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Utility & Business Solutions



PROSPECTUS

Residential End Uses of Water, Version 3 Proposal Participation October 2023

Flume Data Labs, a division of Flume Water, and WaterDM are teaming up to submit a proposal to the Water Research Foundation (WRF) in response to RFP 5242 to conduct the *Residential End Uses of Water, Version 3: A Single-Family and Multi-Family Study*. We are seeking utility participants from across the US and Canada. This letter will explain what the *Residential End Uses of Water* studies are, how the Flume/WaterDM team intends to approach this research project, and exactly how water providers are able to participate. We have also attached a copy of RFP 5242 so you can see exactly what the Water Research Foundation is looking for.

Basic utility participation in the study proposal with the Flume/WaterDM team is free and available to any water provider regardless if there are Flume sensors in your service area or not. The number of utility participants is limited, so if you are interested please let us know as soon as possible.

Because of the existing network of more than 100,000 Flume water use sensors installed across the US, the technological capability that Flume has developed, and the experience of the Flume/WaterDM team, we believe we have an excellent chance of submitting a successful proposal and conducting this research.

Background Information on the Residential End Uses of Water, Version 3

Residential end-use studies measure where, how, and how much water is used in homes (and soon apartments and condos). These studies quantify indoor per household and per capita use as well as the water used for toilets, showers, clothes washers, faucets, dishwashers, leaks, and other fixtures and appliances. End-use studies also measure the frequency of use and other statistics and look at the trends in water use over time.



The Water Research Foundation has published two national residential end-use studies in 1999 and 2016 which have had a profound impact.¹ These studies are considered foundational resources that remain reference points regardless of how much data we have today. These studies established the basic science for the field of water demand management and quantified the impacts of plumbing codes, WaterSense, and other efficiency codes. This research has helped move the industry from conservation guesstimates to meaningful conservation savings as a resource to be planned for, counted on, and managed. The WRF Residential End Uses of Water studies have proven critical and influential for resource management across the industry to the broader resource management, policy, engineering, and finance.

The Flume/WaterDM team looks forward to contributing to this essential knowledge base with the Residential End Uses of Water, Version 3.

The Flume/WaterDM Research Approach

Indoor water use is the focus of the RFP for the Residential End Uses of Water, Version 3. The key goals of this project are to evaluate changes in disaggregated single-family indoor water use and to set a baseline for disaggregated multi-family water use. Both indoor and outdoor use will be analyzed, but the substantial focus of the project will be on disaggregated indoor use - as specified in the RFP.

To evaluate residential water use nationally, the Flume/WaterDM team intends to work with participating water utilities and leverage existing Flume water sensors currently installed in more than 100,000 single-family homes and on more than 1,000 multi-family units across the US. Participation is open to any water provider, regardless if there are Flumes in the service area or not.

Participating water utilities will contribute historical consumption data from representative samples of single-family and multi-family homes in the service area and (where applicable) from properties equipped with Flume sensors. The metered consumption data is essential for comparing residential water use across water providers and to track changes in annual demand over time from the previous studies. Meter consumption data will be supplemented by property data Flume collects, which includes: the age of the home, size of the home, value of the home, and lot size. This data and the time it takes to deliver it constitute in-kind support for the project and will be counted in the proposal towards the in-kind requirement. For utilities that do not have many or any Flume devices in their service area, the Flume/WaterDM team will use monthly billing data (and if available, daily or hourly or similar AMI data) to disaggregate indoor and outdoor use as was done in both previous Residential End Use studies (1999, 2016).

¹ [Mayer, P., W.DeOreo, et. al. 1999. Residential End Uses of Water. Water Research Foundation. Denver, CO](#)
[DeOreo, W., P. Mayer, et. al. 2016. Residential End Uses of Water, Version 2. Water Research Foundation. Denver, CO.](#)



Existing Flume data will be augmented with data from new Flume sensors with a particular focus on installing them in submetered multi-family units. The Flume sensor records flow through the meter every 5 seconds enabling detailed disaggregation of end uses like toilets, showers, and clothes washers. This is the same basic approach deployed in the 1999 and 2016 Residential End Use studies which collected data every 10 seconds using data loggers. You can learn more about [Flume's approach to collecting and disaggregating residential water use here.](#)

An important element of the project will be to correct for any potential bias in the Flume sample. Meter data from properties equipped with a Flume sensor will be used to assess differences in water use and to develop appropriate methods to address any bias in the Flume sample. Team member, Anil Bamezai, Ph.D., Principal at Western Policy Research will direct this task.

The Flume/WaterDM team plans to conduct customer survey research as part of this project opportunistically when email addresses are available. For participating water providers with electronic contact information the Flume/WaterDM team plans to conduct a brief internet-based customer survey to better assess demographic characteristics and changes in housing and water use over time. The survey will be prepared by the research team, but sent out by the water utility. The survey will enable additional comparisons between the Flume samples and the general population and will assist with the bias correction task. The research team will tabulate the results and each participating agency will receive a summary of their survey findings.

The RFP specifically seeks disaggregated end-use data from multi-family units including condos, townhomes, and apartments. The Flume/WaterDM understands that the only affordable method for collecting these data is to find multi-family units that are fully submetered and to install Flume sensors on the submeters.

Because we are able to leverage existing data, the Flume/WaterDM team plans to complete this project in 18 months, just half the time of previous Water Research Foundation end-use studies.

National End-Use Samples

Previous WRF residential end-use studies have relied on samples of single-family homes that were representative of specific service areas pooled together to create a "national" sample. To improve upon this and present a more accurate assessment of typical water use in American residences, an additional component of the Flume/WaterDM research approach will be to select a national sample of representative single-family residences across the US equipped with a Flume sensor. This national sample will serve as a basis for comparison with utility participants so that they can understand if water use in their service area is above or below the national average.

In addition to a single-family sample, Flume will also analyze data from several hundred individually metered multi-family residences from across the US, already equipped with a Flume sensor.



Water Provider Participation

The cost of participation is free unless you opt for one of the additional options such as a data dashboard and/or installing additional Flume sensors. Here is some basic information on what is required for participation. Detailed information on participation costs is provided below.

What We Need From You Now

1. Please email Sarah Musiker (sarah@flumewater.com) to express your interest in participating in the Flume/WaterDM proposal.
2. Sarah will send you an online questionnaire and participation agreement for the Flume/WaterDM proposal. The questionnaire includes the amount of cash and in-kind support to be included with participation so that the final proposal budget can be prepared.

That's it for now. Once a water provider completes the online form, that's all we need to include you in our proposal.

What We Need From You If Our Proposal Is Successful

- **Single Family Billing Data** - 3 - 5 recent years of monthly (or bi-monthly or hi-rez AMI) consumption data for all single-family customers **or** for a sample² of 1000+ single-family customers.
- **Metered consumption data from Flume customers** - In areas where Flumes are installed, we will need metered data for all single-family Flume customers in your service area (we will provide addresses).
- **Multi-Family Billing Data** - 3 - 5 recent years of monthly (or bi-monthly or high-rez AMI) consumption data for all multi-family customers **or** for a sample of 1000+ multi-family customers including dedicated irrigation meters associated with a multi-family customer.
- **Supporting Customer-Level Single and Multi-Family Data (if available)**
 - # of units - for multi-family
 - # of residents
 - Lot size
 - Previous area
 - Water budget
 - Pool?

² The Flume/WaterDM team plans to use the same systematic random sampling approach used in both previous Residential End Use studies to select representative, random samples whose water is statistically similar to the population.



- Other landscape or property information (e.g., if the site has dedicated irrigation meters)
- **A Brief Survey** - Agree to send a brief email survey to a sample of customers (if email addresses are available).
- **Data sharing agreement** - Flume will enter into a mutually agreeable data-sharing agreement with all participating utilities.

What You Will Get in Return for Free Participation

- Customer survey results
- Online project workshop and early access to research findings

Optional Study Components Available to Participants

The following optional study components are available only to water providers with existing Flume sensors in the service area and water providers with meters that are compatible with Flume.³

Additional Flume Sensors

Participants who wish to increase the sample size of single or multi-family are able to purchase additional Flume sensors for \$200 each - a 25% discount. It is assumed these sensors will be installed by the resident or participating utility.

Residential End-Use Data Dashboard

Participants are eligible for a customized residential end-use data dashboard prepared by Flume Data Labs. Each dashboard will include detailed end-use information collected from customers in your service area along with comparisons with other relevant providers and regions. The Flume Residential End Use Data Dashboard will provide participants with unprecedented insight into residential water use in their service area.

A data dashboard is a secure, online data interface created in Tableau that provides spectacular graphics and information. Contact Flume for more information or a demonstration.

The cost of the optional Residential End Use Data Dashboard is scaled based on the number of connections in the service area.

Number of Connections in Service Area	Optional Dashboard
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³ For information on meter compatibility with Flume, visit:
<https://help.flumewater.com/en/articles/1618594-is-the-flume-device-compatible-with-all-water-meters>



1,000 - 10,000 Connections	\$15,000
10,000 - 50,000 Connections	\$25,000
50,000 - 100,000 Connections	\$35,000
100,000+ Connections	\$50,000

How Can I Learn More and Join the Study?

To learn more about participation in the Residential End Uses of Water, Version 3, our research team, and our approach please contact Sarah Musiker - sarah@flumewater.com

All participants must complete and sign a letter of support and agreement to participate in our proposal. A sample participation letter is included with this invitation. Each participant must complete the online questionnaire and agree to participate in our proposal. The questionnaire includes the amount of cash and in-kind support to be included with participation so that the final proposal budget can be prepared.

Flume/WaterDM Team

The Flume/WaterDM team includes a talented set of proven professionals who have been delivering end-use studies together for the past three years.

Peter Mayer, P.E., WaterDM - Principal Investigator

Peter was a principal investigator for both the 1999 and 2016 studies and is one of the most experienced end-use researchers in the world. Peter will serve as the principal investigator for the Flume/WaterDM team. He will bring continuity, exceptional expertise, and a deep understanding of water demand data and research methods.

In 2020 Peter began working with Flume and Joe Fazio to analyze high-resolution end-use data and to deliver comprehensive residential demand analysis to clients across the US. You can learn more about Peter and his firm Water Demand Management at www.waterdm.com.

Joe Fazio, P.E., Flume Data Labs - Project Manager

Joe Fazio is a veteran of the computer software industry with deep experience in Product Marketing and Product Strategy. Joe is a graduate of UCLA with a BSEE in Electrical Engineering. Joe has worked at a number of high-tech technology companies, most notably, he co-founded two different software companies, Agile Software and givezooks!

Joe is currently the General Manager of Flume Data Labs, for Flume Water. In this role, Joe manages a team that collects and analyzes very granular water data for water agencies, state agencies and consumer brands. Under Joe's leadership, Flume has become the leading authority on water use data in



the nation. Joe and Peter have worked closely together for three years to deliver comprehensive residential demand analysis to clients across the US.

Anil Bamezai, Ph.D., Western Policy Research - Team Statistician and Technical Advisor

Anil has conducted urban water research for more than 30 years including research on residential demands with WaterDM and Flume. Anil will help design and implement the statistical sampling approaches and will develop any bias corrections deemed necessary.

Sarah Musiker, Flume Data Labs - Senior Director, Water and Utility Affairs

Sarah Musiker has over a decade of experience in the water industry. An expert in external affairs, Sarah has directed business development, strategy, community engagement, and policy for smart technology companies around the world. She has special expertise in the municipal water space, working to foster and develop public-private partnerships and advance sustainable water management initiatives.

Sarah is currently the Senior Director for Water and Utility Affairs at Flume. In this role, she directs utility partnership development and policy engagement at the regional, state, and national level. Sarah is a graduate of Smith College and has her Masters in Public Policy from the University of California, Berkeley.

Max Behrens - Flume Data Labs - Data Scientist

Max Behrens has worked as a data scientist at Flume since 2021. In this role, he conducts complex analysis and visualization of end-use water data. Max creates interactive dashboards that provide customers with the latest insights into residential water usage at the most granular level. This enables utilities and homeowners to strategically plan for the future. Additionally, Max contributes to improving Flume's machine-learning models.

Prior to moving to the U.S., Max worked as a research assistant at the Helmholtz Center for Environmental Research (UFZ) in Leipzig, focusing on cutting-edge water treatment technologies. He previously held research assistant positions at Berlin's municipal water supply (Berliner Wasserbetriebe) and the Environmental Engineering Institute at the Technical University. Max has an M.Sc. in environmental engineering from TU Berlin.

Grant Bernosky - Flume - Senior Machine Learning Engineer

Grant Bernosky is a Senior Machine Learning Engineer at Flume focusing on the integration of machine learning, statistics, water end-use, and building consumer IoT applications.

Grant earned a bachelor's degree in Mathematics with a minor in Data Science at Cal Poly in San Luis Obispo where he worked as a Frost Research Fellow. His research focused on computer vision and natural language processing and he published a paper in the 2020 IEEE Seventh International Workshop on Artificial Intelligence for Requirements Engineering. While in school, Grant worked at Pacific Life and



Flume, allowing for a holistic understanding of practical applications of machine learning and data science.

Currently, Grant is deeply involved in refining methods for labeling/modeling water end-use data and using the resulting models for various applications. His focus is not only on the technical aspects but also on the practical implications that these models can bring to water management and customer interactions.