ATTACHMENT 1

THE MAYOR'S YOUTH FOR A SUSTAINABLE FUTURE

Improving Water Conservation Efforts in Chapel Hill Public Housing

Colony Woods Case Study

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I. Introduction

The Mayor's Youth for a Sustainable Future aims to empower the youth to become leaders of change in their homes, schools, neighborhoods and community by way of the political process through engagement in relevant, hands-on sustainable learning models. In order to achieve such goals, members of the Mayor's Youth for a Sustainable Future participate in three learning modules over the course of the academic school year to better understand the three-legged stool that is sustainability: economy, environment and society.

Water conservation and audit training was selected as the topic for our project with the Mayor's Youth for a Sustainable Future. Water conservation has become an increasingly pressing issue because society views water as an unlimited resource that will never run out. However, this is not the case given the high level of drought this region has experienced over the past several years.

As a result of drought, increased costs of water supply development and treatment, and increased costs for maintaining and replacing water system infrastructure, the price of water in our community, and around the State and nation, has been increasing. Given the recent economic problems facing our community and country, we decided that efforts to promote water conservation while still remaining fiscally responsible were becoming more and more important. Therefore, we chose to focus our efforts on conservation in public housing. Specifically, we chose Colony Woods public housing units because the residents within this complex are financially responsible for their water consumption each month.

The team had two primary goals for the project: 1) Perform water audits and retrofits to help residents lower their water use and monthly water bill, which would offer some additional relief in these tough economic times; 2) As members of the Mayor's Youth for a Sustainable Future, help the environment and learn skills that will allow us to continue our community service and conservation education in the future.

In order to prepare for our audit and retrofit of five units in Colony Woods, we received educational supplements from UNC's Environmental Resource Program and the Foundation for a Sustainable Community and audit training from Orange Water and Sewer Authority (OWASA). Thanks to the UNC Environmental Resource Program and the Foundation for a Sustainable Community, we were more aware of the demands society places on the environment and the economic demands that each place on the other. With the help of OWASA, we learned how to assess the water consumption of a building using OWASA home audit kits and a residential home audit calculator (Appendix A). OWASA employees and town housing maintenance staff assisted with the onsite audits and installations.

I. Summary of Audits & Retrofits

In order to create a demonstration-scale model of conservation within Colony Woods, the Mayor's Youth for a Sustainable Future partnered with the Niagara Conservation Corporation to provide the necessary fixture renovations for the project. Generally, fixtures that are used everyday are evaluated because they are the most water-intensive. Upon learning about the project from OWASA staff, Niagara

Conservation Corporation generously donated 5 Ecological Flapperless HET Round Bowl Toilets with 1.28 gallon per flush (GPF) rating, 5 Earth High Efficiency Massage Showerheads with 1.5 gallon per minute (GPM) rating, 5 1.0 GPM dual threaded bubble spray aerators and 5 1.5 GPM dual flow kitchen sink aerators. The donated fixtures were tested before and after the retrofits.

For our evaluation of Colony Woods, the Town's department of Housing and OWASA worked together to select 5 units for observation. The units, labeled A-E (actual addresses are not disclosed to maintain privacy), were all built around the same time and have the same floor plan. Each unit has one toilet, one bathroom sink aerator, one showerhead and one kitchen sink aerator.

For our project, OWASA took a water meter reading about three weeks before the units were retrofitted. On the day of the audit, we checked the water meter reading and calculated the average daily water use for the pre-retrofit period. The results appear in Table 1.

Table 1. Water consumption prior to retrofits

UNIT	Number of Occupants	Pre-Audit Water Meter Reading (11/03/08)	Water Meter Reading on day of Water Audit (11/22/08)	Difference	Average Use per Day for Pre-Retrofit Period
A	4	1224210	1228500	4290	226
B	1	795310	797529	2219	117
C	1	670400	671830	1430	75
D	3	820130	823170	3040	160
E	1	14080	15848	1768	93

Second, we evaluated the gallon per flush (GPF) rating of each toilet for the five units. To do this, one student flushed the toilet inside the unit while another student monitored the outside water meter to determine how much water was being consumed with each flush. The change in the meter reading (i.e., the gallon per flush rating) suggested whether or not the toilet needed to be replaced. We then verified the flush volume by measuring the dimensions of toilet tank and height of the water in the tank. The GPF rating of each initial toilet can be found in Table 2. Once the rating of the existing toilet was determined, we compared the results with the rating of Niagara Ecological Flapperless HET Round Bowl Toilets, which has a reported rating of 1.28 GPF. Given that each existing toilet had a GPF rating considerably greater than 1.28 GPF, we decided to replace the existing toilets with the more efficient toilets donated by Niagara Conservation Corporation (NCC).

Third, the showerheads were measured using home water audit kits from OWASA. We measured the flow rate of each showerhead for 5 seconds (Table 2). The measurement was then compared with the

reported 1.5 GPM flow rate of the Niagara Earth High Efficiency Massage showerhead. When tested, the showerhead in unit D had a 1.0 GPM reading so it was not retrofitted. Because the remaining units (A-C, E) all had GPM measurements greater than 1.5 GPM, the existing showerheads were replaced with the more efficient showerhead donated by Niagara Conservation Corporation.

Fourth, we assessed the flow rate of each bathroom faucets (Table 2). We used the same measuring bag provided by OWASA and measured how much water was used for five seconds. All aerators in the bathrooms were changed because all units had fixtures less efficient than the Niagara 1.0 GPM dual threaded bubble spray aerators.

Finally, we assessed the flow rates of each unit's kitchen aerator (Table 2). After several readings, we found that the existing kitchen faucet aerators were relatively efficient and comparable to those donated by Niagara Conservation Corporation. Therefore, we chose to keep the existing aerators and the kitchen faucet aerators were not retrofitted.

Table 2. Observed flow rates for existing fixtures

Unit	Toilet (gallons/flush)[1]	Showerhead (gallons/minute)[2]	Bathroom Aerator (gallons/minute)[3]	Kitchen Aerator (gallons/minute) [4]
A	3.5	2.0	2.0	2.0
B	3.7	2.2	2.0	2.0
C	3.5	2.0	2.0	1.8
D	4.0	1.0	2.1	1.8
E	4.0	2.7	1.5	1.9
NCC Flow rates	1.28	1.5	1.0	1.5

For all households, we noted any other water-using appliance in the house that would account for the total water use in the dwelling unit and reflected in the actual meter readings. Most units had older large-capacity top loading washing machines, which we estimate would use about 40 to 45 gallons per load of wash. Based on that factor, and an estimated use rate of 0.37 loads of wash per person per day, we estimated the average day water use for clothes washing to be approximately 14.8 gallons per person a day (Table 3).

[1] All units were retrofitted with a Niagara 1.28 GPF flapperless round bowl toilet.
[2] Units A-C, E were retrofitted with a Niagara 1.5 GPM massage showerhead; unit D was not retrofitted.
[3] All units were retrofitted with a Niagara 1.0 GPM dual threaded bubble spray aerator.
[4] None of the units were retrofitted.

Table 3. Water Usage per day by washing machines[5]

Unit	Description	Gallons used per day
A	GE extra large capacity top loader	59.2 (4 occupants)
B	Kenmore heavy duty, top loader	14.8 (one occupant)
C	Crosley heavy duty, giant capacity top loader	14.8 (one occupant)
D	GE heavy duty, large capacity top loader	44 (3 occupants)
E	Roper by Whirlpool super capacity top loader	14.8 (one occupant)

II. Results and Recommendations

On January 29, 2009 OWASA staff took post-retrofit period meter readings for each of the retrofitted units. We calculated the average-daily water use for each unit during the post-retrofit period; compared those results to the pre-retrofit water use rates; and then determined the savings. We then compared the actual daily savings to our estimates of the expected savings that would be realized from the retrofits we completed.

Prior to the retrofit, the five surveyed units used an estimated total of about 671 gallons of water daily. Based on our post-retrofit evaluation, the units are now using a total of about 542.3 gallons daily, providing a total savings of 28%.

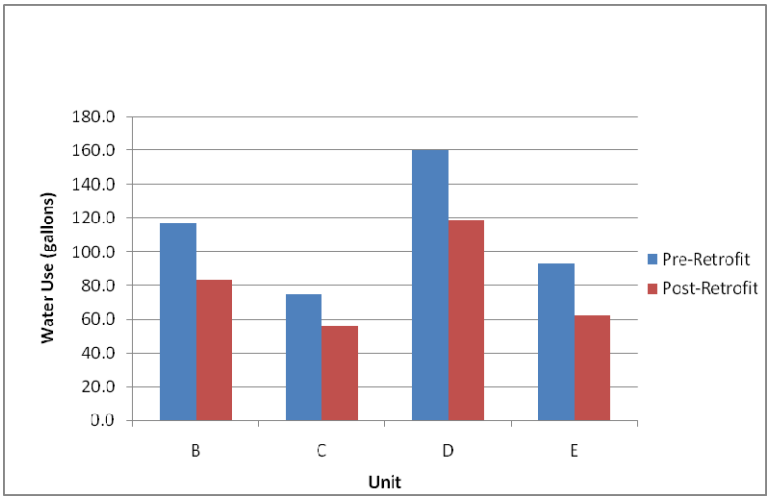
Four of the units had substantial water savings – ranging from 26 to 33%. The actual savings for those units were very close to our estimates of expected savings. However, Unit A experienced less water savings than anticipated. Because Unit A exhibited abnormal results with only 1.8% decrease in consumption, we have elected to remove its data from our remaining calculations as illustrated in Table 4. While the cause of this outlier is unknown, we believe that the lack of significant savings may be attributed to an increase in the number of visitors to the home. The remaining units, B – E, experienced significant savings in their daily water use as illustrated in Figure 1.

[5] The amount of water used daily by washing machines is affected by the number of occupants.

Table 4. Daily Water Use and Percent Reduction in Retrofitted Units.

Unit	Occupants	Meter Readings			Average Daily Use (Gallons)		% Reduction
		Pre-Retrofit Reading	Day of Retrofit Reading	Post-Retrofit Reading	Pre-Retrofit Period	Post-Retrofit period	
A	4	1224210	1228500	1243580	226	221.8	1.8%
B	1	795310	797529	803230	117	83.8	28.2%
C	1	670400	671830	675610	75	55.6	26.1%
D	3	820130	823170	831240	160	118.7	25.8%
E	1	14080	15848	20090	93	62.4	33.0%
All Units	**10**				**671**	**542.3**	**19.2%**
Adjusted Savings[6]	**6**				**445**	**320.5**	**28%**

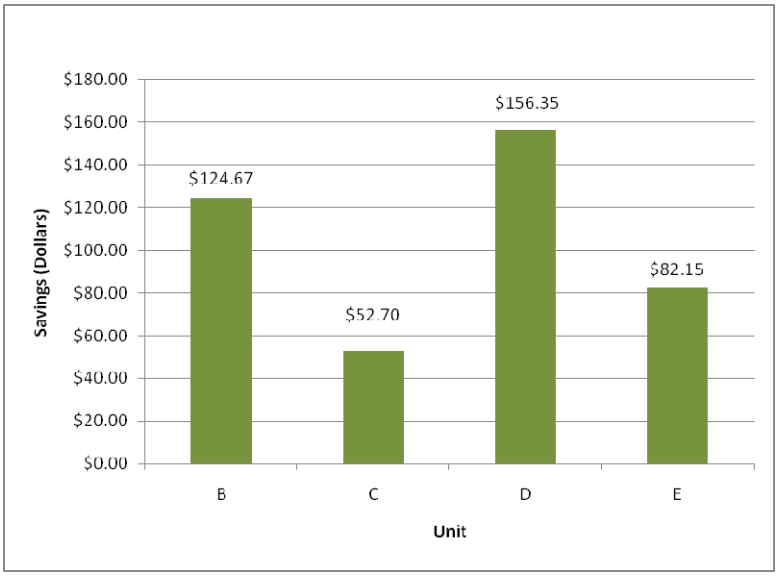
Figure 1. Daily Water Use Comparison



Using OWASA's 5-tiered increasing block-rate system of billing, we estimate the total savings each year for units B-E totaled about $416 as illustrated in Figure 2.

[6] Unit A has been removed from the data set.

Figure 2. Projected Annual Water and Sewer Bill Savings for Residents in Units A-E[7]



Based on the findings from our water audit of five public housing units in Chapel Hill, which is likely to be representative of Colony Woods, we believe that it would be beneficial to do a complete audit and retrofit of all units at Colony Woods. Although they meet building code requirements that existed at the time of their construction, from a conservation perspective many of the fixtures we tested in the units were out-dated and used a considerable amount of water compared to newer models now available. Given the community and state's recent history of severe drought, it is important that the Town remain vigilant in its efforts to conserve water and become more sustainable. That being said, it is our recommendation that the Town consider auditing and retrofitting the remainder of the Town supplied fixtures in its public housing stock, including faucets, showerheads and toilets.

Although it would be ideal for the Town to replace all such fixtures in the remaining public housing units from a water conservation standpoint, we recognize that with the current economy, these retrofits may prove to be too costly. Not all units need to be retrofitted to make a significant difference. The Town could choose a portion of the units to retrofit now, and then retrofit the remaining units later when money is more readily available. In doing this, the Town might ask: which units should be retrofitted? To this question, we have three recommendations.

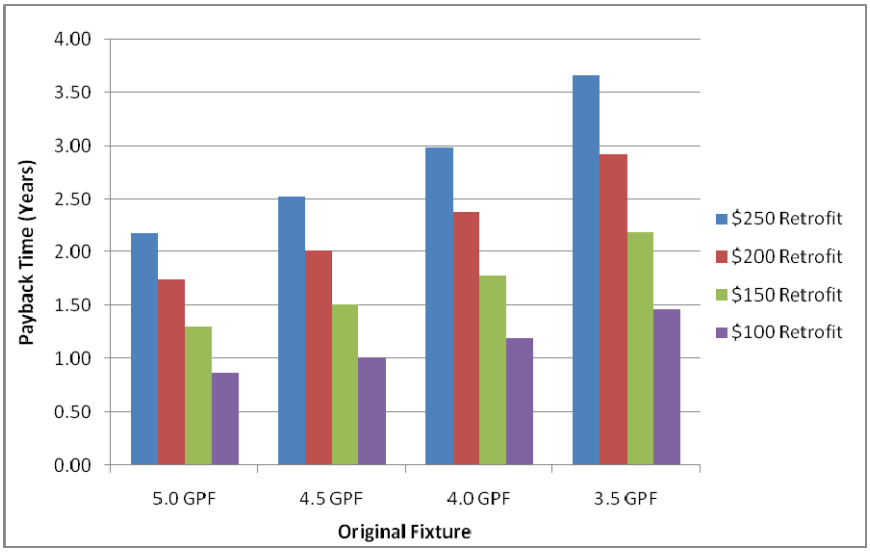
First, the Town should consider retrofitting the least efficient fixtures first. Toilets are the largest consumer of water in the household, accounting for approximately 31% of indoor water use according to OWASA. If we assume that each residence has 2.3 occupants, we can determine the potential payback period of a toilet retrofit based on the potential GPF savings. For instance, a unit with a 5.0 GPF toilet could potentially use 57.5 gallons of water each day (based on 2.3 person occupancy and 5 flushes

[7] Units B and D have higher annual savings because these are the units with more occupants. If there are more people they use more water and will see more savings.

per person per day). If this same toilet was replaced with a 1.28 GPF toilet, the consumption would decrease by 74.4% - a savings of nearly 43 gallons each day.

As the cost of purchasing and installing a new toilet decreases, the time needed to see a return on the investment would decrease as illustrated in Figure 3. As a result, we recommend that the Town conduct an audit on public housing toilets to determine which units have the most outdated toilets and those units should be retrofitted with a high efficiency toilet first.

Figure 3. Cost-benefit Analysis of Retrofitting with 1.28 GPF Toilets[8]



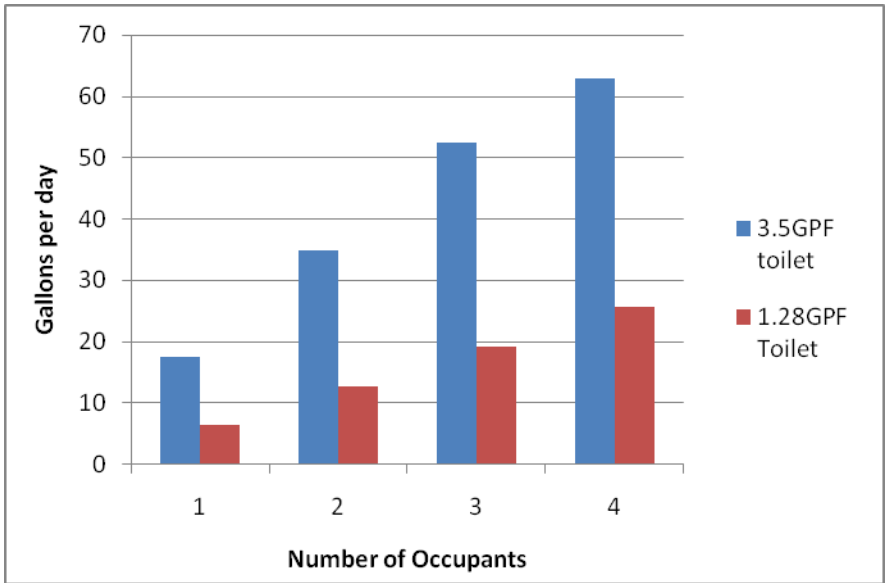
Second, the Town should consider retrofitting units with the most occupants. An average person flushes the toilet five times a day.[9] Most of the toilets in the public housing units used about 3.5 GPF. If only one person is using a toilet, then this will come to about 17.5 gallons of water a day. If the toilet is replaced with one that only uses 1.28 GPF, then the same person will use 6.4 gallons a day, saving about 11 gallons of water each day. Now, if a public housing unit has four occupants then their toilet will use about 70 gallons of water each day. If this toilet is replaced with one that only uses 1.28 GPF, the use will drop to about 25.6 gallons each day, thereby saving almost 45 fewer gallons each day, or more than 16,200 fewer gallons each year. Fixtures with higher flow rates used by more occupants would yield greater savings if retrofitted. The same applies to other fixtures as well. If the town replaces fixtures in the units with more occupants, more water will be saved.

These calculations demonstrate that the number of occupants in a public housing unit strongly affects the amount of water that is saved. In our retrofitted units, we saw the greatest savings in Unit D which had three residents. Figure 4 illustrates the possible savings per day if a 3.5 GPF toilet was replaced with

[8] The payback time is based on changing a fixture with the shown rates (in gallons per flush) to a toilet with a flow rate of 1.28 gallons per flush.
[9] Based on national averages

a 1.28 GPF model with regards for the number of people in a home. Therefore, it would be in the Town's best interest to replace toilets, showerheads, and sink facets in the units that have three or more occupants. Not only will it save more water and more money, but it will benefit those people with larger households and greater living expenses during this time of economic hardship.

Figure 4. Gallons Used per Day Based on Occupancy[10]



Finally, the Town could install new high efficiency fixtures in the units where the Town is responsible for the water costs. Currently, the Town pays for water usage in 192 of its 336 public housing units. This could potentially save thousands of gallons of water as illustrated in Figure 5. If the town were to retrofit these units first, the expected savings in water costs may enable the Town to retrofit the remaining units' fixtures in future years. If the Town's 192 units were retrofitted a new high-efficiency, low-flush toilet with a rating of 1.28 GPF, the Town could expect to save at least $13,000 each year in water and sewer bills. Depending on the costs of the toilets and the difference in water use, we estimate that the Town may begin to recoup the costs of such retrofits in 3.5 years as illustrated in Figure 6. While this is a conservative estimate based on higher priced fixtures and lower GPF savings, the potential cost savings the Town would receive each year after the initial payback period would allow the Town to retrofit its remaining 139 public housing units.

[10] This data is based on the national average of 5 flushes per person each day.

Figure 5. Estimated Water Savings from Retrofitting 192 Town-paid Units[11]

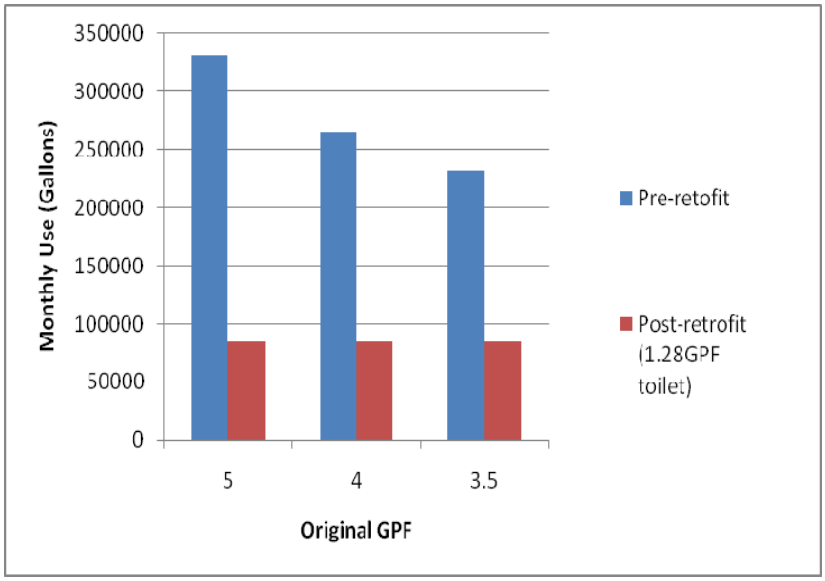
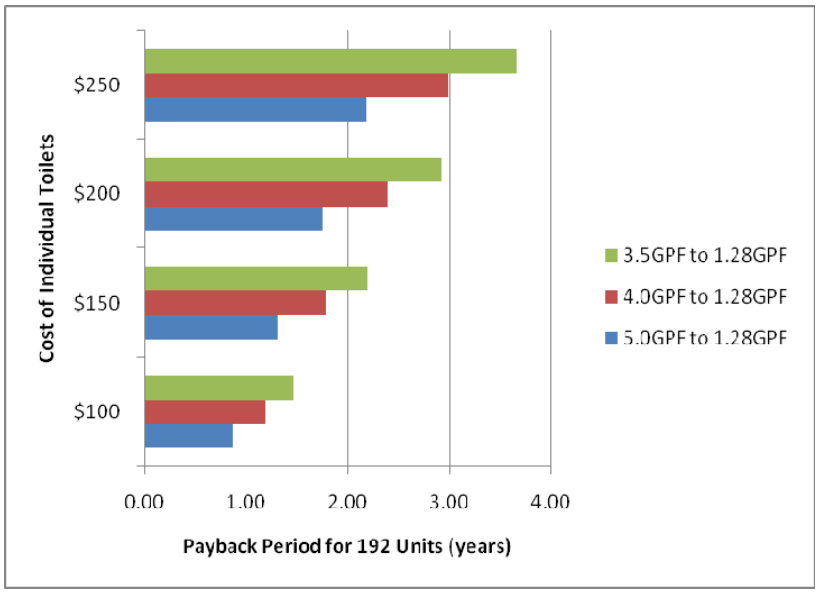


Figure 6. Payback in Years of Retrofitting Town-paid Units[12]



[11] This assumes that all 192 pre-retrofit toilets had the same flow rate and the same number of residents (2.3 persons); difference in water usage would vary depending on the number of occupants and the actual flow rates of the 192 toilets.

[12] See footnote 10.

In summary, we recommend that the Town of Chapel Hill consider the following:

- Conducting audits and retrofits of the remainder of the Town supplied fixtures in its public housing stock, including faucets, showerheads and toilets; or
- Retrofitting toilets first, especially those that use 4 gallons per flush or more; or
- Retrofitting units with the most occupants first; or
- Retrofitting units that the Town pays water bill for first.

III. Conclusion

In light of current economic conditions and in the interest of fiscal responsibility, it is important that the Town consider completing a retrofit of the water-using fixtures in its public housing units in an efficient, cost-saving manner. In order to be the most cost-effective, the Town should consider retrofitting the fixtures in households with the greatest number of occupants and the oldest fixtures, particularly those households in which the Town pays the residents' water bill. The expected savings would most certainly allow the Town to allocate the necessary funds to retrofit the remaining public housing units. To this end, the Mayor's Youth for a Sustainable future recommends that the Town Council conduct an audit of the remaining 331 public housing units to determine which retrofits would provide the greatest payback in the least amount of time. Money is tight everywhere right now, but these water-saving retrofits are worth every penny. Not only will these cost-saving recommendations helps residents and the Town save money each month on their water bills, they will also be helping to conserve our essential and limited drinking water resource. By conducting an audit of the units, the Town would demonstrate its commitment to social equity and environmental protection while also remaining fiscally responsible. It is our hope that the Town Council strongly considers these recommendations for the future as they will most certainly improve the Town's efforts to create a more sustainable community.

Appendix A.

PART I. RESIDENTIAL INDOOR WATER AUDIT SPREADSHEET FOR YOUTH COUNCIL CONSERVATION PROJECT

(Enter your data directly into chart and it will automatically calculate results.)

RESIDENT: _____

ADDRESS: _____

 # RESIDENTS: 1

DATE AND TIME OF AUDIT: _____

NAME OF AUDITOR _____

WHO PAYS WATER BILL? _____

INITIAL METER READING _____ Gallons

IS WATER METER CREEPING? _____

IF YES, WHAT IS ESTIMATED LEAKAGE RATE (GALLONS/DAY)? 0

ESTIMATED DAILY WATER USE FOR PLUMBING FIXTURES TARGETED FOR RETROFIT				
	Toilet	Showerhead	Bathroom Faucet	Kitchen Faucet
# of FIXTURES:				
FLOW AND FLUSH RATES	gallons per flush	gallons/minute	gallons/minute	gallons/minute
USE LEVEL/RESIDENT/DAY	5 flushes/person/day	8.2 minutes/person/day	2 minutes/person/day	6 minutes/person/day
IS THE FIXTURE LEAKING?				
TOTAL USE/DAY FOR ALL RESIDENTS, BY FIXTURE TYPE				

* Values shown are national averages as reported in "Residential End Uses of Water" study (1999) sponsored by AWWA Research Foundation. Please change these as necessary to reflect the results of your fixture flow tests.

ESTIMATED DAILY USE FOR OTHER WATER USES IN THE HOME		
TYPE OF USE	DESCRIPTION AND BASIS OF ESTIMATE	GALLONS/DAY

ESTIMATED TOTAL DAILY WATER USE: _____ **GALLONS, OR** _____ **GALLONS/DAY PER PERSON**

ESTIMATED TOTAL WATER USE/MONTH: _____ **Gallons**

AVERAGE MONTHLY WATER USE PER OWASA BILLS: 2,000 **Gallons**

PART II. ESTIMATE OF EXPECTED WATER USE AND SAVINGS AFTER COMPLETION OF WATER CONSERVATION RETROFITS

(Enter your data directly into chart and it will automatically calculate results.)

ADDRESS:

 # RESIDENTS:

DATE/TIME OF RETROFITS:

IS WATER METER CREEPING?

IF YES, WHAT IS ESTIMATED LEAKAGE RATE (GALLONS/DAY)?

ESTIMATED DAILY WATER USE FOR PLUMBING FIXTURES THAT WERE RETROFITTED				
	Toilet	**Showerhead**	**Bathroom Faucet**	**Kitchen Faucet**
# of FIXTURES:				
FLOW AND FLUSH RATES	gallons per flush	gallons/minute	gallons/minute	gallons/minute
USE LEVEL/RESIDENT/DAY	**5** flushes/person/ day	**8.2** minutes/person/ day	**2** minutes/person/ day	**6** minutes/person/ day
IS THE FIXTURE LEAKING?				
TOTAL USE/DAY FOR ALL RESIDENTS, BY FIXTURE TYPE				

* Values shown are national averages as reported in "Residential End Uses of Water" study (1999) sponsored by AWWA Research Foundation. Please change these as necessary to reflect the results of your fixture flow tests.

ESTIMATED DAILY USE FOR OTHER WATER USES IN THE HOME		
TYPE OF USE	**DESCRIPTION AND BASIS OF ESTIMATE**	**GALLONS/DAY**

ESTIMATED TOTAL DAILY WATER USE: **GALLONS, OR** **GALLONS/DAY PER PERSON**

ESTIMATED TOTAL WATER USE/MONTH: **Gallons**

AVERAGE MONTHLY WATER USE PER OWASA BILLS: 2,000 **Gallons**

EXPECTED WATER SAVINGS: **Gallons/Mo.** % **Savings**

PART III. ESTIMATED SAVINGS ON WATER AND SEWER BILLS AS A RESULT OF WATER CONSERVATION RETROFITS

(Cost savings are to be calculated from Parts I and II.)

ADDRESS: _____

 # RESIDENTS:

DATE/TIME OF RETROFITS: _____

BEFORE RETROFITS WERE DONE: **Gallons/Month**

AFTER RETROFITS WERE DONE: **Gallons/Month**

EXPECTED SAVINGS: **Gallons/Month**

	Gallons Saved	Applicable Usage Charge	Savings
Savings on Water Usage Charges			
		$2.15	**$0.00**
		$5.22	**$0.00**
		$6.41	**$0.00**
		$8.95	**$0.00**
		$16.18	**$0.00**
Savings on Sewer Usage Charges			**$0.00**
		$5.29	**$0.00**
TOTAL ESTIMATED SAVINGS ON MONTHLY WATER AND SEWER BILL			**$0.00**
TOTAL ESTIMATED ANNUAL SAVINGS			

OWASA's Water and Sewer Usage Charges
(Rates as of October 1, 2008)

Water Rates

0 to 2,000 Gallons	**$2.15**	**/1,000 Gallons**
3,000 to 5,000 Gallons	**$5.22**	**/1,000 Gallons**
6,000 to 10,000 Gallons	**$6.41**	**/1,000 Gallons**
11,000 to 15,000 Gallons	**$8.95**	**/1,000 Gallons**
All Use Over 15,000 Gallons	**$16.18**	**/1,000 Gallons**

Sewer Rates

All Use Up to 15,000 Gallons	**$5.29**	**1,000 Gallons**