FOCUS GROUP REPORT

UNDERSTANDING THE ENABLING ENVIRONMENT FOR ON-SITE NON-POTABLE REUSE

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San Francisco, California, USA

Background: the need for alternative water sources

Urbanization, climate change and depletion of natural resources increasingly challenge the conventional paradigm of centralized water supply, treatment, and reuse [1–3]. There is growing evidence that addressing key challenges for urban water management requires more flexible, modular, decentralized or small-grid water systems that are implemented in parallel with or as a substitute to expansive sewer-based systems [3,4].

The adoption of such alternative water systems presents an opportunity for new options for water reuse and resource recovery, adding flexibility and modularity into water infrastructure, strengthening local resilience to future uncertainties (e.g. climate change, increasing demand, etc.). At the same time, cities have encountered various non-technical challenges in adopting and diffusing on-site reuse technologies, such as risk aversion due to the risk to public health, lacking legitimacy for new technologies, lacking user acceptance for wastewater recycling technologies, and challenges in creating new governance frameworks that clarify different actor's roles in designing, installing, and operating on-site reuse systems.

These challenges are an inherent part of the transition process. In the same way that centralized water and wastewater utilities have established actors, roles, regulation, and buy-in from end users and the public in the past, a fitting institutional support structure needs to be developed for on-site innovation. San Francisco (SF) is pioneering on-site non-potable water systems, developing a safe addition to the local water portfolio. As such, the city presents a showcase of best practices for planning and installing on-site systems, which could potentially serve as an example for other cities around the globe.

This focus group thus sought to bring together some of the thought leaders connected to San Francisco's on-site non-potable water system (ONWS) program to identify the current and most complex non-technical challenges and novel ways for overcoming them in further diffusing and upscaling the innovation.

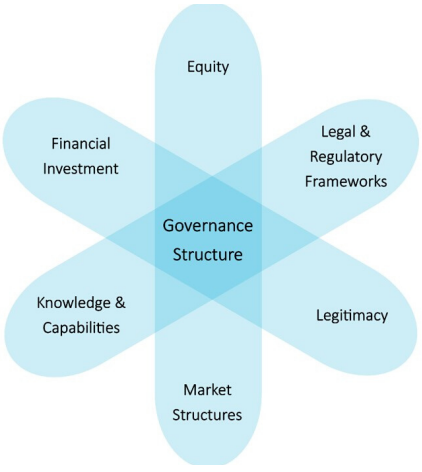
How to understand the types of non-technical barriers: institutional support structures

Studies and reports have touched on the challenges faced by ONWS [5,6]. Using discussions in innovation and transition studies as a starting point [7,8], an analytical framework was introduced to the focus group as a means to capture the various resource pools of an institutional support structure in which practitioners may encounter non-technical barriers. This is shown and defined in figure 1..

Equity
Structures that guarantee the provision of an acceptable minimum quality and quantity of water service to all end-users and allow for broad and inclusive representation in all stages of the decision-making and planning processes.

Financial Investment
Structures that mobilize and allocate financial investment for the new technology. This includes bank loans, equity/angel investments or subsidies allocated over the whole lifetime of a project, including operation and maintenance.

Knowledge & Capabilities
Structures enabling the creation and diffusion of new technological knowledge as well as structures that increase the capacity of practitioners to operate and manage innovative technology.



Legal & Regulatory Frameworks
Regulation used for structuring the design, installation and operation/maintenance of new technologies. This also includes legally binding performance criteria, testing and monitoring procedures, and equipment standards.

Legitimacy
Enhancing trust in the system with users, regulators and sector experts. Activities that explain benefits and align the innovation with the widely held norms, beliefs, and ways of doing things in a sector.

Market Structures
Development of a market for the new technology, e.g. through demonstration projects, the creation of a protected market segment (e.g. subsidies), codification of the demand, exchange, and supplier structures around a new technology.

Figure 1. *Institutional support structure and its resource pools.*

Methodology: focus group activities

Identifying barriers for ONWS in the Bay area

Participants were given sticky notes and asked to write out any non-technical challenges that were experienced in their work (fig. 2). Responses were organized by the key resource pools of the framework (equity, financial investment, knowledge and capabilities, legal and regulatory frameworks, legitimacy, market structures) and discussed for what was the most critical at the present phase of development. From this group of barriers, participants were asked to select one general category for further discussion (fig 3). Although legal and regulatory frameworks, as well as legitimacy were more prevalent from Activity #1, participants decided to further examine the financial costs and benefits associated with ONWS.

A closer look: return on investment for ONWS

From the previous exercise, the lack of a substantial return-on-investment (ROI) for on-site systems was identified as a key challenge faced by most stakeholders in the SF context and the ONWS landscape overall.

Figure 2. *Results from Activity #1.*

This examination of costs and benefits also related to other resource pools, for example, there is a lack of documentation of ROI in pilot projects. Using a transdisciplinary discussion tool [9], participants identified what specific aspects of ONWS systems and their institutional support structures were contributing to the lack of ROI. Accompanied with these root causes was a discussion about which stakeholder groups are connected, or have decision-making power, to these challenges and what incremental steps can be taken in the future to improve the ROI of ONWS.

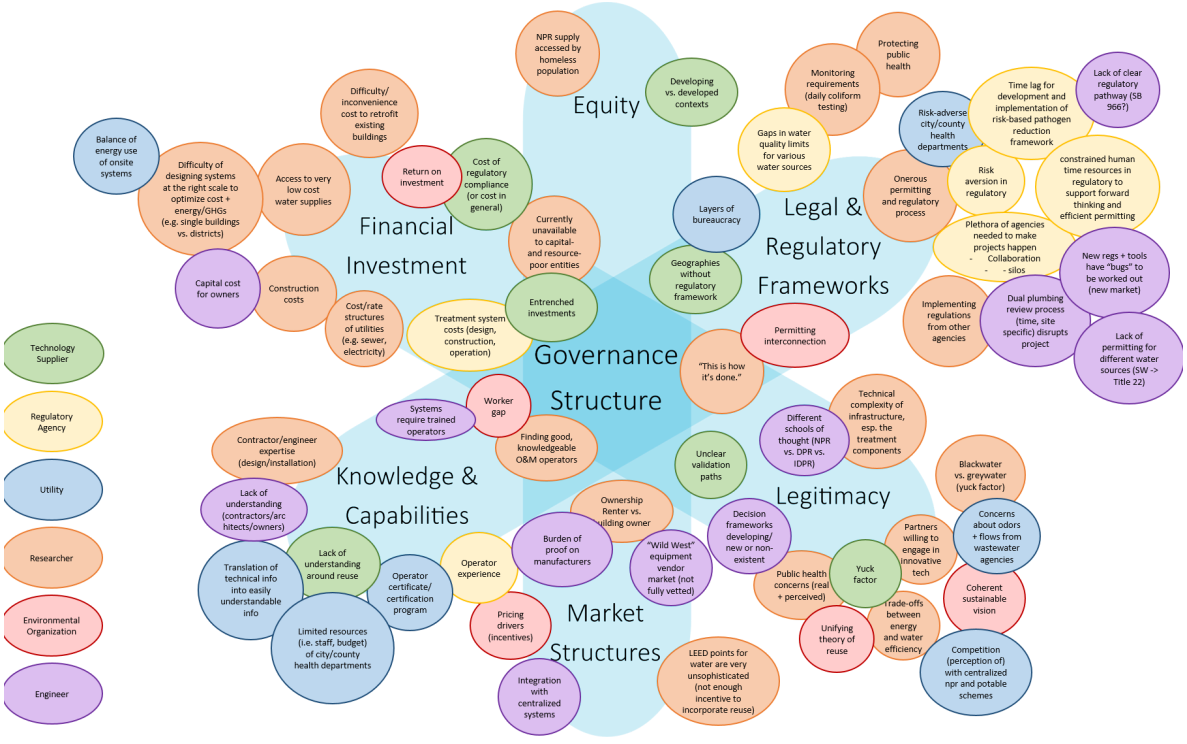


Figure 3. *Processed results from Activity #1. Green - technology supplier, Yellow - regulatory agency, Blue - utility, Orange - researcher, Red- environmental organization, Purple - engineering firm.*

Preliminary results: Activity #1

Non-technical barriers for ONWS

Below are the most important barriers that were described for each resource pool. As in any transition process, many of these barriers overlap across resource pools. For example, a desire to protect public health may result in a lack of legitimacy as well as slowed regulatory pathway for developers.

Equity. The current lack of ROI creates a dynamic where only those with large amounts of capital have the ability to install ONWS. While there is an interest in equity, there exists a lack of consensus of how this is defined within this decentralization of alternative water supply.

Financial Investment. The costs surrounding implementation of ONWS currently presents a significant challenge to developers. Capital costs are high, and with the strict performance-based regulation, sampling requirements pose another costly expense after the system has been officially commissioned. These expenses, combined with pricing for operation and maintenance hinder the business case for ONWS.

Knowledge & Capabilities. Limited human, time, and expert capacity of health departments to review the technical designs for ONWS. While training and guidelines are currently being developed to help with this barrier, there is admittedly a steep learning curve and limited dedicated staff towards these permitting processes. More capacity building is needed for practitioners across all phases of adoption, including design, construction, permitting, commissioning, operations, and maintenance. Finally, information surrounding the costs for projects is not always readily available due to stakeholders maintaining competitive advantage in industry. Additional transparency and access to quantifiable information is needed to accurately calculate costs and benefits.

Legal & Regulatory Frameworks. Multiple pathways to alternative sources have created confusion in adoption of ONWS. For example, the San Francisco Recycled Ordinance in 1991 pushed for dual-plumbing in specific areas to facilitate centralized water recycling. Title 22 of California's Code of Regulations refers to state guidelines for how treated and recycled water is discharged and used at a municipal scale, but this has been used in permitting for on-site systems. A need exists to provide regulation specific decentralized projects that is still protective of public health. Work has been done to address this gap [5]. A combination of onerous permitting processes and lack of capacity in regulatory agencies to expand to this new way of working has slowed the progress for commissioning ONWS. In the Bay Area, jurisdictions adjacent to San Francisco are struggling to establish clear roles, responsibilities and collaboration in the various regulatory agencies to permit similar ONWS. The passing of Senate Bill 966 has sought to assist in this regulatory pathway development.

Legitimacy. Consistent with the larger conversation regarding recycled water, overcoming the "yuck factor" with end users is a challenge in the on-site program. Along with soliciting acceptance from end users, practitioners also carry a hesitance for ONWS due to real and perceived health concerns coupled with a organizational culture of high aversion to risk. This risk aversion creates a resistance to change, favoring the status quo, or centralized arrangements, which are well-known and accepted. It should be noted that key stakeholders are producing data-based reports to help alleviate some of these concerns and guide decision-making.

Market Structures. Incentives exist, such as grant programs and accrediation (e.g. LEED, LBC), however at present, these mechanisms are not proportionate to the extent necessary to establish an ROI. The market for decentralized systems is really based on Article 12C, requiring ONWS for new development over 250,000 sq.ft. in San Francisco. In the surrounding Bay Area, other major companies are aligning with this requirement for various reasons, such as pre-emptive compliance in case similar programs are adopted in their city, or to increase sustainability imaging. Along with these drivers, a gap exists in the technology vendor side of the market structure. Limited ONWS equipment exists because suppliers are responsible for the financial burden of providing proof of concept. This in turn creates an unreliable equipment vendor market, operating without a full vetting process.

Preliminary results: Activity #2

Improving return on investment (ROI)

All stakeholders are affected by a lack of ROI of ONWS. For example, technology suppliers are required to carry the financial burden to provide a proof of concept for new technology. Regulatory agencies require additional human resources to expand oversight activities for ONWS and until these resources are provided, developers and building owners are delayed in the regulatory process, further increasing costs (e.g. incuring excessive costs for daily coliform sampling during trial operations). The following suggestions were presented for overcoming the ROI barrier:

Increasing political will. With buy-in from local and state-level politicians, more funding may be made available for grant programs or to offset capital costs of systems, increasing the legitimacy for on-site approach, improving permitting processes.

Improve building certification systems. Increasing the amount of credits given out for alternative water sources in green-building systems (e.g. LEED, LBC) might improve the desirability for adopting ONWS. Steps are already being taken by utilities and USGBC to address this.

Improve messaging related to increased costs. Rent for buildings with ONWS may increase to accommodate additional fees for operating and maintaining the system. This may be messaged as the cost for "more resilient" and "green" buildings – thus a distinguishing feature from other, more polluting buildings.

Create more inclusive calculations of ROI. Academic support is needed to improve the means of calculating the ROI for ONWS, taking into account the full lifecycle costs and potentially undervalued ecological/societal benefits from ONWS systems. Specifically, the financial benefit for diversifying water portfolios is not currently included in calculations.

Increase regulatory understanding. Practitioners, specifically design firms and building owners, need a clearer understanding of what is necessary for navigating the regulatory pathways in order to minimize delays and costs in the construction and permitting process. SFPUC, Urban Fabrick, and the National Blue Ribbon Commission for Onsite Non-potable Water Systems have provided substantial material on these pathways in their jurisdiction and serve as an example for surrounding areas [10–15].

Conclusions and next steps

San Francisco has been on the front lines of demonstrating the viability of alternative water sources at a city-scale and developing models for replication in other places in the United States and around the world. As this program is expanded (as recently started through the passing of SB 966), it is critical to understand the various non-technical factors that provide support for uptake. Eawag's Barrier Project introduced an analytical framework (fig. 1) in this focus group that can be used as a diagnostic tool to help bring together various areas or resource pools that have already been discussed or acknowledged in a diversity of conversations about system-level barriers for adoption. For example, as discussed in the focus group, to improve the ROI of ONWS for a stronger business case, regulatory frameworks need to be created or amended, additional financial investments are needed, and knowledge and capabilities for practitioners need to improve.

Following this focus group and an interview campaign in San Francisco, the Barriers Project is working to analyze and synthesize in-depth results for the specific ONWS program in at least three specific studies (expected in 2021):

- Equity implications from the decentralization of basic service provision of infrastructure in an urban context
- Governance arrangements that result in the present ONWS program and implementation
- Compatibility of the different ideologies invested in ONWS program development (i.e. institutional complexity)

Conclusion and next steps, cont'd

Additionally, while these studies are being done, a webinar in late 2020 is anticipated to help present insights from the San Francisco context and open up the translation of these results to other contexts around the world. The COVID-19 situation has introduced a level of complexity to expanding this project to other locations as originally planned, however, as the situation unfolds, updates will be made available to interested stakeholders.

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The inter- and transdisciplinary research program - **WINGS** - strives to develop novel non-grid-connected water and sanitation systems that can function as comparable alternatives to network-based systems

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