



Secure Structure Alliance
Nonprofit Environmental Organization
Clean Water. Resilient Structures. Safer Communities

The Hidden Life of Wet Waste

Stormwater, Leachate, and the Science of Source Control

High School Environmental Science Edition

TITLE PAGE

The Hidden Life of Wet Waste
Stormwater, Leachate, and the Science of Source Control

Applied Environmental Science Series

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SECTION 1

Two Rainstorms, Two Outcomes

It begins with a storm.

Rain falls across a city — rooftops, sidewalks, parking lots, and dumpsters.

In one location, a dumpster lid is fully closed. Rain strikes the metal surface, slides off the sides, and flows across pavement into a storm drain.

In another location, a dumpster lid is partially open. Rain enters the container and mixes with food waste, cardboard, plastic, and debris.

At first glance, the difference appears minor.

Within hours, however, two very different environmental pathways have been created.

One pathway remains stormwater.

The other becomes leachate.

This difference illustrates how small physical conditions can influence larger environmental systems.

SECTION 2

Urban Hydrology and Runoff

Impervious Surfaces

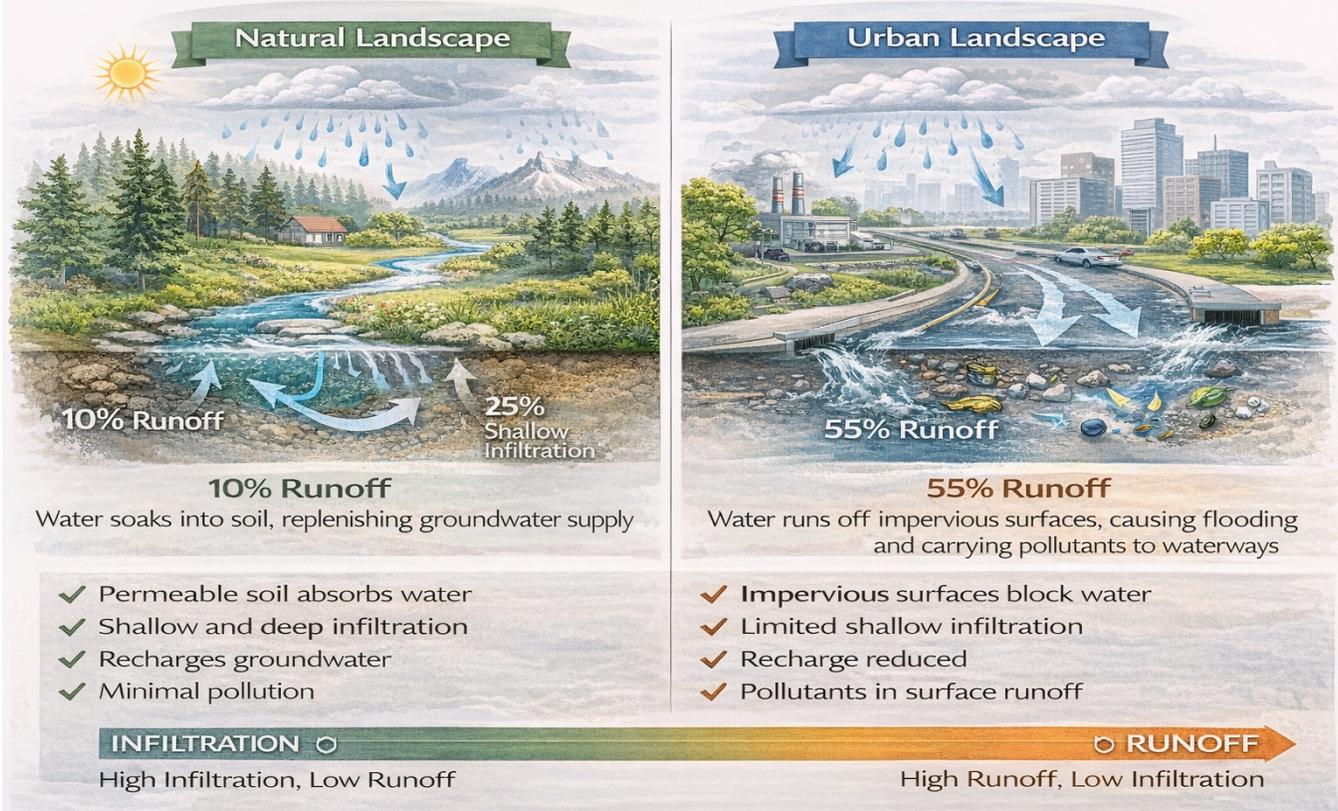
Urban environments are dominated by impervious surfaces such as asphalt, concrete, and rooftops. These materials prevent rainfall from infiltrating into soil.

Instead, precipitation becomes surface runoff.

Runoff moves quickly due to gravity and enters stormwater systems designed primarily for flood control.



Natural Infiltration vs Urban Runoff Comparison



Municipal Separate Storm Sewer Systems (MS4)

Most municipalities operate MS4 systems.

These systems collect and convey stormwater through:

- Street gutters
- Catch basins
- Underground piping
- Open channels
- Outfall structures

Stormwater typically discharges directly into rivers, lakes, or coastal waters without treatment.

Because of this, pollutants transported by runoff can enter natural ecosystems.

SECTION 3



When Water Meets Waste

When rainwater enters a waste container and contacts solid waste, a transformation occurs.

Water passing through waste dissolves and suspends contaminants. This liquid is known as leachate.

Leachate may contain:

- Organic matter
- Bacteria
- Nutrients
- Heavy metals
- Oils and grease
- Microplastics

The longer moisture remains in contact with waste, the higher the concentration of contaminants.

Increased Mass and Moisture

Water increases total waste mass.

As waste absorbs moisture:

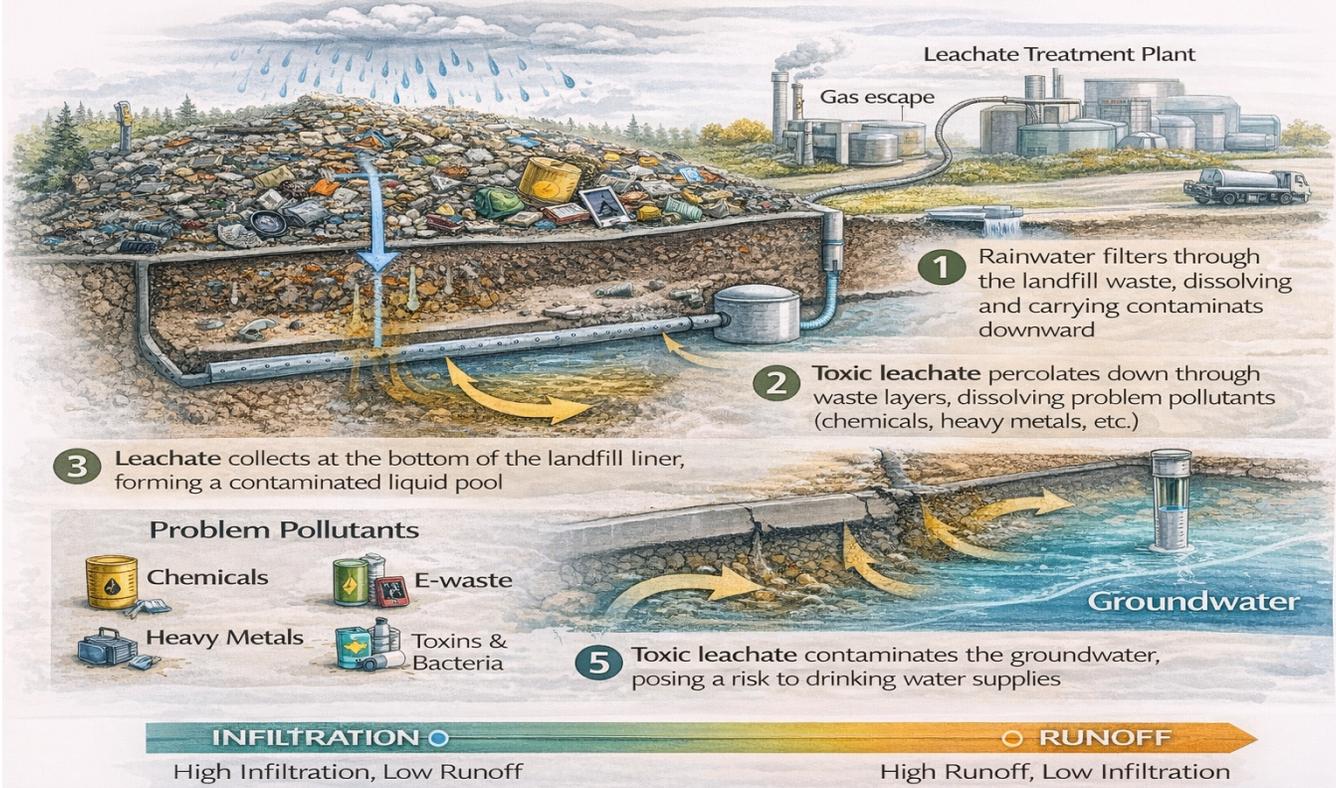
- Disposal weight increases
- Hauling costs increase
- Fuel consumption increases

Moisture also accelerates biological decomposition.



Leachate Formation Process

How Leachate Forms from Landfill Waste and Contaminates Groundwater



SECTION 4

Modern Landfill Engineering

Modern landfills are engineered systems designed to isolate waste from the surrounding environment.

Key components include:

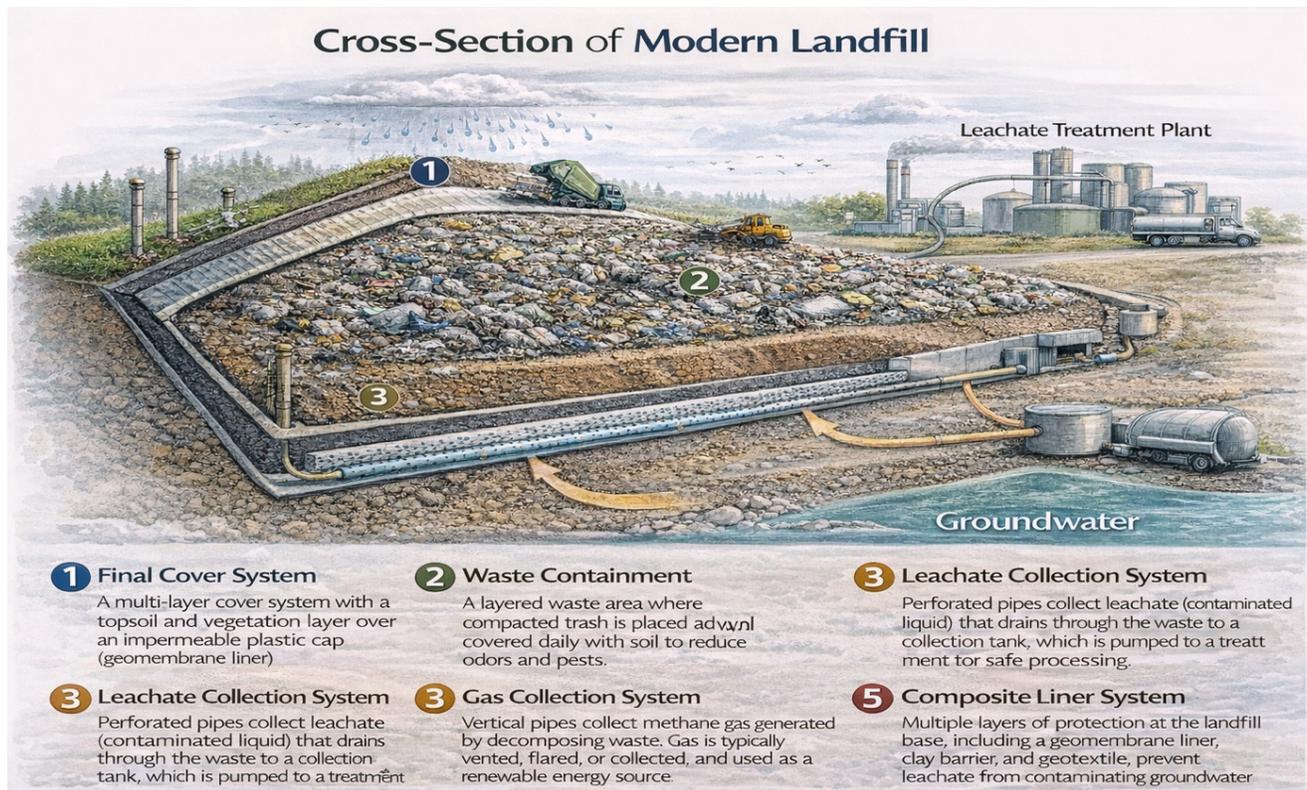
- Composite liner systems
- Leachate collection piping
- Drainage layers
- Gas collection wells
- Groundwater monitoring wells

Landfills are designed to manage moisture. However, unnecessary water increases:



- Leachate volume
- Treatment requirements
- Methane production

Reducing moisture at the source reduces operational demands on landfill systems.



SECTION 5

Methane and Climate Impact

Organic waste decomposes anaerobically in landfills, meaning without oxygen.

This process produces methane.

Methane is a greenhouse gas with a higher short-term warming potential than carbon dioxide.

Landfills install gas collection systems to capture methane and reduce emissions.

Some captured methane is converted into energy.

However:



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- Gas collection systems are not 100% efficient
 - Increased moisture can increase gas generation
 - Environmental impacts accumulate over time
-

SECTION 6

Regulatory Framework

Stormwater and solid waste systems are regulated under federal and state law.

Key regulatory components include:

- Clean Water Act
- National Pollutant Discharge Elimination System (NPDES)
- Municipal stormwater permits
- Solid waste management regulations

Municipalities are required to reduce pollutant discharge to the maximum extent practicable.

Source control supports regulatory compliance by preventing pollution before it enters stormwater systems.



SECTION 7

Transportation and Emissions

Solid waste must be transported from collection points to transfer stations or disposal facilities.

Moisture increases waste weight.

Increased weight results in:

- Higher fuel consumption
- Increased vehicle emissions
- Greater wear on infrastructure

Emissions associated with waste hauling include:



- Carbon dioxide
- Nitrogen oxides
- Particulate matter

Reducing moisture reduces emissions intensity per ton of waste transported.



SECTION 8

Pollution Pathways

When leachate escapes a container and reaches pavement, it can enter storm drains.

Storm drains typically discharge untreated water into natural waterways.

This creates potential impacts including:

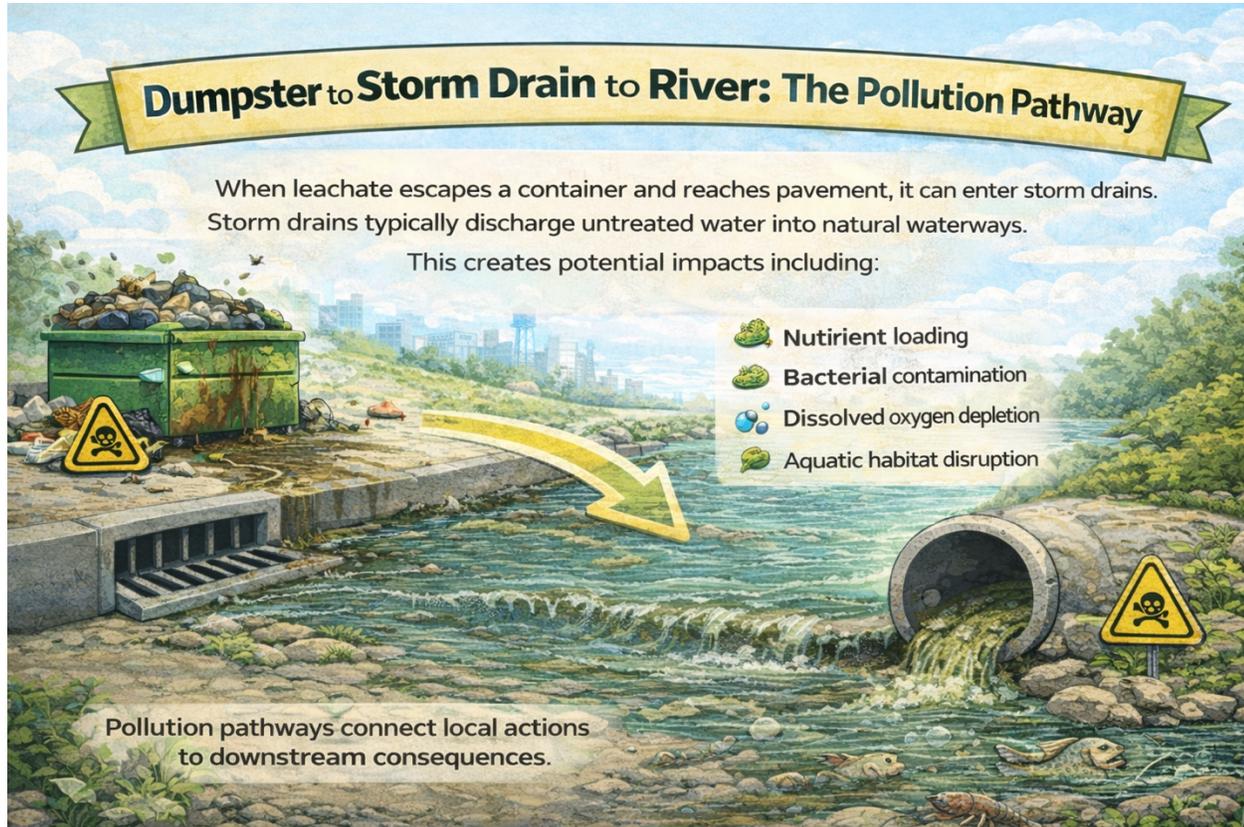
- Nutrient loading
- Bacterial contamination



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- Dissolved oxygen depletion
- Aquatic habitat disruption

Pollution pathways connect local actions to downstream consequences.



SECTION 9

Source Control as a Management Strategy

Environmental management strategies include:

- End-of-pipe treatment
- Source control

End-of-pipe strategies attempt to remove pollutants after contamination occurs.

Source control prevents contamination from entering the system.

Source control is generally more efficient, cost-effective, and sustainable.



Covered containers and proper waste storage represent simple source control measures with measurable system-wide benefits.

SECTION 10

Systems Interconnection

Environmental systems are interconnected.

Hydrology, waste management, transportation, and climate systems interact continuously.

Moisture entering waste can influence:

- Leachate formation
- Methane production
- Emissions
- Water quality
- Regulatory compliance

Systems thinking is essential for understanding environmental outcomes.



SECTION 11

Summary of Core Concepts

Urban development alters the natural water cycle.

Stormwater systems move water but do not treat it.

When water mixes with waste, leachate forms.

Leachate contains biological and chemical contaminants.

Modern landfills manage moisture and gas but operate more efficiently with reduced water intrusion.

Methane contributes to climate change.

Transportation emissions increase with additional waste weight.

Source control reduces environmental risk across multiple systems.



GLOSSARY

Leachate – Liquid formed when water passes through waste and dissolves contaminants.

Impervious Surface – A surface that prevents water infiltration.

MS4 – Municipal Separate Storm Sewer System.

Source Control – Preventing pollution at its origin.

Methane – A greenhouse gas produced during anaerobic decomposition.

NPDES – Federal permitting program regulating pollutant discharges.

Watershed – Land area that drains to a common water body.

Greenhouse Gas – A gas that traps heat in Earth’s atmosphere.