CAROLLO ENGINEERS VOLUME 1 2023

currents

HONOLULU SAND ISLAND SEWER BASIN

A CLIMATE CHANGE ASSESSMENT

PLUS –

- Improving Stormwater Design in Old Town Alexandria
- Wet Weather Treatment Ideas for the Future

THIS ISSUE'S EDITORIAL

NICK WEBBER, PE (nwebber@carollo.com)

Welcome to the first issue of ***Currents*** in 2023!

In our feature story, you'll read about the Sand Island Sewer Basin in Honolulu, Hawaii. Carollo worked with the City and County of Honolulu to assess the vulnerability and resiliency of the basin with respect to climate change and natural disasters. Since Hawaii is an island state, this project identified critical ways to protect its infrastructure from future storms.

You will also read about Old Town Alexandria, Virginia, and our ideas to use a "hybrid design storm" to handle future flooding events. Plus, we explore the pros and cons of wet weather treatment alternatives and highlight our work for a Texas client.

I hope you enjoy reading this issue and learning about some exciting projects we are involved in around the country. Please contact me or the primary authors with any questions or comments!

IN THIS **ISSUE**

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Selecting the Design Storm of the Future for a Historic Neighborhood

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People and communities everywhere are feeling the effects of climate change. From droughts to flooding to wildfires to hurricanes, our changing climate requires that we look at water management problems differently.

Flooding forces road closures in Old Town Alexandria in May 2022.

Photos by James Cullum for Local News Now, LLC

Learn more about the City's Waterfront Implementation Project.

Old Town Alexandria is a historic waterfront community situated along the Potomac River across from Washington, D.C. The City's existing stormwater infrastructure is undersized and unable to manage common, smaller rain events. When coupled with more severe storm events and rising tides of the river, the area experiences more significant flooding. These conditions impact historic buildings and businesses, cause road closures, and restrict waterfront access to visitors and residents. In response, the City committed to a $100M waterfront investment, much of which will be dedicated to new stormwater infrastructure.

Given these changing weather patterns, the City recognized the need to evaluate the most up-to-date climate science to ensure the new infrastructure will serve this historic community into the future.

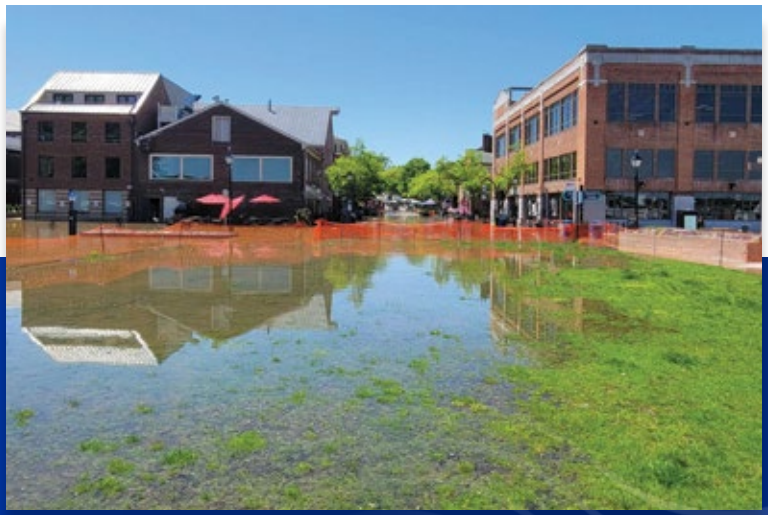
The City's current guidelines are based on rain events that occurred in the past, which is common industry practice. However, climate models indicate that the past can no longer be used as the sole standard when designing for the future.

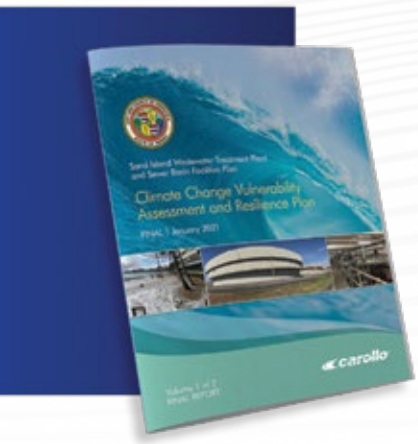
Carollo worked with the City to develop a new hybrid design storm —a hypothetical rainstorm to determine stormwater infrastructure sizing and evaluate system performance— by reviewing and analyzing historical references, global and regional climate change model results, and City-specific guidance and planning documents. This new design storm balances conservatism across storm intensity, volume, and duration to appropriately account for projected climate change and guide the City to cost-effective investments and solutions. Based on the analysis, Carollo recommended the following:

- Continued use of the 10-year design storm per the City's local Intensity-Duration-Frequency curve with a peak rainfall intensity of 9 inches per hour. This is equivalent to a 100-year storm peak intensity as defined by NOAA Atlas 14.
- Use of the 10-year design storm volume as defined by NOAA Atlas 14.
- Use of a 2-hour storm duration to size stormwater infrastructure.

The new hybrid design storm was then used to size future stormwater system upgrades including upsized storm sewer piping, two new pumping stations, and underground stormwater storage. Taken together, these proposed investments will significantly improve stormwater-related flooding over current conditions.

Looking ahead, this data-driven approach will continue to guide the City in making a smart investment in the City's critical infrastructure to mitigate the challenges of today and the future.





Honolulu's Climate Change Vulnerability Assessment and Resilience Plan

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Hawaii is an island state and, therefore, is arguably one of the most vulnerable states to the direct and indirect impacts of climate change. The City and County of Honolulu are taking proactive measures to reduce the detrimental effects of climate change in the state.

Together with the City and County of Honolulu's Department of Environmental Services, Carollo completed the Climate Change Vulnerability Assessment and Resilience Plan for the Sand Island Sewer Basin (SISB) in January 2021. Carollo performed a climate vulnerability assessment of the wastewater facilities in the SISB. The flooding threats enhanced by climate change (specifically, sea level rise) included coastal erosion, tsunamis, hurricane storm surge, and 100-year flood events.

The City owns and operates the largest wastewater system in the State of Hawaii. The system includes nine wastewater treatment plants (WWTPs) and approximately 70 wastewater pump stations (WWPSs) on the island of Oahu. The Basin is served by the Sand Island WWTP, and a collection system composed of 580 miles of gravity pipes and force mains, 17 city-owned WWPSs, and one Army-owned WWPS. The City and County of Honolulu provide services and businesses that support the most significant economic drivers for the entire state. Thus, protecting critical wastewater infrastructure within the City and County of Honolulu is essential to supporting a thriving economy.

VULNERABILITY ASSESSMENT - KEY TOOLS AND FINDINGS

Key tools and findings resulting from the climate change vulnerability assessment included:

- Detailed maps and cross sections illustrating the extent and depth of enhanced flooding threats to wastewater facilities within the SISB, including 17 WWPSs and the Sand Island WWTP **(Figure 1)**.
- Categorization of vulnerability and risk (low, medium, severe) to wastewater facilities (WWPSs and the Sand Island WWTP).
- Identification of near- and long-term adaptive strategies to mitigate evolving threats.
- Recommended approach for implementing climate adaptation strategies.
- Considerations to facilitate regional, collaborative discussions among agencies to coordinate climate change mitigation efforts.

Figure 1. As part of the climate change vulnerability assessment, Carollo provided detailed maps and cross sections illustrating the extent and depth of enhanced flooding threats to wastewater facilities within the Sand Island Sewer Basin.

ASSESSMENT DETAILS

The vulnerability assessment used a two-pronged approach—a desktop analysis and site visits/interviews. The desktop analysis took into account critical facility information from drawings and compared them to historical observations and projected threat scenarios. The work products of this analysis included drawings that indicate critical flood levels and pathways, as well as aerial maps **(Figure 2)**.

The project team leveraged available data sources, including the Federal Emergency Management Agency (FEMA) flood insurance rate maps (FIRMs) and Pacific Islands Ocean Observing System (PacIOOS) maps.

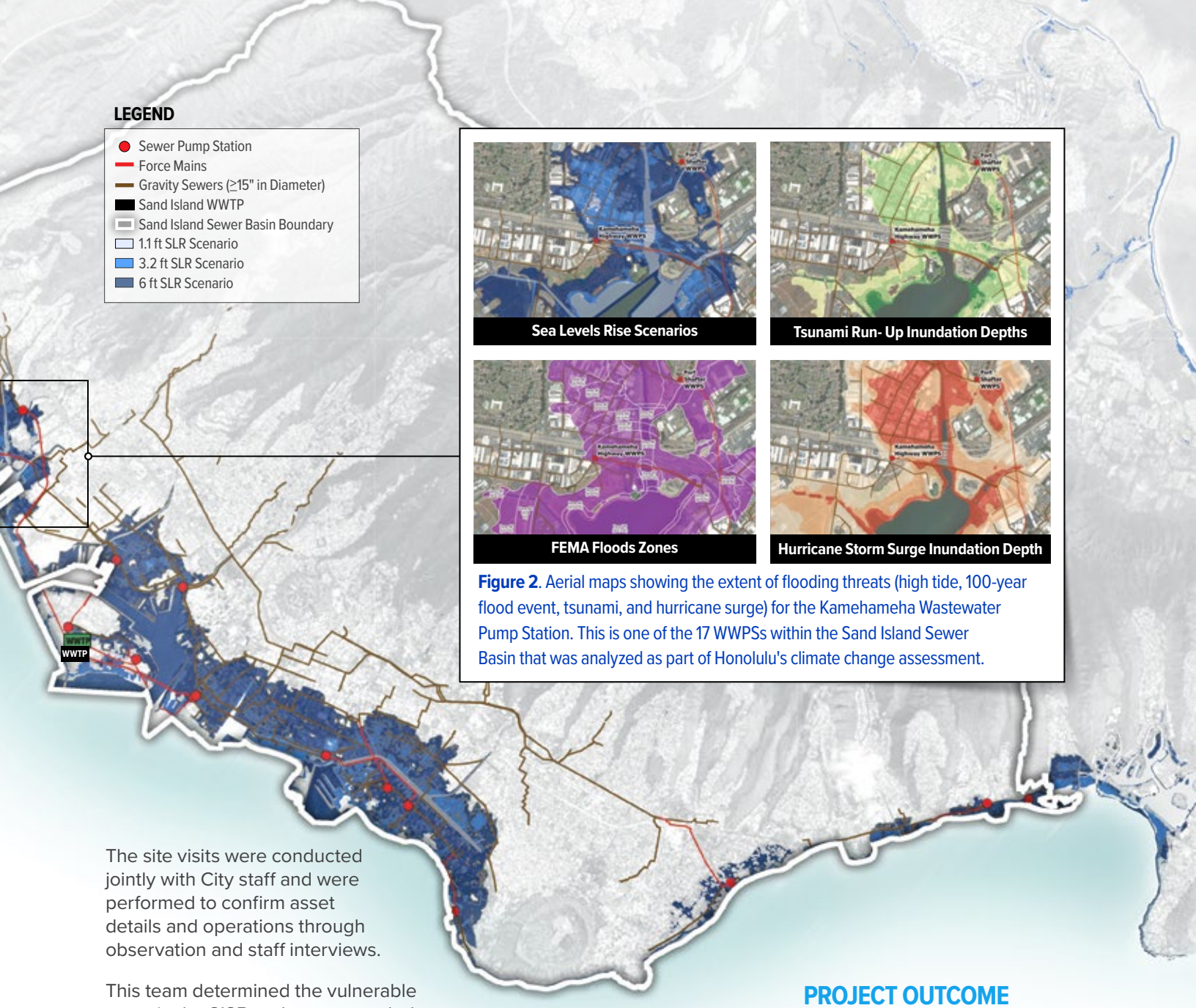

Figure 2. Aerial maps showing the extent of flooding threats (high tide, 100-year flood event, tsunami, and hurricane surge) for the Kamehameha Wastewater Pump Station. This is one of the 17 WWPSs within the Sand Island Sewer Basin that was analyzed as part of Honolulu's climate change assessment.

The site visits were conducted jointly with City staff and were performed to confirm asset details and operations through observation and staff interviews.

This team determined the vulnerable areas in the SISB and recommended adaptive management strategies that will increase resilience to flooding and evolving climate change threats. Examples of the adaptation strategies that were considered include:

- Install watertight doors.
- Elevate exterior equipment.
- Install temporary and permanent flood barriers.
- Install flood walls for buildings.
- Elevate access roads.
- Elevate site grade.
- Reinforce or seal manholes.
- Restore or expand coastlines.
- Relocate or abandon facilities.

The maps and figures produced as a result of the assessment serve as visual tools to aid the City in clearly identifying and communicating the potential flooding risks due to climate change. These tools help the City demonstrate the need for facility hardening or other improvement projects to internal and external stakeholders. Visualizing the potential magnitude of the flood impacts sparks conversations and invokes a call to action to prepare for climate change.

PROJECT OUTCOME

The City is currently starting a One Water plan that will leverage the tools, findings, and recommendations resulting from this climate change vulnerability assessment and resilience plan to further prepare for enhanced flooding impacts. In addition, the assessment approach can be replicated and applied to other City departments and their assets to prepare for flooding impacts related to climate change. In turn, use of the approach across City sectors would also position the City to hold collaborative planning sessions to develop holistic regional solutions that better leverage City funds for its protection and increased resilience.

The Future is Changing for WET WEATHER Treatment

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Wet weather wastewater flows at water resource recovery facilities (WRRFs) are caused by infiltration and inflow in the collection system that occur during storm events. These high-magnitude and low-strength streams hydraulically overload process units and can result in "washout" of activated sludge biomass. The increased unpredictability and intensity of rain events due to climate change have further complicated flow management and treatment. The primary options for handling wet weather flows are the following:

- Peak flow storage or equalization at the plant or in the collection system.
- Peak flow handling in the main treatment train by increasing the number and/or size of process units and configuring aeration basins with processes like step-feed mode, ballasted activated sludge, or integrated fixed film activated sludge.
- Peak wet weather conveyance to auxiliary treatment (ballasted high-rate clarifiers or wet weather filters) and combining the treated wet weather flow with the main treatment train prior to disinfection.

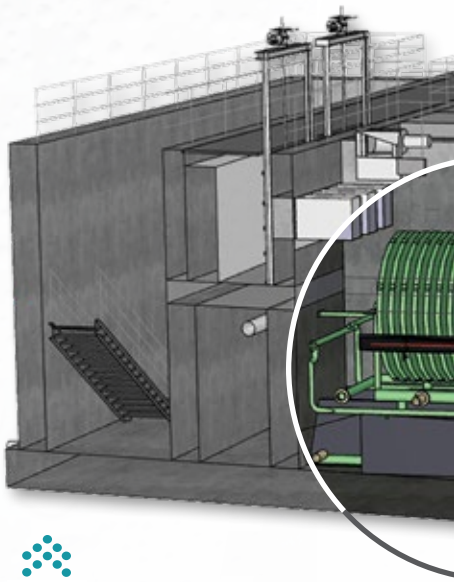
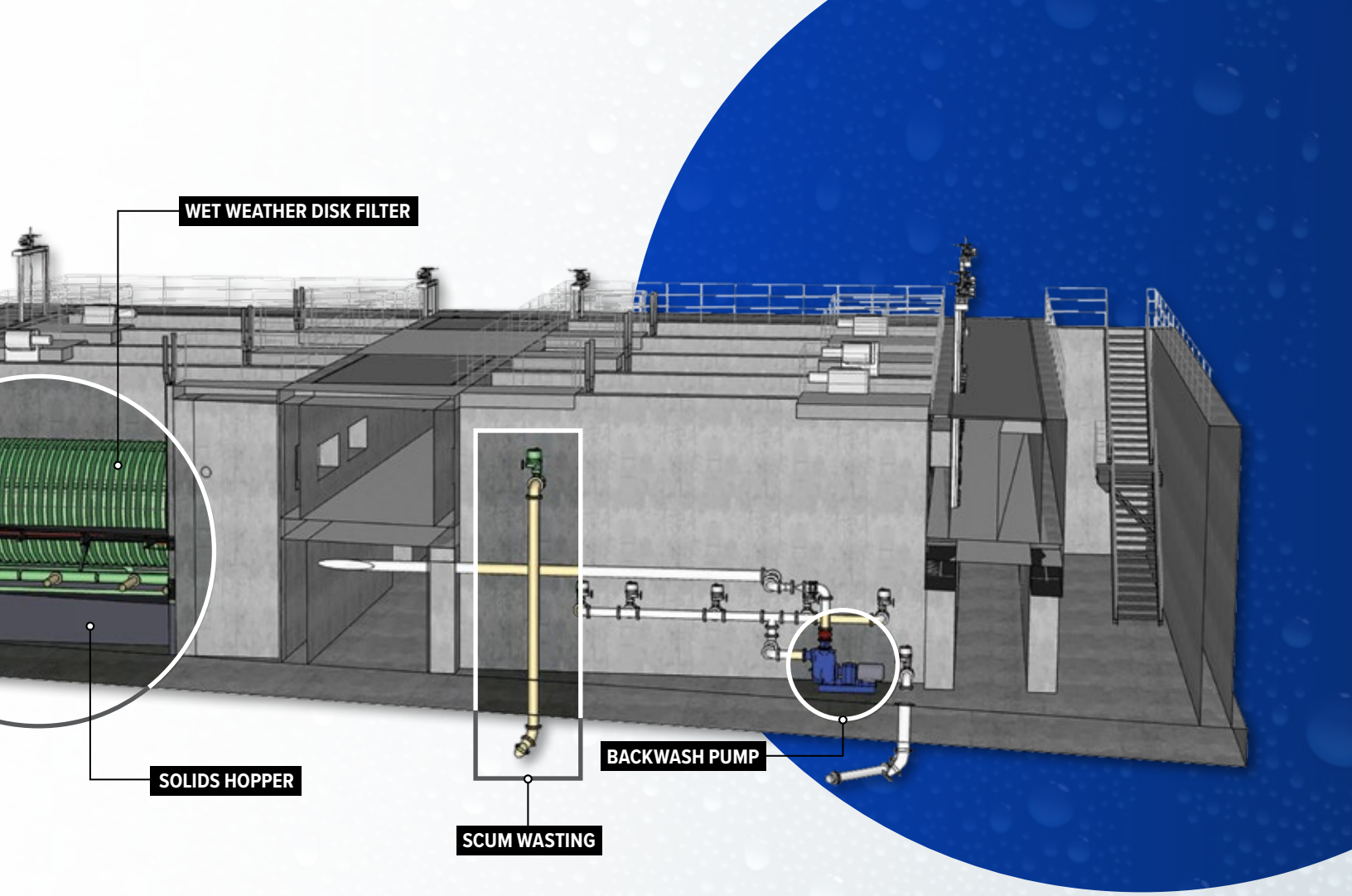


Figure 1. Carollo is providing design services for a 100-mgd wet weather filtration system for a Texas client. Shown here is a cut-away view of the filtration facility.

The table below summarizes the main advantages and disadvantages of each wet weather treatment alternative.

NON-ECONOMIC COMPARISON OF WET WEATHER TREATMENT OPTIONS

TREATMENT TYPE	ADVANTAGES	DISADVANTAGES
Peak Flow Storage	▸ Reduces size of treatment processes and effluent outfall. ▸ Does not rely on combining effluents to meet effluent limits. ▸ Does not require special approval by regulators.	▸ Larger footprint than auxiliary treatment. ▸ Potential odor concerns. ▸ Basin wash-down is labor-intensive. ▸ Limited sustained peak flow capacity. When it's full, it's full.
Secondary Treatment Enhancements	▸ Does not rely on combining effluents to meet effluent limits. ▸ For conventional processes, it does not require special approval by regulators.	▸ Providing more or larger clarifiers is costly and requires a large footprint. ▸ Biological system may become stressed during peak flow events. ▸ May add complexity to secondary system operation.
Auxiliary Treatment	▸ Smaller footprint than other alternatives. ▸ Can handle sustained design peak flow. ▸ Certain technologies can serve dual purpose (tertiary and wet weather treatment).	▸ Relies on combining effluents to meet permitted limits. Lower treatment efficiency than the main treatment train. ▸ Limited number of full-scale installations. ▸ Backwash or solids wasting must be returned upstream of primary clarifiers. ▸ May require special approval by regulators.



WET WEATHER FILTRATION

Wet weather filtration is emerging as a preferred choice for auxiliary treatment because of its small footprint, operational familiarity, and low complexity. While the United States Environmental Protection Agency (USEPA) previously considered non-biologically treated wet weather flows combined with main plant effluent a National Pollutant Discharge Elimination System (NPDES) violation, the USEPA and some state regulatory agencies recently indicated they are amenable to non-biological wet weather auxiliary treatment on a permit-by-permit basis.

Carollo is designing a 100-million-gallon-per-day (mgd) wet weather filtration system for a Texas client. Due to a revised flood plain elevation, the site's usable area cannot accommodate oversized clarifiers or storage basins to handle peak flows. While compressible media and cloth media disk filters are two options for filtration, the utility's familiarity with cloth media disk filters makes it the ideal solution for this project **(Figure 1)**.

Wet weather disk filters are similar to the tertiary disk filters installed at dozens of WRRFs across the United States. Solids deposit on the outside of the submerged cloth media disks and filtrate is collected through the disk's hollow core and combined in a common center tube.

Filters are backwashed when the solids collected on the media achieve a pre-set headloss and high-water level. Solids are removed from the cloth using vacuum "shoes" connected to backwash pumps. Unlike tertiary disk filters, wet weather filters include scum wasting and solids removal mechanisms. Heavier solids that settle in the basin are collected in a hopper at the bottom of the filter basin and conveyed to preliminary or primary treatment. Floatable scum is allowed to collect on the water surface within a scum trough and periodically wasted after a pre-set number of backwashes.

As wet weather filtration gains more state regulatory acceptance and existing installations continue successful operation, Carollo anticipates that this method will become the technology of choice for the treatment of low-strength wet weather flows.

We see more in water—more than the science, more than the planning, and more than the design. We see the families and communities we serve, and the increasingly fragile ecosystems we must protect. For 90 years, we've been inspired to safeguard the quality of life for all communities, developing the most innovative solutions in the water industry. It just doesn't get any bigger than that.

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