



the partnership  
for water sustainability in bc

## **Cross-border collaboration would enhance water resources research and practice in North America**

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Moving Towards “Sustainable Watershed Systems, through Asset Management” in British Columbia



Center for Infrastructure Modeling & Management:  
**“British Columbia experience in whole-system,  
water balance based approaches in the Pacific  
Northwest adds a critical combination of tools and  
understanding to the water resources toolbox,”  
states Dr. Charles Rowney, Director of Operations**

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*The Partnership for Water Sustainability in British Columbia develops online tools and delivers capacity-building programs on behalf of government. These programs provide professional development and tackle “the disconnect” between information and implementation in the local government setting.*

*Given the evident benefits of strategic interaction, the Partnership and the Urban Watershed Research Institute (UWRI) have an agreement to collaborate regarding reciprocal benefits and joint actions related to water resources research and practice in North America. The focal point for collaboration is the newly formed and US-based Center for Infrastructure Modeling and Management ([ncimm.org](http://ncimm.org)).*

*Under an agreement with the US Environmental Protection Agency, [ncimm.org](http://ncimm.org) has been created to provide sustainable research, development and outreach for water infrastructure modeling, initially focusing on two foremost modelling tools – known around the world by the acronyms EPA SWMM and EPANET.*

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**Ted van der Gulik**

President, Partnership  
for Water Sustainability  
in British Columbia

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### **The Partnership for Water Sustainability:**

*Develops tools and  
implements programs  
that are accessible and  
replicable.*

*Tackles “the disconnect”  
between information and  
implementation.*

*Facilitates alignment of  
regional and local  
actions with the Province  
of British Columbia's  
policy, program and  
regulatory framework.*

*Profiles, showcases and  
celebrates local  
government successes  
through professional  
development and  
outreach.*

## **Cross-border collaboration opens the door to sharing and learning**

The Partnership for Water Sustainability in British Columbia delivers services on behalf of government. In particular, the Partnership is responsible for the Water Sustainability Action Plan for British Columbia. Under this umbrella, the Partnership is leading the Georgia Basin Inter-Regional Educational Initiative (IREI).

The Georgia Basin region encompasses the east coast of Vancouver Island and Lower Mainland (Metro Vancouver). These lands drain into the Salish Sea, which includes Puget Sound in Washington State.

Five regional districts, representing 75% of British Columbia's population, are sharing and learning from each other through the IREI capacity-building program. The current focus is on [Sustainable Watershed Systems, through Asset Management](http://waterbucket.ca/rm/category/sustainable-watershed-systems/)<sup>1</sup>.

### ***Collaboration with Urban Watersheds Research Institute:***

“The Partnership for the Water Sustainability is excited to enter into an agreement with the Urban Watershed Research Institute (UWRI) to collaborate in the advancement of water resources research and practice in North America. The focal point for this collaboration is found at [ncimm.org](http://ncimm.org),” states Ted van der Gulik, President.

Formerly the Senior Engineer in the Province of British Columbia's Ministry of Agriculture, Ted van der Gulik received the 2014 Legacy Award when he retired from government. He was also an inaugural inductee into the British Columbia Public Service Hall of Excellence.

“This is a mutually beneficial strategic partnership founded on strong human links,” continues Ted van der Gulik. “Since 2005, Dr. Charles Rowney has been the Partnership's Scientific Authority. And, as the Director of Operations for the new Center for Infrastructure Modeling and Management, Charles is a driving force behind [ncimm.org](http://ncimm.org).

“In addition, Jim Dumont, our Engineering Applications Authority, now sits on the Center's panel of expert advisors. This provides a wonderful opportunity for Jim Dumont to cross-fertilize his experience with that of his peers in the United States and elsewhere.”

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<sup>1</sup> <http://waterbucket.ca/rm/category/sustainable-watershed-systems/>



**Dr. Charles Rowney**

Director of Operations,  
[ncimm.org](http://ncimm.org)



**Dr. Lew Rossman**

Environmental Scientist  
US EPA (retired) & Member,  
Expert Advisory Panel

*Lew Rossman was the principal designer and software architect of EPA's redevelopment of SWMM5 and principal author of its more than 700 pages of documentation.*

*He was the original author of the EPANET water distribution system model.*

## Center for Infrastructure Modeling and Management established because.....

Dr. Charles Rowney is the Director of Operations for [ncimm.org](http://ncimm.org). He is also a Board member of the Urban Watersheds Research Institute and a Research Fellow at the University of Texas. In addition, Dr. Rowney is the Scientific Authority for the Partnership for Water Sustainability and its Water Balance family of modelling tools.

***Evolving Expectations and Needs:*** “Used for decades world-wide, either stand alone or as a component of other technologies, SWMM and EPANET have filled a role that remains highly relevant today, and this will continue for some time to come,” states Dr. Charles Rowney.

“This longevity is a tribute to the many individuals who defined needs, developed solutions, contributed code, and promulgated best practices in this technical practice area. We need to ensure these hallmarks of professional practice are maintained, promoted, and developed going forward.

“The expectations and needs of users have evolved, so the tools and their support mechanisms must evolve as well. Also, emerging practices in software development, particularly in the open source arena, define both a need and an opportunity for action.

“The new Center has been set up as a sustainable undertaking, founded on participation by users, vendors, owners, regulators, academics, and professional societies, which will support the continued development and maintenance of the tools, with a strong emphasis on open source contributions coupled with solid QC, training and support functions.”

***Continuity:*** The retirement of Dr. Lew Rossman from the US Environmental Protection Agency was a catalyst for creating [ncimm.org](http://ncimm.org). As an expert advisor to the Center, he provides technical guidance, review and oversight of [ncimm.org](http://ncimm.org) activities involving both EPANET and SWMM.



## Whole-System, Water Balance Approach

1. *Understand where the water goes naturally and reproduce those conditions.*
2. *Restore sub-surface **interflow** to maintain hydrologic integrity.*
3. *Maintain the proportion of rainwater entering a stream via each of 3 water balance pathways!*
4. *Replicate the streamflow-duration pattern to mimic the Water Balance*



**Jim Dumont**

Engineering Applications  
Authority, Partnership for  
Water Sustainability in  
British Columbia

## Synergies in Action

"It is the combination of diverse needs, ideas and solutions that will make this vision for the Center work," explain Dr. Rowney. "That is one of the reasons we're so pleased with the agreement just reached with the British Columbia Partnership for Water Sustainability. We have many needs in common, and many ideas to share."

"British Columbia's Water Balance Model is an outstanding initiative, and I think it is clearly unique in the way it has delivered technology for water resource practitioners on-line dating back to 2003."

"The current industry-wide move to on-line computation, propelled by changing approaches to software delivery as a multitude of enterprises commit to The Cloud, is hugely important."

"The leadership shown by the British Columbia Partnership for Water Sustainability in decisively moving in this direction well over a decade ago has led to a body of knowledge from which others can learn."

"We will certainly tap into the Water Balance Model experience as the Center explores options for SWMM and EPANET deployment beyond the desktop."

"The Partnership understanding of hydrology and watershed management issues in the Pacific Northwest provides some intriguing insights into new diagnostics, targets and interpretation needs for watersheds, and the tools we develop will very likely need to embrace those ideas," concludes Dr. Rowney.

### **British Columbia's Whole-System, Water Balance Approach:**

"Cross-border collaboration through [ncimm.org](http://ncimm.org) opens new doors for the Partnership for Water Sustainability. The Water Balance Model's QUALHYMO calculation engine is now linkable with SWMM. This would fill a need in watershed assessment and enable setting of performance targets for a whole-system, water balance approach to restoring and protecting watershed health," states Jim Dumont, the Partnership's Engineering Applications Authority.

"Watershed protection starts with an understanding of how water gets to a stream, and how long it takes. Protection of watershed and stream health in the urban environment ultimately depends on maintaining the natural proportion of rainwater entering streams via three pathways: overland runoff, shallow interflow and deep groundwater flow."

## Benefits of Whole-System, Water Balance Approach

*Less flooding, less stream erosion, more streamflow when needed most.*

*And communities would be able to:*

*Avoid an unfunded infrastructure liability.*

*Adapt to a changing climate.*

## Bring the ‘State-of-the-Art’ into ‘Standard Practice’:

*“If communities are to truly benefit from use of nature’s assets to provide vital community infrastructure services, then two issues must first be recognized as being impediment to changes in practice.*

*“Issue #1 is widespread lack of understanding of the relationship between flow-duration and stream (watershed) health.*

*“Issue #2 is widespread application of a standard of practice that has led to the current situation of degraded streams, and that has little connection to real-world hydrology.”*

*- Jim Dumont  
March 2017  
Comox Valley Eco-Asset  
Symposium*

“The innovation of the **Water Balance Methodology** is in the way it integrates and applies standard scientific and engineering principles to address these components in ways which are not typically applied in planning and design of municipal infrastructure.

“Tools like SWMM and QUALHYMO can enable the hydrologic computations; it is up to us to recognize the need, and to deliver tools that facilitate the analysis. I expect that discussions about methodology will be as much a part of the new Center as the development of new code,” concludes Jim Dumont.

In the 1980s, Dr. Charles Rowney developed the QUALHYMO engine. It is a continuous quality/quantity model with watershed, receiving stream and BMP (best management practice) components.

## Water Balance Methodology<sup>2</sup>

The whole-system, water balance approach simplifies things down to an understanding of the consequences of changes in duration of flow. If the desired outcome is to limit stream erosion, prevent flooding and improve water quality, then a lynch-pin guiding principle for watershed planners and drainage designers must be to replicate the flow-duration pattern to mimic the annual Water Balance.

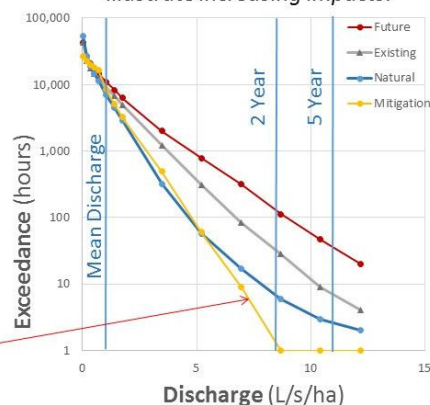
If the desired outcome is to limit stream erosion, prevent flooding and improve water quality by restoring watershed hydrology, then....

**APPLY THIS GUIDING PRINCIPLE:**  
*Replicate the flow vs duration annual distribution that mimics the natural Water Balance flow paths*

**TO ACHIEVE THIS MITIGATION OBJECTIVE:**  
*Reduce flow-duration to natural conditions*

**AND A DESIRED OUTCOME:**  
*This represents a future scenario with mandated mitigation for all new development & redevelopment*

*Flow-Duration Results for a range of development scenarios. These illustrate increasing impacts.*

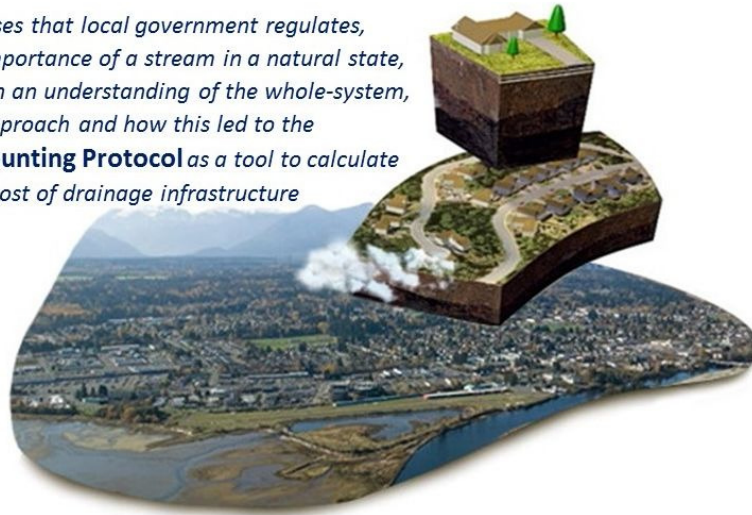


<sup>2</sup> [http://waterbucket.ca/wp-content/uploads/2012/05/Primer-on-Water-Balance-Methodology-for-Protecting-Watershed-Health\\_February-2014.pdf](http://waterbucket.ca/wp-content/uploads/2012/05/Primer-on-Water-Balance-Methodology-for-Protecting-Watershed-Health_February-2014.pdf)

By 2017, an educational goal in British Columbia is that everyone involved in land use and drainage would understand the vision for.....

## “Sustainable Watershed Systems, through Asset Management”

Applies to land uses that local government regulates, recognizes the importance of a stream in a natural state, and is founded on an understanding of the whole-system, water balance approach and how this led to the **Ecological Accounting Protocol** as a tool to calculate the opportunity cost of drainage infrastructure



## Asset Management Continuum

Asset management for sustainable service delivery occurs alongside associated evolution in community thinking. It is a continuous quality-improvement process, and incremental.

A local government would experience the asset management process for sustainable service delivery as a continuum leading to a water-resilient future.

**Sustainable Watershed Systems** would be the outcome in Step Three



### Asset Management Continuum for Sustainable Service Delivery

**GROUND ZERO:** In the beginning, no **Asset Management Plan** exists. A consequence is 'unfunded infrastructure liability'.

**STEP ONE:** Local governments embrace the BC Framework, with an initial focus on core engineered assets (water supply, sewage, roads) and embark on an **Asset Management Strategy / Plan / Program** process.

**STEP TWO:** Local governments start thinking holistically and implement a life-cycle approach to infrastructure decision-making so that **Sustainable Service Delivery** for engineered assets becomes standard practice.

**STEP THREE:** For drainage function, local governments will integrate natural systems thinking and climate adaptation into asset management and account for the **Water Balance Services** provided by watershed systems.

As understanding grows, local governments will progress incrementally along the **Continuum**

THE OUTCOME:  
A Sustainable Watershed System



**ANNOUNCEMENT:****Partnership for Water Sustainability publishes Primer to support vision for “Sustainable Watershed Systems, through Asset Management”**

By Kim Stephens, M.Eng., P.Eng, Executive Director  
Partnership for Water Sustainability in BC

Released in September 2016, *Sustainable Watershed Systems: Primer on Application of Ecosystem-based Understanding in the Georgia Basin* is written in a magazine-style to appeal to technical and non-technical readers alike. TO DOWNLOAD A COPY, VISIT:

[http://waterbucket.ca/rm/files/2016/09/Primer-on-Application-of-Ecosystem-based-Understanding\\_Sept-2016.pdf](http://waterbucket.ca/rm/files/2016/09/Primer-on-Application-of-Ecosystem-based-Understanding_Sept-2016.pdf)

The Primer serves as a refresher on core science-based concepts that underpin the vision for *Sustainable Watershed Systems, through Asset Management*, a guidance document released by the Partnership for Water Sustainability in November 2015.



*A watershed is an integrated system. The need to protect headwater streams and groundwater resources in BC requires that communities expand their view from one that looks at a site in isolation to one that considers all sites, the watershed landscape, streams and foreshores, groundwater aquifers, and so on, as an integrated system.*

**Ask the Right Questions**

Everyone learns about the water balance (water cycle) in elementary school, but by high school most have forgotten what they learned. So what does this mean for communities, the reader might well ask? Consider that: A legacy of community and infrastructure design practices has failed to protect the natural water balance (hydrologic integrity). Failure has financial, level-of-service and life-cycle impacts and implications for local governments, and hence taxpayers. Consequences include expensive fixes.

Local governments are starting to recognize that natural assets have value, ecosystem services have a role in municipal service delivery, and so need to be integrated into their asset management programs. Hence, the sixth in the Beyond the Guidebook Primer Series is written to help multiple audiences – whether elected, technical or stewardship – ask the right questions and ensure that “science-based understanding” is applied properly and effectively to implement practices that restore the hydrologic integrity of watersheds.

**Vision: Re-Set the Ecological Baseline**

The vision for Sustainable Watershed Systems is the culmination of a building blocks process which cross-pollinated Washington State and BC experience. In the mid-1990s, Washington State research established the **primacy of hydrology** in either protecting or impacting stream health. In BC, this finding spurred development and evolution of the Water Balance Methodology. Twenty years later, a convergence of initiatives and ideas is the catalyst for taking stock of past and current research.

In 1995, Dr. Daniel Pauly coined the phrase “shifting baseline syndrome” (Figure 1) to describe why each new generation lacks direct knowledge of the historical condition of the natural environment, and how this lack of understanding plays out as a failure to notice change.

The flip side of an impact, however, is an opportunity. Over the past two decades, a series of teachable moments has set the stage to reverse the sliding baseline in the Georgia Basin. Communities could re-set the ecological baseline IF they would implement standards of practice that truly replicate and restore a desired watershed condition. This outcome requires a ‘whole systems’ approach to community planning and infrastructure servicing.



## Watersheds are Infrastructure Assets

BC has a provincial policy, program and regulatory framework that enables local governments to move from UNDERSTANDING to IMPLEMENTATION of a “whole systems” approach keyed to the primacy of hydrology.

The new Water Sustainability Act (“the Act”) plus **Asset Management for Sustainable Service Delivery: A Framework for BC** are lynch-pins for looking at water and watersheds differently. The Act connects land and water, and makes the link to desired water balance outcomes. The BC Framework is a powerful tool for local governments to focus their community planning and infrastructure decision processes on beneficial life-cycle outcomes.

Asset management has traditionally been about hard engineered assets such as waterlines, sanitary and storm sewers, and roads. Yet, watershed systems are also “infrastructure assets”. Trees, soil, green spaces and **Water Balance pathways** contribute to a municipal service function. These assets provide *hydrologic integrity* for a healthy watershed system. This desired outcome is a driver for protecting and managing nature’s services in the same way that engineered assets (and the services they provide) are managed.

## Whole Systems Approach

Restoring hydrologic integrity, and thus the water balance, is key to achieving a water-resilient future in urban areas. A key message in the Primer is the necessity of “staying true to the science” IF communities are to achieve a vision for *sustainable watershed systems*.

The Partnership hopes that readers will be inspired to learn more about the science behind the Water Balance Methodology. Four themes are introduced (in the box below).

Achieving sustainable watershed systems through asset management will require long-term commitment by communities, successive municipal councils and regional boards, and generations of land and water professionals.

**Harness nature to adapt to a changing climate:** Part 1 introduces new ecosystem-based adaptation (EbA) research in BC that may inspire a new generation to “think and act like a watershed”.

**Get the hydrology right and residential water quality typically follows along:** Part 2 celebrates the 20th anniversary of publication of the seminal Washington State research by Dr. Richard Horner and Dr. Chris May on the primacy of hydrology.

**A journey to a water-resilient future starts with the first rain garden:** Part 3 showcases breakthrough rain garden water quality research by Dr. Jenifer McIntyre at Washington State University that builds on the work of Horner and May.

**Water balance pathway to a water-resilient future:** Part 4 introduces the parallel journeys of Washington State, California and BC; and how the Water Balance Methodology is the foundation for an ecosystem-based approach to protection of hydrologic integrity.

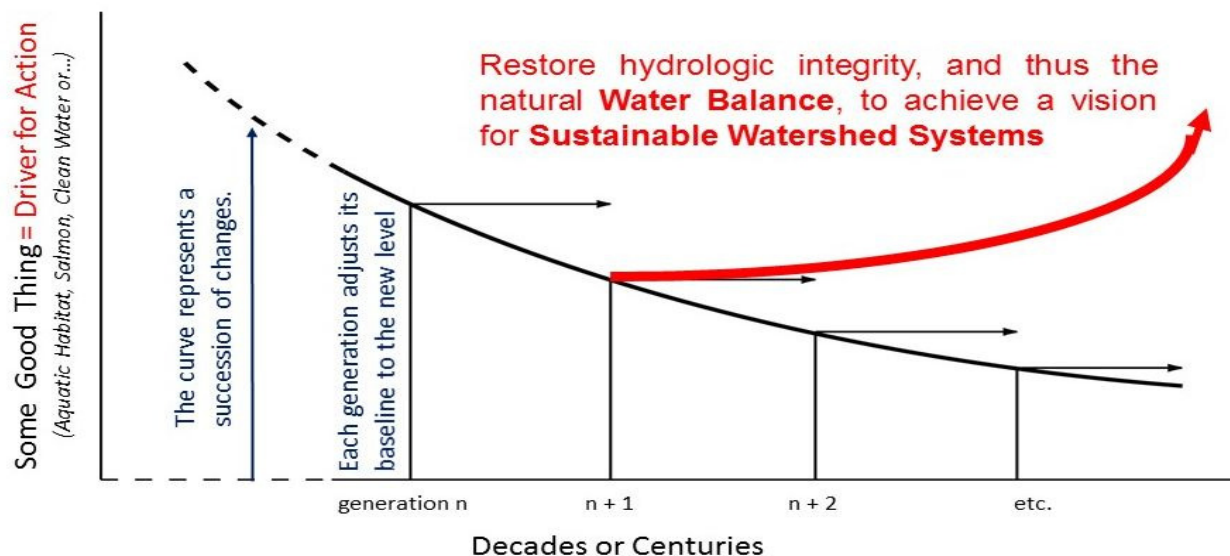


Figure 1 – Re-Set the Sliding Ecological Baseline

## OPINION: Vision for “Sustainable Watershed Systems” resonates with audiences in BC and beyond

By Kim Stephens, M.Eng., P.Eng, Executive Director  
Partnership for Water Sustainability in BC

A new way of thinking about municipal infrastructure has the attention of the local government world. Simply put, natural watershed systems are infrastructure assets – we must manage and protect them as such.

A mere fifteen months ago the Partnership for Water Sustainability framed the following **program goal** for the Georgia Basin Inter-Regional Education Initiative:

*By 2017, local governments would understand how to achieve “Sustainable Watershed Systems, through Asset Management”*

At the dawn of 2017, the purpose of this article is two-fold: take stock of our progress in 2016 to inform and educate; and foreshadow where we may be at year-end

The desired outcome that would flow from Sustainable Watershed Systems is a water-resilient future. This way of thinking builds on the vision for *Asset Management for Sustainable Service Delivery: A Framework for BC*; and has twin technical pillars – Water Balance Methodology and Ecological Accounting Protocol.

Understanding leads to action. Getting there is a step-by-step process to build practitioner capacity to get the job done. Presently, we are creating awareness of the goal.

## Looking Back: What We Accomplished

Early uptake of the vision for Sustainable Watershed Systems has exceeded our expectations. There is clearly interest and an appetite to learn more. It is an idea whose time has come.

**Asset Management Continuum:** Starting in November 2015, we have introduced the Asset Management Continuum (see image below) to an array of audiences in a variety of forums and media.

Our key message is that Sustainable Watershed Systems will be the outcome in Step Three. But it is not a wait-and-see proposition. Even as local governments are progressing through Steps One and Two for their core infrastructure, they need to be laying the groundwork so that they will be ready to implement Step Three.

Our outreach program for sharing the Sustainable Watershed Systems message is broadly based. Within the initial 12-month period, getting the word out involved constantly making presentations to inform and educate:

Regional boards and municipal councils (6), conference audiences (6), local government technical groups (3), professional groups (1), stewardship sector (1) and university classes (2).

So, what were the defining moments in 2016? In August, my keynote address at a national conference in Australia provided a platform to reflect on “parallel journeys”. In October, publication of an op-ed in the Vancouver Sun demonstrated that our whole-system, water balance message is news worthy.



## Asset Management Continuum for Sustainable Service Delivery

**GROUND ZERO:** In the beginning, no **Asset Management Plan** exists. A consequence is an ‘unfunded infrastructure liability’.

**STEP ONE:** Local governments embrace the BC Framework, with an initial focus on core engineered assets (water supply, sewage, roads) and embark on an **Asset Management Strategy / Plan / Program** process.

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**STEP THREE:** For the drainage function, local governments will integrate natural systems thinking and climate adaptation into asset management and account for the **Water Balance Services** provided by watershed systems.

As understanding grows, local governments will progress incrementally along the **Continuum**

**Australian Keynote:** The BC approach to infrastructure asset management has learned from and built upon Australian experience, and is now taking asset management to another level with *Asset Management for Sustainable Service Delivery: A Framework for BC*.

To develop a storyline on parallel journeys for my 2016 keynote, I interviewed a cross-section of “water thought leaders” from across Australia. These conversations allowed me to identify over-arching themes that shaped my storyline and relevancy to an Australian audience.

The conference then served as the moment of truth for audience response. Would Australians be receptive to the storyline? Would they understand our way of watershed systems thinking? Would they grasp the significance of the Asset Management Continuum?

Just as the BC Framework has garnered both Canada-wide and international attention, so too is “Sustainable Watershed Systems, through Asset Management” attracting interest in our pragmatic whole-system, water balance approach to GETTING IT RIGHT.

Other regions recognize BC as a leader. They perceive BC moving in the right direction with integration of watershed systems thinking and asset management. International exposure allows us to judge how BC stacks up against the rest of the world.

### Journey to a Water-Resilient Future

Visit <https://youtu.be/JCrdEkK61GY> to watch and learn how I introduced Australians to three “big ideas” that underpin where we are heading in BC, namely: Primacy of Hydrology, Shifting Baseline Syndrome, and Cathedral Thinking. The three are interconnected. The outcome would be Sustainable Watershed Systems.

Changes in hydrology, not water quality, must be the primary focus. If we can get the hydrology right, and recreate watershed systems, then as an added benefit the water quality would be greatly improved.

The good news is that redevelopment creates an opportunity. If we do get the hydrology right the second time, and restore the **watershed system**, this would then reset the ecological baseline.

Coined by University of British Columbia’s Dr. Daniel Pauly, the Shifting Baseline Syndrome describes an incremental and imperceptible eroding of expectations and standards that results from each new generation lacking knowledge of the historical condition of the environment.

Resetting the ecological baseline would take time, inter-generational commitment, and perseverance. This is the essence of “cathedral thinking” which describes our BC vision for **Sustainable Watershed Systems**.

In embarking on the journey to a water-resilient future, we can learn from our ancestors. The foundation for cathedral thinking is a far-reaching vision, a well thought-out blueprint, and long-term implementation.

These ideas resonated with the audience in Australia, and opened eyes and minds to a different way of thinking. These ideas are also resonating with audiences in British Columbia.

### Looking Ahead: What is on the Horizon

The BC Framework links local government services, infrastructure that supports service delivery, and watershed health. Thus, it sets a strategic direction that would refocus business processes to properly manage **watershed systems** within the built environment:

*Mimic natural flows in streams. Preserve the natural pathways by which water reaches streams. Slow, spread and absorb runoff.*

Benefits of the whole-system approach include less flooding, less stream erosion, and more streamflow during dry weather when needed most. These water balance benefits ultimately translate into lower life-cycle costs and a water-resilient future!

But there is a caveat - moving from understanding to implementation requires a sustaining commitment by local governments to implement ‘standards of practice’ that restore the desired watershed condition over time.

Some communities already have some of the puzzle pieces needed to ensure a water-resilient future. What is lacking, however, are precedents that demonstrate HOW to fit those pieces together to form a complete puzzle picture.....AND also ‘walk the talk’ to implement a pragmatic whole-system approach that resets the baseline. This is a major gap. The Partnership is working with our local government partners to fill it through development of the **Ecological Accounting Protocol**.

By the end of 2017, success would be measured by progress on two case studies that would refine, apply and test application of the Ecological Accounting Protocol to show that: *To protect watershed health, engineered infrastructure out to fit into natural systems, rather than the other way around.*

