PEELING BACK THE PAVEMENT

A Blueprint for Reinventing Rainwater Management in Canada's Communities

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KEY MESSAGES

➤ In the natural environment, rainfall is absorbed by the landscape; it nourishes plants and recharges groundwater. In Canada's cities however, hard surfaces like asphalt and concrete do not absorb water. Rain and snowmelt become stormwater runoff, creating a threat that must be managed.

➤ Flooded streets and basements, polluted beaches, degraded urban streams, ruined aquatic habitat, dead fish, stressed aquifers, and expensive drainage infrastructure that demands constant (and increasingly costly) maintenance are evidence that the current approach to managing stormwater runoff is not a sustainable long-term option, financially or environmentally.

➤ Rethinking the way we deal with rain and snow in our urban areas means replacing the conventional pipe-and-convey approach, which moves water off the land as quickly as possible to far from where it initially fell. Instead, we need an approach that recognizes rainwater as a valuable resource and seeks to keep it where it falls to support natural systems and provide a viable decentralized source of water.

➤ In a "Rainwater City" the natural water cycle is protected, runoff volume is dramatically reduced, and runoff quality is improved when expanding and retrofitting communities. Urban fish streams are restored and sewage overflows are reduced.

➤ Incorporating green infrastructure at the earliest stages of development is a critical starting point and is generally less expensive than larger-scale conventional stormwater controls. Retrofitting existing neighourhoods can also be cost effective. Both approaches can enhance recreational opportunities, green space, and urban aesthetics.

➤ One of the greatest challenges to reinventing rainwater management is the fragmented and disconnected responsibility for fresh water across and within jurisdictions in a watershed. Creating robust solutions requires addressing issues of governance and decision making.

➤ Transitioning from managing stormwater to managing rainfall is possible and many communities in Canada and around the world are already leading the way.

THREE DESIGN PRINCIPLES ARE CRUCIAL FOR MOVING FROM A STORMWATER PARADIGM TO A RAINWATER PARADIGM IN OUR URBAN COMMUNITIES:

1. **Reduce the amount of impermeable surfaces** by changing the way we build and retrofit our communities
2. **Use rain as a resource** and as a viable decentralized source of water for non-potable needs
3. **Integrate decision making** on a watershed scale

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INTRODUCTION

A TALE OF TWO CITIES

Picture two cities. Now, picture that it is raining. In one city, you see rain falling on your standard urban landscape of concrete, asphalt, and roofs. The city is primarily constructed of impermeable surfaces and water is flowing down the street and into storm sewers. Once there, it is quickly piped away to a receiving body of water, whether it is a local creek, a lake, or the ocean. In the second city, the picture is different. There is less concrete and asphalt and very little water is washing down the storm drains.

Why?

Because green infrastructure is visible everywhere: downspouts connected to rainwater cisterns, rain gardens, green roofs, deep-soiled lawns, sidewalks with planter boxes, permeable pavement, and bioswales. In this city, rain is a valuable resource. It is not a threat to be dealt with, but a resource to be harnessed to recharge aquifers, support functioning streams and watersheds, and provide important services in our homes, such as flushing toilets, cleaning laundry, and watering our green spaces. Rain is managed to mimic the natural water cycle and its capture and reuse are part of everyday urban life.

In the first city—the Stormwater City—rain and snowmelt pick up pollutants from the urban landscape as they sweep over roofs, streets, and parking lots. In the process what was simply *rain* becomes *stormwater*. This contaminated water is conveyed through storm sewers at high speeds and volumes into the surrounding lakes and rivers. Stormwater runoff is one of the biggest water pollution challenges facing the city, and it is the main source of toxic chemicals entering urban streams.[1] Runoff channelizes and destroys urban fish-bearing creeks, taints shellfish, prompts beach closures, and prevents groundwater recharge. In stormwater runoff, a valuable resource—fresh water—literally runs down the drain.[2] The pipe-and-convey approach to managing wet weather in this city also comes at a financial cost to taxpayers, and prompts expensive maintenance and expansion of hard infrastructure.

This is the Stormwater City, and its approach to rainwater management remains entrenched in most of North America and, indeed, the industrialized world.

In the second city—the Rainwater City—urban planning is based on a bigger picture, one that emphasizes healthy, functioning watersheds (areas or regions drained by a river, river system, or other body of water). In the Rainwater City, rain is viewed not just as a handful of extreme storm events, but also as a resource that literally falls from the sky. Instead of heavy reliance on built infrastructure, such as sewers, drains, pipes, and concrete, this city seeks to deal with rain where it falls and prevent runoff, dramatically minimizing the need for hard and impermeable surfaces. This is achieved by designing with nature and emphasizing green (or ecological) infrastructure in widespread retrofits and new developments. The focus is on tools and practices like rain gardens, increased tree canopy, grassy swales, porous pavement, green roofs, and rainwater harvesting. Rainwater is managed to protect buildings and roads, to ensure a healthy, reliable flow of fresh water and proper watershed function, and to maintain and repair natural systems, such as wetlands, creeks, and lakes. In the Rainwater City, a balance between human-built systems and natural systems is achieved by assessing the ecosystem impacts of each individual land-use decision and making these decisions at a watershed scale with the whole hydrological cycle in mind.

What separates the Stormwater City from the Rainwater City is not geology, climate, or wealth, but the scale of decision making and the degree to which the water cycle has been integrated into the fabric of the urban environment. The Stormwater City is rooted in a centuries-old practice of building cities in ways that ignore natural systems and the water cycle by replacing soil with impervious surfaces. The result is that rainwater is transformed into polluted runoff that, being a threat to property, is piped away to distant receiving bodies of water. Over the past several decades as understanding of stormwater issues has evolved, many Canadian communities have implemented a broader range of stormwater management practices through a process of adaptive management. Management has changed and continues to do so. However, governance and the core philosophy remain entrenched in a pipe-and-convey approach. Instead of embedding nature's needs into decision making, the question being asked is, how can the hydrological cycle be adapted to meet our building practices and demands? The transition to the Rainwater City is the next evolutionary step in moving beyond this mindset. Using ecosystem-based approaches, the human-built environment in a Rainwater City is designed to fit within the natural hydrological cycle. This ensures ecosystem function and natural capital are maintained as settlements grow.

In the Rainwater City, rainwater is a resource to be used and reused by people and nature.

ABOUT THE HANDBOOK: MOVING FORWARD BY PEELING BACK

Peeling Back the Pavement: A Blueprint for Reinventing Rainwater Management in Canada's Communities is a resource for decision makers, community leaders, and local government staff who want to take action to improve stormwater management. This handbook is not a technical how-to guidebook or manual for developing stormwater or watershed management plans. Instead, it makes the case—from ecological and financial perspectives—for a new approach to managing rainfall and snowmelt in Canada's communities, and seeks to engage in a sophisticated discussion about rainwater governance.

The purpose of this handbook is to empower communities to "peel back the pavement" and manage rainwater in concert with natural systems. It outlines the problems associated with the Stormwater City, and then provides a blueprint for transitioning to the Rainwater City.

The core focus of this handbook is on reducing the amount of impermeable surfaces in urban areas, repairing and upgrading broken drainage infrastructure, using rain as a resource, and integrating local land and water management on a watershed scale. With these actions, communities can adopt a rainwater approach to managing wet weather. Getting there will require a transformation in practice, priorities, and how and by whom key decisions are made. The approach outlined in this handbook is not only better for ecosystems, it is also less expensive than conventional management techniques (even in the short term and most certainly in the long term) and therefore sustainable.

"HOW CAN WE MOVE BEYOND CURRENT BEST PRACTICES, USE RAIN AS A RESOURCE, AND PREVENT THE PROBLEM OF RUNOFF ALTOGETHER?"

Over the past several decades, numerous reports have documented and catalogued the damage caused by urban stormwater runoff and offered detailed prescriptions to improve its management (see Appendix). Many communities across Canada have attempted to improve upon conventional stormwater management by introducing additional measures that improve the quality and reduce the volume of runoff. While some jurisdictions are ahead of others, a complete integration of land- and water-use decisions has yet to be realized. The questions of why poor stormwater decisions continue to be made in many places and why positive alternative management practices are rarely fully employed or widely implemented (despite being increasingly recognized as a viable solution) have not, to date, been effectively addressed. This handbook goes beyond the question of "What are the problems with stormwater runoff?" by asking "How can we move beyond current best practices, use rain as a resource, and prevent the problem of runoff altogether?"

Peeling Back the Pavement begins by describing the three core problems associated with conventional stormwater management. Together, these problems define the Stormwater City. But, each problem has a corresponding solution. These solutions form the design principles of the Rainwater City and are the foundation of the Blueprint for the Rainwater City developed and described in the last section of this handbook. The blueprint outlines several actions that together lay out a comprehensive approach to make the Rainwater City a reality. Examples of communities that are already taking positive steps, as well as national and international case studies, provide proof that the transition to a Rainwater City built on a new paradigm of sustainable urban water management is not only feasible, but in many places is already underway.

> ***PEELING BACK THE PAVEMENT* OFFERS A FORWARD-THINKING VISION...**
>
> **...IT CALLS FOR COMMUNITIES TO MOVE TOWARDS A RAINWATER CITY BY THINKING LIKE A WATERSHED—NOT LIKE A BULLDOZER.**

Addressing these issues is all the more urgent today as federal, provincial, and local infrastructure budgets shrink and the impacts of a changing climate, including an inevitable increase in extreme storms, become more apparent. It is increasingly clear that society will feel dramatic effects of climate change through impacts on the water cycle. These concerns challenge the current capacity of stormwater infrastructure and today's approach to stormwater management.[3] The future lies in how we build, retrofit, and govern our cities. *Peeling Back the Pavement* offers a forward-thinking vision that fundamentally challenges Canadian water managers, planners, leaders, all levels of government, and even the broader public to think differently about rainwater. It calls for communities to move towards a Rainwater City by thinking like a watershed—not like a bulldozer.

BOX 1: WHY SHOULD WE CARE ABOUT STORMWATER?

We don't normally think of rainfall as pollution. But, we have built our cities in a way that transforms rainwater into an agent of environmental and human harm: stormwater runoff.

Stormwater runoff causes a large proportion of urban water pollution. In Washington State, for example, the United States Environmental Protection Agency estimates that more than 100,000 pounds of toxic chemicals are washed into Puget Sound via stormwater runoff every day.

The transformation of rainwater into polluted stormwater occurs in stages as it flows through our urban spaces. The first stage is the creation of "hard" surfaces in cities, such as roofs, driveways, patios, sidewalks, parking lots, and road networks.

In the second stage, heavy metals, PCBs, oils, grease, antifreeze, solvents, pesticides, herbicides, fertilizers, road salt, detergents, and pet waste collect across the urban landscape. When heavy rains sweep across a city's hard surfaces, these pollutants are picked up and washed away.

Photo: Capital Regional District, BC

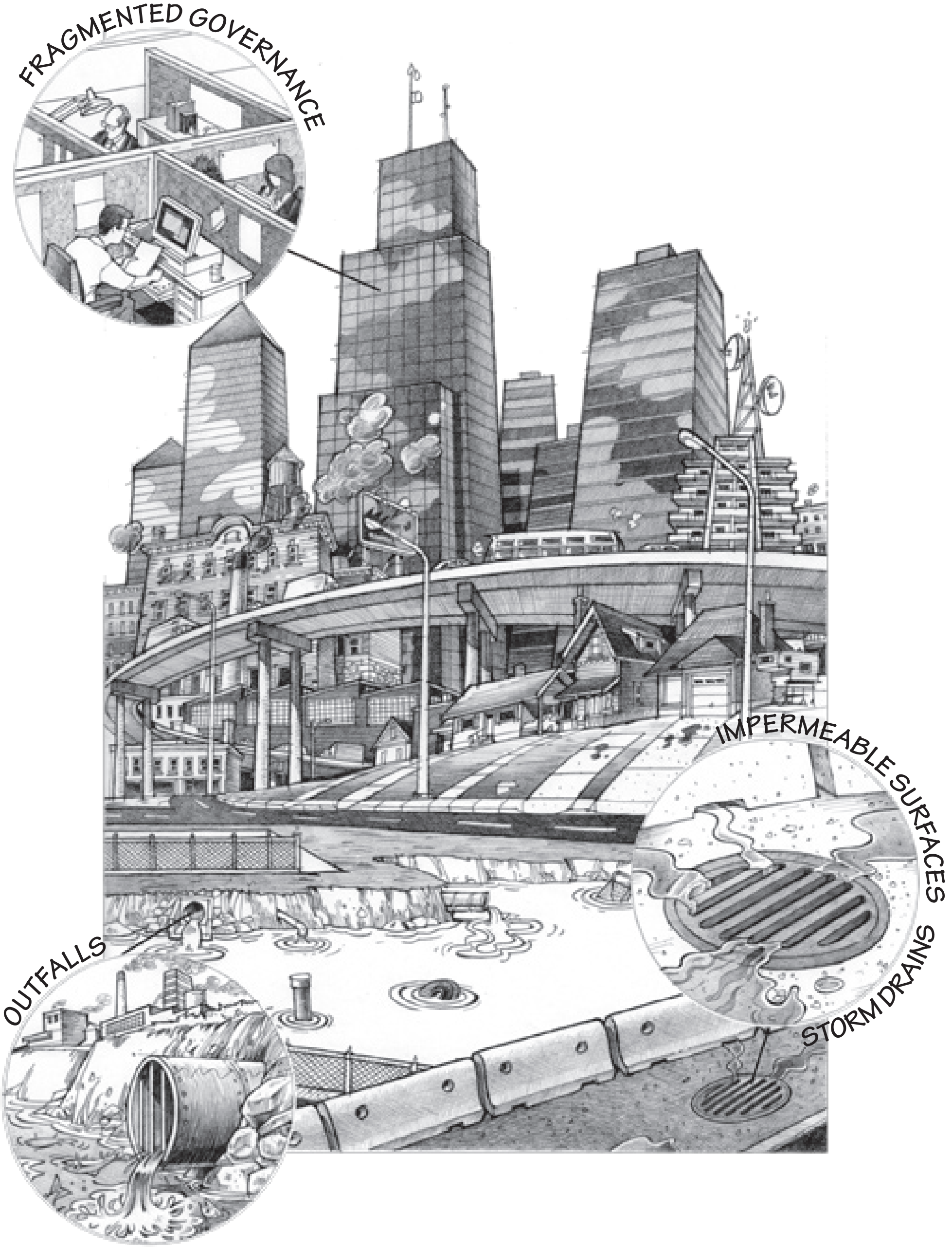
The last salmon documented in Bowker Creek in British Columbia's Capital Regional District. Due to urbanization and stream degradation, the creek no longer supports salmon populations.

But, there is no "away." In the final stage, the storm drainage system rapidly conveys the polluted runoff—often without treating it—to the nearest body of water where it is flushed into the aquatic ecosystem.

Stormwater runoff impacts urban ecosystems. It can destroy the spawning grounds of salmon and other fish, decrease stream baseflows, erode stream banks, and increase the water temperature of streams. Numerous studies link rapid decline in water quality and stream health to uncontrolled stormwater runoff from areas in which the total impervious surface area exceeds 10 per cent of the total watershed area (known as "The 10% Rule").

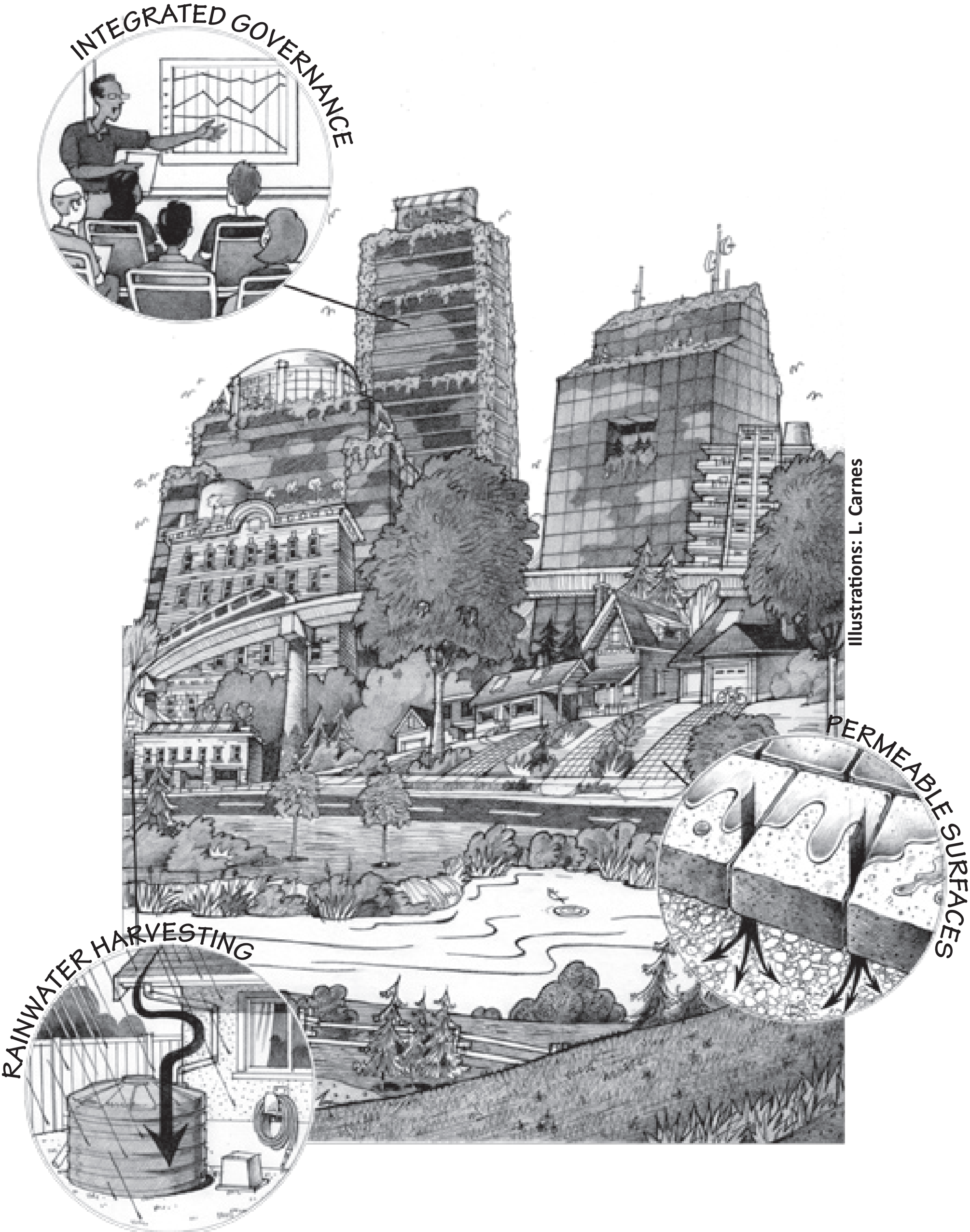
To make things worse, in older municipalities stormwater runoff and sewage may be carried in the same pipe, which means bodies of water can become contaminated with fecal coliforms. An even bigger risk occurs when stormwater mixes with sewage and contaminates drinking water supplies. This is an issue in many places and fixing it may necessitate the expenditure of millions—or even billions—of dollars. For example, the cleanup costs of the stormwater-related impacts at Ontario's 16 Remedial Action Plan sites were estimated to be $2.5 billion. *Sources on page 65*

STORMWATER CITY



In the Stormwater City, **rain picks up pollutants from the urban landscape as it sweeps over roofs, streets, and parking lots, and is transformed into "stormwater." This contaminated water is conveyed offsite through storm sewers at high speeds and volumes into the surrounding lakes and rivers. Fragmented jurisdiction over managing stormwater within and between municipalities that share a watershed means that there is no coordination between local governments.**

RAINWATER CITY



In the Rainwater City, **rain is viewed as a resource that literally falls from the sky. Using tools and practices like increased tree canopy, permeable pavement, green roofs, and rainwater harvesting dramatically reduces the need for impermeable surfaces. Rainwater is managed on a watershed scale across municipalities in order to ensure a healthy, reliable flow of fresh water and proper watershed function, and to maintain and repair natural systems, such as wetlands, creeks, and lakes.**

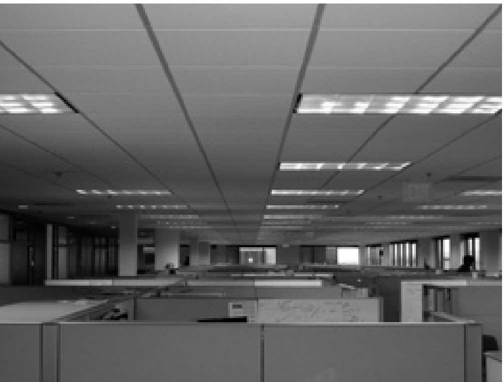
THE STORMWATER CITY

THREE PROBLEMS WITH THE STORMWATER CITY

In nature, rainfall is absorbed by the soil where it nourishes trees and plants and recharges groundwater. In cities, hard surfaces like asphalt and concrete do not absorb water and rain becomes runoff. To remove this runoff and prevent it from collecting and damaging property, engineers construct curbs, gutters, and storm sewers to carry the water offsite. Yet this extensive drainage infrastructure, even when combined with more modern practices such as detention ponds and infiltration techniques, does not properly manage stormwater for nature or recognize its value as a resource. Flooded streets and basements, polluted beaches, degraded urban streams, ruined aquatic habitat, and expensive infrastructure that demands constant maintenance are all evidence that the existing system is not sustainable as a long-term option.

Many of these concerns are the legacy of old stormwater management practices and can be attributed to three root problems.

1. Urban design that creates the “problem” of runoff by ignoring the water cycle and replacing the natural landscape.
2. Viewing rainwater as a risk that must be quickly removed from the landscape.
3. Fragmented roles and responsibilities related to watersheds between levels of government, and a lack of integration between land-use and water planning, especially within local government.



Photos (cw from top left): iStockphoto, N. Grigg, Wikipedia

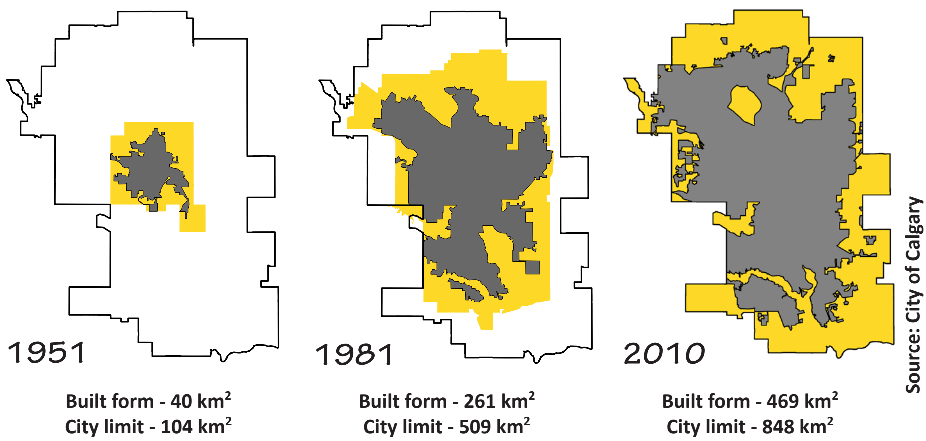
PROBLEM 1

"CONCRETE JUNGLES": DESIGN THAT CREATES RUNOFF

NEW DEVELOPMENT AND URBAN SPRAWL

Building cities has always meant replacing the natural landscape—forests, wetlands, and grasslands—with streets, parking lots, rooftops, and other hard surfaces. Rather than designing urban infrastructure to absorb water the way nature does, the use of impermeable materials creates the problem of runoff. Over the past several decades, the proportion of impervious surfaces has increased dramatically in Canada's urban areas. Hard surfaces constitute almost half of urban land cover, and in downtown commercial settings cover up to 96 per cent (with as much as 70 per cent being roof surfaces).[4]

The problem of runoff is compounded by the zoning decisions and subdivision design characteristics common in most Canadian communities. Since the 1950s, population growth has been met by developing more land, roads, and water and sewage treatment infrastructure to meet demand for housing. This has resulted in urban sprawl across the country. When urban sprawl replaces natural landscapes with impervious surfaces, significant changes in the natural patterns of water movement occur.



Concrete Creates the Problem. A supply-side approach to population growth has led to soaring rates of urban sprawl outside of Calgary, Alberta. This sprawl translates into a loss of natural surfaces and increased runoff.

MAINTAINING EXPENSIVE INFRASTRUCTURE

The Stormwater City drains runoff into a system of pipes where it is conveyed to streams, lakes, oceans, or other bodies of water that are often several kilometres from where the rain initially fell. This drainage infrastructure tends to be designed based on the "major flow" of extreme storm events rather than regular patterns of precipitation, thus creating an expensive, overbuilt network of infrastructure. Managing stormwater runoff through hard infrastructure costs Canadian taxpayers billions of dollars each year. For example, the **City of Toronto**, which developed before any conventional stormwater infrastructure was in place, estimates that over the next 25 years it will spend $1 billion on capital expenses and $233 million on operating costs ($42 million a year) for the management of stormwater and wastewater systems that service its 2.5 million residents.[5] In the **Greater Vancouver Regional District**, a survey of local governments showed that in 1996 $33 million was spent on stormwater management alone in areas serviced by separated stormwater systems.[6] As governments are increasingly financially limited, this represents a huge expense and a significant ongoing liability.

Many cities across Canada have old stormwater systems that include vestiges of the 19th century, including pipes and tunnels made of wood and brick, as well as vitreous clay, asbestos pipe, and cast iron. In many cases (particularly in eastern Canada where infrastructure is older) sewage and stormwater run in the same pipe or tunnel. A mixture of the two can often be discharged out of these storm sewer outlets. This is known as combined sewer overflow (CSO). The **City of Ottawa** is currently spending more than $140 million over a five-year period just to upgrade its stormwater system, which has led to a 10 per cent increase in its water rates.[7] These expenses are common across the country. The Federation of Canadian Municipalities indicates that water and wastewater infrastructure repairs represent significant unmet capital costs for taxpayers. It estimates that $23 billion to $49 billion is needed Canada-wide just to catch up.[8] This infrastructure deficit is a result of decreasing infrastructure grants from senior governments and costs not being adequately funded through property taxation and utility charges.[9] The consequence is deteriorating and obsolete stormwater infrastructure that becomes a liability for taxpayers and is often insufficient to control the influx of water associated with extreme storm events.[10]

Aging stormwater infrastructure also represents a new and growing liability for property owners. In terms of the number and value of insurance claims, stormwater now constitutes the largest risk to municipalities posed by a changing climate.[11] For example, an extreme rainfall event in the **City of Edmonton** in 2004 flooded over 4,000 basements and resulted in $171 million in insurance claims. According to statistics from the Insurance Bureau of Canada, water damage claims grew from 20 per cent to 50 per cent of all property-related claims within Canada over the past nine years. Although basement flooding and damaged or inadequate drainage infrastructure is not new, what is new is the increased occurrence of extreme storm events, and the resulting cumulative financial impacts.

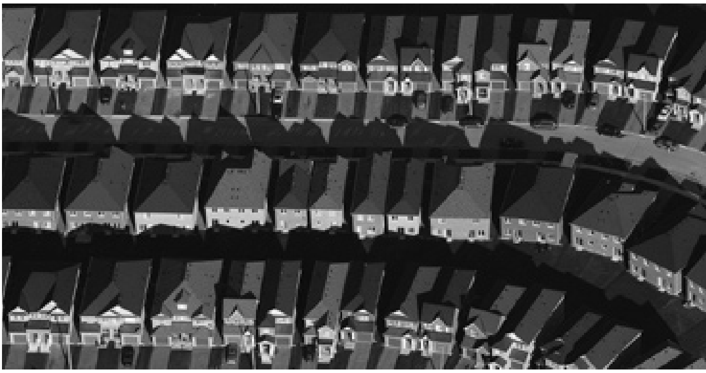
PROBLEM 2

RAINWATER DOWN THE DRAIN: WASTE OF A VALUABLE RESOURCE

In the Stormwater City, large amounts of money and resources are focused on drainage infrastructure because runoff (stormwater) is viewed as a threat that ultimately needs to be removed. However, transporting rainwater away from a property via storm drains when water is being piped to the very same property from a municipality's centralized supply system translates into missed opportunities to use rainfall as a water source. In this era of strained infrastructure capacity, frequent water shortages, and growing environmental concern, why waste rainwater? Why not use it on site for non-drinking-water purposes?

This missed opportunity comes at a great cost. Maintaining water supply infrastructure is expensive. In 2006, local governments in Canada spent over $4.5 billion to purify and supply water—an expense compounded by growing demands that are, in part, fuelled by water overuse.[12] Part of the problem is that there really is no such thing as "drinking water" in Canadian cities. All municipal water is treated to drinking quality standards, whether we flush it down the toilet, wash our cars with it, use it to water the lawn, or drink it. Yet only a small portion of the water treated to drinking standards is actually used for purposes that require such high quality. According to Environment Canada, drinking, cooking, and bathing account for only about one-third of indoor residential water use.

Photo: I Duke



Low-density, automobile-dependent developments like this one in Markham, Ontario contribute to the billions of dollars Canadian municipalities must spend each year treating drinking water. Large amounts of impervious surfaces let rainwater run down the drain while, at the same time, water is piped back into homes for use.

Our current water systems do not match water quality requirements to end use. Instead, as more water is piped through the supply infrastructure to satisfy growing demands, more water must be withdrawn from the source and treated to (costly) drinking standards. Viewing rainfall as a threat that needs to be quickly removed means that communities miss the opportunity to capture and store rainfall for reuse and reduce their dependence on centralized supply. This depletes local water supplies, undermines water conservation efforts, and eventually leads to demand for expensive new dams, bigger pumps, and increased water supply infrastructure.

PROBLEM 3

STORMWATER GOVERNANCE: WHO DOES WHAT?

Historically, Canadian stormwater management focused on areas that were prone to flooding in order to reduce risk to property owners in towns and growing cities. Over time the focus has expanded to include consideration for water quality and, in some cases, concern for impacts on fish and their habitat. But this priority focus on property protection continues to shape stormwater management, even as new problems emerge, such as the ecological effects of a changing climate.

Local governments are ultimately in charge of managing stormwater in Canada and are provided with general statutory functions to manage runoff through provincial and territorial Local Government and Municipal Acts. The power of local government includes taking measures to protect the community from flooding, providing drainage infrastructure, and managing development through zoning and development permitting. In the main federal legislation related to fresh water—the *Canada Water Act*, the *Canadian Environmental Protection Act*, and the *Fisheries Act*—the term "stormwater" is rarely defined beyond something very general, such as "surface water" or "water within a watercourse."[13] Nor are there any specific provisions for stormwater in any of the provincial or territorial Environment Acts. Vague provisions for the management of stormwater are folded into sections of provincial and territorial environmental protection and water resources legislation that address wastewater.

In the absence of a clear governing legal framework, municipalities respond to liability concerns by modelling stormwater facilities, infrastructure, and management practices on various guidance documents from senior government, practitioners, or professional associations. Examples include Saskatchewan Environment's *Stormwater Guidelines*, the Ontario Ministry of Environment's *Stormwater Management Planning and Design Manual*, and British Columbia's *Beyond the Guidebook: Context for Rainwater Management and Green Infrastructure in British Columbia*.[14]

The result of the current legislative and institutional framework in Canada is that stormwater management is largely left up to the discretionary powers of local governments. With few incentives to coordinate or harmonize efforts, a patchwork of approaches and practices has resulted. Like many services provided by local governments relating to environmental concerns, water and watershed management is divided between levels of local and senior government and across various departments. Decisions that concern fresh water are made in a fragmented way with no one entity concerned with, or responsible for, the entire hydrological cycle. In addition, land- and water-use decisions are largely separated across departments in local governments. Even though land and water are part of one natural system—from source, to site, to wastewater, and back to the receiving environment—they are rarely integrated. For example, treatment, drinking water, and sometimes source protection decisions are made by one department within a regional govern-

Photo: P. Lynch

Flooding due to storm events, combined with insufficient drainage and lack of infiltration can cause roads to collapse, as happened on Toronto's Finch Avenue (not shown) in 2005, which cost $45 million to repair.

ment and governed by Health Acts or Drinking Water Protection Acts. Another department is responsible for sewers while yet another might deal with stormwater. In addition, a separate planning department deals with land-use decisions, such as zoning and community development, which directly impact local water resources. Individual municipalities are responsible for different aspects of the physical infrastructure, including pipes, pumps, and storm sewers, within their mutually exclusive boundaries. And senior governments have separate environmental responsibilities related to fisheries, watersheds, and water quality and quantity. The result is a complex patchwork of actors and legislation that creates a system with generally siloed decisions and often-competing objectives. Little attention is paid to cumulative impacts or whole-system function. Land-use planning is conducted and decisions are made on the basis of municipal boundaries or property ownership—neither of which have much to do with ecological systems.

As described, the responsibilities for stormwater management flow through local government and are executed through land-use planning tools, such as regional plans including integrated liquid waste management plans, community plans, zoning bylaws, and site-specific development standards and permits. Local governments may also be responsible for managing and protecting the local environment, which they typically do through regulatory powers, such as tree protection and soil erosion and deposit bylaws. In some cases, these stewardship powers are extended to include additional regulatory authority over watercourse protection and pollution prevention through, for example, pesticide bans. Even with these tools and best "past" practices in place, the Stormwater City does not, in practice, fully protect ecosystems and water resources. Ineffective and disconnected governance is at the core of this problem. Changes must be made to our existing institutional structures and governance. Changes must be made to how we think and make decisions about rainwater in the context of our communities with a clear focus on functioning rivers, streams, creeks, wetlands, and lakes as parts of a healthy, resilient watershed.

BOX 2: A SHORT HISTORY OF STORMWATER MANAGEMENT IN CANADA

The Romans were famous for the extensive network of aqueducts that serviced the Empire's cities, towns, and industrial sites with drinking water, wastewater, and stormwater infrastructure. More than 2,000 years later, the aqueduct approach is still the core design concept in modern urban water management across the globe. Runoff is still channeled off the land and out of cities as quickly as possible. Canada's own history of stormwater management can be roughly divided into three eras. In each era, the problems and solutions associated with stormwater runoff shifted. Stormwater infrastructure in communities across the country reflects these changes. Some cities have 19th-century combined sewer systems as well as new developments that feature today's urban stormwater best management practices. Yet, the majority of urban stormwater infrastructure in Canada is still dominated by a basic storm sewer system.

THE STORM SEWER ERA (1880-1950)

As Canada began to urbanize, ditches were dug alongside streets and roads to manage drainage in growing towns and cities. These ditches were later connected to the nearest river, lake, stream, or creek to alleviate flooding during wet seasons. As populations grew and became denser, human waste disposal became an issue of concern. Poor management of human waste led to several cholera and typhoid epidemics in urban areas in the late 1800s and early 1900s. The problem was "solved" by dumping human waste into the existing sewer system, thus creating the first combined stormwater and human sewage disposal network. Eventually, pipes made of wood, brick, vitreous clay, asbestos pipe, and cast iron were built and buried under the ground to transport both stormwater and sewage from upstream urbanized areas to downstream receiving waters. At this time, overflows during wet weather events were not seen as a problem since discharges were considered effectively "diluted" after entering the receiving body of water.

THE STORMWATER MANAGEMENT ERA (1950-1980)

The separation of sewage and stormwater began as a result of public health concerns when major storms caused flooding and overflows into local bodies of water. Increased flooding due to storm events prompted water managers to begin controlling stormwater in ponds within or downstream of the storm sewer network. Compared with the *Storm Sewer Era*, the stormwater management solutions of the 1950s to the 1980s minimized local and downstream flooding, and provided waterfront property around stormwater ponds. However, long-term costs remained, including costs for erosion control downstream of the ponds. Generally, throughout most of this era the issue of polluted runoff and its effect on receiving waters was still not recognized.

Photo: www.drainsofmycity.com

In some older sewage tunnels, sewage and stormwater run beside each other, separated by a low wall. During extreme storm events, the sewage and stormwater may combine causing sewage discharge into surrounding bodies of water.

THE URBAN STORMWATER BEST MANAGEMENT PRACTICES ERA (1980-PRESENT)

By the 1980s, communities were beginning to realize that stormwater runoff is a significant source of pollution. This current era redefines the problem of runoff and its solutions. Solutions include extended detention ponds, infiltration basins and trenches, permeable pavement retrofits, sand filters, water quality inlets, urban stream rehabilitation, and vegetation through low impact development. Combined sewers are being phased out due to pollution control provisions in provincial and territorial Environment Acts and the federal *Fisheries Act*.

Throughout the eras, many Canadian communities have developed a broader range of stormwater management techniques through a process of adaptive management. We are rapidly approaching the next phase of evolution in some regions, with British Columbia at the forefront. State-of-the-practice stormwater management in B.C. is materially distinct from much of the country. In British Columbia, the critical driving issue is damage to and loss of fish habitat caused by development and erosion of headwater streams. Elsewhere in the country, the stormwater agenda has primarily tended to be driven by a narrower focus on flooding and water quality. The emphasis on stream health in British Columbia provides a more holistic framing of the problem and results in measures that decrease runoff volume and improve runoff quality—a possible portend of future practices for the rest of Canada.

Sources on page 65.

REIGN OF A NEW PARADIGM: FROM MANAGING RUNOFF TO HARNESSING RAINWATER

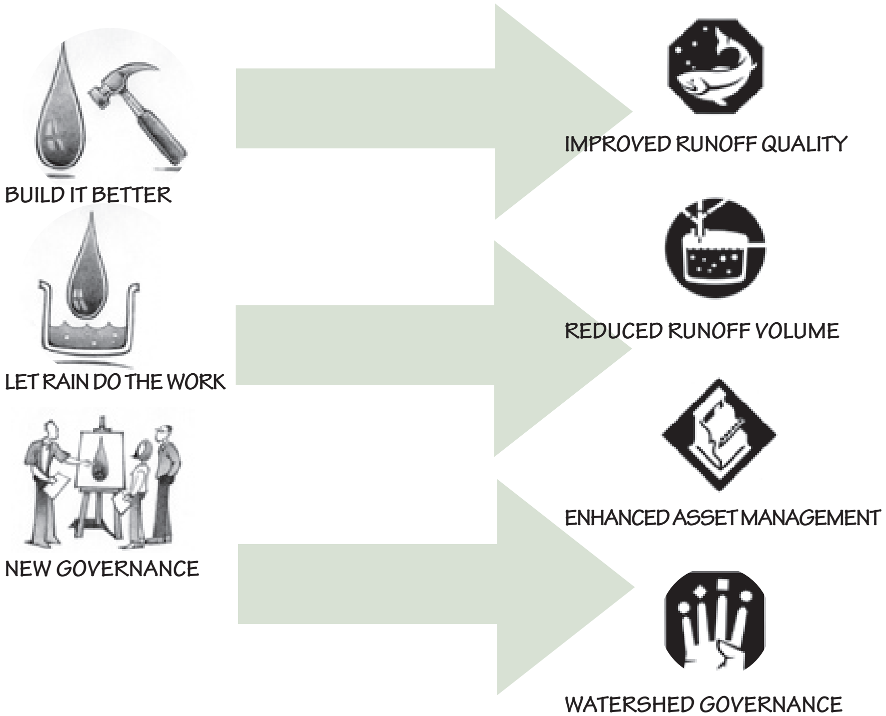
The problems associated with the Stormwater City can be solved. Indeed, many Canadian communities have attempted to improve stormwater management by adopting better practices as understanding has evolved over time. Measures such as more efficient drainage infrastructure, retention ponds, and infiltration trenches, and techniques that reduce deleterious discharges into storm drains have promoted better management of runoff and improved runoff quality. The province of British Columbia is generally viewed as a leader in pioneering a more ecosystem-based focus that integrates rainwater management into land-use planning. Many of these efforts are driven by concerns around salmon health, an iconic species on the west coast. A decline in wild salmon populations catalyzed a new ethic and has driven many of the province's innovative approaches to better protect stream health and reduce damage to and loss of habitat.[15]

Ultimately, incremental improvements to stormwater management are likely insufficient to address the root problems of the Stormwater City. A major shift is needed to move Canada's cities and towns onto a new and more sustainable path. Not only do we need to continue to adapt and improve best practices, but we also need to address the fundamental issues of broader community design and governance. The solution is not just in improving the old paradigm, which perpetuates the problem by creating ever more impermeable surfaces and, therefore, more runoff. Instead, the solution must address changing city design and growth patterns to avoid as much runoff as possible. Our communities must learn to function like healthy watersheds. In a Stormwater City, structures, roads, and communities are built on the principle of draining away the problematic "excess" rainfall. In contrast, a Rainwater City (re)builds communities around the principles of using rainwater as a source for humans and for ecosystems.

Emerging evidence and practice demonstrate that a comprehensive watershed-based approach is not only less expensive, but also avoids many of the environmental costs associated with conventional and best "past" practices of stormwater management. This is discussed in detail *The Business Case for the Rainwater City* on page 57.

THE TRANSFORMATION OF A STORMWATER CITY INTO A RAINWATER CITY REQUIRES TAKING THREE CRUCIAL STEPS...

...THAT WILL RESULT IN FOUR TANGIBLE OUTCOMES.



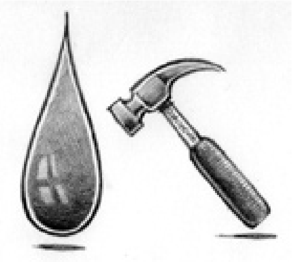
BOX 3: WHAT'S IN A NAME?

Stormwater management is the most common term used to describe the controlling of runoff with conventionally built drainage facilities. As described throughout this handbook, this approach is narrowly focused on a handful of annual rainfall events and fundamentally views runoff as a problem. Its solution emphasizes getting water off the land via hard infrastructure, such as drains and pipes. The transition to a Rainwater City requires a new way of thinking and doing that starts with changing the way we think and talk about managing rainfall. For a sustainable world, the mission should be to integrate rainwater into planning, instead of just managing runoff. With this approach, stormwater management becomes rainwater management, and a simple shift in focus opens a world of innovation and possibilities.

HOW A RAINWATER CITY WORKS: THREE PRINCIPLES

PRINCIPLE 1: BUILD IT BETTER:

DESIGN CITIES THAT WORK WITH THE WATER CYCLE



The transition to a Rainwater City begins by changing the conditions that create runoff. This involves (re)building cities to approximate a naturally vegetated watershed and mimic the natural water cycle. Impermeable surfaces that repel rainfall are replaced with soil, plants, trees, bioswales, rain gardens, permeable pavement, and green roofs. Even sidewalks and plaza areas can be retrofitted with permeable pavement on a deep granular base. Porous pavement allows water to pass through to infiltrate the soil below, recharging groundwater tables, supporting local streams and creeks, and reducing runoff and pollutant discharge. Although clearly beneficial, even the leading thinkers and practitioners in the field acknowledge that widespread retrofits and implementation of green infrastructure cannot completely displace the need for some impermeable load-bearing surfaces, such as roads and some public walkways. Neither do green infrastructure efforts completely defend a city against extreme storm events. Therefore some provisions may still be needed to convey and regulate runoff and release rates, such as scaled-down, narrower drainage pipe systems, underground stormwater storage chambers, and detention ponds. The key is to use these structures to complement a “design with nature” approach that seeks to discharge the stored water at a manageable rate downstream to restore (or mimic) natural hydrological function.

Building it better also means being more strategic about where communities are developed. By directing growth to areas where people already live and work, the Rainwater City minimizes the amount of new paved and other impervious surfaces and reduces further impact on watersheds. "The 10% Rule" means that development and redevelopment should be encouraged in areas already beyond the 10 per cent impermeability threshold, while focusing efforts on protecting more valuable resource lands.[16]

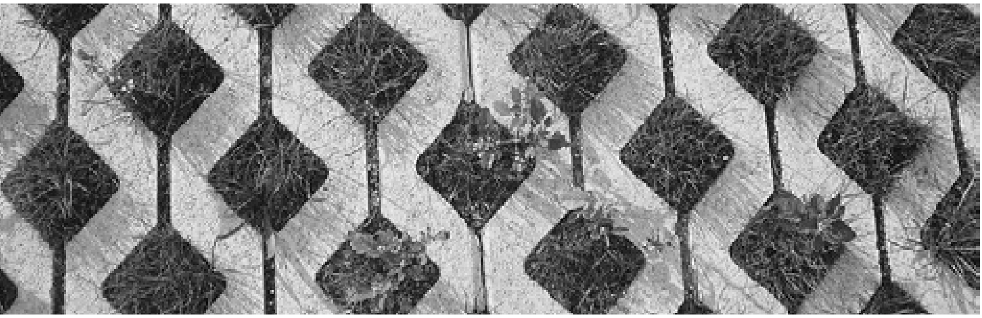


Photo: Immanuel Giel

Permeable pavers help reduce stormwater runoff by allowing water to infiltrate into the soil, passing through areas (e.g. driveways, roads, sidewalks, or parking lots) that are traditionally impervious.

GREEN INFRASTRUCTURE PRACTICES

Conservation Planning	• Cluster development • Open space preservation • Integrated watershed management plans
Conservation Designs	• Reducing impervious surface, through reduced pavement widths (streets, sidewalks) • Shared driveways • Reduced setbacks (shorter driveways) • Site fingerprinting during construction
Infiltration Practices	• Infiltration basins and trenches • Porous pavement • Disconnected downspouts • Rain gardens and other vegetated treatment systems
Runoff Storage Practices	• Parking lot, street, and sidewalk storage • Rain barrels and cisterns • Depressional storage in landscape islands and in tree, shrub, or turf depressions • Green roofs
Runoff Conveyance Practices	• Eliminating curbs and gutters • Creating grassed swales and grass-lined channels • Roughening surfaces • Creating long flow paths over landscaped areas • Installing smaller culverts, pipes, and inlets • Creating terraces and check dams • Integrating runoff into the built environment
Filtration Practices	• Bioretention/rain gardens • Vegetated swales • Vegetated filter strips/buffers
Low Impact Landscaping	• Planting native, drought-tolerant plants • Converting turf areas to shrubs and trees • Reforestation • Encouraging longer grass length • Planting wildflower meadows rather than turf along medians and in open space • Amending soil to improve infiltration

The table outlines the different categories of low impact development (LID) techniques with specific examples under each heading. Note that ideal LID begins with proper land use and watershed plans that respect natural water systems. Such proactive planning is then optimized by the use of innovative site-specific techniques and technologies. Altogether, this approach maintains and creates a green infrastructure to deal with rainwater.

Table reprinted, with permission, from McGuire, G., Wyper, N., Chan, M., Campbell, A., Bernstein, S., & Vivian, J. (2010, February). *Re-inventing Rainwater Management: A Strategy to Protect Health and Restore Nature in the Capital Region*. Victoria, B.C.: The Environmental Law Centre at the University of Victoria. Retrieved from http://www.elc.uvic.ca/press/documents/stormwater-report-FINAL.pdf.

PRINCIPLE 2: LET RAIN DO THE WORK: IMPLEMENT WIDESPREAD RAINWATER HARVESTING

In addition to the widespread implementation of green infrastructure, rainwater is embraced as a resource in the Rainwater City. Rainwater harvesting (RWH) is the practice of collecting rain from roofs and other impermeable surfaces and storing it for use in irrigation, industrial purposes, and non-potable indoor commercial and residential uses, such as clothes washing and toilet flushing.

A systemic approach to RWH involves more than simply implementing a standard rain barrel rebate program for homeowners. Instead, it focuses on widespread, integrated use of RWH across the city, and rainwater is viewed as a legitimate decentralized water supply source. In a Rainwater City, rain does the work of meeting many non-potable water demands including some indoor hot water demands. Rainwater is collected on site, stored, and then used as a primary source for irrigation at schools and universities, city parks, boulevards, recreation areas, swimming pools, golf courses, urban farms, and household gardens.

Photo: Regional District of Nanaimo

Residential rainwater harvesting tanks store rainwater collected from roofs and other impermeable surfaces. Stored rainwater can be used in irrigation and for other non-potable uses such as clothes washing and toilet flushing.

PRINCIPLE 3: NEW GOVERNANCE: AN INTEGRATED WATERSHED-BASED APPROACH

As the United States Environmental Protection Agency (EPA) has noted, rainwater must be managed on a watershed scale.[17] Watershed governance starts a cultural shift toward integrated and ecosystem-based land- and water-use management practices. Some experts and practitioners in the field call this integration "water-centric planning."[18] Beyond an attitudinal shift, turning ideas into action requires incentives and the reorganization of internal local government structures. Collaborative planning must occur across municipal boundaries and should be supported by the introduction of a formalized coordinating mechanism, such as a Regional Water Commission, Watershed Authority, or Watershed Agency. This could also be supported through increased responsibility of and capacity for existing structures, such as Conservation Authorities or Regional Districts. This formalized entity, whether something new or building on an existing body, would have a clear mandate to ensure watershed health and function, thus enabling it to become a crucial formal player on land- and water-use decisions that affect the surrounding watershed. Through its coordinating role, such a body would enable municipalities in the same watershed to share the costs of implementing rainwater management practices and measures.

Together, these three core concepts—build it better, let rain do the work, and new governance—illustrate the character and potential of the Rainwater City.

THE BRITISH COLUMBIA WATER AND WASTE ASSOCIATION (BCWWA) HAS TAKEN A PROGRESSIVE STANCE ON STORMWATER IN ITS POSITION STATEMENT ON MANAGEMENT OF STORMWATER:

"In order to protect water quality and the public, every community should adopt an integrated watershed based approach to stormwater management which emphasizes on-site reduction and retention as best practice and recognizes the need to maintain and enhance existing infrastructure."

A SPECTRUM OF WET WEATHER MANAGEMENT APPROACHES

	Stormwater Management	Stormwater Management Best Practices	Rainwater Management
The issue	***Manage*** runoff and protect property from extreme storm events	***Mitigate*** the negative impacts of conventional urban development on ecosystems by improving runoff quality and reducing runoff volume	***Prevent*** runoff altogether and harvest rainfall for non-potable use through an ecosystem-based approach to rainwater management
The solution	Build ***centralized, large-scale drainage systems*** using hard infrastructure, such as pipes and sewers, to pipe runoff away to receiving bodies of water	Supplement existing, large-scale drainage infrastructure with ***onsite and end-of-pipe measures*** that improve runoff quality and reduce runoff volume	Fully ***rehabilitate urban ecosystem function*** by maximizing the use of rain as a resource and managing wet weather primarily through green infrastructure
The governance approach	Administered within ***municipal boundaries by public works*** in existing hierarchical and sectoral divisions	Administered within municipal boundaries by public works with some ***coordination between municipal planning departments***	Administered on a ***watershed scale***, enabling municipalities up and down the watershed to coordinate planning, regulations, and development ***Land- and water-use decisions are fully integrated*** across public works departments

BOX 4: VALUING PROPERLY FUNCTIONING ECOSYSTEMS

“Stormwater” is strictly a human concept. Precipitation, on the other hand, is a dynamic process of the natural world. The hydrological cycle connects the atmosphere, surface water, soils, vegetation, and animals (including humans). The movement of water creates a dynamic equilibrium as it flows from rain, to water stored on the leaves of plants and in the soil, and then back to the atmosphere through evapotranspiration. The flow of water through soil to groundwater and into streams and wetlands creates a baseflow for a watershed, which provides moisture to plants and animals during dry periods.

Left to its own devices, the natural world is in a relatively comfortable state of equilibrium, maintained by constant change, rebalancing, growth, and decay. The natural water cycle in proper functioning condition supports ecologically productive wetlands, streams, and lakes. These bodies of water provide us with a critically important water supply as well as rich recreation, fish and wildlife, and cultural and historic values. They also provide key economic inputs necessary for everything from crop and livestock production to timber and energy production.

But, many contemporary patterns of human settlement, such as rapid increase of impervious surfaces, fundamentally change these relationships. In urbanized areas, streams and rivers frequently serve as conduits for pollution via urban stormwater runoff. Large water infrastructure projects also strain the resilience of complex natural systems by quickly moving large volumes of water within and even across watersheds. These impacts compromise the quality of the ecological, social, and economic services that watersheds provide.

In the future, we will need to better integrate the environment into urban areas and mimic nature’s processes. As urban ecosystems, Canada’s cities must grow and decisions must be made in ways that protect and promote — not erode — the proper functioning condition of ecosystems. To do this, society needs to be prepared to make difficult trade-offs. As a starting point, we need to learn how to better value ecosystems and incorporate “full cost accounting” into all of our activities. We also need to plan on a much broader watershed scale and work with the water cycle, not against it.

Sources on page 65.

Photo: R.J. Frith

FROM THE STORMWATER CITY TO THE RAINWATER CITY

Green infrastructure and rainwater harvesting techniques are not new, yet these effective practices are rarely fully employed or widely implemented in Canada. Why do we continue to build and expand cities in a way that treats rain as a threat rather than an opportunity? How can we move beyond a "tale of two cities" towards a future where the Rainwater City is the norm?

The Stormwater City/Rainwater City designation need not be a dichotomy. Instead, the principles of the Rainwater City can better inform current water management practices. Transitioning from a Stormwater City to a Rainwater City will take time, but the necessary tools and ideas already exist. The challenge is effective implementation.

An oft-cited reason for inaction is an absence of political or community will to implement alternative management systems. This inertia is fuelled by a lack of urgency and a generally low level of awareness of the full costs of conventional approaches, including the environmental impacts. As well, sustainable municipal funding mechanisms for retrofitting existing urban areas are not always in place. The dominance of the traditional engineering-based focus on built infrastructure, and the status quo risk aversion common to most land-use planning processes tends to limit experimentation and the implementation of innovative emerging approaches.

LOCAL GOVERNMENTS ALREADY HAVE ACCESS TO SOME OF THE KEY TOOLS NEEDED TO MAKE THE RAINWATER CITY A REALITY.

This combination of political inertia, status quo practices, and silo thinking point to the larger issue: the absence of a long-term and whole-system approach to urban water governance. The fundamental problems are the way in which communities separate land management from water management and the scale at which rainwater decisions—and indeed all urban water decisions—are made. Untangling and correcting urban water governance is the key to widespread adoption of Rainwater City principles across Canadian communities. While governance reform by itself cannot correct inadequate management, it will catalyze new approaches and provide opportunities for innovation. New practices can become "business as usual." Creating the Rainwater City requires institutions and incentives to deal effectively with the entire watershed when making land-use decisions. At a minimum this starts by carefully assessing the cumulative impacts of new developments and changing land uses across the watershed—not just on a site-by-site basis. Different perspectives and multidisciplinary approaches must be blended to ensure a full range of options and priorities is established.

Illustrations: L. Carnes

Transitioning from a Stormwater City to a Rainwater City is possible using building practices that focus on a new kind of infrastructure that embeds a "build with nature" philosophy.

Governance reform is never easy. It requires legislation, policies, programs, and most importantly attitudes and behaviour to change. For stormwater management to become rainwater management, governance reform will need to start with building practices that focus on a new kind of infrastructure that embeds a "build with nature" philosophy. Local governments already have access to some of the key tools needed to make the Rainwater City a reality. Zoning bylaws are among the most powerful tools municipalities have to regulate rainwater through land use. These bylaws can be used to determine density, as well as the location, size, and types of structures that can be built in a community. Bylaws can be used to protect riparian areas by prohibiting discharge of contaminants and preventing an increase in runoff flow.

In addition to bylaws, local governments can establish green development standards that encourage or impose requirements on land-use planning to ensure rainwater is collected and reused on site. For example, the **City of Chicago** provides grants, waives fees, and expedites permitting processes if a green roof is included in a building plan. It also allows density bonuses (which permit the construction of more units) for plans incorporating green roofs.[19] Development approvals can also include conditions that require the provision of green housing units that have no net impact on the quality and quantity of runoff, or that use rainwater as a source for non-potable uses. Many places across Canada, including the cities of **Victoria**, **Vancouver**, **Edmonton**, **Calgary,** and **Toronto**, are already using some of these approaches. It is critical to recognize that in Canada local governments already have a significant degree of autonomy to manage rainwater effectively. This means a city can choose to grow sustainably, or not.

Transitioning to a Rainwater City will, however, require more than just bylaw amendments and green development standards. At the core of the process are the structural changes required to embed sustainable land-use planning principles—and attention to the whole watershed—into local government decision making. Water utilities and local government organizational structures will need to shift to align land-use planning with ecosystem considerations and watershed function. As a basic starting point, technologies and practices that increase permeability and rainwater reuse must be implemented.

FOR OUR COMMUNITIES TO BECOME SUSTAINABLE, WE MUST REIMAGINE AND REINVENT OUR SYSTEMS OF GOVERNANCE.

"Watershed Governance" (as an applied subset of Ecological Governance)[20] is the practice of embedding environmental priorities at all levels of decision making and action—from the personal to the global. It means thinking about cities and communities, forests and watersheds, and economic and political life within a new paradigm that treats the environment as all encompassing and all pervasive, not an add-on or afterthought to be "managed." For our communities to become sustainable, we must reimagine and reinvent our systems of governance. Transitioning to a Rainwater City will require clear roles and responsibilities for watershed health and function managed through a coordinating body, such as a Regional Water Commission or something broader such as a Watershed Authority or Agency. Reform need not create another layer of government but instead could evolve out of regional governments or existing bodies.[21] Reform would specifically seek to facilitate collaboration, coordination, and whole-system thinking across jurisdictions in a given watershed, or across departments in areas where multiple watersheds exist within community boundaries.

Watershed governance is not yet common in Canada, and the form it will take will vary from region to region depending on local geography, political and social priorities, and even historical development and existing institutions and practices. Experimentation and a "learn by doing" approach are needed to demonstrate its potential to overcome jurisdictional fragmentation and embed the necessary comprehensive watershed focus.[22]

HOW TO USE THE BLUEPRINTS

The following blueprints outline a process for weaving the three principles of the Rainwater City into a coherent approach to rainwater management. The three principles, as introduced already, are:

BUILD IT BETTER

LET RAIN DO THE WORK

WATERSHED GOVERNANCE

Although each aspect is discussed separately, the three principles should be viewed as an interconnected whole. Each of the following sections begins by describing how the principle addresses its corresponding problem as identified in the Stormwater City section. Specific actions for local governments based on each of the principles are then listed with attention to the provincial/territorial and federal government roles in each.

Each set of actions contains a “First Step” that describes the critical initial action needed to implement the principle. Examples of other communities that have already taken this step are also provided to illustrate the proof of possibility. The “Next Steps” include specific priority implementation actions that are needed to turn the concept into on-the-ground results. Implementing all the actions collectively will begin the transformation from a Stormwater City to a Rainwater City.

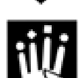
These principles collectively represent a comprehensive whole and actions can be done in any order. The actions described in each blueprint support and reinforce one another and are intended to be implemented as a suite across all municipalities sharing a watershed. For example, as communities adopt a new governance model that provides a funding mechanism for rainwater projects and increases the coordination between neighbouring municipalities, implementing rainwater harvesting systems and green infrastructure across the watershed will become more desirable and attainable.

In the blueprints, each action is linked to its associated outcome(s), as initially discussed in the Rainwater City section:

 IMPROVED RUNOFF QUALITY

 ENHANCED ASSET MANAGEMENT

 REDUCED RUNOFF VOLUME

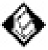
 WATERSHED GOVERNANCE

Throughout the Blueprint section, case studies demonstrate leading examples of what is possible and happening on the ground today in Canada and around the world.

OUTCOMES

 IMPROVED RUNOFF QUALITY

 REDUCED RUNOFF VOLUME

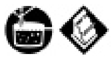
 ENHANCED ASSET MANAGEMENT

 WATERSHED GOVERNANCE

BUILD IT BETTER

LOCAL GOVERNMENT

Create Incentives for Green Infrastructure 

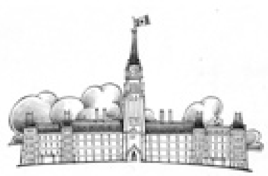
Implement Rainwater Utility Charges 

Mandate “Runoff Neutral” Standards for All New Developments and Redevelopments 

Set Effective Permeability/ Impermeability Targets for the Region 

Repair and Replace Obsolete Drainage Infrastructure and Restore Urban Streams and Watersheds 

Install End-of-Pipe Runoff Treatment Where Needed 



SENIOR GOVERNMENT

Create Incentives for Green Infrastructure Including Linking Infrastructure Spending 

LET RAIN DO THE WORK

Promote Non-Potable Water for All Irrigation

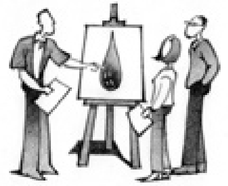
Develop Local Government Support and Guidelines

Mandate Dual Plumbing for All New Developments

Overcome Cost Barriers

Overcome Code Restrictions

Develop Provincial/ Territorial Guidelines and Policy Support



WATERSHED GOVERNANCE

Integrate Water Service Departments

Create an Integrated Water Management Plan

Establish Multidisciplinary Departments

Develop Rainwater and Green Development Guidelines

Enhance Reporting

Support Citizen-Driven Stewardship Initiatives

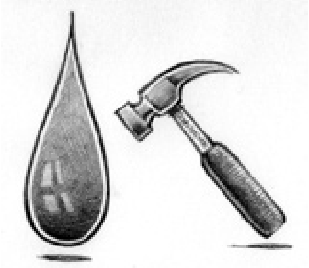
Establish a Regional Water Commission, Agency, or Authority

Legislate Integrated Water Management Plans

Enforce the *Fisheries Act*

PRINCIPLE 1

BUILD IT BETTER: DESIGN CITIES THAT WORK WITH THE WATER CYCLE



MAKING GREEN INFRASTRUCTURE "BUSINESS AS USUAL"

When green infrastructure practices are integrated throughout a region (e.g. replacing curbs and gutters with grassed swales and grass-lined channels, planting wildflower meadows rather than turf along medians and in open space, and installing permeable pavement) runoff volume and peak discharge are reduced more effectively than with traditional development and stormwater management practices.[23] Even if a watershed is covered with a high percentage of impervious surfaces, the use of green infrastructure can reduce their effect by facilitating the infiltration of water into the ground. In this way, the majority of total annual rainfall in a Rainwater City can be managed through a more natural system. Certain green infrastructure techniques, such as establishing or restoring wetlands and introducing streamside vegetation buffers and swales, also provide significant co-benefits. These include improved water quality and aquatic habitat, increased recreation areas, reduced heat island effect, and enhanced capacity for carbon storage.[24] Reintegrating nature can also add beauty to the urban environment.

A critical first step toward widespread implementation of green infrastructure is to create incentives for property owners and developers, such as expedited permitting and favourable zoning allowances. Setting effective permeability targets for a region provides direction

PROBLEMS

Current patterns of development in many Canadian cities lead to higher proportions of impermeable surfaces and, therefore, runoff and contribute to the cycle of overbuilt infrastructure. Existing infrastructure is aging and needs repair and upgrades, especially where stormwater is not adequately separated from sewage.

SOLUTIONS

Design cities and growth based on green infrastructure. Improve aging drainage infrastructure.

CHALLENGES

Regulatory obligations and current practices challenge the implementation of ecologically focused solutions. This is compounded by professional and political inertia. Costs for green infrastructure may appear more expensive if the additional ecological benefits are not taken into account.

BENEFITS

Significant reduction in runoff. Less expensive in the long term. Improved runoff quality. Costs are spread over a longer period of time since green infrastructure can be incrementally introduced into urban environments.

and focus for local government incentive programs, as well as benchmarks against which future development can be measured. Mandating "runoff neutral" standards or site-level regulations, such as release rates for all new redevelopments, can help achieve the overall permeability target for a region.

Using green infrastructure to manage rainwater in new developments is one thing, but what about the existing infrastructure in a Stormwater City? When retrofitting, changes will inevitably be made in stages. Although some small-scale green infrastructure retrofit projects can be more expensive than conventional approaches, green infrastructure is generally cost-effective when incorporated into larger redevelopment projects or when major infrastructural improvements are already needed. In these cases, the costs of green infrastructure are often minimized relative to the scope and cost of the overall project.[25] In the **City of Philadelphia** redevelopment projects are exempt from various regulatory requirements if they reduce impervious area by 20 per cent or more. Almost all redevelopment projects now reach this 20 per cent reduction target[26] with most developers now building on infill sites instead of undeveloped, natural areas.[27]

FIXING AND RETROFITTING OBSOLETE INFRASTRUCTURE…

Even with widespread adoption of green infrastructure that reduces a city's overall impermeability, the presence of roads, sidewalks, and extreme storm events means that there will still be a need to manage some amount of runoff. In a Rainwater City, existing hard infrastructure complements green infrastructure to accommodate these particular drainage priorities. So, while green infrastructure is the focus, identifying, repairing, and upgrading conventional drainage infrastructure is also relevant in Rainwater Cities. For example, the **City of Toronto** is installing tanks and tunnels to capture and hold combined sewer overflows and runoff. Before the water is slowly released into Lake Ontario, it is subjected to ultraviolet light to kill bacteria. In addition, the City will use a technique known as "flow balancing" to capture runoff and treat it through the use of ponds and wetlands. The City's *Wet Weather Flow Management Master Plan* calls for the creation of 180 ponds/wetlands.[28]

Canada's communities have billions of dollars invested in conventional stormwater infrastructure and in many cases are projecting a financial shortfall in addressing the future upkeep of aging infrastructure.[29] An opportunity lies in making evolutionary changes during the lifecycle of the infrastructure. For example, the **City of Calgary** is taking a two-tiered approach to transitioning to infrastructure that better mimics the natural water cycle. New developments are being built to capture approximately 80 per cent of their runoff volume. The City is working with developers to promote new practices for lot and block developments to achieve pre-development flow profiles. In older areas, the City prioritizes redevelopment opportunities such as end-of-pipe retrofits.

…AND PAYING FOR BOTH

Making green infrastructure "business as usual" and ensuring proper maintenance and repair of drainage infrastructure requires a dedicated budget. Rather than funding these measures out of property taxes, a Rainwater City can employ a more effective "user pay" approach and establish separate utility charges similar to those imposed by municipalities for water and sewer services. Rainwater utility charges (RUCs) place a regional or local public service charge on property owners based on the measured area of impervious ground cover on individual lots (e.g. parking lots, driveways, building rooftops). This practice rewards landowners that reduce demands on the centralized drainage system. Hundreds of local governments in the United States have established rainwater (sometimes called rainwater/drainage) utilities. In the state of Florida alone, more than 100 cities and counties have established a rainwater/drainage utility with utility charges.[30]

HUNDREDS OF LOCAL GOVERNMENTS IN THE UNITED STATES HAVE ESTABLISHED RAINWATER (SOMETIMES CALLED RAINWATER/DRAINAGE) UTILITIES.

The **City of Waterloo** changed its stormwater management program funding from a tax-based to a rate-based approach. In the past, the stormwater program had to compete for funds with other city services such as parks, roads, libraries, and social services. Now, a stormwater user rate is charged on the basis of runoff contribution to the city's rainwater management system. Under the new method, land-use classification, property size, estimated impervious area, and the intensity of infrastructure are the basis for estimating the level of contribution of stormwater. The City will implement the stormwater user rates in phases with full funding coming from the user rate by 2014.

The **City of Portland**, Oregon charges a stormwater utility fee and reduces the fee if property owners reduce their runoff by planting trees, installing rain gardens, or disconnecting downspouts. This creates an incentive for property owners across the city to reduce their stormwater runoff and saves both property owners and the City money.[31]

CASE STUDY 1

HALIFAX SHOWS FIVE REASONS "RAINWATER UTILITY CHARGES" WORK


Photo: hughreynoldsphotography.ca

Halifax Water is an autonomous and self-financed utility with a history of demonstrating leadership in pressure and leakage management and stormwater management. It provides utility services to a population of approximately 350,000 with more than 80,000 metered connections in the Halifax Regional Municipality. In 2007, Halifax's utility services were merged and Halifax Water became the first regulated water, wastewater, and stormwater utility in Canada. This created a unique opportunity to provide integrated, cost-effective, and environmentally sound services across the full urban water cycle.

Halifax Water's billing structure consists of fixed charges coupled with two separate, variable components that are based on the customer's water consumption volume:

- a water consumption charge that reflects the cost of pumping and treating water and maintaining the distribution system; and
- a wastewater and stormwater management charge that reflects the cost of operating both the stormwater and sanitary sewer systems, as well as infrastructure, operating, and capital upgrade costs associated with the wastewater collection and treatment system.

Halifax Water's billing approach illustrates five reasons why rainwater utility charges (RUCs) work:

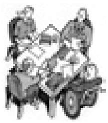
1. **Dedicated funding.** A modest utility charge on individual properties provides a line item on a municipality's annual budget that is dedicated exclusively to rainwater.
2. **Self-sustaining funding.** The amount of revenue needed for rainwater management can be predicted for years to come, meaning that real long-term planning over multiple-year periods can take place.
3. **An incentive to protect the environment.** Nuanced fee structures create incentives to motivate homeowners and developers to provide on-site controls to reduce rainwater runoff and pollutant loads.
4. **Greater fairness by implementing the "user pays" principle.** The municipality can bill its ratepayers more fairly. If the utility charge is based on the percentage of impervious land cover on each lot, those who contribute more to runoff problems will pay more while those who adopt a more modern approach to rainwater management will save money.
5. **Charging tax-exempt properties.** When rainwater services are funded through property taxes, tax-exempt owners do not pay for these services, regardless of how much they use them. A utility charge provides a mechanism to ensure that all property owners pay for the utility services they consume.

Sources on page 66.

BLUEPRINT PRINCIPLE 1: BUILD IT BETTER

DESIGN CITIES THAT WORK WITH THE WATER CYCLE

FIRST STEP

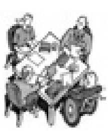


Create Incentives for Green Infrastructure

Create guaranteed, upfront incentives for property owners and developers to adopt green infrastructure practices. For developers, this can include expedited permitting and favourable zoning allowances for new developments and redevelopments that include urban stream and wetland restoration as part of functional site development. For homeowners, incentives can include reductions in rainwater utility charges when runoff is minimized and grants for retrofits and xeriscaping (water-wise landscaping). Disincentives can also be introduced, such as increased costs for developers that do not use green infrastructure in new developments and redevelopments. Lead by example and require all existing government buildings and lands to rely on green infrastructure as a primary approach to managing rainwater on site.

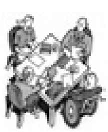
Municipalities and senior government should link all infrastructure funding to basic green infrastructure requirements, such as stream health and restoration, minimum permeability requirements, or green roofs. Governments can also provide support for educational and professional development programs for developers, green builders, landscapers, real estate agents, environmental consultants, and engineers.

NEXT STEPS



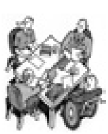
Implement Rainwater Utility Charges

Shift the financing of drainage systems and new and retrofit green infrastructure from property taxes to rainwater utility charges with fees based on property owners' actual use of the stormwater system.



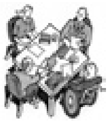
Mandate "Runoff Neutral" Standards for All New Developments and Redevelopments

Require that all new developments and redevelopments meet net-zero post-construction runoff standards through infiltration and retention.

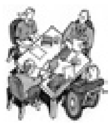


Set Effective Permeability/Impermeability Targets for the Region

Establish maximum allowable percentages of effective impervious and pervious surface area for different areas in the region. Alternatively, set release rate targets for new developments and redevelopments.



Repair and Replace Obsolete Drainage Infrastructure and Restore Urban Streams and Watersheds
Use rainwater utility charges to finance necessary infrastructure repairs and leverage the restoration of urban waterways. Make upgrading combined sewers and repairing cracked pipes the priority.



Install End-of-Pipe Runoff Treatment Where Needed
Although upstream green infrastructure should be the priority, implement modern end-of-pipe mechanisms, such as constructed wetlands, where appropriate to reduce runoff pollution.

OUTCOMES

- IMPROVED RUNOFF QUALITY
- REDUCED RUNOFF VOLUME
- ENHANCED ASSET MANAGEMENT
- WATERSHED GOVERNANCE

Photo: Architectsea

Bioswales line a street in West Seattle, Washington to enhance infiltration and reduce runoff.

CASE STUDY 2

RAINWATER MANAGEMENT IN GERMANY

In Germany, a widely recognized pioneer in rainwater management, the country's first subsidy for rainwater harvesting was implemented by the City of Hamburg in 1988. Five years later, Hessen was the first state to give municipalities the authority to mandate rainwater harvesting. In individual states the national *Water Resources Act* is used as a framework for the development of water regulations. The Act obligates "everyone… to use water economically, in order to protect available water resources… to maintain an adequate water supply while sustaining the water balance… [and to] prevent increased water runoff."

Between 1993 and 1997, the Hessen government used revenues from the state groundwater tax to provide grants to develop 114 rainwater harvesting systems. These pilot projects—implemented in buildings such as schools and retirement homes—were used to determine engineering standards for rainwater harvesting. These new standards were introduced through a municipal ordinance in 1999. Since that time, rainwater harvesting has become common across the entire country.

Germany's standard for rainwater harvesting, DIN 1989, outlines requirements for the design, installation, operation, and maintenance of rainwater harvesting systems. It applies to personal and commercial applications and requires rainwater harvesting systems to be designed in a way that they can receive municipal water as a supplementary source.

INCENTIVES

Almost all communities have introduced a "split-fee" system that charges property owners for the diversion of precipitation into the sewage system. Customers pay separately for wastewater treatment (in Berlin, approximately Can$3.50 per cubic metre of drinking water consumed in 2011) and for stormwater treatment (in Berlin, approximately Can$2.70 per square metre of impermeable surface per year in 2011).

As motivation for rainwater harvesting, most German cities offer incentives for reducing stormwater fees. Customers can receive tax deductions or exemptions when measures are taken to reduce the volume and rate of stormwater flow into municipal systems. In Berlin, the stormwater tax reduction for extensive green roofs is 50 per cent.

RAINWATER MANAGEMENT IN ACTION

In the City of Stuttgart, a new housing development, known as "Hohlgrabenäcker," is pioneering rainwater management for new building sites in the city. The complex was built on 16.7 hectares of land, and consists of approximately 265 private homes and nine apartment buildings. Because of the limited capacity of the city's existing drainage system, "Hohlgrabenäcker" was required by City Council to comply with strict design criteria. Legal and municipal requirements have restricted runoff flow from the development site to the public sewer system to 30 per cent. To reduce the environmental impacts of the new development, engineers designed an integrated rainwater management system that incorporates green roofs, runoff retention, and sustainable infiltration. With permeable pavement and road surfacing, and 18,300 square metres of green roofs, the final design achieved the ambitious target of only 20 per cent impermeable surfacing. *Sources on page 66.*

CASE STUDY 3

PHILADELPHIA THINKS BIG WITH ALL-GREEN STORMWATER MANAGEMENT PLAN

Since 2009, the City of Philadelphia has been making headlines for its unconventional vision of urban stormwater management. Philadelphia's plan for controlling combined sewer overflow, *Green City, Clean Waters*, is the largest green stormwater infrastructure program ever envisioned in the United States. Submitted in 2009, *Green City, Clean Waters* was approved in 2011 after multiple negotiations with the Pennsylvania Department of Environmental Protection.

The drainage area of Philadelphia's combined sewer system covers about 60 per cent of the city and contains 164 combined sewer outfalls. During major rainfall events, these sewers cause billions of gallons of sewage to flow into the surrounding waterways on an annual basis.

Fixing the overflow problems using conventional "grey" infrastructure would cost the City more than US$10 billion. Taking a different and less costly tactic, Philadelphia instead decided to invest in green infrastructure. By recreating the natural systems that were degraded by urbanization, Philadelphia plans to manage rainwater where it falls and keep stormwater out of its sewer system. Through *Green City, Clean Waters* commitments, the City plans to convert more than one-third of its total drainage area into greened acreage. A "greened acre" represents an acre of impervious land within the combined sewer service area that employs green infrastructure to manage at least the first inch of runoff. In addition, the City plans to restore close to 15 miles (24 kilometres) of urban streams. Techniques used will include, for example, pervious pavement, rainwater capture, rain gardens, and planting trees along streets.

Philadelphia has also implemented a new parcel-based billing and stormwater-crediting system. Replacing its meter-based system, stormwater charges are now based on the amount of impervious area and gross size of a customer's property. Customers who retrofit their properties to include approved management practices, such as green roofs, bioretention systems, or constructed wetlands, can earn stormwater credit.

In total, the City's water department will invest $2.4 billion into the *Green City, Clean Waters* program over the next 25 years.

Sources on page 66.

PRINCIPLE 2

LET RAIN DO THE WORK: IMPLEMENT WIDESPREAD RAINWATER HARVESTING

A NEW SOURCE OF WATER

When implemented on a large scale across many sites in a community, rainwater harvesting can relieve pressure on water supply and infrastructure while enhancing water security for property owners and municipalities. Canadian cities have average precipitation rates ranging from about 260 millimetres to 1,500 millimetres per year, indicating an enormous opportunity to collect rain and snowmelt for regular use. RWH is used extensively in British Columbia's Okanagan Valley and Gulf Islands, two of the seasonally drier regions in Canada. A Canadian study showed that with as little as 20 to 30 millimetres of monthly rainfall (a dry climate), a typical roof could still collect enough water to irrigate 25 to 40 square metres of lawn or garden area, or flush an efficient toilet for one month.[32] Other research suggests that RWH can save up to 40 per cent of indoor water consumption when used for washing clothes and flushing toilets.[33] Outdoor water use can also be drastically cut by employing xeriscaping and using stored rainwater for irrigating gardens and other landscaped areas.

In the Rainwater City, RWH isn't limited to residential purposes. Significant water savings are realized when rainwater is captured and used for irrigating city parks and for commercial and institutional uses. For example, in **Nova Scotia**—where captured rainwater is used as a major supply of water in areas with poor surface and groundwater quality—the Nova Scotia

PROBLEM

Conventional stormwater management allows a valuable resource—fresh water—to run down the drain.

SOLUTION

Install on-site rainwater harvesting systems in homes, businesses, and city properties for outdoor and indoor non-potable uses, such as clothes washing and toilet flushing.

CHALLENGES

Provincial building and plumbing codes limit the widespread uptake of rainwater harvesting and lead to perceived higher short-term costs, in part driven by liability concerns. Low-level public awareness also presents challenges. A history of underpriced municipal water promotes dependence on centralized supply since there is little incentive for users to look to efficiency, conservation, and alternative sources.

BENEFITS

Reduces stormwater runoff by up to 90 per cent. Significant water and financial savings for homes and businesses when used to complement municipal water supply. Builds community resilience to a changing climate by helping manage storm and drought events.

Department of Transportation and Public Works has, since 2005, been installing RWH tanks in all new schools in regions with water quality and/or quantity issues.[34]

RWH decreases the pressure placed on municipal potable water infrastructure to meet all of a community's water needs. This deferral creates savings in both energy use and greenhouse gas emissions from lower rates of pumping and treatment,[35] and financial benefits in the long term from reduced infrastructure capital, operations, and maintenance costs. Researchers in **Australia** found that using rainwater tanks in dryer regions, such as the Lower Hunter and Central Coast, deferred drinking water infrastructure needs by 28 to 100 years, with projected savings of $78 million in Lower Hunter and $47 million in the Central Coast. The study found that wetter areas, like Sydney or Brisbane, yielded even greater water savings.[36] In a Rainwater City, uptake can be promoted by helping property owners reduce the costs associated with installing RWH systems through incentives such as rebate programs.

The key to harnessing the full benefits of RWH in a Rainwater City is to diversify applications and end uses across sectors so that rainwater storage tanks can be constantly drawn down, minimizing dependence on municipal supply. Separating drinking water supply from other water uses may facilitate this. A 2007 report from the British Royal Society of Chemistry called for a separate water supply system for drinking water pipes as an ideal system for Great Britain.[37]

PROVINCIAL/TERRITORIAL POLICY ENDORSEMENT AND GUIDELINES PROVIDE NEEDED SUPPORT TO "EARLY ADOPTER" COMMUNITIES IN REGIONS THAT ARE ATTEMPTING TO OVERCOME THESE REGULATORY BARRIERS.

Most major cities in **Australia**, driven by years of drought, require that all new construction be fitted with "purple pipe" systems (dual pipe connections that deliver recycled, non-potable water to properties) in order to meet water needs. In Canada, although rainwater can be immediately mandated for all outdoor non-potable uses (including use on city-owned properties and golf courses), builders and local governments still face a number of regulatory barriers to implementing RWH across a broad spectrum of end uses. National, provincial, and territorial building and plumbing codes lack clear differentiation between greywater, non-potable water, and rainwater. Liability concerns prevent innovative local governments from mandating purple pipes in new construction and redevelopment, and from mandating the widespread use of RWH systems inside homes and commercial buildings. Overcoming code restrictions is a crucial step to using rain as a viable source of water. Provincial/territorial policy endorsement and guidelines provide needed support to "early adopter" communities in regions that are attempting to overcome these regulatory barriers.

REDUCING RUNOFF

Capturing rainwater on site and reusing it for a range of non-potable services has obvious implications for reducing the total volume of water entering centralized drainage systems. The reduction in runoff volume achieved through rainwater reuse can be significant, particularly in high-density residential areas and commercial areas with a large amount of impermeable surfaces and high rates of water use.[38] In the **City of Guelph**, a runoff reduction study on a residential home with an underground RWH system found that using rainwater could reduce the total volume of runoff from a site by as much as 89 per cent. This reduction was achieved using a 100 square metre roof catchment area and an 8,000-litre cistern, which were connected to the laundry facilities and toilets in a five-person household.[39] In **Germany**, many cities charge an annual "rain tax" based on the amount of on-site runoff. The tax can be reduced or eliminated if landowners implement rainfall and snowmelt retention measures, such as RWH.[40] This initiative has been acknowledged as the major driver of widespread RWH in Germany. As a bonus, the German rain tax also provides a potential source of funding for other infrastructure projects.

BUILDING COMMUNITY RESILIENCE

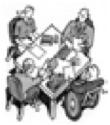
The most important benefit provided by integrating RWH into a Rainwater City is an improved ability to adapt to the impacts of a changing climate. Changes in climate are likely to result in too much water in some places at certain times, and too little water in others. RWH can help reduce the volume of runoff created by increased storm event frequency and it can expand the supply of water during dry periods. This flexibility reduces demands on strained groundwater, rivers, and lakes and builds community infrastructure resilience, which will be critical as the impacts of a changing climate emerge.

OUTCOMES

- IMPROVED RUNOFF QUALITY
- REDUCED RUNOFF VOLUME
- ENHANCED ASSET MANAGEMENT
- WATERSHED GOVERNANCE

IMPLEMENT WIDESPREAD RAINWATER HARVESTING

FIRST STEP



Promote Non-Potable Water for All Irrigation

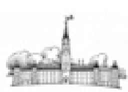
Ensure all institutions, city parks, boulevards, recreation areas, swimming pools, and golf courses are using rainwater for irrigation and other non-potable uses, especially outdoor uses.

Overcome Code Restrictions

Building and plumbing codes must be amended to allow for the widespread use of rainwater for indoor non-potable uses. Overcoming barriers and promoting this "off the grid" water supply requires all levels of government to take an active role. National, provincial, and territorial building and plumbing codes should be updated to differentiate between greywater, non-potable water, and rainwater. Building codes should explicitly permit and mandate the use of rainwater harvesting and greywater systems in homes and commercial buildings for irrigation, clothes washing, toilet flushing, and in heating and cooling units.

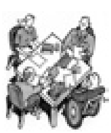
National, provincial, and territorial codes must explicitly expand permitted end uses. Until recently, it was difficult to get approval to use non-potable water supplies in dwellings in Canada. However, both the National Building Code (NBC) and the National Plumbing Code (NPC) now permit the use of non-potable water for some uses, such as toilet flushing. In its proposed revisions of provincial building and plumbing codes, Ontario has gone a step further by allowing clothes washers to be connected to rainwater supplies.

NEXT STEPS



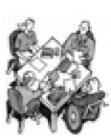
Develop Provincial/Territorial Guidelines and Policy Support

Mitigate concerns about liability for innovative communities by developing mechanisms for flexibility or standardized technical requirements related to green infrastructure and rainwater harvesting; best management practices regarding end uses, treatment, and maintenance; and general guidance on how to implement rainwater harvesting on a widespread scale.



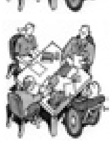
Develop Local Government Support and Guidelines

Adapt provincial and territorial guidelines (or technical requirements) to local circumstances. Ensure that guidelines are adaptable and able to change as best practices evolve. Incorporate the guidelines into community and regional planning documents.



Mandate Dual Plumbing for All New Developments

Look to the future and ensure all new developments contain purple pipes, regardless of whether they are immediately connected to a non-potable water source.



Overcome Cost Barriers

Introduce incentives for property owners to implement rainwater harvesting such as rebate programs (including installations) and full cost conservation-based pricing of municipal water supply. To realize economies of scale, start with large properties such as institutions and industry.

CASE STUDY 4

GUELPH: AN EARLY ADOPTER OF WIDESPREAD RAINWATER HARVESTING IN CANADA

Working with a number of stakeholders, the City of Guelph, Ontario is piloting an exemplary rainwater harvesting (RWH) program to offset its municipal water use and reduce runoff.

The Guelph Rainwater Harvesting Project began in 2005 when the City of Guelph, University of Guelph School of Engineering, Reid's Heritage Group, Evolve Builders Group Inc., the Ontario Centres of Excellence, and Canada Mortgage and Housing Corporation partnered to develop the initiative. The goal of the project is to build capacity for large-scale RWH systems across the country.

Cost, lack of market readiness, liability concerns, and lack of clear policy are all known barriers that have slowed the widespread adoption of RWH in Canada. The Guelph project studied the feasibility and design of RWH systems, focusing on the steps required to overcome these barriers and bring RWH into the mainstream.

The project began with the installation and monitoring of RWH systems in and around the city, including water quality and quantity testing at the study sites. University of Guelph researchers determined that using rainwater for flushing toilets and laundry as well as occasional outdoor use could reduce a household's water demand by as much as 47 per cent, and reduce the total volume of runoff at sites by as much as 89 per cent.

As part of the project, Reid's Heritage Group built North America's first LEED Platinum home, which included a residential RWH system. The system consisted of a filtration device, a 6,500 litre underground cistern, and a dedicated hot water system that supplied rainwater to the washing machine and dishwasher. Overall, the house used rainwater in three toilets, the washing machine, the dishwasher, and in a sub-surface irrigation system. A special permit allowed these "additional" uses for the purposes of research since the current Ontario Building Code only allows rainwater to be used for the priming of floor drains and toilet/urinal flushing.

In April 2010, the City of Guelph launched its RWH System Rebate Program. With this incentive, residents can receive a $2,000 rebate toward the installation of an approved system. The City's Water Conservation Strategy budgets for 200 RWH system installations over its 10-year duration. In total, the program will provide $400,000 to support RWH systems in the city. The rebate program was a recommendation of the City's 2009 Water Conservation and Efficiency Strategy Update, which aims to reduce Guelph's water production by 8,770 cubic metres per day by 2019. This represents an almost 19 per cent reduction in 2009 daily water production.

Most recently, the City of Guelph is conducting an assessment of how to expedite RWH within large-scale industrial and commercial applications. In addition, it is furthering awareness and the market for residential RWH through its Blue Built Home Certification and Incentive Program. This program, targeted at new single and semidetached homes, uses an approved set of high-quality home fixtures and appliances to save water and reduce utility bills by as much as 54 per cent.

Sources on page 66.

CASE STUDY 5

RAIN AS A NEW SOURCE DOWN UNDER

Australia is a world leader in developing government programs that promote rainwater harvesting (RWH) for residential and industrial use. Decades of droughts have eroded the country's agricultural sector and signalled a need to reduce dependence on conventional sources of water. As part of its *Water for the Future* initiative, the Australian Government delivered the National Rainwater and Greywater Initiative (NRGI). Through NRGI, the federal government provided rebates up to $500 for households to install rainwater tanks or greywater systems, and grants up to $10,000 for surf life saving clubs to install water saving and efficiency devices on club premises. The initiative promoted more general water conservation practices and encouraged residents and businesses to expand the use of collected rainwater beyond outdoor use.

The adoption of RWH systems across the country has also been enabled through legal and institutional shifts across jurisdictions. For example, many states have adopted progressive water-saving building codes for new development. Each state has taken a slightly different approach to its building code to achieve the ultimate objective of more sustainable water management. Queensland, for example, requires all new homes to meet established water savings targets. Water savings targets vary from 10 kilolitres to 70 kilolitres per year depending on the region and the type of dwelling. RWH is promoted as one option for meeting the targets. Collection tanks must meet minimum capacity requirements and be connected to indoor plumbing with cold-water connections made available for clothes washers and toilets, as well as an outdoor water fixture.

In New South Wales, new developments are required to comply with BASIX, the Building Sustainability Index. For most residential developments, BASIX Water targets call for a 40 per cent reduction in gross water usage. Residents can comply with water targets through a variety of actions such as installing water-efficient fixtures, using captured rainwater for irrigation, toilet flushing, laundry, or water-wise gardening. Similar regulations are in place in Victoria. In May 2011, the State adopted a "6 Star Standard," which requires all new homes, home renovations, alterations, and relocations to include either a solar hot water system or a rainwater tank for toilet flushing. In South Australia, rainwater tanks with a minimum storage capacity of 1,000 litres must be incorporated into the plumbing of all new homes.

Each of these states has developed detailed technical requirements to support the design and installation of RWH systems to enable compliance with the various regulations and legislation.

Sources on page 67.

BOX 5: LEADING BY EXAMPLE BY "PEELING BACK THE PAVEMENT"

A key early step toward the widespread implementation of green infrastructure is educating local government, elected officials, and the public about the differences between conventional and progressive rainwater management. This includes education on techniques, liabilities, and existing on-the-ground examples. In many U.S. cities, such efforts have lead to the development of effective policy to implement green streets and other green infrastructure projects.

GREEN STREETS

- In 2011, the **City of Edmonton** released its draft environmental strategic plan, *The Way We Green*. The plan seeks to implement and maintain a stormwater management strategy that gives priority to green infrastructure approaches over traditional stormwater management approaches. It will also establish and implement green infrastructure guidelines for application in all developments in Edmonton.
- *Green City, Clean Waters* is the **City of Philadelphia's** 25-year, US$2 billion plan that focuses on managing the city's stormwater largely through green infrastructure by "peeling back" concrete and asphalt, installing rain gardens, planting thousands of trees, and installing porous sidewalks.
- The **City of Portland's** *Green Street* program has resulted in extensive building of wetland-like vegetated swales into the city's streets. In total, 35 per cent of stormwater in Portland's combined sewer area will be managed through green approaches, and this is projected to reach 43 per cent by 2040. On SW 12th Avenue, the program introduced bioretention planter boxes into the landscaping strip between the sidewalk and the street. The planters, which cost only US$30,000, manage 180,000 gallons of runoff annually and reduce the peak flow of a 25-year storm event by 70 per cent.
- The **City of Vancouver** installed three "country lanes" as a pilot project to introduce green space and encourage on-site stormwater infiltration. The project replaced paved alleys and lanes with more permeable materials, such as two concrete or gravel strips surrounded by structural grass. The initial cost of one country lane was approximately $71 per foot, which is four times greater than the typical cost of $18 per foot. However, the City estimates that the cost will eventually decrease to $30 per foot.
- In the **City of Seattle**, an entire 660-foot city block was redesigned using green infrastructure techniques that reduce runoff and provide a more livable community. The 2nd Avenue *Street Edge Alternatives* Project (SEA Streets) replaced the original 25-foot-wide straight street with a 14-foot-wide curvilinear street. Vegetated swales designed to infiltrate and treat stormwater were installed within the right-of-way

on both sides of the street. Street parking was replaced with designated angled parking stalls. The final constructed design reduced imperviousness by more than 18 per cent and added 100 evergreen trees and 1,100 shrubs. The redesign reduced runoff by 99 per cent.

RAINWATER HARVESTING PROJECTS

- To promote rainwater capture in the **City of Seattle**, **King County's** King Street Center installed three 5,400-gallon tanks to collect rainwater from the building's roof. The rainwater is used for toilet flushing and landscaping needs. This system provides about 60 per cent (1.4 million of 2.2 million gallons annually) of the water needed for toilet flushing. Stormwater discharge from the building has also been reduced by the same percentage.
- The Automotive Building at the **City of Toronto's** Exhibition Place collects rainwater from the roof for use in the building's toilets and urinals. The rainwater is filtered prior to being stored in an underground cistern. Water is then pumped through dedicated non-potable water pipes to service all toilets and urinals throughout the building.

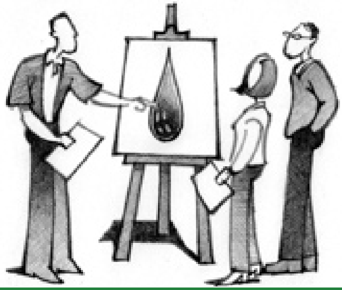
Sources on page 65.

Photo: TonyTheTiger

Leading by Example. Ten years ago, the City of Chicago's Department of Environment took the initiative to implement a green roof pilot project at Chicago's City Hall to test different types of green roof systems, heating and cooling benefits, success rates of native and non-native vegetation, and reductions in rainwater runoff. Since then, Chicago has expanded the program to offer incentives to private developers through its Green Roof program and Green Permit program. Between 2005 and 2007, Chicago's Green Roof program awarded grants to more than 70 green roof projects on commercial and small residential buildings. Chicago also adopted a local ordinance to require retention of stormwater on site. In January 2008, the City adopted the Stormwater Management Ordinance, requiring any new development or redevelopment that disturbs 15,000 square feet or more or creates a parking lot of 7,500 square feet or more to detain at least the first half inch of rain on site.

PRINCIPLE 3

NEW GOVERNANCE: AN INTEGRATED WATERSHED-BASED APPROACH



In the Stormwater City, much of the focus of local government is on water *management*: maintaining drinking water quality, protecting and securing local drinking water supplies, and controlling stormwater and wastewater. In contrast, the Rainwater City recognizes how *governance* shapes management approaches. Several studies and experiences point to the importance of "good governance" to help overcome the status quo in urban water management.[41] In the Rainwater City, "good governance" integrates land and water management at a watershed scale. Integrated governance is essential to sustainable urban water management.

THE CASE FOR GOVERNANCE ON A WATERSHED SCALE

We don't always recognize cities as ecosystems, but they are.[42] And in urban ecosystems every land-use decision has an impact on water. For example, when a peri-urban area is rezoned from agricultural to commercial or residential, its impervious surface area will increase as new houses, schools, shopping centres, and roads are built. This land-use decision induces a cascade of water-related needs; infrastructure is needed to drain runoff and new water supply and wastewater systems are needed to service the region. The decision also creates a number of costs to the ecosystem. In aquatic environments, water quantity, quality, rate of flow, and timing of flow are all affected. Lower rates of groundwater recharge, higher amounts of polluted runoff discharging into local waterways, increased drawdown from local

PROBLEMS

Decision making does not account for cumulative impacts or whole watershed function. Fragmented jurisdiction over managing stormwater runoff within and between municipalities that share a watershed means that there is no coordination between local governments within the same watershed. This leads to inefficient use of public resources and a disconnected approach to land-use planning and ecosystem impacts.

SOLUTIONS

Plan and govern on a watershed scale. Integrate land- and water-use planning.

CHALLENGES

Outdated local government legislation that embodies and perpetuates a siloed approach to decision making. Lengthy and onerous legislative changes to Local Government Acts are necessary. Poor record of inter-jurisdictional collaboration on urban water issues in Canada. Poorly defined roles and responsibilities over stormwater.

BENEFITS

Integrated watershed planning reduces the negative ecological impacts of land use, saves money, and builds community resilience.

water supplies, and flooding all result in negative impacts on fish populations and habitat. In this way, a distant land-use decision triggers a range of impacts on local water resources and ecosystems.

Many studies and experts point to the need to plan human activities across entire watersheds to fully assess land-use decisions for ecosystem impacts.[43] This rationale is based on recognition of the water cycle as the pathway that integrates the physical, chemical, and biological processes of the entire regional ecosystem. For example, when an upstream city has a significant amount of impermeable surfaces, a large quantity of polluted runoff is generated which directly affects downstream communities and ecosystems. The Rainwater City recognizes the importance of scale when considering the relationship between land use and ecosystem impacts. As a result, a *watershed governance* approach is adopted to address the complex and interdependent dynamics of water, land, and human and wildlife needs and activities across a landscape.

An appropriate vehicle for integrating ecosystem-based land management into the Rainwater City is an integrated water management plan that recognizes all water—including rainwater—is connected. Such a plan uses the watershed as the primary boundary for all land-use planning. It enables a bird's-eye-view understanding of ecosystem function and status within an entire drainage area and accounts for ecological considerations that need to be integrated into land-use planning and decision making. With an integrated water management plan, local governments in a Rainwater City are enabled to develop and implement a rainwater plan for the entire urban watershed or basin through changes to provincial or territorial legislation via Local Government Acts and Municipal Acts.[44]

Plans that focus on rainwater management across a region are rare in Canada. However, there are exceptions. The **City of Toronto's** *Wet Weather Flow Management Master Plan* (approved in 2003) is a watershed-based stormwater plan that treats the area's natural landscape as a whole functioning system. The **Toronto and Region Conservation Authority (TRCA)** is an important example of a watershed governance body that is actively ensuring a "think like a watershed" approach in the city. Working with the City, TRCA liaises with neighbouring municipalities to develop consistent stormwater criteria for new development and protective measures where development already exists. **Metro Vancouver's** *Integrated Liquid Waste and Resource Management Plan* is a leading document that uses an ecosystem-based approach to managing stormwater on a regional scale. Although its focus is replacing the 50-year-old Lions Gate and Iona Island primary sewage plants with advanced treatment facilities, the plan is also built around the goal of improving the natural environment in the region. The plan ultimately integrates liquid and solid waste recovery, rainwater management, and land-use planning for the entire Greater Vancouver area.

One way to ensure that regions develop an integrated water management plan is to have provinces and territories amend relevant sections of Environmental Management Acts to mandate, rather than simply enable, these plans. A further driver could be clear requirements for these plans and their implementation as a condition for future infrastructure grants from senior levels of government. These legislative amendments should include definitions and requirements for best management practices for preparing and implementing the integrated water management plan at both the regional and municipal scale. They should also require regular reporting on plan and watershed status. The **City of Portland**, a North American leader in rainwater management, requires that its comprehensive plans contain specified best management practices, as does **South Australia** (see Case Study 7).

THE GROWING NUMBER OF URBAN WATERSHED PLANS THAT ARE GATHERING DUST ON LOCAL GOVERNMENT SHELVES ACROSS THE COUNTRY CHALLENGES US TO ASK WHY SO FEW OF THESE PLANS ARE FULLY IMPLEMENTED.

Developing an integrated water management plan does not ensure it will be implemented. The growing number of urban watershed plans that are gathering dust on local government shelves across the country challenges us to ask why so few of these plans are fully implemented.

Establishing an entity like a Regional Water Commission in each urban watershed is one potential key enabler of a transition from Stormwater Cities to Rainwater Cities. This regional body would serve as a comprehensive entity that could have broad responsibilities to deal with water in an integrated way, using best practices in planning and bylaw approaches that have been proven elsewhere. Using rainwater as a starting point, it could ensure consistent action for different types of landscapes across regions, enforce implementation of regulation and policies, support citizen-driven stewardship initiatives, and also be responsible for coordinating the development of a rainwater plan for the region.

A more modest alternative is to have an inter-local agreement between the municipalities and regional districts (or equivalents) sharing a watershed to ensure alignment of rainwater management efforts. One can see the foundation for these types of structures in entities such as the **Okanagan Basin Water Board** in British Columbia, **Ontario's Conservation Authorities** and **Québec's "ZIP" committees**. Funding for these types of watershed bodies could be recouped through a direct delegated taxation authority or by charging a utility service fee (a rainwater utility charge) for management functions.

Photo: R. J. Frith

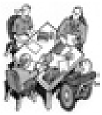
INTEGRATE LAND AND WATER DECISIONS WITHIN LOCAL GOVERNMENT

In addition to making decisions on a watershed scale (and, where appropriate, across municipalities) with the support of a coordinating body, the Rainwater City integrates land-use decisions so the ecosystem impacts of new projects are assessed at every stage of the planning process. To start, water services are integrated to align more closely with stages in the natural water cycle. In this way, drinking water, stormwater, and wastewater are managed as a single system from "source to source." Both the **Halifax Regional Municipality** and **City of Toronto** have merged their respective water services departments along these lines and the **Capital Regional District** in British Columbia also appears to be considering this approach. This streamlining enables utilities to deliver water and wastewater services cost effectively and with a commitment to long-term water sustainability.[45]

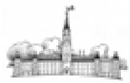
The Rainwater City ensures rainwater planning is coordinated with the activities of other departments in the region's local government. This can be achieved through something as simple as water departments putting together specific rainwater guidelines for planning, parks, and transportation departments, or by requiring all departments involved in land management to work with the water department to develop green development standards for the entire region. Comprehensive integration of land-use and ecosystem objectives may require fundamentally restructuring local government departments to align with the steps in the planning and redevelopment process. For example, the **City of Brisbane**, Australia reorganized the structure of its water branch from a division of labour along technical specialties (for example, stormwater engineers, wastewater engineers, etc.) to one based on a process that integrates the technical groupings across each phase of the planning cycle: strategy, planning, and implementation.[46] Importantly, integration must be formalized in order to be timely, effective, and lasting. While voluntary "advisory groups" or ad hoc "inter-departmental committees" can be helpful, they generally have limited capacity. Regardless of the extent of organizational restructuring, integration results in a greater understanding of the full suite of programs being delivered and thus enhances the opportunity to combine complementary projects and resolve conflicts between priorities, projects, and programs for more efficient delivery of community services.

AN INTEGRATED WATERSHED-BASED APPROACH

FIRST STEP

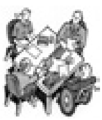


Integrate Water Service Departments
Merge water departments so that drinking water supply, stormwater, and wastewater are managed as a single system that mimics the natural water cycle.

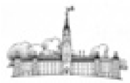


Establish a Regional Water Commission, Agency, or Authority
Establish a regional watershed entity with a clear mandate to address watershed-level issues and decision-making powers as they relate to land-use decisions that impact water resources. This body should have broad responsibilities and be tasked with catalyzing action to deal with water in a comprehensive, integrated way using best practices in planning and bylaw approaches. A Regional Water Commission could ensure consistent action for different types of landscapes across urban regions or act as a support for municipalities that do not have the in-house expertise to address the challenges of integrated rainwater management. An important starting point for this kind of body is to coordinate the development of an integrated water management plan for the region. It could also provide expertise and support to municipalities implementing the plan by helping to draft—and enforce—the bylaws, policies, and technical standards necessary to achieve the targets set out by the plan. In some jurisdictions, regional governments, such as Conservation Authorities or Regional Districts, already fulfill some of these roles. The goal of a Regional Water Commission would be to formalize coordination between all relevant jurisdictions and municipalities. To start, such an entity could be funded through rainwater utility charges.

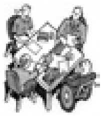
NEXT STEPS



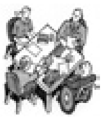
Create an Integrated Water Management Plan
Base the rainwater sections of the plan on runoff volume reduction, water quality, and rate control/detention. Ensure implementation by incorporating the plan into land-use and community and regional planning documents.



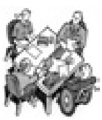
Legislate Integrated Water Management Plans
Amend the relevant sections of provincial and territorial Environmental Management Acts to mandate the development of watershed-based water management plans. Explicitly define the key content required in such a plan. Link the development and execution of the integrated water management plan to eligibility for infrastructure funding or programs.



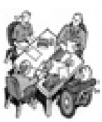
Establish Multidisciplinary Departments
Develop capacity for multidisciplinary problem solving by establishing a mix of professionals within planning and water departments, including those with social science and natural science backgrounds (e.g. ecology, economics, landscape design, behavioural psychology, and education). These kinds of formal "working groups" should be complemented by local advisory groups to ensure a broad range of perspectives are included.



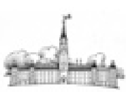
Develop Rainwater and Green Development Guidelines
Ensure that water, planning, and transportation departments work together to develop water-sensitive land-use guidelines based on a triple-bottom-line approach for new developments and redevelopments across the region. Incorporate the guidelines into all land-use and planning documents.



Enhance Reporting
Publish regular "state of the watershed" reports that include updates on the health of each watershed in the region; documentation and targets for reducing total impervious cover and/or release rates in the region; restoration priorities for local streams, lakes, and aquifers; targets for replacing obsolete infrastructure and installing end-of-pipe treatments; and data regarding the quality of stormwater discharge.



Support Citizen-Driven Stewardship Initiatives
Provide resources and, at a minimum, support meaningful engagement to local stewardship groups and educational institutions to raise awareness, engage citizen action, and promote watershed protection, rehabilitation, and monitoring.



Enforce the *Fisheries Act*
Enforce the prohibition against the deposition of deleterious substances into waters frequented by fish and the prohibition against destruction of fish habitat when runoff discharges violate those provisions.

OUTCOMES

- IMPROVED RUNOFF QUALITY
- REDUCED RUNOFF VOLUME
- ENHANCED ASSET MANAGEMENT
- WATERSHED GOVERNANCE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CASE STUDY 6

TORONTO'S MULTIDISCIPLINARY APPROACH TO RAINWATER MANAGEMENT

The City of Toronto, Ontario is in the process of implementing a 25-year plan to help solve water pollution in the city. Approved in 2003, the *Wet Weather Flow Master Plan* (WWFMP) represents a comprehensive approach to urban stormwater governance, with a focus on reducing pollution caused by stormwater runoff and combined sewer overflows (CSOs).

In 1987, the International Joint Commission identified the City of Toronto waterfront as one of 43 polluted Areas of Concern in the Great Lakes Basin. The geographic boundary of the City of Toronto spans six different watersheds and from these watersheds pollution from CSOs and stormwater runoff ultimately flows into Lake Ontario.

The WWFMP takes a hierarchical approach to rainwater management. It starts with source controls, which deal with rainwater where it falls. It then focuses on conveyance system measures and, finally, end-of-pipe facilities.

The plan identifies a host of measures to be implemented on individual lots including using porous surfaces rather than concrete or asphalt, especially in parking lots; planting trees to help capture runoff; a green roof incentive pilot program; and a rainwater harvesting demonstration project at Exhibition Place, the city's largest entertainment venue.

As the city's aging sewer infrastructure requires replacement, it will be updated with new purposefully "leaky" pipes that allow captured stormwater to seep into the ground. What isn't captured by the surrounding soil or sand will re-enter the storm sewer pipes and will be controlled through end-of-pipe measures. In addition, a "search and destroy cross-connections" program aims to fix linkages between drainage pipes that are erroneously connected to sanitary sewers.

The total capital cost for the 25-year WWFMP is approximately $1 billion, or $42 million per year. Operational and maintenance costs to implement the capital projects are estimated at $16 million annually.

Complementing the WWFMP, the City has also developed the award-winning Toronto Green Standard (TGS), which outlines performance measures and guidelines for sustainable site and building design for new developments. It was developed collaboratively across a number of divisions within the city, highlighting Toronto's progress toward integrating land- and water-use management and decision making.

Sources on page 67.

Photo (facing): hughreynoldsphotography.ca

CASE STUDY 7

PROGRESSIVE LEGISLATION IN ACTION: UNITED STATES *CLEAN WATER ACT* AND SOUTH AUSTRALIA *STORMWATER MANAGEMENT AUTHORITY*

The United States' *Clean Water Act* (CWA) and South Australia's recent amendments to the *Local Government Act* provide two good examples of action by senior government on stormwater management. While the law is only one aspect of good governance, it can catalyze significant change and create an environment that enables positive action.

THE UNITED STATES' CLEAN WATER ACT

The CWA is the primary federal law in the United States regulating discharges of pollutants into U.S. waters. It establishes national quality standards for surface waters and penalizes violators. When the CWA was signed into law in 1972 it was hailed as landmark legislation—and has enabled significant improvements to the quality of U.S. water. The original act introduced the National Pollutant Discharge Elimination System (NPDES), a permit system for regulating point sources of pollution.

Urban runoff and industrial stormwater discharges were originally excluded from the NPDES program. However, a series of court rulings through the 1980s expanded the NPDES to include stormwater discharges both from urban storm sewer systems (MS4) and industrial sources as part of the permit program. The MS4 permits require regulated municipalities to use best management practices to reduce pollutants in discharges to the "maximum extent practicable."

As a result of providing national standards and practices for the regulation of stormwater, the CWA is considered to be a key driver for the widespread implementation of green infrastructure and best practices of stormwater management in parts of the United States. The proposed *Green Infrastructure for Clean Water Act* of 2009 aimed to further support uptake of green infrastructure across the country by creating "Centers of Excellence" for green infrastructure research, establishing a green infrastructure program at the Environmental Protection Agency (EPA), and authorizing the issuance of grants for green infrastructure projects. This bill never became law, but does foreshadow the trend to more comprehensive approaches to green infrastructure and their critical link to progressive stormwater management.

Many have acknowledged that the CWA is becoming obsolete. To address some of these issues the EPA recently initiated a law reform process to establish a program to reduce stormwater discharges from newly developed and redeveloped sites and make other regulatory improvements to strengthen its stormwater program. Another change proposed by the National Academy of the Sciences involves introducing a watershed permitting structure that would put the authority and accountability for stormwater discharges at a more local level. A municipal lead permittee, such as a city, would work in partnership with other municipalities in the watershed as co-permittees. Permitting Authorities (designated states or the EPA) would adopt a minimum goal in every watershed to avoid further loss or degradation of "beneficial uses" in the watershed. This change mirrors a similar move in Australia towards a more integrated "watershed perspective."

SOUTH AUSTRALIA'S STORMWATER MANAGEMENT AUTHORITY

The *Stormwater Management Authority* (SMA) is a relatively new independent statutory body created under the *Local Government Act* in the State of South Australia. Established in 2007, the *Local Government Stormwater Management Amendment Act* sets out the joint roles and responsibilities of the State and local governments within the state and provides governance arrangements for stormwater management on a watershed basis throughout South Australia.

Local councils continue to play a major role in stormwater management under the SMA, including preparing stormwater management plans and oversight of infrastructure projects, with the Authority facilitating the coordination of stormwater issues between councils that share the same watershed. The act also commits approximately Can$4 million per year (indexed) for 30 years by the State for local governments to carry out stormwater planning, community education, pilot projects, and catalyze green infrastructure projects through a Stormwater Management Fund. Parliament, Natural Resource Management Board, and local government disaster funds support the fund.

One of the SMA's early actions was to establish a set of guidelines including six policy goals for comprehensive stormwater management planning. A principle objective of these goals is to define the responsibility of the SMA (rather than individual councils) to coordinate planning for stormwater management on a watershed basis.

- Apply risk management framework for hazards/flooding based on catchment characteristics and rigorous data collection;
- Facilitate more productive use of stormwater;
- Manage the environmental impacts of stormwater as a conveyor of pollution;
- Manage stormwater as part of the urban water cycle recognizing natural watercourses and ecosystems where feasible;
- Achieve responsible stormwater management locally by making better use of the statutory development planning system; and
- Gain innovative stormwater policy outcomes through the most effective funding and procurement arrangements.

Local councils that want funding support for stormwater infrastructure through the SMA's Stormwater Management Fund must first develop a Stormwater Management Plan (SMP) that conforms to these six guidelines. These plans must be developed in consultation with the community. As outlined in South Australia's water plan, *Water for Good*, SMPs also need to explore the harvesting and reuse aspects of stormwater management. Ultimately, both the Natural Resources Management Board and the SMA must approve plans. Eventually, all future investment in stormwater infrastructure with state government support (i.e. beyond the SMA's Stormwater Management Fund) will be in infrastructure that has been justified through the SMP process. In South Australia, this is creating a strong incentive for ongoing innovation and a positive cycle of progressive infrastructure development. *Sources on page 67.*

CASE STUDY 8

THE BOWKER CREEK INITIATIVE: GRASSROOTS AND MULTI-JURISDICTIONAL

The Bowker Creek Urban Watershed Renewal Initiative (BCI) is a collaborative pilot project that is leading the way in watershed management in British Columbia's Capital Regional District on Vancouver Island. Through the BCI, dedicated citizens are proving that water resources can be effectively managed across political boundaries and management doesn't have to take a top-down approach.

For nearly 10 years, residents around the **City of Victoria** have been shaping the management of Bowker Creek to improve the health of the highly urbanized watershed. Almost 90 per cent of the watershed has been developed for commercial, industrial, institutional, and residential use and about half of its surface is impermeable, covered by roads, buildings, and pavement. Urbanization has confined much of the original creek channel to culverts and many of the region's storm drains flow directly into the creek. Management is complicated by the fact that the watershed crosses three different municipalities before discharging into the Pacific Ocean.

The BCI is a unique, collaborative effort that works with the three municipalities, the regional district, residents, and the University of Victoria to achieve a common vision by addressing pollution, flooding, and habitat degradation in the watershed.

The initiative began when a local stewardship group, the *Friends of Bowker Creek Society*, began raising awareness about the creek and advocating for coordinated watershed planning and restoration. As interest spread, the initiative transformed from a strictly grassroots endeavour into a model for multi-jurisdictional collaboration. In 2003, the first formal steps were put in place when the three member municipalities and the Capital Regional District Board approved the Bowker Creek Watershed Management Plan (BCWMP), providing a clear vision and goal that emphasized liveability, quality of life, and respect for the environment.

In 2009, building on the BCWMP, the *Bowker Creek Blueprint: A 100-year action plan to restore the Bowker Creek watershed* was developed. The *Blueprint* assists municipalities, land stewards, and community groups in meeting the goals of the BCWMP. The document provides an action plan that allows the three municipalities and other land stewards to coordinate their efforts to ensure the long-term vision for the watershed is achieved. Recognizing that it takes time for significant change to occur in an urban environment, the document provides the information and guidance needed to manage and restore the watershed over the next 50 to 100 years.

Current and future projects include building rain gardens, creek day-lighting, removing invasive species, reviewing and revising municipal plans to include Bowker Creek goals and actions, supporting the development of an urban forest strategy, and working with a local high school to design and implement creek restoration on school district property as old buildings are replaced. *Sources on page 67.*

BOX 6: THE BUSINESS CASE FOR THE RAINWATER CITY

Many studies have shown that storing and treating stormwater runoff costs more than reducing the amount of stormwater generated at the source. Studies in Maryland and Illinois have shown that new residential developments that use green infrastructure stormwater controls can save US$3,500 to $4,500 per lot compared with conventional new development. A recent study from the University of Guelph found that when all costs, including environmental costs, are taken into account, the cost of implementing rainwater capture systems is comparable to the cost of implementing conventional stormwater systems.

In 2009, the **City of Philadelphia** commissioned a study to compare traditional stormwater management techniques with a green infrastructure approach. The study used a triple-bottom-line analysis to capture the benefits of a variety of factors including increased recreational opportunities, improved aesthetics and property value, and water quality and aquatic habitat enhancement. US$122 million in benefits were expected from the traditional approach while the green infrastructure option was expected to yield benefits of $2,846 million—a difference of 23 to one. As a result, Philadelphia is pursuing one of the most ambitious rainwater programs in North America through its *Green City, Clean Waters* plan.

Although it is simpler to design a green development from scratch than to incorporate green infrastructure into existing developments and buildings, retrofitting is both important and doable, particularly when it can piggyback on replacements and repairs that need to be made. An analysis conducted by the **City of Vancouver** showed that incorporating green infrastructure into locations with existing conventional stormwater controls would cost only marginally more than rehabilitating the conventional system, and introducing green infrastructure into new developments would cost less. **Seattle Public Utilities** estimated that using green infrastructure techniques in place of conventional sidewalks, curbs, gutters, and catch basins could reduce construction costs by 24 per cent to 45 per cent in street redesign projects. In the **City of Portland**, the Bureau of Environmental Services will save more than $58 million through the large-scale integration of green infrastructure and targeted pipe replacement and repairs in its Brooklyn Creek Basin project. The total cost of the project will be 40 per cent less than the cost of traditional infrastructure solutions.

Photo: S. Porter-Bopp

Dockside Green, a mixed-use development built to house 2,500 people in Victoria, B.C., demonstrates integrated stormwater management strategies. Naturalized artificial creeks and retention ponds clean and control stormwater flows. Green roofs retain and recycle water by directing overflow into rain cisterns on each resident's balcony, providing water for planters and houseplants. Excess water is directed to the naturalized creeks and ponds on site.

Sources on page 65.

Illustration: L. Carnes

CONCLUSION

A BLUEPRINT TO CHANGE THE FUTURE

The Rainwater City tells one possible tale of the future: cities grow and are retrofitted to have less concrete and minimize runoff, and use rain as a primary water supply. Ensuring that land and water management decisions are integrated and made on a watershed basis is key to making this story a reality. As the Blueprint for the Rainwater City demonstrates, correcting governance and making structural changes to government departments are important steps. The Rainwater City isn't just a pipe(less) dream. Many cities across the world are already putting the principles of a Rainwater City into action by managing rainwater in concert with natural systems. **Philadelphia**, **Portland**, and **Seattle** are just some of the communities that are pioneering this path. In Canada, cities from coast to coast are also beginning to adopt innovative and more holistic approaches to managing wet weather, including **Victoria**, **Vancouver**, **Calgary**, **Toronto**, **Halifax**, and many other smaller communities in British Columbia and Ontario.

However, the full vision of the Rainwater City has yet to be realized. No community in Canada has yet managed to incorporate all the elements necessary to catalyze a new era of designing with nature and water-centric municipal planning. No community is truly built around using rain as a resource—at least not yet.

TRANSITIONING TO A RAINWATER CITY DOES NOT MEAN DOING OLD THINGS BETTER. IT MEANS FUNDAMENTALLY SHIFTING OUR RELATIONSHIP WITH WATER IN OUR DAILY LIVES.

For the first time in history, the majority of the world's population lives in cities. How our cities grow, how we build and retrofit neighbourhoods, how we provide housing, how we choose to get around, how well we incorporate nature into the places we live, and how we make collective decisions will largely determine our future. In cities, the way in which rain and snowfall are managed is fundamental to determining how the urban ecosystem will interact with the natural water cycle. Transitioning to a Rainwater City does not mean doing old things better. It means fundamentally shifting our relationship with water in our daily lives. It requires us to see rain differently, break old habits, think and act on new design principles, and harness the full spectrum of nature's services in our cities.

Achieving this new future will mean a shift towards accommodating nature's water needs and fully understanding and considering the impacts our actions have on water. It will require innovation in planning and redevelopment, integration of land and water use, and a clear priority to ensure watershed function. By considering the needs of the natural environment, we can ensure that our communities continue to thrive and prosper. The transition to a Rainwater City is no longer an unattainable vision. It is a necessity.

APPENDIX

LEADING THINKING AND PRACTICE ON RAINWATER MANAGEMENT

GREEN INFRASTRUCTURE/LOW IMPACT DEVELOPMENT

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POLIS Project on Ecological Governance
University of Victoria

Created in 2000, the POLIS Project on Ecological Governance is a research-based organization housed at the University of Victoria in British Columbia. Researchers who are also community activists work together at POLIS to dismantle the notion of the environment as merely another sector, and to make ecological thinking and practice a core value in all aspects of society. Among the many research centres investigating and promoting sustainability worldwide, POLIS represents a unique blend of multidisciplinary academic research and community action. Visit www.polisproject.org to learn more.

POLIS Project on Ecological Governance
watersustainabilityproject

The Water Sustainabilty Project (WSP) is an action-based research group that recognizes that water scarcity is a social dilemma that cannot be addressed by technical solutions alone. The project focuses on three themes crucial to a sustainable water future:

- Water Conservation and the Soft Path
- Water-Energy Nexus
- Water Law, Policy and Governance

WSP works with industry, government, civil society and individuals to develop and embed water conservation strategies to benefit the economy, communities and the environment. WSP is an initiative of the POLIS Project on Ecological Governance at the University of Victoria. Visit www.poliswaterproject.org to learn more.

Environmental Law Centre
UNIVERSITY OF VICTORIA

The Environmental Law Centre (ELC) is a non-profit society that operates the ELC Clinic at the University of Victoria, Faculty of Law. Its mission is to provide citizens with the tools and resources to advocate effectively for the restoration, conservation, and protection of British Columbia's unique and diverse environment. Since 1996 the ELC has provided pro bono representation and research on public interest environmental issues to community groups, conservation organizations, and First Nations across British Columbia. Guided by a case selection policy that prioritizes access to justice for clients who would be otherwise unable to obtain legal representation, the ELC assists clients in tackling today's complex environmental challenges. Visit: www.elc.uvic.ca to learn more.

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