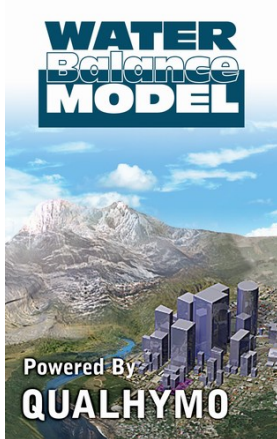


Water Balance Model for Canada – The Plan for the Future

A Message from the Chair



The Water Balance Model is moving toward an expert system with broad capabilities that can quickly provide answers to questions, and compare a number of site / watershed conditions, while giving consideration to the effects of climate change. The identified next steps in the development process will target specific technical matters; and will produce a system that can be a coach, providing guidance to all levels of users.

The Water Balance Model will continue to be fashioned around the basic concept of adaptive management; this can provide moving targets as scientific knowledge advances. In a similar manner, there must be a parallel shift in its coaching abilities to match the moving targets.

Beyond these very significant facets of the Water Balance Model, and its future incarnations, is a driving factor that is critical. This evolution offers more than a useful and responsive environment for calculations and knowledge sharing: it constitutes an evolution that will reduce costs for regulators and proponents of change alike; and it will significantly increase the uniformity, reliability and robustness of the conclusions and the results that are created using this system.

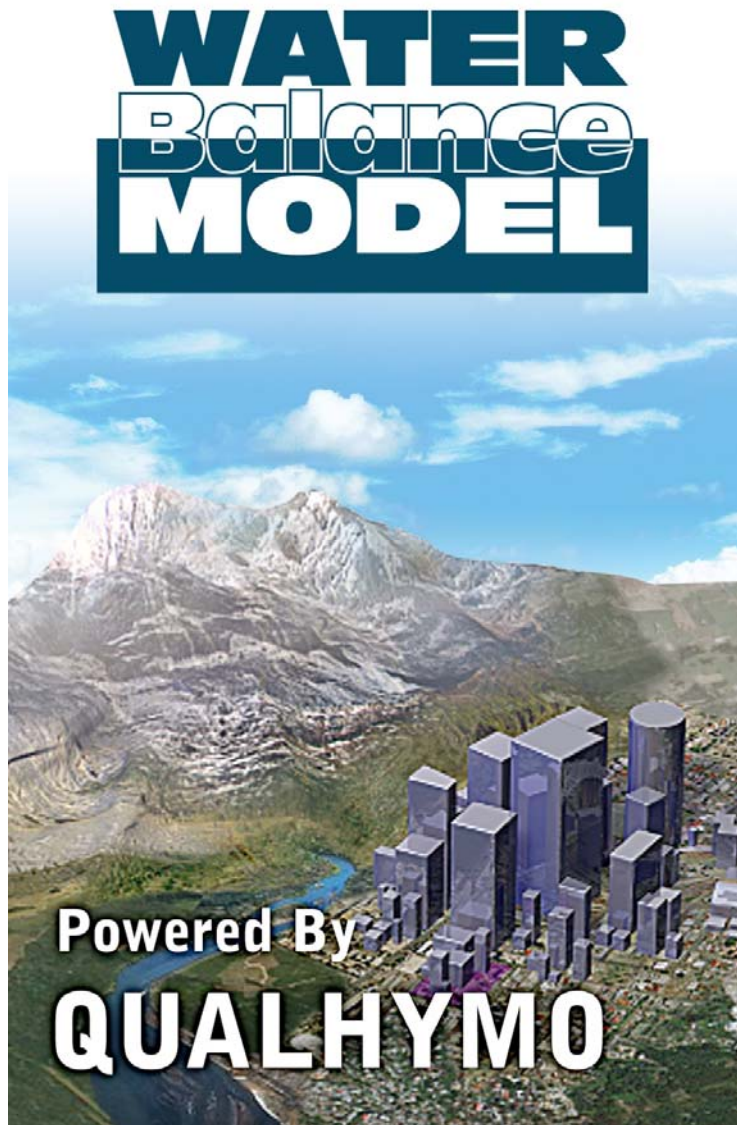
Since the target of this framework is the responsible development and management of lands under pressure, the significance of this from an economic and preferred practice perspective is very substantial, and should be welcome to all ranges of stakeholders in the decision processes surrounding this issue.

Ted van der Gulik, P.Eng., Senior Engineer, BC Ministry of Agriculture & Lands

Chair, British Columbia Inter-Governmental Partnership
Chair, Water Balance Model Inter-Provincial Partnership

September 2009





Water Balance Model for Canada – The Plan for the Future

Context: The rapid growth and success of the present second generation of the Water Balance Model (WBM) has fuelled a level of user interest and need that has made it clear that the time has come for the next bold leap forward in the evolution of the tool.

The goal in constantly improving the WBM is to serve an ever widening range of user sophistication and problem-solving capabilities. To deliver what is ultimately needed by practitioners, two principal dimensions will be accommodated in the third generation of the WBM:

- The analysis competencies will be expanded to enable effective responses to climate change and resource depletion. To do this, more than one tier of user (expert, capable and lay) will be accommodated and more than one kind of analysis (proven simplified methods and rapidly evolving new technologies) will be launched.
- The level of on-line expert knowledge that is available will be expanded substantially to communicate to both lay and expert users alike the principles behind the WBM technologies; as well as the options available for response to climate change and resource management pressures.

The next steps in the WBM development process will target specific technical matters; and will result in a system that can be a coach providing guidance to all levels of users.

The Road Map: This *Plan for the Future* provides a concise synopsis of 'need to know' information about the WBM. Also presented is a road map for greatly increasing both the computational capabilities of the WBM and its usability in visioning future alternatives for use of water and land.

At this time, use of the WBM as a scenario modelling and decision support tool has mainly been limited to planners and non-technical persons with an interest in the effects of land development and climate change. The next step will enlarge the family of users to include the technically knowledgeable so that the WBM is used as a design tool.

Implementation of this *Plan for the Future* will allow a single analysis tool to be used from planning through design; and in this way the flow of intent and information will be seamless, while maintaining integrity in process.

This simple change in the implementation process of projects and development will allow the goals and objectives established in the initial stages of watershed planning to be firmly upheld during the design and implementation stages. This will provide a greater degree of certainty that the intent of the watershed goals and objectives are actually being implemented through a science-based approach.

Among the many enhancements are capabilities not currently available in commercial software.

September 2009

Road Map for Water Balance Model Enhancement & Rolling 3-Year Plan for Implementation

Provincial Context	British Columbia	Living Water Smart, BC's Water Plan and the Green Communities Initiative provide a policy framework for aligning efforts at three scales – provincial, regional and local – to achieve desired outcomes for community design.		
	Alberta	Water for Life Strategy, Land Stewardship Act and a number of water management planning documents promote sustainable use of water resources and provide a framework for efforts that will help Alberta achieve a better balance between economic growth and environmental / social values.		
Partnership Vision	Design with nature to achieve settlement in balance with ecology		Partnership Mission	Help local governments prepare for climate change, choose to live water smart, and build greener communities
Goal	Achieve water sustainability and protect stream health through implementation of green infrastructure policies and practices			
Objective	<p>Provide regulators, developers and designers with a science-based decision support tool that enables evaluation of the effectiveness of site planning that incorporates green infrastructure to achieve rainwater management performance targets.</p> <p>Explanatory Footnote: <i>Focus on watershed outcomes so that there are clear linkages with the land use planning and development approval process. Establish achievable performance targets for rainwater volume capture and runoff rate control, under various combinations of land use, soil and climate conditions. Develop affordable and effective land use strategies that both green the urban landscape and improve watershed health.</i></p>			
Plan for the Future	<p>General improvements to the Water Balance Model (WBM) have been identified through user and stakeholder input. These enhancements comprise a series of linked improvements that form the backbone of a “road map” for the future. Today’s shared vision provides a path for continuing improvement over time; and the process is described as the Water Balance Model Enhancement (WBME).</p>			
	<p>The individual “tracks” of this road map follow a set of user requests for WBM enhancement, based upon a generalized grouping of user interests. The enhancements have been placed on one of the three identified tracks, based upon the priority expressed by the users with like concerns and priorities. Combining the tracks into the roadmap produces an overall vision of the Watershed Interface Enhancement. The process is represented graphically below. This identifies the common linkages of the various improvement tracks:</p> <div style="display: flex; justify-content: space-around; align-items: center;"> <div style="border: 1px solid black; padding: 10px; width: 25%;"> <p style="text-align: center;">Climate Change Track</p> <ul style="list-style-type: none"> • Develop and/or adopt climate change algorithms • Include climate algorithms in QUALHYMO • Obtain additional climate data </div> <div style="font-size: 2em; margin: 0 10px;">+</div> <div style="border: 1px solid black; padding: 10px; width: 25%;"> <p style="text-align: center;">Watershed Enhancement Track</p> <ul style="list-style-type: none"> • Water reuse modules • Natural stream section erosion index • Tree canopy module • Green roof module • Novice User Interface • Training </div> <div style="font-size: 2em; margin: 0 10px;">+</div> <div style="border: 1px solid black; padding: 10px; width: 25%;"> <p style="text-align: center;">Enhanced User Interface Track</p> <ul style="list-style-type: none"> • Technical documentation • Advanced user interface • Statistical calculations • Enhanced soil data input • ET calculator • Enhanced groundwater routines </div> <div style="font-size: 2em; margin: 0 10px;">+</div> <div style="border: 1px solid black; padding: 10px; width: 15%; text-align: center;"> <p style="font-size: 1.5em;">OCEP</p> <p>(Outreach & Continuing Education Program)</p> </div> </div> <p>The guiding philosophy for model evolution is that the whole is greater than the sum of the individual tracks. In other words, the three tracks are inter-dependent such that WBME implementation will be an integrated process; and enhancements that address the needs of one user group will be linked to items within other tracks to achieve the greatest benefit for all WBM users. OCEP is the acronym for <i>Outreach & Continuing Education Program</i> that is integral to model evolution.</p>			

Road Map for Water Balance Model Enhancement & Rolling 3-Year Plan for Implementation

Plan for the Future: <i>Integration of the Three Tracks</i>			
<p>WBM Flowchart</p>	<pre> graph LR UI[User Interface] --> Data[Data] Data --> Q[QUALHYMO] Q --> CR[Calculation Results] CR --> R[Reporting] R --> UI </pre>	<p>Model Overview</p> <p>The WBM provides information to multiple users who have a wide range of technical backgrounds: that is, from little technical knowledge to hydrologic experts.</p> <p>The QUALHYMO engine does the hydrologic and hydraulic computations.</p> <p>The user interface, data management and reporting functions are handled by a separate set of computer routines.</p>	<p>Guiding Philosophy</p> <p>Bring all three tracks along at the same time, thereby maximizing the resulting benefits.</p> <p>Identify the most efficient method of achieving the objectives, whether it is in the calculation or management of information from/to the user.</p> <p>Divide WBM enhancements into two categories: QUALHYMO engine; user interface</p>
<p>Climate Change Track</p>	<p>Context</p> <p>The WBM allows comparison of multiple scenarios of watershed condition using historical climate data. This supports design of communities that have no net impact on the stream environments. The historical data already includes the effects of climate change; what the data lacks is the greater occurrence of extreme weather increases that is expected to occur in the future.</p> <p>Refer to Table 1 for <i>Tasks and Budgets for Climate Change Track</i>.</p>	<p>Need Served</p> <p>This track addresses the needs of one user group to include a number of inter-related but individual components that allow a user to view impacts of climate change over a wider range of geographically separate locations. Simply adding the enhancements in Table 1 will not provide a robust tool to evaluate the effects of climate change. Rather, the sum of all three tracks is required to satisfy the computational requirements of assessing climate change.</p>	<p>Value Provided</p> <p>The addition of a Climate Change Module will allow systematic evaluation of possible effects of climate change and the anticipated alteration of rainfall, snowfall and temperature. This capability will then enable regulatory agencies to establish mitigation requirements to counter both physical alteration of the watershed and the contributing impacts cause by climate change</p>
<p>Watershed Enhancement Track</p>	<p>Context</p> <p>The QUALHYMO Engine as a whole remains very effective within the scope of its original development. Ongoing enhancement will ensure that it delivers what is needed in response to user feedback/requests.</p> <p>An enhancement for one user is often a benefit to many users and the whole modelling community benefits.</p> <p>The list of desired enhancements is somewhat fluid and will be continuously updated as enhancements are completed and new needs are identified.</p> <p>Modification to the WBM Interface fall into two general categories: those needed to allow users to access the enhancements to QUALHYMO, and those needed to provide enhanced user interaction with the model.</p> <p>Refer to Table 2 for <i>Tasks and Budgets for Watershed Enhancement Track</i>.</p>	<p>Need Served</p> <p>The BC Inter-Governmental Partnership is collaborating with various organizations and institutions to develop additional modules that will further expand the capabilities and usability of the Water Balance Model vis-a-vis addressing and integrating land development, water sustainability, stream health and climate change issues.</p>	<p>Value Provided</p> <p>Water Re-Use from Storage Module: This is a joint project with Canada Mortgage & Housing Corporation (CMHC) and the City of Calgary. The module will include a rainwater harvesting and storage component with variable sizing and demand; this will allow the user to optimize both the demand for potable water and the size of the physical storage required to achieve a maximum benefit.</p> <p>Tree Canopy Module: This is a partnership with UBC. A network of 60 tree monitoring stations has been established on Vancouver's North Shore region to obtain data for the UBC Tree Canopy Interception Research Project. The module will enable simulation of the influence of urban and rural tree cover</p>

Road Map for Water Balance Model Enhancement & Rolling 3-Year Plan for Implementation

Plan for the Future: <i>Integration of the Three Tracks</i>			
Watershed Enhancement Track (continued)	Context	Need Served	Value Provided
			<p>Green Roof Module: This is a partnership with the BC Institute of Technology. The module will incorporate the findings from the BCIT Green Roof Research Project.</p> <p>Natural Stream Section and Erosion Index: The WBM can calculate the Erosion Index for a simple channel shape, but natural streams are seldom simple. The capability to assess impacts to natural streams will greatly enhance the usability of the WBM as a tool to compare the impacts of varying scenarios of land use and urban fabric on the natural environment.</p>
		Priority Areas of Enhancement	Priority Tasks within Each Area
	QUALHYMO Modifications	1. Water Re-Use Component	<ul style="list-style-type: none"> – enable rainwater storage & domestic water reuse – incorporate rainwater storage & irrigation reuse
		2. Evapotranspiration Component	<ul style="list-style-type: none"> – enable variable abstraction to suit varied climate zones and differing vegetation types – incorporate tree canopy module – enable an updated transpiration calculation
		3. Channel Calculation Capabilities	<ul style="list-style-type: none"> – enable natural channel reach routing capability – add an erosion index method for channel stability assessment
		4. Strengthened Pond-Type Calculations	<ul style="list-style-type: none"> – enable a filter model with under-drains – enable a POND model with a 'leaky' bottom (exfiltration)
		5. Other Updates and Improvements	<ul style="list-style-type: none"> – enhanced statistic and graphical capabilities – groundwater accounting for multiple soil layers – update and improve the snowmelt algorithm
	Implications of Enhancements		
WBM Interface Modifications	In general, the QUALHYMO enhancements listed above will require input of additional user data, extraction of calculation results from QUALHYMO output, and creation of reports that summarize the results of the analyses.	Highly complex interface enhancements will only be required when large amounts of user data are required (e.g. for implementation of a GIS interface).	

Road Map for Water Balance Model Enhancement & Rolling 3-Year Plan for Implementation

Plan for the Future: <i>Integration of the Three Tracks</i>			
	Context	Need Served	Value
Enhanced User Interface Track	<p>The WBM presently has a selection of helpful information comprising a large number of separate technical documents that describe WBM operation. The <i>Enhancement User Interface Track</i> would address the desires of a second user group to allow a wider range of definable watershed conditions, and a larger suite of mitigation types to be assessed by a user.</p> <p>Refer to Table 3 for <i>Tasks and Budgets for Enhanced User Interface Track</i>.</p>	<p>The user community has been asking for a consolidated technical manual that lays out the logic and algorithms for programming. The manual will document WBM fundamentals, the information and data that it holds, how that data is applied to a project by the user, and the importance of the results. In other words, the manual will lay out the integrated suite of advanced capabilities that reside within the WBM and that are available to the user. This provides an opportunity to create an overall set of documentation that includes all items in one place, and is accessible to the user as needed.</p>	<p>The <i>Enhanced User Interface Track</i> module will allow a technically advanced user to fully utilize the power of QUALHYMO in establishing watershed goals and undertaking advanced assessments. This track comprises priority enhancements as identified by users and/or stakeholders. While separate budgets are shown below for purposes of planning and implementing individual enhancements, undertaking the work as an integrated package will provide the greatest benefit to all users. The results of the whole process are greater than the sum of the individual pieces</p>
Outreach & Continuing Education Program (OCEP)	<p>Commencing in 2003, the Water Sustainability Action Plan for British Columbia has pioneered an inclusive and participatory approach to practitioner training and continuing education that draws on the experience of planning and engineering managers in local government. A critical success factor is that program elements are outcome-oriented. The BC experience has shown that success in moving from awareness to action is maximized when broad understanding and alignment is achieved among all relevant stakeholders.</p> <p>Refer to Table 4 for <i>Tasks and Budgets for OCEP</i>.</p>	<p>In 2004, Canada Mortgage & Housing Corporation funded development of the national Water Balance Model website. This provided the impetus for formation of the Inter-Provincial Partnership (IPP) comprising British Columbia, Alberta and Ontario. The vision of the IPP is to enable better land use decisions across Canada. The WBM addresses some of the gaps in existing hydrologic models, is a useful decision support tool, and advances knowledge and state-of-the-practice about rainwater source controls.</p>	<p>In 2008-2009 Environment Canada funded Water Balance Model Forums on Vancouver Island and in Metro Vancouver. These forums were regional pilots for advancing a regional team approach to implementing green infrastructure. A national series is a logical next step in a capacity-building process that would adapt the BC approach to suit the shared needs of other provinces.</p> <p>An outcome of the 2009 Metro Vancouver Forum was recognition of the need to capture green infrastructure implementation experience in a series of "cheat sheets" that will help all communities advance the state of the practice.</p>