SWEEP

(Save Water & Energy Education Program)

Frigidaire

caroma
AUSTRALIA

City of Lafayette Oregon

City of
WILSONVILLE
in OREGON

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The Save Water and Energy Education Program: SWEEP

Water and Energy Savings Evaluation

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Executive Summary

In 1999 and 2000, in response to a significant water shortage, two of Oregon's fastest growing cities, Lafayette and Wilsonville, volunteered to be "test communities" for an innovative approach to saving water and energy. The Save Water and Energy Education Program (SWEEP) was designed to maximize water and energy savings in these communities and to serve as a model for other communities seeking an integrated approach to resource efficiency.

The cities of Lafayette (pop. 2,586) and Wilsonville (pop. 13,991) joined with a number of companies and government agencies to implement a program that seeks to educate citizens, involve students from local schools, demonstrate the effectiveness of high-efficiency appliances, and save money for citizens and the cities. In addition to the cities, program partners included the U.S. Department of Energy, Electrolux Home Products (donor of 50 sets of Frigidaire high-performance clothes washer/dryer pairs and dishwashers), Caroma USA, Inc. (donor of over 100 high-performance dual-flush toilets), the Pacific Northwest National Laboratory (PNNL), Portland General Electric (the serving electric utility and donor of faucet aerators and low-flow showerheads), Energy Technology Laboratories (also a donor of showerheads), the Oregon Office of Energy, CTSI Corporation, the Northwest Energy Efficiency Alliance, the League of Oregon Cities, and the Mid-Willamette Valley Council of Governments.

Participating appliance and fixture manufacturers donated the water and energy-efficient devices for installation in the 50 test homes, 25 in each community. The equipment included clothes washers, clothes dryers, dishwashers, toilets, showerheads, and faucet aerators. All homes received the new appliances and toilets; only a subset of homes received the new showerheads and aerators because most of the homes had already participated in a successful showerhead/aerator program sponsored by Portland General Electric.

PNNL evaluated the water and energy savings achieved in these homes. This was done with a unique approach to estimating end-use water savings using data collected at the whole-house water meter. These data were then disaggregated into individual household water uses, using a special software package. This method allows appliance-by-appliance water savings estimates without having to individually meter those appliances. More limited end-use metering was done to verify results and to collect energy use data. Data were collected over a two-month *baseline* period (before SWEEP was implemented) and then again over a two-month *retrofit* period (after the new equipment was installed).

The evaluation results presented below are from the end-use metering of the 50 test homes. These homes were chosen for their water savings potential—the test homes were built before passage of the Energy Policy Act of 1992 (EPAct),[1] when the use of some types of water- and energy-efficient equipment became mandatory. In addition, the homes were chosen to be representative of those in the communities—that is, they were chosen to ensure the program had a representative distribution of both home size and occupancy.

Figure S.1 presents the 25-home aggregation of all annual indoor water use for the *baseline* (before SWEEP was implemented), for the *retrofit* (after SWEEP was implemented), and for the resulting *savings*. The results are presented for both cities and then for the combined study mean. The units shown in the graph are in thousands of gallons (kgal).

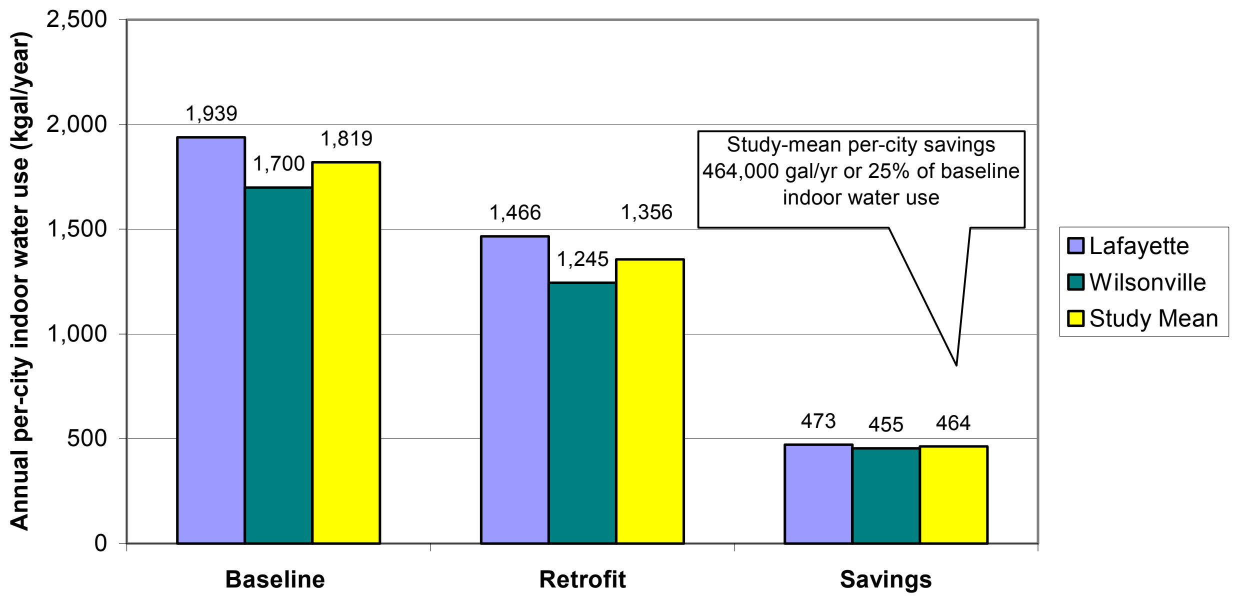

Figure S.1. Annual Per-City Indoor Water Use and Savings (kgal/yr) for the 25 SWEEP Homes in Each City: Aggregated Program Equipment (clothes washer, dishwasher, and toilet) Findings

While the sample of homes in SWEEP is not representative of the entire population of homes in these cities, we do feel it is representative of homes built before the passage of EPAct. The water savings potential for a SWEEP program implemented in 100, pre-EPAct homes would be more than 1.8 million gallons/yr; if implemented in 1,000 homes the SWEEP savings potential would be over 18.5 million gallons/yr.

[1] The Energy Policy Act of 1992 (EPAct) was signed into law by President George Bush and was designed to, among other things, help reduce the amount of energy and water used by various consumer and industrial products.

Couching these savings in a slightly different way, if one were to place one-gallon plastic milk jugs, side-by-side, and fill them with the annual water savings from 100 SWEEP homes, the line of jugs would stretch about 175 miles—or from Portland to Roseburg along Interstate 5.

Presented in Figure S.2 are the aggregated per-home findings for both cities and the study mean. The aggregated per-home data indicate a mean annual savings of about 18,600 gallons. These savings represent a 25% reduction in mean per-home indoor water use over the baseline. Put in different terms, these savings represent the water used by over 700 clothes washing cycles—that's about two-years' worth of clothes washing for the typical family.

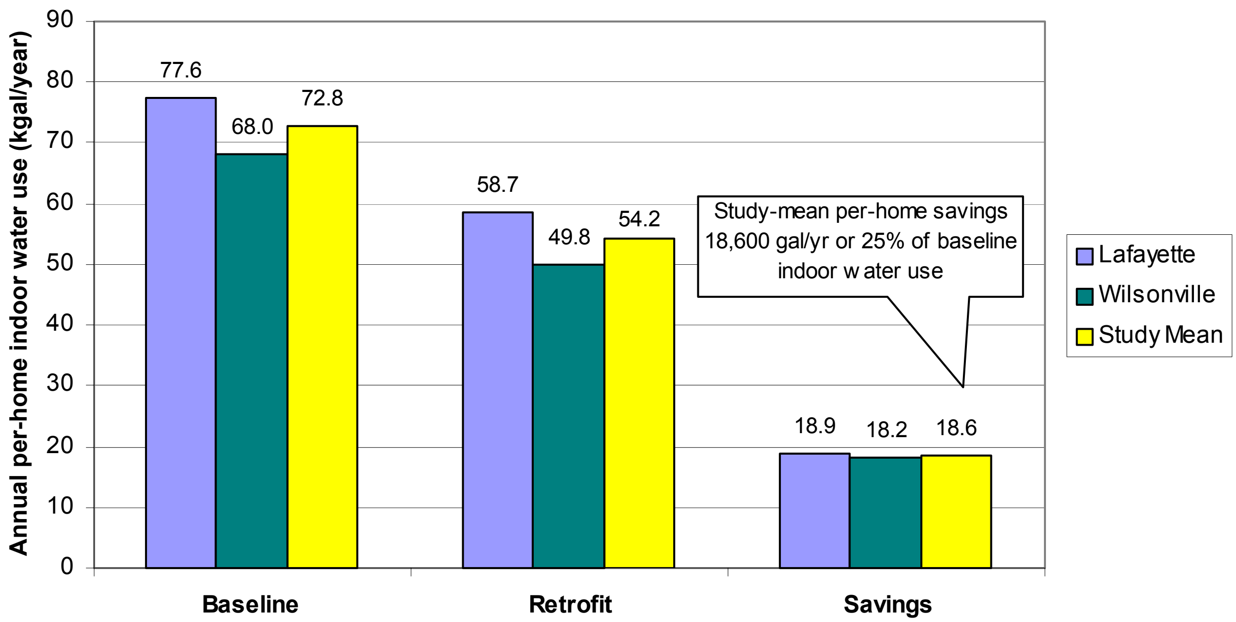

Figure S.2. Annual Per-Home Indoor Water Use and Savings (kgal/yr): Aggregated Program Equipment (clothes washer, dishwasher, toilet) Findings

Clothes Washer Results

Figure S.3 presents the mean per-cycle clothes washer total water use and savings resulting from the SWEEP program. The mean water savings was 15.2 gallons/cycle, for a 38% reduction in use over the baseline. Aggregated over the year, the new clothes washer results in mean savings of over 6,300 gallons per home. These annual savings represent the water used by more than 250 clothes washings in the new washer.

Figure S.4 presents the mean per-cycle clothes washer total energy use and savings from the program. The mean electricity savings from the new washer was 0.9 kWh/cycle, for a 68% reduction in use over the baseline (data presented here assume electric water heater—gas water heating is discussed in the body of this report). Aggregated over the year, the clothes washer results in a mean electricity savings of 440 kWh per home—that's about the amount of electricity used in a new energy-efficient refrigerator for one year.

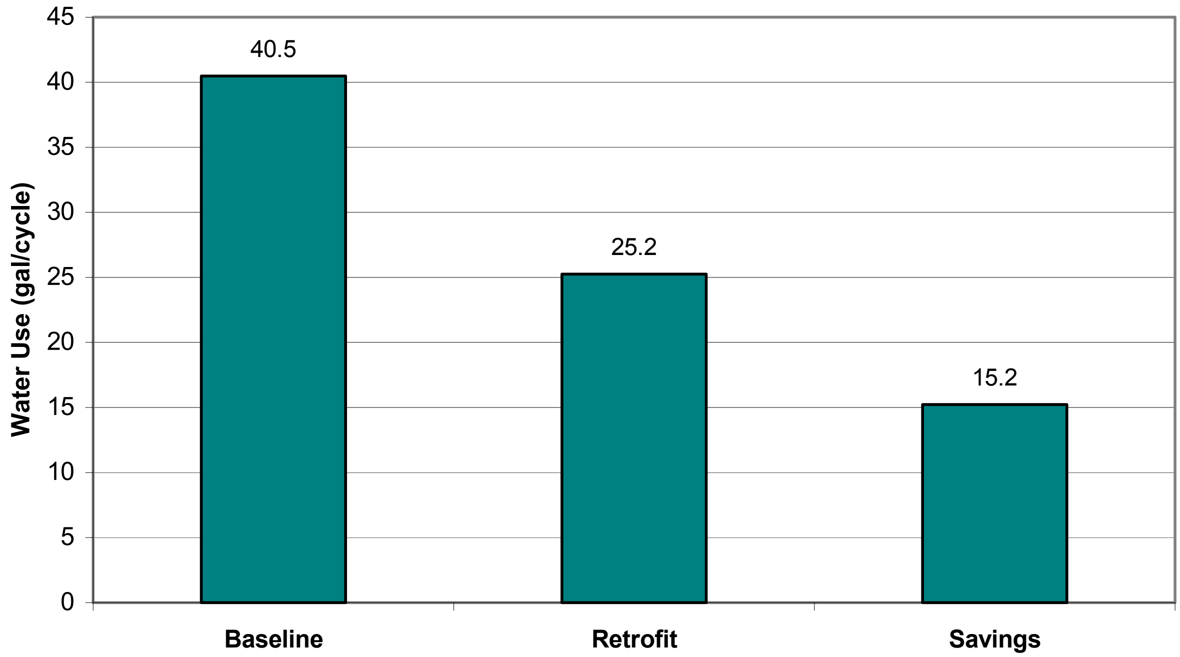

Figure S.3. Clothes Washer Findings: Mean Per-Cycle Water Use and Savings (gal/cycle)

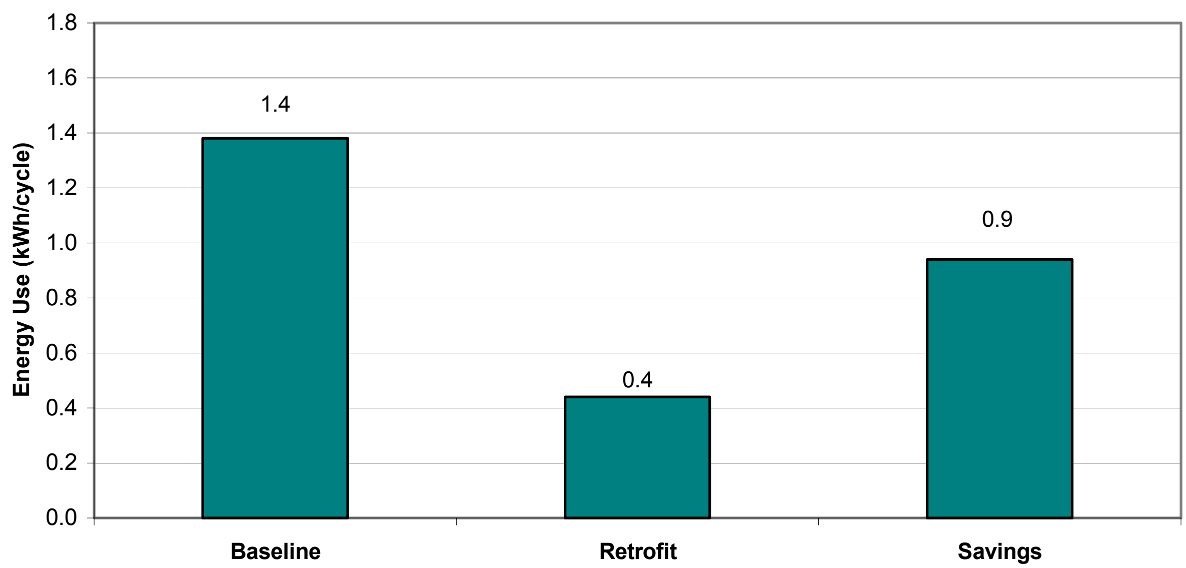

Figure S.4. Clothes Washer Findings: Mean Per-Cycle Electricity Use and Savings (kWh/cycle)

Clothes Dryer Results

Figure S.5 presents the mean per-cycle clothes dryer total energy use and savings from the program. The mean electricity savings from the new dryer was 0.8 kWh/cycle, for a 25% reduction in use over the baseline. Aggregated over the year, the clothes dryer results in a mean electricity savings of 290 kWh per home.

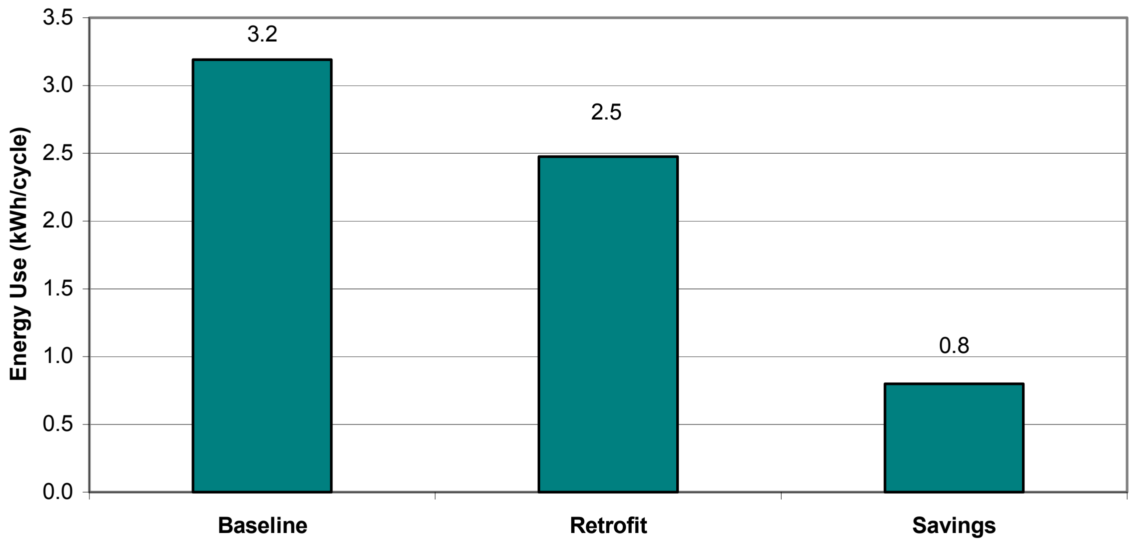

Figure S.5. Clothes Dryer Findings: Mean Per-Cycle Electricity Use and Savings (kWh/cycle)

Dishwasher Results

Figure S.6 presents the mean per-cycle dishwasher total water use and savings from the program. The mean water savings from the new washer was 3.7 gallons/cycle, for a 39% reduction in use over the baseline. Aggregated over the year, the dishwasher results in mean savings of 690 gallons per home in water savings. These annual savings represent the water used by more than 120 dishwashings in the new dishwasher.

Figure S.7 presents the mean per-cycle dishwasher energy use and savings from the program. The mean electricity savings from the new dishwasher was 0.6 kWh/cycle, for a 39% reduction in use over the baseline. Aggregated over the year, the dishwasher results in a mean electricity savings of 110 kWh per home.

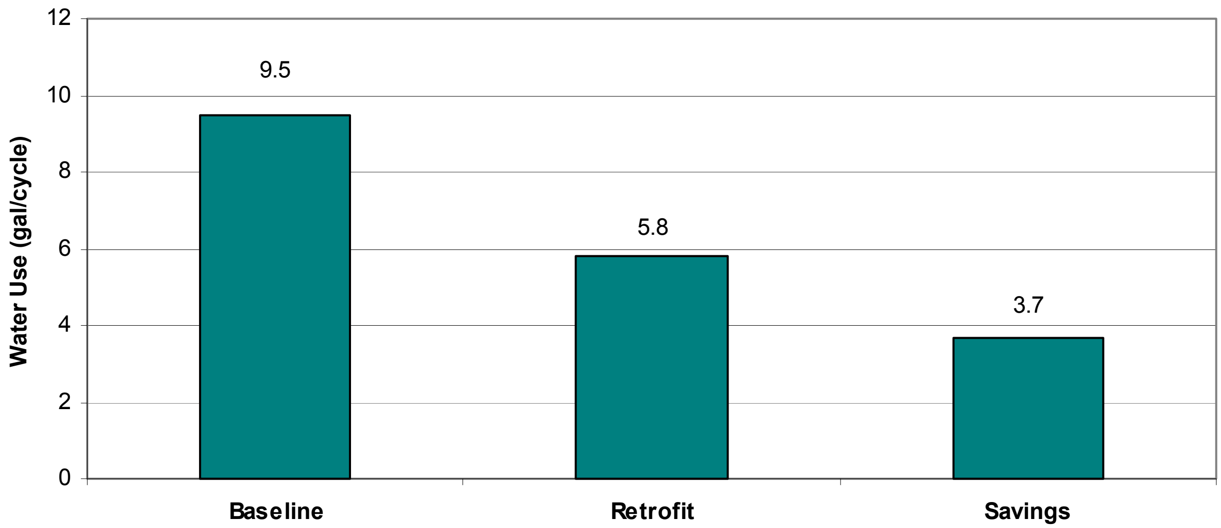

Figure S.6. Dishwasher Findings: Mean Per-Cycle Water Use and Savings (gal/cycle)

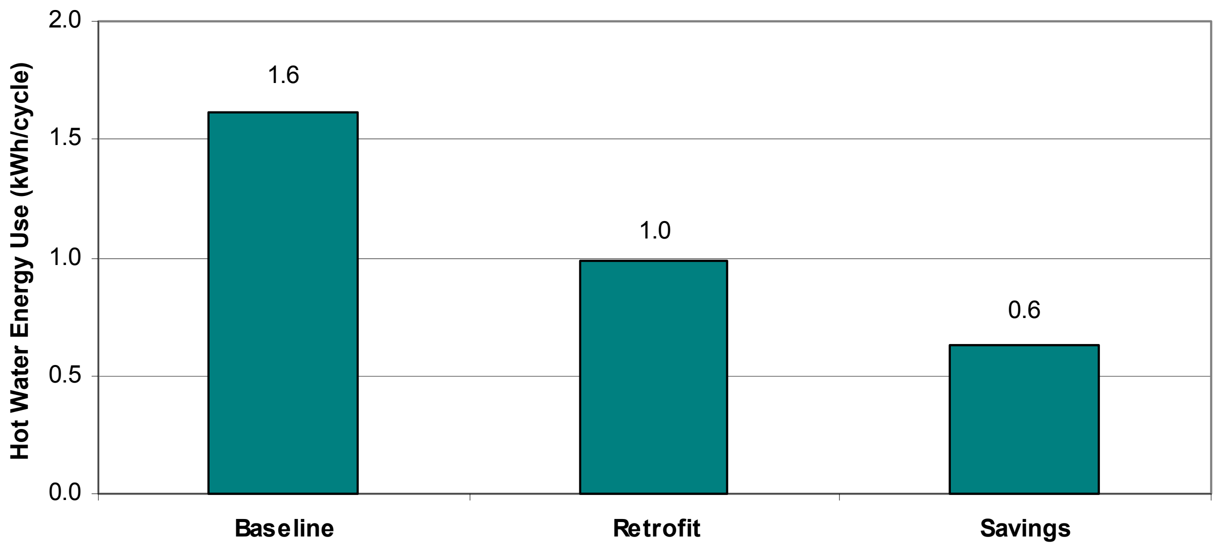

Figure S.7. Dishwasher Findings: Mean Per-Cycle Energy Use and Savings (kWh/cycle)

Toilet Results

Figure S.8 presents the mean per-cycle toilet water use and savings from the program. The mean water savings from the new toilet was 2.6 gallons/cycle, for a 67% reduction in use over the baseline. Aggregated over the year, the new toilets result in mean savings of over 11,550 gallons per home in water savings. These annual savings represent the water used by more than 8,800 flushes of the new toilet.

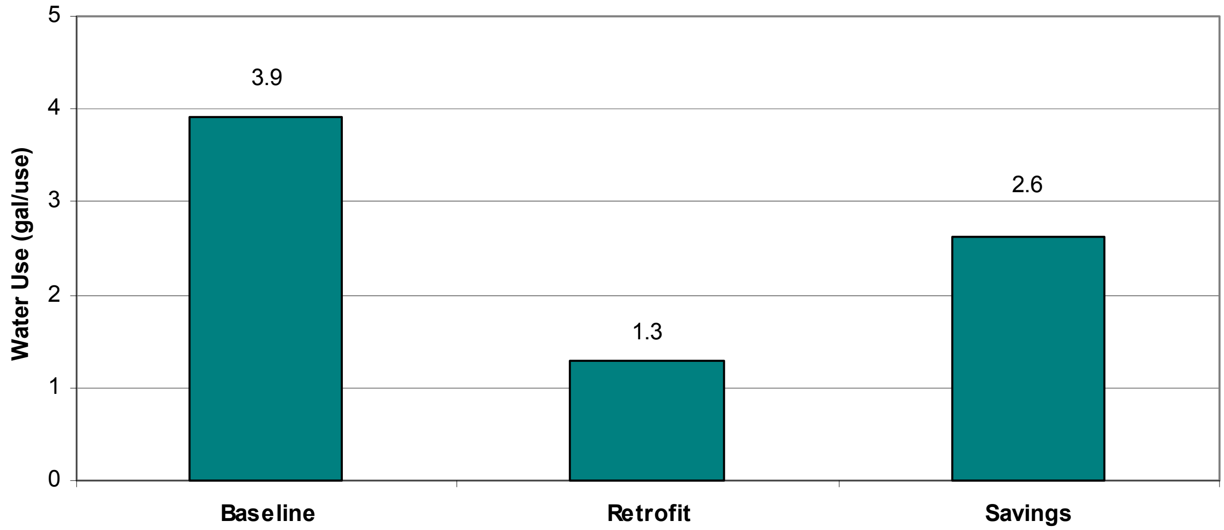

Figure S.8. Toilet Results: Mean Per-Cycle Water Use and Savings (gal/use)

Annual Savings

Figure S.9 presents the mean annual per-home water savings by equipment type from the program. It's interesting to note that while on a per-cycle or per-use basis the clothes washer is the dominant savings device in the program (15.2 gallons/cycle savings for the clothes washer to 3.7 gallons/cycle for the dishwasher to 2.6 gallons/use for the toilet), it's the toilet that overwhelmingly drives the total program savings over time. These savings, of course, result from the relative high usage a toilet sees in comparison to the other equipment in a typical home.

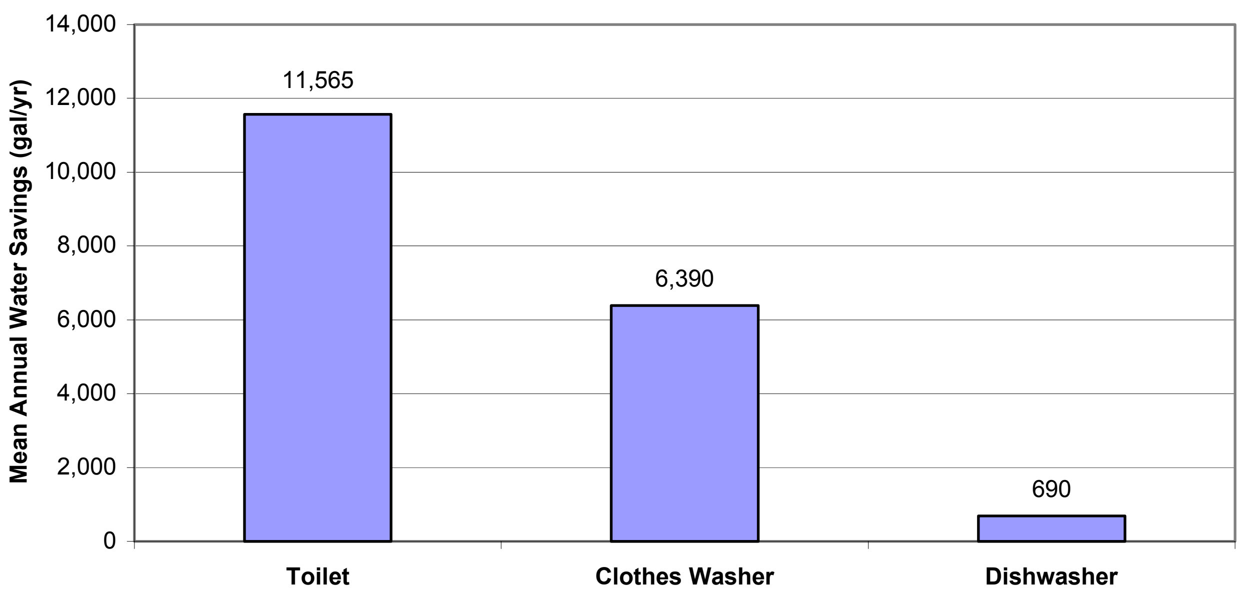

Figure S.9. Mean Annual Per-Home Water Savings (gal/year)

The annual energy savings estimated from the program equipment is included in Figure S.10. These saving are predominately related to the savings in hot water in both clothes washers and dishwashers; clothes dryer savings may be due to a reduction in the remaining moisture content (i.e., due to the high spin speeds typically achieved in front-loading clothes washers, there may be less moisture remaining in the clothes after washing, a so-called lower *remaining moisture content*) and to other unknown technical effects from substituting *retrofit* clothes dryers for *baseline* clothes dryers. Also shown in Figure S.10 are the savings that accrue at the central points of water distribution and wastewater treatment. These savings, labeled Water System Impact, result from less water needing to be pumped and treated at the water supply and wastewater treatment points, and therefore less electricity is used.

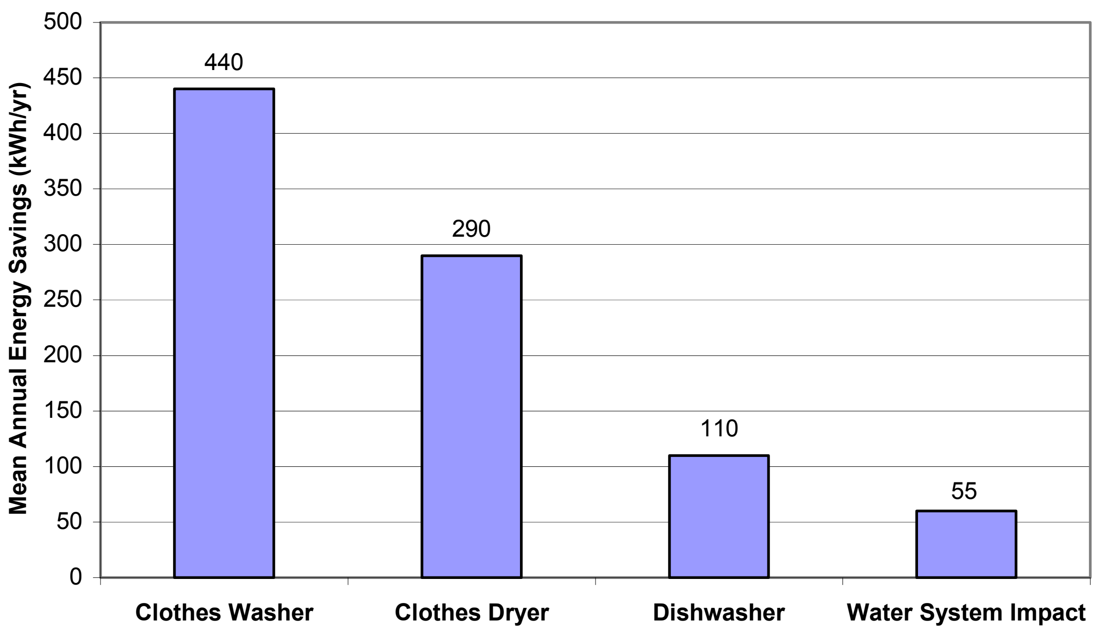

Figure S.10. Mean Annual Per-Home Energy Savings (kWh/year)

When compared with the *baseline* equipment, every year the aggregated savings from the new washer, dryer, and dishwasher (840 kWh/yr and 7,080 gallons/yr) results in enough energy and water to provide the average SWEEP home with 250 free clothes washings, 110 free dishwashings, and enough electricity savings left over to run an energy-efficient refrigerator all year.

Additional energy savings were evaluated for two other program devices, the low-flow showerheads and hot water heaters. However, these data were not reported due to statistical significance issues—in the case of the showerheads, only 6 of the 50 homes had all high-flow baseline showerheads replaced with low-flow showerheads (the other 44 homes already had replaced some or all of their showerheads with low-flow models). In the case of hot water heaters, the relatively short duration of metering precludes the ability to draw statistically significant results from the data.

The values of the resource savings in the SWEEP study homes are significant and will be reflected in lower energy and water bills. Figure S.11 presents the mean annual impact per home, by appliance and by resource savings. These calculations use a combined marginal rate for water/wastewater of $6.50 per 1,000 gallons saved, and a marginal electricity rate of $0.058 per kilowatt-hour saved; these rates are what the average resident pays in both cities. To estimate the savings for homes with natural gas water heaters, the electricity portion of the savings should be multiplied by 0.65.[2]

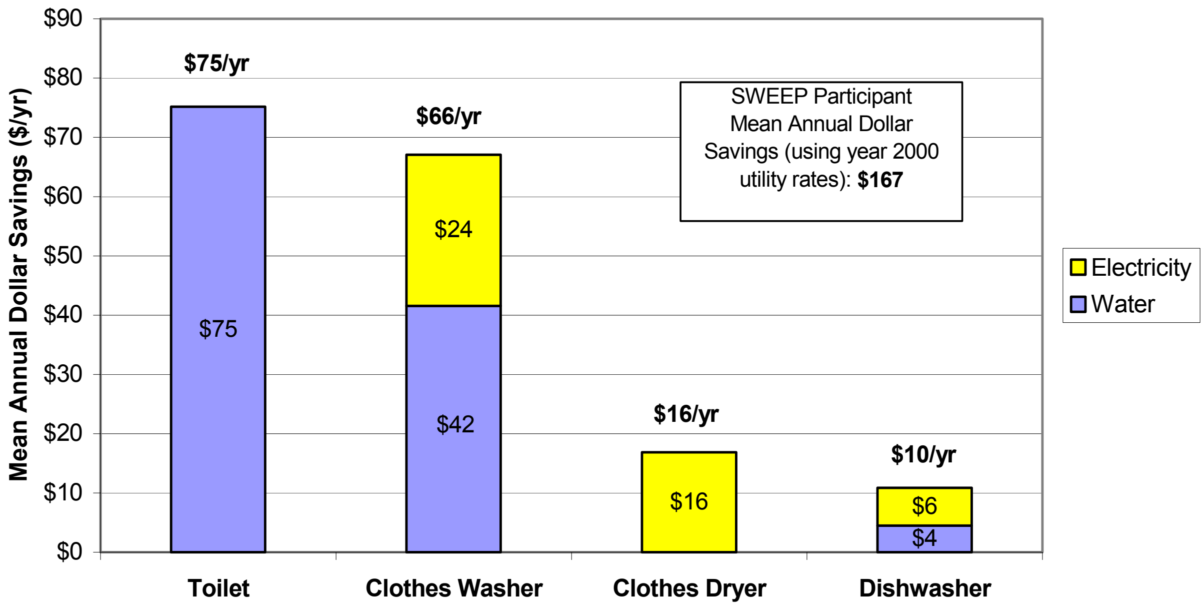

Figure S.11. Mean Annual Per-Home Dollar Savings ($/year): SWEEP Program Equipment Findings (using year 2000 utility cost of $6.50/kgal and $0.058/kWh)

In summary, the SWEEP equipment used in the test homes in Lafayette and Wilsonville, Oregon, produced significant savings in water and energy when compared with the *baseline* equipment. The SWEEP study demonstrated that a properly chosen suite of appliances and equipment can make a significant impact on indoor water use—the study mean savings were 25% of indoor water use, for a mean per-home savings of 18,600 gallons/yr. These water savings were present with the new clothes washer (with a 38% reduction over the mean baseline use), the new dishwasher (with a 39% reduction over the baseline use), and the new toilets (with a 67% reduction over the baseline use). The resulting per-home mean annual energy savings from the program totaled 840 kWh and reduced clothes washer energy use (mechanical and hot water) by 68%, dishwasher energy use (hot water use only) by 39%, and clothes dryer energy use by 25%. The energy savings from reduced water distribution and water/wastewater treatment

[2] This factor adjusts the results to account for the difference in gas and electricity cost as well as their difference in typical efficiencies.

were calculated to be 55 kWh per home per year. These savings are realized by the community through reduced electricity use by supply pumps and other water/wastewater treatment equipment.

From a regional perspective, if SWEEP were implemented in 1,000 pre-EPAct homes, the expected resource savings would include over 18.5 million gallons of water per year and over 890,000 kWh/yr.

Finally, it should be noted that the water/wastewater rate in both communities will be increased over the next year, with the final target of $8.00 per 1,000 gallons. Likewise, given the current electricity-supply situation, electricity rate increases are probable. Both of these actions would serve to increase the cost savings, making this equipment even more economically attractive. Figure S.12 presents the annual dollar savings of this equipment using the anticipated water/wastewater rate of $8.00/kgal, and assuming a 50% increase in electricity rates from $0.058/kWh to $0.087/kWh.

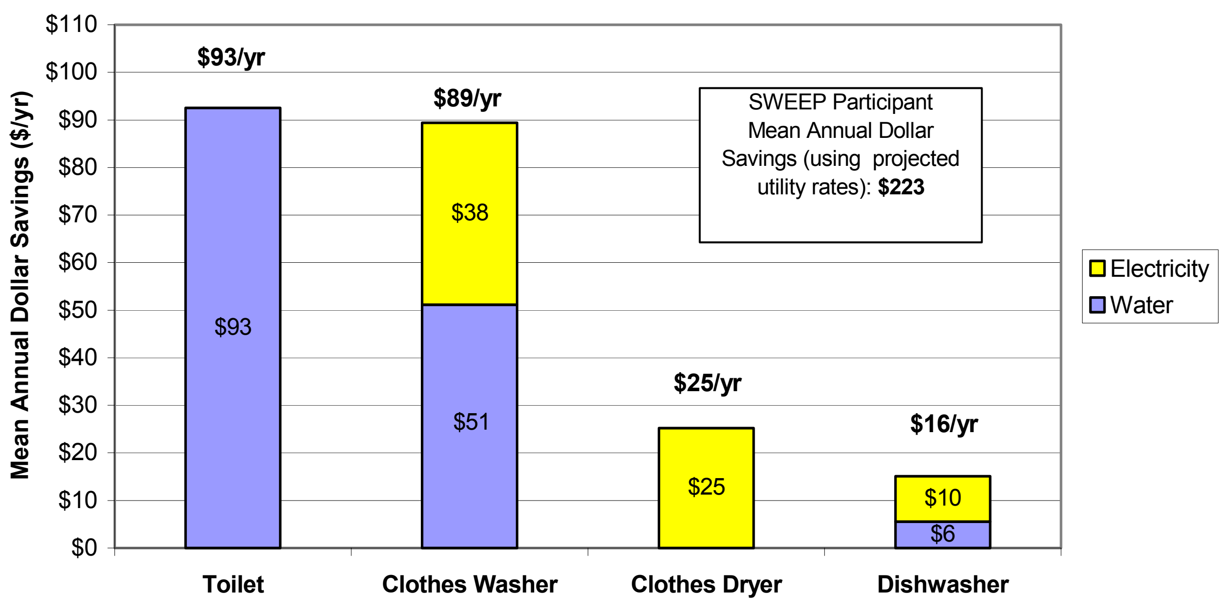

Figure S.12. Mean Annual Per-Home Dollar Savings ($/year): SWEEP Program Equipment Findings (assumes future utility cost of $8.00/kgal and $0.087/kWh)

Acknowledgments

The authors of this report would like to thank all the participants of SWEEP, including Louis and Terry Nelson, Sally J. Razo, Don and Kathy Jones, Tia Wagener, Bob and Shanon Cullen, H. Alan Ross, Flora Lane, Terry L. Yarbrough, Erica Morgan, Eileen Ray, Ann Helm, Jackie Constans, Laura and Terry Archer, Theresa Syphers, Jeff and Louis Winter, Doug Wasson, Valerie Katzler, Frank and Evelyn Palmer, Nancy Larson, Cecil and Jean Mead, Kirk and Mari Morgan, Rick and Gina Regalado, Mike and Barb Lewis, Don and Stephanie Beehner, Kathy Chytka, Mark T. Laughman, Troy Roberts, Gerri Krummel, Neal Stixrud, Charles O. Reeves, Alan and Wendy Johnson, John Helser, Albert Levit and Patricia Rehberg, Lori Anderson, James Gillies, Lynn and Tim Woodley, Adele Lehan, Bernard Bruenderman, Heather and Dan Duff, Terry Baxter, John and Lynn Ries, Thomas and Rosanne Case, Mary Joyce VanWechel, Randal Wortman, Bryan Loun, Michael and Lisa Leman, Ken Cooper, Heath and Elizabeth Foott, Jeffrey D. Stokes, and Tom and Michelle Ripple for their participation in the SWEEP study. Without their commitment and allowing the necessary access to their homes, this study would not have been possible.

The authors would also like to thank Electrolux Home Products and Tony Evans, Caroma USA, Inc. and Darrell Rasell, and Portland General Electric and John McLain for their generous donations of appliances and equipment to this program. In addition, we'd like to thank CTSI Corporation and Jim Craft for his assistance in planning SWEEP and conducting water audits, Ray Engle of Energy Technology Laboratories for his donation of showerheads, and Krohn's Appliance for their expertise in equipment installation.

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Finally, we would like to thank the SWEEP program partners: the cities of Lafayette and Wilsonville, Portland General Electric, the staff at the Oregon Office of Energy in particular Larry Gray and Lisa Schwartz, the Northwest Energy Efficiency Alliance, the League of Oregon Cities, and the Mid-Willamette Valley Council of Governments.

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Introduction and Background

Who would have thought that Oregon's notoriously soggy Willamette Valley could have a water shortage? The residents of two of its fastest growing communities—that's who! It's true. The residents of Lafayette and Wilsonville, Oregon, are in the midst of a water shortage. These two cities, located about 20 miles south/southwest of Portland, are two of Oregon's fastest growing communities. Lafayette, with a population of 2,586, has experienced 100% growth since 1990. Wilsonville, with a population of 13,991, has experienced similar growth during this period. This rapid growth has strained the water supply and wastewater treatment systems in both communities.

Due to these constraints, both communities volunteered to participate in a research project targeting maximum indoor water savings via a community-wide water conservation program. This program, titled the Save Water and Energy Education Program (SWEEP), was the result of a coalition of organizations including officials from both communities, the U.S. Department of Energy, Electrolux Home Products (donor of 50 sets of Frigidaire high-performance clothes washer/dryer pairs and dishwashers), Caroma USA, Inc. (donor of over 100 high-performance dual-flush toilets), the Pacific Northwest National Laboratory (PNNL), Portland General Electric (the serving electric utility and donor of faucet aerators and low-flow showerheads), the Oregon Office of Energy, CTSI Corporation, Energy Technology Laboratories (also a donor of showerheads), the Northwest Energy Efficiency Alliance, the League of Oregon Cities, and the Mid-Willamette Valley Council of Governments.

The SWEEP concept as applied to Lafayette and Wilsonville included the installation and field evaluation of high-performance water- and energy-efficient equipment. Moreover, the program included the promotion of this type of equipment through schools and community education, as well as energy and water audits, technical assistance, and financial incentives packages taking advantage of tax credits, low-interest loans, and manufacturer rebates.

Through a series of planning meetings, the concept of SWEEP was developed and implemented. Lafayette began SWEEP in September of 1999 with the selection of 25 homes chosen for their water-savings potential and representation of community residences. These homes were then instrumented with a variety of end-use metering equipment to capture water and energy use data. Data were collected both before and after the installation of the water- and energy-efficient equipment. The new equipment included efficient clothes washers and dryers, dishwashers, toilets, and low-flow showerheads. The metering of this new equipment was completed in March of 2000, at which time a comprehensive education program targeting both the school system and the community was initiated. This education program focused on hands-on learning about water and energy efficiency in the school system as well as a community-wide water and energy efficiency campaign.

Figure 1. SWEEP Planning Meeting

Once the evaluation of Lafayette was completed, the metering equipment was moved to Wilsonville where the program was begun in March of 2000. As with Lafayette, 25 homes were chosen, followed by metering both before and after the new equipment was installed. All metering equipment was removed from Wilsonville by September of 2000.

Currently, the Oregon office of Energy is carrying on the SWEEP program in five communities: Wilsonville, Lafayette, Salem, Bend, and Redmond.

The balance of this document addresses the SWEEP process with a focus on the evaluation of the water- and energy-efficient equipment.

This report is organized as follows:

- The second section provides an overview of the program evaluation objectives.
- The third section describes how SWEEP was developed.
- The fourth section provides the metering plan used in the program.

- The fifth section presents the evaluation findings.
- The sixth section presents the study conclusions.
- The seventh section lists the references used in this report.
- The appendices provide specific information on additional analysis results, as well as additional information on the program appliances and equipment, the metering equipment, and a variety of other program resource documents.

Overview and Evaluation Objectives

The objective of this study was to evaluate the water- and energy-savings potential from a suite of indoor water- and energy-efficient equipment in a set of homes built before passage of the Energy Policy Act of 1992 (EPAct).[3] Pre-EPAct homes were targeted because they typically contain less water-efficient equipment than new homes, and thus present a larger opportunity for water savings. Lafayette and Wilsonville, Oregon, two water-constrained cities, were chosen as the study sites.

As a secondary objective, the data from this and related studies will be used in the development of a water conservation model being developed by George Mason University. This model is designed to give small- to medium-size communities a tool useful in estimating the effects of changes in end-use water consumption from a variety of conservation opportunities. This model will examine the effects that end-use water savings have on the system's capital investment needs as well as quantify water and resulting energy savings to the system.

Finally, this study was conducted to help decision-makers and consumers alike evaluate the real-world performance of this equipment. The authors and program partners hope to bring about an increased awareness of the benefits of the water- and energy-efficient equipment included in this program as well as that available through other manufacturers.

[3] The Energy Policy Act of 1992 (EPAct) was signed into law by President George Bush and was designed to, among other things, help reduce the amount of energy and water used by various consumer and industrial products.

How SWEEP Was Developed

The SWEEP concept and development was made possible through a series of informal agreements between program partners. Integral to these agreements was a partnership between the two cities, the U.S. Department of Energy (DOE), the Pacific Northwest National Laboratory (PNNL), Portland General Electric (PGE) and their subcontractor CTSI Corporation, the Oregon Office of Energy (OOE), Frigidaire Home Products Corporation, Caroma USA, Inc., the Northwest Energy Efficiency Alliance (NEEA) the League of Oregon Cities, and the Mid-Willamette Valley Council of Governments. The key activities that were part of SWEEP are presented in the flow chart in Figure 2.

Study Site Selection

Following a successful demonstration of high-performance clothes washers in Bern, Kansas (ORNL 1998), DOE was interested in continuing the promotion and demonstration of water- and energy-efficient equipment. To this end, DOE asked NEEA if there was interest in the Pacific Northwest to conduct a demonstration. For their part, NEEA solicited local Oregon communities asking for interest in participation. Among others, Lafayette and Wilsonville responded to this solicitation. Some very general guidelines were used in final selection of these communities. These guidelines included:

- *Recurring water/wastewater capacity issues*—a documented need was a key requisite.

- *Presence of municipal water/wastewater utilities*—it was felt that a private utility would have other economic interests to consider, potentially complicating the process.

- *Community size*—a small enough community to make possible a project with substantial community-wide impact.

- *Community interest*—city official, city personnel, and community resident commitment to the program would be necessary for its success.

Of these guidelines, the first, a documented need for assistance, was the most important. As one of the key objectives, this study targeted communities that have a significant need for water conservation. In both communities, fast-paced growth exacerbating already capacity-constrained water supply and treatment systems made them ideal candidates.

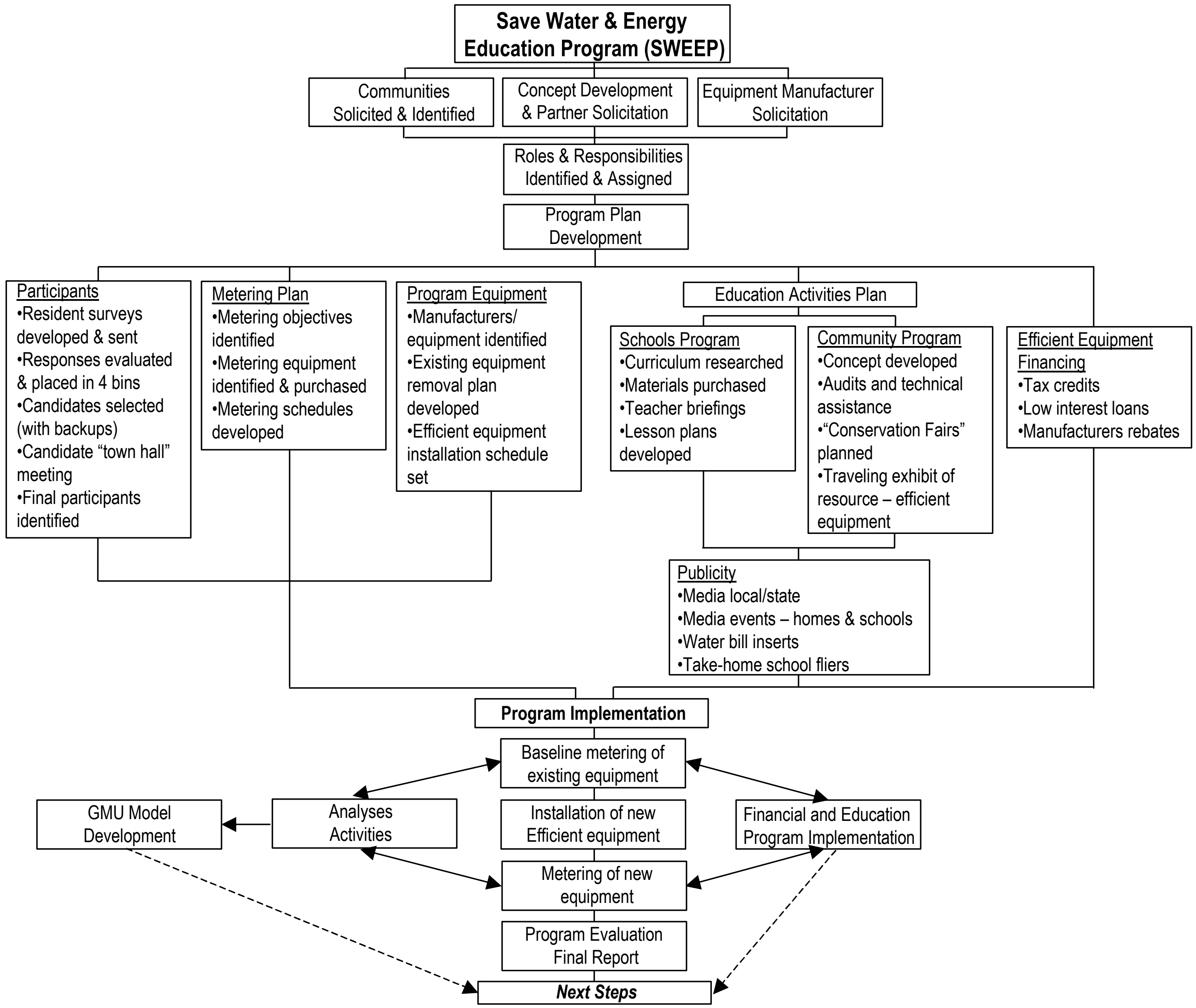

Figure 2. Key Activities of SWEEP

Study Sites

Lafayette, Oregon. Located about 20 miles southwest of Portland along historic Highway 99 and in the heart of Willamette Valley wine country, Lafayette bills itself as Oregon's third oldest city having been incorporated in 1847. As in many greater metropolitan areas, once rural farming communities are giving way to residential development and are serving as bedroom communities to these expanding metropolitan areas. Lafayette is no different in its relation to Portland. Lafayette's location, accessibility via Highway 99, and scenic surroundings have led to 100% growth in population since 1990; the current population is 2,586. This growth has outstripped the community's ability to upgrade an antiquated infrastructure—most notable are the water supply and wastewater treatment systems.

Figure 3. Lafayette City Hall

Lafayette currently supplies water from wells and a reservoir located on city-owned watershed property. In periods of high demand, mostly in the summer months, the reservoir supply must be supplemented with water from backup wells. During these periods, water quality has been questioned; in addition, issues have been raised as to the sufficiency of supply to both provide for residential water uses and have a buffer for other city activities such as fire-fighting.

The treatment of wastewater takes place at a treatment facility located on the banks of the Yamhill River. While effective, this facility is dated and suffers from capacity issues, particularly in winter months when rain water infiltrates the wastewater return system. Plans have been drawn to replace this treatment facility.

Faced with continued growth, Lafayette has begun negotiations with neighboring communities and landowners to identify new sources of ground water. Additionally, the city is scheduled to begin construction of a new wastewater treatment facility in the fall of 2001.

In 1999, Lafayette generated and used approximately 80 million gallons of water. The marginal combined water/wastewater cost for Lafayette residents varies with use. However, on average, most residents pay between $6.00 and $7.00 per 1,000 gallons (kgal). The marginal electricity rate in Lafayette is approximately $0.058 per kilowatt-hour (kWh). Both of these rates are expected to increase in the near future.

Figure 4. SWEEP Study Sites of Lafayette and Wilsonville, Oregon

Wilsonville, Oregon. Also located about 20 miles, in this case directly south, of Portland, Wilsonville is both a residential community and an employment center along the rim of the Portland metro area's urban growth boundary. Conveniently located on Interstate 5, Wilsonville affords quick and easy access to Portland while still maintaining a rural sense of space and environment. Wilsonville, too, has experienced significant population growth over the past 10 years, with growth of 97% over that time; the current population is 13,991.

Water supply is a major constraint on further development in Wilsonville. Wilsonville currently supplies water to its residents from wells and, as with Lafayette, during the summer season these supplies have been getting dangerously low and jeopardizing the city's ability to carry out all of its necessary activities. In fact, measurements taken at city wells indicate the water table is dropping about four feet per year. To mitigate this problem, Wilsonville has instituted strict summer outdoor water use restrictions in four of the past six years. In addition, Wilsonville had put a temporary moratorium on new residential construction in 1999 and 2000.

Faced with the continued shortages and increasing growth pressures, Wilsonville recently approved the construction of a new water treatment facility on the banks of the Willamette River. While this facility is expected to ease the water shortages in Wilsonville, it comes at the expense of higher water rates—water rates are expected to double in a two-year period—and continued shortages are expected during the two-year construction schedule. The new treatment facility is expected to be on-line in April of 2002.

In 1999, Wilsonville generated and used about 925 million gallons of water with roughly 30% of that allocated to single-family residential connections. The marginal combined water/wastewater cost for Wilsonville residents also varies with use. However, on average most residents pay about $6.50/kgal. The marginal electricity rate in Wilsonville is approximately $0.058/kWh. Both of these rates are also expected to increase in the near future.

Participant Selection

Working with both cities, PNNL staff developed an informational letter and questionnaire that was mailed to each single-family residence served by the municipal water systems. The letter was designed to provide information about the program, its duration, participant responsibilities, and equipment included. The questionnaire was designed to give the program partners information about their potential participant. Both the letter and the questionnaire are included in this report as Appendix A. As stated previously, participants were not selected in a random fashion; rather they were selected to fulfill an important objective of this study, i.e., choosing a representative sample of participants living in pre-EPAct homes. Figure 5 shows a typical SWEEP home.

Figure 5. Typical SWEEP Home

The selection process made use of a number of participant screens developed to target a representative sample of community residents while still fulfilling the program objectives. These screens included:

- *Owner occupied residences*. Program partners wanted to make sure that those using the water and energy were also those paying for the water and energy. Furthermore, the installation of the new equipment could not legally be done in a home not owned by the occupant.

- *Pre-EPAct home construction*. As a primary objective, program partners wanted to target homes with the greatest conservation potential. Pre-EPAct homes typically did not have low-flush toilets and fixtures as original equipment.

- *Home size*. Two different home size groupings or bins were developed to segment the participants selected. The first bin has homes with less-than 1,800 ft^2 and the second has homes with 1,800 ft^2 or more.

- *Home occupancy*. As with home size, two home occupancy bins were developed to further segment the participants selected. The first bin was three and fewer occupants and the second was greater than three occupants.

In all, 25 homes in each community were selected and chosen to participate in this program. Table 1 presents the distribution of homes by city into the four bins.

Baseline Equipment

Given our participant selection criteria, most of the toilets and dishwashers found in the homes were of pre-1992 vintage. In a few cases, homes had been retrofit with post-1992 equipment. In the case of toilets, these retrofit installations were noted. In the case of showerheads and faucet aerators, a very successful program implemented by PGE had already retrofit many of the participant homes with energy- and water-efficient low-flow showerheads and faucet aerators. The baseline penetration of these efficient devices in participant homes was approaching 70%.

Table 1. SWEEP Number of Participants and Participant Distribution

City	Bin 1: ≤3 occupants <1,800 ft^2	Bin 2: ≤3 occupants ≥1,800 ft^2	Bin 3: >3 occupants <1,800 ft^2	Bin 4: >3 occupants ≥1,800 ft^2
Lafayette	7	5	6	7
Wilsonville	6	6	6	7

As expected, the existing program appliances and equipment showed a large variance in age. Ages ranged from only 1-2 years to greater than 20 years old. Table 2 presents the mean age of the existing appliances. In the case of toilets, the home age was usually a good surrogate for the toilet age when the age data were not available. Figure 6 pictures SWEEP baseline toilets on their way to disposal.

Table 2. Mean Age Data in Years for Program Appliances

Appliance/City	Clothes Washer Mean Age (years)	Clothes Dryer Mean Age (years)	Dishwasher Mean Age (years)	Home/Toilet Mean Age (years)
Lafayette	8.8	9.4	8.2	38.8
Wilsonville	10.4	11.0	8.3	17.4

Figure 6. SWEEP *Baseline* Toilets Headed for Disposal

Efficient Equipment

The efficient equipment installed in all 50 homes was identical. It included a new ENERGY STAR®[4] front-loading clothes washer and matching dryer, an energy- and water-efficient ENERGY STAR dishwasher, an innovative two-button toilet imported from Australia, and low-flow showerheads/faucet aerators. A brief description of each piece of efficient equipment is provided below. Pictures and other technical documentation can be found in Appendix B.

Clothes Washer/Dryer. The clothes washer/dryer models included in SWEEP were the Frigidaire Gallery model FWTR647GHS washer and Gallery model FDE546RES dryer. The washer model, being an ENERGY STAR horizontal-axis (H-axis) model, uses less water and energy than standard top-loading, vertical-axis (V-axis) washers. Indeed, other studies (ORNL 1998; EPRI 1997) have quantified the benefits of a variety of H-axis washers over V-axis washers. The measure of efficiency of a clothes washer is the so-called clothes washer energy factor. The energy factor is the normalized (to tub volume) measure of energy consumption (mechanical/motor and water heating) per standard wash cycle and given in units of cubic feet of tub volume per kilowatt-hour per cycle (ft^3/kWh/cycle); it is important to note that the *higher* the energy factor the more efficient the washer. The current minimum energy factor allowed for residential clothes washers is 1.18 ft^3/kWh/cycle. A typical clothes washer may have an energy factor (depending on age) of 1.18 to 1.40, while to qualify as ENERGY STAR the clothes washer must have an energy factor of 2.50 or more. The Frigidaire clothes washer included in this program has an energy factor of 4.01.

Dishwasher. The dishwasher model included in SWEEP was the Frigidaire Gallery model GLDB656JS. Through proprietary wash technology, this model is promoted as energy and water efficient and also carries the ENERGY STAR label. The measure of efficiency of a dishwasher is the so-called dishwasher energy factor. This energy factor is the inverse of the energy consumption for one full cycle and given in units cycles per kilowatt-hour (cycle/kWh). As with the clothes washer energy factor, it is important to note that the *higher* the dishwasher energy factor the more efficient the dishwasher. The current minimum energy factor allowed for residential dishwashers is 0.46 cycle/kWh. A typical dishwasher may have an energy factor (depending on its age) of 0.46 to 0.50, while to qualify as ENERGY STAR the dishwasher must have an energy factor of 0.52 or more. The Frigidaire dishwasher included in this program has an energy factor of 0.64.

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[4] The ENERGY STAR program is a voluntary partnership among the U.S. Department of Energy, the U.S. Environmental Protection Agency, product manufacturers, local utilities, and retailers. Partners help promote efficient products by labeling with the ENERGY STAR logo and educating consumers about the benefits of energy efficiency. ENERGY STAR-labeled products promote low utility bills and environmental benefits. A list of qualifying ENERGY STAR products and their efficiency levels can be found on the ENERGY STAR web site at www.energystar.gov

Toilets. The toilets included in SWEEP are manufactured and imported from Australia by Caroma USA, Inc. This design, the Caroma Caravelle 305, makes use of an innovative two-button flushing mechanism; one button is designated for liquid waste and the other button is designated for solid waste. The liquid-flush is advertised to use 0.8 gallons while the solid-flush uses the current standard of 1.6 gallons. The measure of efficiency of a toilet is the amount of water used per standard flush. The current maximum allowed water use per flush is 1.6 gallons. A typical toilet manufactured before 1992 uses about 3.5 gallons per flush, while toilets manufactured before 1985 have been found to use as much as 5 to 6 gallons per flush.

Showerheads. The showerheads included in SWEEP were a well-tested and accepted low-flow model. This same model was used in a very successful showerhead retrofit program that resulted in the high baseline penetration of these showerheads in both communities prior to the start of SWEEP. The measure of efficiency of a showerhead is the flow rate, given in gallons per minute (gpm). The showerhead included in this program was rated at 2.5 gpm. Older and/or high-flow showerheads have been found to use as much as 8 to 10 gpm.

The appliances and equipment described above define the SWEEP "program equipment." The following analysis focuses on this equipment, evaluating its water and energy savings potential as installed in the participant's homes. While all homes received the new appliances and toilets, only a subset of homes received the new showerheads and aerators. This is because most of the homes had already participated in a successful showerhead/aerator program sponsored by Portland General Electric.

Schools and Community Programs

Integral to the success of SWEEP was an educational program targeting both the school system and the communities. The focus of the school education program was hands-on learning about energy and water efficiency in the local elementary and middle schools. The community programs targeted awareness campaigns and offered creative financing options for the purchase of energy and water efficient appliances.

Schools Program

In both communities, elementary and middle-school students participated in a water-and energy-efficiency curriculum titled Learning to Be Water Wise and Energy Efficient™. In Lafayette, the curriculum was incorporated as part of a science module in the elementary school. In Wilsonville, the curriculum was a centerpiece of a week-long "Outdoor School" completed by 200 6th grade students. This curriculum was specifically designed for hands-on learning and was purchased by the communities. Information on the curriculum used can be found in Appendix A.

In addition to the middle-school curriculum, Wilsonville SWEEP organizers developed a writing contest open to all middle-school students. Participating students were asked to write a poem or short essay explaining to a fictional (or real) neighbor why it is important to save water and energy. The contest resulted in 96 entries that were judged by a local senior citizens group. All participants received free movie passes and the four finalists each received $50 gift certificates. The grand-prize winner received a new efficient Frigidaire washer/dryer set. The entries of the four semifinalists were included in the following month's water bill and sent to 4,000 residential accounts. The four winning entries are included in Appendix A.

Community Program

Both communities organized water and energy conservation fairs and other awareness activities as part of various community events. Appendix A presents some of the promotional material used for these events.

In addition to awareness, both communities participated in a low-interest loan program developed by the OOE and administered by PGE via the monthly electric bill. This program complimented the OOE's existing Efficient Appliance Tax Credit program already in place. Sample documents for both programs can be found in Appendix A.

Figure 7 shows some of the people and equipment so important to SWEEP.

Figure 7. New Appliances, Happy Participants, and SWEEP Program Partners: Ready for Installation

Metering Plan

The SWEEP water and energy evaluation completed three levels of water-use metering intervention. The first level (Level I) focused on end-use metering of the clothes washer, dryer, and hot water heater. The second level (Level II) used the existing whole house water meters in combination with an innovative data logger and software package to meter end-use water consumption. The third level (Level III) focused on the metering at the water and wastewater system treatment points and the development of a model to estimate the system-wide benefits of the program. Each level was designed to fold into the level above, with the third level serving as an aggregated total of the previous two.

Objectives

The SWEEP evaluation was designed to determine the impacts of a targeted water and energy conservation program in the cities of Lafayette and Wilsonville, Oregon. The objectives were as follows:

- Evaluate the per-cycle water and energy savings of new high-performance front-loading clothes washers compared with existing standard top-loading clothes washers.

- Evaluate the per-cycle water and energy savings of new high-efficiency dishwashers compared with existing pre-EPAct dishwashers.

- Evaluate the per-use water and energy savings of new high-efficiency low-flow showerheads compared with existing showerheads.

- Evaluate the per-use water savings of new high-efficiency dual-flush toilets compared with existing pre-EPAct toilets.

- Estimate annual water-use savings resulting from the installation of the "program equipment" in the 50 homes.

- Collect clothes dryer energy use data for subsequent evaluation by DOE.

- Collect water heater energy use data for subsequent evaluation by DOE.

- Collect additional information on the laundering habits of participants with the use of "laundry journals" detailing load size, cycle selections, and additives for subsequent evaluation by Frigidaire.

- Develop a model to estimate system-wide water supply and wastewater return impacts resulting from the retrofit equipment and the comprehensive community and schools water- and energy-use education program.

Metering Plan

As discussed, this evaluation proposes three levels of water-use metering. Where possible each level was aggregated up to the level above with the third level serving as the aggregated total of the previous two levels. Discrepancies at each level were explored for data inconsistencies and/or indications of system anomalies (i.e., leakage, infiltration, etc.). Because of the desire to project these evaluation results onto other communities, a representative demographic sample of Lafayette and Wilsonville was needed. Due to budget constraints this evaluation focused on a total sample size of 25 homes in each community; 10 homes in each community were proposed for Level I metering, and all 25 homes in each community for Level II metering. All 50 homes selected were pre-EPAct homes and were divided between the four demographic groups, or bins, discussed in the Participant Selection subsection on page 9.

Level I Metering

The primary objectives of Level I metering was to evaluate high-performance clothes washer resource savings (energy and water), to collect clothes dryer energy-use data, and to collect hot water heater energy-use data. A secondary objective of Level I metering was to generate clothes washer water-use data that could be compared with similar data collected by Level II metering equipment.

Level I metering relied on end-use metering equipment (data logger and water and electricity metering equipment) as well as occupant intervention. The occupant was asked to keep a "laundry journal" detailing dates and times of clothes washings, wash cycle selection, detergent types and amounts, etc. A copy of the laundry journal form is included in Appendix A. A description of each Level I metered parameter is included below. A diagram showing metering connections is provided in Figure 8.

Clothes Washer Water Temperature: Water temperature, both hot and cold, was recorded at the time of metering equipment installation and at subsequent visits to the home. These measurements were used to calculate the energy content of the hot water used.

Clothes Washer Water Use: Water use was metered by water flow meters installed on the hot and cold supply line to the washers. The meters provided per-cycle water use data to the data logger where it was stored in a time-series format at 5-minute intervals.

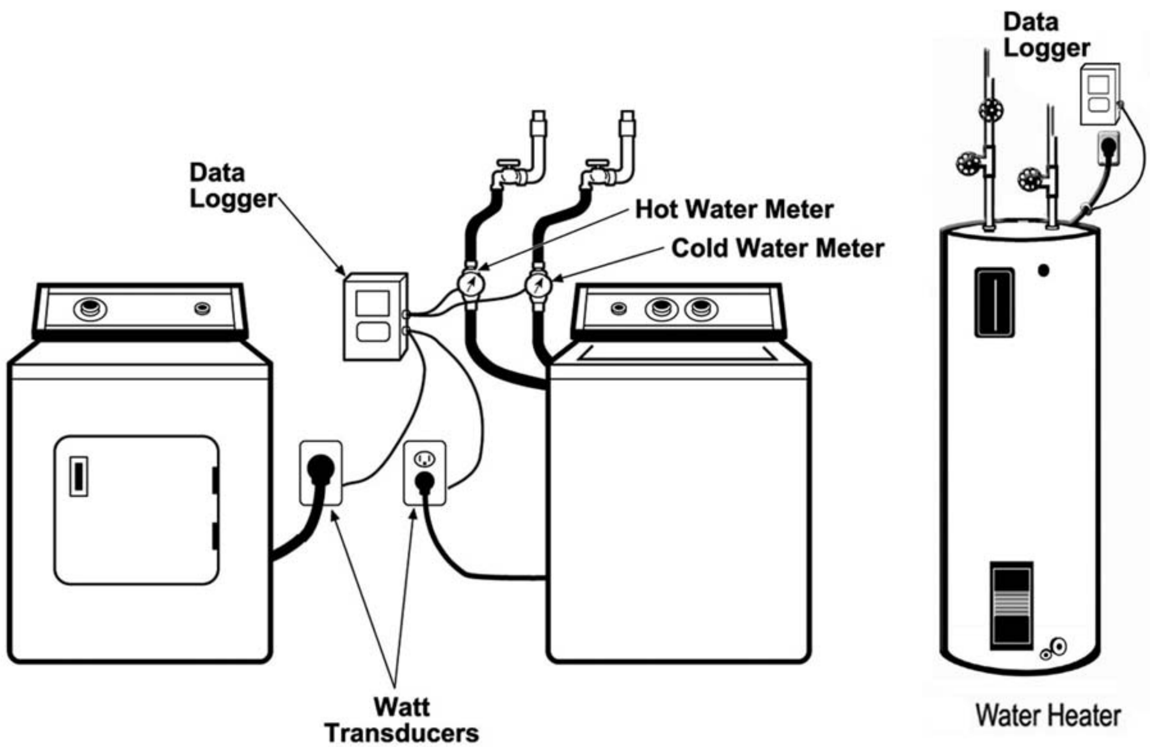

Figure 8. Level I Metering Equipment and Connections

Clothes Washer Energy Use: Clothes washer electrical energy use was metered by watt transducers installed on the power connections to the washer. The transducers provided per-cycle electricity-use data to the data logger, where it was stored in a time-series format. The clothes washer hot water energy use was calculated using the volume of hot water used (as recorded by the hot-water meter) and the temperature difference of the water coming in-to and out-of the water heater.

Clothes Dryer Energy Use: Clothes dryer energy use was monitored by watt transducers installed on the power connections to the dryer. The transducers provided per-cycle electricity use data to the data logger where it was stored in a time-series format.

Hot Water Heater Energy Use: Hot water heater energy use was monitored by current transformers (CTs) installed on the power connections to the water heater. The CTs provided electricity-use data to the data logger where it was stored in a time-series format at 5-minute intervals.

The data loggers used to record and store data held approximately 90 days worth of data. At monthly intervals these data loggers were downloaded in the field by analysts. The specifications and additional pictures of the metering equipment used in Level I are included in Appendix C.

Figure 9. End Use Metering (Level I) Equipment as Installed in Participant's Home

Level II Metering

The objective of Level II metering was to measure water use at the participant's city water-metering point (the city water meter is usually located in a metering "pit" at the participant's home). This metering was done to estimate end-use water consumption before and after the installation of the efficient equipment. The metering technique for Level II metering used an innovative data logger, the Meter-Master, developed by F.S. Brainard of Burlington, NJ. The Meter-Master is a data logger and a magnetic sensor that is attached to the city water meter; the logger and sensor were installed inside the metering pit and left there for the duration of the metering period. Figure 10 shows installed Meter-Master logger in a metering pit.

As water is used it flows through the city water meter, spinning magnets inside the meter. This magnetic movement is picked up by the sensor and registered by the logger. The Meter-Master logs data every 10 seconds and writes a record to memory. Once collected, these magnetic pulses were downloaded and processed through a software program called Trace Wizard©.

Figure 10. Meter-Master Metering (Level II) Equipment Installed in Metering Pit

The software program, Trace Wizard, developed by Aquacraft, Inc. of Boulder, Colorado, was designed to recognize specific flow signatures of water-using devices and appliances. The basic premise behind its development is that most residential water-using devices use water at relatively constant flow rates and volumes. Toilets, for instance, will typically flush with the same flow rate and volume. The same is largely true for clothes washers, dishwashers, showers, etc. The key to the successful use of the software is in the user's ability to recognize a specific water-using event and categorize it as such. Once categorized, the software uses this signature to identify similar events throughout the period. As the different events are identified, the software stores this information as it builds a water-use database. Once complete, this database becomes a disaggregation of the specific end uses of the total water use as seen by the city water meter. The specifications and additional pictures of the metering equipment used in Level II are included in Appendix C.

Figure 11 presents a typical Trace Wizard screen used by analysts in processing the Meter-Master data. Visible in this trace are a number of water-use events that have been color coded for recognition. Along the left border of the figure are small boxes that are used by the analyst in identifying the various end uses, the event properties, and other identifying characteristics. On the graph window, the X-axis represents a two-hour time window, the Y-axis gives the flow rate of the event in gallons per minute (gpm); therefore, the area under any specific colored region represents the actual water use, in gallons, for that event. Along the right portion of the screen is a legend identifying different water using events. Shown on this particular trace are a number of faucet uses (yellow events), a shower (red/orange event), two toilet flushes (green events), and a dishwasher event (starts with one turquoise labeled Dishwasher@ in the legend area, followed by four pink events). For water uses that have multiple discrete events making up a complete cycle (e.g., a clothes washer or dishwasher), the first event in the series is identified with the event name plus the '@' symbol.

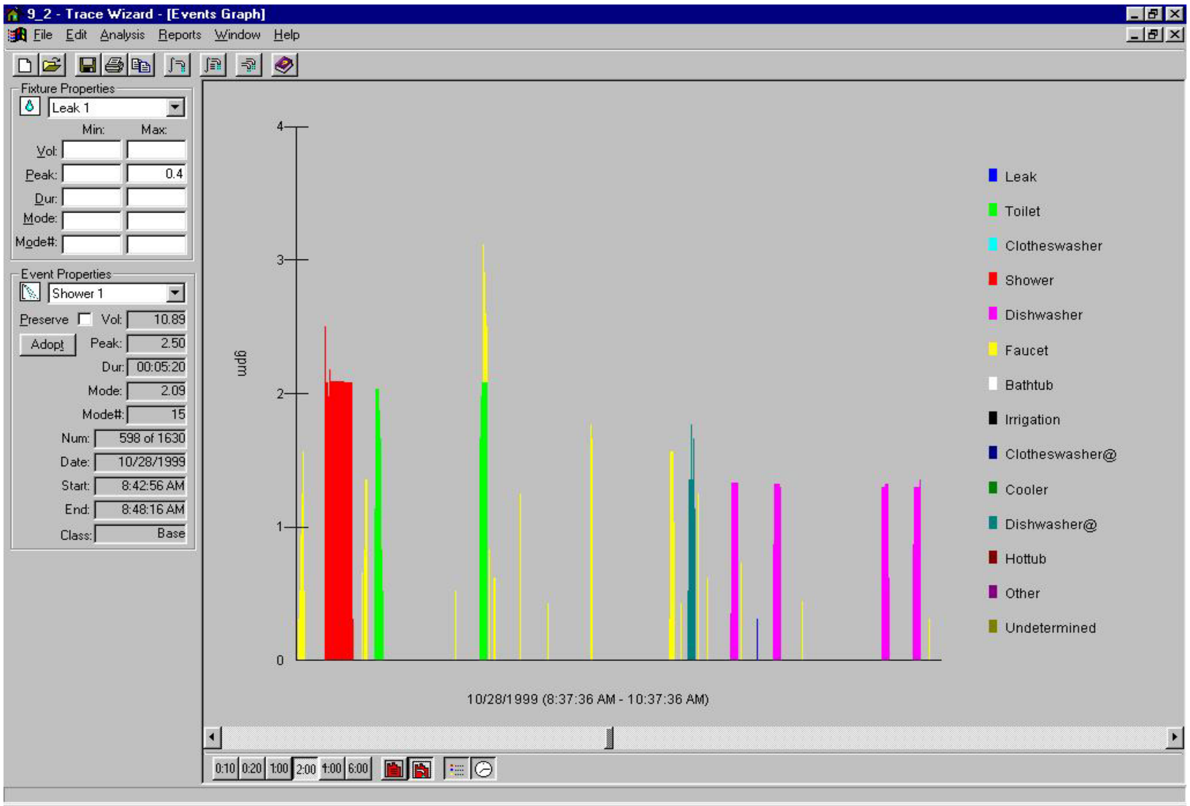

Figure 11. Typical Trace Wizard Output Screen Used in Meter-Master Data Processing

It is interesting to note that the shower event shown on the screen in Figure 11 begins with a small spike and then settles down to a flow of about 2 gpm. This shower was taken in a bathtub that also has a shower fixture. The initial spike represents the water being turned on at the bathtub faucet and let run before the bathtub shut-off was activated sending the water to the lower-flow-rate showerhead.

A diagram showing the Meter-Master metering connections and a depiction of Trace Wizard's function is provided in Figure 12.

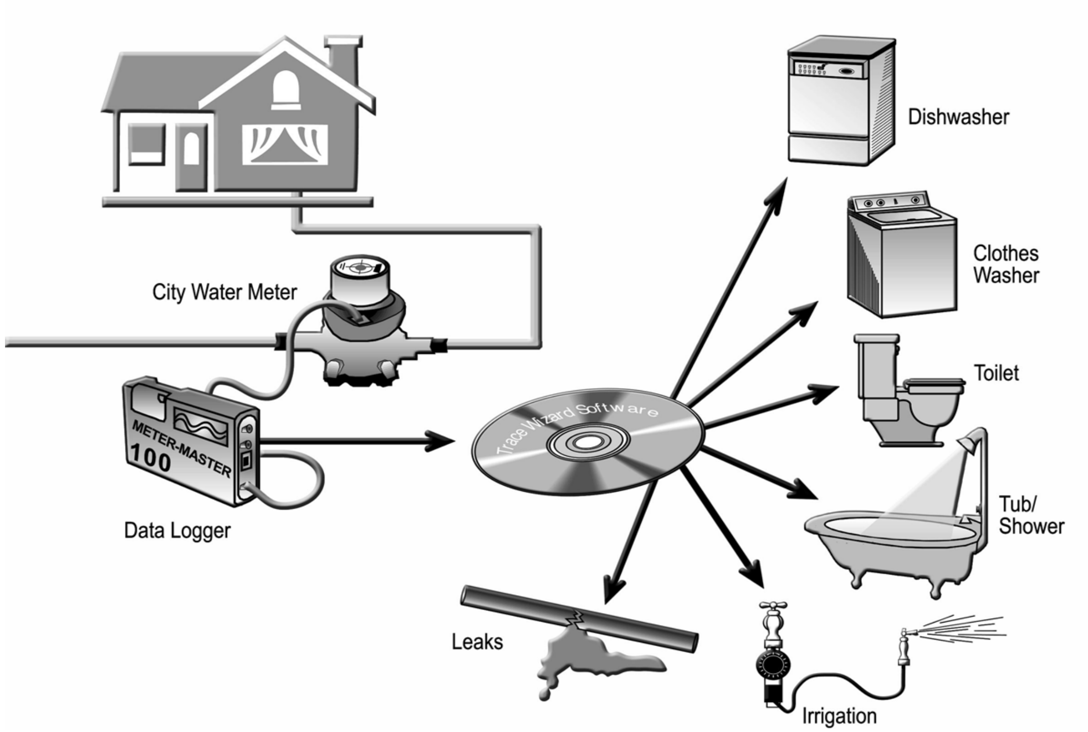

Figure 12. Level II Metering Equipment Connections and Trace Wizard Interface

While the Meter-Master/Trace Wizard system has the potential of accurately quantifying significant water using appliances and equipment, this evaluation was not successful at accurately quantifying lower-flow water uses such small faucet uses and leaks. Because of this inadequacy, this analysis focused on the larger uses consistent with the program objectives and made no attempt to quantify leaks and other low-flow water using events.

These results of Level II metering provided detailed water savings values for the major water end-use equipment included in the study. Level II metering affected all 25 homes in each community. Included in these homes were the 10 Level I homes, allowing for an accuracy check of the Meter-Master/Aquacraft system, through comparison with the end-use metering equipment installed on the clothes washers.

Level III Metering

Level III metering was designed to track system-wide impacts of the overall program. This metering took place using the existing city water supply and wastewater return metering and is used in conjunction with a model being developed at George Mason University to estimate system-wide benefits to this program. Level III metering connections are shown in Figure 13.

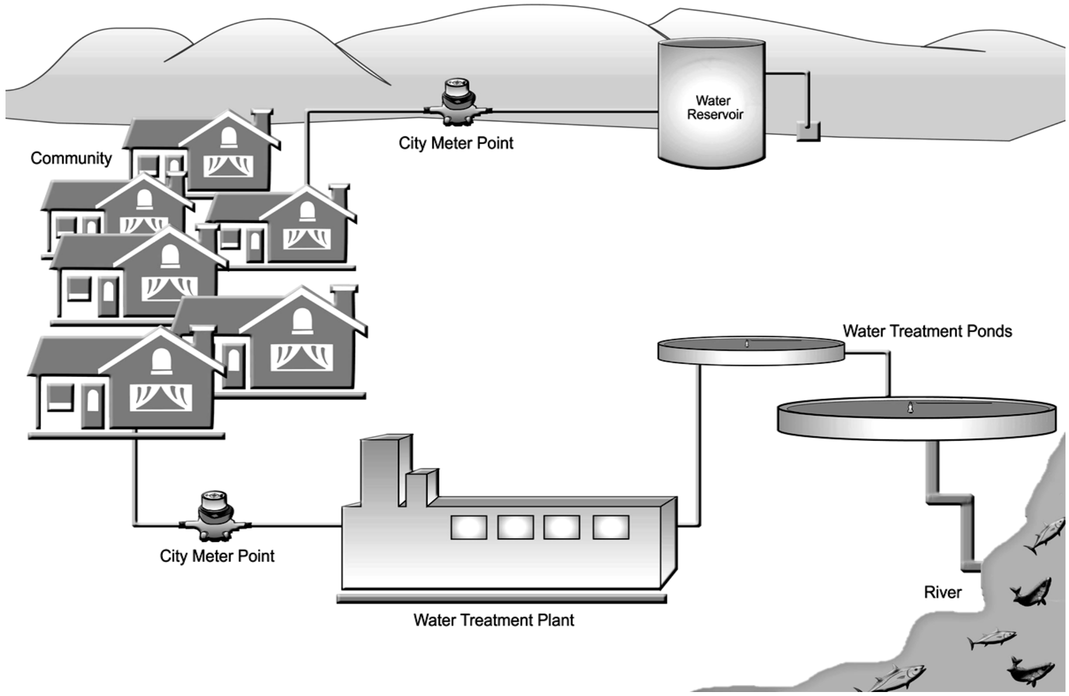

Figure 13. Level III Metering Connections

Evaluation Findings

The data collected from the 50 SWEEP homes represented an enormous analysis effort. Consider that 50 homes (25 at a time) were monitored for end-use water flow at each city water meter; this metering was recording data every 10 seconds. Additionally, in about half of the homes, dedicated end-use metering was installed at the clothes washer, clothes dryer, and hot water heater, and this metering was recording data every 5 minutes. Simple calculations show that the metering equipment used on this project recorded more than 220,000 data points per day.

The findings below are presented starting at the highest level of aggregation—the aggregated city-wide savings results, and progressing to the lowest level—the equipment end-use results. These results are followed by the aggregated annual end-use results. The results presented in this section are for the "program equipment," including the clothes washer and dryer, the dishwasher, and the toilet. The showerheads are not presented here because of the small sample size of homes receiving the retrofit low-flow showerhead. A very successful showerhead retrofit campaign by PGE over the previous two years resulted in a high penetration of low-flow showerheads; only three homes in each community went from a situation of having all standard-flow showerheads to having all low-flow showerheads. Due to the small sample size, the savings proved to be statistically insignificant; these data are included in Appendix D.

Aggregated Data

The data presented below represent the aggregated totals of water use in each of the 50 homes. These data were generated using a combination of data collected with the Meter-Master metering system and data collected over the past 2 years by the cities at the city water meter. For consistency in calculating the aggregated savings, the Meter-Master clothes washer data were used instead of the end use data collected at the clothes washer.

Aggregated Per-City Data

Figure 14 presents the 25-home aggregation of all annual indoor water use for the *baseline* (before SWEEP was implemented), for the *retrofit* (after SWEEP was implemented), and for the resulting *savings*. The results are presented for both cities and then for the combined study mean. The units on the graph are thousands of gallons (kgal).

The mean annual baseline indoor water use was calculated using the city's water meter readings for each home. To calculate these values, two-years of consumption data were examined. These data were then reduced to include only the months of November, December, January, and February—in the Pacific Northwest, residential water use during these months is likely to be strictly indoor use. Calculating the total mean indoor water use by this method allowed for a

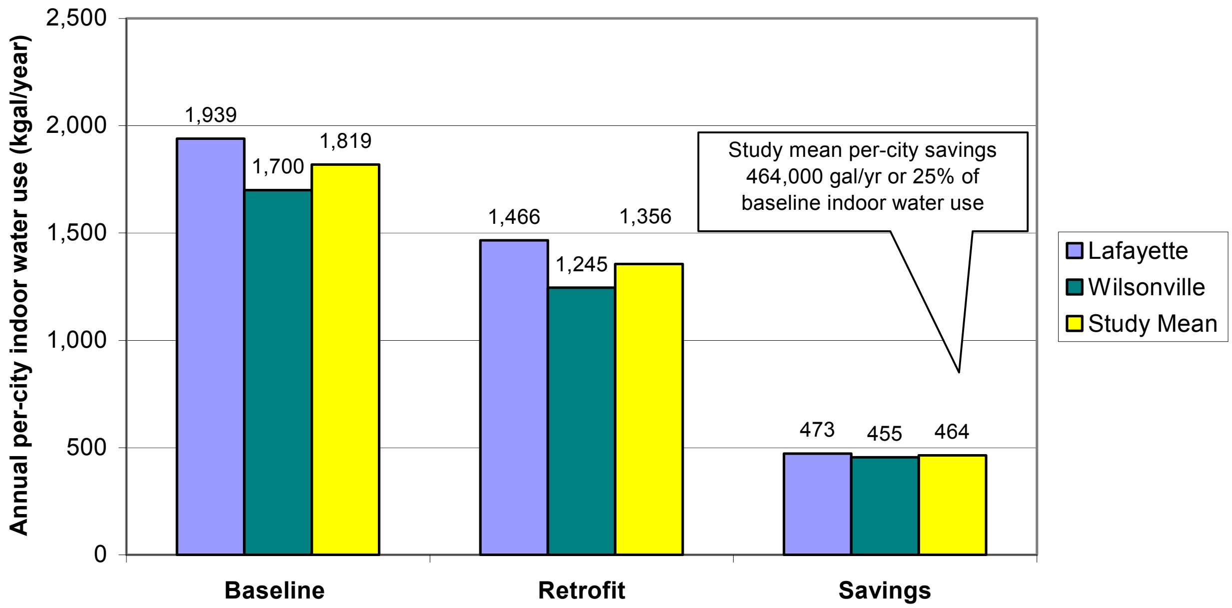

Figure 14. Annual Indoor Water Use and Savings (kgal/yr) for the 25 SWEEP Homes in Each City: Aggregated Program Equipment (clothes washer, dishwasher, toilet) Findings

more representative mean total indoor water use than using the Meter-Master data for only the periods metered. The results of this calculation produced a mean indoor water use for each participant with an overall mean of 72,750 gallons/home/year. This value compares well with data collected as part of an American Water Works Association (AWWA) 1,000 home water use study. This study (AWWA 1999) reported a mean annual indoor water use range of 61,300 to 90,600 gallons/home/year.

The mean annual indoor *retrofit* water use was the difference between average annual *baseline* indoor water use and the end-use savings calculated by Meter-Master at each home. In other words, retrofit water use was calculated by subtracting the estimated water savings from the estimated baseline water use. This approach was chosen because the authors believed they could more accurately estimate water savings from the Meter-Master data than they could from the total indoor water use.

As shown in Figure 14, the aggregated 25-home data indicate that each community will save in excess of 450,000 gallons/yr resulting from the installation of the SWEEP equipment in the 25 homes. For the 25 homes in each community, these savings represent roughly a 25% reduction in all indoor water uses. The community-specific savings are 473,000 gallons/yr in Lafayette, for a 24% savings of indoor water use in the study homes, and 455,000 gallons/yr in Wilsonville, for a 27% savings of indoor water use in the study homes. In addition to the community water savings, savings in pumping and water/wastewater treatment costs should be realized as well.

Aggregated Per-Home Findings

Presented in Figure 15 are the aggregated per-home findings for both cities and the study mean. The aggregated per-home *baseline* data were calculated again using two-years of city billing data. The *retrofit* data represent the mean indoor water use with all "program equipment" implemented (clothes washer, dishwasher, and toilet) and were calculated using the Meter-Master data collected at each home. The units in Figure 15 are in thousands of gallons (kgal).

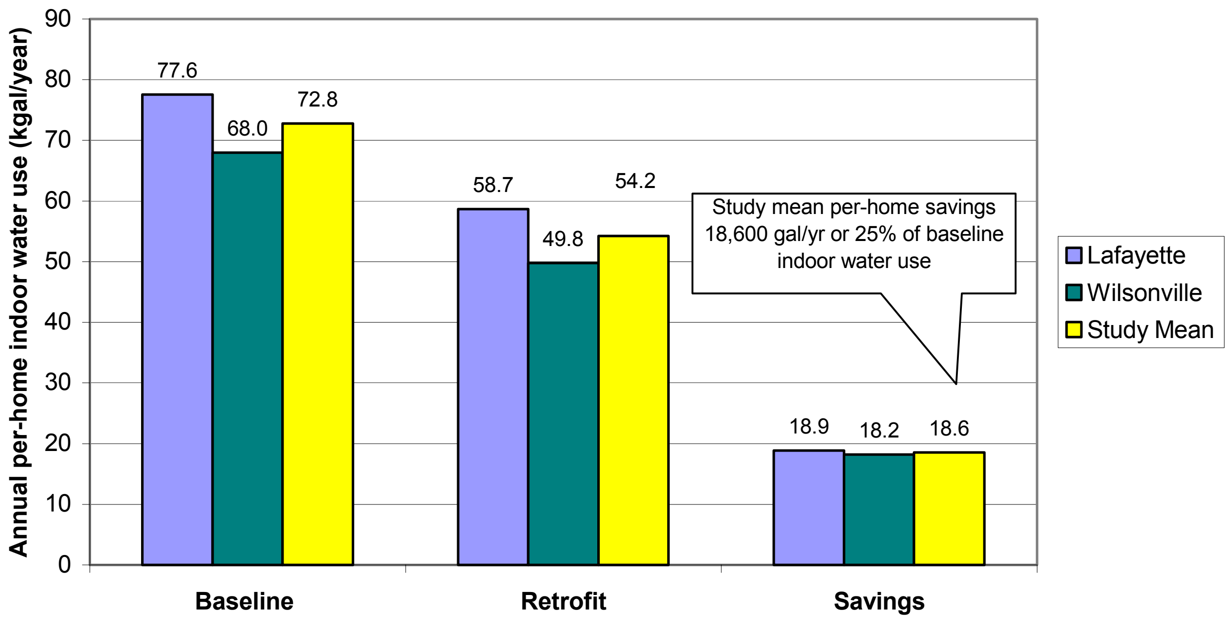

Figure 15. Annual Per-Home Indoor Water Use and Savings (kgal/yr): Aggregated Program Equipment (clothes washer, dishwasher, toilet) Findings

The aggregated per-home data indicate a mean annual savings of about 18,600 gallons. This mean included a low of 5,800 gallons/yr (single-occupant household) to a high of 55,400 gallons/yr (seven-occupant household). These savings represent a 25% reduction in mean per-home indoor water use over the baseline. The community-specific mean savings are 18,900 gallons/home/year in Lafayette, for an average of 24% savings in indoor water use, and 18,200 gallons/home/year in Wilsonville, for a mean savings of 27% in indoor water use.

End Use Data

The findings presented below represent data from two different metering systems, the Meter-Master metering and end-use metering equipment (see the Metering Plan section). One of the analysis goals of this study was to validate the Meter-Master metering equipment with the end-use metering installed on the clothes washers in 20 of the 50 homes. In addition to being redundant, the value of the end-use metering was that it allowed for detailed metering of the total clothes washer water use, hot and cold water use, and the machine energy (motor and controls), as well the dryer energy use.

For the statistical analysis in this study, 95% confidence intervals were computed for the mean difference in energy consumption within households after the *retrofit* equipment was installed. If the lower limit of the resulting confidence interval is greater than zero, one can conclude the amount of energy savings is statistically significant. This procedure assumes that observed energy consumptions are independent and constitute random samples from the respective underlying populations. While the participating households were not actually randomly selected, this is not expected to significantly impact the conclusions on energy savings.

This analysis assumes that the observed energy consumptions in the *baseline* and *retrofit* samples are representative of the expected energy consumptions on any given day with the same appliances. Sources of variability in the data include differences in appliance usage both within and between households. Of particular influence are the differences in different appliance usages due to factors such as temperature selection or load size. None-the-less, any water and energy savings found statistically significant are deemed so above and beyond this inherent type of variability in the consumption data.

The confidence intervals are computed in the following manner. The average savings is computed for each of the 50 households by subtracting the average *retrofit* appliance energy consumption from the *baseline* average appliance energy consumption. The mean and standard deviation of these 50 resulting household average savings are then represented respectively by D-bar and S_d. The resulting 95% confidence interval is then

$$\text{D-bar} \pm 1.96\, S_d \,/\, \text{sqrt}(50).$$

The 1.96 value is the corresponding percentile of the normal distribution that is appropriate due to the Central Limit Theorem given the relatively large sample size. The quantity S_d/sqrt(50) is the estimated standard error of the mean. Note that 95% of the time such intervals are computed, the true underlying water or energy savings for the particular appliance would be captured within the interval. Thus when the lower limit of a resulting interval exceeds zero, we are at least 95% confident that the true associated savings are indeed greater than zero.

Clothes Washer Findings

Figure 16 presents the Meter-Master mean per-cycle clothes washer total water use. These data are presented by community for the *baseline*, the *retrofit*, and for the resulting *savings*. The study's mean Meter-Master clothes washer data indicate a per-cycle savings of about 15.2 gallons. This included a mean savings low of 4.5 gallons/cycle (baseline machine was likely relatively new and/or used on low-water setting) to a mean savings high of 25.0 gallons/cycle (baseline machine was likely an older high water using model and/or used on full-load setting). The standard deviation of these savings is 6.7 gallons/cycle. The corresponding 95% confidence interval for the true mean savings, as described in above, is therefore 15.2 ± 1.96 x 6.7/sqrt(50). This gives the interval 15.2 ± 1.86, or (13.3, 17.1). We can thus conclude with 95% confidence that the true mean savings is not only greater than zero, but also actually greater than (or equal to) 13.3 gallons/cycle.

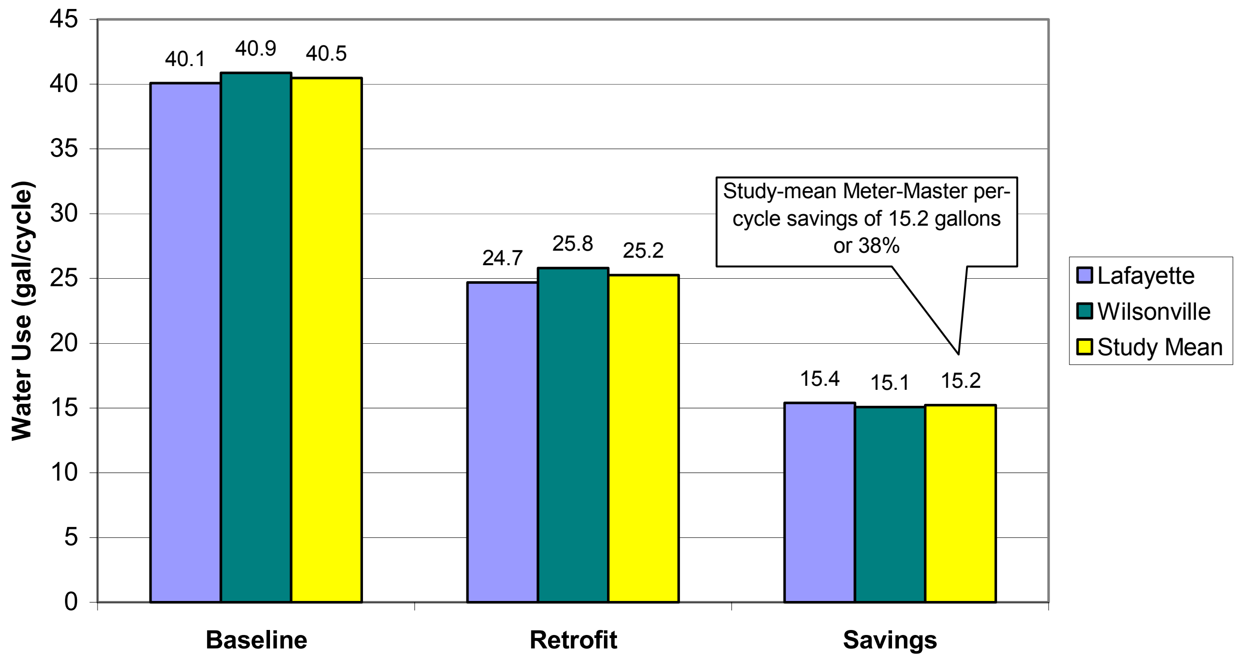

Figure 16. Clothes Washer Water Findings: Meter-Master Mean Per-Cycle Water Use and Savings (gal/cycle)

These savings represent a 38% reduction in the mean per-cycle clothes washer water use over the baseline. The community-specific savings are 15.4 gallons/cycle in Lafayette, for a mean savings of 38%, and 15.1 gallons/cycle in Wilsonville, for a mean savings of 37%.

Figure 17 also presents the mean clothes washer total water use results; however, these data were collected by the dedicated *end-use* metering equipment installed at the clothes washer. It is interesting to note the consistency of findings between the two metering systems. In most cases, these mean data differ by less than 1-2 gallons when comparing the results from the two metering systems. This end-use validation of the Meter-Master equipment gave us additional confidence in the metering systems.

The mean end-use clothes washer data indicate a per-cycle savings of 14.1 gallons. This included a mean savings low of 5.5 gallons/cycle, to a mean savings high of 23.0 gallons/cycle. The standard deviation of this savings is 4.6 gallons/cycle. Due to the smaller sample size (recall the end use metered data were collected on only 20 of the homes), the resulting confidence intervals are larger. The corresponding 95% confidence interval for the true mean savings is

14.1 ± 2.29, or (11.8, 16.4). We can thus conclude with 95% confidence that the true mean savings is greater than (or equal to) 11.8 gallons/cycle.

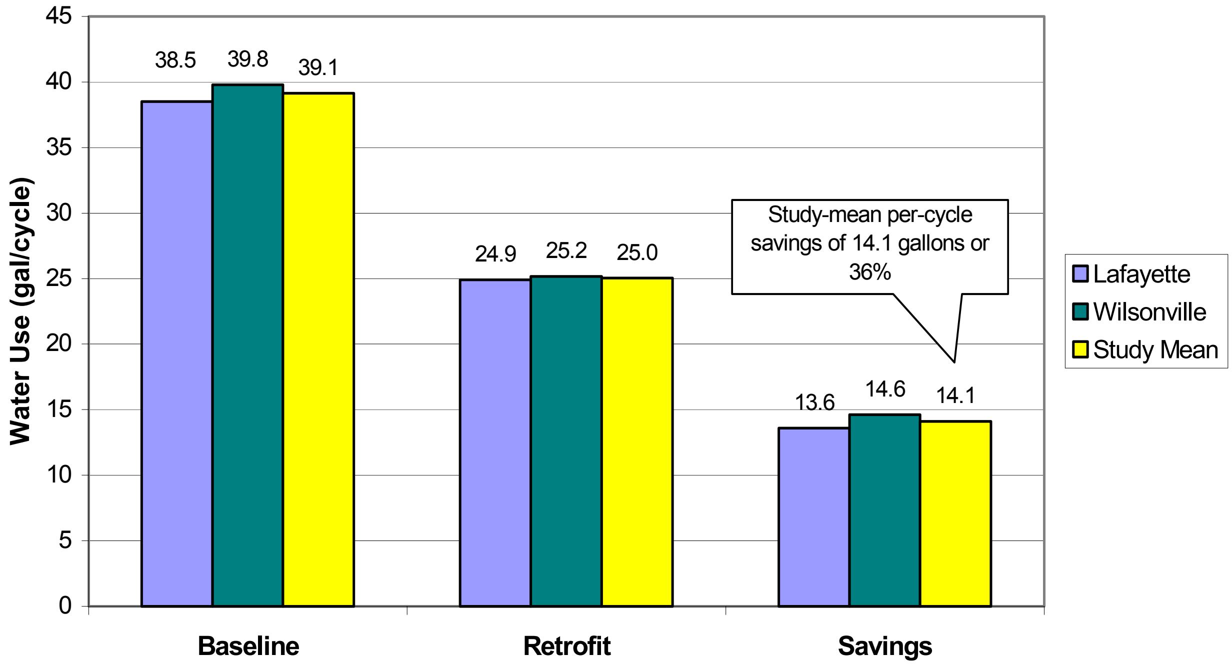

Figure 17. Clothes Washer Water Findings: End-Use Metered Mean Per-Cycle Water Use and Savings (gal/cycle)

These savings represent a 36% reduction in mean per-cycle clothes washer water use over the *baseline*. The community-specific savings are 13.6 gallons/cycle in Lafayette, for a mean savings of 35%, and 14.6 gallons/cycle in Wilsonville, for a mean savings of 37%.

The energy used by the clothes washers takes place by two different mechanisms. First, the energy needed by the electric motor and washer controls, and second the energy embodied in the hot water used by the washers. The energy used by the motor and controls is monitored directly; however, the energy embodied in the hot water must be calculated. To calculate this energy, the volume of the hot water used and both the hot and cold water temperatures are needed. As shown in Figure 8, the volume of hot water is measured by a dedicated hot water meter. The water temperature of both the hot and cold supply was measured during metering installation and equipment removal visits to the homes. Using these values, the energy content of the hot water is calculated. It should be noted that in homes using a natural gas water heater (20 of the 50 homes), this calculation accurately estimates the energy savings; however, it underestimates the actual amount of energy purchased by the participant for the use of heating hot water. For the purposes of consistency and simplicity, all savings are reported in kilowatt-hours (kWh).

In the case of a home with a gas water heater, to accurately account for the amount purchased, the natural gas water heater conversion efficiency should be used. The actual energy savings amount would be greater due to the inefficiency of energy conversion in a gas water heater compared with an electric water heater. However, the dollar value of these savings would be less due to the difference in energy cost between gas and electricity. Based on an average gas water heater conversion efficiency (estimated at 75%) and current electricity and natural gas prices ($0.058/kWh and $0.83/therm), the energy use and savings specific to the gas water heater case would increase by a factor of 1.33,[5] while the cost savings would decrease by a factor of 0.65.[6] Therefore, to calculate the energy savings in the gas water heater case, one would multiply the electric savings by 1.33 and convert these to the proper units, either therm or Btu. To calculate the relative dollar savings, one would multiply the electric water heater dollar savings by 0.65.

Figure 18 presents the mean clothes washer energy use and savings results. It is interesting to note the difference in *baseline* energy use comparing the Lafayette mean (1.1 kWh/cycle) to the Wilsonville mean (1.7 kWh/cycle). This difference is likely a function of the differences in *baseline* washer types, age, and usage (i.e., cycles selected) in the two communities. It is also interesting to note that in the *retrofit* case the difference is much less, perhaps indicating the variance in the *baseline* was more a function of the *baseline* equipment characteristics and less a function of usage.

The mean per-cycle clothes washer energy use data indicate a savings of 0.9 kWh/cycle. This included a mean savings low of 0.03 kWh/cycle and a mean savings high of 0.18 kWh/cycle. The standard deviation of this savings is 0.7 kWh/cycle. The corresponding 95% confidence interval for the true mean savings is 0.9 ± 0.35, or (0.6, 1.3). We can thus conclude with 95% confidence that the true mean savings is greater than (or equal to) 0.6 kWh/cycle.

These savings represent a 64% reduction in mean per-cycle clothes washer energy use over the *baseline*. The community-specific savings are 0.7 kWh/cycle in Lafayette, for a mean savings of 63%, and 1.2 kWh/cycle in Wilsonville, for a mean savings of 71%.

Clothes Dryer Findings

Figure 19 presents the mean clothes dryer energy use and savings results. It is again interesting to note the difference in *baseline* energy use comparing the Lafayette mean (3.7 kWh/cycle) to the Wilsonville mean (2.6 kWh/cycle). This difference is also likely a function of the differences in *baseline* dryer types, age, and usage in the two communities. However, unlike the clothes washer finding of less difference in the *retrofit* case, the clothes

[5] Factor calculated as 1 divided by the efficiency, or 1/0.75.

[6] Factor calculated as follows: [($0.83/therm x 1 therm/100,000 Btu x 3,412 Btu/kWh x 1/0.75)/($0.058/kWh)].

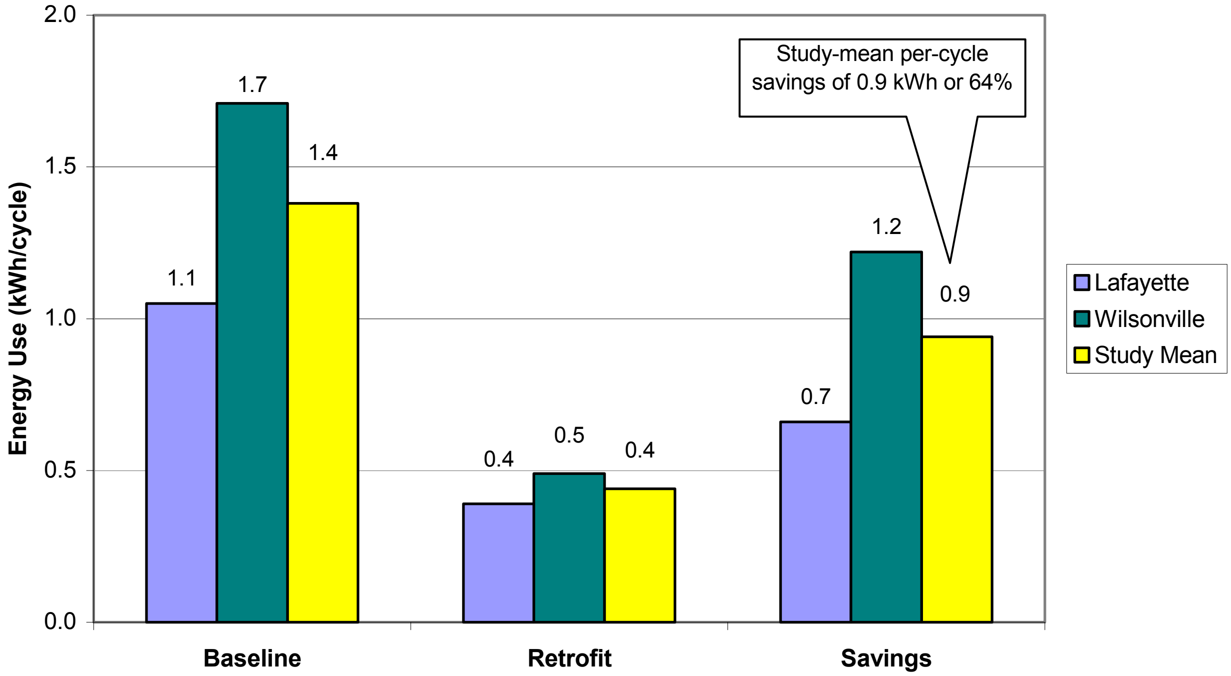

Figure 18. Clothes Washer Energy Findings: End-Use Metered Mean Per-Cycle Energy Use and Savings (kWh/cycle)

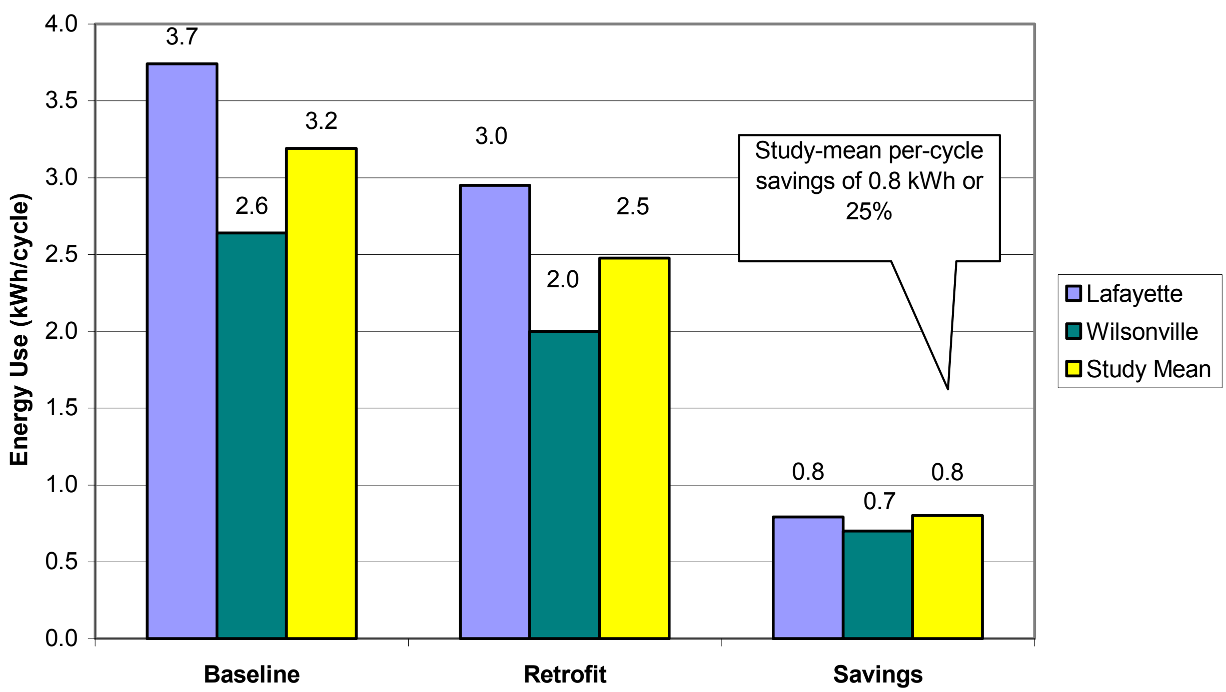

Figure 19. Clothes Dryer Energy Findings: End-Use Metered Mean Per-Cycle Energy Use and Savings (kWh/cycle)

dryers continue to show significant variance between cities in the *retrofit* case. Here, the consistent difference may suggest that the variance is more a function of how the equipment is used and less a function of equipment characteristics.

Taking a closer look at the dryer savings, it is important to note that, unlike clothes washers where energy savings are linked mostly to the hot water savings, the source of the clothes dryer energy savings is not as clear. The clothes dryer savings may be a result of one or more of the following mechanisms.

First, due to the high spin speeds typically achieved in front-loading clothes washers, at the end of the clothes washing cycle there may be less moisture remaining in the clothes, a so-called lower *remaining moisture content*. If this is the case, and if the dryer has the necessary controls to turn itself off when it senses the clothes are dry, the *retrofit* dryer should use less energy than the *baseline* case.

Second, by virtue of its design and age, the way a dryer is used can have a potentially large impact on its energy use. For instance, while all new dryers have automatic termination control (i.e., the dryer shuts off automatically when the clothes are dry) they also have the "timed dry" option. Thus, the termination control option selected can have a large impact on dryer energy use. In this evaluation, the option selected was not tracked; therefore, the savings (or in two participant's cases, the *increased use*) over the *baseline* are influenced by any changes in how dryers were used. Furthermore, prior to 1994, clothes dryers were not required to have termination control; therefore, many dryers functioned on a timed-dry mode only. The lack of termination control (or the lack of use, if it were present) can result in additional energy use due to improperly timed settings.

Finally, some dryer savings could be related to technology improvements of the new dryer in relation to an old, or poorly maintained, *baseline* dryer. Even in comparison to old dryers having termination control, some savings may be expected from the new dryer because of improvements in heat delivery, termination control accuracy, and perhaps the installation of the vent connection.

To better allocate the source(s) of the dryer savings, a more detailed study of clothes dryer savings potential should be completed. This study should include determining the remaining moisture content, along with an accurate accounting of clothes washed and then dried, while capturing all settings selected and energy used both at the washer and dryer.

The mean per-cycle clothes dryer energy-use data indicate a savings of 0.8 kWh/cycle. This included a mean savings low of -0.29 kWh/cycle and a mean savings high of 1.52 kWh/cycle. The standard deviation of this savings is 0.78 kWh/cycle. The magnitude of this standard deviation reflects the occurrence of negative savings (increased energy use in the *retrofit* case). While these negative saving occurrences (2 of 20) could be considered "outliers," there was not enough information to make a defendable judgment; therefore, these data were included. The corresponding 95% confidence interval for the true mean savings is 0.8 ± 0.39, or (0.4, 1.2). We can thus conclude with 95% confidence that the true mean savings is greater than (or equal to) 0.4 kWh/cycle.

Dishwasher Findings

Figure 20 presents the mean per-cycle dishwasher total water use and savings results. These data are presented by community for the *baseline*, the *retrofit*, and the resulting *savings*. The dishwasher data indicate a mean per-cycle savings of about 3.7 gallons. This included a mean savings low of -1.4 gallons/cycle (*baseline* machine was relatively new and used on low-water cycle) to a mean savings high of 8.6 gallons/cycle (*baseline* machine was an older high-water-using model). The standard deviation of these savings is 2.0 gallons/cycle. As with the clothes washer data, there is some difference in savings by community. This variance is likely a function of the differences in *baseline* dishwasher types, age, and usage (i.e., cycles selected) in the two communities. The corresponding 95% confidence interval for the true mean savings is 3.7 ± 0.55, or (3.2, 4.3). We can thus conclude with 95% confidence that the true mean savings is greater than (or equal to) 3.2 gallons/cycle.

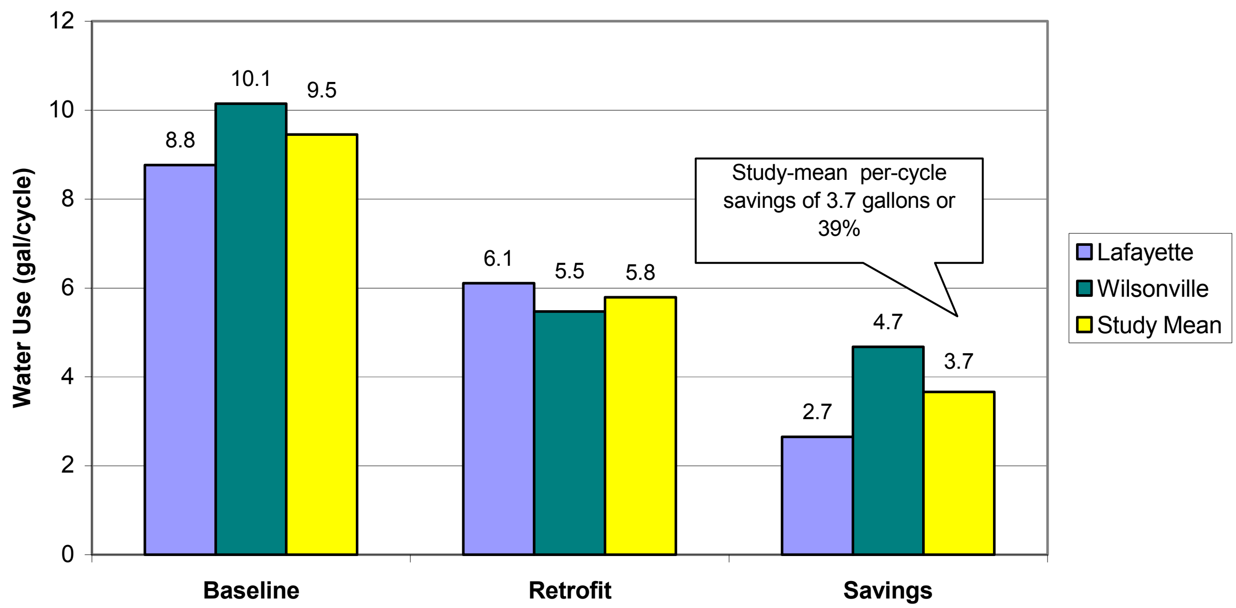

Figure 20. Dishwasher Water Findings: Meter-Master Mean Per-Cycle Water Use and Savings (gal/cycle)

These savings represent a 39% reduction in mean per-cycle dishwasher water use over the baseline. The community-specific savings are 2.7 gallons/cycle in Lafayette, for an average of 30% savings, and 4.7 gallons/cycle in Wilsonville, for an average of 46% savings.

Figure 21 presents the mean dishwasher hot water energy use and savings results. It is important to note that the savings presented here are only in hot water; the pumping, internal water heating, and controls energy were not metered for the dishwashers. While these unmetered parameters represent a portion of the total dishwasher energy use, this analysis assumes a similarity in function of these parameters from the *baseline* to the *retrofit* as well as similarity in use by the resident (e.g., if a resident used the "heated drying" mode in the *baseline* case it was also used in the *retrofit* case).

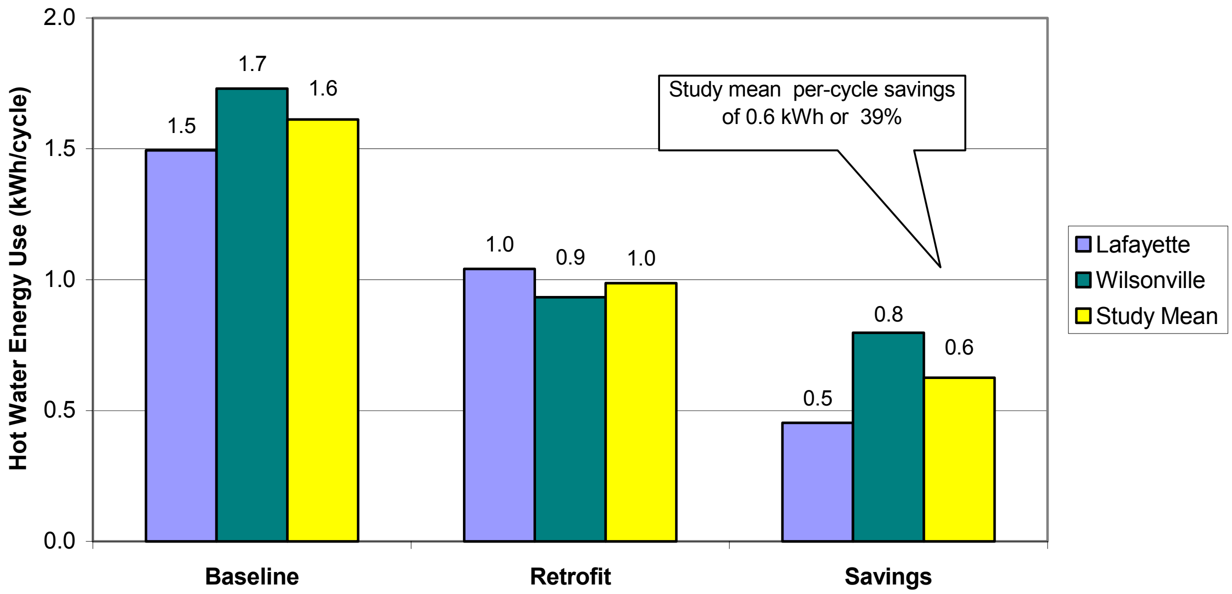

Figure 21. Dishwasher Energy Findings: Meter-Master Mean Per-Cycle Hot Water Energy Use and Savings (kWh/cycle)

The dishwasher hot water energy use and savings were calculated based on the volume of water use (as recorded be the Meter-Master) and the temperature difference of the water coming into and out of the water heater. These savings are considered conservative in that once water is inside a dishwasher it typically is further heated by the dishwasher's booster heater. Typically, this water is heated to between 140 and 160°F. This analysis captures the reduction in hot water being delivered to the dishwasher; however, it does not capture the reduction in the energy that the booster heater uses to elevate the water to the higher temperature.

The mean per-cycle dishwasher hot water energy use data indicate a savings of 0.6 kWh/cycle. These savings represent a 39% reduction in mean per-cycle dishwasher hot water energy use over the *baseline*. The community-specific savings are 0.5 kWh/cycle in Lafayette, for a mean savings of 30%, and 0.8 kWh/cycle in Wilsonville, for a mean savings of 46%.

Toilet Results

Figure 22 presents the mean per-use toilet total water use and savings results. These data are presented by community for the *baseline*, the *retrofit*, and the resulting *savings*. As discussed in the Efficient Equipment subsection on page 14, the retrofit toilets are a unique design employing an innovative two-button flushing mechanism; one button is designed for liquid waste and the other is designed for solid waste. The data showed that the toilets performed as expected, with the liquid flush using about 0.9 gallons and the solid flush using about 1.6 gallons. The differential between the two flushing modes, 0.7 gallons per flush, could be expected to be saved by using this technology over a standard low-flush (i.e., 1.6 gallon per flush) toilet in the liquid flushing mode. Furthermore, the data showed that on average the liquid flush mode was used about 65% of the time. Therefore, based on the study-wide use, this toilet design offers an additional 2,000 to 2,500 gallons savings per home per year over the standard 1.6 gallon per flush toilet.

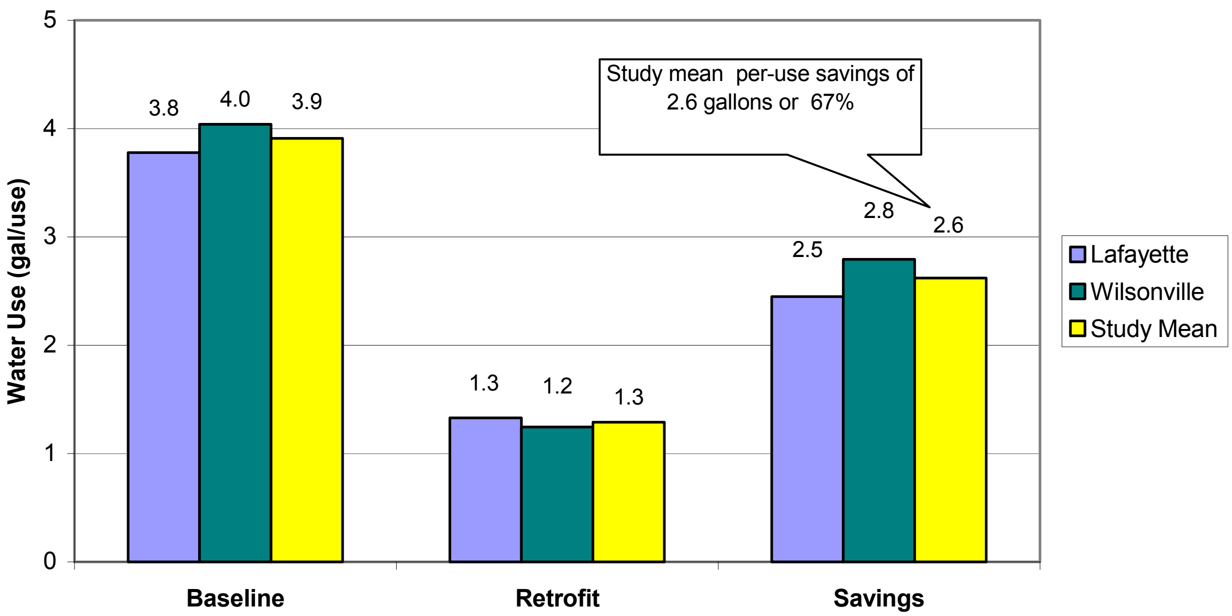

Figure 22. Toilet Results: Meter-Master Mean Per-Use Water Use and Savings (gal/use)

The toilet data indicate a mean per-use savings of about 2.6 gallons. This included a mean savings low of 1.6 gallons/use (most likely a pre-EPAct toilet modified to operate in a low-consumption mode) and a mean savings high of 4.5 gallons/use. The standard deviation of these savings is 0.87 gallons/use. The corresponding 95% confidence interval for the true mean savings is 2.6 ± 0.24, or (2.4, 2.8). We can thus conclude with 95% confidence that the true mean savings is not only greater than zero, but also actually greater than (or equal to) 2.4 gallons/use.

It is interesting to note the difference in *baseline* water use comparing the Lafayette *baseline* mean of 3.8 gallons/use to the Wilsonville *baseline* mean of 4.0 gallons/use. This difference is likely a function of the differences in *baseline* toilet types and age in the two communities. It is also interesting to note that in the *retrofit* case, the same relative difference exists (about 12%); however, the higher usage has changed cities from Wilsonville in the *baseline* case to Lafayette in the *retrofit* case. The variance in the retrofit case would have to be explained by toilet usage and the ability of the user to select one of two toilet-flushing flush modes (see the Efficient Equipment subsection for equipment description and Appendix B for toilet specifications).

End-Use Annual Savings Data

The data collected were analyzed on a per-cycle/per-use basis as well as on a per day basis. Capturing data on a per-day basis affords the ability to estimate the annual impacts of the water and energy saving. While these extrapolations can be subject to a variety of external variations (e.g., seasonal differences in how people use their clothes washer or other equipment), the authors of this evaluation feel comfortable that in most cases those variations would not significantly affect the outcome.

Annual Water Savings

Figure 23 presents the mean annual per-home water savings by equipment type. It is interesting to note that while on a per-cycle or per-use basis the clothes washer is the dominant savings device in the program (15.2 gallons/cycle savings for the clothes washer to 3.7 gallons/cycle for the dishwasher to 2.6 gallons/use for the toilet), it is the toilet that overwhelmingly drives the total program savings over time because it is used more often. Moreover, these savings indicate the importance of prioritization when making decisions on equipment selections for inclusion in a water conservation program.

On a per-home basis, the mean annual water savings is about 18,600 gallons. From a regional perspective, if SWEEP were implemented in 1,000 pre-EPAct homes the expected water savings would be over 18.5 million gallons/yr.

Annual Energy Savings

The annual energy savings estimated from the program equipment is included in Figure 24. As mentioned, these saving are predominately due to the savings in the hot water in both the clothes washers and dishwashers; the clothes dryer savings may due to a reduction in remaining moisture content in addition to other technical advantages of the *retrofit* clothes dryer over the *baseline* dryer.

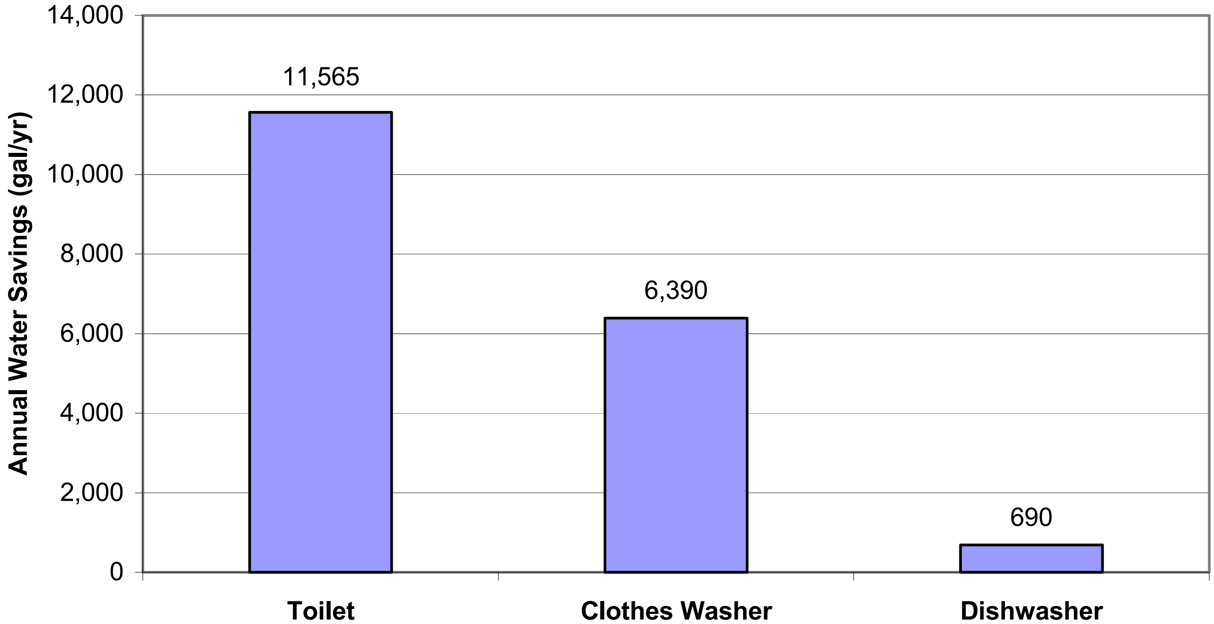

Figure 23. Mean Annual Per-Home Water Savings (gal/year)

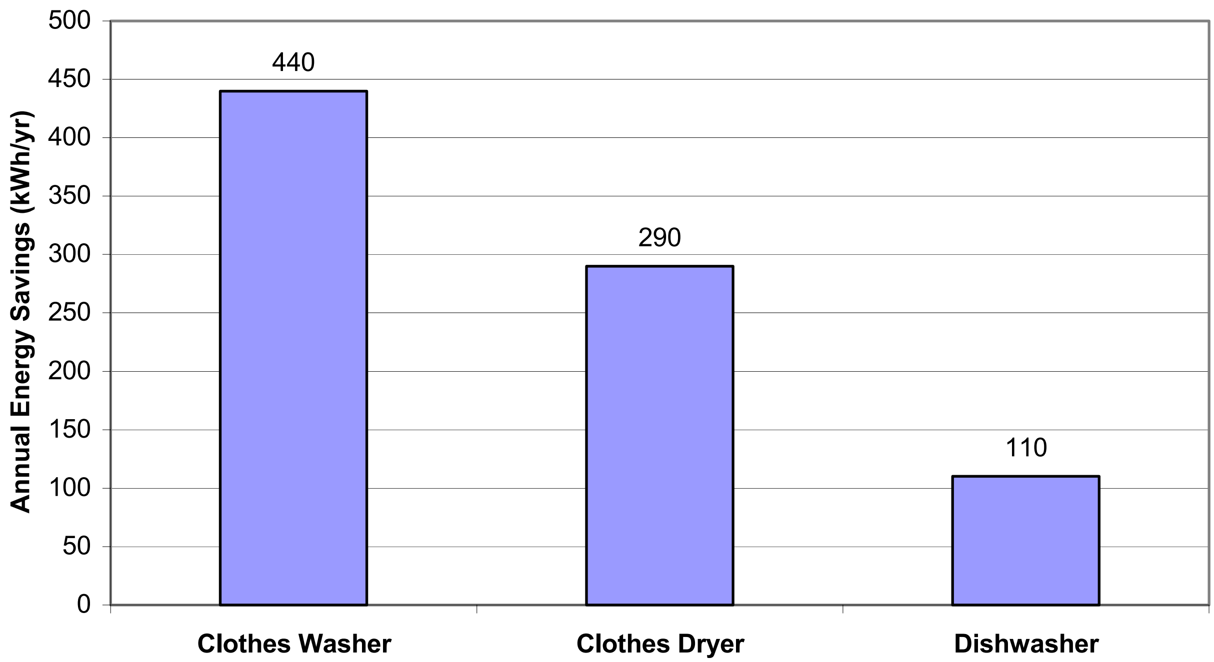

Figure 24. Mean Annual Per-Home Energy Savings (kWh/year)

Additional energy savings were evaluated for two other program appliances, low-flow showerheads and hot water heaters. These data are not reported in the body of this report due to statistical significance issues—in the case of the showerheads, only 6 of the 50 homes had all high-flow baseline showerheads replaced with low-flow showerheads. In the case of the hot water heaters, the relatively short duration of metering precludes the ability to draw statistically significant results from the data. While not statistically significant, the data are presented, in Appendix D. While the accuracy of the data collected for the showerheads and hot water heaters is not suspect, the potential for misuse of the findings has led the authors to consider these data interesting, but not valid for decision-making purposes. Furthermore, the authors of this evaluation request that these data not be used for any evaluation, decision-making, or program development purposes. These data are provided because the corresponding equipment was metered and program partners indicated an interest in their results.

In addition to the reduced water and energy use at each home, there are, depending on the types of water/wastewater treatment systems, corresponding reductions in energy use at the distribution and treatment systems. These reductions usually include reduced energy use for pumps and mixing/aerating equipment, as well as reductions in treatment chemicals. Preliminary data from Wilsonville indicate an average energy intensity of 3.0 kWh/kgal. This value is the sum of the water supply/treatment energy intensity of 2.5 kWh/kgal and the wastewater treatment intensity of 0.5 kWh/kgal. While this is lower than the California statewide average of 4.1 kWh/kgal (CEC 1999), it is in the range of the expected energy intensities of 1.9 kWh/kgal to 9.0 kWh/kgal (QEI 1992). Based on the mean per-home water savings of 18,600 gallons/yr, the resulting energy impact at the community water distribution, water/wastewater treatment systems is about 55 kWh per home per year.

On a per-home basis, the mean annual electricity savings (assuming electric water heating) is 840 kWh. From a regional perspective, and including the electrical savings at the points of water distribution and treatment, if SWEEP were implemented in 1,000 pre-EPAct homes, the expected electricity savings would be over 890,000 kWh.

Conclusions

The major objective of this study was to evaluate a suite of water- and energy-efficient appliances installed in 50 homes. The quantification of the savings took place on a per-appliance, per-cycle basis and were aggregated-up by home and finally across all homes in the study. All savings were calculated in relation to the existing baseline equipment present in the homes at the start of the study.

The results of this study showed that the mean per-city savings, from the appliances and equipment installed, was more than 450,000 gallons/yr for the 25 homes in each community. The per-home savings were reported at a mean of 18,600 gallons/yr and about 840 kWh/yr. The mean per-home dollar savings, using mid-2000 water/wastewater and electricity rates, is estimated to be greater than $160 per year.

The benefits to the two cities from this program are in the potential for reducing demand both at the water supply and waste treatment points. These demand reductions, while not having a significant impact from only 25 homes, could hold great potential as the program grows. One very positive effect the demand reductions can have is providing needed relief to water system capacity shortages occurring on the "peak day." Additional impacts can take the form of justifying delays in planned capital upgrades to the system. These delays can have a net positive dollar impact to the communities through the deferment of capital expense. These potential system impacts from SWEEP-type programs are the focus of the computer model being developed by George Mason University and due to be released in spring 2001.

The results of the individual program appliances showed that on a per-cycle basis the clothes washer reported the greatest amount of water savings at about 15.0 gallons/cycle. These were followed by the dishwasher savings at 3.7 gallons/cycle and then the toilet at 2.6 gallons/use.

Examining the per-home results on an annual basis showed that clothes washers still showed significant savings, a mean of 6,390 gallons/yr; however, these savings were roughly half of the mean annual savings reported from the toilets, 11,565 gallons/yr. Of course, this is because toilets are used far more often than clothes washers; therefore, the annual savings are much higher.

The value of the resource savings in the SWEEP study is significant and will be reflected in lower energy and water bills for the homeowner. Figure 25 presents the mean annual impact per home, by appliance and by resource savings. These calculations use a current Lafayette and Wilsonville combined marginal rate of water/wastewater of $6.50 per 1,000 gallons saved and a

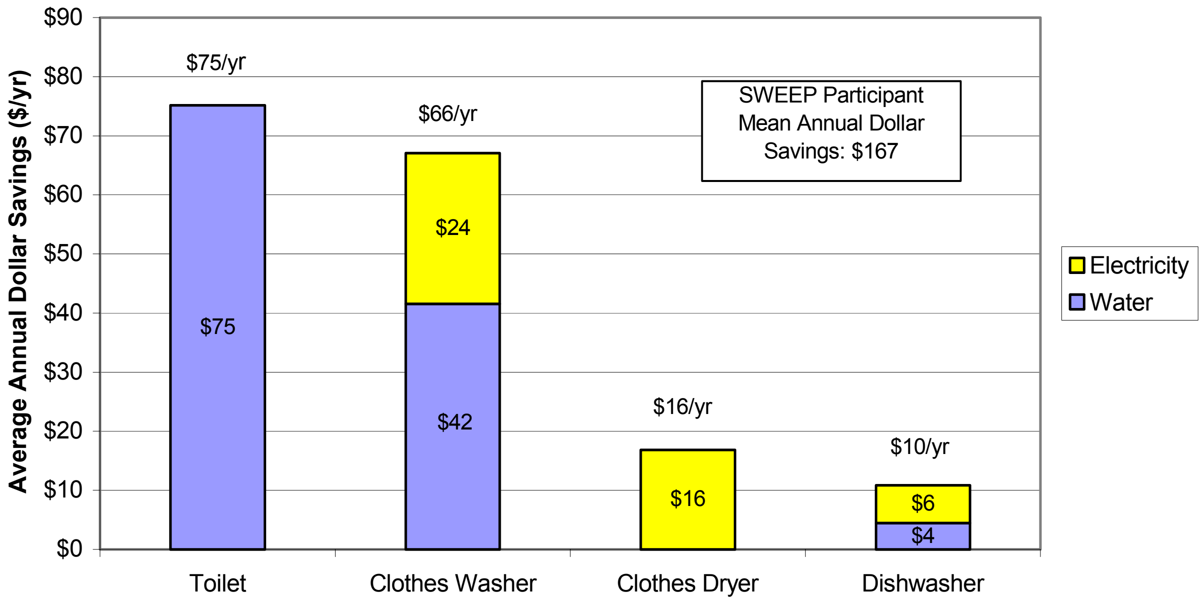

Figure 25. Mean Annual Per-Home Dollar Savings ($/year): SWEEP Program Equipment Findings

current marginal electricity rate of $0.058 per kilowatt-hour saved. To calculate the dollar savings for homes using natural gas water heaters, the electricity portion of the savings should be multiplied by 0.65.[7]

It should again be noted that the water/wastewater rate in both communities will be increased over the next year with the final target approaching $8.00 per 1,000 gallons. Likewise, the electricity and natural gas rate increases are expected. In addition to saving dollars today, these appliances and fixtures afford the ability to hedge against future water, electricity, and natural gas rate increases.

In summary, the SWEEP program, as implemented in the communities of Lafayette and Wilsonville, Oregon, produced significant savings in water and energy when compared with the *baseline* equipment. The study demonstrated that a properly chosen suite of appliances and equipment can make a significant impact on indoor water use—the study mean savings were 25% of indoor water use, for an average per-home savings of 18,600 gallons/yr. These water savings were present at the clothes washer with a 38% reduction over the mean baseline use, the dishwasher with a 39% reduction over the baseline use, and the toilets with a 67% reduction over the baseline use. The resulting per-home mean annual energy savings totaled 840 kWh and reduced clothes washer energy use (mechanical and hot water) by 68%, dishwasher energy use (hot water use only) by 39%, and clothes dryer energy use by 25%.

[7] This factor adjusts the results to account for the difference in gas and electricity costs, as well as their difference in assumed water heater efficiencies, see the Clothes Washer Findings subsection on page 28.

Finally, from a regional perspective, if SWEEP were implemented in 1,000 pre-EPAct homes, the expected resource savings would include over 18.5 million gallons of water and over 890,000 kWh of electricity per year.

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Appendix A

SWEEP Program Documents

SWEEP Participant Interaction Material

SWEEP Participant Questionnaire

Thank you for your interest in the SWEEP program. Please fill out this questionnaire (answer all of the questions) and return it to:

City of Wilsonville
Attn: Public Works Department
30000 SW Town Center Loop E.
Wilsonville, OR 97070

But before you fill out the questionnaire, please read this:
Pacific Northwest National Laboratory, not the City, will select the project participants. ***Participant selection will be made to assure that together they make up a statistically valid, representative sample of the target homes being studied.*** If you are selected, you will receive your appliances in the spring of 2000. You will be required to keep a daily journal on your use of the appliances. Technicians will come to your home several times to install meters and equipment, and to take readings and remove meters.

You must agree to participate in the study for its entire duration (which may be up to a year) and to not change the number of people living in your home during the study. In addition, you must agree to participate in all conservation measures requested by the study sponsors. We are looking for people who can make a long-term commitment to ***water and energy conserving equipment and practices***, not people just looking for free appliances.

To be eligible, you must own your home and have lived in it for at least one year. You must also have a washing machine, electric dryer and dishwasher currently installed. Preference may be given to homes built prior to ***1992.***

1. Your name:____
2. Your address:____
3. Your phone #:____
4. Total number of people living in your home:________________
   Number of adults:___________________________________
   Number of children and their ages:_____________________
5. The size of your home in square feet:______________________
6. Year your home was built:_________________________________
7. How long have you lived at this address?____________________
8. Please indicate whether you own the following:

Electric water heater	yes___	no ____	approx. age in years:____
Gas water heater	yes___	no ____	approx. age in years:____
Washing machine	yes___	no ____	approx. age in years:____
Electric clothes dryer	yes___	no ____	approx. age in years:____
Gas clothes dryer	yes___	no ____	approx. age in years:____
Built-in dishwasher	yes___	no ____	approx. age in years:____
Underground sprinkler	yes___	no ____	approx. age in years:____

9. Please indicate how many of the following you have in your home:
   Toilets ___ Sinks ___ Showers ___
10. Housing type (please check all that apply):
    Owner occupied ___
    Renter occupied ___
    Mobile/Modular/Manufactured home ___

SWEEP Participant Acceptance Letter

February 22, 2000

Dear SWEEP Applicant:

I am writing to inform you that you have been selected to participate in the Saving Water and Energy Education Program (SWEEP) – congratulations.

The next step is for you, or someone representing your household, to attend an introductory meeting scheduled for Wednesday, March 8, 2000 at 7:30 pm at the Community Center (located behind City Hall at 30000 S.W. Town Center Loop East).

The meeting should last about 1 hour and we will discuss:

- Program objectives
- Program requirements
- Appliances and equipment to be donated
- Disposition of old appliances and equipment
- Energy and water metering equipment to be installed in your home
- Schedules for installation of removal of appliances and metering equipment
- Questions from program participants

If you have an opportunity before the meeting, please visit Krohn's Appliance in Newberg and look at the Frigidaire laundry and dishwasher products that are included in this program. As we will discuss at the meeting, if you agree to participate, you will be required to trade your old clothes washer/dryer and dishwasher for these new energy- and water-efficient Frigidaire appliances. You will also be required to trade your toilets for new water-efficient toilets made by Caroma. Installation and old appliance removal will be provided by Krohn's. The city of Wilsonville will coordinate the installation of your new toilets. If this new equipment does not meet your needs, please let us know as soon as possible; we will designate an alternate to take your place in the program.

The location of Krohn's and the appliances included are listed below. Krohn's personnel are aware of this program and should be able to answer any questions you have about the equipment.

Krohn's Appliance	**Frigidaire washer/dryer:** "Gallery" Model FWT 449
516 E. 1st Street	**Frigidaire dishwasher:** Model FDB 635
Newberg, OR	
(503) 538-3613	

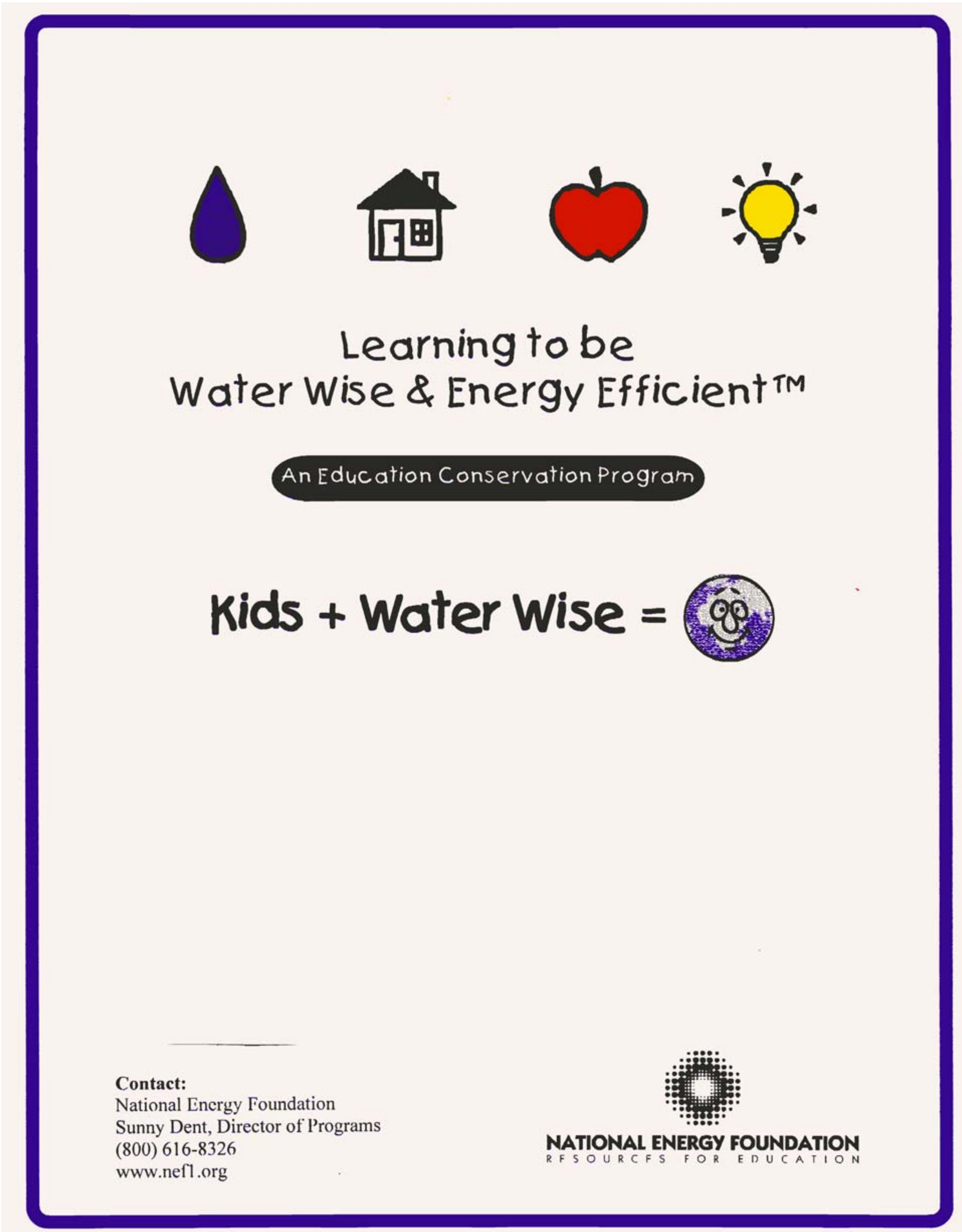
Again, congratulations and I look forward to working with you in the coming months. Feel free to contact me if you have any questions

Sincerely,

Greg Sullivan
Senior Research Engineer
Pacific Northwest National Laboratory
P.O. Box 999, MS K8-17
Richland, WA 99352

SWEEP Schools and Community Programs

School Curriculum



Poetry/Essay Contest Winning Entries

As the summer draws to a close, it's tempting to think the water shortage is over. But conservation is a year-round need. Earlier this year, 96 Wood Middle School students entered an essay/poetry contest regarding conservation. Students were asked to express thoughts they would like to share with members of the Wilsonville community. Below are the four prize winning entries.

To Whom It May Concern:

Hi. I've heard you're considering wasting our precious water and energy. What's this you say? Water and energy aren't precious! It's not my business what you do with your water and energy! *Excuse me!* Wake up and smell the coffee! Water and energy *are* precious and it's *not* just your water and energy you're wasting, so some of us it *is* my business. Let me explain:

First of all, not everything lasts forever. I know that energy lasts forever, but you can't harness or use it forever. I mean, sometimes it escapes into space and there it won't be harnessed again for a long time. When talking about water, the source you get your water from may not be around for even ten years if you waste it. In the city I currently live in (Wilsonville), we get our water from wells into the water table. Which rises from the precipitation in the soil can fill them up. Then you don't have any water until there is enough precipitation seeping through the soil. You want to conserve things to keep them around longer.

Second, here's another look at this situation. Imagine you're stranded in a desert, say in New Mexico. There's nothing around you except for many, many cactuses. All you have are the clothes on your back and about a quart of water. What are you going to do? How are you going to survive? If you had been taught to conserve, you would probably drink little sips of the water every so often (you would not use it all or almost all of it up in the beginning.) You would probably also try to conserve your energy. Maybe by walking by night and sleeping by day. (It is cooler at night so you won't use so much energy sweating and you don't use much energy sleeping.) The reason I brought this up was because this is much like the situation I am talking to you about. This can also be compared to when you get a paycheck. You can't go out and use up what you've got because then you won't have any left 'til the next paycheck. No one's going to give you any of their money unless they have extra, because they need theirs for their own needs.

Third, it's not that hard to conserve water and energy. It's something you probably learned in Kindergarten you just didn't know you knew it. Turn off the water or any electrical appliances when you're not using them. Don't take super long showers. If you have pets, try to use the extra water from their water bowl to water plants. Have squirt gun fights on the grass, not the road; that way the grass gets watered while you are having fun. Get any leaks in your plumbing that you might have fixed. Don't turn on the sprinklers outside in the middle of the day because then most of the water evaporates into the air.

Fourth, you'll notice that once you start conserving water energy, your bills for these tings will go down quite a bit. Even small amounts of water and energy saved every day can add up to be a lot of money. With this extra money, you can buy more of the things you really want.

Are you awake yet? Have you smelled the coffee about conserving water and energy? Hopefully you *are* awake and you *have* smelled the coffee. Show people everywhere that you aren't lazy. Show them that you can and will conserve water and energy as much as you are able. Believe me, it will be much appreciated.

Sincerely,

Poetry/Essay Contest Winning Entries (con't)

Conserve Our Water and Energy!

Do you want your children's kids not having enough water and energy, the two essentials to life? Do you want them getting sick just taking a few mere drinks of water? If we keep neglecting the fact that we do not have enough water to waste, then that is going to happen.

You might say how could we conserve our water and energy? I think that if we follow a few guidelines, like taking shorter showers, then we could stop our water problem. Here are a few examples:

- Taking shorter showers
- Watering your lawns every few days instead of every day
- Don't leave the water running, like in the bathtub and when brushing your teeth
- When you have trash, don't dump waste in the rivers and oceans that can be thrown out or recycled
- Just use common sense while using water

If we follow a few steps like the ones above, then I think that our water would be cleaner. With cleaner and better water, then we have a better and safer world to live in. Since water is one of our only irreplaceable natural resources, we have to have it for a lifetime, for without it, we would not live.

Pretty much everything we do depends on energy. Without energy, we couldn't function. The city of Wilsonville and the whole nation needs to work on conserving our energy, so in the future we will have plenty of it to live on. If we are going to do this then I have come up with a few ways to do this. They are:

1. When you leave a room, make sure that all lights and things that are running, such as stereos, are turned off when leaving or when you don't need them anymore.
2. Only use the amount of energy needed; do not overuse it.
3. Don't leave the water running; that uses energy too.
4. If something is plugged in such as a curling iron or lights then unplug them as soon as you are done using them. If you don't need them at all, then don't plug them in, in the first place.
5. Just use common sense when using electricity and energy.

If everyone followed these few simple steps while using water and energy, then our future and the future for our kids and their children will be a success. If we use up all of our natural resources, then we would all be in a lot of trouble. Please, don't mess up the future for my future kids and me.

Poetry/Essay Contest Winning Entries (con't)

CONSERVING WATER AND ENERGY

You may think that we will have water and energy forever and ever. Well, you're wrong. Sooner or later we will have used up all water and energy will be gone because we don't use it wisely. The whole world knows that we need water to stay alive. We must know how to conserve it.

Some ways that we can save our energy is to <u>not</u> leave lights on when we don't need them, or leave the house. Like on a sunny day, open the blinds and window instead of turning on the lights. Another way is not watch TV or listening to the radio as much, instead, go outside and play. One more way to save energy is to always unplug things around the house. It is also safe.

Energy has made a huge difference in the way we live today since the 1800's. Now we can cook in microwaves and on electric stoves. We use lights instead of candles. And, the TV's give us warnings and watch programs. As you can tell electricity is very important so we need to save and use only what we need at all times.

Water is a very valuable thing to us. So you need to know how to use it wisely. Ways to do that are to not leave the water running or dripping when you brush your teeth or wash your hands. Use only what you need at all times. And only water your lawn on days you need to in the summer and springtime.

Did you know that our water goes in a cycle? And that we use the same water all the time? So you could be drinking the same water that Cleopatra or Caesar took a bath in. But there is no need to worry, because the water goes in a cycle so all of it gets cleaned.

The water cycle starts up in the clouds. The second step is when the clouds let the water out (rain). Next is when the water comes to us and we use it. This is where we have to know how to use it well. Then the last step is when the water goes to the ocean and vaporizes back into the clouds. That is the water cycle.

As you see water and energy are very important to us. So you need to use these precious things wisely.

Poetry/Essay Contest Winning Entries (con't)

RIVER BLUES

To the Tune of "Oh Susanna"

Streams, rivers and oceans all are so blue
At least that's how I thought it was until I looked it through
The water problem we have had, oh it scares me a lot
I wish that we could find the water that we have always sought.

Oh dear Wilsonville we need some watered land
Or else my beloved city cannot start to expand.

We thought that the Willamette would answer our plea
But half of that darned river is made of yellow...HEY!

Oh dear Wilsonville we need some watered land
Or else my beloved city cannot start to expand.

If we could let our lawns go brown for just a year or two
It would make it so much better for even you and me.
If everyone took showers that lasted five minutes per day
You'd save a lot of water and you'd never have to pay.

Oh dear Wilsonville we need some watered land
Or else my beloved city cannot start to expand.

Water conservation means a heck of a lot to me
And if we worked together we would all be so happy.

Oh dear Wilsonville we need some watered land
Or else my beloved city cannot start to expand.

SWEEP Promotional Material

Conservation Fair Announcement

SAVE
Water
Energy
Money

Captain Efficiency says

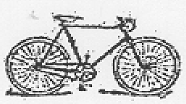
"Come to the Wilsonville Conservation Fair"

Saturday, June 10

10 a.m. to 3 p.m., RAIN OR SHINE

Wilsonville Community Center, 7965 SW Wilsonville Road

- Visit the new Captain Efficiency interactive exhibit designed to educate students and adults about the latest in water- and energy-saving technology for home and garden



- Enter to win a 21-speed Diamondback mountain bike from G.I. Joe's and home improvement equipment from Shebuski & Lloyds Hardware
- Drink solar-brewed coffee from our solar electricity display
- Learn how to save up to $250 a year on your water and energy bills at free workshops
- Find out about zero down, low interest loans and state tax credits for high-performance clothes washers, dishwashers, toilets, showerheads and irrigation equipment
- Check out the Honda Insight—a 70 mpg gas-electric hybrid car—and the all-electric EV1

Especially for Kids

Get cool free stuff • Play with solar K'nex and toy cars • Meet Bullwinkles' roving cartoon characters • Find out what kids think about saving water and energy: poems and essays from Wood Middle School • Mayor presents student awards at 1:30 p.m.

Contributors: Bullwinkles, G.I. Joe's, Lamb's Thriftway, Lowrie's IGA, Shebuski & Lloyds Hardware

Participating Retailers: Fry's Electronics, Krohns Appliance Center, George Morlan Plumbing, Shebuski & Lloyds Hardware

City of WILSONVILLE

OREGON OFFICE OF ENERGY

PGE Portland General Electric

For more information call Dave Kanner at 570-1505 or Jeff Bauman at 570-1542

Program Promotional Brochure

Conserving Water and Energy Saves Money

Here are the savings you'll enjoy *every year* if you replace inefficient appliances and fixtures with high-performance models:

	Water	Energy*	Money[1]
Clothes washer	4,900 gal	26 therms and 150 kWh	$64
Dishwasher	1,000 gal	5 therms and 55 kWh	$14
Toilets	10,000 gal	—	$80
Showerheads	7,000 gal	27 therms or 600 kWh	$72 $90

* Energy savings for clothes washer and dishwasher are for gas water heating. If you have an electric water heater, you'll save a little more. Clothes washer savings also include reduced drying time in an electric dryer. If you have a gas dryer, you'll save a little less. For showerheads, use therms if you have a gas water heater; use kWh if you have an electric water heater.

[1] Approximate savings on water, sewer and energy bills for a typical household with inefficient appliances and fixtures. Based on Wilsonville water and sewer rates (after rates more than double by April 2002) and local energy rates.

If you install all of these high-performance appliances and fixtures, you'll save about 25% on your water bills and 10% on your energy bills — $230 to $250 a year. How much you'll save depends on household size, usage, fuel type, and the appliances and fixtures you replace.

Source: Oregon Office of Energy

SWEEP (Save Water & Energy Education Program)

SWEEP participants

City of Wilsonville
City of Lafayette
Portland General Electric
Oregon Office of Energy
Frigidaire Home Products
Cooperative Technologies & Services International
U.S. Department of Energy
Pacific Northwest National Laboratory
Northwest Energy Efficiency Alliance
League of Oregon Cities
Caroma Company
Energy Technology Laboratories
Krohns Appliance Center
Shebuski & Lloyds Hardware
George Morlan Plumbing

For more information...

...on incentives to save water, energy and money, please visit participating SWEEP retailers or call the Oregon Office of Energy.

OREGON OFFICE OF ENERGY
Toll-free in Oregon: 1-800-221-8035
Web site: www.energy.state.or.us

May 2000

Get cash back, tax credits and low-interest loans for high-performance appliances, fixtures and irrigation equipment

SAVE Water Energy Money

SWEEP (Save Water & Energy Education Program)

City of WILSONVILLE
PGE Portland General Electric
OREGON OFFICE OF ENERGY

Program Promotional Brochure (con't)

Wilsonville water rates will more than double over the next two years. The increases will help pay for construction of a plant to treat water from the Willamette River.

The City of Wilsonville has teamed up with the Oregon Office of Energy and Portland General Electric to help you save water — and energy — and reduce your utility bills.

Zero down at 7 1/2% interest

Beginning June 1, Wilsonville residents and businesses can get a 7 1/2% loan for 36 months from the City of Wilsonville for appliances, fixtures and irrigation equipment that save water and energy:

- Premium-efficiency clothes washers and dishwashers*
- High-performance toilets
- High-performance showerheads
- Kitchen faucet aerators with a flip switch
- Bathroom faucet aerators
- Hot water recirculating systems
- Hose shutoffs, flow controllers and sprinkler timers
- Rain shut-off sensors for automatic irrigation systems

Savings on your water, sewer and energy bills will help cover loan payments. After the loan is paid off, the savings is money in your pocket.

Apply for the loan when you buy qualifying equipment at participating SWEEP retailers:

- Krohns Appliance Center, Newberg (Frigidaire appliances[1])
- Shebuski & Lloyds Hardware, Wilsonville (Water-saving toilets, irrigation equipment)
- George Morlan Plumbing, Tigard, Salem and Portland (Water-saving fixtures)

Or, to buy from another retailer, call Portland General Electric at (503) 464-7901 for a loan application. PGE is providing loan services for the City of Wilsonville.

Models that qualify for the Oregon Residential Energy Tax Credit. Participating SWEEP retailers also represent other manufacturers of high-performance appliances and fixtures.

Conserving Water and Energy Is Good for the Environment

- Conserving water community-wide means more water for fish and recreation. And the less water we use, the less energy we need for water pumping, water treatment and wastewater treatment.
- Conserving energy reduces air pollution. It also reduces emissions of gases that contribute to global warming.

Source: Oregon Office of Energy

Tax credit for residents

Right now, the Oregon Office of Energy offers residents another incentive to save water and energy: a tax credit of $120 to $210 for premium-efficiency clothes washers and $50 to $70 for premium-efficiency dishwashers. You claim the credit when you file your Oregon income tax return. You can get a tax credit application and the current month's list of qualifying models at most Oregon appliance dealers. Or visit the Office of Energy Web site (www.energy.state.or.us) or call 1-800-221-8035. If you buy from participating SWEEP retailers, they'll send in the application for you.

Tax credit for businesses

Oregon businesses are eligible for a 35% Business Energy Tax Credit for the additional cost of energy-saving equipment. Premium-efficiency appliances, air-conditioning upgrades and industrial efficiency projects can save water as well as energy. The Office of Energy must approve the project before you start. Call 1-800-221-8035 or visit www.energy.state.or.us for more information.

Manufacturer discounts

PGE has arranged manufacturer discounts for water-saving clothes washers and toilets:

Frigidaire: Rebates for Frigidaire clothes washers that also earn you a state tax credit. Available at Frigidaire dealers in Oregon.

Caroma: Special pricing on the Caroma two-button "Washdown" toilet. It uses just 0.8 gallons per flush for liquids, 1.6 gallons for solids. Available at Shebuski & Lloyds Hardware and George Morlan Plumbing.

Look for special event pricing at the Wilsonville Conservation Fair on June 10, Wilsonville Community Center. You can apply for the tax credit and 7 1/2% loan at the fair.

Wilsonville is short on water.

In September, voters approved construction of a treatment plant to use water from the Willamette River. But conservation will remain an important part of Wilsonville's long-term water supply plan, delaying any future expansion of the water treatment plant.

Program Financial Documents

State of Oregon Efficient Appliance Tax Credit Application

Special Application and Verification Form for Residential Energy Tax Credit Certification for Wilsonville and Lafayette Residents - Save Water and Energy Education Program

Premium Efficiency Appliances

OREGON OFFICE OF ENERGY
625 Marion St. NE, Suite 1
Salem, OR 97301-3742
Toll-free: 1-800-221-8035
Salem: (503) 378-4040
Web site: www.energy.state.or.us

FOR OFFICE USE ONLY
File no.:
Date received:
Tax credit amount: $
Tax year:

1. CUSTOMER INFORMATION

Name:			Social Security No.*:
Mailing address:			Daytime phone:
City:	State:	ZIP:	County:
Street address where appliance(s) will be used (if different):			
City:	State:	ZIP:	County:
If different than mailing address, please explain:			
Are you a homeowner? ❑ Renter? ❑ (Landlords and builders are *not* eligible for the tax credit.)			
Number of people in household:			

2. UTILITY INFORMATION

Name of electric utility:	Name of natural gas utility:
Fuel used for water heating: ❑ Electricity ❑ Natural gas ❑ Other (specify):	

3. APPLIANCE INFORMATION

Provide the following information for all appliances for which you are claiming a tax credit, and **attach receipts for your purchase(s):**

Brand name	Model no.	Type of appliance	Energy use[1]	Tax credit[2]	Net price[3]	Date of purchase
Frigidaire EXAMPLE	FWT445GE	Clothes washer	249 kWh	$140	$699	May 6, 2000

[1] From yellow EnergyGuide label on appliance, in kWh or therms.
[2] From list of appliances qualifying for the Oregon Residential Energy Tax Credit or 25 percent of the net purchase price of the appliance, whichever is less.
[3] Purchase price less any manufacturer or retailer rebates shown on receipt (*not* including mail-in rebates). To maximize your tax credit, don't deduct any mail-in rebate from the purchase price.

Please note
We cannot approve your application unless it is complete and signed.

*OAR 330-070-0025 authorizes the Oregon Office of Energy to request that you voluntarily provide your social security number for use as an identification number in maintaining records. If you provide your social security number and consent to its use, it will be used only for the purpose(s) stated above or as otherwise required by law.

4/00

Continued on next page

SWEEP Appliance Financing Application

Procedure for Appliance Sales using Portland General Electric (SWEEP)* Loan Application Program

(Store #16 Wilsonville only)

Customer steps to participate in SWEEP:

- Customer selects energy/water saving appliance(s) (dishwashers and clothes washers and dryers) for purchase.
- Customer completes PGE **Application for Loan** in Store and gives completed application to AVTA Associate.
- AVTA Associate submits completed loan application to Customer Service Supervisor to be **faxed to PGE Business Office (** **)**. PGE office hours are Monday-Friday from 9:00 a.m. to 5:00 p.m. PGE will review loan application to determine customer eligibility for 7-1/2 % thirty-six month loan. Associates ***should advise customer*** that no sale may be completed and no product may be delivered, under SWEEP, until loan application is approved by Portland General Electric, and that there may be as much as a 48 hour turnaround (weekends) for PGE to approve or disapprove loan application. During regular business hours on weekdays, PGE estimates a half hour to one hour response on loan authorization. PGE will provide personnel with loan application approval number via telephone.
- Once is notified by PGE that loan has been approved, Associates may contact customer to arrange delivery or pick up of product. may only deliver products to customer once PGE loan approval has been obtained.
- Once approved, completed loan application, with Invoice Number written on it, should be mailed with invoice copy to PGE for payment to . A copy should be kept by Wilsonville Store Audit Manager. Copy of loan application package and Fry's invoice should be sent to Accounts Receivable Supervisor at the Home Office.
- **Important:** Should merchandise be returned to Store by customer, PGE Open Account # should be credited full value of invoice. **No Store Credit is to be issued directly to customer.**
- will also have available applications for **Oregon Residential Energy Tax Credits** which are supplied by the Oregon Office of Energy. Customers who purchase qualifying appliances may take one, complete the form, and mail it with their receipt directly to the Oregon Office of Energy to receive tax credits.

***SWEEP stands for Save Water and Energy Education Program.**

SWEEP Appliance Financing Application (con't)

PGE

PORTLAND GENERAL ELECTRIC COMPANY AND CITY OF WILSONVILLE
SAVE WATER AND ENERGY EDUCATION PROGRAM
APPLICATION FOR LOAN

(503) 464-7901

WATER/ENERGY EFFICIENT APPLIANCES TO BE PURCHASED

____	Model # ____	Size: ____	Price: ____
____	Model # ____	Size: ____	Price: ____
____	Model # ____	Size: ____	Price: ____
____	Model # ____	Size: ____	Price: ____
			Delivery: ____
			Installation/Disposal: ____
			Less Down Payment: ____
			TOTAL ____

Amount to be financed: ____ No. of months 36

Address of installation: ____ Wilsonville OR 97070

Name on PGE account: ____ ☐ Rent ☐ Own

Name on City of Wilsonville account:

APPLICANT INFORMATION	CO-APPLICANT INFORMATION
FIRST NAME MIDDLE LAST	FIRST NAME MIDDLE LAST
ADDRESS (If different from above)	ADDRESS (If different from above)
CITY STATE ZIP	CITY STATE ZIP
HOW LONG HAVE YOU LIVED AT PRESENT ADDRESS? / HOME PHONE NO. ( )	HOW LONG HAVE YOU LIVED AT PRESENT ADDRESS? / HOME PHONE NO. ( )
PREVIOUS ADDRESS / HOW LONG YRS. MOS.	PREVIOUS ADDRESS / HOW LONG YRS. MOS.
CITY STATE ZIP	CITY STATE ZIP
DATE OF BIRTH / SOCIAL SECURITY NO.	DATE OF BIRTH / SOCIAL SECURITY NO.
EMPLOYMENT AND INCOME INFORMATION	**EMPLOYMENT AND INCOME INFORMATION**
PRESENT EMPLOYER / ADDRESS	PRESENT EMPLOYER / ADDRESS
DATE EMPLOYED / OCCUPATION / SUPERVISOR	DATE EMPLOYED / OCCUPATION / SUPERVISOR
EMPLOYMENT STATUS ☐ FULL TIME ☐ PART TIME ☐ TEMPORARY NO. OF HRS PER WK / WORK PHONE & EXT	EMPLOYMENT STATUS ☐ FULL TIME ☐ PART TIME ☐ TEMPORARY NO. OF HRS PER WK / WORK PHONE & EXT
MONTHLY GROSS SALARY $ / HOURLY RATE $	MONTHLY GROSS SALARY $ / HOURLY RATE $

1. The goods will be kept at ____ in Wilsonville, Oregon and shall not be removed from said location without written consent by PGE and City of Wilsonville.

Additional terms and conditions on the reverse hereof are part of this agreement. Read reverse before signing.

I/we certify that the information on this Application is complete, true, and submitted for the purposes of obtaining credit. I/we agree (a) that PGE and/or the City of Wilsonville can use credit reporting agencies or otherwise verify the information on this Application for the purposes of extending credit to me/us or reviewing or collecting a credit account of mine/ours, and (b) that PGE and/or the City of Wilsonville can tell others about their credit experience with me/us and obtain information from others about my/our credit history and performance. I/we agree to the terms and conditions of the Loan Agreement and Disclosure. I/we acknowledge receipt of the applicable Agreement and Disclosures. If Applicant is a corporation, limited liability company or sole proprietorship, the undersigned is authorized to sign on behalf of and bind the Applicant to the terms of this Agreement.

APPLICANT ____ DATE ____ CO-APPLICANT ____ DATE ____

Dealer's Name ____

Salesperson ____

PGE CREDIT APPROVAL NO.	PGE APPROVAL BY:	DATE
WILSONVILLE ACCOUNT NO.	PROVIDED BY:	DATE

Save Water and Energy Education Program loans made possible by financing from: **Oregon Office of Energy**

White: PGE Yellow: Dealer Pink: Customer

PGE 72411 (Aug 2000)

SWEEP Appliance Financing Application (con't)

PGE

PORTLAND GENERAL ELECTRIC COMPANY AND CITY OF WILSONVILLE
SAVE WATER AND ENERGY EDUCATION PROGRAM

DISCLOSURE STATEMENT

Pursuant to the Federal Truth in Lending Act

Name ______________________________

Address ______________________________

Creditors: Portland General Electric Company and City of Wilsonville

ANNUAL PERCENTAGE RATE (The cost of your credit as a yearly rate).	FINANCE CHARGE (The dollar amount the credit will cost you).	AMOUNT FINANCED (The amount of credit provided to you).	TOTAL OF PAYMENTS (The amount you will have paid after you have made all payments as scheduled).
________ %	$ ________	$ ________	$ ________

YOUR PAYMENT SCHEDULE WILL BE:

NUMBER OF PAYMENTS	AMOUNT OF PAYMENTS	WHEN PAYMENTS ARE DUE
		Monthly, on the due date of the Wilsonville water billing of ________ (estimated)

PREPAYMENT: If you pay off early, you will not have to pay a penalty.

See your Wilsonville and PGE Water and Energy Efficient Appliance Loan Agreement for information about nonpayment, default, the right to accelerate the maturity of the obligation, prepayment refunds, and penalties.

PAYMENTS AND INTEREST CALCULATION:

I will pay you the total of payments shown above according to my payment schedule also shown above. However, the amount of the last payment will be adjusted to include interest figured on the money I owed, for the time I owed it. Interest is charged on the unpaid balance outstanding each day. The TOTAL OF PAYMENTS and FINANCE CHARGES shown above apply only if I pay in the manner agreed. If I pay late or less than the required payment, the finance charge is increased. If I pay earlier or more than the required payment, the finance charge is decreased. Payments will first pay interest owing to the date you receive my payment and the remainder will reduce the balance I owe. I may prepay the note in whole or in part at any time without penalty. **Partial payments of principal will be applied to the last payments to become due under this contract, and I will still be required to make a payment each month until this contract is paid in full.**

ITEMIZATION OF THE AMOUNT FINANCED OF $________

$________ Amount given to you directly
$________ Amount paid on your account
$________ Prepaid finance charge

______________________________ ______________________________
Customer Signature Date Customer Signature Date

White: PGE Yellow: Dealer Pink: Customer

PGE 71554 (May 2000)

SWEEP Appendix Financing Application (con't)

PORTLAND GENERAL ELECTRIC COMPANY AND CITY OF WILSONVILLE
SAVE WATER AND ENERGY EDUCATION PROGRAM

NOTICE TO CANCEL LOAN AGREEMENT

YOUR RIGHT TO CANCEL

You have a legal right under federal law to cancel this transaction, without cost, within three business days from whichever of the following events occurs last:

(1) the date of the transaction, which is _______________; or
(2) the date you received your Truth in Lending disclosures; or
(3) the date you received this notice of your right to cancel.

Within 20 calendar days after we receive your notice, we must return to you any money or property you have given to us or to anyone else in connection with this transaction.

You may keep any money or property we have given you until we have done the things mentioned above, but you must then offer to return the money or property. If it is impractical or unfair for you to return the property, you must offer its reasonable value. You may offer to return the property at your home or at the location of the property. Money must be returned to the address below. If we do not take possession of the money or property within 20 calendar days of your offer, you may keep it without further obligation.

HOW TO CANCEL

If you decide to cancel this transaction, you may do so by notifying us in writing at:

Portland General Electric Company
Energy Efficiency Dept.
121 SW Salmon St, 1WTC-0701
Portland, Oregon 97204

You may use any written statement that is signed and dated by you and states your intention to cancel, and/or you may use this notice by dating and signing below. Keep one copy of this notice because it contains important information about your rights.

If you cancel by mail or telegram, you must send the notice no later than midnight of the third business day following the latest of the three events listed above. If you send or deliver your written notice to cancel some other way, it must be delivered to the above address not later than that time.

I WISH TO CANCEL

Consumer's Signature ______________________________ Date ________________

Property Address ____

PGE 71487 (May 2000) White: PGE Yellow: Dealer Pink: Customer

SWEEP Laundry Journal

SWEEP
Laundry
Journal

October 1999

____
(Name)

SWEEP Laundry Journal (con't)

Instructions

Thank you for taking part in this study. In addition to monitoring the energy and water use of your clothes washer, we also need to collect specific information on your laundry use. Your assistance and cooperation is critical to the success of this study!

Directions: Please complete one of these Laundry Journal forms for **each load** of laundry you run during the course of this study.

Questions: Please contact Linda Sandahl at Pacific Northwest National Laboratory, Portland, OR at (503) 417-7554.

If you fill out all forms in the Journal before the conclusion of the study, please call Linda Sandahl to request an additional Journal.

At the conclusion of the baseline study, the journals will be collected.

SWEEP Laundry Journal (con't)

Laundry Log - Existing Clothes Washer and Dryer

Complete one form for each load of laundry

Date:________________________________ Time: _____________________A.M. P.M.

Your Name: ____

Load Characteristics	
1. Load size	____extra large ____large ____medium ____small ____extra small
2. Fabric color	____whites ____colors ____mix of whites/colors
3. Load type	____jeans ____towels ____bedding ____delicates ____outerwear ____mixed
4. Fabric soil content	____heavily soiled ____moderately soiled ____lightly soiled
Washer Settings and Additives	
5. Temperature setting	____warm wash/warm rinse ____cold wash/cold rinse ____warm wash/cold rinse ____other, explain ____________________ ____hot wash/cold rinse
6. Wash cycle selection	____normal/regular ____permanent press ____delicate/knit ____heavy duty
7. Water level setting	____extra low ____medium/normal ____low ____high/large
8. Detergent used?	____yes ____no If yes, 1) What brand?____________________________ 2) What type? ____liquid ____powder ____delicate 3) How much did you use compared to package instructions? ____used less ____used as directed ____used more
9. Bleach used?	____yes ____no If yes, 1) What brand?____________________________ 2) What type? ____chlorine ____color 3) How much did you use compared to package instructions? ____used less ____used as directed ____used more
10. Stain pretreatment used?	____yes ____no If yes, specify brand:______________________________________
11. Fabric softener used?	____yes ____no If yes, specify brand:______________________________________
Dryer Setting and Additives	
12. Amount of load put in dryer	____1/4 of load ____3/4 load ____1/2 of load ____full load
13. Dryer fabric setting	____cotton ____knits/delicate ____permanent press ____air/fluff dry ____regular ____other __________________________
14. Fabric softener used in dryer?	____yes ____no If yes, specify brand:______________________________________
Comments (please add any comments in the space provided below)	

SWEEP Laundry Journal (con't)

Laundry Log - Frigidaire Clothes Washer and Dryer

Complete one form for each load of laundry

Date:________________________________ Time: ____________________A.M. P.M.

Your Name: ____

Load Characteristics

1. Load size	____extra large ____large ____medium ____small ____extra small
2. Fabric color	____whites ____colors ____mix of whites/colors
3. Load type	____jeans ____towels ____bedding ____delicates ____outerwear ____mixed
4. Fabric soil content	____heavily soiled ____moderately soiled ____lightly soiled

Washer Settings and Additives

5. Temperature setting	____warm wash/warm rinse ____cold wash/cold rinse ____warm wash/cold rinse ____other, explain ________________________ ____hot wash/cold rinse
6. Wash cycle V selection	____normal/regular ____permanent press ____delicate/knit ____heavy duty
7. Detergent used?	____yes ____no If yes, 1) What brand?__________________________________ 2) What type? ____liquid ____powder ____delicate 3) How much did you use compared to package instructions? ____used less ____used as directed ____used more
8. Bleach used?	____yes ____no If yes, 1) What brand?__________________________________ 2) What type? ____chlorine ____color 3) How much did you use compared to package instructions? ____used less ____used as directed ____used more
9. Stain pretreatment used?	____yes ____no If yes, specify brand:____
10. Fabric softener used?	____yes ____no If yes, specify brand:____

Dryer Setting and Additives

11. Amount of load put in dryer	____1/4 of load ____3/4 load ____1/2 of load ____full load
12. Dryer fabric V setting	____cotton ____knits/delicate ____permanent press ____air/fluff dry ____regular ____other ______________________________
13. Fabric softener used in dryer?	____yes ____no If yes, specify brand:____

Comments (please add any comments in the space provided below)

Appendix B

Specifications and Pictures of SWEEP Program Equipment

Appliances

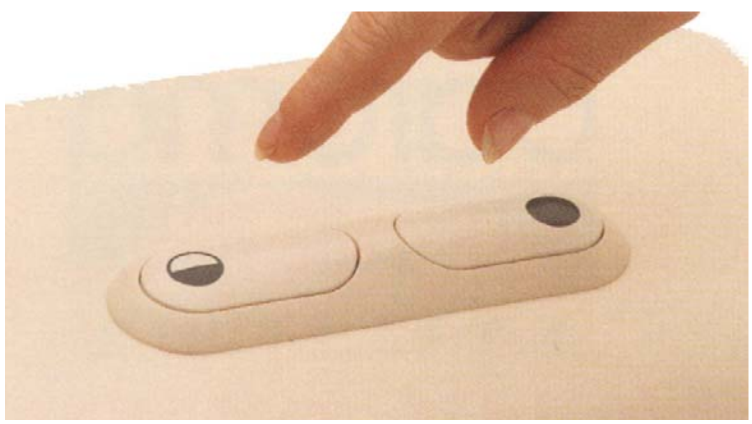
Frigidaire Gallery Model FWTR647GHS Clothes Washer used in SWEEP

Frigidaire Gallery Model FDE546RES Clothes Dryer used in SWEEP

Frigidaire Gallery Model GLDB656JS Dishwasher used in SWEEP

Toilet

Caroma Caravelle 305 Toilet used in Lafayette/Wilsonville SWEEP



Two-Button Operation of Caroma Toilet used in Lafayette/Wilsonville SWEEP

Shower/Faucet Fixtures

Low-Flow Showerhead use in Lafayette/Wilsonville SWEEP

Low-Flow Faucet Aerator use in Lafayette/Wilsonville SWEEP

Appendix C

SWEEP Metering Equipment Technical Data

Data Logging Equipment

End Use Clothes Washer/Dryer Data Logging Equipment. From left to right, clothes washer watt transducer, clothes dryer watt transducer, data logger, hot water meter, cold water meter.

End Use Hot Water Heater Logging Equipment. At the top of picture is the current transformer; below is the data logger.

Meter-Master Data Logger. The yellow cable at the top with sensor gets attached to "barrel" of water meter.

Meter-Master Data Logger as installed in metering pit.

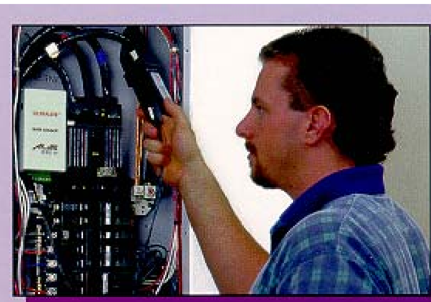
Metering Equipment Specifications

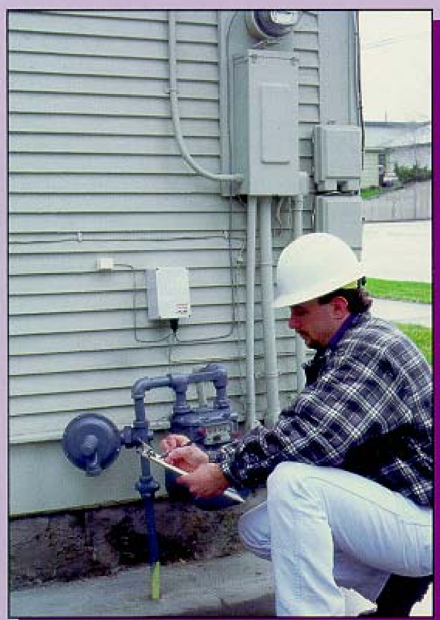
Data Logging Equipment – Clothes washer/dryer data logger

Data Logging Equipment (con't)

4C ULTRALITE™

4 Channels of True-RMS Current can be monitored simultaneously with this unit. Great for monitoring several motors in an HVAC equipment room or 4 branch circuits. Both split-core and clamp-on current transformers are available and come in various sizes, ranging from 5A to 3000A. The UltraLite 4C measures True-RMS current, even for highly distorted waveforms.





4P ULTRALITE™

Monitor up to 4 pulse channels!

The UltraLite 4P is used for applications where multiple utilities need to be recorded. Use it with electric, gas, water, sewer and steam meters. This unit also records up to 10 pulses per second. If your meter does not have a pulse output, contact us for pulse initiating retrofit kits for electric and gas meters.

Three options available:

Weather Proof - this version is dust and liquid resistant, allowing the UltraLite to operate in harsh, wet, and outdoor environments.

Internal Modem - any of the UltraLites can come equipped with a built-in internal modem. This will enable easy remote data collection and eliminate the possibility of modem incompatibility. Your choice of 2400 or 9600 baud.

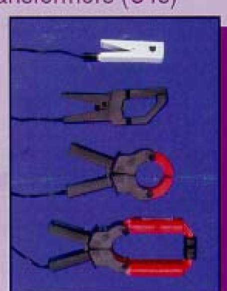
High Memory - this is one option you will want if you do not have telephone lines available. Quadruples the logger memory to 512 kbytes (120,000 records) allowing for long recording periods before downloads are necessary.

Shunted and Safe Current Transformers (CTs)

The UltraLite 4C connects directly to CTs with a voltage output.

Clamp-On CTs

This style combines ease of use, convenience and accuracy. (from top) 150A CT, 500A CT, 1000A CT, 3000A CT



Split Core CTs

are also available in a large number of current ranges.

UltraLite Monitoring Specifications

Inputs........................4 channels of current, pulse count, or temperature
Measurements...........True RMS (current)
Frequency..................10 Hz (pulse) and 50 or 60 Hz (current)
Accuracy.....................<1% of reading exclusive of sensor accuracy
Baud Rate..................1200, 2400, 4800, 9600, 19200 or 2400 and 9600 (Internal Modem)
Resolution..................12 bit (1 part in 4,096; ±1 pulse, 0.01 Amp, 0.1°F or °C
Memory.......................128k (30,000 readings) or 512k (120,000)
Dimensions.................8 X 15 X 6 cm (3.2" X 5.9" X 2.4")
Weight.........................0.4 kg (12 ounces)
Sampling Frequency...7.68 kHz (128 points per current waveform) or 10 Hz, interrupt driven
Recording Intervals.....1,5,15,30,60 minutes and 12,24 hours
Real Time Clock..........20 ppm accuracy (<1 min/month)
Operating Temp. ....-7 to 60° C (20 to 140° F)
Operating Humidity.....5% to 95% non-condensing
Battery Life.................3+ years @ 1 min. sampling, with LED indicator of low battery charge

Water Meters

Model Industrial RCDL

Nutating Disc Meter (Bronze and Thermoplastic)

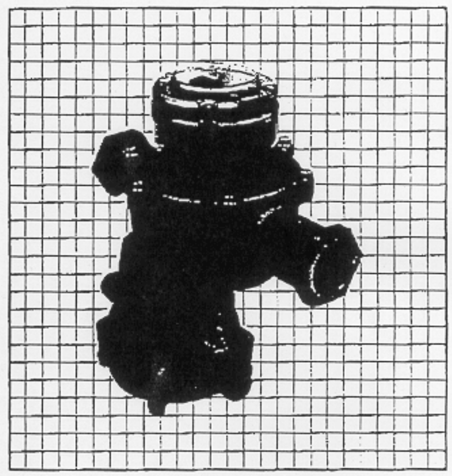
Technical Brief

GENERAL

Badger's RCDL positive displacement meters are one of the most cost effective methods in metering industrial fluids. The RCDL meter's simple but efficient design assures high accuracy and repeatability over the entire meter flow range.

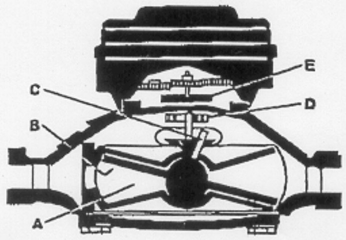
Available in sizes, 1/2" through 2" for flows up to 170 GPM, these meters are extremely rugged and reliable. Maintenance is seldom required, but if necessary, takes but a few minutes. All parts are designed and built of materials to meet your application, providing you with long life and a trouble-free, precision flow meter.

To complement the RCDL meter line, Badger offers a complete line of accessories that includes totalizers, electromechanical and electronic transmitters, rate of flow indicators and batch/process controllers.



OPERATION

The metering principle, known as positive displacement, is based on the continuous filling and discharging of the measuring chamber. Controlled clearances between the disc and the chamber insure minimum leakage for precise measurement of each volume cycle. As the disc nutates, the center spindle rotates a magnet, whose movement is sensed through the meter wall by a follower magnet or by electronic sensors. Each revolution of the magnet is equivalent to a fixed volume of fluid, which is converted to any engineering unit of measure for totalization, indication or process control.



Liquid flowing through the meter chamber (A) causes a disc (B) to nutate or wobble. This motion, in turn, results in the rotation of a spindle (C) and drive magnet (D). Rotation is transmitted through the wall of the meter to a second magnet (E) which operates the transmitter.

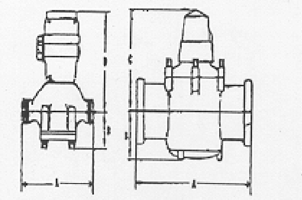
FEATURES

- Accuracy: ±1.5% over full range
- Repeatability: ±0.5%
- Wide flow range
- Rugged bronze or thermoplastic housing
- Maximum Operating Temperature
  Plastic Housing: 100° F
  Bronze Housing: 120° F
  Models 25, 70 and 120; Bronze: 250° F Option
- Maximum Operating Pressure: 150 PSI
- Easily maintained without removing from line
- Durable components for minimal maintenance
- Wide range of compatible accessories
- Direct replacement for SC-ER

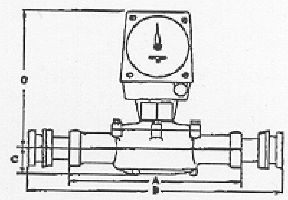
BadgerMeter,Inc. ®

Bulletin No. ITB-072-08
December 1999

Water Meters (con't)



Model 25, 35 & 70



Model 120 & 170

SPECIFICATIONS								
Dimensions in inches (Without Register)						Flow Rates - Gallons		
Meter Model	Meter Size Inches	Housing Material	A Meter Length	B Meter Length w/ Conn.	C Center Line To Base	Cold Liquids 32° F to 120° F	Hot Water Chemicals & Oils 32° F to 250° F (BZ) 32° F to 100° F (PL)	Approx. Weight Pounds
M25	5/8	BZ or PL	7-1/2	12-7/16	1-3/8	1/2 - 25	1 - 25	5
M25	3/4	BZ or PL	7-1/2	12-5/8	1-3/8	1/2 - 30	1 - 30	5
M35	3/4	BZ	9	14-1/8	1-3/4	3/4 - 35	N/A	6
M40	1	PL	10-3/4	16-3/16	2-1/4	3/4 - 50	N/A	5
M70	1	BZ	10-3/4	16-5/8	2-1/4	1 - 70	5 - 70	12
M120	1-1/2	BZ	12-5/8	19-3/4	2-5/8	2 - 120	10 - 120	20
M170	2	BZ	15-1/4	22-7/8	3-3/8	2 - 170	N/A	30

BZ = Bronze; PL = Plastic
Connection set assembiles available, all having NPT threads.

N/A = Not available in High Temperature / Chemical option.

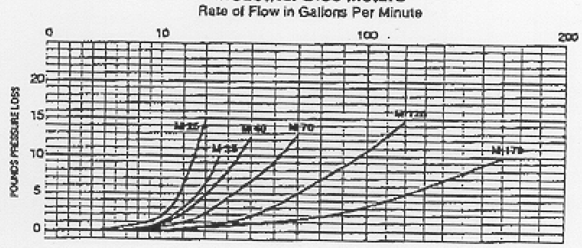
HEIGHT DIMENSIONS (INCHES) (D) WITH REGISTER AND ACCESSORIES

Meter Size	With Non Resetable Register	With Transmitter	With MS-ER1 Transmitter	With ECA Transmitter	With 258 Register	With Series 76 Registers
5/8 & 5/8 x 3/4	5-3/4	7-3/8	11-1/4	9-3/8	8	15-1/4
3/4	6-1/8	7-3/4	11-5/8	9-3/8	8-3/8	15-5/8
1 & 1 x 1-1/4	7-1/2	9-1/8	13	11-3/16	9-3/4	17
1-1/2	9-1/8	10-3/8	14-1/4	12-3/4	11	18-1/4
2	10-3/4	12-1/4	16-1/8	14-3/8	12-7/8	20-1/8

MATERIALS OF CONSTRUCTION

	Cold Liquid Units	High Temp. and/or Chemical Units Models 25, 70 & 120
Housing:	BZ or PL	BZ - 250° F PL - 100° F
Chamber:	Noryl	LCP
Disc:	SAN	LCP
Crossbar:	Nylon	Ultem
Magnetic Assembly:	Nylon	Ultem
Chamber Retainer:	Polyethylene	Metal Clip
Screen:	Polypropylene	None

PRESSURE LOSS CHART
Industrial Disc Meters
Rate of Flow in Gallons Per Minute



PERFORMANCE

Accuracy: ± 1.5%
Repeatability: ± 0.5%
Max. Operating Pressure: 150 PSI

BadgerMeter,Inc.
P. O. Box 245036 Milwaukee, WI 53224-9536
Telephone: (414) 355-0400
Fax: (414) 355-7499

Water Meters (con't)

Models MSE5, PM5, & MSE5XP

Mechanical Scalable Transmitters

Technical Brief

GENERAL

The PM5, MSE5, amd MSE5XP models are pulse transmitters designed to be used with Badger Meter's magnetic drive meters. The pulse transmitter provides a scaled electrical pulse signal (switch closure type) for each discrete unit of liquid volume metered. The signal is used to operate instruments and controls.

These transmitters are identical except for the housing. The PM5 transmitter has a glass filled plastic housing and a NEMA 4X rating. The MSE5 and MSE5XP housings are bronze with a NEMA 4 rating.

The transmitters are available in a wide range of gear ratios and pulse rates up to 1500 contact closures per minute.

OPERATION

The flow of liquid through the meter is measured by a disc or piston metering element. The motion of the measuring element is transferred to a magnetic coupling. One of these magnets is in the measuring chamber, the other in the transmitter.

The driven magnet (inside the transmitter) then rotates a gear train and pulse magnet. As the pulse magnet turns, it causes the reed switch to open and close. Contact closures from the switch are transmitted to a remote instrument or counter which records the quantity of flow.

APPLICATIONS

These transmitters are used in metering systems that require pulse closures for recording rate of flow, quantity of flow, liquid feeding, blending and batching.

MSE5 (rear) and PM5 Transmitters

FEATURES

- MSE5 and MSE5XP transmitters are explosion-proof with CSA listing for Class 1, Group D, Division I (Hazardous Locations)
- Does not require external power
- Rugged, Cast Bronze Housing (MSE5 only)
- Corrosion resistant, glass filled plastic enclosure (PM5 only)
- High Temperature Rating: 250° F.
- Watertight - NEMA 4 (Bronze) or NEMA 4X (Plastic) Housing
- Hermetically sealed reed switch output

BadgerMeter,Inc.

Bulletin No. ITB-074-04
Part No. 53406-074
October 1998

Watt Transducers

OSI WATT/WATTHOUR TRANSDUCER *MODEL* AGH

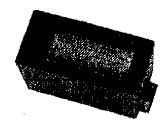
UL LISTED, ACCURATE TO 0.2% OF READING

FEATURES
- Accurate regardless of variations in voltage, current, power factor, or load.
- Dual outputs. 0 - 1mA proportional to instantaneous watts, relay closure proportional to watthours.
- Calibrated with standards traceable to NIST.

5 YEAR WARRANTY

APPLICATIONS
- Designed for applications which require UL listed devices.
- Integration into energy management systems, or a variety of sub-metering applications.
- Measurement using direct-connection, current and/or potential transformers.

LISTED 87X9
Energy Management
Equipment Accessory
E134941



INPUTS		PHASE CONNECTION	NO. OF ELEMENTS	F.S. (WATTS)	STANDARD OUTPUT MODEL AGH: OUTPUT OPTIONS			WATT HOUR COUNTS /HOUR
VOLTS	AMPS				±1mA	±10V	4-20mA	
0 - 150	0 - 5	1 phase, 2 wire	1	500	AGH-001B	AGH-001D	AGH-001E	500
0 - 300	0 - 5	1 phase, 2 wire	1	1000	AGH-002B	AGH-002D	AGH-002E	1000
0 - 600	0 - 5	1 phase, 2 wire	1	2000	AGH-003B	AGH-003D	AGH-003E	1500
0 - 150	0 - 5	3 phase, 3 wire	2	1000	AGH-004B	AGH-004D	AGH-004E	1000
0 - 300	0 - 5	3 phase, 3 wire	2	2000	AGH-005B	AGH-005D	AGH-005E	2000
0 - 600	0 - 5	3 phase, 3 wire	2	4000	AGH-006B	AGH-006D	AGH-006E	4000
0 - 150	0 - 5	3 phase, 4 wire	3	1500	AGH-007B	AGH-007D	AGH-007E	1500
0 - 300	0 - 5	3 phase, 4 wire	3	3000	AGH-008B	AGH-008D	AGH-008E	3000
0 - 150	0 - 5	3 phase, 4 wire	2 1/2	1500	AGH-007.5B	AGH-007.5D	AGH-007.5E	1500
0 - 300	0 - 5	3 phase, 4 wire	2 1/2	3000	AGH-008.5B	AGH-008.5D	AGH-008.5E	3000

To calculate full-scale Watts when using potential and/or current transformers:
a = initial transducer calibration (from table above)
b = current transformer ratio (e.g. 100:5, or 20)
c = potential transformer ratio (e.g. 600:120, or 5)
F.S. WATTS = a x b x c
NOTE: UL recognized current transformers available from factory on page 77.

MODEL AGH SPECIFICATIONS

INPUT
VOLTAGE: See table
CURRENT: 5A
FREQUENCY RANGE: 58-62 Hz.
POWER FACTOR: Any
BURDEN:
Voltage: Less than 0.1VA per phase
Current: Less than 0.25VA per phase
Output amplifier: 2 Watts
OVERLOAD:
Voltage (cont.): 150V range: 175V
300V range: 350 V
600V range: 600V
Current (cont.): 2 Times full-scale
(transient): 50A (10 sec./hr.)
250A (1 sec./hr.)
DIELECTRIC TEST (Input/Output/Case):
(150V & 330V)1800Vac
(600V) 2200Vac

Surge: Withstands IEEE SWC Test
OUTPUT
ACCURACY: ±0.2% RDG.; ±0.04% F.S.
(Includes combined effects of voltage, current, load and power factor.)
WH RELAY: N/O SPST; 120Vac, 0.5A rated
Contact closure period: 200 milliseconds
CLOSURE CALIBRATION (STD.): 1 watthour/closure
ANALOG OUTPUT RIPPLE: Less than 0.5% F.S.
ANALOG OUTPUT LOADING (OHMS): 0 - 1mA 0 - 10K
0 - 10Vdc: 2K min.
4 - 20mA: 0 - 500
RESPONSE TIME (99%): Less than 400 milliseconds
TEMPERATURE EFFECT (-20° - +60°C):
± 0.005% per degree C
INSTRUMENT POWER: 90 - 135Vac, 60 Hz, 7.5VA

CONNECTION DIAGRAMS AND DIMENSIONS SHOWN ON PAGES 26 - 27

OHIO SEMITRONICS, INC.
4242 REYNOLDS DRIVE * HILLIARD, OHIO * 43026-1264
PHONE: (614) 777-1005 * FAX: (614) 777-4511
WWW.OHIOSEMITRONICS.COM * 1-800-537-6732

Watt Transducers (con't)

WATTHOUR METER WITH INTEGRATED CT — SWH SERIES

DESCRIPTION

The model SWH is a single phase watthour transducer with integrated current transformer. The model SWH has a form A solid state contact closure pulse output.

VOLTAGE Vac RMS	CURRENT Amp RMS	MODEL
115	100	SWH-1100
	200	SWH-1200
	400	SWH-1400
208/230	100	SWH-2100
	200	SWH-2200
277	100	SWH-3100
	200	SWH-3200

FEATURES

- Easy to install split core design
- LED indications of proper installation/operation

APPLICATIONS

- Energy Allocations
- Sub Metering
- Revenue Metering
- Process Control

ORDERING INFORMATION
Example: 100Amp input for use on 230Vac L-N Voltage
SWH-2100

SPECIFICATIONS

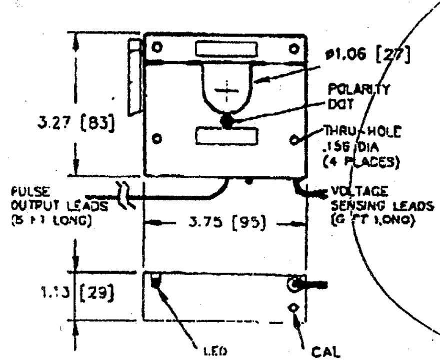
INPUT

CURRENT:	0 to 125% rated
BURDEN:	VA < .1(100A), .4 (200A)
VOLTAGE:	± 10% rated
BURDEN:	<0.2VA
POWER FACTOR:	any
FREQUENCY:	48 to 62Hz
INSTRUMENT POWER:	self powered

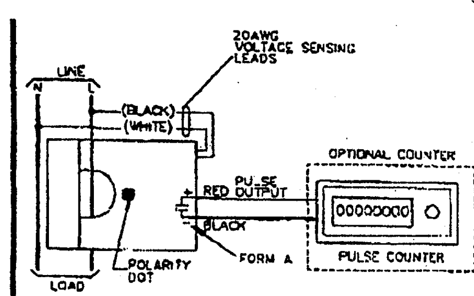
OUTPUT

LED:	Energy Rate & Direction Indicator Scaling same as pulse output Green = Forward Red = Reverse
PULSE:	10 WH / pulse, 71 ms min std
CONTACT RATING:	Form A, 30V peak, 100mA max
ACCURACY:	1% F.S.
ISOLATION: (current/potential/output)	2250Vac
TEMPERATURE:	-20 to 70°C

CASE DIMENSIONS



CONNECTION DIAGRAMS



OHIO SEMITRONICS, INC.
4242 REYNOLDS DRIVE HILLIARD, OHIO 43026-1264
Phone: (614) 777-1005 FAX: (614) 777-4511
TO PLACE AN ORDER: 1-800-537-6732

8902-38381 08/09/99

Hot Water Heater Data Logger

HOBO® 4-Channel External Indoor Logger

Specifications

Accepts external sensors and input cables for temperature, AC current, 0-2.5 Volt DC and 4-20 mA. Capacity: 32,520 measurements total

User-selectable sampling interval: 0.5 seconds to 9 hours, recording times up to 1 year. Readout and relaunch with optional HOBO Shuttle.
Drop-proof to 5'. Mounting kit included (hook/loop, magnet, and tape)
Programmable start time/date
Memory modes: stop when full, wrap-around when full
Nonvolatile EEPROM memory retains data even if battery fails
Blinking LED light confirms operation
User-replaceable battery lasts 1 year
Battery level indication at launch
Operating range: -4°F to +158°F (-20°C to +70°C), 0 to 95% relative humidity, non-condensing, non-fogging
Time accuracy: ±1 minute per week at +68°F (+20°C)
Size/Weight: 2.4 x 1.9 x 0.8" (60 x 48 x 19 mm)/approx. 1 oz (27 gms)
NIST-traceable temperature accuracy certification available
Compliance certificate available

Meter-Master Data Logger

METER-MASTER MODEL 100EL
FLOW RECORDER

The MODEL 100EL offers a solution for portable flow recording from existing water meters. The instrument is compatible with Sensus/Rockwell, Schlumberger/Neptune, Badger, Hersey, ABB/Kent, Precision, Master Meter, Water Specialties, Meineke, and other meters worldwide. It is submersible, small enough to fit inside a residential meter box. An integral handle enables the unit to be chained for security.

The Model 100EL uses a patented, strap-on magnetic sensor to digitize a meter's magnetic drive signal. Set-up requires velcro straps to secure the sensor in position. A rocker switch toggles the recording on/off and initiates a test of the sensor pick-up. An LED signal light flashes in unison with the meter's dial movement in order to verify accurate recording.

Memory capacity for continuous recording ranges from 7.5 days using a 5 second data storage interval to 3 months using a 60 second data storage interval. Recording automatically stops when the memory is used up; the recorder will not overwrite.

Two internal, rechargeable batteries provide approximately 3-4 months of battery life on each charge; much longer continuous operation is available through external battery or AC operation. The unit automatically stops recording and powers down the batteries are low to preserve recorded data and avoid battery damage.

The flow data from the meter is logged into memory for later downloading and analysis on a computer. The 100 Program for Windows verifies the accuracy of downloaded data by comparing the total volume of water registered by the water meter during the recording period to the total volume of water recorded by the Meter-Master. The Model 100 Program functions with all Meter-Master recorders and provides a variety of report and graph options. Data may also be exported to the MeterSizer program, the Trace Wizard end-use recognition program, and other widely used software, such as Lotus®, Excel®, Quattro Pro®, WordPerfect®, and Microsoft Word®. The Meter-Master software also offers a real-time 3-D graphic display of the current flow through a meter. New meters can be added to the database by the user at any time so that they appear as standard meter options.

Meter-Master Data Logger (con't)

Specifications:

Size: 8.6" x 5.4" x 2.1" (225 mm x 139 mm x 54 mm).
Data Storage Capacity: ranges from 7.5 days (5 sec.) to 90 days (60 sec. resolution).
Battery life (internal): 3+ months before recharging.

Capacity to make 20 records before downloading. Approximately 1200 different pre-programmed meter options.

Flashing LED verifies recording accuracy based on preset meter selections.

Software verifies data accuracy by comparing Meter-Master volume to register volume.

Meters may be added or deleted from database.

Aquacraft Trace Wizard© Software (adapted from AWWA 1999)

Trace Wizard is a 32-bit software package developed by Aquacraft, specifically for the purpose of analyzing flow trace data. Trace Wizard provides the analyst with signal processing tools and a library of flow trace patterns for recognizing a variety of residential fixtures. Any consistent flow pattern can be isolated, quantified, and categorized using Trace Wizard including leaks, evaporative coolers, humidifiers, and swimming pools. Trace Wizard is integrated with the Meter-Master for Windows software that comes with the F.S. Brainard data logging system.

Analysis with Trace Wizard is currently a multi-step, iterative process. First Trace Wizard takes the raw gallons per minute flow data from the Meter-Master for Windows program and disaggregates the data into individual water use events from the smallest leak to the largest automatic sprinkler session. During the event calculation process, Trace Wizard calculates a specific set of statistics about each water use event. These statistics are: start time, stop time, duration, volume (gal), peak flow rate (gpm), mode flow rate (gpm) and mode frequency. All of these statistics are included in the final database of water use events.

Once all the water use events have been isolated and quantified and statistics generated, Trace Wizard implements a user defined set of parameters developed for each individual study residence to categorize the water use events and assign a specific fixture designation to each event. These parameters can include the volume, duration, peak flow rate, and mode flow rate of each specific fixture. For example, a toilet may be defined as using between 3.25 and 3.75 gallons per flush, the peak re-fill flow rate is between 4.2 and 4.6 gpm, the duration of flush event is between 30 and 50 seconds, and the mode flow rate is between 4 and 4.5 gpm. Similar parameters are established for each of the fixtures found in the household. This simple signal processing routine runs quickly and assigns a fixture category (toilet, shower, clothes washer, etc.) to each water use event. The routine is re-run by the analyst frequently during the analysis process as the parameters are "fine tuned" to fit the fixtures in each specific house. The analyst uses the survey response data detailing the specific water-using appliances and fixtures in the house to build the parameter file which assigns fixtures to water use events. The graphical interface of Trace Wizard allows the analyst to visually inspect water use events and build the parameter file so that it correctly identifies as many of the water use events as possible. Trace Wizard is also capable of recognizing simultaneous events that frequently occur in residential households. For example, if someone is taking a shower in one bathroom and someone else in the house flushes the toilet and uses a faucet, Trace Wizard is able to separate these three distinct events through a set of user defined parameters.

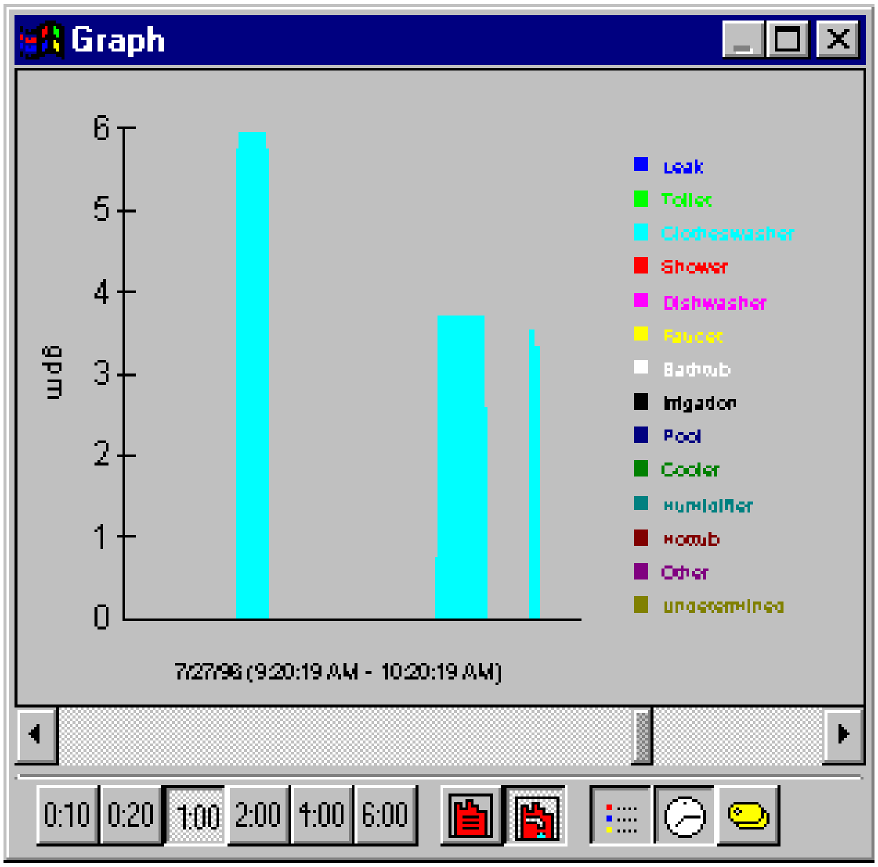


Figure C.1. Sample Flow Trace from Trace Wizard Showing a One-Hour View. Water events depicted include a three-cycle clothes washer.

Figure C.1 shows a one-hour portion of a typical flow trace in Trace Wizard. The three light blue spikes are clothes washer cycles. The first is the wash cycle, the second is a rinse cycle, and the third is a spin cycle. Note that the times shown on the graph's x-axis are the time interval depicted in the graph. In Figure C.1, this is a one-hour time interval. The Trace Wizard graph has six time interval settings: 10 minutes, 20 minutes, 1 hour, 2 hours, 4 hours, and 6 hours. The analyst may use any of these "views" during the flow trace analysis process.

Figure C.2 shows two toilet flushes, miscellaneous faucets, and another three cycle clothes washer. The first green spike in a toilet flush with a refill rate of approximately 5 gpm. The small yellow spikes are miscellaneous faucet uses and the small dark blue spike is a leak. The three light blue spikes are clothes washer cycles. A second toilet flush occurs during the first clothes washer cycle and is easily distinguished by Trace Wizard as a simultaneous event.

Additional simultaneous water use events can be seen in Figure C.3. Here, in a six-hour view, two toilet flushes can be observed occurring simultaneously with a seven-zone drip/ combination irrigation system. The irrigation system zones are clearly delineated by small and

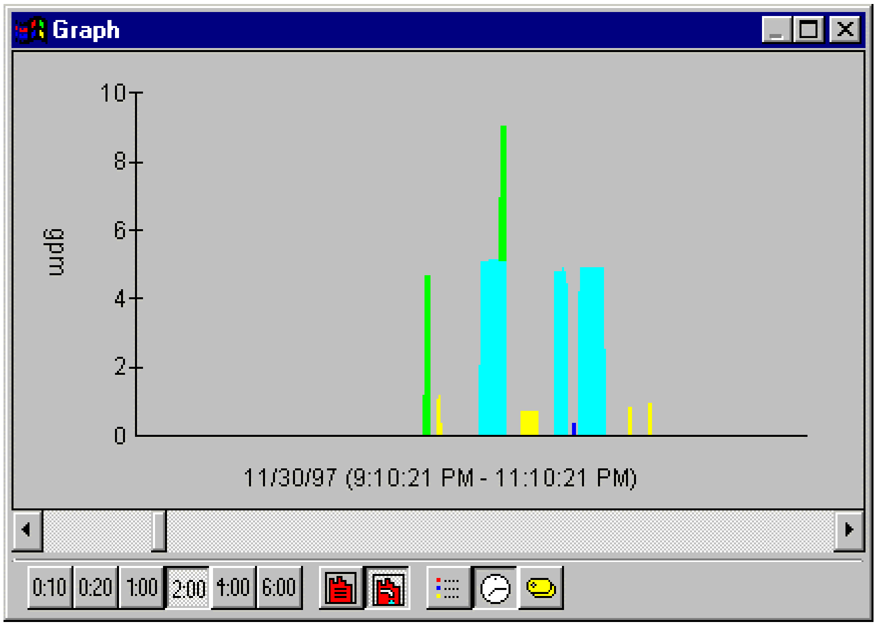


Figure C.2. Sample Flow Trace from Trace Wizard Showing a Two-Hour View. Water events depicted include two toilet flushes, a three-cycle clothes washer, and several faucets.

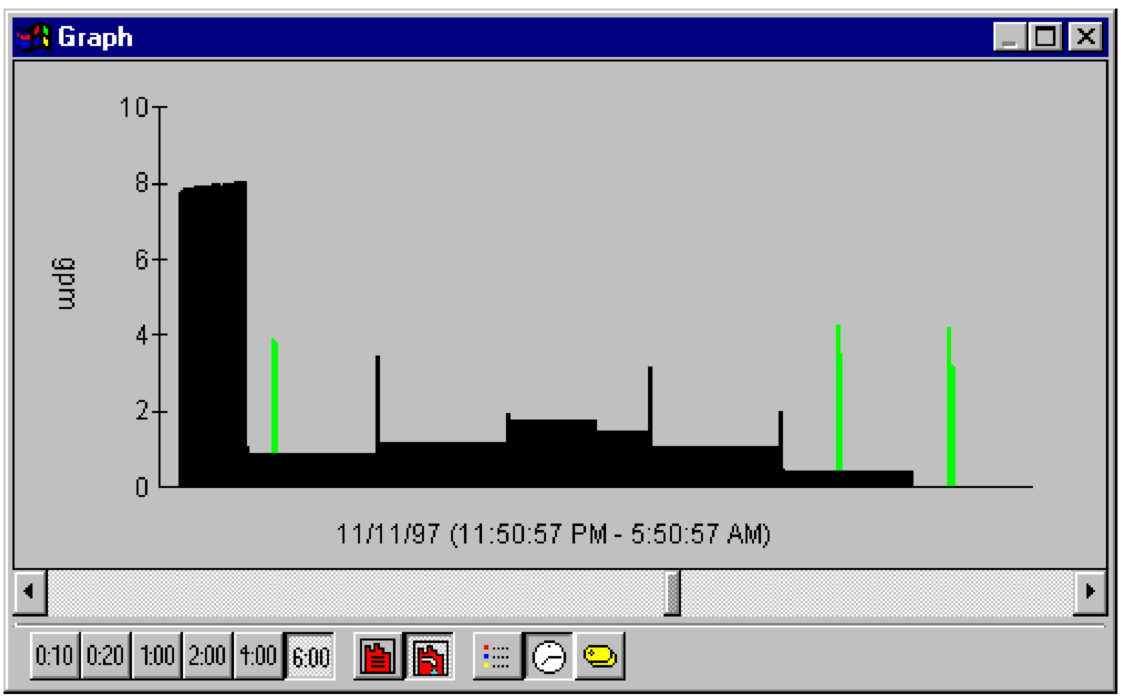


Figure C.3. Sample Flow Trace from Trace Wizard Showing a Six-Hour View. Water events depicted include a multi-zone automatic irrigation system and three toilet flushes.

consistent differences in flow rate over the 4.5-hour irrigation session. The first zone with an 8-gpm flow rate is a turf area and the remaining six zones cover different drip irrigation areas.

Figure C.4 shows a typical five-cycle dishwasher that was run between approximately 9:30 and 10:30 p.m. Dishwashers typically have between three and eight cycles and use a total of between 8 and 20 gallons for a full load. They are easy to distinguish because of their box-like shape and consistent volume, flow rate, and duration.

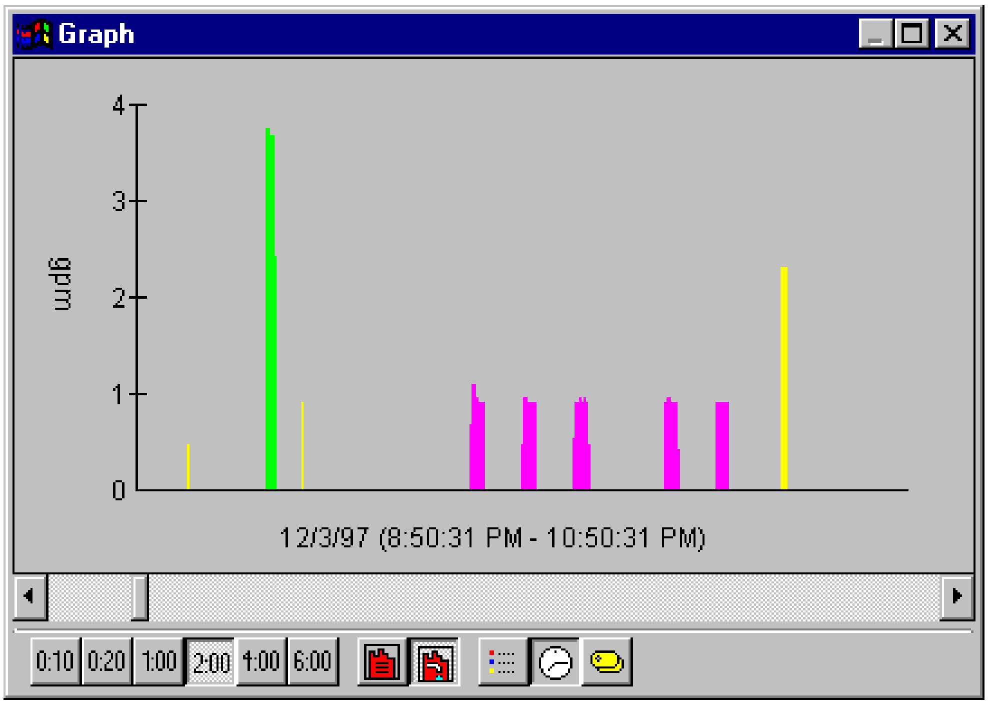


Figure C.4. Sample Flow Trace from Trace Wizard Showing a Two-Hour View. Water events depicted include a toilet flush, a five-cycle dishwasher, and various faucet uses.

Figure C.5 shows the capability of Trace Wizard's simultaneous event calculating routine. The red shower event is typical of bath/shower combination traces. The water is started in the bath for about 30 seconds while the temperature is adjusted then the shower diverter valve is pulled and the water starts to flow through the showerhead—in this case a low-flow head which restricts the flow to 2.5 gpm. The shower continues for about 10 minutes at this consistent flow rate until the water is shut off. What makes this example unusual are the blue clothes washer extraction and rinse cycles which are plainly visible on top of the shower. The second set of extraction cycles occur shortly after the shower had ended.

At the conclusion of analysis, the final product is a database of water use events, which have been given fixture identification. This database is created in the Microsoft Access 7.0 or 97 formats and can be further analyzed using either version of Access or any compatible database product.

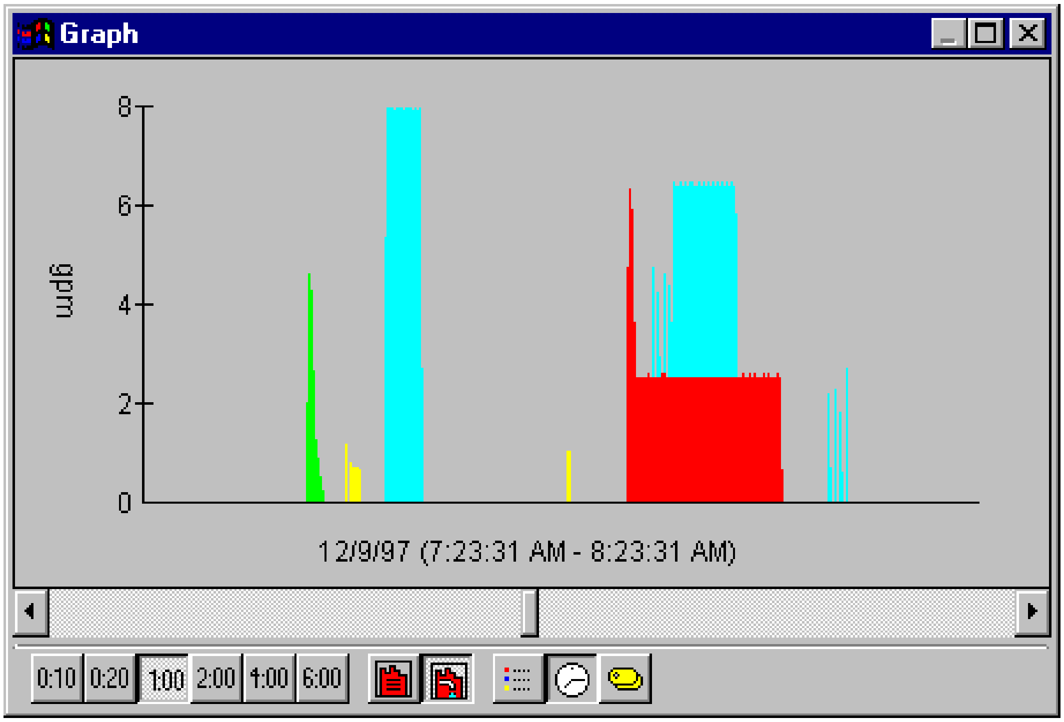


Figure C.5. Sample Flow Trace Showing a One-Hour View. Water events depicted include a toilet flush, multi-cycle clothes washer, and shower.

Appendix D

Other SWEEP Program Equipment Findings

Appendix D

Other SWEEP Program Equipment Findings

The data presented in this appendix supplement the data found in the main report. The purpose of presenting these data is to provide more detail as well as the accompanying statistics.

While each chart below presents different data, the general format is consistent. The x-axis of each graph represents the home number. Homes 1-25 are the Lafayette participants; homes 26-50 are the Wilsonville participants. The y-axis of each graph is one of the evaluation metrics. These metrics include water use, water savings, energy use, and energy savings for the different program appliances. The numeric value on the graph represents that home's mean use, or savings, over the study period.

The solid lines shown on each graph represent the study-wide mean savings for the particular metric reported. On the charts reporting savings, each mean savings line is bracketed by 95% confidence intervals. These intervals represent the range of values that the reported value could statistically take, with 95% confidence. Another way of thinking of this interval is as follows. If we were to conduct this same test 100 times, we would expect the resulting values to fall with this range 95 of the 100 times. Recall the confidence interval discussion at the beginning of the End Use Data subsection on page 27 of the main text. The solid line indicates the estimated mean of the average savings, D-bar. The standard deviation S_d is the variability between the observed average household savings. The standard error of the mean savings is then S_d/sqrt(50), which leads to the upper and lower 95% confidence limits indicated by the red dotted lines.

Clothes Washer Data

Figure D.1 presents the mean per-cycle clothes washer water use. Note the significant home-to-home variance in the *baseline* water use compared with the *retrofit* water use. This variance is likely due to the *baseline* clothes washers being a mix of washer models and ages, whereas the retrofit clothes washers are all the same age and model.

Figure D.2 presents the mean per-cycle clothes washer water savings. The mean savings are 15.2 gallons/cycle. The upper and lower 95% confidence intervals, 13.3 and 17.1 gallons/cycle, respectively, are indicated by the red dotted lines. We can thus conclude with 95% confidence that the mean savings is not only greater than zero, but is actually greater than (or equal to) 13.3 gallons/cycle. The home-to-home variance is again likely due to the *baseline* clothes washers being a mix of washer models and ages, whereas the retrofit clothes washers are all the same age and model.

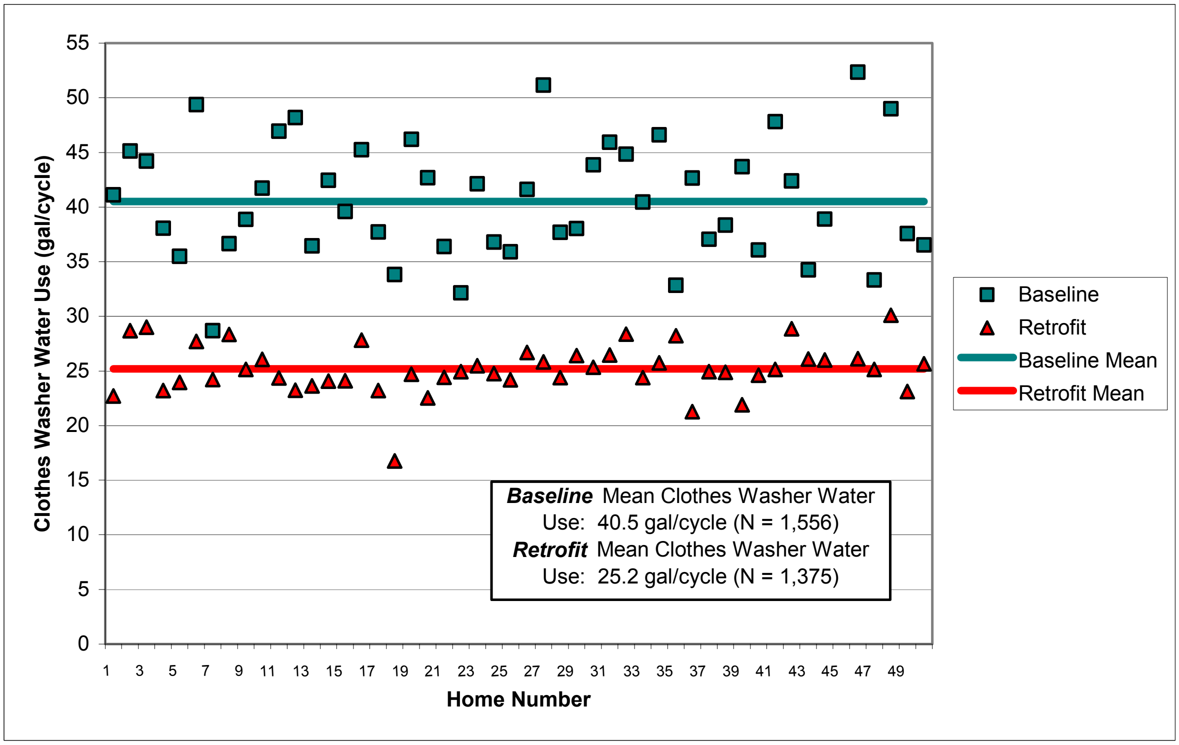


Figure D.1. Mean Per-Cycle Clothes Washer Water Use

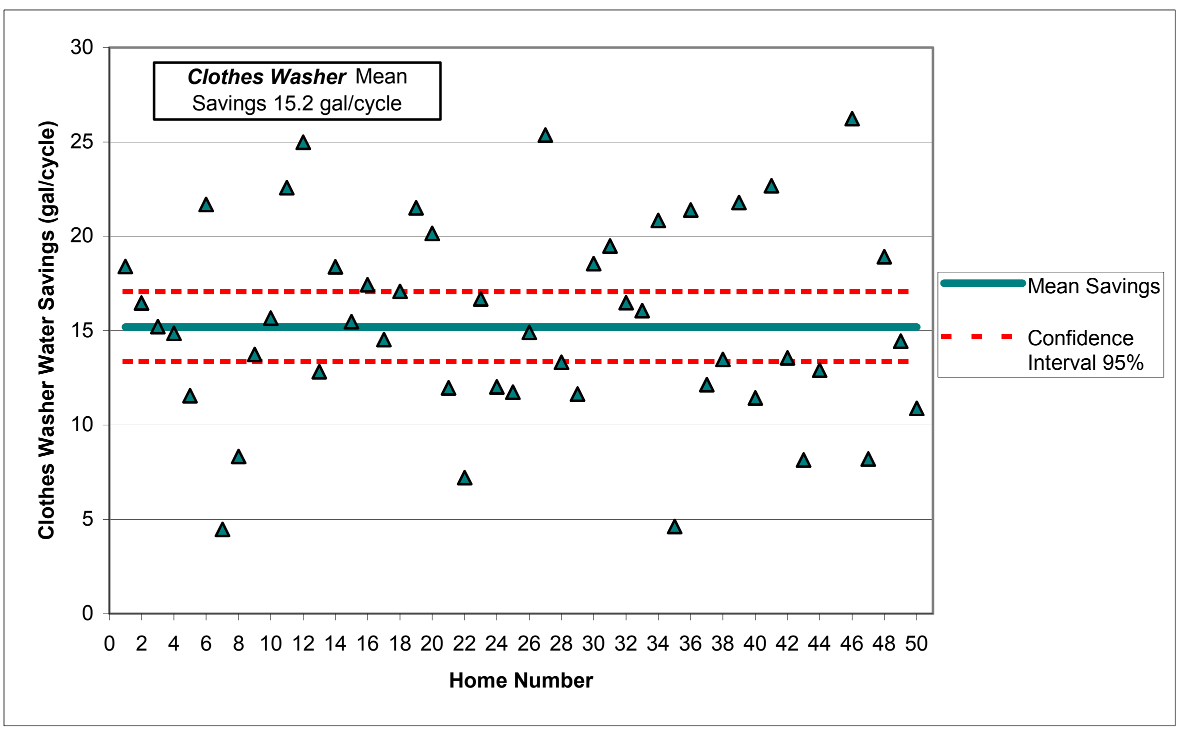


Figure D.2. Mean Per-Cycle Clothes Washer Water Savings

Figure D.3 presents the mean per-cycle clothes washer energy use. Recall that only a subset of the 50 homes received end-use metering capable of monitoring the energy use at the washer and dryer. Again, note the significant home-to-home variance in the *baseline* energy use compared with the *retrofit* energy use. This variance is also a likely a function of the *baseline* clothes washer age and water use characteristics in each home. Home 34's *baseline* washer was found to use and excessive amount of hot water—on the order of 20 gallons/cycle. Initially, it was thought that this was a problem with the metering equipment; however, it was checked and found to be operating properly. Its proper function was also confirmed when the retrofit data were collected and values were as expected. It is not clear why the baseline washer used so much hot water—possible explanations include a faulty hot-water control valve (solenoid), or a problem at the hose-bib connection.

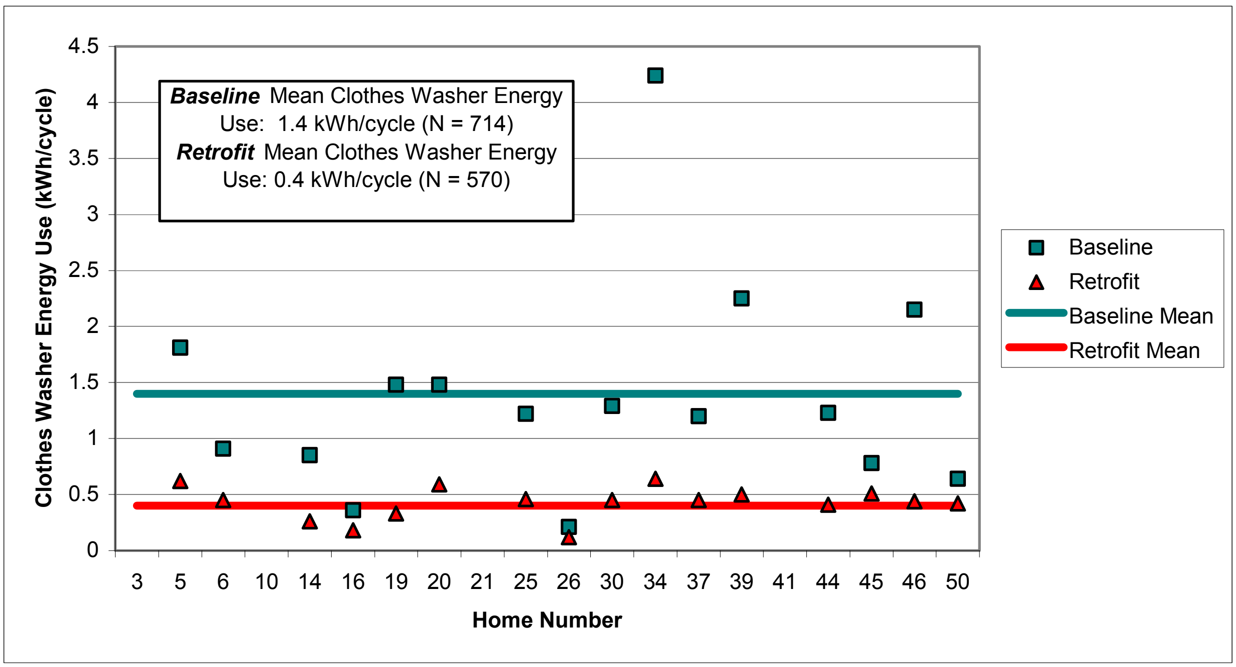


Figure D.3. Mean Per-Cycle Clothes Washer Energy Use

Figure D.4 presents the mean per-cycle clothes washer energy savings. The mean savings are 0.9 kWh/cycle. The upper and lower 95% confidence intervals, 1.3 and 0.6 kWh/cycle, respectively, are indicated by the red dotted lines. We can thus conclude with 95% confidence that the mean savings is greater than (or equal to) 0.6 kWh/cycle. The home-to-home variance is expected because the per-cycle energy use is a function of the wash cycle selected (hot, warm, or cold) as well as the load size. This is true in both the *baseline* and *retrofit* cases; therefore, the savings variance capture these differences.

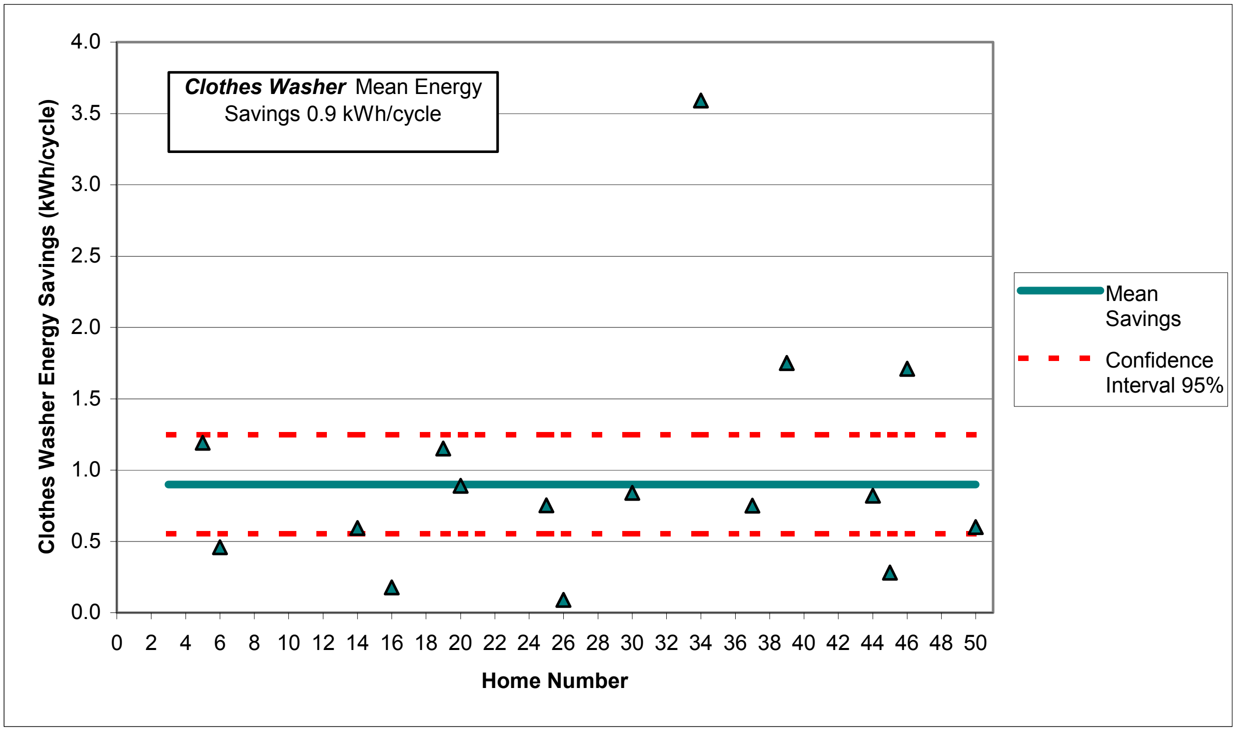


Figure D.4. Mean Per-Cycle Clothes Washer Energy Savings

Clothes Dryer Data

Figure D.5 presents the mean per-cycle clothes dryer energy use. In this case, the data show significant home-to-home variance in both the *baseline* dryer energy use and the *retrofit* dryer energy use. This variance is a likely function of clothes dryer use, settings, and load size/type.

Figure D.6 presents the mean per-cycle clothes dryer energy savings. The mean savings are 0.8 kWh/cycle. Note that included in these savings are two homes that showed increased mean clothes dryer energy use in the *retrofit* case over the *baseline*. The upper and lower 95% confidence intervals, 1.2 and 0.4 kWh/cycle, respectively, are indicated by the red dotted lines. We can thus conclude with 95% confidence that the mean savings is greater than (or equal to) 0.4 kWh/cycle.

In the raw data there was noted a significant variance in the per-cycle energy use of the clothes dryer. This variance is likely a function of the many different ways a clothes dryer is used, e.g., drying a full load of light-weight clothing (t-shirts, socks, etc.) versus a full load of heavy-weight clothing (jeans, work shirts, etc.), or drying a full load of general mixed clothing versus drying a light jacket wet from rain. These different clothes drying events typically use vastly different amounts of energy. It is these types of differences that result in significant variance in the data set and a correspondingly larger confidence interval.