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Evaluating the Costs and Benefits of Single-Family Package Graywater Systems

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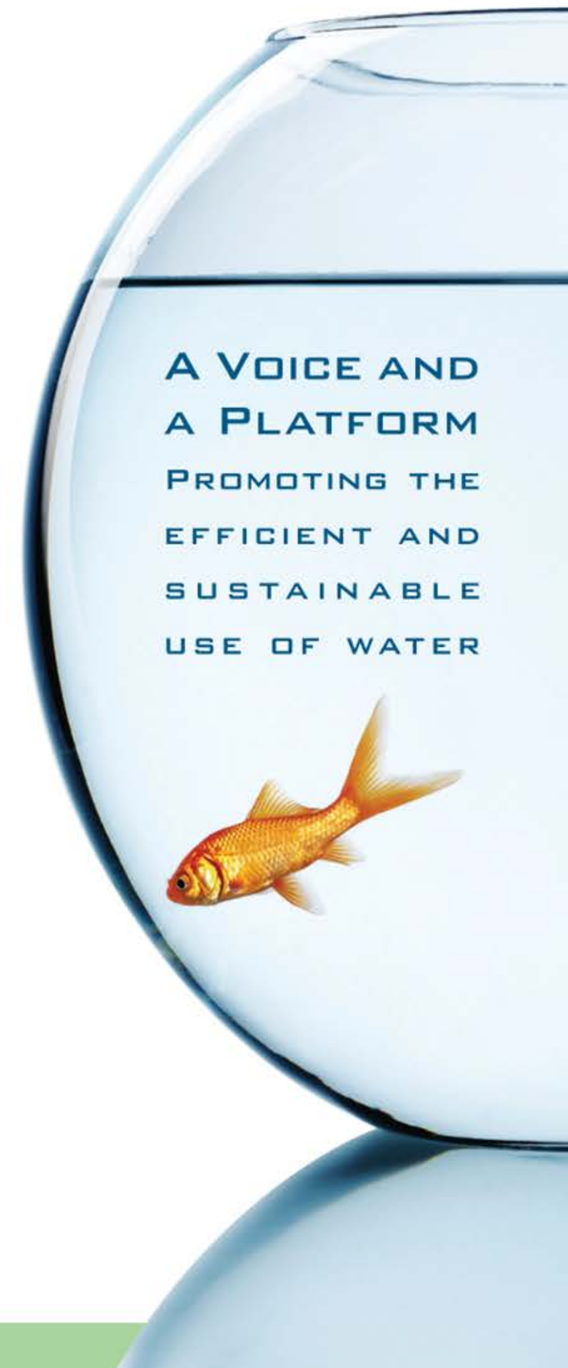
Alliance *for* Water Efficiency

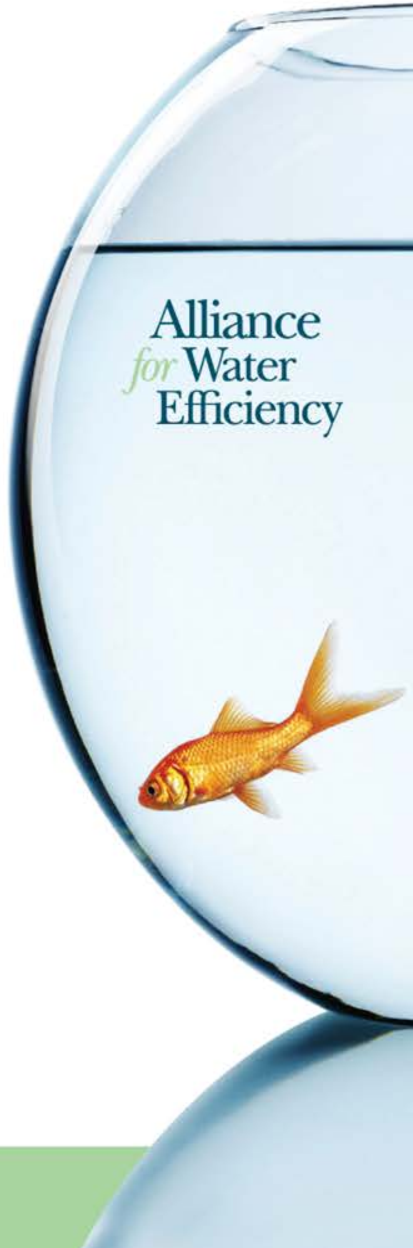


Residential Graywater

- Very few residential water uses require potable water (drinking, cooking, etc.)
- Others – especially toilet flushing and landscape irrigation – do not require potable water
- In fact, makes little sense to use “cleanest water on earth” to flush your toilet or water your lawn

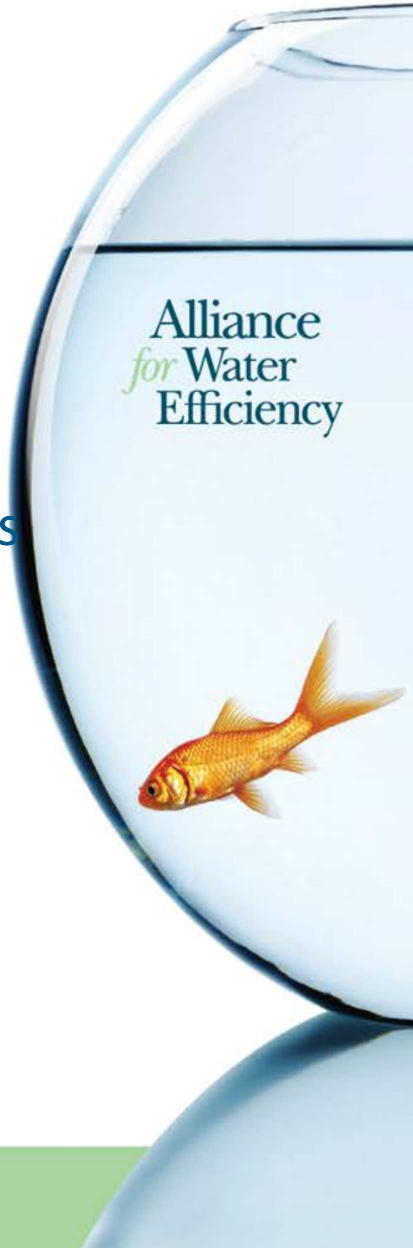
But:

1. Virtually all homes in N.A. have a ready source & system for potable water
    - Currently have source but not system for graywater
2. Potable water is still very inexpensive
3. Some preference to “err on side of caution”



Project Background

- Project initiated by AWE Water Efficiency Research Committee because…
- Utilities under increasing pressure to incentivize single-family package graywater systems – but facing mixed messages
- Project focus specifically on costs & benefits of SF systems (not technical or design details)
- Funded by the California Water Efficient Products Initiative and Portland Water Bureau



Project Approach

- Identify main types of SF package graywater systems used in USA and Canada
- Calculate maximum savings
- Research expected water savings
- Review benefits and costs
- Identify/describe important considerations

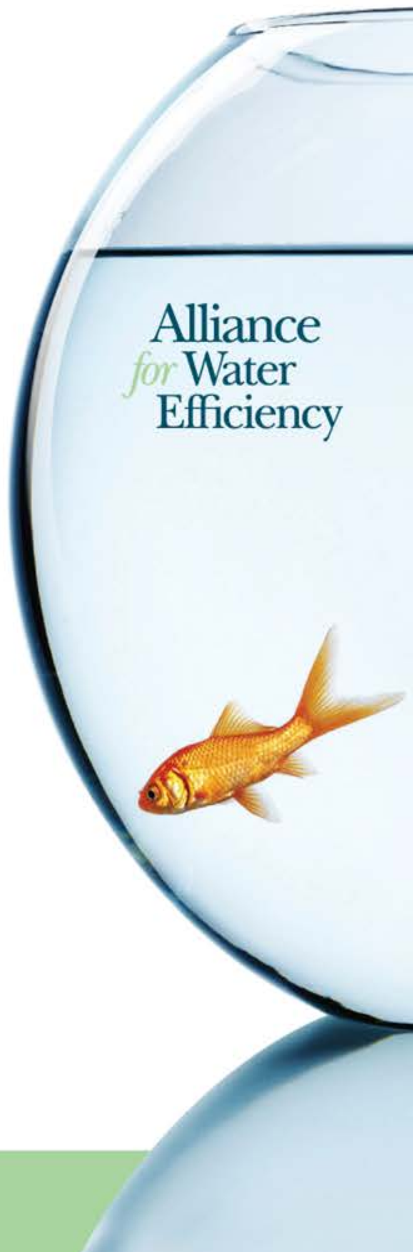
Main Types of Single-Family Systems

United States (typically)

- Graywater used for landscape irrigation
  - Laundry to landscape (L2L)
  - Branched drain
  - Pumped systems

Canada (typically)

- Pumped graywater used for toilet flushing



Graywater Sources

Laundry to Landscape

- Clothes washer

Branched Drain

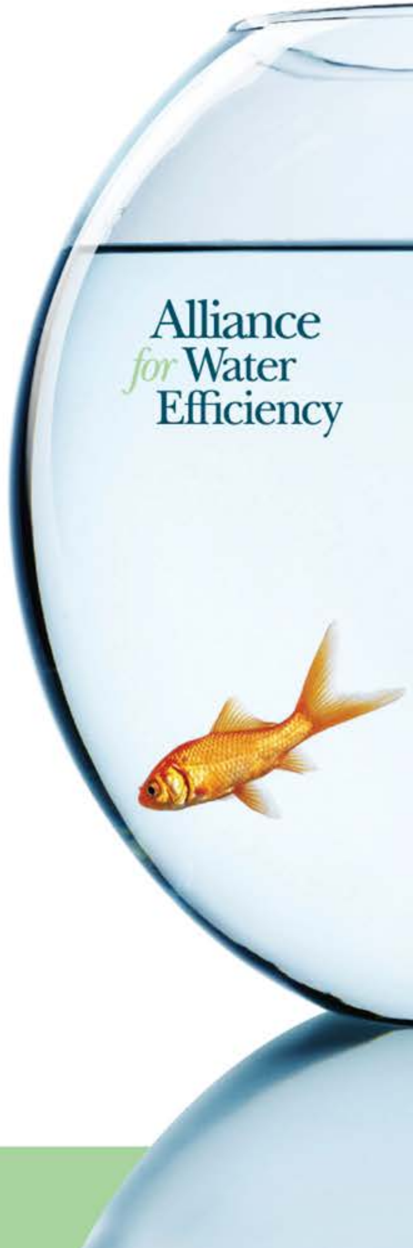
- Showers, lavatory sinks

Pumped System (landscape)

- Showers, clothes washer, lavatory sinks

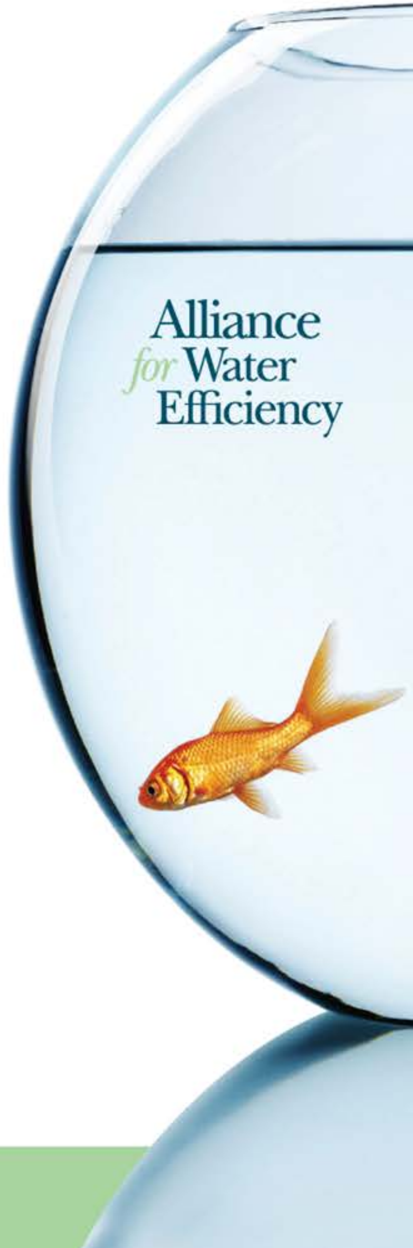
Pumped System (toilets)

- Showers (and possibly lavatory sinks, though contribution is minimal and not required)



Toilet Systems - Water Savings

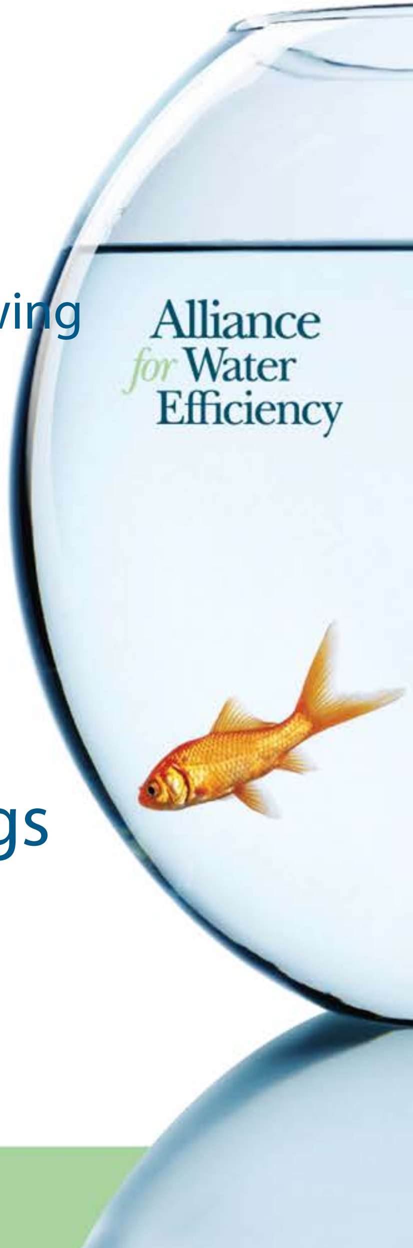
- Graywater production and toilet demand relatively constant, so easy to calculate <u>maximum theoretical savings for typical single-family home</u>
- Theory = 6,167 gal/home/yr
  - 2016 REUS = 2.64 pph & 5.0 fcd
  - 2.64 pph x 5.0 fcd x 1.28 gal/flush x 365 days
  - Produce more than enough graywater from showering to flush toilets on average day
- Observed savings in 2 field studies is lower
  - 3,944 & 4,226 gallons/home/year (based on 2.64 pph)
  - Some potable water make-up water
  - Field savings may increase as systems improve



Water Savings - Landscape Systems

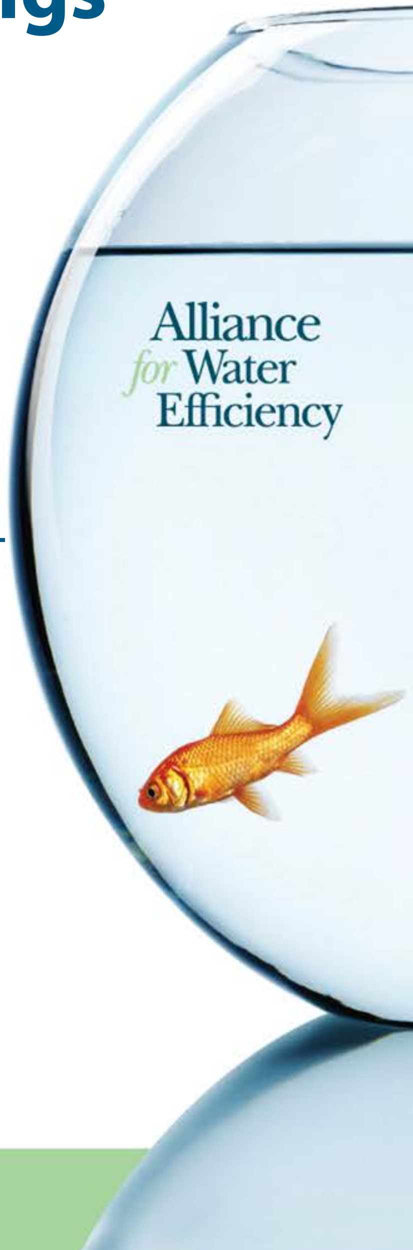
- Lack of independent 3rd-party field study results
- Highly variable irrigation demands / savings
    - Some homes had an increase in water consumption following installation of graywater system
- Seasonal variation
- Annual variation
- Difficult to quantify savings because…

Graywater production ≠ Potable water savings



Graywater Production ≠ Potable Savings

- Applying graywater to landscape that does not require irrigation (e.g., after rain event)
- Applying more graywater than needed for irrigation
- Irrigating plants or turf area that was not originally (pre-graywater system) irrigated
- Planting new trees or flower beds to receive graywater



Graywater Production ≠ Potable Savings

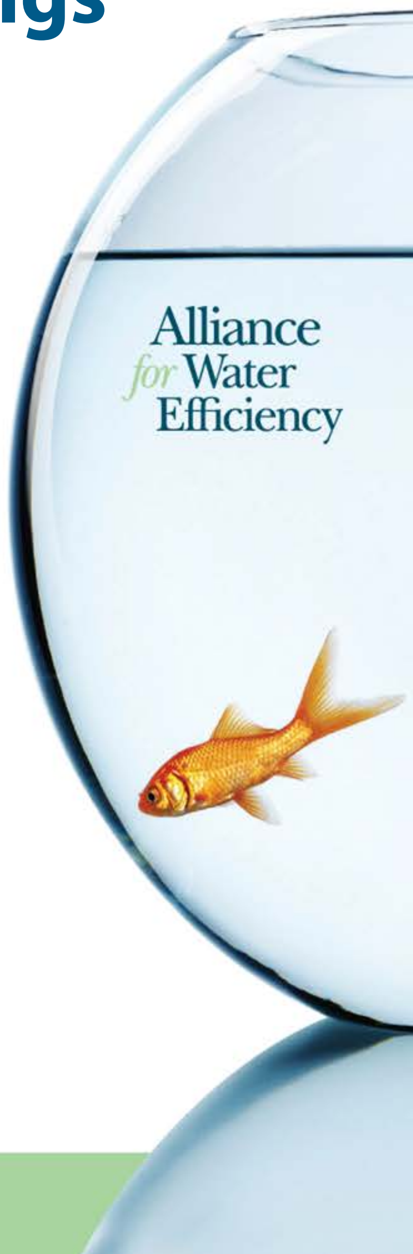
- Graywater-related savings can only be quantified by measuring reduction in customer potable water demands

Need to have PRE vs. POST demand rates

AND

Need to use both Study & Control groups because of variability in weather and, therefore, variability in irrigation demands

- Currently not many independent field studies available!

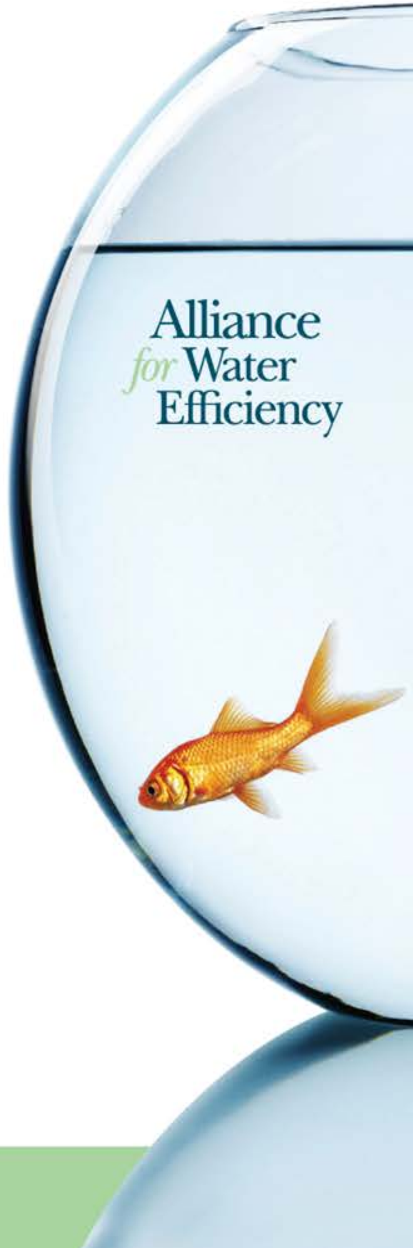


Graywater-Related Savings

- 2016 REUS (2.64 pph, installed base) identified:
  - 23 gal/day/home for clothes washing
  - 28 gal/day/home for showering
  - Contribution from lavatory faucet insignificant

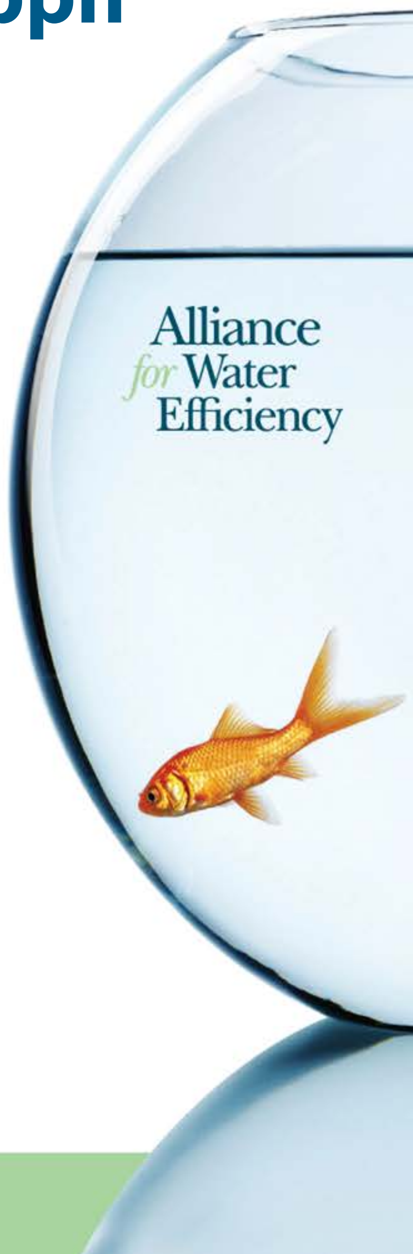
- *Maximum* Theoretical Savings for a Typical 2.64 pph Single-Family Home
  - L2L = 23 gal/home/day (8,395 gal/yr)
  - Branched drain = 28 gal/home/day (10,220 gal/yr)
  - Pumped system = 51 gal/home/day (18,615 gal/yr)

- *Note: max potential savings will decline as fixtures become more efficient*



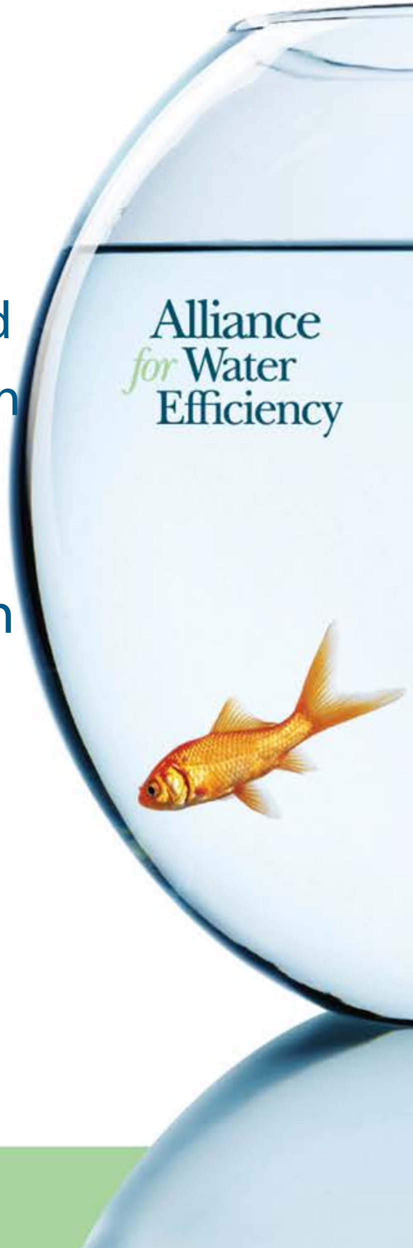
Graywater-Related Savings for other pph

- 2016 REUS (2.64 pph):
  - 8.7 gcd for clothes washing
  - 10.6 gcd for showering
  - 19.3 gcd from clothes washer + shower
- *Maximum* Theoretical Savings
  - L2L = 8.7 gcd x pph x 365 days/yr
  - Branched drain = 10.6 gcd x pph x 365 days/yr
  - Pumped system = 19.3 gcd x pph x 365 days/yr



Actual Savings < Maximum Savings

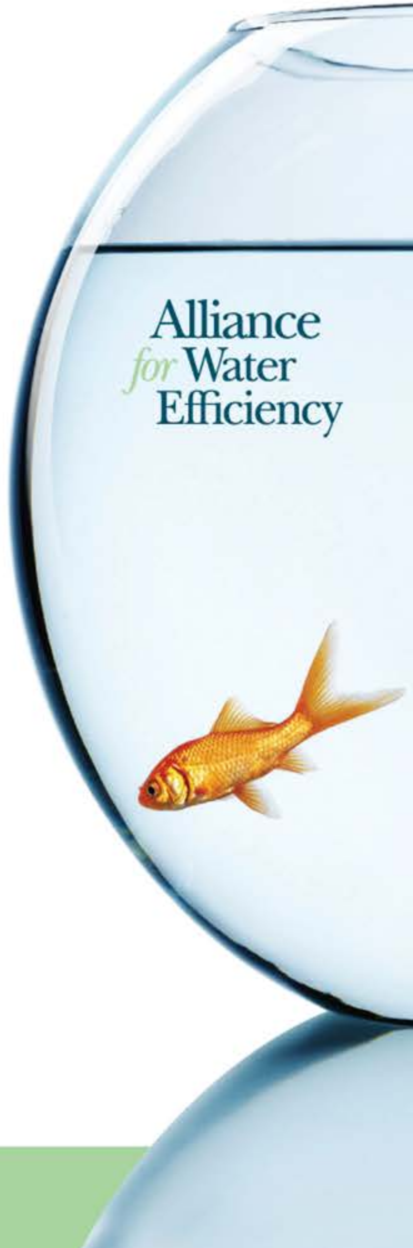
- EBMUD - preliminary estimates, L2L systems save ~ 3,600 gal/yr, about 43% of max potential savings
  - Unlikely to offset 100% potable water each day
  - Graywater production may not align with irrigation demand
  - May not require irrigation every week (especially in northern communities)
- **<u>At minimum</u>**, water agencies should adjust maximum potential water savings based on length of their irrigation season, e.g.,
  - 12 month season = 100% potential savings
  - 9 month season = 75% of potential savings
  - 6 month season = 50% of potential savings



Example Savings Calculations

- Optimistically, assume all irrigation-based systems save 2/3 of max potential (66.7%)
  - Irrigation not required 365 days/year
  - Not offsetting 100% of potable water irrigation demand
  - Graywater production not always aligning with demand

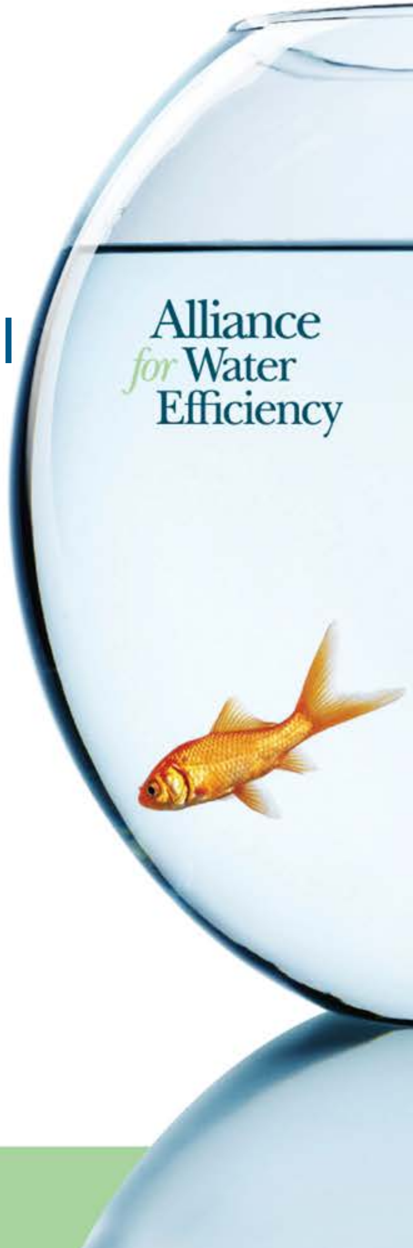
- Savings used in example calculations:
  - Laundry to Landscape ~ 5,600 gal/yr
  - Branched drain savings ~ 6,800 gal/yr
  - Pumped systems ~ 12,400 gal/yr



Water Rates

- 2014 Water and Wastewater Rate Survey
  - AWWA, Raftelis Financial Consultants, Inc.

- Table III-7: Typical 2014 residential monthly water bill and components
  - Avg. consumption of 7,375 gallons/home/mth
  - Avg. water bill of $33.79 ($13.20 fixed, $21.87 variable)
  - **<u>Only use variable, so…</u>**
  - Save $2.96 for every 1000 gallons of reduction

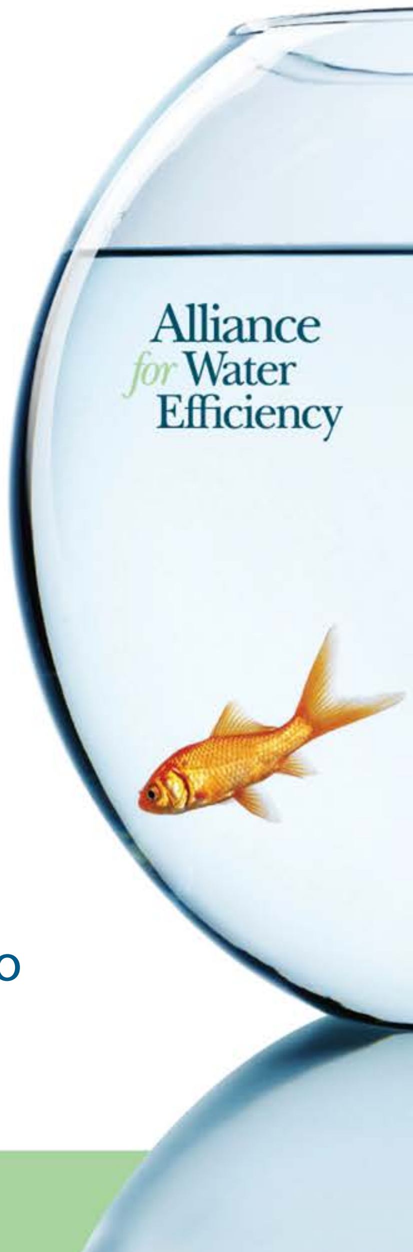


Wastewater Rates

- 2014 Water and Wastewater Rate Survey
  - AWWA, Raftelis Financial Consultants, Inc.

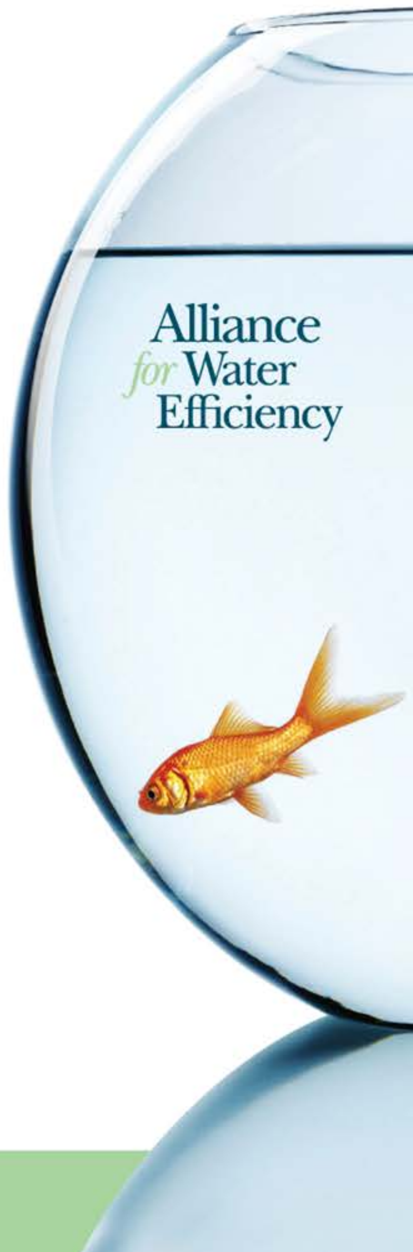
- Table III-10: Typical 2014 residential monthly wastewater bill and components
  - **Again, only use variable costs, so…**
  - Save $4.12 for every 1000 gallons of reduction

- **Total savings of $7.08 per 1000 gallons of potable water reduction**
  - Note: This is an example - **use your own variable rates!**
  - Note: Some water agencies do not apply wastewater fees to irrigation or apply fixed fees



Toilet Systems – Costs & Savings

- Maximum Savings = 6,167 gal/yr
  - At $10/thousand gallons <u>volumetric price</u> ~ $62/yr
  - Net Savings = Gross Savings – O&M
  - Chemicals and energy ~ $1 per thousand gallons
  - Parts - including pumps, filters, etc. ~ variable
  - Possible cost of annual backflow testing
  - Life-cycle ~ estimated as 15 to 25 years
  - Best Case Savings ~$56/year (**<u>minus maintenance cost</u>**)
- Total system cost ≥ $3,000 (variable)
- Payback ~ $3,000 ÷ $56/yr ~ 53 years
  - "right thing to do"
  - limited potable water supply / drought conditions
  - not typically installed to save customer money



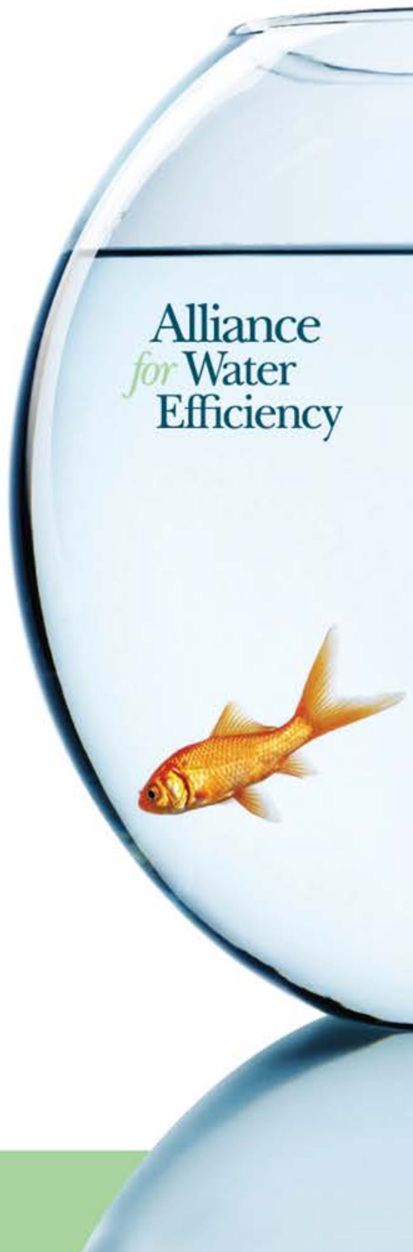
Toilet Systems using High Rates

- Some utilities charge $17 or more per 1000 gallons for water/sewer (retail rates)!

- Maximum Savings = 6,167 gal/yr
  - At $17/thousand gallons <u>volumetric price</u> ~ $105/yr
  - Operations cost ~ $5/yr
  - Save ~$100/year (**<u>minus any maintenance cost</u>**)

- Total system cost ≥ $3,000 (variable)

- Payback ~ $3,000 ÷ $100/yr ~ 30 years

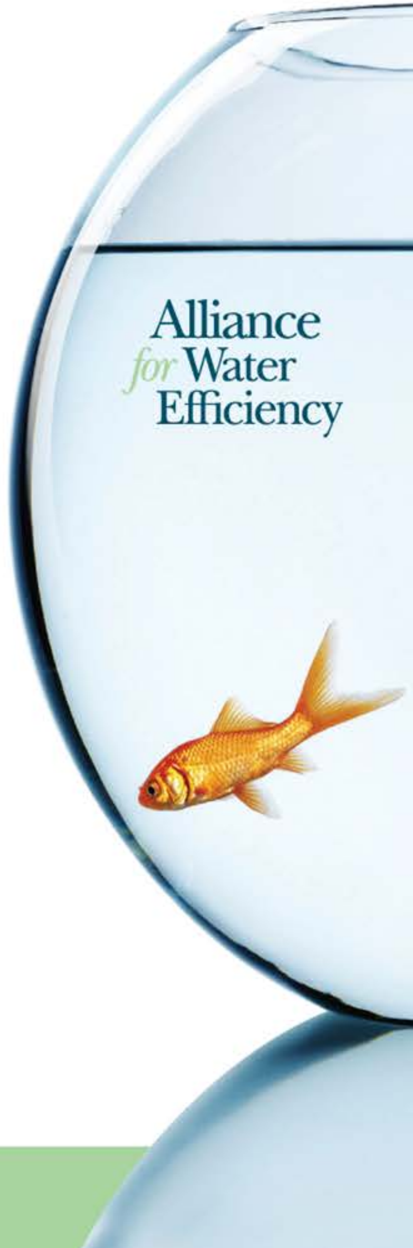


Landscape System – Savings

- Using volumetric water/sewer rate of $10 per thousand gallons customers will save:
  - L2L = $56 per year
  - Branched Drain = $68 per year
  - Pumped = $124 per year

- Little O&M with L2L or Branched Drain Systems
- Some level of O&M cost for Pumped Systems

- *Note: at $17 per 1000 gallons*
  - *L2L = $95 per year*
  - *Branched Drain = $116 per year*
  - *Pumped = $211 per year*



Costs - Landscape Systems

Depend on type of system/installation - wide range in costs!

Laundry to Landscape

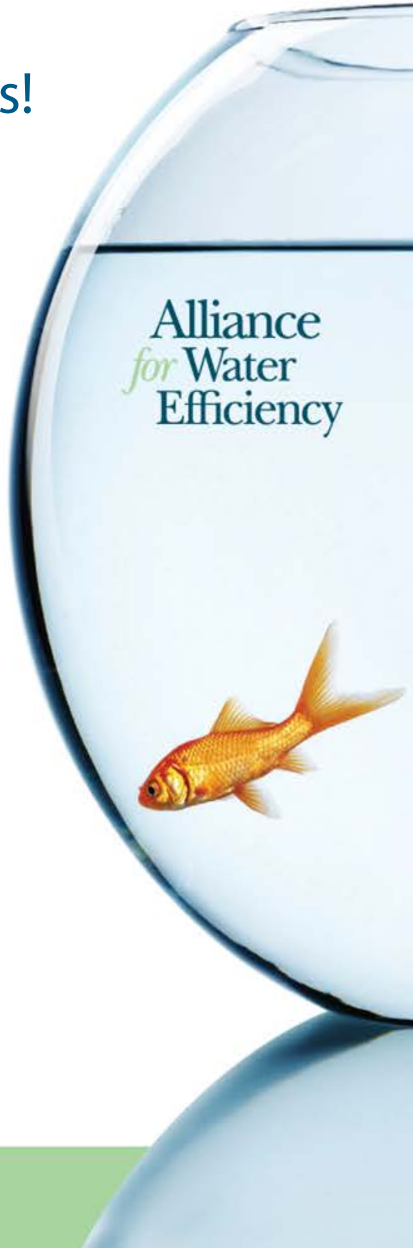
- DIY - $120 to $250
- Professional Installation - $750 to $1,250

Branched Drain

- DIY ~ $700
- Professional ~ $1,750

Pumped System

- DIY - $1,800 to $2,300
- Professional - $3,800 to $10,000



Approximate Payback Periods

Laundry to Landscape

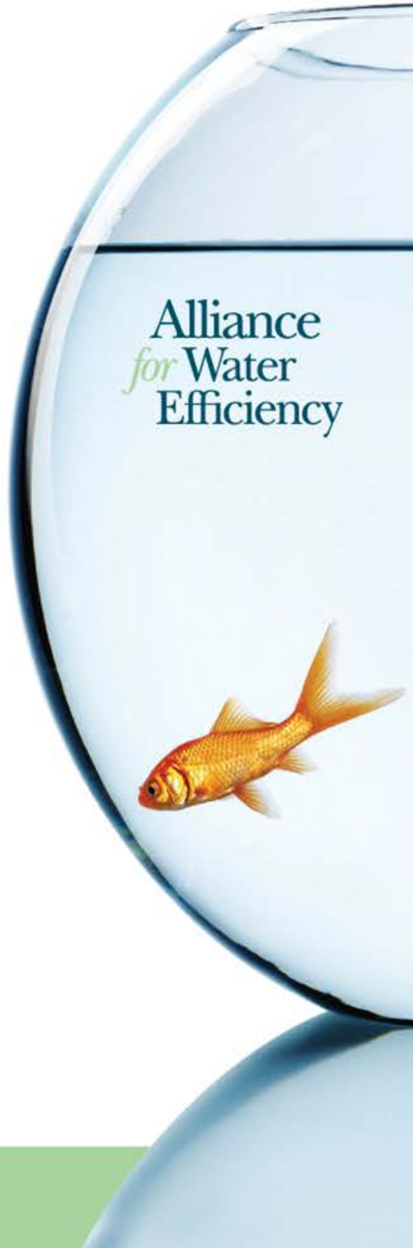
- DIY: 2.1 to 4.5 years
- Professional Installation: 13 to 22 years

Branched Drain

- DIY: 10 years
- Professional Installation: 26 years

Pumped System

- DIY: 14 to 18 years
- Professional Installation: ≥ 30 years



Payback Periods @ $17 per 1000 gal

Laundry to Landscape

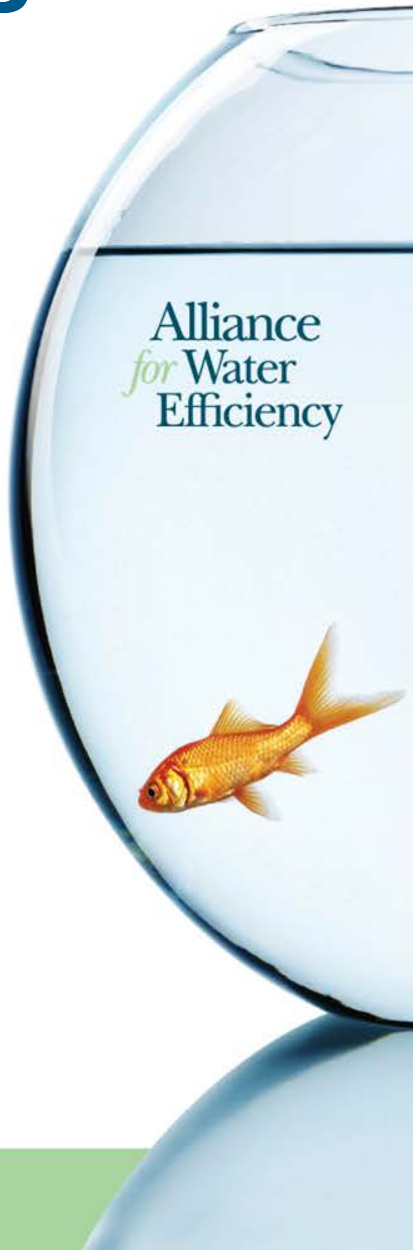
- DIY: 1.3 to 2.6 years
- Professional Installation: 7.9 to 13 years

Branched Drain

- DIY: 6 years
- Professional Installation: 15 years

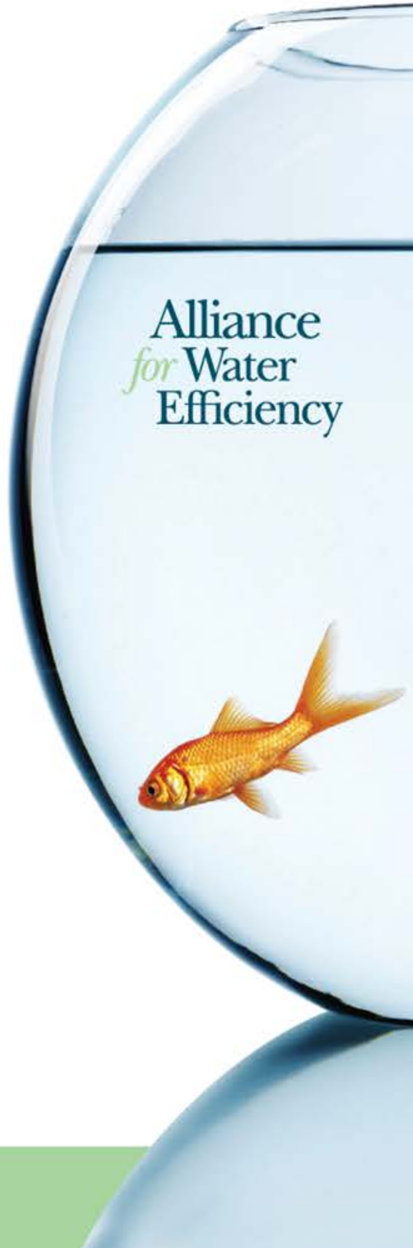
Pumped System

- DIY: 8.5 to 11 years
- Professional Installation: ≥ 18 years



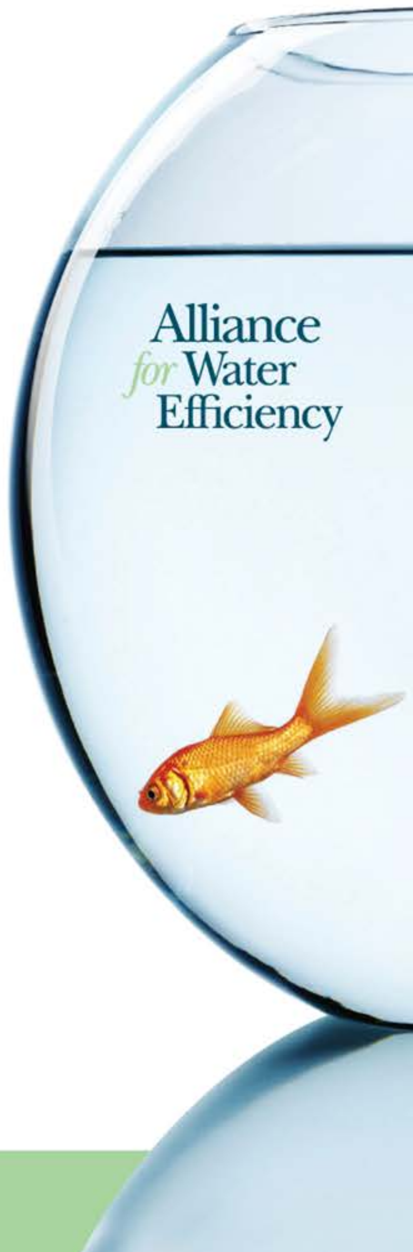
Findings

- Cost-effectiveness varies greatly depending on the potential for avoided costs (no surprise!)
- Systems are more beneficial if:
  - Water rates are very high
  - Ongoing shortage of potable water supply
  - Frequent short-term shortage of potable water supply (drought)
  - Customer lives in area with long irrigation season
  - System incorporated in new building vs. retrofit
  - Customers with high occupancy rate (produce more graywater for toilet-based systems)
  - Water utility has limited water supply or needs to expand water supply/treatment infrastructure



Important Considerations

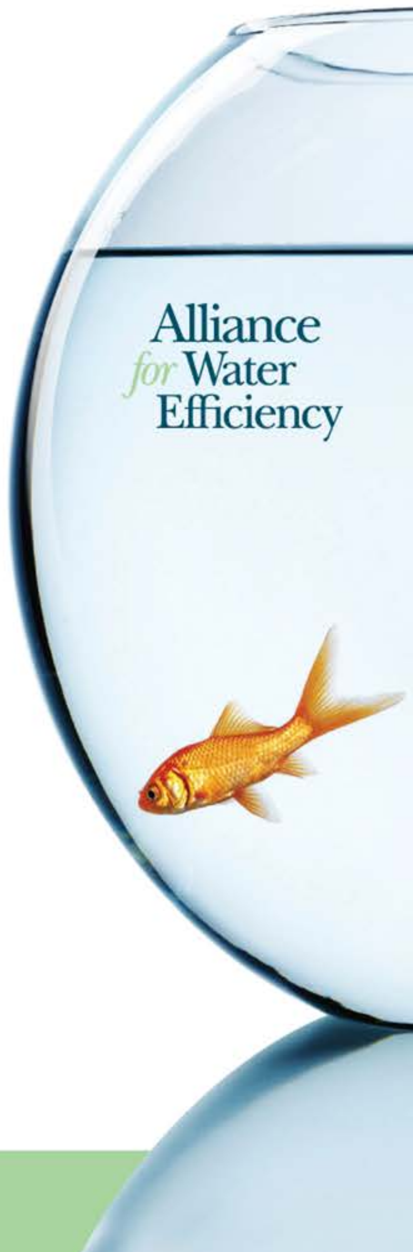
- Ongoing O&M may be/likely required
- Lowest hanging fruit may still be conversion to more efficient fixtures and appliance
- <u>Potable water savings ≠ graywater production/collection</u>
- Timing of graywater production may not equal timing of demands, especially for irrigation systems (potentially seasonal savings)
- Possibly some unintended consequences related to reduced flows in building or community sewers
- Eliminating irrigation demand may be more beneficial than using graywater as source
- If graywater system has potable water back-up, may need backflow prevention device and potentially periodic inspection of the device.



Looking Forward

- Cost-effectiveness will be negatively affected change as operating costs increase
- Cost-effectiveness will improve as:
  - Water rates increase
  - System costs decrease with growing sales
  - System maintenance costs decrease as systems get more sophisticated

- **But – cost-effectiveness to customer is not the only reason to consider a graywater system!**



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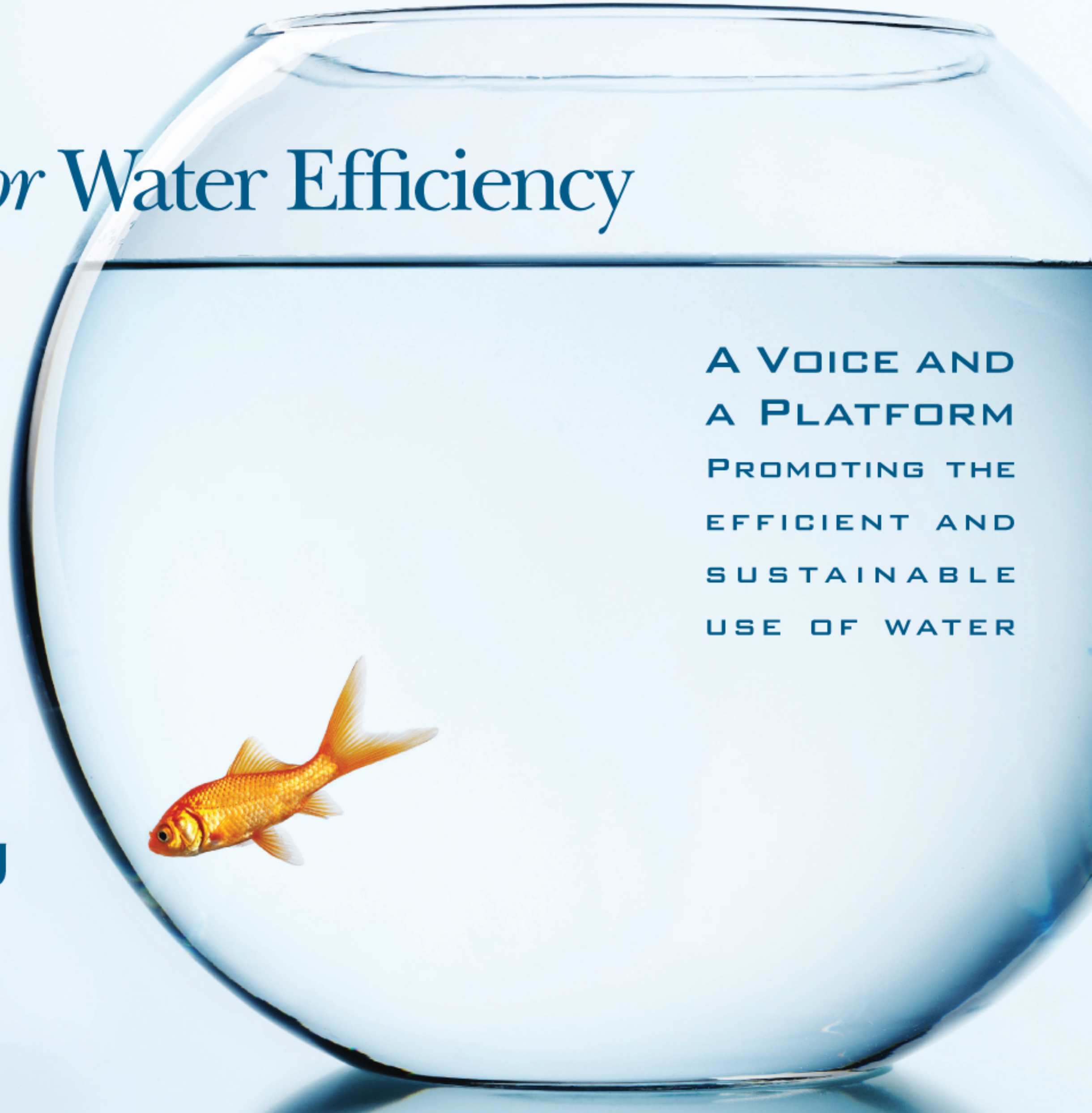

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