



CARIBBEAN WATER AND
WASTEWATER ASSOCIATION

34th **ANNUAL
CONFERENCE
& EXHIBITION
2025**



Engineering Progress Together:
Collective Action for a
Connected Region.

Conference
Magazine
2025





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WASTEWATER ASSOCIATION

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Collective Action for a
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Message from the Honourable Michel Chebat
Minister of Public Utilities, Energy, and
Logistics

On the Occasion of the CWWA 34th
Water and Wastewater Association (CWWA)

October 20-204 2025

Grand Caribe – San Pedro, Ambergris Caye, Belize, C.A

Ladies and Gentlemen, distinguished Ministers, regional leaders, development partners, sector professionals, and esteemed delegates, welcome to Belize!

Belize is honoured to host the 34th Caribbean Water and Wastewater Conference here in beautiful San Pedro. Your presence reflects our shared commitment to safeguarding one of the most vital resources for life, health, economic development, and climate resilience—water.

Belize stands at the crossroads of rich biodiversity, cultural heritage, and environmental responsibility. As a Caribbean nation with abundant marine and land resources, we are deeply committed to

managing and protecting our water systems—surface, groundwater, and coastal ecosystems alike. Hosting this conference is both a privilege and a reflection of our growing leadership in sustainable water management and climate action.

Over the past decade, Belize has made significant strides in expanding access to safe and reliable water services. Today, over 90% of our urban population has access to an improved water supply. Through strong governance, infrastructure investment, and partnerships with regional and international agencies, Belize Water Services and our rural water units are increasingly adopting innovative technologies, improving operational efficiency, and strengthening regulatory oversight.

We are also advancing wastewater management systems, particularly in tourism-dependent areas like San Pedro and Caye Caulker, to protect our marine environment and the Belize Barrier Reef, a UNESCO World Heritage Site.

Like all Caribbean nations, Belize is on the frontline of climate change. We face stronger hurricanes, coastal erosion, saltwater intrusion, unpredictable rainfall, and prolonged droughts. These directly threaten our water security.

In response, Belize has committed to building a climate-resilient water sector. We are:

- Developing drought preparedness plans,
- Implementing watershed protection,
- Building elevated and hurricane-resistant water infrastructure,
- Incorporating renewable energy into water systems,
- Improving data, monitoring, and early warning capabilities.

Our approach recognises that water security is climate security.

One of Belize's proudest achievements—and a global milestone—has been the successful negotiation of the Belize Blue Bond for Ocean Conservation. This innovative debt conversion has unlocked more than US\$180 million for marine and environmental protection.

Some of these resources have notably supported water resilience and coastal protection initiatives. This exemplifies how finance, sustainability, and public policy can collaborate to protect both communities and the environment. It demonstrates that small island and coastal developing nations can spearhead innovation and capture global interest. We also know we cannot do this alone; the challenges we face—climate change, financing gaps, ageing infrastructure, and equity in service delivery—are shared across the

Caribbean. That is why this conference is so critical. It brings together governments, regulators, utilities, the private sector, academia, and development partners to exchange knowledge and develop tailor-made solutions for our region.

Belize is honoured to serve as host, not just for the beauty of our shores, but for the opportunity to lead and learn alongside all of you. Together, we can ensure that future generations inherit a region where water is protected, managed sustainably, and accessible to all.

On behalf of the Ministry of Public Utilities, Energy and Logistics, the Government and people of Belize, I welcome you to San Pedro. May this conference be fruitful, inspiring, and transformational for our shared future.

Thank you, and welcome to Belize!



Distinguished colleagues, partners, and friends, It is my distinct honour to address you through the pages of this year's CWWA Annual Magazine. For over three decades, the Caribbean Water and Wastewater Association has been the premier platform for knowledge exchange, technical innovation, and policy dialogue in water, wastewater, and solid waste management across our region. We are a community of small states and diverse territories, but what binds us together is far greater than what sets us apart: the shared challenge of building resilience in an age of uncertainty.

The Caribbean and Central America today are at a crossroads. Intensifying hurricanes, prolonged droughts, sea-level rise, saltwater intrusion, pollution, aging infrastructure, and widening financial constraints threaten our very development. These pressures do not stop at our borders, they flow across watersheds,

aquifers, supply chains, and communities. Global economic volatility, climate-driven migration, and food and energy insecurities compound our vulnerabilities. Yet within these challenges lies an extraordinary opportunity: to unite as a region, to engineer progress together, and to harness the transformative power of collective action.

This year's theme "Engineering Progress Together: Collective Action for a Connected Region" is both a call to action and a roadmap. It reminds us that engineering is not only about pipes, pumps, and plants. It is about building the systems, institutions, and human capacity that underpin resilient services.

1. On the technical front, we must accelerate the use of smart hydrological monitoring, robotics, and hydroinformatics to reduce non-revenue water, recycle wastewater, and restore ecosystems through circular economy solutions.
2. On the institutional front, we must strengthen utility governance, modernize regulatory frameworks, and advance regional standards for equitable and efficient service delivery.
3. On the financial front, we must mobilize climate finance, leverage blended public-private investment, and adopt innovative tariff and cost-recovery mechanisms that secure long-term sustainability.

4. On the social front, we must prioritize inclusion and equity ensuring that communities, women, youth, and vulnerable groups are not passive recipients but active partners in shaping water resilience.

Progress cannot be engineered in isolation. It demands utility-to-utility cooperation, academic partnerships linked to practice, stronger regulatory dialogue, and deeper engagement with regional and international partners.

As President of the CWWA, I reaffirm our Association's commitment to being the hub for this transformation. Our work today is aligned with global best practice but grounded in Caribbean realities. CWWA is engineering resilience at scale, from advancing parametric insurance through the Caribbean Water Utilities Insurance Collective, to youth engagement under the CWWA ReEF, to shaping regional governance with partners.

But let me be clear: the CWWA is not merely an institution; it is a movement. Its strength comes from you, the engineers, scientists, policymakers, regulators, researchers, students, and professionals who live on this mission every day. Each of you is essential to building the connected region we envision.

As we convene, collaborate, and share knowledge this year, let us go beyond reflection. Let us catalyze implementation. Let us scale innovation, integration, and engineer not only infrastructure, but also trust, solidarity,

and resilience.

On behalf of the Board, Secretariat, and membership of the CWWA, I extend gratitude to our hosts Belize, sponsors, and partners whose commitment sustains this work. Most importantly, I thank each of you for your service and dedication to this noble mission.

Together, we can and we must engineer progress. For our communities. For our economies. And for the generations that will inherit this Caribbean we call home.

Sincerely

Candice Santana

President-

Caribbean Water and Wastewater Association



It is with great pleasure that I welcome you to the 34th Annual CWWA Conference and Exhibition. This year's Conference theme "Engineering Progress Together: Collective Action for a Connected Region" resonates deeply with the challenges and opportunities that define our region today. As Small Island Developing States (SIDS), we are on the frontline of climate change, increasing resource scarcity and environmental pressures. Yet, these challenges can also drive our collective will through innovation and resilience. The CWWA Conference offers us a space to share success stories, advance transformative solutions, and strengthen the partnerships that make sustainable progress possible.

This year, we proudly celebrate a major

milestone within the region. For the first time in the Association's history, we have the honour of hosting this annual event in collaboration with the Government of Belize and the Belize Water Services Limited (BWSL) on the beautiful island of San Pedro. This collaboration represents an important achievement for the CWWA, as it is the first time we have had the opportunity to host the event in Central America with direct involvement of our Latin American counterparts within the water and sanitation sectors.

Hosting the Conference in Belize also carries special significance as Belize has long demonstrated leadership in sustainable resource management, conservation, and integrated water governance. By bringing our regional community here, we highlight not only these achievements but also the shared commitment of Caribbean nations to collaborate for a more water-secure, waste-resilient, and climate-ready future.

Looking back over the last year, the CWWA has continued to champion the causes that matter most to our members and stakeholders. We have deepened collaboration with key regional and international partners, including, Caribbean Biodiversity Fund (CBF), Caribbean Centre for Renewable Energy and Energy Efficiency (CCREEE), Caribbean Development Bank (CDB), Caribbean Institute of Meteorology and Hydrology (CIMH), Development Bank of Latin America and the Caribbean (CAF), Global

Water Intelligence (GWI), Global Water Partnership-Caribbean (GWP-C), the Gulf Cooperating Countries (GCC), Inter-American Development Bank (IDB), Japan International Cooperation Agency (JICA), Organisation of Caribbean Utility Regulators (OOCUR), United Nations Environment Programme (UNEP) and the World Bank. Together, we are advancing integrated water and wastewater management, supporting policy development, promoting sector financing and driving regional waste management.

I also wish to highlight the unwavering support of our member utilities, national chapters, regional governments, development partners, sponsors, and exhibitors; these stakeholders continue to contribute to the strength and sustainability of the CWWA and

our regional mission. To our hosts in Belize, we express heartfelt gratitude for your partnership, hospitality, and leadership in making this historic event a success.

As we gather here in San Pedro, let us be reminded that the voice of the Caribbean in the global water, wastewater, and solid waste dialogue must continue to be strong, unified and action-oriented. The issues we face transcend borders and so too must our solutions. This Conference is more than an annual meeting, it is a manifestation of regional solidarity and a catalyst for the collective action that our future demands.

On behalf of the CWWA Secretariat and Board of Directors, I thank you for being part of this journey. May this year's Conference inspire renewed collaboration, bold ideas, and tangible commitments toward securing a sustainable and resilient Caribbean for generations to come.

Laurayne Lucky

Executive Director

Caribbean Water and Wastewater Association



UNEP and CWWA Driving Collaborative Action for a Zero Waste Caribbean

Dear Colleagues,

The longstanding and transformative partnership between the United Nations Environment Programme (UNEP) and the Caribbean Water and Wastewater Association (CWWA) continues to serve as a catalyst for sustainable development across the Caribbean. United by a shared commitment to environmental resilience and circular innovation, this collaboration is addressing the region's most urgent challenges, including waste and pollution.

Strategic Collaboration for Circular Progress

At the heart of this effort is the UNEP-implemented Zero Waste in the Caribbean: New Ways, New Waves initiative, co-financed by the European Union and the German Government and delivered in partnership with CARIFORUM. UNEP's technical support is helping governments strengthen waste governance, mobilize sustainable financing and identify circular economy pathways that transform waste into opportunity.

The CWWA Annual Conference and the High-Level Forum (HLF) for Caribbean Ministers Responsible for Waste have emerged as key platforms for advancing this agenda. The upcoming HLF9—under the theme “Enabling a Zero Waste Caribbean: Advancing Solutions, Accelerating Action”—builds on the momentum of the 2024 Port of Spain Declaration, which reaffirmed regional commitment to the Caribbean Waste Management Action Plan (CWMAP) and outlined a shared vision for accelerating circular solutions and deepening cross-sector collaboration.

Building Capacity, Sharing Knowledge

Since its launch in 2022, the Zero Waste project has made measurable progress in strengthening waste management frameworks, introducing innovative financing instruments and supporting the development of circular strategies. These efforts are reinforced by a strong focus on regional cooperation and capacity building.

In collaboration with development partners, the initiative has convened technical workshops, policy dialogues and site visits to promote integrated financing, private sector engagement and data-driven decision-making. Capacity building through webinars and training in 2024 and 2025 continues to empower institutions and stakeholders with the tools needed to implement zero-waste strategies effectively.

A Model for Regional Sustainability

The UNEP–CWWA partnership exemplifies how international and regional collaboration can deliver practical, scalable solutions for

sustainable development. Through shared vision, technical expertise and continued commitment, the Caribbean is steadily moving toward a future where waste is reimagined as a resource—creating cleaner environments, stronger economies and more resilient communities.

Vincent Sweeney

Head, Caribbean Sub-Regional Office
United Nations Environment Programme
(UNEP)



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There is perhaps no better opportunity for engagement with water sector decision makers in the Caribbean than the Caribbean Water and Wastewater Association (CWWA) annual conference. This is why, for a second year running, the World Bank is proud to support CWWA during its 31st Annual Conference and Exhibition.

We look forward to leveraging the strong convening power of the CWWA during this event as it enables us to hear directly from Caribbean leaders on their pressing water supply and pollution management needs. Indeed, systematically engaging with Small Island Developing States is a priority for the World Bank due to their extreme vulnerability to climate change and natural disasters, their pivotal role in global ocean management, and unique developmental challenges like debt burdens and small economies. Along this vein, last year's Conference kick started a deep

engagement from the World Bank with many Caribbean countries which, since then, has enabled us to gain valuable insight on the considerable work that needs to be done to ensure resilience, efficiency and sustainability of the water sector and to put together a robust Caribbean Regional Water Program. To summarize we understand that water and wastewater services face growing stress from high energy costs, aging infrastructure, intermittent supply, significant losses—over 50% of produced water is often lost—which are all compounded by climate change. Meanwhile, around 85% of wastewater is discharged untreated, polluting coastal ecosystems and threatening public health, tourism, and fisheries – and ultimately, jeopardizing jobs and prosperity. While addressing these issues is urgent, the institutional capacity to respond is weak. As such, To inform the Bank's response to these issues, we look forward to continuing to learn from regional leaders during the Conference thereby ensuring our programs are tailored to best advance water sector goals.

The World Bank also considers this Conference as a valuable opportunity to promote transparency as it provides a significant platform to provide our clients (and would-be-clients) with updates on the work we have been doing to address persistent water sector challenges while creating opportunities for economic development and job creation. To highlight, through partnership with the



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CWWA, over the past year we have been able to co-deliver key capacity building events in the areas of Creditworthiness for Caribbean Water Utilities aiming at bringing operational and financial efficiency to the Region's water service providers. We have also co-hosted workshops on accelerating wastewater management to promote a more integrated and practical approach to country-wide wastewater and sanitation services. As our team will be on the ground in Belize, we hope to co-develop a way forward on attracting more financing, improving policies and regulations, adopting affordable water and wastewater solutions, and promoting a broader push for water security.

October 2025 is also the month that the World Bank put forward the preparation of the Caribbean Water Security and Sector Efficiency Regional Multi-Phased Approach Program which is expected to have its first phases approved early 2026. With dedicated financing packages for an initial set of countries (including concessional funds, soft loans and private sector financing) as well as a regional knowledge component, the Program will support each country's unique objectives, while also promoting regional replicability and gains of scale. In support of this, the Bank made a significant move to approve a Grant Facility for Project Preparation, in partnership with the Caribbean Community Climate Change Centre (CCCCC), to prepare the Program through technical studies, data gathering, capacity building and multi-country advocacy and

policy dialogue.

As the World Bank develops our Caribbean Regional Water Program and other initiatives, we will continue to prioritize measures that closely align with the ambitions of the CWWA and its members and the World Bank Group's new Water Strategy that takes a comprehensive approach to tackling water challenges through increasing access to water for people, ensuring water security for food, and managing water for the health of the planet. I sincerely appreciate the CWWA Secretariat for their work in making this Conference possible. I wish all a successful event and look forward to fruitful discussions and outcomes.

Benoît Bosquet

Regional Director for Sustainable
Development Latin America and Caribbean
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Young Professional Rapporteurs 2025

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Kimoy-Marie Douglas

Water Resources GIS Specialist
Jamaica

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Kimoy-Marie Douglas is a GIS Technician at the Water Resources Authority (WRA) in Jamaica, where she applies geospatial technology to support the monitoring and management of the island's water resources. Her work spans surface water, groundwater, and water quality projects, with a focus on data analysis, mapping, and developing tools that help transform technical information into practical insights. She is skilled in platforms such as ArcGIS, Python, and Google Earth Engine, and is passionate about using GIS to strengthen decision-making in water resource management and environmental sustainability. Kimoy-Marie holds a Bachelor of Science degree in Geology and continues to explore innovative ways to integrate technology in addressing water-related challenges across the Caribbean.



Queenena Edwards

Upcoming Civil & Environmental Engineer
Jamaica

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Queenena Edwards is an upcoming Civil & Environmental Engineer from Trinidad and Tobago with a passion for water resilience and sustainable infrastructure. She holds a BSc in Civil with Environmental Engineering (First Class Honours) from the University of the West Indies, St. Augustine where she built a solid foundation in hydrology. With almost 2 years' experience in engineering, Queenena has contributed to the designs of irrigation projects in both Grenada and Antigua focused on improving and developing water systems for farmers to strengthen food security.

With a commitment to continuous learning and a driven mindset, Queenena strives to continue contributing to innovative projects that promote adaptation to climate change, enhance water security and build sustainable systems that support Caribbean livelihoods.

Outside of engineering, Queenena enjoys exercising, reading and spending time with her family and friends.

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THEME 1

Empowering Integrated Water Management for Sustainable Prosperity and Climate Action (IW)





Title

Strengthening the role of Water Professionals in Capacity Development

IW001

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Water professionals play a crucial role in tackling the numerous challenges linked to water capacity development, especially given the increasing demands of a growing global population and environmental stressors. Effective management of water resources requires a strong framework that emphasizes the enhancement of technical skills and promotes collaborative networks among different stakeholders.

The role of water professionals is critical in advancing sustainable development, particularly regarding the United Nations Sustainable Development Goals (SDGs). These experts manage water resources, ensure equitable access, and promote efficient use. Their work transcends traditional boundaries, as they often engage in interdisciplinary collaborations that emphasise the resource nexus, highlighting the interconnectedness of water, energy, and food systems. As articulated by Lindner et al.

The current landscape of water capacity development is fraught with multifaceted challenges that necessitate an urgent reevaluation of strategies and stakeholder engagement. Notably, the marginalization of certain

groups, particularly women, poses significant barriers to effective governance and resource management in urban water systems.

A critical examination of water professionals in various contexts reveals significant gaps in both skills and knowledge that impede effective water management. A study involving an interdisciplinary Water Security Colloquium highlighted numerous challenges, including a marked deficiency in governmental skills and the political will necessary to address water security comprehensively.

Enhancing the role of water professionals is crucial for effective water capacity development, particularly in regions facing significant challenges associated with water resource management. A primary strategy involves the integration of interdisciplinary approaches, promoting collaboration among hydrologists, economists, and social scientists. For instance, in Laos, a country recognized for its limited socioeconomic development, a four-year research initiative highlighted the importance of utilizing groundwater resources, which had historically been overlooked due to a focus on surface water (Pavelic et al.).

The successful implementation of training and education programs is paramount for skill development among water professionals, particularly in the context of water capacity development. Training initiatives must be strategically designed to encompass both technical knowledge and practical applications, fostering an environment where water professionals can thrive.

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Title

Implementing Climate Resilience Principles: Case Studies for Small Island Developing States

IW004

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Small Island Developing States (SIDS) like Barbados face unique vulnerabilities due to climate change, particularly in terms of water security. Barbadians experience water security challenges in inland and coastal areas that are exacerbated by environmental hazards. The interconnectedness of land and marine environments is important to consider, namely the fact that any compromise in one area can significantly affect the other. Sea level rise and saline intrusion impact coastal infrastructure and inland groundwater supplies, making water management challenging. This work explores the transformative role of climate financing in addressing these challenges through three key water-related projects in Barbados: the Water Sector Resilience Nexus for Sustainability (WSRN S-Sustainability), the 3R-CReWS (Reduce, Reuse, Recycle for Climate Resilience

Wastewater Systems), and the Roofs to Reefs Programme (R2RP). These projects exemplify the value of a systems perspective and the "One Water" approach, integrating all aspects of water management to promote sustainable development and climate resilience. By leveraging climate financing, Barbados is enhancing water security, reducing greenhouse gas emissions, becoming more resilient, and improving the quality of life for its residents. This paper highlights the importance of innovative and well-funded projects in adapting to the impacts of climate change on small island developing states.

Keywords: Water, Climate, Financing, Systems Perspective, SIDS

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Title Hillsborough Dam Case Study

IW007

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This case study examines the Hillsborough Dam de-silting project, focusing on the engineering challenges, hydrological impacts, and environmental considerations involved in rehabilitating a vital water reservoir in the Eastern Caribbean. The Hillsborough Dam, located on the Hillsborough East River in Tobago, has experienced significant siltation since its commissioning in 1952, leading to reduced water storage capacity and increased pressure on the region's water supply. In response to this, a comprehensive de-silting operation was initiated, involving bathymetric surveys, sediment analysis, environmental and risk assessments.

Key engineering challenges included maintaining the water supply during the de-silting process, managing environmental impacts, access to the site, handling the transportation and disposal of large quantities of silt and maintain turbidity levels of the raw water at the intake to the water treatment plant. This case study provides an in-depth analysis of these challenges, alongside the methodologies employed to overcome them, such as the use of cutter suction dredging, silt dewatering techniques, selection of the most feasible site for silt

disposal and implementation of silt mitigation strategies within the reservoir to maintain raw water quality at the water treatment plant intake. The project outcomes highlight significant improvements in reservoir capacity and water quality, although long-term siltation management remains a priority.

Lessons learned from the Hillsborough Dam de-silting project offer valuable insights for similar reservoir rehabilitation efforts in the region, particularly for small island states facing water security challenges. Recommendations are provided for optimizing future de-silting projects with a focus on pre-assessment, stakeholder engagement, and environmental compliance.

Keywords: Reservoir; De-Silting; Dredging; Hydrology



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Bridging the gap from Concept to Development



Title

Vulnerability of Trinidad and Tobago's Water Supply to the effects of climate change

IW008

Author

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Like countries throughout the world, the nation of Trinidad and Tobago is vulnerable to the potential effects of climate change, and as a small island developing state our resources to respond to those impacts are limited. Climate change will adversely affect many aspects of our lives, including our ability to produce sufficient quantities of potable water for our population. At the present time, Trinidad and Tobago produces potable water from a wide range of sources, including large surface impoundments, ground water, river intakes and desalination, with approximately half of the water supply coming from large surface impoundments (the Hollis Dam and Reservoir, the Hillsborough Dam and Reservoir, the Arena Dam and Reservoir and two Dams and Reservoirs at Navet). This paper discusses the potential adverse effects of climate change on the reliability of each type of water source, vis-à-vis the importance of that source in Trinidad and Tobago. It also comments on whether measures are available to reduce our vulnerability, and how practical each measure is from a technical and financial standpoint. It then draws conclusions as to whether climate change is likely to lead to a significant shift in the present proportions of potable water derived from each source in the medium term.



Title

Application of Biological Filtration and Air Stripping for Iron and Ammonia Removal in Wakenaam Island, Guyana

IW009

Authors

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This study assesses an integrated water treatment system using biological filtration and air stripping to treat groundwater with high iron (12-14 mg/L) and ammonia (14-17 mg/L) on Wakenaam Island, Guyana. The pilot system combined two biological filtration vessels with a downstream air stripping tower. Caustic soda (NaOH) was dosed before the stripper to raise pH to about 10.5, enhancing ammonia removal.

The biological filtration achieved >99% total iron removal across both vessels. The first biofilter removed over 95% of the iron, with the second polishing the remaining amount. Maintenance varied; the first filter required weekly backwashing due to higher iron loading, while the second needed backwashing monthly, both triggered at +5 PSI differential pressure.

For ammonia, the system employed a dual-strategy. Biological filtration reduced ammonia by approximately 25% (from 17 mg/L to 14 mg/L), and air stripping removed the rest, resulting in final concentrations below 1 mg/L. Biological ammonia removal was limited to prevent excessive nitrate formation beyond WHO guidelines (10 mg/L as NO₃⁻).

Continuous Dissolved Oxygen (DO) and Oxidation-Reduction Potential (ORP) monitoring proved valuable for optimization. Raw water ORP values between -100 to -120 mV indicated soluble ferrous iron (Fe^{2+}), ideal for biological oxidation. These parameters allowed dynamic adjustment of aeration levels, supporting microbial activity and iron precipitation.

Pilot results confirm that a biological filtration system, combined with air stripping, efficiently and sustainably removes iron and ammonia. Reduced chemical reliance and infrequent backwashing ensure lower operational costs and waste. This integrated approach is suitable for widespread adoption across the Caribbean, offering a path to safer and reliable drinking water.



Title
**Risk Assessment and
Management in Water
Infrastructure**

IW011

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Crucial to assessing any utility's water and sewer assets is understanding where the assets exist, the history of the assets and their condition. A Capital Improvement Program that has an initial focus on the collection of 100,000+ data points, establishes a starting point from which to create a baseline risk profile and plan for future years. Assessments are not focused only on the assets themselves, but on combined surface structures, planning initiatives, historic damage locations, and

socioeconomic factors across neighborhoods. **Apply Risk and Criticality Modeling** to the data collected to prioritize each asset relative to its risk of failure and consequence of failure and aggregate these assets by neighborhood. Each neighborhood can then be prioritized based on risk and priority for condition assessment and subsequently rehabilitation or replacement. The Asset Prioritization/Neighborhood Ranking Map presented to Owners in a workshop for review of the output, gain feedback and improve the model and results. The risk asset prioritization model will create a "Top" list of neighborhoods with the greatest concentration of critical high-risk assets. CIP project teams will focus their future CIP development efforts on these identified high-risk areas. As more information is gathered on water and sewer assets through condition assessment and other investigative work, the asset prioritization model will be updated and the model run to identify any potential changes in the rankings. This process helps ensure that limited resources are focused on the most critical assets, minimizing disruptions and maximizing system resilience.

The data collection, analysis, and CIP Planning effort requires a review of project execution and information-management foundations. The goal is to ensure that available information can be accessed in a system providing a single point of truth and leveraged to make information-based defensible decisions. As with most large cities, IT infrastructure is complex, sometimes siloed, and implemented to meet disparate operational objectives. The result is that engineers and managers do not have access to the information necessary to make decisions in a consistent, uniform, and repeatable way, or to defend those decisions with factual condition and performance data. The IT landscape is particularly complex and individual departments establish innovative ways of delivering their services, and of aligning new processes with newly emerging technologies. information-based defensible decisions. As with most large cities, IT infrastructure is complex, sometimes siloed, and implemented to meet disparate operational objectives. The result is that engineers and managers do not have access to the information necessary to make decisions in a consistent, uniform, and repeatable way, or to defend those decisions with factual condition and performance data. The IT landscape is particularly complex and individual departments establish innovative ways of delivering their services, and of aligning new processes with newly emerging technologies.



An aerial photograph of a water treatment facility. In the foreground, a building with a white corrugated metal roof is visible. To the right, a large circular tank with a blue metal walkway and yellow railings is partially filled with water. In the background, more circular tanks and lush green trees are visible. The text 'THEME 2' is overlaid on a dark blue rectangular background in the upper left corner.

THEME 2

Innovative and Resilient Water Infrastructure for Sustainable Utility Operations (RI)



Title

Reconceptualizing Caribbean Water Systems as Hybrid Distributed Systems: A Call for Adaptive Governance

RI001

Author

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Caribbean water systems have traditionally been evaluated through the framework of centralized water infrastructure models, with their diverse arrangements often perceived as incomplete or substandard compared to idealized continental systems. This paper argues for the fundamental reconceptualization of Caribbean water systems as hybrid distributed systems—complex networks that integrate centralized infrastructure with decentralized solutions, formal governance with informal practices, and traditional knowledge with technical expertise. Drawing on socio-technical systems theory and Ostrom's commons governance principles, this study demonstrates how Caribbean water systems have evolved through the co-evolution of technical components and social arrangements, resulting in configurations marked by technological diversity, spatial distribution, institutional fragmentation, and functional specialization. These island hybrid distributed systems demonstrate remarkable resilience through redundancy and adaptation but face governance mismatches, as conventional approaches attempt to impose centralized models on distributed realities. This tension between traditional governance structures and the inherent nature of distributed systems gives rise to several key challenges, which the study identifies as five fundamental governance mismatches: regime-level focus versus multi-level reality, technical orientation versus socio-technical complexity, uniformity versus

diversity, stability versus adaptation, and centralized control versus distributed agency.

To address these governance mismatches, the paper suggests governance principles that better align with the Caribbean's water hybrid distributed reality, including recognizing diverse governance systems, clarifying boundaries, coordinating across scales, developing contextualized rules, and providing accessible conflict resolution. This reconceptualization shifts the discourse from viewing Caribbean water systems as vulnerable, developmental failures to recognizing them as contextually appropriate configurations with unique strengths that regional and national governance should embrace rather than undermine.



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Title

Effective Methods for Non-Revenue Water Reduction: Methods, Challenges and Recommendations

RI002

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Non-revenue water (NRW) symbolizes the water produced by utilities that does not generate revenue either due to physical losses, such as leaks, unauthorized consumption or inaccurate metering. Reducing NRW is essential for financial stability, environmental sustainability, and ensuring reliable and affordable water services for consumers. Neglecting NRW leads to economic losses, inefficient resource use, and increased financial burdens on utilities and consumers.

Financial and Operational Challenges

NRW causes revenue loss, costing utilities over \$14 billion annually, with a significant impact on developing regions. This financial strain can limit investment in infrastructure and maintenance. Additionally, operational costs rise due to wasted energy and resources in treating and pumping water that never reaches customers. Water utilities account for approximately 4% of global electricity consumption, meaning NRW significantly contributes to unnecessary energy expenses.

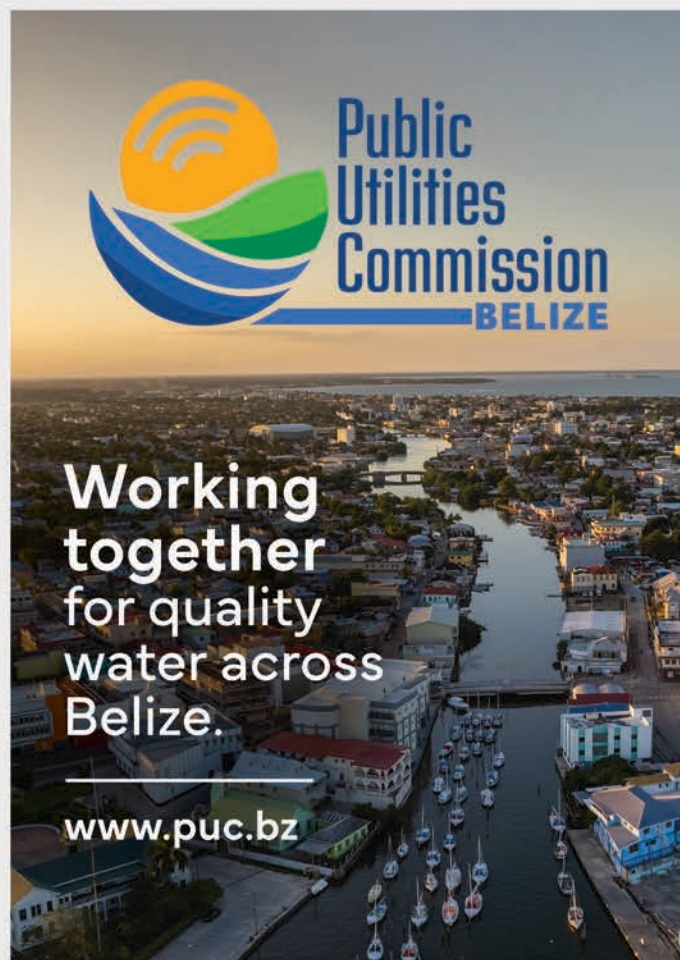
Environmental and Social Impacts

The excessive extraction of water to compensate for

NRW disrupts ecosystems, reduces river flow, and harms wildlife. Water loss also increases carbon emissions due to unnecessary energy use. Furthermore, high NRW levels lead to service disruptions, affecting daily life and business operations. Addressing NRW is critical for affordability and social equity, as utilities may raise rates to recover losses, making water less accessible for low-income households.

Strategic Solutions

To tackle NRW, utilities must implement leak detection, proactive monitoring, and data-driven strategies. Investing in infrastructure upgrades and leveraging advanced forecasting tools can enhance efficiency. Collaborating with industry experts and setting realistic goals ensures long-term success. NRW reduction is not just a responsibility, it is a strategic investment in water sustainability, financial viability, and equitable access to water for all.





Title
**Optimizing Coagulation at
Double Run Water Treatment
Plant: Polyaluminum Chloride Vs
aluminum Sulfate**
RI004

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Introduction

The use of coagulants in water treatment plants plays a crucial role in removing contaminants, improving water clarity, and ensuring safe drinking water. Polyaluminum chloride (PAC) and aluminum sulfate (alum) are two widely used coagulants in water treatment processes, particularly in large-scale facilities like Double-Run Water Treatment plant.

Study

The study aimed to compare the performance and efficiency of PAC and alum in water treatment under similar operational conditions. The analysis focuses on parameters such as coagulation efficiency, water quality impacts, chlorine demand, Aluminum residuals and cost-effectiveness.

PAC, a more advanced coagulant, has been shown to have superior performance in terms of coagulation at lower dosages. Additionally, PAC's ability to work effectively in a wider pH range contributes to its versatility in treating varying water qualities. On the other hand, alum, a more traditional coagulant, remains effective but typically requires higher doses and more frequent pH adjustment. The comparison also explores the impact of each coagulant on the overall treatment

plant's operational costs and water quality impact, focusing on water quality complaints, treated water production, chemical usage, and chlorine demand within the Belize City Distribution System.

Results

Results indicate that PAC outperforms alum in terms of efficiency, with lower operational costs and improved water quality by reducing customer complaints due to water quality issues. Assisted significantly in maintaining stable chlorine residuals throughout the Belize City distribution system and decreasing chlorine demand in filtered water. However, the higher initial cost of PAC remains a consideration for many treatment plants.

Recommendations

This abstract concludes by highlighting the importance of coagulant selection based on site-specific water quality conditions, economic constraints, and long-term environmental sustainability. Further research is suggested to optimize the use of PAC and alum in tandem or as part of a multi-stage treatment process to achieve optimal results in water treatment plants.

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Title

Water 2050 Sustainability Race to Net Zero Emissions - How Can We Select Options for Coating and Lining Water Tanks, Piping and Treatment Facilities to Reduce Carbon Now

RI005

Author

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In 2022, AWWA began a series of Think Tanks composed of influential leaders in the water industry tasked with establishing a long-term vision of the future of water. The first of these think tanks was “Water 2050 Sustainability”. This group emerged with 10 recommended actions encompassing four broad categories:

- Implement a new water utility paradigm
- Establish a climate resilient water future
- Define the value of water for a new reality
- Achieve circularity of water

Under the recommendation to “Implement a new water utility paradigm”, the Water 2050 Sustainability report stated, “With rising sea levels and warming temperatures globally, the water community must not only achieve a holistic “One Water” mindset, but it also must fully embrace energy production and emissions reduction as integral to its work.” One of the focus areas that the group established was a roadmap to “the race to net zero emissions”.

These initiatives will require a review of utility facility maintenance (water tanks, piping, treatment facilities) procedures – specifically coating and lining. Historically, coating and lining projects had some significant environmental impacts but technological advancements have significantly reduced these issues. This review will require FAR more than evaluating what is

in the bucket of paint, but true carbon emission reduction over the life of the structures must look at life cycle of the maintenance, application methods, amount of time to complete the maintenance as well as the contents of the bucket.

This presentation will provide a framework to evaluate and select the maintenance painting and lining option that moves toward zero carbon emissions.



Title

Desalination: A Resilient Water Solution for the Caribbean

RI006

Author

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In the face of increasing water stress in the Caribbean – driven by factors such as saltwater intrusion and climate change – desalination presents a critical pathway to long-term water security. This presentation highlights the experience of Seven Seas Water Group in deploying rapid-response desalination solutions through its renowned Water-as-a-Service® (WaaS®) model. Through this approach, the company designs, builds, finances, and operates water treatment facilities, allowing public and private clients to access high-quality water without upfront capital investment or operational risk.

Case studies from island and coastal communities illustrate how these systems enhance resilience by securing supply through advanced reverse osmosis technology. In one example, the Government of the British Virgin Islands partnered with Seven Seas to optimize plant efficiency, reduce water rates, and overcome infrastructure limitations to ensure a stable water supply. These insights are directly applicable to similarly challenged Caribbean contexts.

Seven Seas has also received Gold and Silver ratings from the United States Resiliency Council (USRC) for

infrastructure resilience and is ranked by GRESB for its sustainability performance. The presentation will further explore the energy-water nexus, including how the company integrates energy-efficient technologies and operates in areas with unstable power grids. It will conclude with reflections on the role of public-private partnerships in advancing climate-resilient water systems across the Caribbean.

Keywords: Water-as-a-Service®, Desalination, Climate Resilience, Sustainability



Title

Enhancing Reverse Osmosis Performance through Self-Cleaning Membrane Technologies: Efficiency Gains and Long-Term Cost Benefits

RI010

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Reverse osmosis (RO) is a vital technology for potable water production in island and coastal regions, yet membrane fouling remains a persistent challenge affecting operational reliability and cost efficiency. This study explores the implementation of self-cleaning membrane technologies in RO systems, emphasizing their performance improvements and long-term economic advantages, with contextual relevance to high-fouling environments such as San Pedro, Belize.

Self-cleaning membranes incorporate active and passive fouling control mechanisms, including hydrophilic surface coatings, vibration-induced detachment, and periodic backflushing. These designs significantly reduce biofouling, scaling, and particulate buildup, thereby minimizing the frequency of chemical clean-in-place (CIP) procedures. Although initial procurement costs are 1.5 to 3 times higher than conventional membranes, the life-cycle analysis over a five-year period demonstrates a substantial cost recovery. Notably, utilities report a 30–

40% reduction in operational expenditures due to extended membrane lifespan, decreased chemical usage, and reduced system downtime.

Field evaluations indicate that self-cleaning membranes maintain more consistent flux and salt rejection performance, especially in systems exposed to high organic loads or limited CIP infrastructure. This results in enhanced water recovery rates and improved system sustainability. The paper presents a comparative cost-efficiency model and outlines pilot implementation strategies suitable for small to mid-scale RO plants in the Caribbean.

The results support a strategic shift toward adopting self-cleaning membrane technologies in regional desalination operations. Recommendations are provided for phased integration, return-on-investment (ROI) analysis, and retrofitting guidance to improve system resilience, reduce environmental impact, and optimize long-term performance.

A vertical advertisement for Belize Bank's Open Banking Services. It features a woman in a blue shirt holding a tablet. The text includes the Belize Bank logo, the title 'OPEN BANKING SERVICES', a descriptive paragraph, and three API service boxes: E-Commerce API, E-Kyash Business API, and Bill Payment API. A QR code and 'SCAN TO LEARN MORE' text are at the bottom.

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Title

Integrated asset management: Enhancing Resilience and Efficiency in Water & Sanitation Utilities

RI012

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Water and sanitation utilities are under increasing pressure to provide reliable, efficient, and sustainable services amid aging infrastructure, inaccurate asset records, high non-revenue water (NRW), and climate-related risks. Traditional, fragmented, and reactive asset management approaches are no longer sufficient to address these complex challenges.

This paper advocates for a paradigm shift toward Integrated Asset Management (IAM), a strategic, organization-wide framework aligned with ISO 55000 principles. IAM supports optimal lifecycle management of infrastructure assets by aligning data, systems, and

processes to achieve defined service levels in a cost-effective, sustainable manner.

A core strength of modern IAM lies in its use of advanced machine learning (ML) technologies and seamless integration across utility operations. Connected with SCADA, IoT, and ERP systems, IAM enables a unified, intelligent infrastructure environment that supports predictive capabilities—such as early anomaly detection, adaptive maintenance planning, and performance analysis—while enhancing resource use, capital planning, customer service, and strategic decision-making.

The paper features the case of the National Water & Sewerage Authority (NAWASA) of Grenada, where a phased IAM implementation led by Hydro-Comp is underway as part of the Grenada Climate Resilience Water Sector (G-CREWS) Project. A comprehensive suite of EDAMS systems is being deployed, covering network data management, maintenance, fieldwork, operations, demand management, planning, and utility-wide analytics.

Although still mid-implementation, NAWASA has begun enhancing the quality and connectivity of its asset register, establishing a centralized data environment. Maintenance practices are transitioning from reactive to structured, proactive workflows, improving response times and infrastructure reliability. Early DMA analysis is supporting leak detection and NRW reduction. The commercial data evaluation component, already yielding insights, is identifying meter anomalies, unregistered consumption, and incorrect customer classifications—laying the groundwork for improved billing accuracy and revenue recovery.

These advances set the stage for more strategic investments, regulatory compliance, and long-term resilience in infrastructure management.



Title
**Utilizing Artificial Intelligence in
Water Distribution and
Wastewater Collection Analysis**
RI013

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Can Artificial Intelligence be applied to understanding
water distribution and wastewater collection patterns,

issues, predicative analysis, and decision-making? These areas will be discussed in the session plus how this technology can help utilities with cost control, rate determination, and increase customer satisfaction.

The use of sensors to measure and gather data in our industry has become increasingly common in recent years, leading to a wealth of information that can be harnessed to improve operations, reduce costs, and enhance customer satisfaction. That data is often from disparate sources and not organized in a manner that supports analysis across software platforms. With the help of machine learning and artificial intelligence, this data can be organized, normalized, and analyzed to make more informed decisions, identify patterns, and create predictive models that can drive better outcomes.

The session will delve into case studies that demonstrate the practical applications of this approach, as well as the challenges and opportunities that come with leveraging sensor data and AI in the utility industry. Attendees will gain a deeper understanding of the potential for artificial intelligence to drive innovation in the water and wastewater industry for utilities of all sizes.



CULTURE IS WHO AND WHAT WE ARE





Title

Hide and Leak: Proactively Pinpoint Hidden Leaks with Intrinsic Intelligence

RI014

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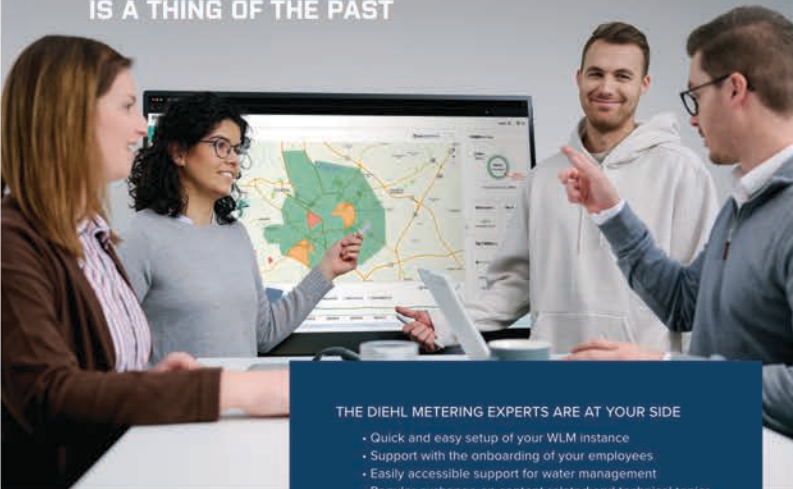
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Understanding the main drivers and total impacts of having a successful Non-Revenue Water Program will be presented.

All Utilities should have a Water Loss or Non-Revenue Water Program in place, however not all programs will be equal given Utilities around the world face unique challenges with size and type of service area and geographical impacts.

We are going to discuss a solution that truly captures the most return on investment for water utilities to address both apparent and real losses with a single device - a water meter. Integrated within the meter, with no external wires, is patented acoustic technology that continuously listens and records acoustic values every day for 20 years. Every water utility needs water meters. Why not install a water meter that can listen to Utility side distribution leaks at the very same time? Wouldn't a continuous and proactive solution for 20 years provide more payback than no solution? More accurate than lift and shift technologies with much greater lifetime? Doing away with the need for annual or quarterly surveys? All in the same RF network? Furthermore, we'll go over specific case studies from several utilities across the U.S. that have successfully used water meters to find not only service line leaks but leaks on mains as well - up

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to 14" water mains! Utilities are not only using the technology to be notified instantly of current and future leaks in their system but are able to significantly reduce costs because awareness is near real time and localization of leaks is easier as well. Water loss calculations are included within the intuitive software platform allowing all utilities to easily track, repair, and report on leaks to corresponding stakeholders, as applicable. There simply is no other solution that provides more return on investment for water utilities.



Sub Theme

Effective approaches to NRW reduction: Methods, Challenges, and Recommendations

Title

Static Water Meters:- The Smart Water Foundation

RI015

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The foundational element of any smart water system should be a static water meter, one that offers enhanced low flow detection and sustained accuracy. Static water meters not only offer a far wider and more precise measuring range than their mechanical counterparts, but its accuracy does not decline with age and use given there are no mechanical moving parts. Static water meters enable water utilities to be paid for every drop of water delivered to its customers. Static water meters enhance a water utility's ability to earn revenue to fund operational costs and future capital needs while maintaining positive community support by limiting rate increases. Combining these benefits of static water meters with today's communication technology and software capabilities and many water utilities are experiencing significant revenue increases along with operational efficiency savings. Real customer case studies and results will be shared to support the content presented.

An advertisement for Atlantic Bank. It features the bank's logo at the top left. Below it, a man in a white shirt and blue tie sits at a desk with a laptop, while a woman in a red shirt stands behind him. The text 'Bank on Your Success with a trusted financial partner' is on the left. A list of services is on the bottom left, and contact information is on the bottom right.

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Title

Examination of Non-Revenue Water Reduction Strategies: A Comparative Study of Barbados and Belize

RI016

Authors

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Non-revenue water (NRW) — water produced but lost before reaching customers — remains a major obstacle to water sustainability and economic growth across developing countries. Barbados, ranked among the world's most water-scarce nations, reports NRW levels of up to 45%, posing significant challenges to water resource management. In contrast, Belize has emerged as a regional leader, maintaining NRW at 24%. This study examines and compares the NRW reduction strategies implemented by the Barbados Water Authority (BWA) and Belize Water Services Limited (BWS). Qualitative data was collected through formal interviews with experts from BWA, BWS, and the Belize Utilities Public Commission, and analyzed using content and thematic analysis. Findings reveal that although both utilities have adopted similar strategies, Belize has successfully maintained low NRW levels over the past 15 years through proactive and preventative measures. Meanwhile, Barbados is advancing new initiatives that are either at the planning stage or early in implementation. Further research will be needed to evaluate the effectiveness of these strategies once fully operational.

Keywords: non-revenue water, water resource sustainability, Barbados, Belize



Title

Targeting Areas for Water Loss Control: Insights from Guam's District Metered Areas

RI020

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Water loss is a concern for many islands due to a variety of factors: aging infrastructure, largely unmetered consumption, and/or limited financial and operational resources. High water loss is particularly stressing on islands with constrained water supply sources. Islands challenged with high water loss and constrained supply sources can maximize the use of limited resources by identifying areas with the greatest water loss and targeting these areas for intervention.

Guam has historically faced high levels of water loss across the entire island. To prioritize the most challenged areas for water loss control intervention, Guam Waterworks Authority (GWA) worked with E Source to divide the island into smaller, discrete District Metered Areas (DMAs) with known points of inflow and outflow for water loss monitoring. Guam and E Source piloted the implementation of 3 DMAs five years ago. Water loss control interventions including manual acoustic leak detection were conducted in the most challenged DMAs. By identifying and repairing leaks discovered in these DMAs, Guam reduced its water loss in the short-term. As of now, Guam is actively monitoring over 10 DMAs. The DMA process has enabled Guam to narrow in on its water loss and continue to prioritize resources for targeted loss reduction.

This presentation will discuss Guam's implementation and use of DMAs to monitor and address water loss. Attendees will learn about the steps involved in DMA implementation and how this prioritized approach can significantly enhance water loss control efforts, particularly for resource-strapped regions with high water losses.

Keywords: non-revenue water, district metered areas, leakage, infrastructure



Title

Smart Metering Implementation: Key Considerations for choosing the proper system and meter type for your utility.

RI022

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Utilities evaluating smart metering systems and deployment methods face tremendous choices regarding the equipment they purchase. While historically many utilities have chosen systems based on the lowest upfront cost, many systems are now evaluating the best value over time as an alternate evaluation method. Traditional items of consideration include price and system functionality, while these are critical considerations, the utility must evaluate other areas to achieve the best long-term decision.

Additional considerations include ease of maintenance, system expandability, equipment lifespan, long-term accuracy, dynamic customer use profiles, warranty considerations, plumbing/ meter set modifications, and system obsolescence. We will examine the importance of these areas to evaluate these factors better when choosing which smart meter and system to select for a Smart Meter project. Thoroughly assessing a smart meter system from multiple points of evaluation and applying upfront and operational costs are the key determining factors for long-term project success.



Title

Cybersecurity for Water Utilities

RI025

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The security landscape of technology is rapidly changing whilst we continue to embrace the realm of the information age. Industry 5.0 has approached us fast and furious on a global scale and has forced us to reinvent and re-engineer in order to play the survival game, however, what is in it for this precious commodity called water. Breaches in cybersecurity are on the rise especially in water systems that are embedded with IoT sensors and devices which aid in the distribution of this precious commodity as well as real time processes. From network security to physical and even more now Cloud cybersecurity, cyber-attacks against water utilities have made cybersecurity a national dilemma. Imagine, water treatment processes having their chemical levels modified which can lead to possible water contamination resulting in public health risks. There are frameworks established as a guide which collectively contribute to fortifying security measures and safeguarding assets, premises, and individuals against potential threats and risks namely communication, control, cybersecurity, concealment and continuity. What of SOC compliance which will give that confidence and comfort. The numerous protocols and best practices that have been established that should be reviewed ever so often due to the varied changes in the landscape. Additionally, analysing the cyber risks involved and mitigating strategies must be developed, tested and implemented.

This paper delves into cybersecurity best practices to enhance the protection of water utilities and the safety of citizens. By executing robust security measures and collaboration, utilities can mitigate the risks associated with cyberattacks and ensure the continued delivery of safe and reliable water services. More and more we see the need to collaborate between utilities, government agencies and private sector companies to address the growing threat of cyberattacks. Bolster the resilience of water and waste water services.



Title

The Integration of IoT, RS, GIS and AI for Real-Time and Sustainable Management of Water Resources in the Caribbean

RI026

Author

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The daily activities of humans, plants and animals depend on the essential resource, water which highlights the importance of managing water sources. In light of population growth, drought, flooding and inconsistent rainfall patterns grappling the Caribbean, there is a growing need for efficient monitoring water resource in order to secure the quality and availability of water. This has led to research being conducted in order to find novel and innovative solutions to meet water demands and conserve the water resources.

There have been recent advancements in emerging technologies such as Remote Sensing (RS), Internet of Things (IoT), Artificial Intelligence (AI) and Geographical Information Systems (GIS) that have revolutionized water resource monitoring. They have significantly improved flood risk assessment, hydrologic modelling, rainfall prediction and groundwater forecasting.

These technologies can be combined to create a complete and real-time monitoring system. An IoT technology such as smart sensors are strategically placed in or near waterways to collect and monitor real-time data such as flow rates and fluctuations in water levels. Remote Sensing is essential for capturing real-time satellite data on water resources, rainfall patterns and changes in land use. This data is critical for determining the impact of human activities on water resources. The data from these technologies are then integrated into a GIS application where it is assessed and analyzed with the help of AI. This paper presents innovative technologies being used to monitor and improve the sustainable management of water resources such as rivers, dams and groundwater.



Title

Improving Operational Efficiency through Asset Management and GIS Software in the Corozal Distribution System

RI028

Author

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Introduction

Small Water Systems often face numerous challenges including funding, staffing, limited resources and aging infrastructure, making it difficult to upgrade and maintain systems. Innovation and technology, as well as asset management, play a pivotal role in the success and efficiency of water utilities. BWSL has adopted the technology required to remain competitive, whilst championing sustainable practices. This study highlights the improvements in operational efficiency in the Corozal Distribution System through Asset Management and GIS software.

Optimizing Operations and Maintenance

BWSL invested in software that would optimize operations, improve customer and stakeholder relations, whilst strengthening its foundation on the road towards a SMART water network. Two of them with very practical field applications that has resulted in improved efficiency.

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B. GIS

Includes the entire distribution network with a complete breakdown of mains, services, valves, DMZs.

Key advantages and supporting data that will be highlighted in this paper include:

- **Improved time management:** The ability to prioritize and administrate tasks, improve response time, monitor daily reports.
- **Enhancing asset performance:** Vehicles are used more efficiently by assigning tasks within routes, thus reducing mileage covered. Through daily preventative maintenance checklists, M&E department has upgraded its records and provide timely maintenance, quicker response time for emergency repairs.
- **Reducing NRW:** Through a more efficient time management of the operations staff, more time has been dedicated to leak detection resulting in further reducing NRW by 1.5%
- **Environmental Responsibility:** Continuing in its sustainable development path, this software has allowed to reduce printing of work orders by 90%, reducing BWS's usage of paper and carbon footprint.

Road Ahead

- Further develop other applications on ELEMENTS
- Expand SCADA coverage



Title

Bypassing use of Coagulants at Double Run Water Treatment Plant for Low Turbidity Conditions

RI029

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Introduction:

Water treatment Plants often face challenges in balancing the need for water treatment with operational efficiency, particularly during dry seasons when turbidity levels are naturally low. In conventional water treatment, coagulants such as Aluminium Sulphate (Alum) and Poly Aluminum Chloride (PAC) are used as coagulants for particle removal from source water. In Belize, normal dry season is from December to May, these conditions cause periods of low turbidity, where the application of Aluminium Sulphate or Poly Aluminum Chloride results in unnecessary chemical usage, increased costs, and potential environmental impacts.

Study Overview:

This study evaluates the feasibility of bypassing the use of Aluminum Sulphate or Poly Aluminium Chloride during periods of low turbidity at the Double Run Water Treatment Plant. By analyzing water quality parameters, operational data, and system performance, the study identifies specific conditions under which alum can be temporarily discontinued without compromising the safety and quality of treated water.

Key findings include:

- **Operational Efficiency:** Significant cost savings can be realized through reduced chemical usage.
- **Maintenance Benefits:** Less chemical input translates to reduced stress on infrastructure and lower maintenance demands.
- **Sustainability:** Seasonal adjustment of treatment protocols enhances long-term sustainability.
- **Projections:** A five-year model demonstrates the long-term benefits of this optimized strategy, including improved resource allocation and continued regulatory compliance.

Conclusion:

Bypassing coagulant use during low turbidity conditions presents a viable, sustainable, and cost-effective strategy for water treatment operations. This optimized approach not only ensures the delivery of safe drinking water but also aligns with goals of operational efficiency and environmental responsibility.



Title

Viavac Vacuflow®: Delivering Sanitary Sewer Systems with Lower Costs and Greater Operational Efficiency

RI030

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Viavac Vacuflow® offers a modern and cost-effective approach to wastewater collection through the use of municipal vacuum sewer systems, an alternative to conventional gravity networks that is particularly advantageous in areas with flat terrain, high water tables, or environmental constraints.

This abstract presents Viavac's technical concept and its proven application in Caribbean and Latin- American countries such as Mexico, Costa Rica and Puerto Rico. Unlike gravity systems that require deep excavation, complex topographic alignment, and multiple lift stations, Viavac uses shallow, sealed piping connected to centralized vacuum stations. This results in significantly reduced excavation depth, faster installation, and a notable decrease in infiltration and exfiltration risks.

Real-world project data demonstrates reductions in capital expenditure of up to 40%, alongside long- term operational benefits such as lower energy use and minimal maintenance demands. These systems have been successfully integrated in both new developments and retrofits of failing gravity infrastructure, often in coastal or flood-prone regions where conventional systems are technically or financially unfeasible.

The presentation will cover engineering principles, hydraulic behavior, system components, and implementation strategies that utility operators and planners can adopt. Viavac's vacuum sewer technology aligns with the broader goals of infrastructure resilience, sustainability, and energy efficiency, making it a strong candidate for regional replication throughout the Caribbean and Latin America.

By rethinking how wastewater can be collected and conveyed, Viavac contributes directly to building smarter, leaner, and more adaptable urban infrastructure.

Keywords: municipal vacuum sewer, high water table, cost-efficient infrastructure, wastewater innovation



Title

Digital Transformation in Utility Management: Achieving Operational Excellence with Elements XS at Belize Water Services

RI034

Author

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Belize Water Services Limited, the national water utility provider for Belize, recently implemented Elements XS, an advanced asset management system by Novotx, to revolutionize its service order management processes. This transition from manual paper based service orders to electronic service orders represents a significant innovative stride in operational efficiency, data accuracy, and service quality. This paper explores the challenges in the legacy system, the rationale behind adopting Elements XS, and the transformational outcomes achieved through its implementation.

The adoption of Elements XS was driven by the need to streamline workflows, reduce operational delays, and improve customer satisfaction. The system's capabilities, including real time tracking, enhanced reporting, and integration with existing platforms like the new Customer Relationship Management system and GIS, have proven instrumental in achieving these objectives. By digitizing service orders, BWS has reduced processing times, minimized errors, and improved accountability. Furthermore, the elimination of paper orders has contributed to environmental sustainability by reducing the company's carbon footprint.

This paper presents a comparative quantitative and qualitative analysis of the pre and post implementation performance metrics, demonstrating significant improvements in service delivery times, customer communication, and employee efficiency. It highlights the implementation process, emphasizing the training and adaptation required to transition employees to a digital platform. Key benefits to employees, such as streamlined workflows and reduced administrative burdens, are discussed alongside the broader organizational gains, including enhanced decision making capabilities and cost savings.

The paper highlights the operational and customer benefits of Elements XS, including faster service resolutions and improved transparency via electronic updates. It examines rollout challenges like resistance to change and technical hurdles, offering a comprehensive view of the transition. Concluding with lessons learned, it explores opportunities to further optimize operations and support Belize Water Services' sustainability goals, positioning BWS as a model for Caribbean utilities pursuing digital transformation.



Title
Optimizing Operations and Maintenance
RI035

Author
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This study aims to examine how operational changes in Reverse Osmosis (RO) water treatment plant can have huge effects on efficiency and membrane lifespan, resulting in huge financial savings. This paper will explore operational changes that were done at the RO plant here in San Pedro, Belize, and analyze the results, hoping that it can be helpful to other plant across the region.

At the heart of the RO plant is the membrane. We have made changes that resulted in reduced membrane fouling and membrane lifespan improving from 22 months to over 7 years. This was done through research and projects, including membrane autopsy, feed water analysis, modifying piping for feed and permeate lines, among others. Other improvements were seen in the reduction in pre and post treatment chemicals, less filtration, and less need for membrane cleaning and replacement, which is labor intensive. The project was a tremendous success. It clearly shows how small operational changes can result in tremendous savings for the company in material, energy, and labor, overall improving plant operational and maintenance efficiency.

At the core of the issue was to identify foulant in feed water, which was Iron and Hydrogen Sulfide, separating them, and treating each individually, or providing an environment where minimal treatment was necessary.

This study also serves to enlighten RO plant operators and managers in detecting potential problems early and addressing them to avoid making costly mistakes.



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Title

Innovative and Resilient Water Infrastructure for Sustainable Utility Operations Transforming and Upscaling Data into Information for Improved Monitoring and Operations

RI037

Author

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Digital transformation can provide significant benefit to utilities as they aim to meet the expectations of a connected constituent by offering 24/7 access to online interactions and information. This helps accomplish the promise of digital transformation; making our day-to-day work more efficient and effective. Within utilities, the digitalization is helping engineers, operators, maintenance and other functional departments to optimize their processes, better utilize capacity and resources and meet increasingly rigorous regulatory requirements. Many utilities have determined that to manage their assets effectively and be able to have metrics for internal and external customers, **a transformation of its' current technology stack was needed.** A solution required to take the organization to a platform that will better streamline and integrate all Operations and Maintenance (O&M), capital assessment and geospatial activities. Having end user involvement from inception through business process redesign, leading configuration workshops and defining the criteria for user acceptance testing is crucial in the adoption of the system and delivery of usable information about life cycle costs and workforce - internal vs. external demands. Leveraging machine learning for decision-making tasks: a walkthrough of how water utilities can maximize information and data available to make better decisions while enhancing service delivery; optimizing capital investment (CAPEX); and reducing operating costs (OPEX), including social and environmental external factors. Digital Twin concept

is more than just a real-time visual replication, but includes hydraulic modelling that allows managers and operators to have a holistic view of the system operating and predictive state to improve decision making and operations based on data integrations coming from multiple systems and technologies, including SCADA, GIS, sensors, work order systems, etc. The modular nature of the solution allows teams to customize critical paradigms, ensuring that the insights seen on the platform support the needs of the organization.

KEYWORDS

- Asset Management
- Digital Twin
- GIS Centric environment
- Single environment for visualization



Title

Implementation of On-site generation of mixed oxidant technology at the Caye Caulker water treatment plant

RI038

Author

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The distribution of safe, potable water is fundamental to modern public health. A key component of ensuring water safety is disinfection, which aims to eliminate pathogenic microorganisms responsible for waterborne diseases [1]. Chlorination is the near universal method of disinfection; a fact that can be attributed to its practicality and proven effectiveness over recent decades [1]. However, chlorination techniques can vary significantly in their application and implementation.

The island of Caye Caulker, Belize C.A. is home to around 3,000 residents [2] whose water is treated via a Reverse Osmosis (RO) process that utilizes raw water obtained from beach wells. Historically, this water would be disinfected with a solution derived from dissolved

calcium hypochlorite before being stored in the plant reservoir. This method is acceptable; however, some improvements were possible with the use of On-site generation (OSG) technology, namely: improvements in the organoleptic properties of the product water, a reduction in operational costs and a decrease in employee exposure to dangerous chemicals. A pilot project aimed at achieving these benefits was executed by BWS in Caye Caulker starting in March of 2024.

Since then, the bulk of water disinfection at Caye Caulker has been achieved via dosing the product water with a mixed oxidant solution generated on-site. As a result, the residual chlorine readings taken along the distribution network have stabilized with the standard deviation decreasing from 0.618 to 0.230 for the month of June (2024 vs 2023). This improved consistency enhancing regulatory compliance as the operators have more precise control over residual chlorine levels, and it enables quicker identification of anomalies. Operational costs have fallen approximately 17% Year-over-year and operators no longer need to be exposed to corrosive sodium hypochlorite.

The pilot project has achieved tangible results which translate to benefits for BWS and the Caye Caulker community at large — outcomes that support broader implementation of OSG systems in similar settings.

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Title
Implementation of Smart Meters
to improve BWS's operational
performance in San Pedro, Belize

RI038

Author
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This paper examines the implementation of a smart water meter pilot project in San Pedro, Belize, and evaluates its potential to enhance the operational performance of Belize Water Services (BWS) within this service area.

High production and operational costs in San Pedro pose persistent challenges for BWS. This pilot project investigates how smart meters, capable of providing real-time, remote water usage data, can address these issues. Key performance indicators include anticipated reductions in NRW, increased revenue collection due to enhanced meter-reading accuracy, cost savings from reduced operations such as decreased manual meter reading and inspections, and improved water conservation outcomes.

Preliminary findings suggest that smart meters offer substantial potential for improving utility operations. They enable more accurate consumption monitoring, reduce the need for physical inspections, and support early leak detection, contributing to a reduction in NRW, and, by extension, a reduced impact on cost of production. Additionally, automated data collection systems enhance billing transparency and customer trust, which may positively affect revenue recovery in the long term. These operational benefits align with broader environmental and economic sustainability goals through increased resilience to climate-change-driven water scarcity.

The project contributes to the growing interest in smart infrastructure in utility management and highlights the relevance of scalable, tech-enabled solutions for small utilities in developing regions. Additionally, this project provides a critical foundation for assessing its feasibility and expected impacts and outcomes for broader replicability across Belize and similar contexts in Central America and the Caribbean.

Keywords: AMI, Smart meters, NRW, Operational efficiency



Title

Digital Compliance & Quality Protection Roadmap for CARICOM Groundwater PERMITTING: WATER SUPPLY UTILITY OPERATIONAL EFFICIENCY

RI041

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Many CARICOM jurisdictions, including Barbados, lack a **standardized and transparent groundwater quality permitting framework**, resulting in inconsistent submissions, manual errors, prolonged review cycles, and diminished stakeholder confidence^{1,2,3}. Concurrently, water supply utilities need robust internal compliance tools and improved operational workflows to manage groundwater resources effectively. A non-binding, open-source digital compliance roadmap serves dual purposes: support for individual CARICOM states permit submissions and streamlining of internal compliance

monitoring and operational reporting for national water utilities. The framework integrates **automated workflows** (FloPy-driven solute transport modelling, GIS ingestion via GDAL/Fiona, python-docx report templating) with a desktop application and flexible AI guidance via a Gemini API or on-premise models. To illustrate the framework's capabilities, this paper describes a hypothetical pilot scenario. Using the Barbados Water Authority solely as a model for this example, the scenario outlines the framework's end-to-end processing capabilities; data ingestion and validation, automated model runs for baseline, projected, and mitigation scenarios, GIS map generation (e.g., drawdown and salinity contours), and auto-populated permit application and technical report. The AI guidance component is designed for adaptability; during prototyping or where cloud connectivity and GPU support are available, users leverage a **Gemini API** for real-time regulatory workflow Q&A; where strict confidentiality or government security requirements apply, the same guidance modules can be deployed on-premise using local AI models and hardware, ensuring data never leaves secure networks. The implementation roadmap outlines a phased approach; interagency workgroup formation, tool customization, parallel pilot deployment, capacity-building workshops, and full rollout with quality assurance metrics. Anticipated benefits include approximately **60-70% reduction in consultant preparation time**, substantial decreases in submission errors, enhanced data integrity via reproducible audit logs, and increased transparency and trust among regulators and communities. By aligning with CARICOM broader commitments to **environmental stewardship, integrated water resources management, and climate resilience**⁴, this approach strengthens groundwater governance through efficient, reproducible, and secure digital processes. Recommendations include circulating the draft framework for government review, executing a proof-of-concept pilot, establishing a CARICOM user group for knowledge exchange, and planning future integration of real time monitoring data alongside adaptable AI deployment for ongoing compliance.

Keywords: Groundwater permitting; Automation; AI guidance; Caribbean resilience.



Title

Hardening OT Systems: Cybersecurity in Water Treatment and Distribution

RI042

Authors

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In today's world, water treatment and distribution plants rely heavily on the implementation of technology for automation, data acquisition, remote operations, and system monitoring. This technology, known as Operational Technology (OT), includes components such as programmable logic controllers (PLCs), human-machine interfaces (HMIs), remote terminal units (RTUs), and SCADA (Supervisory Control and Data Acquisition) platforms. While these tools enhance the efficiency and reliability of water services, they also introduce significant cybersecurity risks.

Modern OT networks now demand connectivity between regions over private or public networks, and this creates potential pathways for unwanted access into a plant's architecture. Apart from connectivity, many OT hardware modules are now considered legacy units due to their creation decades ago and therefore were not manufactured with cybersecurity in mind.

These older modules are vulnerable to cyber-attacks which then could result in disruption of water supplies, infrastructure damage and water contamination throughout regions that can endanger the community. Therefore, when OT networks are implemented, cybersecurity must be considered to assure hardening and protection from any unwanted access to the infrastructure.

Hardening of OT networks consists of adopting and following frameworks designed to protect these architectures. Many of the proper procedures include implementation of firewalls and demilitarized zones to reduce the attack surface. Having an OT network separated from the IT network is now a must as well as implementations of micro-segmentation, strong passwords with multi factor authentication, cyber monitoring, proper personnel permissions, intrusion detections and having regular vulnerability assessments.

Hardening OT systems safeguards the integrity of water infrastructure and protects the communities they serve. Proactive measures are far more effective than reactive ones. Waiting for an incident to act could result in irreversible damage. Cybersecurity must be embedded from the start to ensure safe, continuous, and resilient water operations.

A close-up photograph of two hands being washed under a stream of water. The water is splashing, creating many small droplets and bubbles. The background is dark and out of focus, with some green foliage visible in the upper left corner. The overall tone is clean and fresh.

THEME 3

Ensuring Clean Water and Sanitation Through Effective Wastewater Treatment and Pollution Control (WS)



Title

Introduction to Pressure Sewer Systems

WS002

Author

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Pressure Sewer Systems (PSS) have become increasingly common in today's society. Pressure Sewer systems are no longer just an "alternative" to gravity fed sewer collection systems but rather the "appropriate" solution for collection systems around the country and globe. Traditionally, pressure sewer systems have been used to provide sewer service to areas where gravity sewer could not be installed, or the cost to do so was prohibitive. Now, pressure sewer systems are gaining widespread acceptance in providing a viable, sustainable, and cost-effective solution to expensive traditional gravity systems and shrinking O&M budgets. PSS has paved the way to a more "Green" solution to troubled existing septic systems or potential gravity system leaks that have threatened our waterways in recent times.

A key component of the system reliability is self-cleansing piping system. Pipe scouring velocity is achieved by realistic current and future flow estimates, proper pipe sizing. And use of piping equipment that will provide adequate velocity. When flows do not meet the expectations, problematic issues develop.

With the advances in trenchless technologies for economic pipe installation, reduction in I/I, protection of waterways due to closed system design, system design flexibility, reduced plant treatment footprint, pump and related equipment advances in the past decade, all promote an alternative collection system as a preference over traditional gravity in many applications.

Presentation will provide an introduction of pressure sewer systems, the application of pressure sewer systems, and system design practices.



Title

Building Resilience and Public Trust Through Integrated Water Quality Monitoring.

WS003

Author

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As Caribbean utilities face rising challenges related to climate change, urbanization, and aging infrastructure, water quality monitoring has become a critical tool for protecting public health and improving service delivery. The need for integrated, responsive, and data-driven monitoring systems is more urgent than ever.

This presentation will explore a comprehensive water quality monitoring strategy implemented by a Caribbean utility, highlighting the use of real-time technologies, expanded sampling programs, and community engagement efforts. The utility has upgraded its online monitoring systems at storage sites with multi-parameter meters tied into SCADA, providing 24/7 surveillance. A pilot is also underway to monitor directly from the distribution mains, with plans for expansion if results prove reliable.

Beyond real-time data, the utility maintains routine sampling at key locations across the network, utilizes a Laboratory Information Management System (LIMS) for efficient analysis, and partners with an accredited third-party laboratory for quarterly extended parameter testing. New, more robust sampling stations have also been approved and are set to be installed to further improve access and accuracy.

The session will also highlight public outreach and education initiatives—through school engagement and community programs—that help build awareness and trust around water quality. In addition, protocols for customer complaint resolution, residential testing, and proper commissioning of new mains reinforce a culture of accountability and responsiveness.

Attendees will gain insight into how a layered monitoring framework—combining technology, policy, and public involvement—can strengthen operational resilience and support regional efforts to meet Sustainable Development Goal 6: Clean Water and Sanitation.

Keywords: Water Quality Monitoring, Real-Time Data, Public Health, Distribution Management



Title

Closing the Water Cycle Through Efficient and Innovative Technologies

WS004

Author

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Water scarcity and the increasing pressures of climate variability demand resilient and efficient wastewater treatment strategies—particularly in small island developing states (SIDS), where conventional water resources are limited. This paper explores a regional pathway for “closing the water cycle” by advancing wastewater reuse through the integration of innovative treatment technologies tailored for island environments.

Drawing on the 3R's CReWS Barbados Feasibility Report and pilot designs implemented across the Caribbean, this presentation highlights the role of high-efficiency tertiary treatment technologies—such as membrane bioreactors (MBRs), modular systems, and decentralized approaches—in enabling wastewater to be reclaimed for non-potable uses such as irrigation, toilet flushing, and industrial processes. It also examines how intelligent monitoring, energy optimization, and compact system footprints support scalable reuse infrastructure within dense coastal developments.

Case studies from Barbados and other regional projects

demonstrate significant reductions in effluent discharge, nutrient loads, and potable water demand. The technical, economic, and regulatory lessons presented are relevant to both the private and public sectors, including utilities, regulators, and hospitality sector stakeholders seeking to implement circular water strategies that align with SDG 6 and national development priorities.

Ultimately, this paper advocates for a paradigm shift—from wastewater as a liability to water as a service that generates revenue—by enabling clean, reliable, and resource-conscious reuse that strengthens long-term water security in the Caribbean.



Title

Selecting the Right Wastewater Pump

WS005

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This technical session will provide the attendee with a comprehensive overview of the types of wastewater collection pumps and advancements in the designs of those pumps. The attendee will learn about non-clog, chopper, scroll, and grinder pumps, including submersible and dry-pit configurations. We will cover how to read a pump curve and select the right pump for the correct application. The basics of submersible electric motors and pump sensors will be discussed. The session will also cover pressure sewer wastewater collection design and include discussion of changes to the modern-day waste stream, as well as short videos of the different types of pumps. Some topics include - Industry Changes & Trends, Existing Solutions, Future Industry Outlook, New Technology & Equipment, and Waste Handling Methods.

Keywords: Pump, chopper, non-clog, grinder



Title

Comparative Analysis of PFAS Treatment Technologies: Evaluating Ion Exchange, Granular Activated Carbon, and Reverse Osmosis for Cost-Effective Environmental Remediation

WS007

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Per- and polyfluoroalkyl substances (PFAS) are a group of synthetic chemicals that have been widely used in consumer products and industrial applications since the 1940s. These persistent organic pollutants, often called 'forever chemicals,' are characterized by strong carbon-fluorine bonds, making them highly resistant to degradation in the environment. This presentation explores PFAS contamination and three primary treatment technologies. Ion exchange technology effectively removes PFAS through selective binding with specialized resins, offering high removal efficiency. Granular Activated Carbon (GAC) adsorption provides a versatile treatment option by capturing PFAS molecules within its porous structure. Reverse Osmosis demonstrated excellent PFAS removal through a semi-permeable membrane technology, achieving up to 99% removal, with the PFAS being concentrated into a small concentrate stream. At generally 10-15% of feed flow rate, this concentrate stream can then be treated or disposed of.

Each technology presents unique advantages and limitations in terms of cost, operational complexity, and treatment efficiency, requiring careful consideration for site-specific applications. Understanding the life cycle costs of these treatment technologies is crucial for sustainable implementation. This presentation will delve into a detailed comparison of each technology's specific advantages and disadvantages.

This presentation will analyze the comprehensive financial implications, including initial capital investment, operational expenses, maintenance requirements, media replacement frequencies and disposal costs. By examining these factors alongside effective treatment effectiveness, stakeholders can make informed decisions that balance both economic and environmental considerations for long-term PFAS remediation strategies.

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Title

Performance Evaluation of a Pilot Vetiver-Based Constructed Wetland for Landfill Leachate Remediation in Trinidad

WS009

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Landfill leachate presents a serious environmental risk due to its complex mixture of organic, inorganic, and toxic pollutants. Constructed wetlands (CWs) offer a sustainable, nature-based solution by leveraging plant-microbe interactions to degrade contaminants. This report evaluates the performance of a pilot horizontal subsurface flow constructed wetland (HSSFCW) deployed at the Forres Park Landfill in Trinidad from January to November 2024. The system, sized at 13 m × 7 m × 1.5 m, treated an estimated 200–330 cubic meters of leachate per day from an adjacent drainage pond.

Initial treatment efficiencies were modest, generally below 50%, reflecting the early stages of microbial community establishment. From August onward, a sharp improvement in removal rates was observed, coinciding with system clogging that increased the hydraulic retention time to an estimated 11 days. By November 2024, the system achieved over 90% removal of chemical oxygen demand (COD), total organic carbon (TOC), and ammonia-nitrogen, and 70–90% removal of total suspended solids (TSS), chromium, copper, nickel, and zinc.

These results demonstrate that nature-based solutions

have the real capacity to address industrial wastewater challenges. Biological activity within the wetland system effectively degraded contaminants over time, even though the full intended mechanism—vetiver root-mediated filtration—was not yet realized due to incomplete root penetration into the substrate. The project highlights the ability of living systems to solve real problems, while also acknowledging the need for continued optimization to fully integrate vetiver root functions under more dynamic flow conditions.

Keywords: Constructed Wetlands, Landfill Leachate, Vetiver Grass, Wastewater Treatment



Figure 1. A) Drone shot of Constructed Wetland, note overflow pipe passing on surface of wetland. B) CW after installation of vetiver plants on 19th January 2024. Note 6 vertical perforated pipes for air flow/access into the substrate. C) CW on 5th June 2024, note the growth of vetiver grass.



Figure 2. Visual comparison of Constructed Wetland treated leachate (left test tube) vs untreated leachate (right test tube) November 2024



Title

Integrating Nature-based Solutions and Infrastructure Upgrades to Combat Land- Based Pollution and Hypoxia Risk in Trinidad's Caroni Swamp

WS011

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The Caroni Swamp, a Ramar site of critical ecological importance in Trinidad and Tobago, faces severe degradation from land-based pollution sources, notably leachate and effluent from the adjacent Beetham Landfill and its associated Wastewater Stabilization Ponds (WSP). This influx of contaminants, including nutrients, hydrocarbons, and microplastics, degrades water quality, threatens biodiversity, and significantly elevates the risk of marine hypoxia in receiving coastal waters. Addressing this challenge is crucial for ecosystem health and aligns with the goals of the Global Environmental Facility's Clean and Healthy Ocean (CHO) Integrated Program. This paper presents an innovative

project designed to mitigate pollution impacts on the Caroni Swamp through a multi-component, integrated strategy. Key interventions include enhanced operational practices, sustainable nitrogen management, and integration of constructed wetland systems for leachate treatment. Critically, the project also addresses significant gaps within the existing policy and legislative frameworks. It aims to develop and strengthen comprehensive wastewater management policies and harmonise fragmented regulations, creating clear enforcement protocols and incentives to encourage private sector participation in pollution mitigation. This multi-faceted approach seeks to dramatically reduce pollution loads entering the Caroni Swamp and the adjacent Gulf of Paria, mitigating marine hypoxia, conserving biodiversity, and fostering ecosystem recovery. Furthermore, the project's integration of NbS alongside traditional infrastructure improvements and robust policy and legislative reforms represents an innovative model for sustainable environmental management aligned with circular economy principles. The project offers a holistic solution to substantially reduce contaminant loads entering the Caroni Swamp, decrease the threat of hypoxia, protect vital habitats, and offer a scalable model for addressing complex land-sea pollution interfaces in sensitive tropical ecosystems.

Key Words: Marine Hypoxia, leachate treatment, Nature-based systems (NbS), circular economy

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Title

A System Dynamics Framework for Enhanced Wastewater Management in Barbados

WS012

Authors

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Wastewater, a by-product of various human activities utilizing water, poses significant environmental and public health challenges worldwide. Many Caribbean Small Island Developing States rely heavily on tourism for economic growth, with the industry's success closely tied to the health of marine ecosystems. However, the discharge of nitrogen and phosphorus from domestic and agricultural wastewater is degrading coral reefs—vital natural assets that underpin the economic stability of these nations. In Barbados, the climate crisis will continue to cause significant threats to water security, therefore, supply enhancement strategies, such as wastewater reuse are critical to sustainable development. At present the only 10% of the islands wastewater is treated through two centralized system, the Bridgetown and South Coast Sewerage treatment plants, while at the same time wastewater reuse is quickly coming on stream. The aim of this study is two-fold: (i) to explore the challenges and opportunities of wastewater reuse in Barbados, and (ii) to apply systems thinking to understand how more effective policies can

be developed in the face of climate risks and societal attitudes influence national water security. The study also evaluates the implications of the 2023 Water Reuse Act, which provides regulatory framework for non-potable reuse applications such as irrigation and aquifer recharge. Key barriers include the “yuck factor,” limited public education, infrastructural constraints, particularly for households not connected to centralized treatment plants. A novel system thinking framework is developed to model the interconnections between climate risk, public trust and reuse adoption, offering insights into how public education and institutional transparency can mitigate resistance. The study concludes with policy recommendations and a proposed framework for optimizing wastewater reuse in Barbados, contribution to regional efforts in sustainable water management and climate resilience.

Key Words: Wastewater Reuse, Systems thinking, Climate resilience, Public perception

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Title

Water Crisis as a Result of Human Rights Violations in the Gaza Strip

WS013

Author

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Water shortage is continuously impacting the public health of citizens in the Gaza Strip, and this is a direct result of human rights violations orchestrated by the Israeli government's military occupation and forced displacement of Palestinians in Gaza and the West Bank. The lack of proper wastewater sanitation and, consequently, shortage of potable water is causing hazardous waste to pour into the Mediterranean Sea, due to untreated sewage flow, which spawns completely avoidable health issues that arise from waterborne diseases and other illnesses. Safe drinking water is not only a necessity but a basic human right.

A. History

1. Military Occupation: Israeli government's military occupation of the Gaza Strip and the West Bank.
2. Displacement: Forced displacement of Palestinians.

B. Destruction of Water Infrastructure

Waterborne Diseases: Destruction of wastewater collection systems have caused waste management issues, which creates unbearable living conditions and preventable illness and disease.

Water Shortage: Cutting of electrical flow to the Gaza strip has disrupted the desalination process and prevented access to clean drinking water. Due to over pumping and seawater seepage there is limited water safe for human consumption and hygienic purposes.

C. Human Rights Violations

Energy Manipulation: Manipulation of energy is used as a military tactic, limiting the amount of electricity shared with Gaza residents.

Genocide: Land confiscation, illegal settlement, forced displacement, apartheid system and genocide are some of the many human rights violations provoked by the Israeli government.

Summary

No one is free until everyone is free. It is a luxury for those that can brush their teeth in the morning and have a bed to rest their heads on at night. Basic human rights should be accessible to everyone, and proper infrastructures are necessary for safe human development. From the River to the Sea.

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THEME 4

Promoting Sustainability Through Effective Solid Waste Management (SW)



Title

Implementing Circular Economy Solutions for Plastic Waste Reduction: Insights from the PROMAR Pilot Case in Guyana SW001

Author

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Marine litter, particularly plastic waste from terrestrial sources, continues to pose a severe threat to coastal and marine ecosystems in the Caribbean region. As part of the regional "Prevention of Marine Litter in the Caribbean Sea (PROMAR)" initiative, the University of Guyana's Faculty of Earth and Environmental Sciences is implementing the PROMAR project, focused on piloting circular economy solutions for solid waste management. This paper presents the design, methodology, and preliminary outcomes of a pilot case aimed at reducing the volume of plastic waste entering aquatic environments through integrated stakeholder engagement, behavioural assessments, and waste monitoring strategies.

Through a combination of focus group interviews, citizen science-based data collection, behavioural surveys, and policy reviews, the project fosters a participatory waste management system tailored to the local context. By

incorporating the principles of the three Rs (Reduce, Reuse, Recycle) and promoting biodegradable alternatives, the intervention targets measurable reductions in plastic waste at the demonstration site. The findings highlight the critical role of community engagement, data-driven decision-making, and policy adaptation in promoting sustainability and effective solid waste management. Lessons learned from this pilot are intended to inform scalable, region-wide efforts to transition towards circular economy practices and enhance the resilience of Caribbean coastal systems against plastic pollution.

Keyword: Circular economy; Marine litter; Plastic waste management; Stakeholder engagement; Sustainability

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Title

Using Wind and Plants to Help Solve Leachate Dilemmas: On-Site Nature-Based Solutions for Liquid Waste Management **SW002**

Authors

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Two nature-based leachate management solutions have become strong, cost-effective options for landfills in North America: Wind-Aided Intensified eVaporation (WAIV®) and plant-based Phyto-Utilization™. WAIV® is often called a vertical evaporation pond because it allows for high volumes of evaporation via air flow within a small footprint. Phyto-Utilization™ uses fast-growing and non-invasive plants to consume liquid waste to greatly reduce or eliminate the need for other disposal methods.

WAIV® creates a large amount of wetted evaporative surface area in a small area or within a shipping container where natural wind or fan air flow intensifies evaporation. This is accomplished by installing a

horizontal array of vertically mounted 'sails' on a rigid frame. Leachate is distributed across the top of each sail and the liquid spreads over the fabric due to its specialized properties. Then wind passing through the wetted sails causes significant evaporation.

WAIV® is different from other evaporative technologies because no droplets, mists, or aerosols are sprayed into the air, and it is not a thermal-based approach, so no supplemental fuel is required. The proprietary technology has been demonstrated in a pilot unit at landfills across the US in order to correlate and confirm predictive data modeling. The trials have shown that WAIV® can operate in a variety of climates, including humid areas.

Another nature-based system available for landfills is Phyto-Utilization™. Leachate is distributed to a field of specialized, non-invasive plants or trees to consume the liquid on-site. The leachate is used as a resource, with the liquid utilized as moisture and the contaminants as micro and macro nutrients.

Phyto-Utilization™ reduces a facility's carbon footprint by sequestering CO2 and avoiding tanker truck emissions or other treatment and disposal processes. The technology has won national and international awards, including from the King of Thailand for its use of vetiver grass.

Keywords: leachate, landfills, wastewater, sustainability



Title

Evaluating the Impact of Biochar Application derived from Sewage Sludge on Bok Choy Growth and Soil Quality in Belize

SW005

Authors

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This study investigated the effects of sewage sludge and sewage sludge-derived biochar on the growth of bok choy (*Brassica rapa* subsp. *chinensis*) and soil quality in three distinct tropical soil types in Belize. A three-way factorial experiment was conducted in a controlled greenhouse setting, evaluating the interactions between soil type (clay loam, loam, sandy silt loam), amendment type (control, sewage sludge, and biochar), and application rates (1% and 3% by weight). A total of 144 experimental units were monitored for plant growth metrics including leaf count, height, biomass, and root development. Soil properties such as pH, organic matter, and nutrient content (NPK) were also analyzed before and after the growth cycle. Data were statistically analyzed using ANOVA and regression to determine treatment effects and optimal application rates. The

project aimed to assess whether biochar-amended soils could significantly enhance bok choy productivity and soil health, providing a sustainable approach to sludge management, agricultural intensification, and implementing a circular economy for Belize Water Services Ltd.

Keywords: Biochar, Sewage sludge, Soil quality, Circular Economy





Title

Unlocking the Potential of Organic Waste in SIDS: Lessons from the Recycle Organics Program

SW006

Author

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Organic waste plays a dual role in many countries. On one hand, it contributes to mounting challenges due to population growth, inadequate waste management practices, and the accumulation of large volumes of waste. On the other, it holds significant potential when properly valorized. Since 2023, the Recycle Organics (RO) Program has been active in six Small Island Developing States (SIDS) across the Caribbean and Pacific, showcasing the transformative potential of organic

waste through the development of municipal organic waste management plans, and the implementation of home and school-based composting programs. These innovations demonstrate how decentralized, community-driven solutions can complement formal waste systems. This paper presents case studies illustrating the diverse realities and needs across participating SIDS – Belize, Fiji, Grenada, Guyana, Saint Lucia and Samoa. It highlights the program's role in addressing two critical challenges: (1) the waste sector accounts for approximately 20% of methane (CH₄) emissions, and (2) organic waste represents between 42% and 47% of total municipal solid waste in many of these countries. By turning waste into a resource, the program contributes to reducing waste volumes requiring final disposal, extending landfill lifespans, and mitigating greenhouse gas emissions. Additionally, the production and use of compost supports soil restoration, local agricultural resilience, and food security, while also promoting green job creation and community co-creation spaces. Preliminary results from the interventions include the delivery of 1,058 composting bins to more than 24 communities since August 2024. Preliminary results from monitoring campaigns as of May 2025 estimate the diversion of 15.7 tonnes of organic waste in 4 communities in Belize. Moreover, the paper identifies key challenges and enablers and offers lessons for applying the valorization of organic waste with a community-based approach and providing a solution to reduce the amount of waste that needs to be managed and disposed.

Key words: Organic waste | Composting | Community | Small Island Developing States (SIDS)

A close-up photograph of several hands of different skin tones clasped together in a supportive grip. The hands are positioned in the lower half of the frame, with the fingers interlaced. The background is a blurred green, suggesting an outdoor setting. The overall tone is warm and collaborative.

THEME 5

Fostering Inclusive Growth through Community Outreach and Public Awareness (PA)



Title

Engineering and Functionality of Grenada's First Dual-Purpose Rainwater Roof Tank

PA001

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This paper presents a unique case study on the design and construction of an open rainwater storage tank integrated into a concrete roof — the first of its kind in Grenada. Designed and implemented by the author, Allen Gilbert, at his personal residence, this innovative project explores practical engineering solutions aimed at maximizing rainwater harvesting in small island developing states. The tank, which doubles as the roof structure, demonstrates a novel approach to sustainable water storage, particularly in areas with limited access to piped water or facing increased climate variability.

The study delves into the key structural and engineering elements behind the project. It discusses the application of specialized waterproofing compounds to prevent leakage and maintain long-term durability, and details the specific concrete thickness, reinforcement strategies, and joining techniques used to ensure the structural integrity of the tank-roof composite. These factors are critically analysed to offer practical insights into material selection and construction best practices for similar future applications.

Beyond structural considerations, the paper also evaluates the functional benefits of the system, including its capacity, efficiency in capturing and storing rainwater, and its potential to supplement household water needs. Additionally, the paper addresses water quality

management strategies implemented to ensure the stored water remains safe for domestic use, including filtration, algae control, mosquito control and regular maintenance protocols. This paper will also examine the limitations of such a system.

This case study contributes to the ongoing conversation surrounding sustainable water solutions for the Caribbean and beyond. It serves as a model for low-cost, self-initiated innovations that can enhance water resilience in residential settings. The findings aim to inform engineers, architects, water resource managers, and policymakers about alternative rainwater harvesting systems that are both practical and adaptable to local contexts.

Keywords: Rainwater Harvesting, Roof tank, Waterproofing, Dual-purpose



Title

Empowering Water Conservation: The Impact of Smart Metering and Automated Leak Alerts on Consumer Behavior

PA004

Author

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Water conservation is a shared responsibility, especially for island utilities where resources are limited and demand is rising. This abstract presents the case of Provo Water Company Ltd., which has successfully leveraged smart metering and automated leak alerts to encourage

more responsible consumer behavior and improve operational efficiency.

In 2017, Provo Water Company implemented a full Advanced Metering Infrastructure (AMI) network. This smart metering system enables near real-time monitoring of water usage and has transformed the utility's approach to conservation and customer engagement. By detecting abnormal usage patterns such as high flow or continuous consumption, the system triggers automated leak alerts to notify customers quickly—often before they are even aware of a problem.

These proactive alerts, sent via email and supported by the "My Account" web portal, empower customers to take immediate action. They help prevent unnecessary water waste, avoid costly bills, and reduce the risk of property damage. For the utility, the benefits include reduced non-revenue water, faster leak resolution, and improved system performance.

However, technology alone does not guarantee success. Provo Water Company pairs its smart tools with public awareness campaigns and ongoing education to ensure that customers understand how to interpret and respond to alerts. This combination of innovation and outreach has proven effective in creating a culture of conservation.

This presentation shares Provo Water's experience and offers insight into how other utilities can adopt similar practices. It underscores the importance of engaging consumers through accessible digital tools, clear communication, and consistent support to achieve meaningful, long-term water savings.

Keywords: Water Conservation, Smart Metering, Leak Alerts, Public Awareness



Title

Non-Revenue Beer: Why Isn't Spilled Water a Party Foul?

PA005

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Non-Revenue water is a universal and significant issue for the water industry. Yet, water loss rarely creates the attention or urgency it deserves, certainly given the associated economic and environmental sustainability effects. What's more, water loss resolution is often a real opportunity for utilities to reverse vicious cycles of spending, funding constraints, water demand issues and asset utilizations and to transform these into virtuous cycles of efficiency and effective asset utilization.

In this presentation, we will recast the narrative of water loss with beer in the starring role. The analogy will draw parallels between water utilities and breweries, wherein we will demonstrate the impact of loss in the production and distribution of beer. All the usual non-revenue suspects apply, including apparent losses (accuracy, data, theft, billing), operational use (flushing, hydrants, municipal use) and real losses (spills, overflows, and leaks). However, we will reframe these issues in the context of brewery operations vs water distribution systems.

In addition to providing a colorful analogy, the relationship between the water industry and brewery operations will underscore the significance of loss. It will draw attention to the associated impacts on financial sustainability and demand. And it will facilitate a discussion of mitigation and resolution, including technologies for identifying, locating, and reducing water loss. No specific products or brands will be mentioned in the presentation.



Title

Social Media involvement in driving community change

PA006

Author

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New media, particularly social media, is seemingly becoming the main form of communication offering instant access to information. However, from a project implementation standpoint, the question must be asked how effective are platforms like Facebook, Instagram, Tik Tok, and YouTube in reaching the Grenadian population?

Should social media be the only medium used or should it be intertwined with the traditional approach - face-to-face engagements via townhall meetings, exhibitions, radio and tv outlets, school visits – to achieve broader understanding and involvement.

This paper explores the effectiveness of different communication channels both traditional and non-traditional in promoting awareness of the Climate-Resilient Water Sector in Grenada (G-CREWS) project, to further build relationships and knowledge sharing with citizens, NGOs, and CBOs who in turn share content with their communities.

As it relates to non-conventional methods, a Knowledge, Attitudes and Practices (KAP) survey showed an increase in the use of NAWASA's social media platform from - 40% in the baseline year of 2021 to 64% in 2023 – in accessing water-related information.

Similarly, the G-CREWS social media platform grew from 0 in November 2021 to over 1,700 on Facebook, 483 on

Instagram and 120 on YouTube. Strategic use of 'boosting' has proven effective. For example: A flyer on "Have enough storage?" received over 140,000 views and reached approximately 29,508 people on a budget of USD \$29.00, promoting numerous public inquiries such as: where tanks can be purchased and, what considerations must be explored when setting it up.

While social media proves effective, one cannot negate the impact of face-to-face interactions. Outreach events with schools and collaborations with community groups like the Lions Club continue to play a crucial role. By utilizing both traditional and non traditional communication methods the project can significantly improve citizen participation, awareness and allow for a more effective dissemination of water awareness campaigns.

Keywords: Community empowerment; simplistic messaging; regular engagement; social media; G-CREWS;



Title

Youth Engagement in Water Stewardship

PA007

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Water Stewardship, a term first used in writing in 1970 (IWA Publishing, 2020) has been defined as using water in a way that is socially equitable, environmentally

sustainable, and economically beneficial (United Nations Industrial Development Organization, UNIDO, 2025). As a result of the work being done by conservation organizations to draw attention to water use, the concept of water stewardship has evolved. In this regard, water conservation involves all of humankind, from those who take individual action, to community-level initiatives that encompass stewardship and engagement. This literature review looks at youth engagement in water stewardship, with a focus on youth engagement initiatives related to water stewardship in Trinidad. While sustained effort is evident in youth engagement programmes on water stewardship in other parts of the world (yews campaign unicef India, 2024; Valuing Water Youth Journey IUCN, 2022), in Trinidad, youth involvement in water stewardship is not fully organized or institutionalized, and there is a lack of sustained public awareness and stakeholder participation (Trinidad and Tobago National Report, 2001). Research has shown that several challenges, notably lack of resources, account for decreased youth engagement in water stewardship (Alternative Development Initiatives, 2024) This paper will explore examples of youth engagement and water stewardship, highlighting the important role that youth can play through advocacy and community-based projects designed to ensure sustainability for future generations.

Keywords: water stewardship, youth engagement, humankind, advocacy

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Title

Strengthening Early Warning Systems for Climate Resilience in Water Utilities: A Case Study of Belize Water Services

PA009

Author

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Belize Water Services (BWS) is increasingly exposed to natural hazards—including hurricanes, floods, and prolonged droughts—that compromise its ability to deliver safe, reliable water and wastewater services. These events pose serious risks to water quality, infrastructure integrity, and the continuity of essential services. The implementation of Early Warning Systems (EWS) is critical to improving disaster preparedness and resilience. EWS enables timely and informed decisions, safeguards public health, and minimizes economic losses. This summary outlines the critical importance of EWS, the barriers BWS faces, and actionable strategies for strengthening its disaster preparedness.

Key Challenges

1. Understanding Risk Fundamentals

Inadequate integration of hazard, exposure, vulnerability and risk assessments into daily operation.

2. Gaps in Emergency Response

Targeted training to interpret warnings, initiate emergency protocols and activate response systems.

3. Insufficient Coordination

Strengthen collaboration with NEMO other utilities during emergencies.

4. Resource Constraints

Budget limitations impede investing in advanced monitoring technologies and resilient infrastructure.

Strategic Solutions for Strengthening EWS at BWS:

- **Advance Risk Management Framework**

Finalize and implement Enterprise Risk Management (ERM) system and Water Safety Plans (WSP) to guide responses to a range of hazards.

- **Update Emergency Plans**

Upgrade the existing Disaster Risk Mitigation and Recovery Plan and expand it into a comprehensive, multi hazard Emergency Response Plan supported by drills and training exercises.

- **Integrate Smart Technologies**

Enhance the current GIS and SCADA systems to monitor water levels, water quality, and system performance countrywide.

- **Strengthen Multi Stakeholder Collaboration**

Collaborate with NEMO, National Meteorological Service and the National Hydrological Service to streamline communication and coordinate responses.

- **Secure Sustainable Financing**

Access climate adaptation funds to finance EWS technologies and infrastructure upgrades for BWS assets.

Conclusion:

Early Warning Systems and action save lives. For BWS, investing in people-centered, integrated EWS means embracing innovation, fostering collaboration, and embedding a culture of preparedness across all levels of staff. Building adaptive systems today is key to minimizing the impact of tomorrow's disasters.



Title

Fostering Inclusive Growth in Belize's Water Sector: Community Outreach and Public Awareness as Catalysts for Sustainable Development

PA011

Author

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As Belize confronts ongoing challenges related to water safety, wastewater management, and climate change, it is essential to cultivate a resilient water future—one that can adapt to evolving conditions. This abstract underscores the significance of community engagement and public education. Together, these efforts can bridge informational gaps and foster a more informed populace. Such initiatives are instrumental across all communities: urban, rural, and indigenous, in promoting sustainable water practices and enhancing resilience.

Belize's commitment to enhancing water infrastructure is evident through various community-driven initiatives. In October 2024, Belize Water Services (BWS) inaugurated its 150th Reverse Osmosis Plant in Caye Caulker, addressing previous challenges of water scarcity and quality. This new facility, utilizing advanced desalination technology, is projected to meet the island's water demands for the next 10 to 15 years. Community

outreach and public awareness on this island play a vital role in helping citizens understand the root causes and impacts of scarcity. By organizing educational programs, workshops, and local events, residents can become more informed about the importance of managing resources wisely and sustainably. Awareness campaigns can highlight issues such as water shortages, encouraging individuals to adopt more efficient practices and make informed decisions. When the community is actively engaged and knowledgeable, they are more likely to participate in collective efforts that reduce waste, support local initiatives, and promote long-term solutions. Ultimately, increased awareness empowers citizens to take meaningful action, helping to alleviate scarcity and improve the overall well-being of the island.

Community engagement is also a cornerstone of Belize's water initiatives. In March 2025, a group called WaterWays organized a collaborative water testing event along the Belize River to coincide with World Water Day. This initiative involved teachers and students from various communities, including San Ignacio and Belize City, who were trained in water testing and participated in data collection to assess water quality across the watershed. These are just two examples of how community outreach and public awareness assist in empowering residents to contribute to water conservation. Using real-world examples from national initiatives and community-based projects, the paper highlights the value of localized engagement. Public education campaigns, workshops, and youth-led water stewardship programs have shown measurable success in changing behaviors, improving hygiene practices, and supporting water conservation.



Figure 1 & 2. Pictures of Belize Water Services staff engaging in school visits to discuss water conservation.

By aligning with the conference theme Engineering Progress Together: Collective Action for a Connected Region, the paper frames Belize's experience as a model for how targeted outreach and awareness can reinforce national policy goals while fostering regional solidarity in water governance.

Recommendations:

Institutionalize Community Engagement: Embed community consultation into the regulatory framework for all major water and wastewater projects, ensuring early and ongoing participation from local stakeholders.

Strengthen School and Youth Programs: Expand water education in schools and promote youth-led outreach campaigns to create generational shifts in water use behavior.

Leverage Indigenous Knowledge: Collaborate with Maya and Garifuna communities to integrate traditional ecological practices into national water strategies.

Deploy Mobile and Digital Platforms: Utilize mobile technology and social media to reach remote communities with timely water quality information, conservation tips, and emergency alerts.

Build Capacity in Local Government: Provide training for village councils and municipal leaders to support community water committees and grassroots monitoring initiatives.

Partner with Civil Society and NGOs: Leverage existing networks to co-design and implement outreach programs that are culturally sensitive and locally relevant.

By fostering inclusive growth through intentional outreach and public education, Belize can enhance water equity, improve infrastructure uptake, and contribute meaningfully to regional collaboration for a connected and climate-resilient Caribbean.

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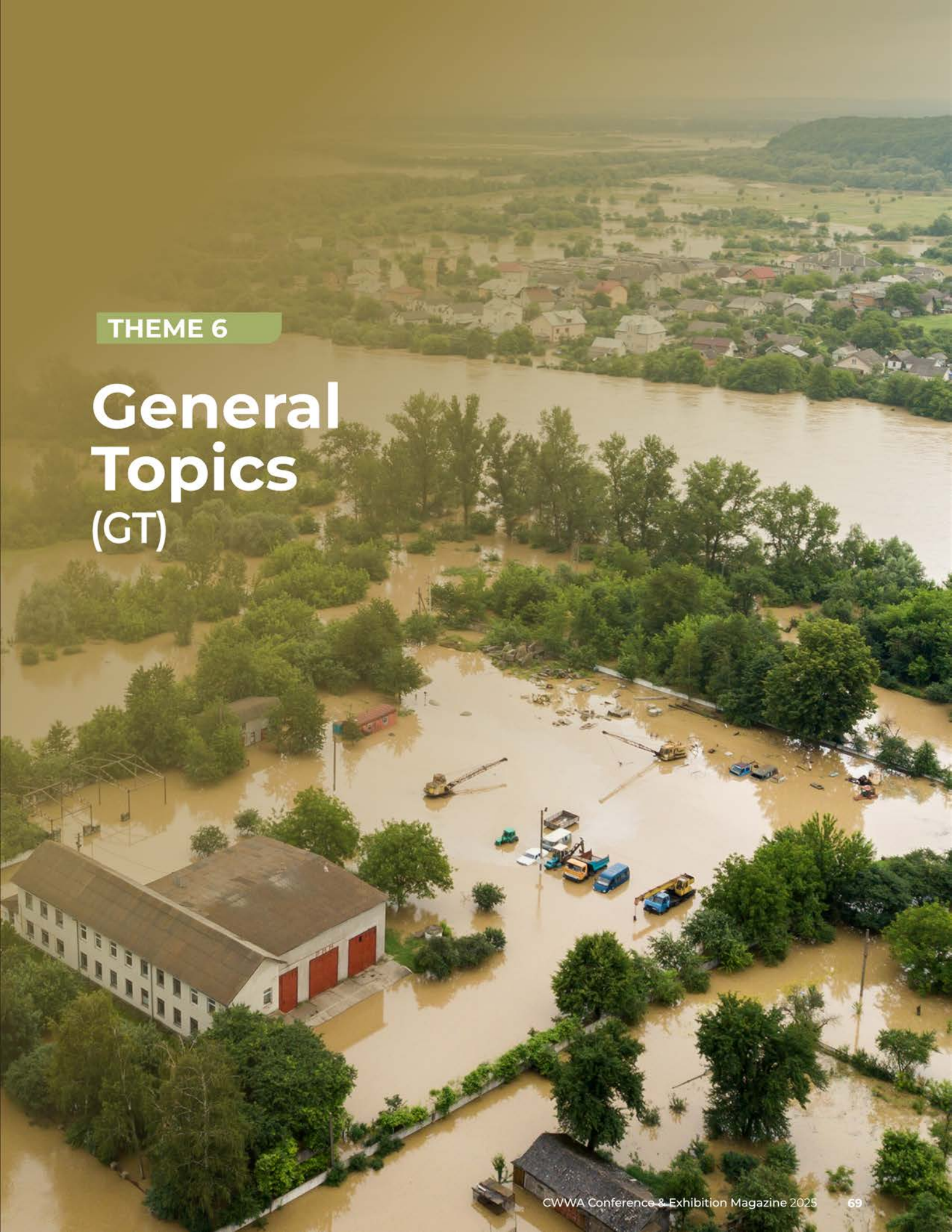
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Dr. Kilian Semmlmann
Vice President, Strategic Business Unit Analytics & Services, Diehl Metering



THEME 6

General Topics (GT)



Title

The Importance of In-Country Expertise in Preparing EIAs for Water Supply Projects

GT001

Authors

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The concept of Environmental Impact Assessment (EIA) was first codified in the National Environmental Policy Act of the United States of America in 1970. Since then, it has been adopted by other countries, including all countries and territories in the West Indies. International development banks have also adopted the use of EIA as a necessary safeguard, particularly on large and technically complex projects. With particular regard to water supply projects, EIAs have been required for a wide range of project types, ranging from dams and reservoirs to pipeline, pump and storage tank projects.

It is generally recognized that EIAs require a multi-disciplinary approach, involving expertise in the Natural Sciences as well as the Social Sciences. Many early EIAs were prepared by international experts, due mainly to a lack of in-country expertise. This approach did not prove entirely satisfactory, since local nuances were sometimes overlooked. As a result, it has become increasingly apparent that studies staffed entirely by international experts do not yield the most meaningful results. Instead, the preparation of effective EIAs would better rely on in-country experts, supplemented by international experts to address specific topics in the study.

This paper begins with a description of steps in the EIA Process as presently operated in the West Indies. For each of those steps, it discusses the optimal use of in-country expertise to ensure the relevance and completeness of the study. It then draws conclusions as to the types of expertise that should be developed locally, as opposed to the kinds of topics which are likely to require international expertise.



Title

Success by Design: Structuring Water Projects for Measurable and Sustainable Success

GT003

Authors

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Achieving long term success in water and wastewater systems hinges not only on effective implementation but on the intentional structuring of projects from the outset. Too often, success is evaluated retrospectively, with limited consideration for how project development choices shape sustainability, inclusivity, and resilience outcomes. This abstract argues for a paradigm shift, placing measurable and sustainable success at the core of project development. It explores how water projects can be strategically designed using integrated frameworks such as Theory of Change, logical frameworks, and results-based management approaches to embed clear indicators, climate resilience principles, and adaptive pathways from the planning stage. By aligning technical specifications with social, environmental, and governance priorities, developers can establish a strong foundation for monitoring progress, evaluating impact, and ensuring accountability over time. The abstract draws from case studies in small island developing states (SIDS) and low and middle income countries where early incorporation of success metrics such as water quality improvements, reduced non revenue water, increased service coverage, and strengthened institutional capacity has enhanced project outcomes and adaptive capacity. It also emphasizes the importance of stakeholder engagement and participatory planning processes to co create definitions of success that reflect local needs and values. In doing so, the paper highlights how structured, impact oriented project development can improve alignment with national development goals, global frameworks like the SDGs, and climate finance requirements. Ultimately, this approach empowers water sector actors to design projects not just to be built, but to endure, delivering tangible, inclusive benefits in the face of growing climate and development challenges.



Title

Strategic Alignment and Institutional Learning in Water Infrastructure Delivery. A Programmatic Analysis of Guyana's Coastal Water Treatment Infrastructure Programme

GT005

Author

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The Coastal Water Treatment Infrastructure Programme, led by Guyana Water Incorporated (GWI), is the single most ambitious and strategically significant water sector initiative in Guyana's history. With an investment exceeding G\$40 billion (US\$200 million), the programme aimed to expand treated water coverage along the coast from 52% in 2021 to 90% by 2025. It included the construction of 13 new treatment plants, 18 compact in-line filtration systems, upgrades to 13 existing plants, over 200 km of transmission pipelines, 14 wells, and a phased non-revenue water (NRW) reduction strategy.

This paper examines the programme through the Program Management Professional (PgMP) framework, focusing on how the domains—Strategic Alignment, Benefits Management, Stakeholder Engagement, Governance, and Lifecycle Management—shaped delivery outcomes and institutional learning. The initiative benefited from full government resourcing and a multi-PMO structure that enabled simultaneous execution across multiple regions. It also showcased effective collaboration between international and local contractors, offering a blueprint for future capacity-building models.

While the programme achieved major physical milestones on time and within budget, it also

highlighted important lessons in sequencing, early operational alignment (especially NRW), robust supervision, and inter-agency coordination. Insights from workforce availability, procurement logistics, and cross-ministerial planning further reinforce the importance of adaptive delivery frameworks.

This case offers a regionally relevant model for large-scale utility-led infrastructure delivery. It demonstrates how strategic alignment, institutional agility, and commitment to continuous improvement can translate public policy into lasting outcomes for communities.

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Title

Rebuilding Beneath the Surface: A Programmatic Response to Georgetown's Aging Urban Water Infrastructure

GT006

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Georgetown's water transmission and distribution network—some components dating back 130 years—presents a compelling case of infrastructure fatigue in the midst of economic transformation. The Urban Transmission and Distribution Replacement Programme, spearheaded by Guyana Water Incorporated (GWI), responds to increasing service disruptions, pipeline bursts, and system inefficiencies in the nation's capital. Framed within the Program Management Professional (PgMP) domains, this paper provides a critical analysis of the programme's execution and institutional learning. It explores the constraints of working in a historically layered urban corridor where coordination among stakeholders, legacy infrastructure,

and the requirement to maintain service continuity converge. The paper argues for a sustained, programme-based methodology as a transformative tool—not just for asset replacement, but for reshaping utility governance, stakeholder engagement, and urban resilience. Comparative insights, stakeholder reflections, and forward-looking recommendations position the Georgetown experience as a model for Caribbean cities grappling with similar challenges.

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