BC Green Building Code
Background Research

Water Efficiency

October 2007

Note: The following research paper on water efficiency was prepared independently by Light House Sustainable Building Centre. The paper provides a review of the current literature and background information that the province will consider during the development of Green Building requirements now and in the future. The provincial government does not necessarily endorse the information or share the views expressed in this paper.

Summary:

This paper provides an overview of the importance of water conservation, its benefits, available technologies, and potential approaches. It reviews some of the existing policies and regulations in British Columbia, and policies and regulations that have been adopted in other provinces, US states, and countries. Roughly three-quarters of BC local governments have adopted some water conservation measures to address such issues as capacity constraints, cost reductions, environmental stewardship and potential droughts.

Canadian municipal water prices rank second lowest among OECD nations while per capita water use is among the highest. The direct economic benefits of water efficiency measures are presented in examples from the cities of Barrie, Ontario, and Cochrane, Alberta.

Barriers to water efficient plumbing practices are identified, with the main technical issue being that “rule of thumb” design practices commonly used by plumbing designers have not kept pace with available water efficient technologies. Traditional design approaches and current Building Code standards for drainage systems are blamed for blockages and call backs that have occurred in various pioneering water efficiency installations in BC. The authors conclude that, if attention is paid to plumbing design, water efficient appliances will perform as effectively as conventional appliances. Education is needed to dispel some current myths of underperforming ultra-low flow (ULF) fixtures. In addition, unreliable CSA certification standards for ULF toilets are identified as a problem, as they leave consumers with no way of easily distinguishing between poorly performing ULF toilets and the many well-performing models that are available.

The paper identifies water metering as a critical point for further investigation. Metering enables consumption-based pricing, and metering alone—without any change in pricing—may help to reduce water use.

Water efficient appliances are identified as potential benchmarks for educational or regulatory approaches to water conservation. They include front loading ENERGY STAR clothes washers, ENERGY STAR dishwashers, low flow faucets and shower heads, ULF toilets and urinals, and irrigation systems that reduce evaporation.

As options for future approaches, the paper notes that amendments to the Building Code could increase water efficiency in buildings by establishing a performance standard, a prescriptive path, or some combination of both. A performance approach could set the total potable water budget for a building. A prescriptive approach could require specific fixtures based on consumption targets or flow rates. Other options include economic and financial tools, such as grants and rebates, loans, taxation programs, pricing structures, and fines; and educational programs, including rating and labeling systems, awards and recognition programs.

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Introduction

The purpose of the following document is to provide technical research summaries that will inform the development of specific code provisions in area of water efficiency. The document therefore comprises literature review and excerpts from relevant technical sources, supported by commentary from Light House, in order to offer guidance and background to the Province of BC's development of a proposed Green Building code for BC. The document was completed by Light House with technical support from Troy D. Vassos, Ph.D., P.Eng., President & Senior Environmental Engineer, NovaTec Consultants Inc. and Rod Yeoh, P.Eng, Associate, Omicron.

[This section includes excerpts from the following source: J. Kinkead Consulting. "An Analysis of Canadian and Other Water Conservation Practices and Initiatives: Issues, Opportunities and Suggested Directions." Canadian Council of Ministers of the Environment, 2006.]

In 2003, a significant drought affecting southern British Columbia reduced water flow in many streams and rivers to historic lows. A survey of water purveyors in September 2003 indicated that 2.2 million people were affected by the drought, 84 water systems were under stress and 43 systems were expected to be under stress in spring 2004.

Currently, over 17% of surface water sources have reached or are nearing their capacity to reliably supply water in a normal year. Observation wells indicate that groundwater levels are declining in some areas of the province. Most of the surface water allocated in the province is for the non-consumptive uses of water for power production and storage for power production. Agricultural, commercial, industrial and drinking water uses, together uses only 3% of water licensed in British Columbia. Water use by sector is as follows:

- 22% for agricultural purposes
- 47% for industrial/commercial purposes
- 31% for domestic water purposes

Statistics for the Georgia Basin (where 74% of BC's population is located and where 75% of the municipal water in 1999 was consumed) indicate the following:

- 65% of municipal water is used for residential purposes
- 20% for commercial purposes
- 8% for industrial purposes
- 7% for other purposes

According to the GVRD, around the home, lower mainland residents use more than 325 Litres per person per day. By comparison:

- the average European uses 150L per day,
- the average Saudi uses just 29L per day, and

- when Doctors Without Borders set up a new refugee camp, they usually reckon on 15L per person per day to be ample.

Water efficiency and conservation measures in buildings play an important in curbing excess water consumption in BC. Research suggests that one of the most effective tools for reducing water consumption is the use of metering and volume-based water pricing. Given only a fraction of British Columbia's residents are on metered systems, this represents a critical point for further investigation and action.

Definition, Concepts and Benefits

Water Conservation and Water Efficiency

[This section includes excerpts from the following source: Cross Government Research, Policy and Practice Branch. "Water Efficient Fixtures: An Inter-Jurisdictional Review of Regulations." Building & Safety Policy Branch, Office of Housing And Construction Standards. June 2007.]

Water conservation refers to a reduction in freshwater use that is accomplished through the implementation of conservation or efficiency measures. *Water conservation* measures include behavioural changes, new technologies or improved design of process equipment, which are all implemented in order to reduce water loss, waste or use. *Water efficiency* refers to improved technologies that allow an activity to be accomplished to an equal or greater degree than in the past while using less water than needed. Overall, conservation and efficiency measures result in decreased water demand.

A whole systems approach to water conservation and efficiency includes:

- behavioural changes through education and feedback (e.g. water metering),
- landscape design (using drought-tolerant and/or native species),
- rainwater harvesting for irrigation and flushing toilets & urinals,
- wastewater reuse including greywater recycling from sinks, laundry and showers for subsurface irrigation and flushing toilets & urinals,
- point of entry and point of use (onsite) treatment, and
- water saving fixtures and fittings such as ultra low flush or dual flush toilets, waterless urinals, composting toilets, and high efficiency irrigation systems.

Importance of Water Conservation

[This section includes excerpts from the following source: J. Kinkead Consulting. "An Analysis of Canadian and Other Water Conservation Practices and Initiatives: Issues, Opportunities and Suggested Directions." Canadian Council of Ministers of the Environment, 2006.]

Three main goals of water conservation:

1. **Sustainability of freshwater resources**. In order to ensure that future generations can withdraw freshwater from the ecosystem, where withdrawal should not exceed the natural replacement rate.
2. **Energy conservation.** Water pumping, delivery and wastewater treatment facilities consume significant amount of energy. Reducing the amount of water used reduces the energy needed.
3. **Habitat conservation.** Minimizing human water use helps to preserve freshwater habitats for local wildlife and migrating waterfowl. Reducing the need to build new dams and other water diversion infrastructure helps preserve habitats.

There are substantial economic costs and foregone opportunities associated with inefficient and less productive uses of water:

- Many agriculturally important areas have semi-arid climates and face growing competition for limited water supplies. Crop and livestock production and many local communities have become dependent on water diversions and constructed storages to meet their needs.
- Many other areas exhibit seasonal and more-prolonged patterns where cumulative demand for water results in competition over supplies and threatens aquatic ecosystems.
- Climate change predictions show that many parts of the country are likely to experience increasing risks from reduced water availability and increased demand.
- Inefficient and non-productive uses of water continue to drive avoidable expenditures and debt accumulation for the construction, expansion, operation and rehabilitation of both municipal and private water and wastewater infrastructure. They also result in excessive energy consumption and contribute to the inefficient use of other resources.

Future Water Supply and Climate Change

[This section includes excerpts from the following source: Natural Resources Canada, Earth Sciences Sector. "Climate Change Impacts and Adaptation: A Canadian Perspective: Impacts on Water Supply" http://adaptation.nrcan.gc.ca/perspective/water_3_e.php Accessed September 2007.]

Greater climatic variability also means changes in the frequency of extreme weather events and increasing incidences of dry and wet year sequences. Water supplies will become more uncertain as this variability combines with increased summer evapotranspiration, reduced snow packs, and higher water use such as increased lawn watering. Diminishing surface-water and groundwater supplies, coupled with increasing demands for these resources, would challenge all aspects of water resource management.

For much of western Canada, snowmelt and glacier runoff from mountainous areas are primary sources of water supply for downstream regions. With warmer conditions, the seasonal and long-term storage capacity of alpine areas may decrease, due to thinner snow packs, more rapid spring runoff, and decreased snow and ice coverage. This, in turn, would result in lower summer river flows and therefore greater water shortages during the period of peak demand. Recent trends observed on the eastern slopes of the Canadian Rocky Mountains suggest that the impacts of diminishing glacier cover on downstream flows are already being felt. Across southern Canada, annual mean stream flow has decreased significantly over the last 30-50 years, with the greatest decrease observed during August and September. Continued decreases are projected to occur as a result of climate change. (3)

Benefits of Water Conservation

[This section includes excerpts from the following source: J. Kinkead Consulting. "An Analysis of Canadian and Other Water Conservation Practices and Initiatives: Issues, Opportunities and Suggested Directions." Canadian Council of Ministers of the Environment, 2006.]

Using water more efficiently and productively has been shown to:

- Prevent or reduce conflicts among water users who share a common resource;
- Contribute to the protection of environmental flows and to the health of aquatic ecosystems;
- Make water resources available for further growth and development;
- Avoid or defer the need to expand the capacity of water and wastewater infrastructure;
- Conserve energy required to pump, deliver and treat water;
- Eliminate the need to augment water supplies through potentially harmful or undesirable diversions from other watersheds;
- Free-up public funding for investment in other priorities including the renewal of outdated water and sewage infrastructure;
- Increase the ability of water users to withstand the impacts of low-water availability, resulting from inherent weather variability and climate change;
- Conserve energy, other resources and raw materials and improve business profitability;
- Enhance wastewater treatment efficiency and reduce environmental emissions; and
- Enhance leverage with other jurisdictions on issues relating to shared waters.

Economic Benefits of Water Efficiency in Buildings

Implementing water efficiency in buildings has direct economic benefits as experienced in other cities across Canada. The City of Barrie, Ontario, engaged in a replacement program offering high efficiency bathroom fixtures (toilets, showerheads and faucet aerators) to homeowners at no cost. The $4.6 million investment resulted in deferral of $23 million in capital costs for additional sewage treatment capacity. Cochrane, Alberta has realized similar success. There, a multi-million dollar pipeline was deferred by giving away toilet tank dams, water-efficient showerheads and faucet aerators. See Appendix G for what is expected if water consumption continues on a business as usual scenario versus water conservation, green building scenarios.

Current State of Water Conservation in BC

[This section includes excerpts from the following source: Government of BC, Ministry of the Environment Website. "Water Use Efficiency Catalogue for British Columbia."]

As part of the development of the strategy, the Ministry of Environment, Lands and Parks (now Ministry of Environment) initiated (in February, 1998) compilation of a catalogue of water conservation activities underway or planned throughout British Columbia. The survey of water use initiatives first inquired into the rationale for implementing efficiency measures and secondly, identified eleven broad categories of measures that may be further divided into eighty-one tools currently being implemented in British Columbia.

Of the local governments surveyed in British Columbia, 76% indicated that they have adopted some water conservation measures as part of their water management programs. (23% of local governments indicated they had not and 1% reported they were not aware whether they had or had not adopted water conservation measures.) Among those local governments that indicated they had adopted a water conservation program, capacity constraints (65%) and the need to

reduce costs (62%) were the two overwhelmingly most common reasons for doing so. Environmental stewardship reasons (33%) and potential droughts (23%) were also commonly identified. Other reasons included: more equitable distribution of costs, part of regional strategy or following the lead of another agency, and to reduce sewer flows.

Development Planning

Water is also a defining consideration in development planning (i.e. island communities and the interior. The Municipality on Bowen Island is using water to define carrying capacity for future growth (residential and commercial growth).

Key Issues of Water Efficiency in Buildings

Codes and Design Practices

Until fairly recently, there was no water efficiency standard in most jurisdictions in the Province of British Columbia. In 1993 the Union of BC Municipalities (UBCM) passed a resolution in response to “continuing growth and increased per capita consumption of water" which requested that the Building Standards Branch (MMA) amend the B.C. Building and Plumbing Code to require the use of water conservation devices in all new construction. In partial response to these requests the Code was amended to include the following specifications in September 1995:

- Restricted flows were set for supply water to fixtures in new construction for group residential, office and mercantile type construction.
- Maximum flush cycles of 13.25 litres for toilets and 5.7 litres for urinals were established. These specifications pertain only to installation occurring in new construction.

The Ministry of Environment is currently researching implementation of higher standards for water conservation for plumbing fixtures. Specifically, one of their planned actions is to convene a sub-committee of the Water Conservation Strategy Working Group. The sub-committee is to address proposed amendments to the water efficiency regulation, including:

- ultra low flush toilets (6 litre) and urinals in new developments; and
- similar standards for industrial, commercial and institutional buildings

The main technical issue regarding whole building water efficiency is that codes and “rules of thumb” design practices commonly used by plumbing designers have not caught up with the water efficient technology available. This has become evident in various pioneering installations of ultra-low consumption fixtures throughout the Province. These fixtures include dual flush toilets, waterless urinals, and ultra-low flow faucets. The use of “typical design” and Code minimum sizes and slopes in drainage systems has resulted in numerous blockages and call backs in these systems. This has subsequently resulted in some institutional facilities replacing these low consumption fixtures with conventional ones. It has also resulted in some Institutions banning the use of these low flow fixtures in their facilities.

Fixture Performance

[This section includes excerpts from the following source: UK Government, Department for Communities and Local Government. “Water Efficiency in New Buildings - A consultation document.” December 2006.]

Research has also shown that consumers may be wary of some types of water efficient appliances e.g. showers, because they think more water efficiency equates to lower performance. We need to demonstrate to consumers that water efficient appliances perform as well as, or as close as possible to, appliances which use more water. (6)

Another issue has been the ability of low flow fixtures to deliver hot water in a timely manner. With the very low flows used by these fixtures, the “rules of thumb” commonly used to design hot water recirculation and temperature maintenance systems do not work. The flow is simply too low to move enough water to provide hot water in a reasonable time.

Low Flow Myth

Low water use does not affect bath drainage or laundry drainage or lavatories. Low water use applications to toilets and urinal flushing (particularly zero flush urinals) have been an operational problem and there has been progress in developing performance standards for low flush toilet (making sure the ping pong balls get flushed), but this usually impacts the water quantity and not the efficacy of drainage (i.e. the need to flush twice). The drainage concern is a technical red-herring (like an urban myth). See Appendix H for further discussion on this issue.

Metering and Cheap Water

[This section includes excerpts from the following sources:

Maas, T. “What the Experts Think: Understanding Urban Water Demand Management in Canada.” POLIS Project, University of Victoria, December 2003.]

Government of BC, Ministry of the Environment. “Environmental Trends in British Columbia” http://www.env.gov.bc.ca/soerpt/files_to_link/trends1993/whole_report.pdf. Accessed September 2007.]

Consideration of volume-based water pricing requires that some form of metering be in place. A widespread lack of metering is a major barrier to the use of water pricing in Canada. Only 55 percent of single-family homes in Canada are metered for water services. By contrast, many countries with similar levels of wealth, including the United Sates, Finland and France, report levels of water metering at 90 to 100 percent. Most of the experts interviewed advocate universal metering as a critical first step toward the use of pricing instruments in urban water management. (9)

It has been suggested that metering alone, without any change in pricing levels, may reduce water use. Several studies support this observation, asserting “that metering alone could reduce municipal water use by 15 – 20 percent over pre-metering values.” Installation of meters without any increase in price has resulted in permanent reductions in municipal water use of 10 to 40 percent. (9)

The BC Ministry of Environment Strategic Policy Division in their "Environmental Trends in British Columbia 2002 report, states that in 76% of British Columbians in 1999 were paying a flat rate for water and consumed an average of 524 Litres per person per day. In comparison, 24% of British Columbians were on metered systems and consumed an average of 455 Litres per person per day (i.e. flat rate consumption was 15% more than metered). For all of Canada,

flat-rate users consumed 70% more water (457 litres/person/day) than metered users (269 litres/person/day). The report suggests that the minimal impact of watering in British Columbia in comparison to the rest of Canada may be due to metered rates being the lowest in the country. (5)

Table 1

Per Capita Domestic Water Use for Metered and Un-metered Users in B.C., 1999			
Metering Status	Total Water Use	Population Served	L/person/day
Metered (Price by volume)	228 449	501 682	455
Unmetered (Flat rate)	513 665	979 452	524

Canadian municipal water prices rank second lowest among OECD nations while per capita water use is among the highest. The influence of these low prices is reflected in our profligate water use, and has in part led to the infrastructure deficit observed in many communities across the country.

Attitudes and Behaviour

[This section includes excerpts from the following sources: UK Government, Department for Communities and Local Government. "Water Efficiency in New Buildings - A consultation document." December 2006.]

Research shows that attitudes to personal water use are very complex. They are based upon our attitudes to the water industry, water as a resource or a commodity, personal preferences for cleanliness, hygiene, our culture and faith. Water use is often habitual – people do not think about it – and it is part of a wider daily routine, e.g. a "wake-up" shower in the morning, and taking a relaxing bath at night. (6)

Clearly buy-in from the public water consumer is all-important in making water efficiency a success. Minimum regulatory standards will help to set the regulatory floor but they can only become part of the fabric of daily life if the general public accepts the need to value water as a precious resource.

Designs, Fixture Types & Technologies

[This section includes excerpts from the following source: Maas, T. "What the Experts Think: Understanding Urban Water Demand Management in Canada." POLIS Project, University of Victoria, December 2003. http://www.waterdsm.org/pdf/report2_full.pdf]

Design Strategies

Design strategies for water efficiency can generally be divided into various forms. Water can be re-used, consumption of fixtures can be reduced per use, or the number of uses can be reduced. The easiest of these to address from a design perspective is to reduce consumption by reducing the consumption of fixtures. This is as simple as replacing conventional plumbing fixtures with low flow or low consumption fixtures. Water re-use, whether as part of a full building water system program or in individual applications, is not as easily implemented. Examples of this application are recycling of rainwater or grey water for use in non-potable applications, such as toilet flushing, cooling applications, or in washing applications. An example of a typical re-use system is the recycling of water in car washes.

In commercial buildings, condensate from cooling systems could also be collected and re-used in non potable water applications. Systems have been installed in the US that collect condensate from cooling systems and re-use it for cooling tower make-up water.

Efficient Fixtures & Technologies

Water efficient fixtures use less water to accomplish a task while maintaining the same of performance as older fixtures. Replacing older fixtures with water efficient fixtures helps conserve water while reducing water and sewer bills. Refer to Appendix J for a literature review of water conservation measures.

Toilets

Newer toilets only use 3-6 litres per flush compared to the 16.5 litres of older models. Some toilets now come with a two-flush setting, which is preferable because the lower flush setting (about 3 litres) tends to be needed more often than the full flush setting.

Recent research indicates that a number of common ultra low-flush (ULF) toilet technologies do not meet industry performance specifications. Despite obtaining Canadian Standards Association (CSA) certification, independent testing has demonstrated that four of the ten most popular ULF toilet models currently sold in Canada fail to meet maximum flush volume and/or waste removal performance standards (Pleasance, 2003: PC).

While the implications of these findings may seem trivial given that other models are available, the problem is that there is currently no way for consumers to distinguish between models. This problem is compounded by the fact that the failing models are also among the least costly and

most accessible products on the market, and as such are typically used in replacement programs and new home construction (Pleasance, 2003: PC).

While these problems manifest as technical issues, they are symptomatic of larger concerns regarding product standards and quality control. According to Pleasance (2003: PC), deficient CSA certification procedures are at the root of these problems. This is clear from the results of the 'Maximum Performance Testing of Popular Toilet Models', a recently completed cooperative project of nineteen municipalities, water utilities and agencies in Canada and the United States.

This study tested over eighty types of toilets against performance-based standards (as opposed to the minimum certification tests used by CSA). Over half of the toilets tested passed the performance testing, illustrating the viability of many ULF toilet designs.

Evidence from other jurisdictions (e.g. Australia and Europe) further demonstrates the technical feasibility of ULF technologies. In Canada, however, current certification procedures allow substandard products to enter and remain in the marketplace (Pleasance 2003: PC).

NSF International recently announced a new voluntary certification program through the US EPA Environmental Protection Agency (EPA) program called WaterSense^{SM}. The EPA launched WaterSense^{SM} in 2006 to focus on high efficiency products and services designed to conserve water. NSF has been approved as an EPA-Licensed Certification Body to certify high-efficiency toilets to WaterSense^{SM} specifications. The certification process includes testing to ensure the high-efficiency toilets use no more than 1.28 gallons (4.85 L) per flush.

Clothes Washers

Front loading clothes washers tend to require less water (90 litres per load versus 170 litres per load) and are able to accommodate larger loads. By using less water, energy and money are saved (less water needs to be heated per cycle). Additionally, front load washers spin clothes faster, which extracts more water from the clothes and reduces dryer time.

Most ENERGY STAR qualified washers extract more water from clothes during the spin cycle. This reduces the drying time and saves energy and wear and tear on your clothes. Compared to a model manufactured before 1994, an ENERGY STAR qualified clothes washer can save up to $110 per year on your utility bills.

Through superior design and system features, ENERGY STAR qualified clothes washers clean clothes using 40% less energy than standard washers. The Modified Energy Factor (MEF) measures the energy used during the washing process, including machine energy, water heating energy, and dryer energy. The higher the MEF, the more efficient the clothes washer is.

Most full-sized ENERGY STAR qualified washers use 18–25 gallons (68-473 L) of water per load, compared to the 40 (151 L) gallons used by a standard machine. The Water Factor

measures the gallons of water used per cycle per cubic foot (for example, a 3.0 cubic foot [0.08 cubic meter] washer using 27 gallons [102L] per cycle has a water factor of 9.0). The lower the water factor, the less water the machine uses. Saving water helps protect our nation's water supplies. Water factor is listed on the qualified product list and can be found at: http://www.energystar.gov/index.cfm?c=clotheswash.pr_clothes_washers

Dishwashers

Earning the ENERGY STAR means a product meets strict energy efficiency guidelines set by the US Environmental Protection Agency and the US Department of Energy:

- ENERGY STAR qualified dishwashers use much less water than conventional models.
- Replacing a dishwasher manufactured before 1994 with an ENERGY STAR qualified dishwasher can save you more than $30 a year in utility costs.

ENERGY STAR qualified dishwashers use at least 41 percent less energy than the federal minimum standard for energy consumption.

Shower heads

Low-flow shower heads reduce water flow without reducing the quality of the shower. These shower heads allow approximately 9.5 litres of water to flow per minute instead of the approximately 15 litres used by older shower heads.

Taps

Taps with low-flow aerators reduce water consumption by adding air to flowing water. This allows 9.5 litres of water to flow per minute instead of 12.5 litres.

Irrigation Systems, Hoses and Washers

The amount of water used in the garden can be reduced by up to 75% by choosing a system that reduces evaporation. For example:

- using irrigation components that apply water as close as possible to the roots of a plant;
- using drip irrigation for trees, shrub beds and areas of groundcover; and
- operating the system at night.
- Using water-efficient hose nozzles

Overview of Green Building Rating Systems

LEED, BREEAM, REAP, BOMA go green, and other rating systems all have water efficiency credits that compare proposed water use to a baseline water usage. This baseline is generally based on 6 L per flush water closets, 3.8 L per flush urinals, 9.5 L per minute showerheads, faucets and Aerators. LEED and BREEAM also have calculators that can be used to determine both baseline and proposed water usage, based on average or estimated numbers of uses for fixtures. It should be noted that most of these rating systems address water used for irrigation but none of them except for BOMA Go Green, directly addresses the use of domestic water for HVAC or process applications. In many commercial and industrial buildings these applications make up the majority of the building's water use. Refer to Table 2 for summary of ratings systems

Table 2: Overview of Green Building Rating Systems

RATING SYSTEM	JURISDICTION	CREDIT REQUIREMENTS	STRATEGIES	WEBSITE
The Building Research Environmental Assessment Method (BREEAM)	U.K.	Wat 1: Internal Water Use	Focuses on water saving fixtures, with checklists accounting for the flow/flush rates of toilets, sinks, showers, baths, appliances	http://www.breeam.org/pdf/EcoHomes2005DevSheetsV1.pdf
		Wat 2: External Water Use	Focuses on rainwater collection	
Leadership in Energy and Environmental Design (LEED)	Canada, US	WE Credit 1.1: Water Efficient Landscaping: Reduce potable water consumption for irrigation by 50%	Perform a soil/climate analysis to determine appropriate landscape types…Use **high-efficiency irrigation systems** and consider using stormwater and/or greywater for irrigation	http://www.cagbc.org/uploads/FINAL_LEED%20CANADA-NC%201.0_Green%20Building%20Rating%20System.pdf
		WE Credit 1.2: Water Efficient Landscaping: No Potable Water Use or No Irrigation	Perform a soil/climate analysis to determine appropriate landscape types and design the landscape with indigenous plants to **reduce or eliminate irrigation requirements**. Consider using stormwater, greywater for irrigation.	
		WE Credit 2: Innovative Wastewater Technologies	OPTION 1 Reduce potable water use for building sewage conveyance by 50% through the use of water conserving fixtures (water closets, urinals) or non-potable water (captured rainwater, recycled greywater, and on-site or municipally treated wastewater). OR OPTION 2 Treat 100% of wastewater on-site to tertiary standards. Treated water must be infiltrated or used on-site. Specify high-efficiency fixtures and dry fixtures such as composting toilet systems and non-water using urinals to reduce wastewater volumes.	

RATING SYSTEM	JURISDICTION	CREDIT REQUIREMENTS	STRATEGIES	WEBSITE
		WE Credit 3.1: Water Use Reduction: 20% Reduction	Use **high-efficiency fixtures, dry fixtures such as composting toilet systems and non-water using urinals, and occupant sensors to reduce the potable water demand.** Consider reuse of stormwater and greywater for non-potable applications such as toilet and urinal flushing and custodial uses.	
		WE Credit 3.2: Water Use Reduction: 30% Reduction	Use **high-efficiency fixtures, dry fixtures such as composting toilet systems and non-water using urinals, and occupant sensors to reduce the potable water demand.** Consider reuse of stormwater and greywater for non-potable applications such as toilet and urinal flushing and custodial uses.	
Green Star	Australia	Potable Water Reduction Credits awarded for reducing water consumption. Greywater reuse is not necessary but is listed as an option. GreenStar design guide includes a greywater calculator to determine points awarded.	Use efficient fixtures for toilets, urinals, sinks, showers	http://www.gbcaus.org/
The Comprehensive Assessment System of Building Environmental Efficiency (CASBEE)	Japan	Resources & Materials Credits awarded for reducing potable water consumption	strategies not specified	http://www.ibec.or.jp/CASBEE/english/method2E.htm

Rating System	Jurisdiction	Credit Requirements	Strategies	Website
Built Green	US, Canada: Currently the program is only available in British Columbia and Alberta	Credits awarded for reducing potable water consumption	CSA approved single flush toilet averaging 1.2 GPF or less installed in all bathrooms.	http://www.chbabc.org/content.php?id http://www.chbabc.org/content.php?id=505
			Install a dual flush toilet (1 point each).	
			Install manufactured composting toilet (2 points per unit - maximum 6 points).	
			Insulate the first three feet of the water lines on the hot water tank with flexible pipe insulation.	
			Insulate all hot water lines to all locations.	
			Install hot water recirculation line.	
			Install low flow faucet aerators on all bathroom and kitchen faucets and showers.	
			Install hands free lavatory faucets. 1 point per faucet/unit.	
			Front loading clothes washer.	
			Install water saving dishwasher that uses less than 26.0 L/water per load.	
			Install efficient irrigation technology that utilizes rainwater use.	
			Install permeable paving materials for all driveways and walkways.	
			Provide a list of drought tolerant plants and a copy of the local municipality water usage guide to homebuyers with closing package.	
			Builder supplies a minimum of 8” of topsoil as finish grading throughout site.	
			Builder incorporates water wise landscaping or xeriscaping in show home or customer home (customers 50% of lawn 2 points, 100% 4 points).	
			Builder attaches an insect screen to downspout of water barrel. Water barrel should also have a hose connector spout and overflow spout (1 point per barrel - maximum of 3 barrels).	

Rating System	Jurisdiction	Credit Requirements	Strategies	Website
NAHB Model Green Home Building Guidelines	US	Credits awarded for the use of water conserving appliances and fixtures, rainwater harvesting and innovative wastewater technologies.	Hot water delivery to remote locations aided by 6 Installer certified installation of: **A.** On-demand water heater at point of use served by cold water only. (Points per unit installed) **B.** Control-activated recirculation system.	http://www.nahb.org/publication_details.aspx?publicationID=1994&sectionID=155
			ENERGY STAR® water-conserving appliances installed, e.g., dishwasher, washing machine	
			Water-efficient showerhead using conventional aerator or 2 per Installer certified venturi technology for flow rate < 2.5 gpm	
			Water-efficient sink faucets/aerators < 2.2 gallons/minute	
			Ultra low flow (< 1.6 gpm/flush) toilets installed: **A.** Power-assist, **B.** Dual-flush.	
			Low-volume, non-spray irrigation system installed, e.g., drip irrigation, bubblers, drip emitters, soaker hose, stream-rotator spray heads	
			Irrigation system zoned separately for turf and bedding areas	
			Weather-based irrigation controllers, e.g., computer-based weather record	
			Collect and use rainwater as permitted by local code. (Additional credit for distribution system that uses a renewable energy source or gravity)	
			Innovative wastewater technology as permitted by local code, e.g., constructed wetland, sand filter, and aerobic system	
			Shut-off valve, motion sensor, or pedal-activated faucet to enable intermittent on/off operation	
			Separate and re-use greywater as permitted by local code	
			Composting or waterless toilet as permitted by local code	

Policies & Regulations

Using the building code, increasing water efficiency in buildings can be accomplished through a pure performance standard, a pure prescriptive path, or some combination of both.

The pure performance approach would set the total potable water budget for the building. For example, the UK's Code for Sustainable Homes uses a range of 80 - 120 litres per person per day (l/p/d), depending on the Code Level achieved.

A prescriptive approach would require specific fixtures based on consumption targets or flow rates. Examples include:

- Toilets - Newer toilets that use 3-6 litres per flush or that have a two-flush setting.
- Clothes Washers - Front loading clothes washers. Reference energy star for residential (commercial washers can take larger loads))
- Dishwashers – ref Energy Star
- Shower heads - Low-flow shower heads
- Taps - Taps with low-flow aerators

Other technologies and key considerations include:

- Dual line water systems for potable and non-potable water;
- Efficient irrigation systems;
- Water audits;
- Landscaping activities including contouring, xeriscaping, trenching, soil moisture retention;
- Leak detection and repair;
- Low flow faucets, showerheads and toilets;
- Meters;
- Rain sensors for automatic irrigation systems;
- Rainwater collection;
- Recirculating and other efficient water-cooling systems;
- Wastewater reclamation systems;
- Water efficient appliances and machinery including washing machines, dishwashers, car washes, ice machines, commercial laundries; and
- Water pressure reduction.

Tools for Increasing Water Efficiency

[This section includes excerpts from the following source: Capital Regional District. "Greywater Reuse Study Report." November 1, 2004."]

Using the building code is one of many tools available to increase water conservation and water efficiency. A range of tools should be included in any plan or program to complement efforts and address specific needs.

The best mix of tools should be identified and evaluated as part of a comprehensive water supply planning process. Specialists within the fields of water resource management, marketing and communications, social research, public policy, economics and engineering can provide valuable advice on the relative effectiveness of each tool. The following "menu of tools" is presented to demonstrate the variety of tools that have been, or can be developed and used.

Regulatory Tools

Legal tools include both mandatory and enabling legislation, regulations, policies, standards and guidelines. These can be used to reduce institutional, legal or economic barriers or to establish barriers against unnecessary water use.

Samples:

- **Building and plumbing code restrictions** (federal & provincial regulations); e.g. toilets, faucets, showerheads, garburators, water and sewer lines, downspouts, water processing and cooling systems. For example– BC's provincial Water Conservation Plumbing Regulation has been amended to require the installation of low consumption (6 litre) toilets in specific local government jurisdictions:
    - Effective January 1, 2005, all new toilets installed throughout the Capital Regional District must have a flush cycle no greater than 6 litres.
    - Effective September 30, 2005, the Regulation applied to an additional 17 geographic areas.
    - Effective April 15, 2007, the Regulation applied to another 21 areas. http://www.housing.gov.bc.ca/building/Low_Consumption_Toilets.htm
- Landscape requirements (local bylaws, provincial guidelines); e.g. pervious surfaces, xeriscapes, slopes, soil cover;
- Outdoor water use restrictions (local bylaw); e.g. lawn and garden, washing, swimming pools;
- Requirements or enabling legislation to consider water use efficiency in plans (provincial legislation and regulations);
- Bylaws for new construction; e.g. requiring "shunt pipes" to facilitate addition of meters in future, low-flow fixtures, standards for installation and construction of water mains, meters;
- Municipal effluent regulations; and
- Subdivision development control bylaw; e.g. specifications setting out material and construction practices for developers and contractors.

Considerations:

- Public and political acceptability is largely dependent on perceived need.
- Health Hazard considerations under the Health Act and water supply system considerations (e.g. portability requirements) under the Drinking Water Protection Act and associated regulations.
- Health Authority public health policy.
- Mandatory measures and voluntary/enabling measures will depend on several factors including: financing, availability of water saving devices and the relative effectiveness of water supply management objectives.

Economic and Financial Tools

Economic and financial tools include both incentives and disincentives. They may be used to convey the message that water is valuable and can assist in motivating people to reduce water use. Increased water service charges also recover costs.

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Samples:

- Grants and loans to municipalities and utilities;
- Financial incentives to install water use efficient devices; e.g. low interest or forgivable loans, tax credits, rebates, buy-backs of inefficient devices;
  E.G. City of Santa Monica's "Save Water Save a Buck Rebate" Program (Appendix F)
- Fines for non-compliance of regulatory requirements;
- Pricing structures; e.g. marginal-cost pricing strategies, increasing block rates, seasonal rates;
- Program funding, e.g. Environmental Youth Team;
- Revolving loan funds;
- "Fee-bate" systems, e.g. water savings from retrofit projects may become the allowable water use in new developments;
- Start-up and venture capital financing;
- Surcharges linking sewer costs with water use;
- Full cost pricing; and
- Water licence rate adjustments.

Considerations:

- Social issues such as equitable distribution and ability to pay require careful deliberation.
- Price is assumed to change consumer behaviour, when in reality a variety of factors influence behaviour.
- The approach taken to pricing is as important as the price.
- Availability of an inexpensive source of water is linked to economic development such as large industries and agriculture.
- Public funding may not be available; other financing arrangements should also be considered including partnerships, private investment and co-operatives.
- Some water uses, particularly indoor residential use, are relatively price-inelastic.
- An emotional response to rising water prices often clouds issues.

Information-Based Tools

Communication and education tools are utilized to encourage voluntary water conservation actions and to support other tools.

Samples:

- Product labelling such as Eco-Logo, Energuide, PowerSmart;
- Product "testing".
- Education and liaison with professional associations, trades, industries and wholesalers / retailers;
- Point of purchase education programs; and
- Competitions, awards and recognition programs;

- Demonstration sites and information centres;

- One-on-one meetings with major water users;
- Irrigation design and scheduling guides;
- Social marketing campaigns such as public broadcasting announcements, brochures and handouts, public displays, slogans, bill inserts, advertising and news bulletins, special public events, internet sites, door-to-door campaigns, newspaper articles and radio / television programs;
- Published materials such as "how to" manuals, case studies, technical reports, resource libraries;
- School programs and materials including activity books, games, videos and CDs, poster contests, in-class visits and demonstrations, "teach the teacher" guides, curriculum guides; and
- Special project committees, seminars and workshops with specific water users.

Considerations:

- Communication and education is based on an assumption that action is influenced by awareness and understanding.
- Some tools are aimed very broadly or indirectly at water consumers, resulting in low or immeasurable results.
- Communication and education requires a good understanding of how people learn and how they are motivated.
- The focus is most commonly aimed at individual behaviour change, which requires a high critical mass and takes time before results are noticeable.
- Market research and targeting specific consumer groups are important elements of a social marketing initiative.
- Messages must be competitive with commercial and issue related messages in the media.
- Water conservation messages are difficult to market.
- Messages should be phased to:
    - create awareness and interest,
    - persuade and motivate,
    - educate and provide skills or other tools to enable people to conserve,
    - create actions, and
    - maintain the behavioural changes.

Other Jurisdictions

Washington

http://www.ecy.wa.gov/programs/wq/reclaim/standards.pdf

Washington State has had water regulations in effect since the early 1990s.

- Regulations apply to all new construction and all remodelling involving replacement of plumbing fixtures in all residential, hotel, motel, school, industrial, commercial use, or other occupancies determined by the council to use significant quantities of water.
- The regulation provides information on the standard of water use efficiency for various fixtures. (Appendix B)

Washington Water Conservation Legislation E2SSB 6117 (2007)

HB 2769 - ACT to creating incentives to encourage the use of 2 reclaimed water.

HB 2884 - Reclaimed Water Act as passed on March 7, 2006.

> *It is hereby declared that the people of the state of Washington have a primary interest in the development of facilities to provide reclaimed water to replace potable water in non-potable applications, to supplement existing surface and ground water supplies, and to assist in meeting the future water requirements of the state. The legislature further finds and declares that the utilization of reclaimed water by local communities for domestic, agricultural, industrial, recreational, and fish and wildlife habitat creation and enhancement purposes, including wetland enhancement, will contribute to the peace, health, safety, and welfare of the people of the state of Washington. To the extent reclaimed water is appropriate for beneficial uses, it should be so used to preserve potable water for drinking purposes. Use of reclaimed water constitutes the development of new basic water supplies needed for future generations.*

RCW 19.27.170 - Water Conservation Performance Standards - Fixtures that meet Standards - Marketing and Labeling Fixtures - Establishes state low flow plumbing fixture requirements. (Appendix B)

RCW 35.67.020 - Sewerage Systems - Authority to Construct Systems and Fix Rates and Charges - Authorizes cities/towns to consider the achievement of water conservation goals and the discouragement of wasteful practices when setting sewer rates.

RCW 70.119A.180 - Water use efficiency requirements -- Rules.

RCW 90.54.180 - Water Use Efficiency and Conservation Programs and Practices - Provides that increased water use efficiency should receive consideration as a potential source of water in state and local water resource planning processes and stipulates that water use efficiency programs should mix incentives and regulation. In determining cost-effectiveness of alternative water sources, consideration should be given to the benefits of conservation, wastewater recycling and impoundments.

Washington State Constitution Article VIII, §10 (Senate Joint Resolution 8210) - Amendments to State Constitution to Encourage Water Use Efficiency (passed by voters November 1989) - Permits county, city, town, quasi-municipal corporation, municipal corporation or political

subdivision of the state engaged in the sale or distribution of water to use public money to finance increased water use efficiency (does not permit state to use funds for this purpose).

RCW 90.82 (ESHB 2514) - Regional Watershed Planning Bill (1998 session) - Local planning units developing watershed plans are required to develop an estimate of water actually being used (water use), an estimate of water needed in the future (water demand forecast), and strategy for increasing water supplies through conservation, reuse, etc. (water conservation).

WAC 246-290 - Public Water System Supplies - Water System Plans - Requires public water systems to address several elements including a "conservation program" in their water system plan. Public water systems are also required to specifically address water demand forecasting, water use data collection, and enhanced water conservation planning where water rights will be needed within 20 years.

Oregon

http://www.cbs.state.or.us/bcd/programs/codes_in_oregon.html#plumbing
The 2005 Oregon Plumbing Specialty Code (OPSC) is based on the following:

- The 2003 Uniform Plumbing Code, Chapters 2 through 11, 13, 14 and 15; and Appendices A, B, D, E, I and J.
- The 2002 edition of NFPA 99C, Medical Gas and Vacuum Systems Standard.
- Oregon amendments.

The 2005 OPSC is a significant revision from the previous edition, and it includes the following provisions:

- Clarifies drainage clean-out and self-closing lavatory faucet requirements.
- Removes references to mechanical, structural and other non-related code provisions.
- Updates plumbing product standards.
- Allows flammable vapor-ignition-resistant, fuel-fired water heaters to be installed at garage floor level.
- Adopts model code medical gas and vacuum systems standards, model code storm water and rain drain provisions, standards for elevator pit drain and model code provisions for fire stopping installations for plastic piping.

A new revision is expected in 2008 to meet water conservation requirements in Oregon.

California

http://www.ciwmb.ca.gov/GreenBuilding/TaskForce/PolicyLaw/#Water
Water conservation is state policy (Water Code Sections 100 & 101) and is implemented through a partnership between local water districts and the Department of Water Resources. Specifically, the state codes require:

- All local jurisdictions to adopt a landscape water conservation ordinance, AB 325, Statutes of 1990, California Code of Regulations, Title 23, Ch 2.7, § 490-495.
- California Water Recycling Regulations and Statutes, California Health and Safety Code, Division 13, Part 1.5, Chapter 2, Section 17921.3 and California Code of Regulations, Title 20, Division 2, Chapter 4, Article 4, Section 1604 and California Code of Regulations Titles 22 and 17

California Statute

Bathroom Fixtures
Health and Safety Code (HSC) section 17921.3
Effective in 1992, a new water-efficiency standard for restrooms became the law in California. The maximum flush volume for each of these fixtures was:

- Water closets and associated flushometer valves that use no more than 1.6 gallons per flush;
- Urinals and associated flushometer valves and that use no more than 1.0 gallon per flush;
- Showerheads that use no more than 2.5 gallons per minute (gpm); and
- Lavatory and sink faucets that use no more than 2.2 gpm.

HSC section 17921.3(c) states that "On and after January 1, 1994, all water closets sold or installed in this state shall be water closets and associated flushometer valves, if any, which use no more than an average of 1.6 gallons per flush and which meet performance standards established by American Society of Mechanical Engineers standards A112.19.2-1990 and A112.19.6-1990, and urinals and associated flushometer valves, if any, which use no more than an average of one gallon per flush and which meet performance standards established by American Society of Mechanical Engineers standards A112.19.2-1990 and A112.19.6-1990. Blowout water closets and associated flushometer valves are exempt from the flush volume requirements of this section."

California Code of Regulations

Washing Machines
California Code of Regulations, Title 20, Division 2, Chapter 4, Article 4, Section 1605.3(p)(1)
Effective January 1, 2007, the maximum water factor for commercial clothes washers shall be 9.5. (The water factor "is a measure of the total water used by the clothes washer. The less water used per cubic foot of laundry, the lower the water factor, and the greater the machine efficiency." [9])

Commercial Pre-rinse Spray Valves
California Code of Regulations, Title 20, Division 2, Chapter 4, Article 4, Section 1605.3(h)(3)(A)
The flow rate of commercial pre-rinse spray valves manufactured on or after January 1, 2006, shall be equal to or less than 1.6 gpm at 60 pounds per square inch (psi).

California Policy

Executive Order S-20-04
The Green Building Executive Order (Executive Order S-20-04) established the State's priority for energy and resource efficient high performance buildings. It directs the State to commit to aggressive action to reduce State building electricity usage. One significant measure that is mentioned in this Order is for the State to design, construct, and operate all new and renovated State-owned facilities paid for with State funds as "LEED Silver" or higher certified buildings. LEED - the U.S. Green Building Council's Leadership in Energy and Environmental Design rating

system - is the nation's leading green building rating system. It promotes "high performance" building practices; energy, water and materials conservation; environmentally preferable products and practices; improvements in employee health, comfort and productivity; and reductions in facility operation costs and environmental impacts.

Executive Order S-3-05

Executive Order S-3-05 established the following greenhouse gas (GHG) emission reduction targets for California: by 2010, reduce GHG emissions to 2000 levels; by 2020, reduce GHG emissions to 1990 levels; by 2050, reduce GHG emissions to 80 percent below 1990 levels. The Secretary of the California Environmental Protection Agency is charged with the coordination of the oversight of efforts to achieve these targets, including addressing impacts to water supply, public health, agriculture, the coastline, and forestry.

UK: Water Supply (Water Fittings) Regulations 1999

[This section includes excerpts from the following source: UK Government, Department for Environment, Food, and Rural Affairs. Water Supply Regulations. 1999. http://www.defra.gov.uk/environment/water/industry/wsregs99/index.htm. Accessed September 2007.]

Defra has responsibility for water fittings policy in England.

In July 1999, the Water Supply (Water Fittings) Regulations 1999 replaced local water bylaws in England and Wales. The Regulations set requirements for the design, installation and maintenance of plumbing systems and water fittings. They are enforced by water companies in their respective areas of supply.

The Regulations set minimum standards for the water consumption of WCs, which account for around 30% of household water consumption, as well as washing machines, dishwashers and washer driers. They also contain requirements to ensure the durability and leak tightness of water fittings and guidance on minimising the length of pipe runs to reduce the run-off necessary to get hot or cold water at the tap. The Regulations reduced the maximum flush volume of new WCs to 6 litres and permitted more efficient dual flush systems.

Preventing contamination

Contamination of drinking water can occur when a decrease in pressure in the water supply causes fluids to travel back up the pipe. This is known as backflow or back siphonage, which can cause contaminants to be drawn back into the drinking water supply unless adequate precautions are taken. The Regulations identify five fluid categories, which reflect the impact of downstream fluids and the associated risk to public health should fluids contaminate drinking water. The backflow prevention specification then equates each fluid category to a range of suitable backflow prevention devices. [In BC, prevention measures in this context are referred to as “cross-connection control” measures.]

Water conservation

The Regulations set minimum standards for the water consumption of WCs, as well as washing machines, dishwashers and washer driers. They also contain requirements to ensure the durability and leak tightness of water fittings and guidance on minimising the length of pipe runs to reduce the run-off necessary to get hot or cold water at the tap. The Regulations reduced the maximum flush volume of new WCs to 6 litres and permitted more efficient dual flush systems. In 2001 a performance specification for WC suites was introduced, with which all newly installed suites must comply.

Water efficiency in new buildings

http://www.defra.gov.uk/environment/water/conserve/what.htm

Defra and CLG jointly consulted on options for regulating for minimum standards of water efficiency in new homes and commercial buildings. The consultation was launched on 14 December 2006 as part of the Government's wider 'green package' announcement including the Code for Sustainable Homes, a draft Planning Policy Statement (PPS) on climate change and a consultation document signalling Government's intention to require zero carbon homes by 2020, and closed on 9 March 2007.

A report has now been published (Appendix C) that gives a statistical summary of who responded to the consultation, responses to the questions asked and summaries of detailed comments made, identifying key themes and issues.

The proposals were for a whole building performance standards with target levels of between 120 and 135 litres per person per day, representing a 10-20% reduction in current UK average consumption, subject to consultation. An alternative approach would be to set performance standards for individual fittings.

For commercial buildings the proposals are similar, and would make good practice the norm. The proposals will not apply to the process uses of water or to residential institutions e.g. hospitals.

Two policy options were presented as part of the proposals:

Option A

Option A would require new dwellings to meet a calculated average whole performance standard based on litres per head per day. The whole performance standards are based on average use assumptions about the amount of water used are based on data about the average frequency and duration of use, and the performance of the water fittings specified.

This option would give building designers and specifiers maximum flexibility on how they would meet a building performance standard, so that they could, for example, specify an ultra low flush toilet to compensate for a higher consumption shower. Detailed guidance (for example, in an Approved Document to supplement Building Regulations), would set out clearly how these

performance measures could be met in practice and what assumptions are made so building control can confirm compliance. For example, it could indicate that, for a given size of property, with a certain number of occupants, a 6/4L dual flush toilet, a maximum 12 litre shower and certain kinds of taps would meet the standard, based on assumptions about normal usage. Designers and specifiers would then have flexibility to select a combination of fittings to meet the performance standard whilst meeting the requirements of the purchasers.

This option is less easily applied to commercial buildings because of the diversity in use of such buildings. For buildings with few or no visitors the building standard could be set at 20% of the value for housing using expected staff numbers as a surrogate for bed space. Where large numbers of clients are expected and catered for the whole building performance is less definable.

Option B

This option would set a performance based standard for each group of water fittings, such as toilets, taps and showers, rather than having a performance standard for the building. Each group of water fittings would have a water efficiency performance specified as a maximum water use (toilets) or flow rate (taps, showers).

This option has the advantage of encouraging a higher level of uptake of more efficient water fittings. Thus in commercial buildings whether a staff only water demand or a client-driven water demand is exercised is immaterial to the water saving which is expressed through the individual water efficient facilities.

The downside is that it would be possible to comply with the minimum standards in key components such as showers, toilets and taps, but still install high water using items such as aerated spa baths if they are outside regulation. It also gives less flexibility if a designer or specifier wishes to fit a particular fixture and does not lead to the most cost-effective solution.

Fitting standards will be based on:

- 6 litre/4 litre dual flush toilets
- 4.5 litre low flush toilets
- A maximum flow rate for mixer and electric showers of 12 litres per min.
- A maximum flow rate for power showers of 20 litres per min.
- Water efficient bidets
- ‘Push-down’ taps , other than for baths
- Taps – flow restrictor for outdoor taps
- Baths maximum capacity of 230 litres
- Water efficient waste disposal and water softening systems
- Automatic stopcocks

For non-domestic buildings, the proposal is to adopt EITHER one of the existing benchmarks in this area, or to adopt a component-based approach similar to that outlined at Option B for new homes, but with the inclusion of standards for fittings not usually in domestic use e.g. urinals.

Other UK Water Conservation/ Efficiency Initiatives
[This section includes excerpts from the following source: UK Government, Department for Communities and Local Government. "Water Efficiency in New Buildings - A consultation document." December 2006."]

UK Code for Sustainable Homes
Communities and Local Government launched the Code for Sustainable Homes on 13 December 2006, which includes standards for water efficiency. The code sets a range of standards above the current statutory baseline. (Appendix D) From April 2007 all new homes receiving Government funding will be required to meet Level 3 of the Code.

Table 5: Maximum Internal Water Consumption for New Homes

	Code Level	Litres per day
	1	120
	2	120
	3	105
	4	105
	5	80
	6	80

Source: Department for Communities and Local Government.
Code for Sustainable Homes. UK, December 2006.

The Code for Sustainable Homes was introduced this year (2007). It will become mandatory next year for all new construction.

Metering
Defra Ministers have recently announced that they intend to consult on a Water Saving Group proposal to allow water companies in areas of serious water stress to install compulsory water meters, alongside other measures as part of a long-term plan for water resources. This consultation will not however propose national compulsory water metering.

Product labelling
Some manufacturers already design and market their products on the basis of water efficiency. As part of the work of the Water Saving Group, Defra is undertaking work to assess the feasibility of introducing a voluntary labelling scheme to assist the promotion of water efficient products. This work stream is supported by the Government's Market Transformation Programme (MTP), which supports UK Government policy on sustainable products. Its aim is to achievable sustainable improvements in the resource efficiency of products, systems and services where these are critical to the delivery of Government commitments in areas including climate change, water efficiency and waste reduction.

Australia

Over the past decade, the federal, state and territorial governments of Australia have worked together to create and implement a comprehensive national strategy for water reform. Most recently, a 2004 Intergovernmental Agreement (IGA) triggered a National Water Initiative (NWI). In the area of urban water reform, the NWI aims to:

- increase water use efficiency;
- promote the reuse and recycling of wastewater;
- encourage innovation; and,
- improve pricing.

As a first step, the States and Territories agreed to undertake the following specific actions in regard to demand management by 2006:

- review the institutional and regulatory models for achieving integrated urban water cycle planning and management, followed by preparation of best practice guidelines;
- take immediate action to develop national guidelines for water sensitive urban designs (including recycled water and stormwater);
- enact legislation to implement the Water Efficiency Labelling Scheme (WELS), a mandatory product labelling scheme for appliances, and a Smart Water Mark labelling scheme for household gardens, including garden irrigation equipment, garden designs and plants;
- review the effectiveness of temporary water restrictions and associated public education programs, and assess the feasibility of making low-level restrictions standard practice;
- implement cost-effective measures to address system losses, and related maintenance issues; and, • review incentives to stimulate innovation.

New South Wales and BASIX

http://www.basix.nsw.gov.au/information/faq.jsp

The State of New South Wales has mandated minimum standards of water efficiency, thermal performance, and greenhouse gas emissions in all residential development. A software tool called BASIX was developed to assess the anticipated water consumption and greenhouse gas emission levels of the proposed development. The expected thermal performance of the proposed building is also assessed. For the Water and Energy indices, points are awarded based on how the proposal is likely to perform against the average of all existing dwellings of the same type.

BASIX relies on comprehensive data sets about resource demand, occupation levels and market penetration rates of technologies provided by utility organisations, state agencies and the Australian Bureau of Statistics. A comprehensive analysis of existing technologies has also been undertaken to ensure BASIX is contemporary and reflects best practice technologies relating to sustainability.

Algorithms within the BASIX tool calculate in qualitative terms how a proposed development is likely to perform against an existing development of the same type.

See Appendix E for a screen Shot and Detailed Description of the Software

BC Transferability

Stakeholder Barriers to Implementing Water Efficiency

What the Experts Think – The Polis Project

[This section includes excerpts from the following source: Maas, T. "What the Experts Think: Understanding Urban Water Demand Management in Canada." POLIS Project, University of Victoria, December 2003]

Entrenched engineering approaches

The predominance of the supply-side paradigm is in part a product of a bias toward engineering practices and expertise in the field of water resource management. The influence of this bias is apparent in both public and private sector participants in urban water management.

Municipal water utilities are usually managed and operated by water supply engineers who are comfortable with traditional 'big pipe' solutions (de Loë, 2003: PC). Many note that this is a major barrier to the Demand Side Management (DSM) approach because of its different emphasis on socio-political and economic techniques, which require very different skill sets than those found in the engineering profession.

Box 1: Quayside Village - A Case in Point

The residents and developers of Quayside Village, a multiunit co-housing project located in North Vancouver, BC, have experienced first hand many of the challenges of DSM. Their experiences demonstrate the need for an integrated approach that combines technical innovation and effective incentive programs.

The 19 unit residential complex includes an experimental greywater reuse system funded by the CMHC. All water from sinks and showers is collected and treated for reuse in toilet flushing. The 'village' has also been double plumbed to permit future reuse of greywater in showers.

By reusing greywater, water demand and wastewater flows are reduced by 40%; the associated savings in water bills are expected to offset the costs of the reuse system. However, this innovative approach to urban water management has not been without its challenges.

Health authorities required over a year of testing to demonstrate system reliability before approving it for use. The systems operators also experienced difficulties finding professionals willing and capable of taking on the maintenance contract - the system is too complex for most plumbers, but too small for most engineering firms to be interested.

Through patience, persistence and the ongoing support of the CMHC, appropriate maintenance expertise has been identified and all permits are in place. However, new challenges have arisen.

Since the project's inception, local water suppliers have changed billing structures for multi-unit dwellings from a volume-based to a flat-rate system. The new billing system is a counter-incentive for water conservation.

The message to residents? - Conserve water, but pay the same as the people who don't!

BC Legislative Barriers

Under the present BC legislation, composting toilets have been missed; they are not considered a legal option under the Sewerage System Regulation (SSR). Because they are not connected to plumbing lines or a drain, they may not be considered a plumbing fixture. The legislation needs to be amended to take these into account.

West Coast Environmental Law Suggestions
[This section includes excerpts from the following source: West Coast Environmental Law. "Cutting Green Tape: An Action Plan for Removing Regulatory Barriers to Green Innovations." April 2002].

Amend Plumbing Code (or provide clear rules for equivalency) to:

- Recognize 'interconnection of two water supplies,' and 'split plumbing systems' and remove the requirement that all water piped to any fixture be potable (this may be a drinking water protection act issue). Changes recommended by a CMHC-commissioned paper include:
    - require colour code or labelling of pipe and plumbing components carrying non-potable water;
    - set guidance on appropriate backflow preventers and cross-connection prevention for reuse systems;
    - allow parallel potable and non-potable systems with pressure differences between them and;
    - define approved locations of non-potable water pipes within a building and trenches.

- Define standards that recognize on-site treatment alternatives that eliminate the need for a direct connection to a local municipal sanitary sewer system.

- Review and update definitions of "fixtures" and "water closets" for plumbing sizing; review safety requirements for shafts (e.g. sprinkling) and operating/maintenance concerns; define operation/maintenance instructions for composting toilets to be permanently affixed to the building; and address concerns of inspectors who unnecessarily require 'future retrofits' (e.g. oversized piping to ensure toilet can be replaced by conventional toilet).

- Update tables of 'fixture units' in order to reflect actual flow to fixtures in order to accommodate current water conserving fixtures and technologies and allow engineered pipe sizing.

- Define appropriate standards for grey water systems for buildings and residences (perhaps defining different standards for buildings that will not be frequently used by children or pets).

Barriers Mitigated:

- Provincial plumbing code required direct connection to local municipal sanitary sewer where one exists.

- Plumbing Code requirement for all water piped to any fixture to be potable.

- Interconnection of two water supplies and split plumbing systems prohibited by plumbing code.

- Code barriers related to safety and health (small children falling into shafts), and ‘future retrofits’ (requiring oversized piping to ensure toilet can be replaced by conventional toilet).
- Plumbing code has no specific prohibitions, but inspectors unfamiliar with the technology require additional documentation and references.

- Lack of guidance in Plumbing Codes for non-potable water systems (see next one).

- Functionally, plumbing codes greatly inhibit widespread use of local wastewater treatment and grey water reuse (e.g. every water distribution system must be connected to a public water main or a private potable water supply system; and only "potable water" can be used for fixtures).

- Plumbing code currently requires prescriptive Fixture Unit sizing which does not allow engineered pipe sizing. This “fixture unit” method was originally developed by Dr. Roy Hunter, in BMS 79 (1979). The fixture unit values currently used are still representative of plumbing fixture flow rates from 1979. The ASPE (American Society of Plumbing Engineers) Research Foundation has called for the abandonment of supply fixture unit sizing methods (1995) and is considered out of date by many in the Plumbing Engineering Field.

BUILDING PLUMBING SYSTEMS

P1 COMPOSTING TOILETS

GREEN PRACTICE CODE/DESCRIPTION

Use of natural biological digestion processes to treat human waste.

REGULATORY BARRIERS

- Plumbing/Health authorities unfamiliar with process (require a full standard disposal system) for grey water [Composting toilets replace black water not grey water].
- Reduced water consumption/sewage capacity not reflected in 'DCCs'.
- Code barriers related to safety and health (small children falling into shafts), and 'future retrofits' (requiring oversized piping to ensure toilet can be replaced by conventional toilet).
- *See also p4 'non-potable water use' and I3 'local wastewater treatment'.*

POTENTIAL IF BARRIER REMOVED

- Clean, uncontaminated, nutrient-rich compost material suitable for landscaping application.
- Reduce potable water consumption in commercial (1/3) and residential (1/4) buildings.
- Eliminate malfunctioning septic systems (major cause of groundwater contamination).
- Reduce raw/semi-treated sewage load into waters (GVRD/CRD).

POTENTIAL SOLUTIONS

- Focused education for health authorities, plumbing inspectors.
- Research program and pilot projects.
- Change plumbing code to require operation/maintenance instructions to be permanently affixed to building.
- Encourage adjustments to DCCs for sewage and potable water connections, piping, and plant capacity.
- Codes: address definition of "fixtures" and "water closets", safety requirements for shaft dimensions, and operating/maintenance concerns.
- Create CSA composting toilet performance standards.

Refer to the BC Green Building Code: Background Research on Grey Water for further discussion on regulation issues

Source: West Coast Environmental Law. "Cutting Green Tape: An Action Plan for Removing Regulatory Barriers to Green Innovations." April 2002.

P2 WATERLESS URINALS

GREEN PRACTICE CODE/DESCRIPTION

Use of an odourless fluid and specially designed waste-traps to eliminate need for flushing water.

REGULATORY BARRIERS

- Plumbing code has no specific prohibitions, but inspectors unfamiliar with the technology require additional documentation and references.
- Slope requirements for installed wastewater piping.
- Few municipalities recognize water consumption benefits when adjusting DCCs.
- Lack of correct "fixture flow rates".

POTENTIAL IF BARRIER REMOVED

- Moderate potential to reduce water consumption.
- Costs are much less than for conventional toilets.

POTENTIAL SOLUTIONS

- Focused education.
- Revise Plumbing Codes to update tables of 'fixture units' in order to reflect current water conserving fixtures and technologies.
- Create CSA waterless urinal performance standards.

Source: West Coast Environmental Law. "Cutting Green Tape: An Action Plan for Removing Regulatory Barriers to Green Innovations." April 2002.

Appendix A: Major ULF Toilet Technologies

1. Gravity
This Ultra Low Flow (ULF) technology functions the same as all of the regular tank type toilets. This technology relies on the head pressure that 'gravity' exerts on the height and volume of water in the toilet tank. The action of pushing the 'flush lever' lifts the flapper, which forces the water into the bowl with a velocity that fills the trapway, initiates the siphoning action, and causes the toilet to flush.

Gravity ULF Toilets have the most limited range specifications. They may have a jet or not. The trapway Ball Pass's vary in size from 1-1/2" to 2-1/8", with the average being around 1-3/4". The Water Seal is generally the CSA minimum of 2", with only a very few offering much more than 2-1/2". The Water Surface is also limited by the technology, and is generally in the 6" x 8" range.

2. Pressurized
There are two types of ULF pressurized technologies. They both use high water pressure to literally push all the waste material out of the bowl and into the plumbing system.

The first version uses a Flushometer-Valve instead of a tank, to introduce the pressurized water into the rim of the toilet bowl. The second, Flushometer-Tank, is the version which only uses the ceramic tank as an aesthetic cover to hide the true pressurized device inside. This airtight 'device' is connected to the water supply from the building, and as the water fills the 'device', it compresses the air inside so that when the toilet is flushed, the pressurized water inside is forced into the toilet bowl causing a strong flushing action. (avoid cross connection issues and potential for contamination)

ULF pressurized toilet technology enables a wide range of specifications, however it must have a jet to regulate the high water pressure. The trapway can achieve a Ball Pass of 2-1/4". The Water Seal is able to reach 3", and the Water Surface a 'full' 10" x 12".

3. Vacuum-Assist
This is the newest of all ULF toilet technologies, and it combines the traditional Gravity Technology, with an innovative method of dramatically increasing the siphoning action.

Head-Pressure from the height of the water in the tank, works in conjunction with components inside of the tank which are connected to the trapway of the bowl. When the toilet is flushed, the water passing from the tank to the bowl creates a vacuum, which evacuates air from the top portion inside the trapway and results in a strong siphoning-action.

The Vacuum-Assist Technology provides the full gamut of specifications. It can have a jet or not. The trapway can achieve a Ball Pass of 2-1/4". The Water Seal is able to reach 3", and the Water Surface a 'full' 10" x 12".

TOILET BOWL SPECIFICATIONS

Jets
Most jets are in plain view at the bottom of the bowl. However, sometimes they are inside the trapway and hidden from view. It is best to check the product literature if you are not sure.

Water Surface
CSA, ANSI, and NOM have a minimum requirement of 4" x 5". In general, the larger the Water Surface the cleaner the bowl will stay. However, this is only a rule-of-thumb.

Ball Pass
CSA, ANSI, and NOM have a minimum requirement of 1-1/2", but this diameter won't even pass a golf ball.

Water Seal
CSA, ANSI, and NOM have a minimum requirement of 2". The larger the water seal, generally the greater the protection against sewer gases entering the building.

Appendix B: Washington State Standards of Water Use Efficiency for Various Fixtures

RCW 19.27.170. Water conservation performance standards -- Testing and identifying fixtures that meet standards -- Marking and labeling fixtures.

(1) The state building code council shall adopt rules under chapter 34.05 RCW that implement and incorporate the water conservation performance standards in subsections (4) and (5) of this section. These standards shall apply to all new construction and all remodeling involving replacement of plumbing fixtures in all residential, hotel, motel, school, industrial, commercial use, or other occupancies determined by the council to use significant quantities of water.

(2) The legislature recognizes that a phasing-in approach to these new standards is appropriate. Therefore, standards in subsection (4) of this section shall take effect on July 1, 1990. The standards in subsection (5) of this section shall take effect July 1, 1993.

(3) No individual, public or private corporation, firm, political subdivision, government agency, or other legal entity may, for purposes of use in this state, distribute, sell, offer for sale, import, install, or approve for installation any plumbing fixtures unless the fixtures meet the standards as provided for in this section.

(4) Standards for water use efficiency effective July 1, 1990

(a) Standards for water closets. The guideline for maximum water use allowed in gallons per flush (gpf) for any of the following waterclosets is the following:

Tank-type toilets	3.5 gpf.
Flushometer-valve toilets	3.5 gpf.
Flushometer-tank toilets	3.5 gpf.
Electromechanical hydraulic toilets	3.5 gpf.

(b) Standard for urinals. The guideline for maximum water use allowed for any urinal is 3.0 gallons per flush

(c) Standard for showerheads. The guideline for maximum water use allowed for any showerhead is 3.0 gallons per minute.

(d) Standard for faucets. The guideline for maximum water use allowed in gallons per minute (gpm) for any of the following faucets and replacement aerators is the following:

Bathroom faucets	3.0 gpm.
Lavatory faucets	3.0 gpm.
Kitchen faucets	3.0 gpm.
Replacement aerators	3.0 gpm.

(e) Except where designed and installed for use by the physically handicapped, lavatory faucets located in restrooms intended for use by the general public must be equipped with a metering valve designed to close by spring or water pressure when left unattended (self-closing)

(f) No urinal or water closet that operates on a continuous flow or continuous flush basis shall be permitted.

(5) Standards for water use efficiency effective July 1, 1993.

(a) Standards for waterclosets. The guideline for maximum water use allowed in gallons per flush (gpf) for any of the following waterclosets is the following:

Tank-type toilets	1.6 gpf.
Flushometer-tank toilets	1.6 gpf.
Electromechanical hydraulic toilets . . .	1.6 gpf.

(b) Standards for urinals. The guideline for maximum water use allowed for any urinal is 1.0 gallons per flush.

(c) Standards for showerheads. The guideline for maximum water use allowed for any showerhead is 2.5 gallons per minute.

(d) Standards for faucets. The guideline for maximum water use allowed in gallons per minute for any of the following faucets and replacement aerators is the following:

Bathroom faucets	2.5 gpm.
Lavatory faucets	2.5 gpm.
Kitchen faucets	2.5 gpm.
Replacement aerators	2.5 gpm.

(e) Except where designed and installed for use by the physically handicapped, lavatory faucets located in restrooms intended for use by the general public must be equipped with a metering valve designed to close by water pressure when unattended (self-closing).

(f) No urinal or water closet that operates on a continuous flow or continuous basis shall be permitted.

(6) The building code council shall establish methods and procedures for testing and identifying fixtures that meet the standards established in subsection (5) of this section. The council shall use the testing standards designated as American national standards, written under American

national standards institute procedures or other widely recognized national testing standards. The council shall either review test results from independent testing laboratories that are submitted by manufacturers of plumbing fixtures or accept data submitted to and evaluated by the international association of plumbing and mechanical officials. The council shall publish and widely distribute a current list of fixtures that meet the standards established in subsection (5) of this section.

(7) The building code council shall adopt rules for marking and labeling fixtures meeting the standards established in subsection (5) of this section.

(8) This section shall not apply to fixtures installed before July 28, 1991, that are removed and relocated to another room or area of the same building after July 28, 1991, nor shall it apply to fixtures, as determined by the council, that in order to perform a specialized function, cannot meet the standards specified in this section.

(9) The water conservation performance standards shall supersede all local government codes. After July 1, 1990, cities, towns, and counties shall not amend the code revisions and standards established under subsection (4) or (5) of this section.

[1991 c 347 § 16; 1989 c 348 § 8.]

Appendix C: UK Government Response to Consultation Regarding Water Efficiency in New Buildings Consultation

[This section includes excerpts from the following source: UK Government, Department for Communities and Local Government. "Water Efficiency in New Buildings - A consultation document." December 2006.]

Key messages from consultation and other discussions:
We suggested that the best approach might be to require new homes to meet a calculated average whole building performance standard, expressed as the amount of water consumed in litres per person per day (l/p/d) and that the standard should be set in the range of 120 to 135 l/p/d. This could be implemented and enforced through an amendment to the Building Regulations.

As an alternative to this we asked whether it would be sensible to set performance based standards for individual types of water fittings such as toilets, taps and showers in terms of the maximum water usage for each toilet flush and the maximum flow rates for taps and showers. This could be implemented through amendments to the Water Supply (Water Fittings) Regulations 1999 (SI 1999 No. 1148).

In general terms, the proposals to regulate for water efficiency in new homes were well received. 74 per cent of the 187 respondents said that they thought that a[n average] whole building performance standard could be made to work for new homes and 56 per cent thought that this offered the most flexible approach.

Forty-one percent of respondents opted for a performance standard for homes of 120 l/p/d and two-thirds of those who expressed a view on the ability of manufacturers to provide compliant fittings thought this was not a problem. However there was a clear divergence of opinion between different sectors on whether a standard of 120 l/p/d was achievable with existing fittings and whilst developers and local authorities thought it was realistic and achievable, manufacturers thought it could only be achieved with rainwater harvesting or grey water recycling.

Fewer respondents (77) expressed a view on how to deal with water efficiency in the workplace. 62 per cent of respondents felt the BREEAM2 offices standard should be used as the benchmark if a whole building approach were pursued. However, the consultation did not directly ask whether a whole building performance approach would be more effective than a fittings standard approach and was practicable. Several respondents qualified their benchmark choice, by supporting a fittings standard approach in their comments arguing that standards for individual types of fittings would be more appropriate and easier to apply across the full range of buildings under consideration.

A number of themes were raised consistently by respondents in their comments on each question and in the general comments box. These were that:

- The whole building performance approach was widely seen as a positive move towards reducing water consumption in new homes but, on its own, it would not deliver the long term water savings that were needed, nor could it be relied upon to drive innovation in the provision of water fittings. There was strong support from all sectors that the whole

building performance approach be coupled with a minimum performance of fittings standards.

- New properties were only a small part of the market and this measure alone would be insufficient to drive the sort of market transformation needed.

- The approach should be consistent with that taken on energy performance and that progressive targets should be set with the initial target achievable with existing technology and progressively more stringent targets for the future.

- There was concern about the perceived growth in the use of high water use, or luxury fittings and how these could be accommodated equitably in the drive for water efficiency. There was a divergence of understanding of what might constitute a high use appliance and whether it was practicable to enforce any new regulations on the water use of such products.

- The current lack of robust information on the amount of water consumed for domestic type uses across the full range of workplaces precluded setting meaningful and workable whole building performance standards. Once again, a package of measures will be needed and performance standards for fittings would be a more effective way of achieving water efficiency. Further research would be needed to develop whole building standard

The results of the consultation are available on the Communities and Local Government website: www.communities.gov.uk/consultations.

The way forward

This section sets how we intend to respond to the views expressed by respondents across five themes:

- regulating in the new housing sector;
- setting the performance standard for homes;
- tackling individual fixtures and fittings;
- regulating in the new non-residential sector; and
- looking to the future.

Regulating in the housing sector- Water efficiency in new buildings

The majority of respondents felt that a whole building performance standard could be made to work, but the two options outlined in the consultation – a whole building approach and fittings standards – were not regarded as mutually exclusive, but as options that addressed slightly different problems. Several respondents favoured a combined approach and saw no reason why both measures should not be introduced.

This view was a combination of a belief that whilst the whole building performance approach had the merit – particularly for developers – of allowing flexibility in the way standards are met, it could not be relied upon to meet the aim of securing longer term reductions in consumption as it might affect too small a part of the market to encourage the level of innovation by suppliers considered necessary. Although a whole building approach would ensure that developers can specify the appropriate fitting type for his/her building/client base without exceeding the regulatory standard, inefficient products would not be wholly ruled out for new properties and could continue to be available for retrofitting in new properties, thus negating the expected water

savings. However, setting standards for water fittings through the Water Supply (Water Fittings) Regulations 1999 would not in itself prevent non-compliant fittings being offered for sale.

To have maximum effect, the standards for new buildings should have an influence on the whole market for water-using appliances including replacement in existing properties. A standard for new buildings alone would have limited impact on retrofit or replacement in both existing and new stock and, therefore, it was desirable to adopt both approaches.

Whilst we accept the argument that a combination of standards for individual fittings and a whole house performance standard provides a very strong incentive for market transformation, bringing the two approaches into a single regulation is not practicable to have one approach enables maximum flow fixtures, whereas the other approach sets minimum flow standards respectively. Whilst it is helpful to set maximum levels of water use for 'wet' appliances and water fittings, we do not wish to include these in building standards where they may prove to be a barrier to innovation in construction and design. We therefore propose to implement a whole house performance standard within the Building Regulations and Defra will review the Water Supply (Water Fittings) Regulations 1999 with a view to setting, where appropriate, revised upper bounds for the efficiency of toilets, urinals and washbasin taps, for example.

Setting the performance standard
More respondents (40 per cent) opted for a standard of 120 l/p/d than for any of the other options presented. However, a close reading of the comments accompanying the tick box responses shows that there is a considerable divergence of opinion on the practicality of this standard. Whilst some thought it could be easily achieved others felt that "achieving this level will in all probability require major improvements to fixture water usage".

Water efficiency in new buildings
In a number of instances this choice of 120 l/p/d seems to be a result of respondents wanting consistency with the Code for Sustainable Homes. This suggests a misunderstanding of the way in which the minimum regulatory standards proposed would relate to the Code and its aspirational standards. In some instances the comments imply that respondents saw a level of 120 l/p/d as an aspirational target at which we should aim.

We wish to maintain the principle that the standard set in Building Regulations sets a minimum level of performance for all, whilst the higher levels of the Code will provide a set of more stretching standards. At present average consumption per person in metered properties including external water use is around 135 l/p/d. We need to take account of external use in the regulatory minimum and fixing on 120 l/p/d would be more onerous than level 1 of the Code which excludes external water use.

We are therefore minded to adopt a minimum standard of 125 l/p/d across England and Wales. This is broadly equivalent to level 1 of the Code if an allowance of 4 per cent is assumed for external water use. Responses to consultation suggest that this will be challenging (and will certainly be a very significant improvement on current water use) but unlike 120 l/p/d should be achievable with increased use of the best of today's readily available fittings.

Regulating in the non-household sector
Although the response statistics suggest that there is overwhelming support for the adoption of BREEAM office standard, the detailed comments suggest that this option was chosen as the

least worst approach. Respondents noted that the standard suggested was for offices only and would not be applicable to a wider range of building types.

Respondents reported that there was little robust evidence of water usage in other categories of non-domestic buildings and where it did exist it related to observed consumption in existing offices. Benchmarks derived from this information would be inappropriate for new buildings and unlikely to encourage more efficient use of water.

Most water in non-domestic settings is used in washrooms, primarily through taps, toilets and urinals. For all of these reasons respondents recommended that a component based approach that set upper limits on these key fittings would achieve considerable improvements in water efficiency and be far more practicable and workable. Several respondents though thought that effort should be made to develop benchmarks to stimulate technical improvements in the water efficiency of fittings.

We agree that in the short term benchmarking is not a robust or practical approach to improving water efficiency in non-residential buildings and we, therefore, intend to address water efficiency through the appropriate use of standards for key water fittings.

However, we recognise the value of benchmarks to both stimulate innovation and drive up standards. We therefore propose to investigate the scope for setting a standard or range of standards for non-residential buildings as part of the Communities and Local Government led work of the Green Commercial Buildings Task Group.

Tackling individual fixtures and fittings
Respondents identified a weakness in the whole building approach to water efficiency in that, once the new building is occupied, there is no way to discourage residents from making changes to fixtures and fittings in the future that may make their home less water efficient. They also noted that the biggest environmental impact comes from buildings already standing. They, therefore, suggested that we should underpin the whole building performance standard with a component based approach.

Water consumption is a function not just of the efficiency of fittings (flow rates for taps, flush levels for toilets, etc) but also of consumer behaviour. Proposals for regulatory change therefore need to go hand-in-hand with measures to achieve behavioural change, such as those being developed by the Water Saving Group.

We have therefore concluded that the three approaches proposed by respondents to this consultation and a broader range of other measures, will be of considerable help in meeting Government's broader objective of raising the sustainability of water use in buildings by:

- transforming the market in water using fittings, encouraging innovation in design and performance;
- helping to remove uncertainty and risk for manufacturers and increase demand;
- securing long term savings in water consumption by discouraging the replacement of water efficient fittings installed in new homes with ones that use more water;
- addressing water use across a wider range of non-domestic buildings than could be achieved through setting whole building standards and ensuring equity of treatment between building users; and

- gradually improving water efficiency in existing buildings through refurbishment and replacement of fittings at the end of life with ones that are more efficient.

To help achieve this, Defra will consult in 2008 on proposals for revising the Water Supply (Water Fittings) Regulations 1999 in a way that will support the planned changes to the Building Regulations.

Conclusions
Communities and Local Government and Defra will:

- bring forward an amendment to Building Regulations in 2008 to set a whole building performance standard for new homes;
- set that standard at 125 l/p/d;
- Also in 2008, bring forward proposals for revising the Water Supply (Water Fittings) Regulations 1999 with a view to setting new performance standards for key fittings that can be installed in buildings such as toilets, urinals, washbasin taps; and
- Communities and Local Government will, as part of the Green Commercial Buildings Task Group, conduct research and analysis to see if a whole building performance standard could be used for non domestic buildings, and possibly to establish higher water efficiency standards above that base.

Appendix D: Code for Sustainable Homes

Code standards

This section lists the issues under each of the sustainability categories included within the Code, the minimum standards where applicable, and the points available for each issue.

SUMMARY OF MINIMUM STANDARDS

The table below summarises all of the minimum standards which exist under the Code:

Minimum standards

Code Level	Category	Minimum Standard
	Energy/CO_2	
1(★)	Percentage improvement over	10%
2(★★)	Target Emission Rate (TER)	18%
3(★★★)	as determined by the	25%
4(★★★★)	2006 Building Regulation	44%
5(★★★★★)	Standards	100%
6(★★★★★★)		A 'zero carbon home' (heating, lighting, hot water and all other energy uses in the home)
	Water	
1(★)	Internal potable water	120 l/p/d
2(★★)	consumption measured in	120 l/p/d
3(★★★)	litres per person per day (l/p/d)	105 l/p/d
4(★★★★)		105 l/p/d
5(★★★★★)		80 l/p/d
6(★★★★★★)		80 l/p/d
	Materials	
1(★)	Environmental impact of materials†	At least three of the following 5 key element of construction are specified to achieve a BRE Green Guide 2006 rating of at least D – Roof structure and finishes – External walls – Upper floor – Internal walls – Windows and doors
	Surface Water Run-off	
1(★)	Surface water management	Ensure that peak run-off rates and annual volumes of run-off will be no greater than the previous conditions for the development site

Source: Department for Communities and Local Government. Code for Sustainable Homes. UK, December 2006.

Appendix E: BASIX

[This section includes extracts from: BASIX website. http://www.basix.nsw.gov.au/information/faq.jsp]

BASIX is a unique software tool for education, sourcing, and regulatory management for water conservation measures. The State of New South Wales (NSW), Australian has mandated minimum standards of water efficiency, thermal performance, and greenhouse gas emissions in all residential development. BASIX was developed to assess the anticipated water consumption and greenhouse gas emission levels of the proposed development. The expected thermal performance of the proposed building is also assessed. For the Water and Energy indices, points are awarded based on how the proposal is likely to perform against the average of all existing dwellings of the same type.

BASIX relies on comprehensive data sets about resource demand, occupation levels and market penetration rates of technologies provided by utility organisations, state agencies and the Australian Bureau of Statistics. A comprehensive analysis of existing technologies has also been undertaken to ensure BASIX is contemporary and reflects best practice technologies relating to sustainability.

Algorithms within the BASIX tool calculate in qualitative terms how a proposed development is likely to perform against an existing development of the same type.

How does BASIX use the "benchmarks"?
BASIX provides a means of setting water and greenhouse reduction targets based on the New South Wales (NSW) average benchmark. These targets are:

- up to a 40% reduction in potable water consumption;
- 25% reduction in greenhouse gas emissions1 (rising to 40% in July 2006).

BASIX also sets minimum performance levels for the thermal comfort of the dwelling.

What are the BASIX "benchmarks"?
Water: the average NSW annual potable water consumption from the residential sector, measured on a per capita basis;

Energy: the average NSW annual greenhouse gas emissions from the residential sector on a per capita basis.

How are these benchmarks calculated?
The benchmarks are determined from NSW average residential water, electricity and gas consumption data collected from state-wide energy utilities by the NSW Department of Energy, Utilities and Sustainability (DEUS).

For Water, the NSW benchmark is expressed in terms of potable water consumption and is equal to 90,340 litres of water per person per year,(248 l/p/d).

[1] except for multi-unit developments of 6 storeys or more, when the Energy Target is 20%.

For Energy, the NSW benchmark is expressed in terms of greenhouse gas emissions and is equal to 3,292 kg of CO2 per person per year.

As an example, each proposed dwelling needs to meet a 25% greenhouse gas reduction on the energy benchmark of 3,292 kg of CO2 per person per year. This means that the dwelling will be designed to enable each occupant to reduce their greenhouse emissions to no greater than 2,469 kg of CO2 per person per year.

Why does BASIX use a per capita benchmark rather than a per household benchmark?
BASIX converts the household water and energy consumption provided by the State's utilities into a per person per year figure. Using the dwelling's location and number of bedrooms in conjunction with the Australian Bureau of Statistics (ABS) occupancy data, BASIX determines the likely number of residents. BASIX then multiplies the water and energy per capita benchmarks by the occupancy rate, and uses the reduction targets to set maximum acceptable greenhouse gas emissions and water consumption levels for the dwelling. This assigns a water and energy budget to the dwelling, which is based on the projected occupancy of the dwelling.

This methodology provides a uniform and transparent basis for comparing the environmental footprint of different dwelling types (e.g. a two bedroom apartment compared to a five bedroom house). A "per household" benchmarch would place highly discriminatory water and greenhouse gas reduction burdens on certain housing forms, if it does not recognise that one particular dwelling may accommodate more people than another.

Why does BASIX use one state-wide average benchmark?
This approach provides the most equitable basis for the assessment of a proposed dwelling's water and energy consumption.

The state average benchmarks provide a per person water and energy budget for all NSW households, irrespective of dwelling type. Those dwelling types that are currently using more energy and/or water per person will have to, on average, work harder to comply with BASIX than dwellings that have a lower per person energy and water consumption.

By allocating everyone a per person energy and water budget to spend in their proposed dwelling, BASIX treats every dwelling equally.

BASIX assesses deviations from this per person budget and, by allowing the target to vary in response to environmental factors such as rainfall, evaporation, insulation, heating and cooling loads etc, it is able to accommodate differences in capacity to achieve energy and/or water reductions.

These benchmarks form a robust and simple basis for comparative greenhouse and water reduction.

Why a target of 25% greenhouse gas reduction for energy and up to 40% reduction for water consumption?

A Cost Benefit Analysis (CBA)2 examined various scenarios of applying BASIX targets to all new residential dwellings across NSW for the Energy and Water indices, including Thermal Comfort.

The results indicated that for a target of 40 in both the Energy and Water Indices, and a pass in the Thermal Comfort index, the net benefits outweighed the costs.

To ensure industry can better prepare for BASIX implementation, the introduction of the BASIX Energy target is staggered, starting with a target of 25, increasing to 40 on 1 July 2006.

Why does BASIX use data from existing dwellings rather than new dwellings?
There is only limited data available from new dwellings, whereas the data relating to water and energy consumption and the technology penetration rates is much more robust for existing dwellings.

The BASIX NSW state-average benchmark for energy and water consumption is collected from over 2 million NSW households.

The use of data from existing dwellings has the added advantage that the total residential annual energy and water consumptions can be correlated with documented ABS Census 2001 findings to asses the penetration of important energy- and water-related features, fittings and appliances in the state-wide sample set.

BASIX uses this information to quantify the effect of implementing certain water and energy efficiency measures such as water-rated showerheads and toilets.

This vital functionality could not be included in BASIX if the benchmarks were only based on new dwellings, unless the “average” water and energy features of new dwellings only could be accurately described to the BASIX engine.

This difficulty, together with the availability of high-quality energy and water consumption data for existing housing stock, steered the choice of benchmarks very strongly in favour of all existing dwellings.

It must be noted that the actual year of benchmarking is immaterial, as targets can be adjusted in relation to the NSW benchmark, in order to achieve the required policy outcomes.

How Do I Pass?
Because BASIX recognises the differences in rainfall and evaporation rates around NSW, the Water targets vary according to location. A typical single dwelling design will meet the target for water conservation if it includes:

- showerheads, tap fittings and toilets with at least a 3A rating;
- a rainwater tank or alternative water supply for outdoor water use and toilet flushing and/or laundry.
  Note: In the very dry areas of NSW, a typical single dwelling may not require a rainwater tank.

BASIX in the Approval Process

[2] Commissioned by the Department of Planning, September 2003

1. Get a BASIX Certificate

   Complete the BASIX assessment and print a BASIX Certificate.
   By printing the Certificate, you are committing to building your project as described. All of the commitments must be marked on the plans.

2. Submit your application

   Submit your development application or complying development application with the BASIX Certificate attached.
   If you make any changes to your project, you must re-do the BASIX assessment and print another Certificate and re-lodge it at Council.

3. Assessing your application

   Council will then assess your application, and if approved, it must be built according to the BASIX commitments. The construction process will be inspected by a Certifying Authority.

4. Construction Certificate
   Attach the BASIX Certificate to the application for a construction certificate and ensure all BASIX commitments are shown on the plans.

5. Occupancy Certificate

   Attach the BASIX Certificate to the application for an occupation certificate.
   The Certifying Authority will only issue an occupation certificate when satisfied that the project has been built as described on the BASIX Certificate.

6. Completion Receipt

   From 1 July 2006, the Certifying Authority will be required to issue a Completion Receipt, once the occupation certificate has been issued.

Guideline to the BASIX SEPP
This guideline outlines the provisions contained in State Environmental Planning Policy—Building Sustainability Index (BASIX) 2004, and explains in detail for consent authorities and others how other planning provisions are affected by the introduction of BASIX in Sydney from 1 July 2004 and in regional NSW from 1 July 2005

Background
State Environmental Planning Policy—Building Sustainability Index (BASIX) 2004 (the BASIX SEPP) operates in conjunction with the Environmental Planning and Assessment Amendment (Building Sustainability Index (BASIX)) Regulation 2004 to introduce BASIX as a mandatory component of the development approval process for residential development in NSW.

The Regulation ensures that applications for certain residential development proposals must be accompanied by a BASIX certificate which indicates compliance with prescribed sustainability targets before those applications can be considered and development consent granted.

The BASIX SEPP seeks to ensure that BASIX serves as the only system of assessment with respect to certain aspects of sustainable residential design. The SEPP provides that other development standards or provisions which seek to achieve the same objectives as BASIX have no effect in relation to development to which BASIX applies.

Why is it necessary to override other planning provisions?
The establishment of mandatory targets to reduce potable water consumption and greenhouse gas emissions in relation to residential development indicates the critical importance of water and energy management across NSW. These issues are of concern to the State as a whole and the NSW Government believes it is appropriate that these issues are addressed by a state wide sustainability policy.
In the absence of such a policy for residential development in the past, local government has taken the initiative, introducing a range of provisions aimed at ensuring that sustainability is a key consideration when development proposals are assessed. The BASIX tool has been developed with reference to this existing experience, drawing together best practice standards and procedures and incorporating them into a single assessment tool.

Development proposals which have satisfied a BASIX assessment have successfully demonstrated that they will achieve the prescribed savings in mains-supplied potable water consumption and greenhouse gas emissions, and an appropriate thermal performance level, if constructed in accordance with commitments made during the BASIX assessment.

Incentive arrangements allowed
Consent authorities should note that they are not precluded from offering incentives which are aimed at encouraging a reduction in the consumption of mains-supplied potable water, a reduction in the emission of greenhouse gases, or an improvement in the thermal performance of a building, for any development assessed by BASIX.
For example, councils are able to offer rate reductions or section 94 (of the EP&A Act) contribution concessions for high sustainability performance buildings.

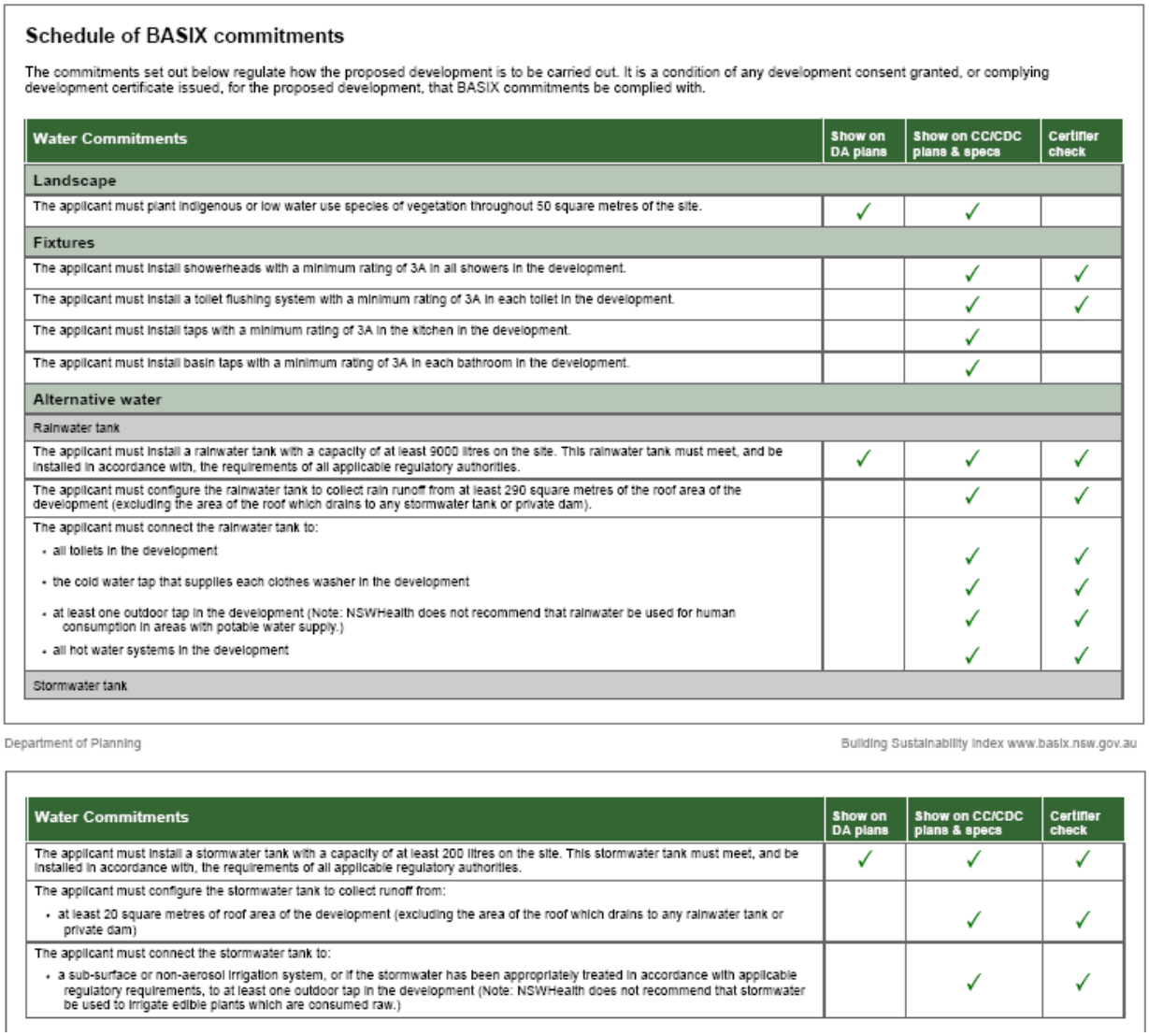
Aspects of sustainable building design not addressed by BASIX
At this stage the NSW Government has only prescribed targets in relation to Water and Energy. Dwellings must also achieve a pass in Thermal Comfort.

This means that provisions in environmental planning instruments and development control plans which address these other aspects of sustainability continue to have effect in relation to development proposals assessed by BASIX, as well as other development proposals. Specific aspects of residential building design which are not affected by the BASIX SEPP therefore include:

- landscaping;
- stormwater management;
- building materials, waste and recycling;
- accessibility, adaptability, affordability;
- orientation and solar access other than for thermal performance objectives;
- visual amenity.

Provisions in environmental planning instruments and development control plans addressing these matters are not ‘competing provisions’ and continue to apply in relation to development to which BASIX applies.

Screen Shots of BASIX Certificate



Schedule of BASIX commitments

The commitments set out below regulate how the proposed development is to be carried out. It is a condition of any development consent granted, or complying development certificate issued, for the proposed development, that BASIX commitments be complied with.

Water Commitments	Show on DA plans	Show on CC/CDC plans & specs	Certifier check
Landscape			
The applicant must plant indigenous or low water use species of vegetation throughout 50 square metres of the site.	✓	✓	
Fixtures			
The applicant must install showerheads with a minimum rating of 3A in all showers in the development.		✓	✓
The applicant must install a toilet flushing system with a minimum rating of 3A in each toilet in the development.		✓	✓
The applicant must install taps with a minimum rating of 3A in the kitchen in the development.		✓	
The applicant must install basin taps with a minimum rating of 3A in each bathroom in the development.		✓	
Alternative water			
Rainwater tank			
The applicant must install a rainwater tank with a capacity of at least 9000 litres on the site. This rainwater tank must meet, and be installed in accordance with, the requirements of all applicable regulatory authorities.	✓	✓	✓
The applicant must configure the rainwater tank to collect rain runoff from at least 290 square metres of the roof area of the development (excluding the area of the roof which drains to any stormwater tank or private dam).		✓	✓
The applicant must connect the rainwater tank to:			
• all toilets in the development		✓	✓
• the cold water tap that supplies each clothes washer in the development		✓	✓
• at least one outdoor tap in the development (Note: NSWHealth does not recommend that rainwater be used for human consumption in areas with potable water supply.)		✓	✓
• all hot water systems in the development		✓	✓
Stormwater tank			

Department of Planning

Building Sustainability Index www.basix.nsw.gov.au

Water Commitments	Show on DA plans	Show on CC/CDC plans & specs	Certifier check
The applicant must install a stormwater tank with a capacity of at least 200 litres on the site. This stormwater tank must meet, and be installed in accordance with, the requirements of all applicable regulatory authorities.	✓	✓	✓
The applicant must configure the stormwater tank to collect runoff from:			
• at least 20 square metres of roof area of the development (excluding the area of the roof which drains to any rainwater tank or private dam)		✓	✓
The applicant must connect the stormwater tank to:			
• a sub-surface or non-aerosol irrigation system, or if the stormwater has been appropriately treated in accordance with applicable regulatory requirements, to at least one outdoor tap in the development (Note: NSWHealth does not recommend that stormwater be used to irrigate edible plants which are consumed raw.)		✓	✓

Source: http://www.basix.nsw.gov.au/information/common/pdf/sample_certificatejuly04.pdf

Appendix F: City of Santa Monica, "Save Water Save a Buck" Rebate Program

City of Santa Monica

Save Water Save A Buck Rebate Amount

July 1, 2007-June 30, 2008*

toll free 1-877-728-2282

www.mwdsaveabuck.com

This program offers rebates for commerical water customers in Santa Monica.

1A High Efficiency Toilets Flush at 1.28 gallons per flush or less includes dual flush toilets	**$255**
1B High Efficiency Toilet Upgrade Replace a 1.6gpf toilet with a high efficiency one	**$60**
2A High Efficiency Urinal Flushes at 0.5 gallon or less	**$290**
2B High Efficiency Urinal Upgrade Replace a 1.0 gpf urinal with a high efficiency one	**$100**
3A Zero Water Urinal	**$490**
3B Zero Water Urinal Upgrade Replace a flushing urinal with a no water using one	**$220**
4 High Efficiency Clothes Washer	**510****
5A Conductivity Controller for Cooling Towers	**$625**
5B pH Conductivity Controller	**$1,900**
6 X-Ray Recirculating System	**$3,120**
7 Connectionaless Food Steamers	**$485 per compartment**
8 Steam Sterilizer	**$1,900**
9 Rotating Nozzle	**$4/nozzle**
10 Smart Controller (WBIC)	**$630/acre**
11 Dry Vacuum Pumps	**$125 per 0.5 HP**
12 Large Notary Nozzles	**$13 per set**
13 Synthetic Turf (Commercial & Multi-family	**$0.30 per sq. ft.**

*restrictions apply, funds available on a first come first served basis
**includes rebate from Southern California Edison & The Gas Company

updated 7/16/2007

Appendix G: Business as Usual versus Green Building Scenarios

Table 1: Water and Wastewater Flows and Expenditures by Sector (2000)

Type of building	Consumption (million cu m)	Water rates ($/cu m)	Wastewater (million cu m)	Sewer Rates ($/cu m)	Expenditures ($ million)
Residential	228	0.5	190	0.5	$209
Commercial	80.7	0.5	70	0.5	$74
Total	309		260		$284

Business As Usual Scenarios

Table 2: BAU Water Consumption 2000 and 2025

	2000	2025 BAU	Increase
	(million cu m)	(million cu m)	(million cu m)
Residential	228	331	103
Commercial	80.7	134	53
Total	309	465	156

Table 3: BAU Wastewater Generation 2000 and 2025

	2000	2025 BAU	Increase
	(million cu m)	(million cu m)	(million cu m)
Residential	192	279	87
Commercial	68	113	45
Total	259	392	132

Environmental Impact of Green Building Scenario

Table 4: Water Consumption in 2025 for BAU and GB Scenarios

Penetration Rate	Consumption in 2025 (million cu m)	Savings Relative to BAU (million cu m)
BAU	465	--
20%	419	47
40%	371	94
60%	324	141
80%	277	190

Table 5: Wastewater Generation in 2025 for BAU and GB Scenarios

Penetration Rate	Flows in 2025 (million cu m)	Savings Relative to BAU (million cu m)
BAU	391	--
20%	352	38
40%	312	78
60%	271	119
80%	232	158

Table 6: Summary of Resource Impact from GB Scenario in 2025 (per year)

Penetration Rate	Energy Savings		Common Air Contaminants (tonnes)	GHG Emissions (tonnes)	Water Savings (million cu m)	Wastewater Reduction (million cu m)	DLC Waste Reduction (tonnes)
	Electricity (million GJ)	Natural Gas (million GJ)					
20%	6	12	1.5	637	47	38	64,000
40%	13	24	3	1,268	94	78	128,000
60%	20	35	4.4	1,899	141	119	192,000
80%	27	47	5.9	2,530	190	158	256,000

Valuation of Green Building Scenarios

Table 7: Present Value of Resource Conservation – Low Scenario 2000 to 2050 ($ million)

Penetration Rate	Energy Savings	Water/Wastewater Savings	Solid Waste Savings	Air Quality Savings	Net Savings
20%	800	160	20	60	1,040
40%	1,600	320	40	120	2,.080
60%	2,400	480	60	180	3,120
80%	3,200	640	80	240	4,160

Table 8: Present Value of Resource Conservation – High Scenario 2000 to 2005 ($ million)

Penetration Rate	Energy Savings	Water/Wastewater Savings	Solid Waste Savings	Air Quality Savings	Net Savings
20%	2,170	480	30	130	2,810
40%	4,340	960	60	260	5,620
60%	6,510	1,440	90	390	8,430
80%	8,680	1,920	120	520	11,240

Source: The Sheltair Group Resource Consultants. “Strategic Assessment of Resource and Economic Impacts of Green Buildings in Greater Vancouver.” 2004.

Appendix H: Low Flow Myth—Insufficient Drain-Line Carry

[Excerpt from opinion piece at: http://www.5dinfusion.com/ulf-water-conservation-articles.htm]

For the second most revered myth, insufficient **drain-line carry** ability, it is definitely a widely held belief among Plumbing Professionals that ULF's will not discharge sufficient water into the existing plumbing systems to keep the **drain-lines** from blocking. However, unlike the perceived 'flushing performance' problems which stemmed from actual field reports of insufficient performance, there has not been a groundswell of complaints to indicate that ULF's indeed do have a problem with **drain-line carry**.

In all of the Toilet Replacement Programs that have been implemented in North America so far, I have still have not seen of, or heard of, any **drain-line carry problems** in normal installations that are caused by the lower flow-rate from ULF Plumbing Fixtures. In fact, there is one well documented Toilet Replacement Program study that reports **fewer instances of drain-line blockages** with the ULF Toilets.

The cases that I have heard about were caused by irregularities. Problems have been reported in older installations where the drainage piping had sagged in the middle section, causing blockages with newly installed ULF Toilets that the original toilets were able to overcome. However, the plumbing system was definitely 'out-of-spec' and would have needed to be corrected sometime in the near future anyway. The only other cases that I know about were in very dry climatic regions, and concerned complications due to severe drought conditions.
There have also been tests completed on laboratory models of **drain-line carry systems**. None of these experiments found any evidence that would suggest that ULF Plumbing Fixtures would cause **drain-line blockages**. If fact, one of these laboratory models reported that the **Pressurized ULF Toilets do not have a longer or better drain-line carry than the Gravity ULF Toilets.**

As well, there are detailed reports from a well respected American laboratory which specify that the ANSI (ie. the U.S. equivalent to the CSA Plumbing Fixture Standard) **Drain-Line Carry Test** is totally ineffective. Virtually every toilet that they tested passed this **drain-line carry test**, even though some of these toilets couldn't pass some of the other minimum 'flushing performance' requirements of the ANSI Standard. Therefore, all of the ULF Toilets that have passed this test and been installed in the U.S. without any **drain-line carry** problems, didn't possess any special design characteristic that would enable them to have a better **drain-line carry**.

Appendix J: Literature Review of Water Conservation Measures

Technology/ Practice	Water Saving (%)	Water Saving[10]	Context	Source
Structural and Operational Strategies				
Toilets				
6-L toilet	64%	52.5 L/day	6-L replacing 16.5 L	Mayer et al., 1999, pg 232. City of Calgary, 2005, pg 13 AWWA, 2006, pg 53
6-L toilet (commercial)	54%	21 L/day	6 L replacing 13 L	AWWA, 2006, pg 53
3.78 L/flush urinal	50%	11.36 L/day	Replacing 7.57 L/flush urinals with 3.785 L/flush urinals	AWWA, 2006, pg 53
1.89 L/flush urinal	50%	1.89 L/flush	Require low flush urinals in new ICI	AWWA, 2006, pg 63
Dual-flush toilet	78%	12.8	4.4/3 L replacing 16.5L	Mayer et al., 1999, pg 23
Dry use/ composting toilet	100%	82.5 L/day	Replacing 16.5 L average water use for toilet	Commonwealth of Australia, 2005, pg 1
Waterless urinal	100%	11.36 L/day	Replacing 3.785 litre/flush urinal with no water urinal	AWWA, 2006, pg 53
Alternative water source toilet (grey-water/ rainwater)	100%	82.5 L/day	Replacing 16.5 L toilet	CEVE, 2000, pg. 1
Early closure device	Up to 35%	11.35 L	Installing an early closure device on toilet	Province of Manitoba, Undated, pg 2; AWWA, 2006, pg 53
Water displacement device	57%	9.46 L/day	Installing a device that reduces the amount of water used by older toilet types	AWWA, 2006, pg 53
Showerheads and Faucets				
Low-flow showerheads	53%	120 L/day	7 L/min replacing 15L/min	City of Davis, Undated, pg 12 City of Calgary, 2005, pg 3 Gleick, Peter et al, 2003, pg 75
Shorter showers	47%	64 L/day	Reduce time for shower from 15 min to 8 min	City of Calgary, 2005, pg 2
Low-flow faucets	21%	20 L/day	9.5 L/min replacing 12 L/min	City of Calgary, 2005, pg 12 U.S. Department of Energy, 2004, pg 13. AWWA, 2006, 53
Ultra low-flow faucets	53%	50.4 L/day	5.7 L/min replacing 12 L/min	Efficiency Partnership, 2005 Mayer et al, 1999, pg. 563. Region of Waterloo, 2005, pg. 2
Aerators	15.8%	15.16 L/day	Adding an aerator to a faucet to reduce water use	AWWA, 2006, pg. 125
Restaurant low-flow spray nozzles	50% of kitchen spray use	3900 L/day	Installing a low-flow spray nozzle in restaurant	AWWA, 2006, pg 63 (based on average daily demand per connection in GVRD: Vickers, 2002, pg 233)
Pre-rinse spray valve (commercial)		757 L/day	Installing a low-flow valve for pre-rinse sprays in restaurants	AWWA, 2006, pg 125
Insulate hot water pipes		7.57 L/day	Protect hot water pipes from losing energy and water	AWWA, 2006, pg 53
Pressure reducer		17 L/day	Installing a device on a faucet or general supply to reduce water pressure	AWWA, 2006, pg 53
Self-closing spray taps	50%	48 L/day	6 L/min replacing 12 L/min	Louw, DB and WE Kassier, 2002, pg. 34
	25% of faucet end use		Install self-closing spray taps in new ICI buildings	AWWA, 2006, pg 63

Dishwashers and Clothes washers				
Water efficient dishwashers	24%	10 L/week	30L/load replacing 40L/load	City of Davis, Undated, pg 2
Water efficient dishwashers	36%	14.4 L/week	25.6L/load replacing 40L/load	EPCOR Canada, Undated, pg 1
Water efficient dishwashers	44%	17.5 L/week	22.5L/load replacing 40L/load	City of Calgary, 2005, pg 1
Water efficient dishwashers	55%	22 L/week	18L/load replacing 40L/load	Government of Australia, 2005, pg 1
Water efficient clothes washer (commercial)		170 L/day	Replacing a regular clothes washer with water efficient model	AWWA, 2006, pg 125
Water efficient clothes washer	45%	77.3 L/load	Average 92.7L (average) replacing 170L	Gleick, Peter et al, 2003, pg 125 (source for frequency of use): Louw, DB and WE Kassier. 2002, pg 118
Horizontal axis washing machine	33%	20.8 L/day	Average 113.5 L replacing 170L	AWWA, 2006, pg. 53
Outdoor Water Uses				
Water saving equipment in a swimming pool	30%	6411 L/day	Reducing/ eliminating leaks; ensuring pools are water efficient	European Environment Agency. 2001, pg. 69
Xeriscaping	30%	995.5 L/day	Xeric landscape replacing turfgrass	Sovocool et al., 2006, pg 92
Xeriscape mix	50%	51.5 L/day	Reducing green turf by half	Gleick, Peter et al, 2003, pg 64
Water saving "equipment" for irrigation	Approx 62%	117.8 L/day	Increase water efficiency of municipal irrigation	European Environment Agency. 2001, pg 69
Rain shutoffs		75.7 L/day	Installing a rain gauge to shut sprinkler off when raining	AWWA, 2006, pg 125
Hose timers		11.5 L/day	Putting a timer on a garden hose to reduce excess watering	AWWA, 2006, pg 125
Smart controllers	24%	24.72 L/day	Add smart controller to automatic irrigation systems	CUWC Council, 2005, pg 37
Rainbarrel program		900,000 L/ year	Using rainwater for residential lawn irrigation	BCMOE, 2001, pg 5
Agriculture				
Surface systems (flood)	55%efficient		Efficient agriculture	Louw, DB and WE Kassier 2002, pg 9
Conventional sprinkler	75% efficient		Efficient agriculture	Louw, DB and WE Kassier 2002, pg 9
Mechanical (centre pivot)	80% efficient		Efficient agriculture	Louw, DB and WE Kassier 2002, pg 9
Micro jet	85% efficient		Efficient agriculture	Louw, DB and WE Kassier 2002, pg 9
Leaks etc.				
Fixing leaks	75.6%	18.9 L/day	Repairing household leaks	AWWA, 2006, pg 53
		21801 L/day	Fixing one belowground leak averaging 15L/min	Jones, Marcellus Jr., 2006, pg 33
	12-15%		Repairing leaks in water supply system	Louw, DB and WE Kassier. 2002, pg 44
Household leaks	77%	19.3/L/day	"with conservation"	Louw, DB and WE Kassier, 2002, pg 118
Remove garbage grinder (commercial)		1514 L/day	Removing apparatus that grinds garbage in restaurant	AWWA, 2006, pg 125
Water saving equipment and leakage detection in individual schools	51-79%	15058 L/day	Improving efficiency of schools	European Environmental Agency, 2001, pg 69.
Cooling tower meters (commercial)	20% of cooling use		Sub-meter installation for cooling towers	AWWA, 2006, pg 63

Socio-political strategies				
By-laws	30%	32.96 L/day	Mandatory restriction limiting watering to twice per week	Vickers, Amy, 2006, pg 60
By-laws	53%	57.68 L/day	Mandatory restriction limiting lawn watering to once per week	Vickers, Amy, 2006, pg 60
Public Education and Behaviour changes	2-5% (of all end uses)	22.78 L/day	Information and education of water conservation	Louw, DB and WE Kassier. 2002, pg 120; BCMOE, 2001, pg 6; AWWA, 2006, pg 63
Public Education and Behaviour changes	15%	99.65 L/day	Reduce peak water usage	Derdall, 2002, pg 1
Irrigation Audit		113.55 L/day	Using an audit to identify residential water inefficiencies	AWWA, 2006, pg 125
Water use regulation		94.6 L/pers/ day	Greywater reuse, residential	Louw, DB and WE Kassier. 2002; pg 120
A reuse program for hotel and motel owners(in Florida: encouraging room occupants to reuse towels rather than get fresh ones every day)		189.25 L/ room/day	The estimated average was 50 gallons of water saved per occupied room per day. Participating hotels and motels also saved an average of 20 to 30% on laundry costs, and the amount of detergent used also decreased.	WaterBucket, 2006, pg 1 (Estimated results show that program participants saved a combined 100 million gallons of water in only one year. The audits covered properties ranging in size from one to 1000 rooms.)
Indoor audit (commercial)	15% of all end uses	378.5 L/day	Using an audit to identify water inefficiencies	AWWA, 2006, pgs 63, 125
Irrigation audits (commercial)		946.25 L/day	Using an audit to identify irrigation inefficiencies	AWWA, 2006, pg 125
Indoor water audits (residential)		75.7 L/day	Using an audit to identify water inefficiencies	AWWA, 2006, pg 125
Economic Strategies				
Home retrofit program		106.85 L/day	Providing households with rebates to install low-flow fixtures: showerhead $7, bathroom aerator $1; up to $14 per household	BCMOE, 2001, pg 6
Rainbarrel rebates		22.7 L/day	Providing money back on purchase of rainbarrel	AWWA; 2006, pg 125
Irrigation rebate		113.55 L/day	Rebates on high-efficiency product purchases	AWWA; 2006, pg 125
Clothes washer rebates(residential)		56.8 L/day	Rebate on high-efficiency clothes washer purchase	AWWA; 2006, pg 125
Coin-op clothes washer rebates (multifamily and commercial)	35% of laundry		Rebate on high-efficiency clothes washer purchase	AWWA, 2006, pg 63
Toilet rebates (residential)		94.6 L/day	Rebate on high-efficiency toilet purchase	AWWA; 2006, pg 125
Toilet rebates (commercial)		128.69 L/day	Providing commercial users with rebates to install low-flow toilets	AWWA, 2006, pg 125
Water rate/ sewer rate; rebates; stormwater utility approach; integration of water issues (rain, grey, potable)	5-13.8% reduction using an increasing block rate		Utility pricing to include full cost; increase water rate; rebates on efficient water fixtures; a 10% increase in water rates provided about 3% more revenue while triggering a 7% reduction in use	USEPA, 1995, pg 122 Louw, DB and WE Kassier, 2002, pg 43
Increasing residential water ratesUniversal metering	2-4%	19.53 L/day	10% increase in price	Louw, DB and WE Kassier. 2002, pg 120
	25-30%		Replacing flat rate with meter; pay according to use	Louw, DB and WE Kassier. 2002, pg 43
	34%		Installing meter on residential water accounts	BCMOE, 2001, pg 5
Submetering	20-40%		Install meters in subunits, such as apartments and condominiums	USEPA, 1995, pg 10

Source: Maas, T. "Urban Water Soft Path, 'Back of the Envelope ' Backcasting Framework." POLIS Discussion Series Paper, University of Victoria, February 2007. http://www.waterdsm.org/pdf/BEBF_lowres.pdf . Accessed September 2007.

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