solutions with comprehensive service giving you peace of mind that your site and investment are protected.

Product Supply

Stormwater management systems are available from all Titan locations. We provide competitive quotes for every component of your stormwater management project.

Design Assistance

Our stormwater management technical team provides preliminary layout designs. This includes calculations, CAD drawings, and specifications to ensure that your project meets performance criteria and regulatory standards.

Installation Support

Our technical expertise extends to supporting contractors on proper installation of stormwater management systems. This helps ensure performance and longevity of a system, and overall project success.

More on Stormwater Management

Get in touch with the Stormwater Management Team to inquire about a current or future project. Titan works closely with engineers, contractors, and project owners on stormwater management projects in Canada and the USA.

- Technical talks on stormwater management systems
- Site specific consultation on system selection
- Design support
- Installation support

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