

WET-WEATHER INFRASTRUCTURE: SMART ANALYSIS AND TOTEX PLANNING EQUAL SAVINGS AND RESILIENCE

HOW “SWEATING THE SYSTEM” WITH SMART ANALYTICS MODELING AND TOTEX PLANNING CAN DELIVER FIT-FOR-PURPOSE SOLUTIONS, CAPITAL COST SAVINGS, AND SYSTEM OPTIMIZATION

By Nick Anderson and Melissa Carter

In the world of data analytics there's a phrase that says we are data rich and knowledge poor. The rise of real-time data has put more information than ever at our fingertips, but without proper analysis and context, this data boom does not deliver much value.

The Stantec team is working to address this challenge in our approach to water infrastructure design and engineering to make our data work smarter and harder to deliver real value to clients. By using advanced hydraulic models, our team is focused on translating extensive data into a holistic story of the overall outcomes of a project.

The goal? To increase understanding and confidence, drive efficiency, and achieve real cost savings.

Setting a plan, and checking it twice

Our ongoing work on one of the largest CSO projects in the Northeastern U.S. serves as a prime example of the great potential for advanced data analysis when applied to hydraulic modeling in optimizing project solutions. In this case, our team developed a detailed fit-for-purpose hydraulic model to help optimize CSO control facilities for the [Narragansett Bay Commission \(NBC\) Phase III CSO Abatement Program](#) in Rhode Island.

Over the past 20 years, NBC, which operates wastewater collection and treatment facilities for 10 member communities, has been leading a three-phase program to address CSO volumes and resulting environmental impacts. Program goals include a reduction of annual CSO volumes by 98 percent with no more than four overflows per year, an 80 percent decrease in shellfish bed closures, and a 98 percent reduction in fecal coliform loading. The main component in Phase I (under construction from 2001 to 2008) involved the installation of a 16,284-ft deep rock storage tunnel with an inside diameter of 26-ft, located approximately 270-ft below grade. This phase also involved the addition of a tunnel pump station, drop shafts, and a consolidation of conduits. Phase II (under construction from 2011 to 2015) added CSO interceptors to connect additional outfalls to the Providence Tunnel, several sewer separation projects, and the addition of a wetlands storage facility.



Prior to kicking off the third and final phase, NBC selected Stantec to revisit the original Phase III plan (involving a second deep rock CSO storage tunnel nearly 13,000-ft. long and 28-ft. in diameter with an estimated capital cost of \$815 million) for opportunities to optimize the existing approach and consider new tactics that may further benefit CSO control goals. Our first task was to make sure what was proposed more than 20 years ago would still meet the regulatory goals of storing a three-month storm and preventing no more than four CSO spills in a typical year, which it did.

However, while the engineering approach proved solid, the original analysis for this project was 20 years out of date from a technological standpoint. Since computing power was limited at the time, teams had no choice but to make broad assumptions in modelling. This was where our team spotted an opportunity.

By harnessing the power of advanced analytics in conjunction with hydraulic models and total expenditure (TOTEX) planning, taking into account capital and operational expenditures, we worked to “sweat the system” to optimize the project. This was done while ensuring the new approach still met the original CSO control criteria without introducing any additional risk.

The result? A detailed model with smart analytics that have helped establish a road map for solution optimization at an estimated \$60M reduction in capital costs.

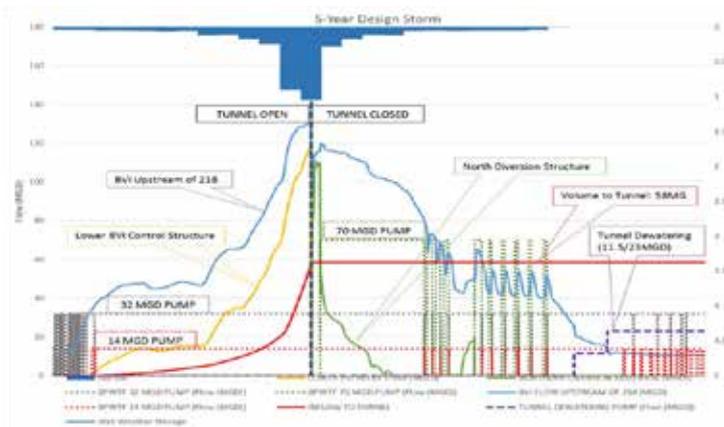
Building a smart model for smarter solutions

Using an adaptive management strategy, we focused on collecting as much data as possible. In many cases more than what is typically at the early stages of a design project, with an eye on using the power of data for project refinement as the hydraulic model becomes more informed. Very few clients have a backlog of data, so getting as much data as early as possible with continuous metering and flow assessment created the means to gain confidence in the design at a much earlier stage, with smaller refinements to follow.

By taking a TOTEX approach, we focused on analyzing the overall outcome for our client, rather than a single output of a project being successfully delivered on time and on budget. In this vein, we looked to examine standard operating procedures such as the long-term legacies, the costs, the impact on future maintenance, and ownership.

This strategy informed our approach in building the hydraulic model, where we mapped all water discharge infrastructure within the terrain and layered in rainfall data to establish flow data. We then used stochastically generated rainfall events to evaluate system exceedance rather than the traditional approach focused on retention. Combined, this data helped us better understand the system to determine flow trends into sewers, available capacity, and general water movement within the system.

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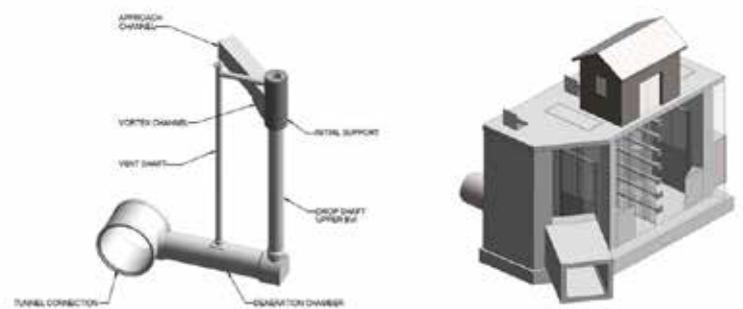
By continuously running the model, collecting NBC's SCADA data, and, in some cases, adding additional flow meters over the course of our five years on this project, the model has become increasingly informed. In seeing this data year over year, our team is looking for trends and changes, making sure that the designed system is standing up to the rigors of this increased implementation via real-time control and adaptation in the face of future impacts like climate change.

One of the keys to the considerable optimization of this project was the opportunity to better use the existing assets to manage flows. Once we were able to understand the system, we used the model to determine that NBC could open and close gates to fill the tunnel – which can hold nearly 59 million gallons of water – earlier, and subsequently direct flows to the treatment plants sooner so that NBC could get the most out of their existing infrastructure.

In the original plan, interceptors had been proposed to help direct flows to the tunnel. With our strategy of optimization, we focused on determining whether aspects of the original system could be reused through minor upgrades to relieve bottlenecks and get flow to the tunnel. The key was making sure the system was able to push flows into the tunnel sooner to create the capacity in the lower reaches. This would then allow flows in the upper reaches to come down, ultimately reducing the need for new infrastructure.

This became the biggest single saving in the optimization strategy. Our reevaluation plan was amended to include this optimized design, which was accepted by the Rhode Island Department of Environmental Management in 2017.

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Analytics tools like this enable engineers to make earlier informed decisions to optimize capital solutions. In making our data and model work harder, our team has been able to support NBC in setting this CSO control solution up for success against the rigors of future climate change, while ensuring the project is being used most effectively and meeting project goals.

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