Appendix 5-2 –
Conservation Measures Analysis Technical Memorandum

Everett Comprehensive Water Plan Technical Memorandum

Date: A complete Technical Memorandum was originally provided on June 16, 2006. Appendices A and B were updated on August 23, 2006. The main body of this Technical Memordanum was not updated at that time.

Subject: Conservation Measures Cost Effectiveness

To: Greg Moore
City of Everett
3200 Cedar Street
Everett, WA 98258

From: Kelly O'Rourke and Andrew Graham
HDR Engineering
500 108th Ave NE
Bellevue, WA 98004

Project Number: 22254

Telephone: (425) 450-6200

1.0 Introduction

The purpose of this Technical Memorandum is to provide results of the measure cost effectiveness analysis performed for the Water Conservation Chapter of Everett's Comprehensive Water Plan (CWP) update. The analysis was performed using a spreadsheet model developed previously by HDR. This technical memorandum also explains the model's methodology. The activity presented in this Technical Memorandum was performed under Task 6.0 of the CWP process.

Appendix A contains printouts from the model which show the results in terms of water savings, costs, and cost effectiveness. This information is provided for both the six year and 20 year planning periods. Appendix B provides detailed definitions for each measure analyzed by the model, including the assumptions behind the primary savings calculation.

The methodology for determining water savings and costs is generally the same for all conservation measures. The basic method is to compile community demographic and fixture information; apply assumptions for customer participation rates for each conservation measure; calculate the savings achieved by shifting to more efficient hardware or behavior; and calculate the costs for those shifts.

This process is performed in the model's four main worksheets: 1) Demographics and Fixture Assumptions; 2) Participation; 3) Savings; and 4) Costs. Each of these worksheets is described in detail in subsequent sections of this technical memorandum and the results are summarized in the next section.

There are three main sources for the information provided in this memo: 1) demographic data developed under Task 5 of the CWP process; 2) review of Everett's current conservation programs; and 3) estimates based on professional knowledge of national and regional information on conservation measures.

Acronyms used in this memo include the following:

- ccf Hundred cubic feet
- gpm Gallons per minute
- gpf Gallons per flush
- gpl Gallons per load (laundry)
- HH Households
- ICI Industrial, commercial, and institutional
- MF Multifamily
- SF Single family

2.0 Summary Results

Table 1 presents a summary of the analysis of conservation measures, including participants, savings, and direct costs for the six year planning period ending in 2011. The remainder of this technical memorandum explains the methodology used to generate these numbers. Table 2 presents the same summary information for the 20 year planning period ending in 2025.

Table 1 – Measure Analysis Summary Results (6 Year Planning Period)

		Participants		Savings		Direct Costs	
	Conservation Measure	W/ Free Riders (affects cost)	W/o Free Riders (affects savings)	Peak Season GPD at Full Implementation (w/o free riders)	CCF Over Measure Life (w/o free riders)	Total Cost Over Plan Period	Cost per CCF Saved During Peak Season Over Measure Life (w/o savings free riders)
Single Family	Toilets - 1.6 gpf ultra low flow toilets (ULFT)	13,619	6,810	221,334	377,964	$2,349,278	$18.60
	Toilets - 1.0 gpf high efficiency toilets (HET)	14,519	14,519	235,208	2,868,963	$3,339,370	$3.48
	Toilets - leak detection	36,297	36,297	289,481	988,670	$105,988	$0.32
	Showerheads - 2.0 gpm	58,632	58,632	171,559	1,255,560	$351,792	$0.84
	Faucet aerators bathroom - 1.0 gpm	65,970	65,970	316,656	2,317,460	$164,925	$0.21
	Faucet aerators kitchen - 2.2 gpm	0	0	0	0	$0	N/A
	Hot Water - on demand recirculating systems	2,904	2,904	29,040	212,530	$435,600	$6.13
	Clotheswashers - residential capacity (in unit)	25,215	22,694	331,332	2,101,554	$2,521,500	$3.59
	Outdoor Irrigation Kits	24,739	24,739	235,605	268,956	$321,607	$1.20
Multifamily	Toilets - 1.6 gpf ultra low flow toilets (ULFT)	7,106	5,330	154,570	263,953	$959,310	$10.87
	Toilets - 1.0 gpf high efficiency toilets (HET)	8,159	8,159	118,317	1,443,176	$1,468,620	$3.04
	Toilets - leak detection	20,398	20,398	145,343	496,392	$9,247	$0.06
	Showerheads - 2.0 gpm	39,355	39,355	147,581	1,080,079	$177,098	$0.49
	Faucet aerators bathroom - 1.0 gpm	37,339	37,339	190,429	1,393,662	$56,009	$0.12
	Faucet aerators kitchen - 2.2 gpm	6,414	3,207	15,156	7,395	$6,414	$2.59
	Clotheswashers - residential capacity (in unit)	4,292	3,863	50,219	318,526	$429,200	$4.03
	Clotheswashers - residential capacity (in common area)	4,292	3,863	50,219	318,526	$85,840	$0.81
	Outdoor Irrigation Kits	778	778	14,908	17,018	$10,114	$0.59
Commercial	Toilets - 1.6 gpf ultra low flow toilets (ULFT)	1,012	759	208,347	355,785	$607,200	$5.11
	Toilets - 1.0 gpf high efficiency toilets (HET)	108	108	17,496	213,409	$86,400	$1.21
	Toilets - leak detection	252	252	12,928	44,152	$4,876	$0.33
	Urinals - 1.0 gpf	623	467	37,827	46,140	$140,175	$9.09
	Urinals - 0.5 gpf	1,084	1,084	29,268	285,599	$243,900	$2.55
	Faucet aerators bathroom - 0.5 gpm	584	438	63,565	31,014	$2,336	$0.23
	Clotheswashers - commercial capacity (in laundromat)	5	5	6,720	42,623	$15,000	$1.05

	Indoor Audit	259	259	61,767	301,363	$77,700	$0.77
	Outdoor Audit	271	271	19,098	31,146	$135,500	$4.35
	Irrigation Systems - school audits only	11	11	4,971	8,107	$8,250	$1.02
	Irrigation Systems - school audits and financial assist.	28	28	31,072	50,672	$66,500	$1.31

Table 2 – Measure Analysis Summary Results (20 Year Planning Period)

		Participants		Savings		Direct Costs	
	Conservation Measure	W/ Free Riders (affects cost)	W/o Free Riders (affects savings)	Peak Season GPD at Full Implementation (w/o free riders)	CCF Over Measure Life (w/o free riders)	Total Cost Over Plan Period	Cost per CCF Saved During Peak Season Over Measure Life (w/o savings free riders)
Single Family	Toilets - 1.6 gpf ultra low flow toilets (ULFT)	13,619	6,810	221,334	377,964	$2,349,278	$18.60
	Toilets - 1.0 gpf high efficiency toilets (HET)	19,885	19,885	312,222	3,808,346	$4,573,550	$3.59
	Toilets - leak detection	49,713	49,713	396,478	3,514,154	$218,121	$0.19
	Showerheads - 2.0 gpm	89,232	89,232	281,081	3,103,401	$807,708	$0.78
	Faucet aerators bathroom - 1.0 gpm	92,802	92,802	466,425	5,344,769	$363,262	$0.20
	Faucet aerators kitchen - 2.2 gpm	0	0	0	0	$0	N/A
	Hot Water - on demand recirculating systems	3,977	3,977	39,770	468,167	$959,550	$6.13
	Clotheswashers - residential capacity (in unit)	37,289	33,560	489,976	5,281,215	$6,336,643	$3.59
	Outdoor Irrigation Kits	34,801	34,801	291,855	903,188	$1,226,447	$1.36
Multifamily	Toilets - 1.6 gpf ultra low flow toilets (ULFT)	7,106	5,330	154,570	263,953	$959,310	$10.87
	Toilets - 1.0 gpf high efficiency toilets (HET)	10,768	10,768	150,752	1,838,808	$1,938,240	$3.15
	Toilets - leak detection	26,920	26,920	191,814	1,727,248	$17,491	$0.03
	Showerheads - 2.0 gpm	52,749	52,749	189,896	2,289,831	$391,101	$0.51
	Faucet aerators bathroom - 1.0 gpm	50,384	50,384	256,958	3,041,945	$122,250	$0.12
	Faucet aerators kitchen - 2.2 gpm	6,414	3,207	15,156	7,395	$6,414	$2.59
	Clotheswashers - residential capacity (in unit)	6,493	5,844	75,972	812,064	$1,094,221	$4.03
	Clotheswashers - residential capacity (in common area)	6,493	5,844	75,972	812,064	$218,844	$0.81
	Outdoor Irrigation Kits	1,050	1,050	19,365	58,686	$36,238	$0.62
Commercial	Toilets - 1.6 gpf ultra low flow toilets (ULFT)	1,012	759	208,347	355,785	$607,200	$5.11
	Toilets - 1.0 gpf high efficiency toilets (HET)	141	141	22,208	270,880	$112,800	$1.25
	Toilets - leak detection	273	273	14,005	137,975	$11,648	$0.25
	Urinals - 1.0 gpf	623	467	37,827	46,140	$140,175	$9.09
	Urinals - 0.5 gpf	1,409	1,409	38,043	371,226	$317,025	$2.55
	Faucet aerators bathroom - 0.5 gpm	584	438	63,565	31,014	$2,336	$0.23
	Clotheswashers - commercial capacity (in laundromat)	7	6	8,064	94,380	$38,750	$1.23
	Indoor Audit	299	299	81,027	723,547	$148,940	$0.62

	Outdoor Audit	352	352	25,082	74,837	$292,019	$3.90
	Irrigation Systems - school audits only	11	11	4,971	16,215	$16,500	$1.02
	Irrigation Systems - school audits and financial assist.	28	28	31,072	101,343	$133,000	$1.31

3.0 Demographics & Fixture Assumptions Worksheet

The Demographics and Fixtures Assumptions worksheet, which is part of Appendix A, includes demographic data and fixture assumptions that are used in the Participation worksheet to calculate the number of customers anticipated to participate in each conservation measure.

Demographic data is a key element of the analysis. The main demographic categories used in the analysis were single family households, multifamily households, and employment. Sources for this data include demographic data from Task 5 of the CWP process and from the U.S. Census. Demographic inputs are shown in Table 3. This represents the entire retail and wholesale water service area, incorporating current and future wholesale customers.

Table 3 - Demographic Inputs for Retail and Wholesale Service Area

Category	2006	2011	2025
Single-family Households	132,500	145,189	198,853
Multifamily Households	69,132	81,590	107,680
Employment	221,495	243,804	316,956

Source: Table 10 of Technical Memorandum: "Demographic Data for Demand Forecasting, Everett Comprehensive Water System Plan." March 13, 2006.

Fixture-related assumptions include the percent of customers who have certain water-using fixtures (e.g., toilets, urinals, irrigation systems) and the remaining life for code-related fixtures. These inputs are based on professional knowledge.

4.0 Participation Worksheet

The Participation worksheet, which is part of Appendix A, contains participation assumptions and calculates the number of participants for each measure.

If specific data were unavailable, the following guidelines were employed when determining the percentages for the "Not Already Implemented", "Not Implemented Naturally", and "Participation Rate" fields:

- 90% signifies very high
- 75% signifies high
- 50% signifies moderate
- 25% signifies low
- 10% signifies very low

Total household or business participation for each conservation measure was determined by beginning with the number of eligible households or businesses, reducing that to the target households or businesses, and reducing that to the participating number. Additionally, a follow through rate is applied to certain measures. Definitions of these terms are important:

- **Eligible:** Households or businesses that have the appropriate fixture or behavior for the measure. For example, those with a toilet.

- **Target:** Eligible households or businesses that have not already implemented the measure. For example, those households with a toilet that do not already have an efficient 1.6 gpf model.
- **Participating:** Target households or businesses estimated to take the first, and in many cases only, step in implementing the measure during the planning period. For example, those with a toilet that do not already have an efficient 1.6 gpf model, and who are estimated to purchase an efficient 1.6 gpf model due to the conservation program. It should be noted that participation rates can increase or decrease the value of implementing measures. For example, while waterless urinals save more water per flush than low volume urinals, the participation rate for waterless urinals is usually much lower than for low volume urinals, thus making the overall savings for waterless urinals lower than for low volume urinals.
- **Follow Through Rate:** The percent of participating households or businesses that follow through on any associated steps for the measure. For example, a household that installs an efficient showerhead given away by the utility.

The concept of free-ridership reduces the participation number further. Free-riders are customers who implement a measure, even without encouragement from the utility's conservation program. For example, they are households that were planning to replace a toilet anyway, and simply take the utility money because it is available. The important point is that the utility money does not motivate the customer to implement the measure. Therefore, the utility is spending money on savings that would occur anyway. This is generally considered an unavoidable problem in water conservation programs.

The analysis incorporates the concept of free-ridership, since this results in the true cost effectiveness of conservation. Incorporating the concept means excluding the savings from free-riders, while including their costs. However, participation and savings numbers including free-riders are also provided because they can be useful for other purposes such as demand forecasting, budgeting, and comparing with other utilities that do not incorporate free-ridership.

A similar issue is plumbing code savings. Certain conservation measures may duplicate water savings that would occur eventually due to the plumbing code. While investing in "code-related" measures spends money on actions that will occur eventually without that expenditure, it has the positive effect of accelerating savings. For example, the utility could wait until the customer naturally replaces a showerhead, or it can accelerate the savings by offering free, efficient showerheads.

The following measures bring hardware up to code:

- Toilets - 1.6 gpf ultra low flow toilets ULFT (for SF, MF, and ICI)
- Urinals - 1.0 gpf (for ICI)
- Faucet aerators bathroom - 0.5 gpm (for ICI)
- Faucet aerators kitchen - 2.2 gpm (for SF and MF)

In the model, measures that bring hardware up to code requirements are handled differently than non-code measures in several ways. First, only existing customers are targeted, because new customers will already have hardware meeting code requirements. Second, savings are counted only for the remaining life of the hardware, which may be shorter than the planning period. This is done to take credit only for the years that a measure accelerates code savings. Third, the measure is implemented only once, even if the measure's life is shorter than the planning period, because when the hardware expires, only code-meeting replacements are available.

It is important to understand the full interplay between code savings and the model analysis. For code related measures, the plumbing code has the potential to affect existing customers who have not already upgraded to code fixtures. This is represented by Column 7 "Not Already Implemented" on the Participation worksheet. For example, 41 percent of existing single family households do not have 1.6 gpf toilets. That 41 percent can be split into the following five groups:

1. **Do not upgrade to code.** This group has no savings or costs and is therefore not represented in the model.
2. **Upgrade to code due to the conservation program, take rebate/equipment.** These are the "code accelerators" and the model claims both savings and costs.
3. **Upgrade to code due to the conservation program, do not take rebate/equipment (e.g., never turn in rebate form).** This group is not represented in the model. Technically, the utility could claim these savings; however, this number is difficult to estimate and a conservative approach is to assume this number is zero.
4. **Upgrade to code, naturally, take rebate/equipment.** These are the "free-riders" and the model claims the costs, but not the savings. This is appropriate to show the cost effectiveness of the conservation program. However, if the utility wants to know how much savings it can expect, regardless of what can be attributed to the conservation program, the model provides this number as well.
5. **Upgrade to code, naturally, do not take rebate/equipment.** This group is part of the traditional "code savings" and is intentionally excluded from the modeled savings because it is not associated with the conservation program.

Key results from the Participation worksheet are generated as follows (using single-family clotheswashers, from the six year planning period, as an example):

- **Participating Households (25,215 with free riders and 22,694 without free riders):** These numbers are important since they are key factors in calculating water savings and costs. The number of existing target households (89,438) is calculated by starting with the number of existing SF households (132,500) and multiplying it by the eligibility rate (90% since 90% of existing SF households have clotheswashers) and by the percent of existing customers that have not already implemented the measure (75%). Similarly, the number of future target households (11,420) is calculated by starting with the number of new SF households added during the planning period (12,689) and multiplying it by the eligibility rate (100% since 100% of new SF households are anticipated to have clotheswashers) and by the percent of new customers that do not naturally implemented the measure (90%). The number of total target households (100,858) is calculated by adding the existing (89,438) and new (11,420) target households. The number of participating households with free-riders (25,215) is calculated by multiplying the total target households (100,858) by the participation rate (25%). The number of participating households without free riders (22,694) is calculated by reducing the number of participating households with free riders (25,215) by the free-ridership (10%).

5.0 Savings Worksheet

The Savings worksheet, which is part of Appendix A, contains savings assumptions and calculates the total savings.

Water savings were estimated by determining the unit savings of the conservation measure compared with previous hardware or behaviors, and then using participation results to calculate total savings.

Key results from the Savings worksheet are generated as follows (using single-family clotheswashers, from the six year planning period, as an example):

- **Savings – Peak Season Gallons Per Day (at full implementation; without free riders) (331,332 gpd):** This calculation is the gallons saved per household per year (5,329) multiplied by the number of participating households without free riders from the participation worksheet (22,694) and divided by 365 days. This measure is not a peaking measure. For peaking measures, such as those related to irrigation, the number would be divided by 122 days instead. It is important to note this number represents savings at full implementation, which occurs at the end of year 6 since it is assumed measures are evenly phased in over six years.

  Note that for the 20 year planning period analysis, it is assumed all existing customers as well as new customers from year 2 to year 6 are evenly phased in over the first six years, and the remaining new customers are evenly phased in over years 7 to 20.

- **Savings – CCF Over Measure Life (without free riders) (2,101,554 ccf):** This number is important since it is used later when calculating the cost per ccf of saved water. This number is comprised of three components. The first component is for the time period when the measure is being phased in over the first six years of the planning period. Those savings are calculated by evenly accumulating the annual gallons saved per year at full implementation without free riders (120,936,326) over the six years (i.e. 1/6 of the savings the first year + 2/6 of the savings the second year, etc). The second component is for the time period when the measure is fully phased in. This will be at least until the end of the planning period, however it may extend further due to the measure lifespan and the assumption that customers and the utility re-opt until the end of the planning period. The third component is for the time period when the equipment installed in years 2-6 of the planning period are phased out. Those savings are the same as the first part, minus one full year of implementation. The three savings components are summed (1,572,172,238) and then converted to ccf by dividing by 748.1.

  Note that there are two methods for calculating the savings over the measure life, depending on the measure characteristics. The example above is used for non-code related measures. The other method is used when the measure brings a fixture up to code and therefore only claims savings for the code-accelerating time period. In those cases, the formula phases in the gallons per year at full implementation evenly through the average lifetime remaining for the pre-code fixtures.

6.0 Costs Worksheet

The Costs worksheet, which is part of Appendix A, contains cost assumptions and calculates total costs.

Costs are estimated by determining the unit cost of each conservation measure, and then using demographic and participation data to calculate costs of implementation.

It should be noted that only direct costs are included in this analysis. This includes rebates, costs of hardware, and labor cost for audits. Indirect costs such as utility staff time, marketing, and distribution are not included in this analysis since they depend on how a conservation program is designed. Both direct and indirect costs are ultimately borne by customers through rates. Some measures require additional costs to be borne directly by customers. All measures where the utility pays a rebate implies the customer will pay the remaining cost of the fixture and any installation costs. For example, single family clotheswashers involve a $100 rebate paid by the utility, but that cost does not include the remaining cost of the clotheswasher and any installation costs paid by the customer.

Key results from the Costs worksheet are generated as follows (using single-family clothewashers, from the six year planning period, as an example):

- **Total Cost over Plan Period ($2,521,500):** This number is important since it is the amount of money the utility will have to spend in order to achieve the savings from the measure. It is derived by starting with the number of participating single family households with free riders (25,215 – note using the number with free riders is necessary since the costs for these customers must be budgeted) and multiplying by the cost per clotheswasher ($100) and by the number of clothewashers per SF household (1.0) and by the number of times the measure must be implemented over the planning period (1.0) in order to retain savings.

- **Cost per CCF Saved During Peak Season Over Measure Life ($3.59):** This number is important since it is used to compare measure cost-effectiveness between measures and against the utility's avoided cost of supply. It is derived by starting with the total cost over the plan period ($2,521,500) and dividing it by the result of the following: the CCF saved over the measure life without free riders (2,101,554) divided by the peaking factor, which is the number of days the measure is in effect (365) divided by the number of days in the peak season (122)..

7.0 Next Steps

After the City of Everett reviews these results, HDR will work with Everett staff to determine which measures are most appropriate to include in the City's conservation program. That determination will reflect the goals of the conservation program, which is a subtask led by Everett staff, and the avoided cost of supply analysis, currently underway by HDR.