Research Paper

Floating Futures:
Redefining Water Management through Sustainable Landscape Interventions in South Boston

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Abstract

This Floating Futures project uses decentralized, community-centered landscape interventions to present a sustainable water management strategy for South Boston. This concept addresses water scarcity, lowers costs, and improves environmental resilience by reinventing home backyards as floating water landscapes that include sustainable planting and wastewater treatment. The floating landscapes provide shared public-private spaces that encourage community interaction while treating and reusing local wastewater through the use of a phytoremediation technology. Pilot projects demonstrate a 27.5% decrease in infrastructure and water expenditures, along with notable environmental advantages like enhanced resilience and better microclimates. For other cities dealing with comparable issues, this flexible model offers a reproducible method of managing urban water resources that fosters social justice and climate adaption.

Keywords

Decentralized Water Management, Sustainable Landscape Design, Landscape Cyborg, Community Engagement, Climate Resilience, Urban Water Infrastructure

1. Introduction

1.1. Background of Water Scarcity

A pressing worldwide issue that affects both urban and rural regions is brought to light by the decrease of drinking water brought on by climate change and made worse by inadequate water management. According to research, increasing global temperatures are speeding up the melting of glaciers and decreasing snowpack, which would drastically reduce the natural freshwater reservoirs that many areas depend on (Bates et al., 2008). "Megadrought" circumstances, which are characterized by severe and prolonged water shortages, are becoming more prevalent in places like Los Angeles and Santiago. As a result, dramatic measures like emergency water rationing plans and restrictions on outdoor watering have been implemented (Cook et al., 2015). In order to solve current and upcoming shortages, prompt action and long-term solutions are required due to the significant and frequently irreversible depletion of these water resources.

In addition to the diminishing supply, this challenge involves questions of access, distribution, and sustainable management. Gleick (2014) claims that "peak water" is a paradigm where water scarcity is governed by social, economic, and ecological factors rather than merely supply and demand. In order to overcome water scarcity, traditional infrastructure must be rethought, and decentralized water management solutions that are adaptable to changing conditions must be adopted. Localized and community-based solutions including rainwater collecting, greywater recycling, and wastewater treatment through landscape interventions can help achieve sustainable water usage and conservation (Brown & Farrelly, 2009).

Furthermore, modern urban environments have special chances to develop hybrid ecosystems that combine technology and organic water management techniques. In the face of climate change, these systems improve water resilience and offer ecological, social, and aesthetic advantages, making cities more livable (Benedict & McMahon, 2006). A more robust framework that can handle present and future water difficulties can be created by combining natural and artificial water management techniques.

1.2. Landscape Cyborg as Cure

A theoretical framework for comprehending and resolving this environmental issue through hybridized landscapes is offered by Elizabeth Meyer's "Landscape Cyborg" idea. In Meyer's ground-breaking book *The Expanded Field of Landscape Architecture*, she called for a traditional classification such as nature-culture, and human - nature fall short of capturing the intricate connections between biological processes and human endeavors. Therefore, by fusing aesthetics, physics, and ethics, she makes the case for a more integrated approach to landscape design. It seeks to develop environments that are both culturally and environmentally appropriate while embracing the complexity of the ecosystem (Meyer, 1997).

One of the basic examples Meyer mentions is the design of Boston's Emerald Necklace Park system by the Olmsted firm in the late 19th century. This seven-mile circle links a range of Boston landscapes, from Franklin Park and the Arnold Arboretum to the Fens and into the city via Commonwealth Avenue to the Public Garden and the Common. It encompasses New England's diverse habitats, such as upland forests and tidal estuaries. Meyer describes this alignment as a collection of objects integrated within an urban park system that functions as a "hybrid of natural and cultural systems." Fens, freshwater streams, and other natural features are examples of these artifacts. This project's primary objective was to restore a tidal marsh in order to improve water quality and lessen floods brought on by urbanization in the Back Bay area. The Emerald Necklace's design combines man-made and natural components to produce a system where mechanical parts and biological ecosystems coexist together (Meyer, 1997).

This technique, which reflects Meyer's idea of the landscape as a connected system of organic and inorganic materials, creates sustainable metropolitan regions by combining the beauty of both natural and artificial features. Meyer states in "Sustaining Beauty": Musings on a Manifesto that the aim of landscape design should be to create landscapes that are informative, practical, and representative of contemporary environmental ideas. Her essays on appearance performance and other subjects are in line with this. Although her theories do not particularly address "landscape cyborgs," they do advocate for the integration of natural and artificial systems to enhance ecological resilience and societal relevance (Meyer, 2008; Meyer, 2015).

For projects like the planned water reconstruction in South Boston, Meyer's viewpoint on the landscape cyborg provides a foundation for reassessing urban water management. Designers may manage water shortages, involve communities, and enhance environmental sustainability by considering the landscape as a system that seamlessly integrates ecological and infrastructure components. Meyer's four main ideas—functional sustainability, aesthetic integration, cultural relevance, and ecological responsiveness—offer helpful guidance for implementing the landscape cyborg concept in light of contemporary urban concerns.Hybrid horticulture challenges the status quo by fusing natural and artificial ingredients. Formal and Functional Juxtaposition combines ecological and recreational areas to encourage shared responsibility.

By putting people in close proximity to nature, Constructing Experiences encourages designs that inspire environmental responsibility. Last but not least, Enduring and Dynamic Design values resilience by shifting away from static beauty and toward adaptable landscapes that thrive in the face of change, thereby fostering a sustainable, regenerative relationship between humans and the environment (Meyer, 2008).

1.3. Project Position and Significance

In order to solve the pressing issue of water scarcity, this project looks into innovative, community-centered approaches to municipal wastewater management using South Boston, Massachusetts, as a model. It accomplishes this by using a "landscape cyborg" intervention to redefine urban water infrastructure. The project aims to establish a decentralized water management system by integrating wastewater treatment and landscape design into a floating water landscape using a phytoremediation method. This intervention reorganizes South Boston's limited water supply in ways that are sustainable from an economic, social, and environmental perspective. The primary goal is to create a strong framework for water management that addresses water scarcity and helps local communities adapt to climate change. This study's primary focus is on how to rebuild water infrastructure in a way that will increase environmental resilience, save costs, and encourage community involvement in water management. By promoting bottom-up participation, the project seeks to transform backyards into practical, sustainable spaces that promote community resilience and the efficient use of natural resources.

2. Research Context and Analysis

2.1. Potable Water System Challenges in South Boston

Due to several operational and infrastructure issues, South Boston's current potable water supply is expensive and environmentally burdensome. Three major reservoirs—the Quabbin Reservoir, the Wachusett Reservoir, and the Ware River—about 72 kilometers from South Boston provide water for this system, which is a component of a larger network. Residents eventually pay hefty monthly water bills as a result of the substantial financial costs associated with the development and upkeep of this vast infrastructure. The top-down, centralized structure of this water infrastructure restricts citizen participation by keeping them out of important decision-making processes pertaining to infrastructure planning, management, and water use.

This system's enormous energy demand—up to 128,716,000 kWh annually needed to pump water into South Boston—is one of its main problems. A significant obstacle to sustainability is that, despite efforts to integrate renewable energy sources, about 84% of this energy still comes from non-renewable power plants (Gleick, 2010). Water distribution to urban dwellers has a significant carbon footprint, which is made worse by the dependence on far-off water sources and energy-intensive transportation. As metropolitan areas deal with expanding demands and depleting resources, the necessity for local, decentralized solutions that lessen reliance on massive infrastructure becomes more evident (Brown et al., 2009; Figure 1).

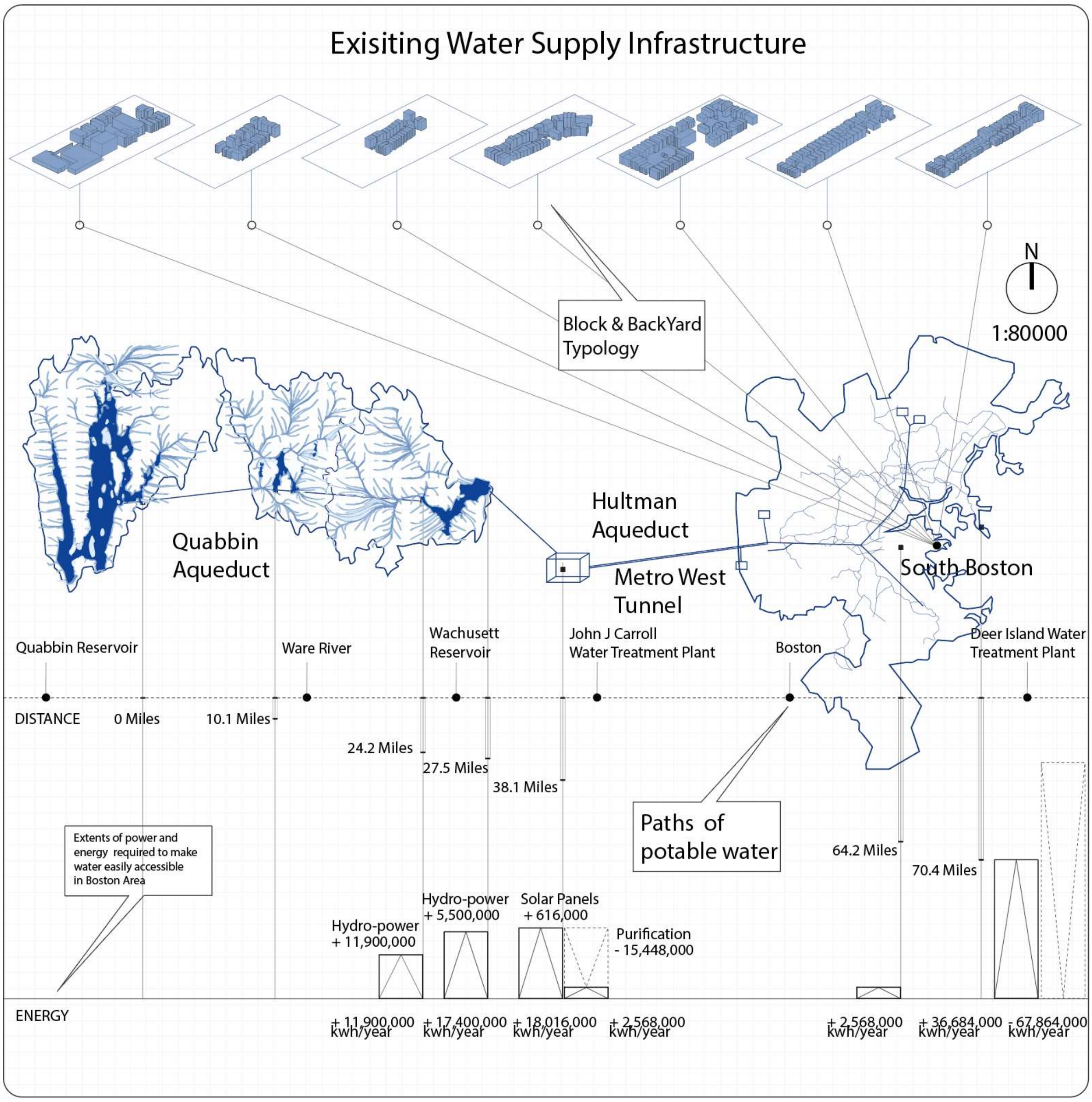

Figure 1. Exisiting Water Supply Infrastructure. Source: Author.

2.2. Sewer and Stormwater System Challenges in South Boston

Additional difficulties arise in the post-use phase of water management, which includes stormwater and sewer systems, primarily because of inefficiency and the negative environmental effects of antiquated infrastructure. Wastewater and storm runoff are channeled by South Boston's combined sewer and stormwater overflow systems, which frequently produce excess flow during major storm events. Since stormwater collecting systems only occupy 15.5% of the city's land surface, mostly in the form of catch basins and backyard soils, they are extremely vulnerable to overflow, which frequently results in flooding and sewage discharge into nearby natural rivers (Benedict & McMahon, 2006).

Untreated wastewater is frequently released directly into Massachusetts Bay or other rivers when storm events overwhelm the infrastructure, which has serious negative effects on the environment. This includes detrimental effects on marine habitats, water body pollution, and bacterial blooms. The energy cost is further increased by the requirement to transport wastewater over long distances to the Deer Island treatment plant, which is around 80 miles away. In addition to raising energy demand and contributing to secondary pollution from fossil fuel-driven power sources, this prolonged conveyance procedure uses more resources.

Additionally, combined sewer overflow (CSO) incidents affect public health and water quality by releasing contaminants and untreated sewage into public waterways. A shift to decentralized, community-managed systems that provide more flexibility, resilience, and sustainability is required since urban water systems that depend on centralized sewage and treatment facilities are particularly susceptible to these problems (Marlow et al., 2013). By encouraging ecologically friendly wastewater management techniques, decreasing reliance on energy-intensive transportation, and allowing citizens to take a more active role in managing local water resources, decentralized systems can help strengthen communities.

3. Proposed Intervention

3.1. Decentralized Water Management Model

In reaction to the expensive and centralized water infrastructure in South Boston, this initiative suggests a community-based, decentralized water management paradigm. Residents are currently burdened with expensive water bills as a result of the city's top-down infrastructure, which demands large financial and energy investments. Decentralized systems, on the other hand, promote local involvement and allow citizens to take an active role in water management. Moving toward decentralized models improves flexibility, strengthens communities, and tackles governance issues related to conventional water systems, as noted by Biswas and Tortajada (2010) (Figure 2).

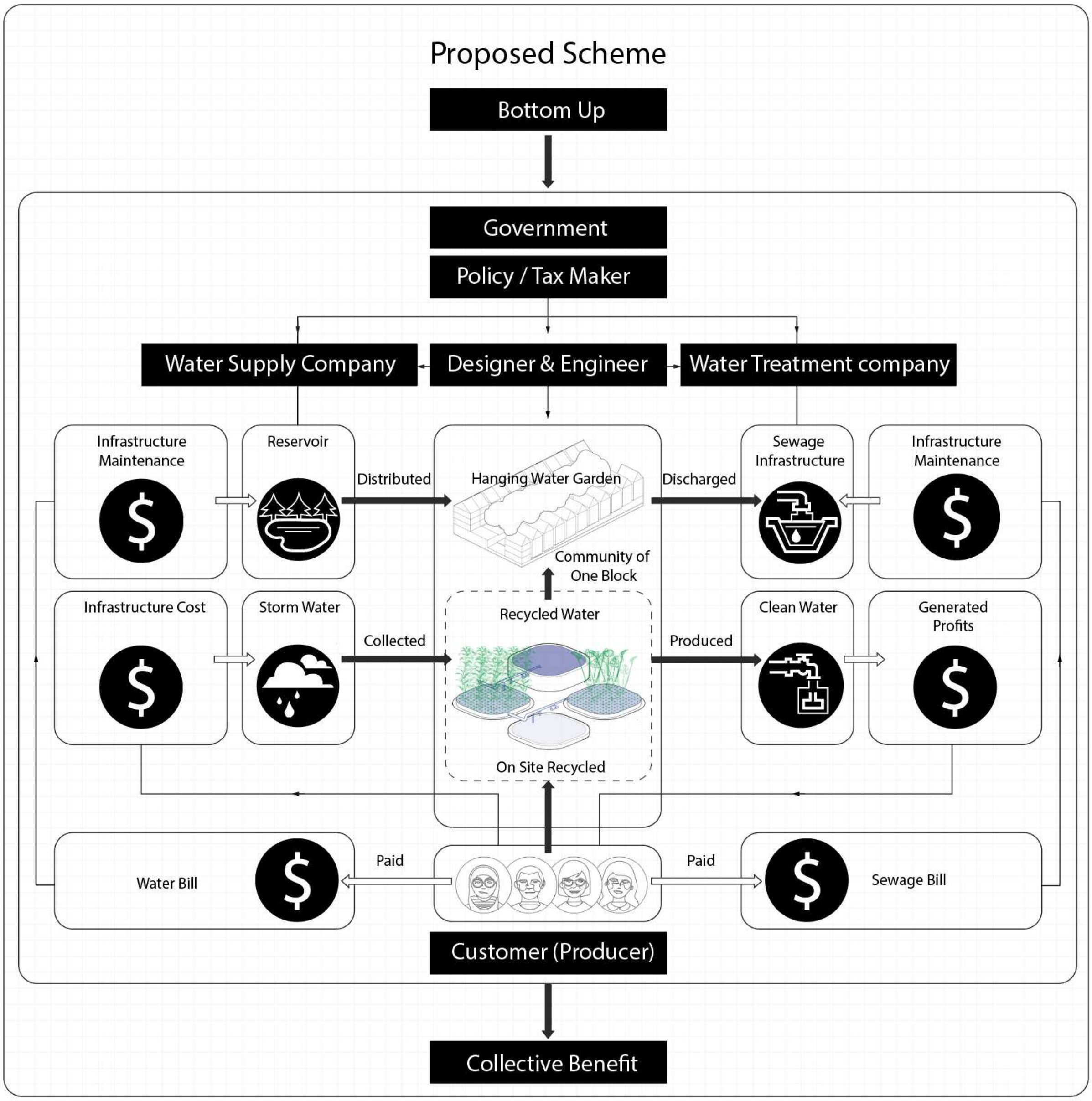

Figure 2. Decentralized Water Management Model. Source: Author.

This suggested intervention uses macrophytes and phytoremediation to create a localized floating water infrastructure landscape in backyards of homes. There are 77 residences in the pilot study close to Dorchester Heights, and each one produces roughly 4608.9 gallons of wastewater every day. 2613.1 gallons are cleaned and recycled locally through on-site treatment, while 1346.2 gallons are sold to neighboring communities, bringing in extra money for locals. This configuration demonstrates the economic feasibility of decentralized systems by potentially lowering home water bills and infrastructure maintenance expenses by 27.5% (Novotny et al., 2010; Wong & Brown, 2009; Figure 3).

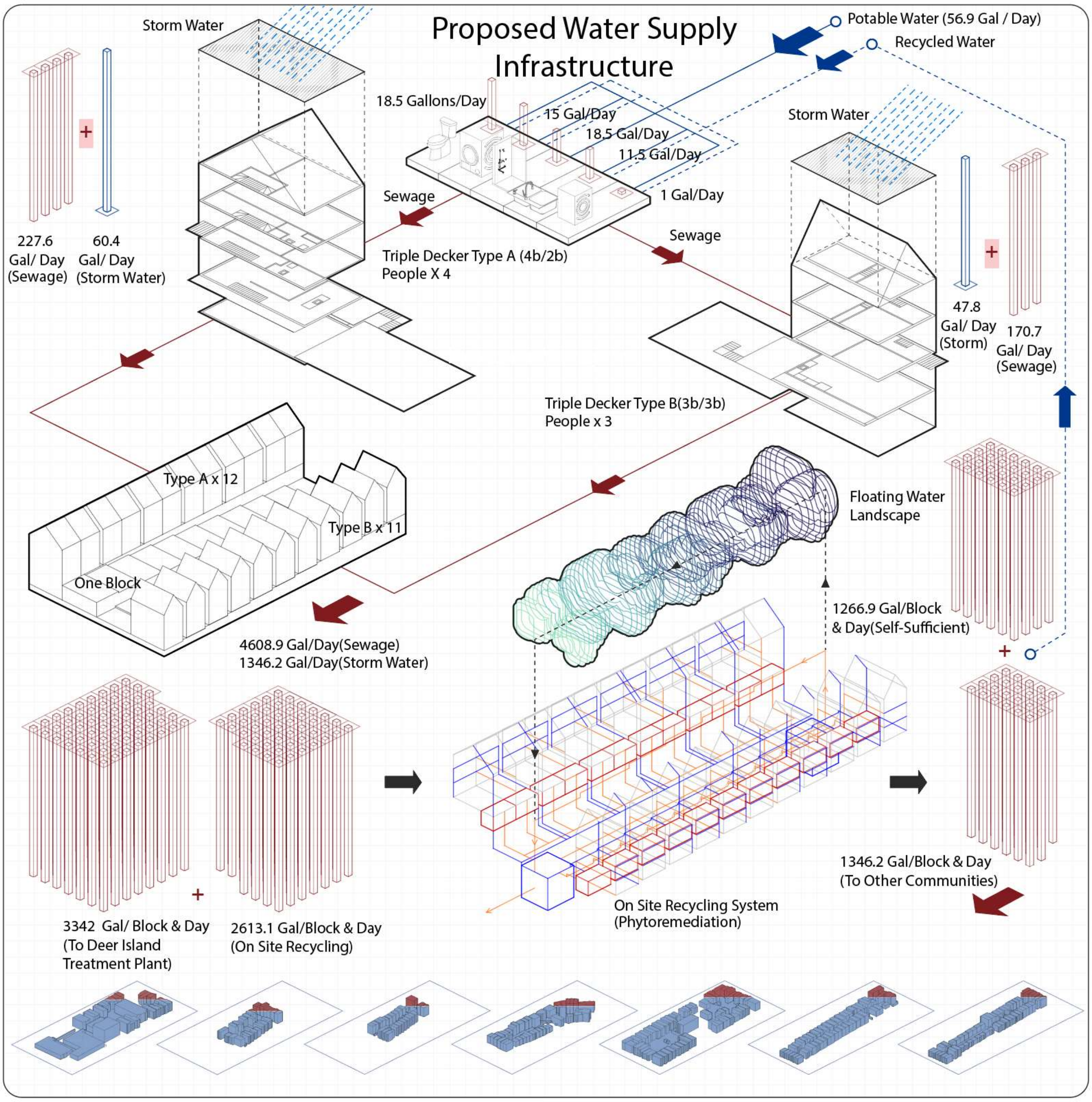

Figure 3. Proposed Water Supply Infrastructure. Source: Author.

By including locals in decision-making, decentralized systems also promote social fairness by converting water management from a city-controlled utility to a resource driven by the community. Due to the fact that locals benefit economically and environmentally, this strategy is consistent with Dunn's (2010) analysis of the social justice advantages of green infrastructure. Additionally, this system's decentralization of wastewater treatment lowers energy requirements related to water transportation and conforms to water-sensitive design principles, strengthening community resilience to the effects of climate change. (Pinkham, 2002; Roy et al., 2008).

3.2. Design and Implementation of Floating Water Landscape

The step-like design of the floating water landscape, which supports gravity-fed, multi-level water filtration, makes use of South Boston's geology. Based on Ferguson's (1998) ideas on simulating natural hydrology, this design enables wastewater to pass through many filtering stages, with distinct macrophytes placed at each stage to maximize purification. In addition to improving treatment efficiency, this tiered system integrates easily with subterranean and rooftop water systems to provide a unified water circulation network that adapts dynamically to local environmental circumstances (UNESCO, 2020).

Prefabricated from lightweight, transparent materials like organic glass, the filtration units are inexpensive and adjustable to various backyard sizes, allowing for modular deployments in various communities. This adaptability is necessary to make sure the system can grow or change to meet the evolving requirements of the community. By grouping these units together across property lines, a shared, semi-public area is created, encouraging social connection and resulting in an urban environment that strikes a balance between social interaction and ecological functionality (Fletcher et al., 2013).

Reconnecting this small water system with larger Boston metropolitan networks also makes the area more resilient to the effects of climate change. Complex urban water regimes require decentralized and adaptive systems, as highlighted by Pahl-Wostl et al. (2010). As a model for comparable urban settings, this floating water landscape offers adaptable and scalable solutions for sustainable water management in a variety of urban contexts (Figure 4).

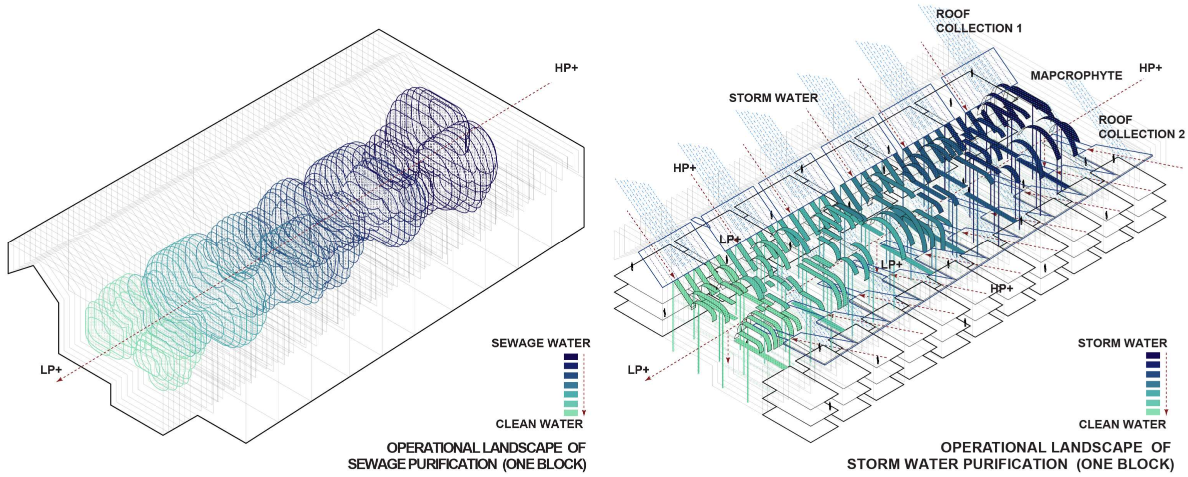

Figure 4. Prototype Study. Source: Author.

3.3. Spatial and Aesthetic Qualities

Aquatic plants are placed in gradients within the floating water landscape's phytoremediation system to optimize the effectiveness of water filtering. Greywater passes through several stages of treatment thanks to these plants' progressive purifying process. The addition of "bubble clusters," which are pliable, tubular components intended to provide light, airflow, and room for flora, improves the system's usability and appearance. This method, which was influenced by Gorgolewski et al. (2016), produces a design that blends in well with the urban setting and is both aesthetically pleasing and functional. By integrating rooftop and subterranean water systems, the system's step-like design maximizes water flow and treatment by using gravity to provide natural, multi-tiered filtering. By reducing heat and promoting ecological balance, this design enhances the local microclimate and adheres to the water-sensitive urban design principles proposed by Wong and Brown (2009). Additionally, semi-public areas are created by floating water clusters across backyard boundaries, which obfuscate the distinction between private and public places and promote closer community connections. Additionally, mock-up models of triple-decker buildings are used to illustrate the system's adaptability and scalability. These models allow for customization in a variety of building and landscape configurations by displaying potential connections to flow equalization tanks and rooftop sprinkler systems. Benedict and McMahon's (2006) demand for ecologically friendly infrastructure alternatives that complement metropolitan environments is supported by this adaptability. An inventive approach to sustainable urban water management that blends environmental resilience, community engagement, and aesthetic appeal is the floating water landscape.

3.4. Broader Project Impact and Future Development

In order to alleviate the world's water shortage and foster environmental resilience while lowering reliance on massive infrastructure, the Floating Water Landscape project uses creative ideas. Decentralized treatment systems are used to filter wastewater from nearby homes. Residents save money on maintenance and water costs when this system is put into place. By actively involving communities in water reuse projects, the project promotes social justice. Local communities can become more climate resilient with the aid of its scalable and flexible architecture. It could be replicated in other water-limited regions across the globe. Future research will focus on preventing water from freezing in the winter and removing social obstacles that prevent different people from adopting sewage-based aesthetics.

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