BEYOND EXPECTATIONS

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ANNUAL DIGITAL EDITION

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Confederation of Indian Industry

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- CII National Awards for Excellence in Water Management have been recognizing industry for its contribution in making a Water Secure World - be it through their operations, innovations, or CSR activities.
- For over a decade, CII–National Awards for Excellence in Water Management have been celebrating and awarding good and innovative water conservation & management practices undertaken by industries from varied sectors.
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The award recognises companies involved in manufacture of water efficient equipment or products, which have an impact on water management, either by reducing freshwater consumption or enhancing wastewater recycling/ reuse and recovery.

Note: MSMEs are encouraged to apply under any category. They will be assessed & compared with other MSMEs.

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For any clarifications or information, please contact Water Awards Team:

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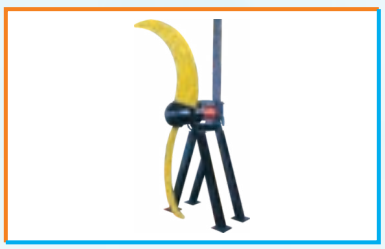

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MAYUR SHARMA | EDITOR
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> "The finest steel has to go through the hottest fire."
> - Richard M. Nixon

THE ANNUAL SMART WATER FINEST-50 CASE STUDY LIST

This gem of an issue - the Annual Digital Edition of Finest-50 Global Case Studies is in your hands.

This super-special edition celebrates the essentiality of case studies in the global water & wastewater market. It is a collector's issue for which we invited and then selected some of the best and leading case studies from across the globe.

Our editorial team has carefully chosen these Finest-50 Case Studies from an overwhelming 200+ entries - based on the overall quality of actual municipal/industrial plants and community projects. The scope of these case studies includes the problems arising in these plants and innovative solutions that were successfully implemented given the unique limitations of these plants or projects' environment and requirements.

These case studies give us an in-depth look at the practical application of the latest technologies being applied and products being used in a real-time environment. We hope you would like it as much as we enjoyed going through the entire process of selecting and preparing the final drafts of these pearls of wisdom.

I would like to personally thank the contributors of these case studies: Aditya Birla Group (Grasim Industries), Advanced Drainage Systems (ADS), Amalgam Engineering, Aquarius Spectrum, Aquatic Informatics, Banka BioLoo, Borouge, SM Chakrapani, CIPET, Vaidic Srijan LLP, CST Wastewater, Econo Services, Elmodis, Wrocław Sewage Treatment Facility, Polish Academy of Sciences, Esri India, EVOLVE, FloNergia, GKD, Gradiant India, Grundfos, IDE Technologies, Intelligen, Ion Exchange India, JanaJal, KETOS, Kishor Pumps, KSB, Lakeside Equipment Corp, Landia A/S, LiquidSky, Mazzei Injector Co., Mueller Water Products, Nixie Engineers, Ovarro, Pani Energy, Pumpenfabrik Wangen, Qatium, Rochem, Roserve, Satish Chilekar, Satsense Solutions, SPML Infra, StormHarvester, TaKaDu, Tata Consulting Engineers (TCE), Toshiba Water Solutions (TWS), Dr. V.K. Seth, VAPAR, Watson-Marlow Fluid Technology Group (WMFTG), Wetlands International, and World of Water (WOW AF).

The prominent application segments which these case studies cover are Water Utilities, Urban Local Bodies (ULBs), Water Supply & Sewage Network Authorities, Desalination Authorities, Municipal Drinking Water Projects & Wastewater Treatment Plants; and various End-User Industries (Dyeing, Power Plants, Hospitals, Hotels & Resorts, Chemicals, Steel Mills, Wildlife Sanctuary, Fish Processing, Food & Beverages, Aquaculture, Textiles, Semiconductors, Automotive, Transportation Hub, Townships, and Treatment Plants for Industrial Clusters and Port Areas).

On this momentous occasion, I would like to reiterate the vision of this magazine for our readers. We promise that the editorial policy of SWWW will always be guided by the high standards of content quality and integrity, professional responsibility, industry awareness, and staying neutral to all stakeholders that constitute the global water sector. SWWW would be at the forefront to consistently highlight the issues crucial for the water industry. To become the most trusted source of information and help you make informed buying decisions, we will come up with the right blend of project news, products, market trends, and analysis. We will address a wide range of issues in diverse disciplines of water & wastewater from across the globe.

The theme of our next magazine issue (May-June 2022) is – "Innovations in Industrial Water & Waste Market". Please keep sharing your editorial contributions (articles, case studies, and stories) with me.

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Smart Water and Waste World™

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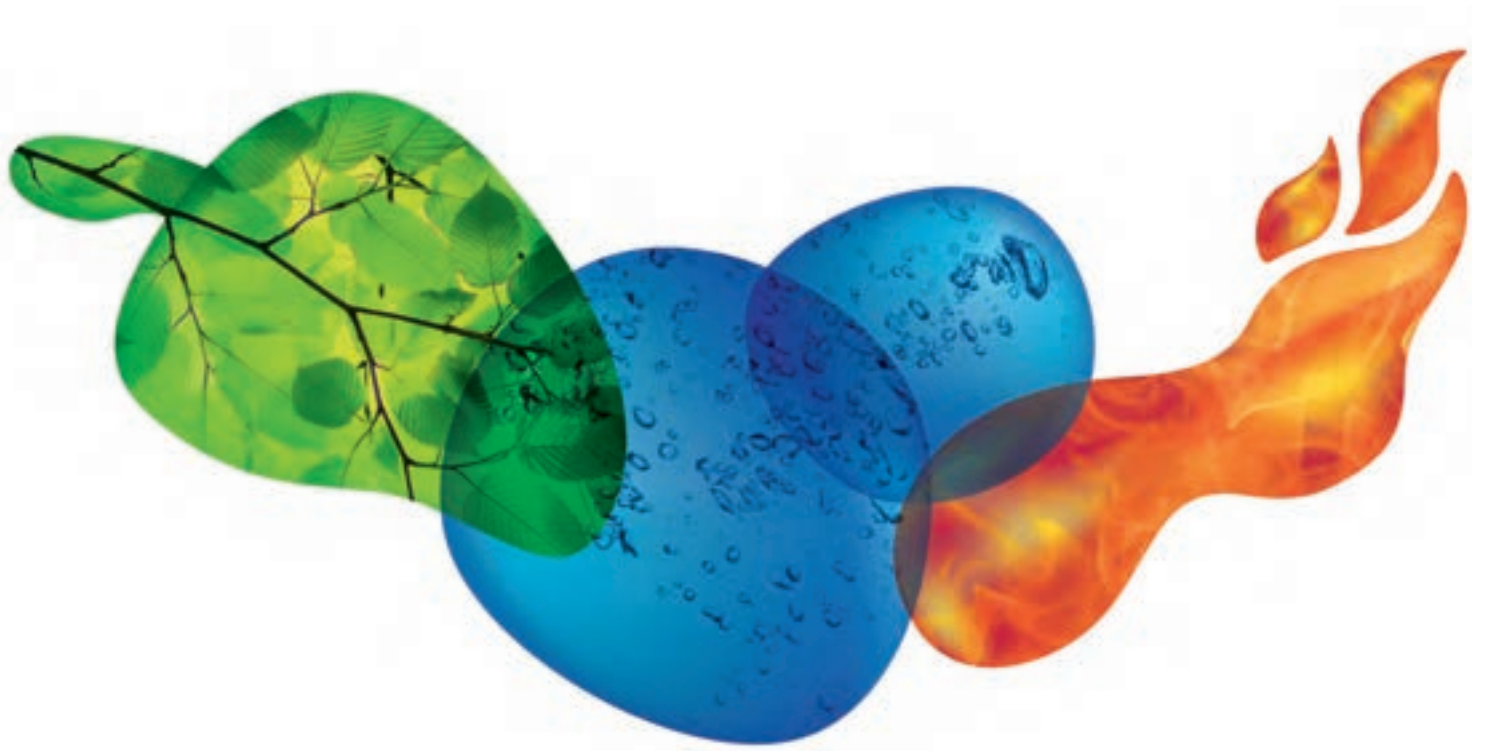

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- *Drinking Water, Conservation, Water Resources*
- *Industrial Process Water & Effluent Treatment*
- *Municipal Water & Wastewater*

SEWAGE, STP, SUBMERSIBLE PUMPS, VFD

TWO LEVEL PUMPING: 20 MLD STP IN PUNE

By Kishor Pumps

THE CHALLENGE

Since the cutomer's plant is in a thickly populated area inside the city, space is very limited.

To address this issue, the technology provider had designed the plant in such a way that SBR basins were built one above the other in a two-storeyed structure instead of having all the basins at the same level on the ground.

This type of design was offered for the first time in India which is a unique feature of this project.

Initially, in this configuration, two different sized/ capacities pumps were considered because of the different head requirements of two floors.

However, in this arrangement, the required standby capacity was not available.

THE SOLUTION

After understanding the problem Kishor team had a series of discussions with the contractor, consultants, and the technology provider about various alternatives.

The Kishor team suggested using 5 identical pumps to be used with the help of VFD to take care of the requirement of feeding raw sewage to two different basins at two different levels and different load conditions.

5 numbers of Submersible Sewage Pumps model ASTRA-SA 200-360 with 75 kW motor were suggested instead of different capacity combinations.

In this alternative, the total flow requirement was being catered by 3 pumps with two pumps remaining as standby pumps.

Complete operational philosophy with VFD curves and operating parameters at varying load conditions were submitted to consultants during detailed engineering.

The same after approval was given as an input for VFD and PLC.

Initial trials were done at the site immediately after installation which were satisfactory and in line with the operational philosophy.

All the stakeholders (Contractor, End

THE CUSTOMER'S OPINION

"After commissioning of the plant, we have had interactions with all related agencies, and all of them are happy about the solution provided by Kishor Pumps."

User, Consultant, Technology Provider are happy about working of pumps and system.

THE BENEFITS

- Plant could be accommodated within much lesser space than normal.
- Both the requirements of meeting the flow and head conditions and the number of standby pumps were achieved.
- With the help of VFD, optimum power consumption was possible.
- In view of space restrictions for STPs especially in big cities, this arrangement now proven successful is being considered at many STPs in metro cities and Kishor is better equipped to understand and satisfy correct technical requirements.

About the Contributor

Kishor Pumps *specializes in the pumping of liquids with high solids content (like sewage), as well as, liquids that are highly corrosive and abrasive in nature. Being the first to introduce dry motor submersible pumps for sewage application in India in the early 1980s, it has since supplied over 50,000 submersible pumps for sewage pumping stations and treatment plants. It has partnered with all relevant Ministries, Government Departments, Utility Boards, as well as, prominent technology and process consultants and EPC companies to continuously upgrade our products suitable for the changing application needs. Some examples include India's first large VFD sewage pumping station in 2013 and India's first multi-level sewage treatment plant in 2018.*

COLOR REMOVAL, DYEING, ETP, POWER PLANT

TREATMENT SYSTEM FOR COLORED EFFLUENT STREAM CONTAINING DISPERSED PIGMENTS

By Pushkar Shukla, Amit Kumar, Sanjeev Gupta and Hiten Mehta

In the present case study, A Viscose Filament Yarn (VFY) manufacturing unit is conducting dyeing operations using dispersed pigments in their plant. During the color change in yarn manufacturing, the existing pigment solution is drained from the tank. This solution is collected in a sump and further sent to ETP along with acid wash effluent (pH= 2, Flow = 200 m^3/h). The complete effluent management system of the plant is mentioned in Figure 1.

Parameter	Value
Total effluent generated from Dye Room	10-20 m^3/day
Pigment Concentration	2 – 8 (%)
Apparent Color	Varying
pH	6.5 – 8
Temperature	30 – 40°C

Table 1: Characteristics of Dye-Room Effluent

The effluent treatment plant comprises of 5 Streams, of which 3 streams (D1, D2, D3) are major streams: D3 stream is the color-rich stream which comprises of dye room effluent along with washing of pot spinning process. D3 stream merges with highly Acidic and Zinc-rich D2 stream. The presence of Zinc Sulphate and Sulphuric Acid make this an acidic and metal-rich stream with a pH ~2. The stream is taken to a clarifier where pH is adjusted with lime to alkaline to precipitate and remove suspended matter. However, color arising due to Pigment rich stream is not efficiently removed.

D1 Stream is Alkaline in nature arising from Caustic Soda Plant, Water Treatment

Trial No.	Pigment	Color reduction @ λmax(%)	TOC Reduction (%)
A	Mix	99.8	93.9
B	Pigment Blue 15	99.9	94.4
C	Pigment Yellow 17	98.8	69.8
D	Mix	99.9	93.59
E	Pigment Black 7	99.9	97.81
F	Pigment Brown 25	99.5	94.05

Table 2: Results of Pilot Scale Trial on VFY Dye Room Effluent

Viscose Filament Yarn (VFY) Manufacturing *(This image is for illustration purpose only, not of the actual plant)*

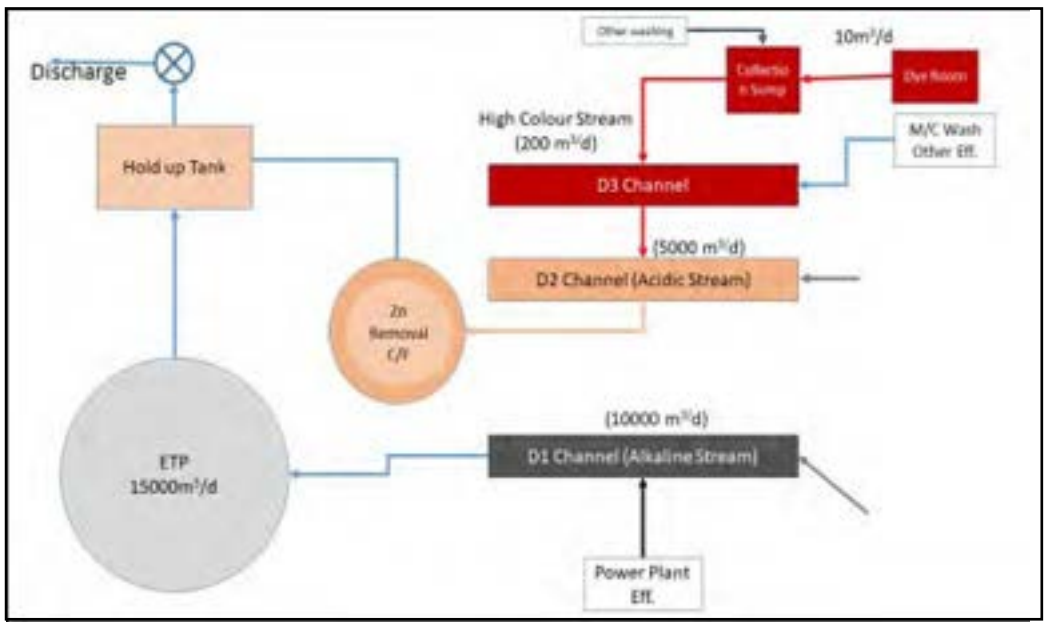


Figure 1: Layout of effluent management stream of VFY manufacturing plant

Batch No.	Apparent Color	VYTAL 641 Dose (ppm)	Absorbance (A.U)		% Reduction	TOC		% Reduction
			I/L	O/L		I/L	O/L	
A	Dark Brown	400	34.19	0.08	99.5	386	21	94.6
B	Green	700	33.79	1.61	95.2	1254	233	81.4
C	Dark blue	500	35.24	0.01	99.9	876	82	90.6
D	Dark Brown	500	34.19	0.09	99.8	1089	415	61.9

Table 3: Result of Commercial Trial

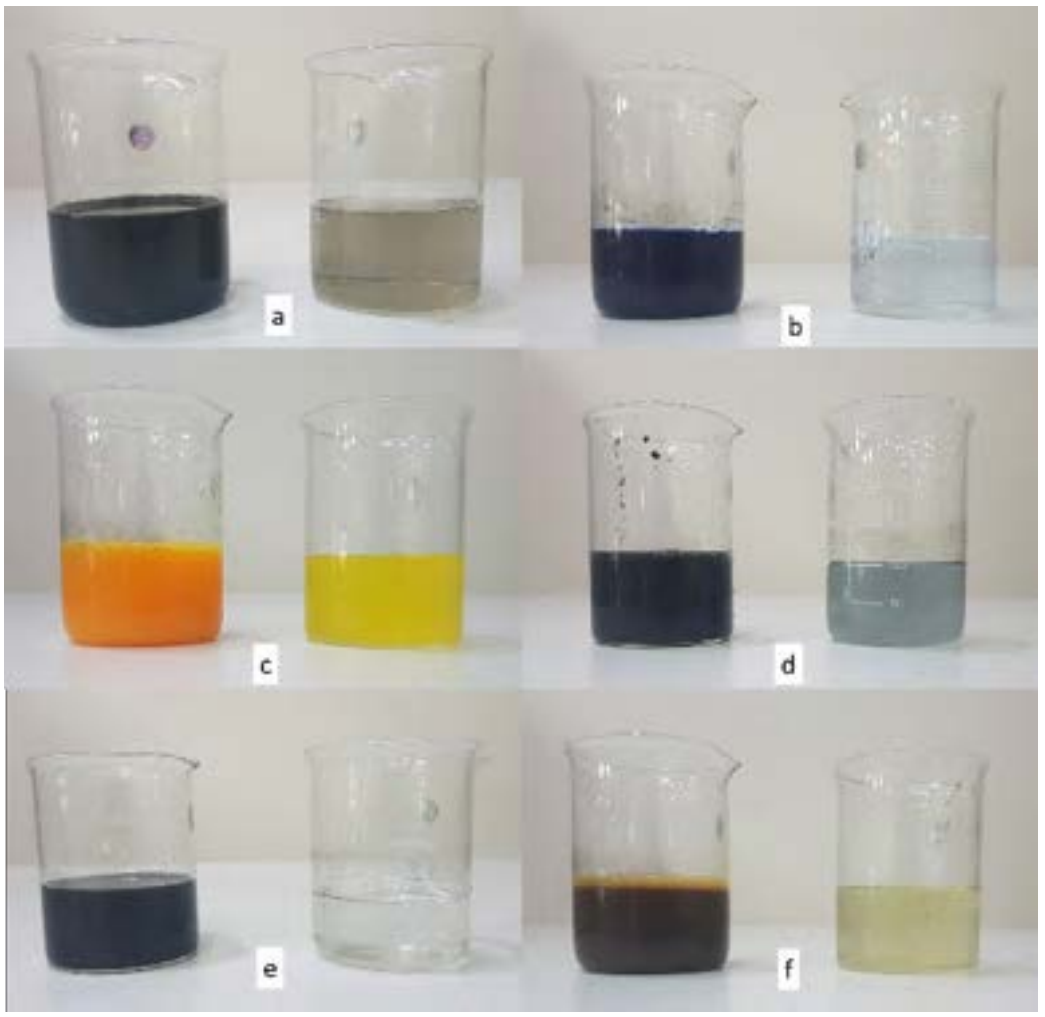


Figure 2 (A-F): Results of pre and post (left-right) treated samples during pilot trials

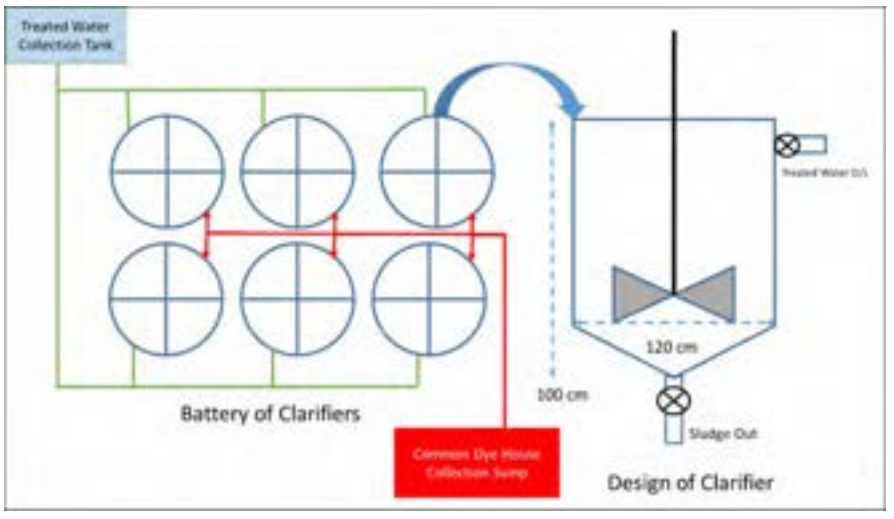


Figure 3: Proposed treatment scheme for dye room effluent with C.S of clarifier

Plant (WTP), Alkaline effluent of other manufacturing processes. The effluent of a power plant is also mixed into this stream. D1 Stream is neutralized and treated with Polyelectrolyte to remove suspended matter.

After conducting lab scale trials on combined (D2+D3) stream good color removal was observed. However, the doses and large volume were making the treatment process economically unfeasible. Hence, it was decided to segregate the color-rich dye room effluent from other effluents and treat it with VYTAL 641 on a batch scale, and then send the treated water to D2 stream. Though, this required additional piping in the current set-up, significant savings in terms of operating cost made it more viable. To check the validity of the proposed system, a pilot-scale trial was planned for 2 days where dye room effluent was treated with VYTAL 641 in a 300 L clarifier and results were monitored. From Table 2 and Figure 2 (A-F) it can be observed that VYTAL 641 was able to deliver consistent performance in the case of an individual as well as mixed pigment-containing effluent giving between 98 to 99.9 % color removal.

On the basis of the successful pilot trial, it was decided to segregate the high color dye room washing stream and treat it separately. As there were space constraints in the plant, it was decided to have 6 clarifiers of 1 m^3 capacity each instead of one large clarifier.

This can treat the incoming effluent from the dye room before discharge to the ETP. Another advantage of this scheme is that effluent can be treated batch-wise depending upon the quantity generated.

The treatment scheme is described in Figure 3. The results obtained from commercial trials are tabulated in Table 3. Good results of final implementation into plant led to the successful deployment of the treatment system. The persistent problem, for several decades, was solved by the novel Product (VYTAL 641).

CONCLUSION

In this study, we synthesized novel hybrid coagulants for the removal of dispersed pigment. VYTAL 641 shows significant

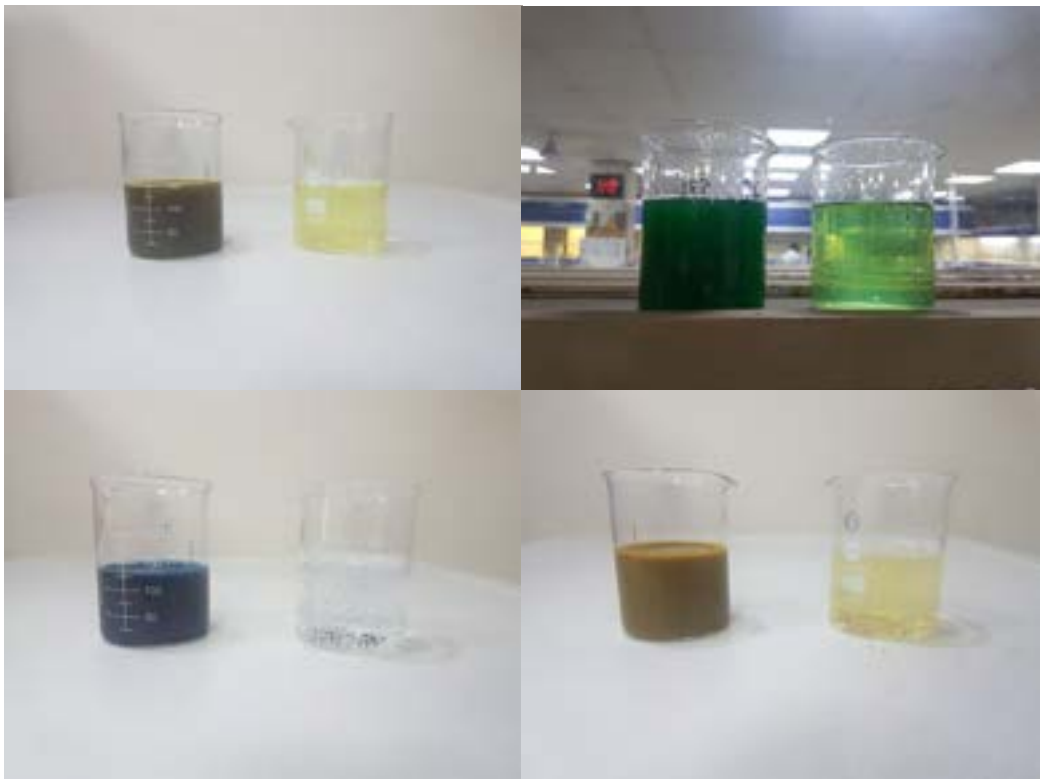


Figure 4 (a-d): Results of pre and post (left-right) treated samples during implementation

removal efficiency for dispersed pigment (≥95 %), it also shows faster and larger floc formation compared to other coagulants which in turn will lead to better operational efficiency. It has shown good anti-dispersant properties to coagulate suspended pigment particles, which conventional treatment system was not able to achieve. The VYTAL 641 based treatment system was found to be robust across all dyes and mixed effluent. Overall, it can be concluded that hybrid-coagulants can provide better color removal than conventional inorganic coagulants, in a single step.

About the Authors

Dr. Pushkar Shukla *holds a Master's degree in Organic Chemistry and Ph.D. in Chemistry from ICT, Mumbai. He has 10 years of research experience in water, wastewater treatment, adsorption, development of separation, and purification technologies and Environment Research. He presently leads the Water Product Development team at the Grasim Industries. He has 10 research papers, and 3 patents to his name.*

Amit Kumar *holds Master's degree in Chemical Engineering from IIT Roorkee. He is having 7 years of experience in specialty chemicals for water treatment and oil & gas industries. He is presently leading Industrial, new product, and application development at Grasim Industries Limited.*

Late Dr. Sanjeev Gupta *had a Master of Science in Applied Chemistry and Ph.D. in Chemistry. He has 18 years of experience in industrial research. His expertise included water & wastewater treatment, hybrid biochemical treatment, environmental management, chemical recovery, new product development, etc. He was awarded Mecaster Young Scientist Award for 2011.*

Dr. Hiten Mehta *holds a Master of Science in Organic Chemistry and a Ph.D. in Chemistry. He has more than 17 years of experience in industrial research. His expertise includes process development, Intellectual properties, regulatory guidelines for various regions of API, specialty chemical, personal care actives, Aluminium chemistry, and applications focused product development.*

BIOLOGICAL TREATMENT, ETP, FOG, HOTELS, STP, WASTEWATER

DEGRADATION OF FAT, OIL & GREASE AT A HOTEL'S STP

By Amalgam Engineering

INTRODUCTION (FOG)

The presence of Fats, Oil, and Grease (FOG) in industrial processing wastewater or hotel industries can cause all kinds of problems in biological wastewater treatment systems onsite and in public sewage treatment facilities. It is, therefore, essential to reduce, if not remove FOG completely, in primary treatment then manufacturing industries, hotel industries, and societies have to experience the most severe problems with FOG.

Organic toxic waste [Oil and Grease (O&G)] causes ecological damages for aquatic organisms, plants, animals, and equally mutagenic and carcinogenic for the human beings. They discharge from different sources to form a layer on the water surface that decreases dissolved oxygen. O&G layer reduces biological activity of treatment process where oil film formation around microbes in suspended matter and water. This leads to decrease dissolved oxygen levels in the water. Then oxygen molecules are difficult to be oxidative for microbial on hydrocarbon molecules and cause ecology damages to water bodies.

The conventional techniques remove oil and grease using skimming tanks and oil and grease traps in treatment plants but the main disadvantage of these methods is their low efficiency of removing oil and grease.

Environmental studies described prevention of fat blockage or filming

CLIENT PROFILE

The "XYZ" company intends to carry on the business of providing innovative technical solutions for environmental applications including wastewater treatment, sewage treatment, solid waste management, etc. The company has achieved more than 300 project installations in all over India. They supplied many STPs (Sewage Treatment Plants) in hotel industry.
But one of the projects was facing a problem of scum generation due to heavy oil and grease which is passing into the system. Because of that plant is not working properly and Hotel is facing smell problems. Due to this the hotel customers and employees turned very hostile and restless.

FAST FACTS

- **Problem Food Particles: Scum formation in a settling tank, chocking, scum, suspended solids carryover, and odor.**
- **Product Used: Bacta Cult™ FOG SR BAR and FOG SR TOUGH**
- **Key Benefits: Fast degradation of fat, oil and grease, good MLSS generation, reduction in BOD and COD, reduction in manpower cost.**

in waste systems before discharging wastewater into the sewage systems.

These studies investigated a new product "BACTA FOG SR BAR & TOUGH" to degrade organic matter with a commercial mixture (lipase enzymes) that cleans holding tanks, septic tanks, grease traps, other systems, etc.

WHY FOG IS A PROBLEM IN WASTEWATER TREATMENT PLANTS?

- When FOG (fat, oil, and grease) enters into the wastewater systems like STP and ETP it creates the layer in the water surface, and because of that presence MLSS in the aeration tank is not able to survive and starts dying.
- Sludge carry-over problem in the secondary clarifier because of dead biomass, reason is only FOG (fat, oil,

and grease).

- Presence of Fat, Oil and Grease (FOG) in wastewater is an ever-growing concern to municipalities and solid-waste facility operators. FOG enters sewer system from restaurants, residences, and industrial food facilities. Its release into sewer system results in a continuous build-up that causes blockage of sewer pipes.
- FOG (Fat, Oil, and Grease) does not mix with water, and when wastes that contain FOG are disposed of in a standard sewer without treatment, the fatty FOG portion of the waste stream can float to the surface and solidify, causing clogging. The improper disposal of FOG waste causes harm to the wastewater systems.
- If high-quantity FOG is collected in the tank, it allows generating the scum in the wastewater systems and it also contributes to generating the bad odor.

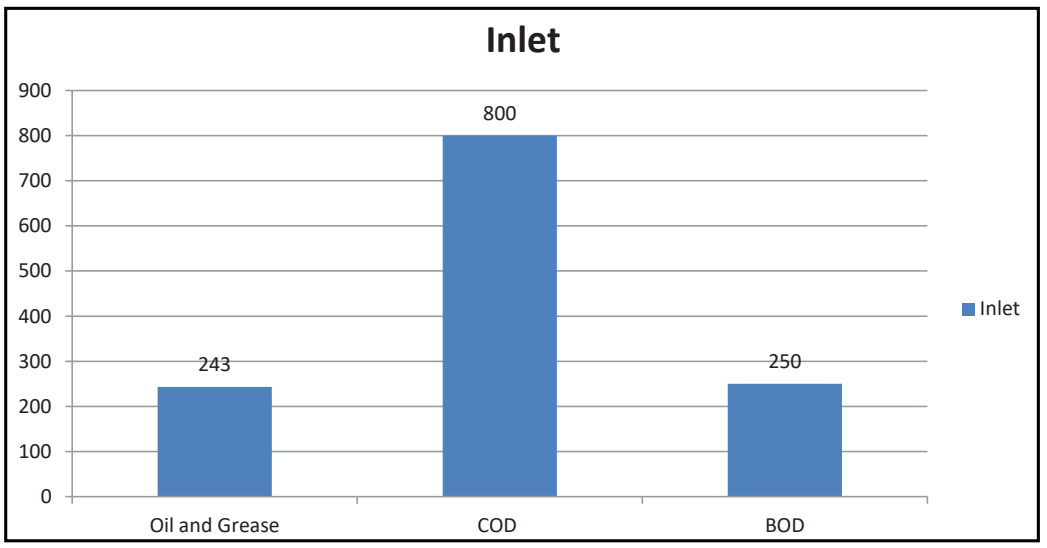
Sr. No.	Parameters	Unit	Inlet to Biological System	Outlet of Secondary
1	Flow	m^3/day 300	300	
2	pH	-	-	-
3	BOD	mg/lit	250	30
4	COD	mg/lit	800	150
5	Total Dissolved Solids	mg/lit	400	-
6	Total Suspended Solids (TSS)	mg/lit	200	-
7	Ammonical Nitrogen	mg/lit	-	-
8	Oil & Grease	mg/lit	243	<21

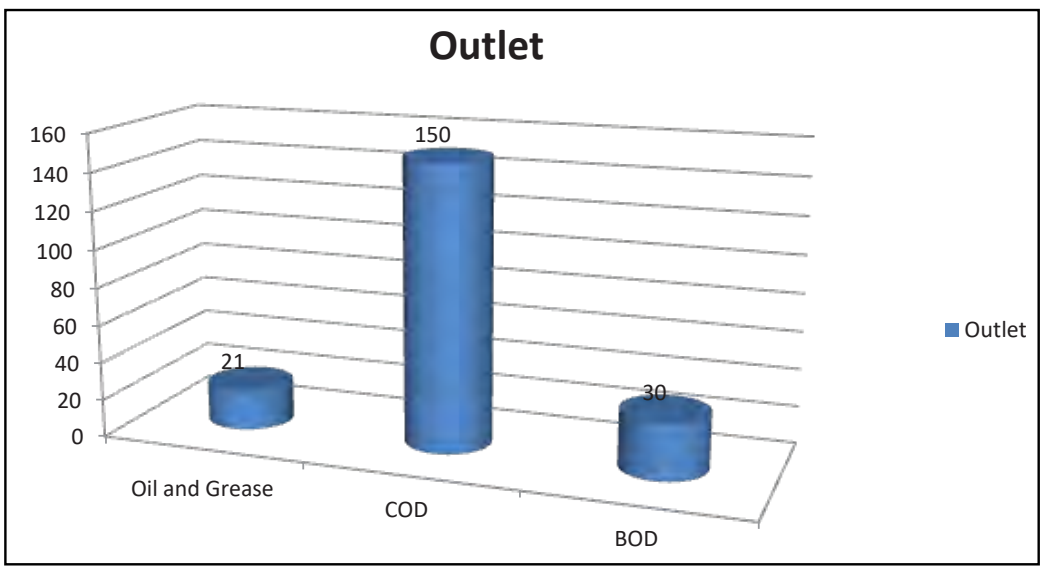
Table 1: Laboratory Measurements

SOLUTION: A NEW TREATMENT FOR FOG REMOVAL

Our product “Bacta Cult FOG SR Bar” can degrade Fat and Oil. Bacta cult FOG SR is a bar/pellet containing active microbes which are released slowly into the water medium containing oil. The slow-release or extended-release is like our “slow-release medicines”. It is a combination of non-pathogenic, naturally occurring, and acclimatized bacteria. They are selected according to their ability to degrade fat, oil and grease.

The FOG SR BAR is tied and suspended at the inlet of the oil and grease trap. It gets consumed over a period. The typical time is around 25 to 35 days depending on the flow and quantity of oil present in the effluent.





S.No.	Flow m³/Day	Quantity Required	Number of Quantity/ Pieces
1	300 m³/day	3 kg	3

Table 2: Bacta Cult FOG SR Ba

APPLICATIONS

- Grease traps
- Wastewater treatment plants
- Holding tanks
- Activated sludge
- Lagoons
- Waste pumps

BENEFITS

- Breaks down of fat and grease build-up
- No special equipment needed
- Eliminates wide range of complex organics bad odors at the source
- Enhances BOD/COD removal
- Facilitates grease trap cleaning
- Cost-effective and easy to use increases system efficiency contains no chemicals
- Reduces sludge build-up
- Degrades a wide range of complex organics

DOSAGE SCHEDULE

Note: Each Fog SR Bar bag will automatically be slowly exhausted which you need to refill. It will last you for 25-30 days. It will be contained in a net, which you need to suspend into the water. It should be immersed in water minimum at a level of 500 mm below water level.

RESULT

After using the Bacta cult FOG SR Bar fat and oil is start getting degraded easily and because of that, the scum which is generating in collection tank is now cleaned. FOG SR Bar also helped to give the reduction in COD and BOD. After the regular use of Bacta Cult FOG SR Bar, biological system is running good and Oil and grease ratio came in the limit.

About the Contributor

***Amalgam Engineering** was established in 2009. It is a collaborative solutions provider in the field of Industrial water and waste management. It has water expertise to cater to industrial wastewater plant engineering and ETP troubleshooting services. It is actively working in the export business of turkey-based projects for water & wastewater treatment and specialized ETP and WTP equipment.*

LEAK DETECTION, PIPES, SENSORS, UTILITY, WATER LOSS

SUCCESSFUL PILOT IN ITALY: 20 LEAKS FOUND IN BRESCIA'S WATER PIPELINE

By Aquarius Spectrum

Founded in 2008, A2A S.p.A. is considered the biggest multi-utility in Italy with more than 12,000 employees, 6.5B annual Rev. It generates, distributes, and markets renewable energy, electricity, gas, integrated water supply, and waste management services. From its headquarters in Brescia, Italy, A2A CicloIdrico (a company of the A2A Group) operates more than 3,000 kilometers of iron water pipes, serving citizens in the Municipalities of Brescia and neighboring towns.

As part of A2A's intensive efforts to increase their efficiency, they have looked for advanced technologies that will enable them to reduce their water loss and energy costs. A2A was impressed by the solutions offered by Aquarius Spectrum, an innovative Israeli company. Based on their robust design of acoustic sensors and cloud-based software that analyzes the data received, Aquarius can trace all the hidden leaks in the water supply network's pipes and calculate their exact location. In addition to the leak detection, Aquarius' system can offer an assessment of pipes condition.

In September 2019, the company initiated a leak detection pilot with Aquarius which was carried out in Brescia City. Based on A2A's GIS data, Aquarius planning department prepared a detailed plan for 39 belowground acoustic correlating sensors that cover around 15 km of pipes (Figure 1).

Following the planning phase, the sensors were installed by Aquarius Technician Engineer Ehud Ben-Menahem accompanied by A2A local team.

It should be noted that the pilot site is close to Brescia's football stadium and despite heavy traffic disruptions due to an important match, within 2 days all 39 sensors were installed and activated (Figure 2).

During the first week, 10 hidden leaks were found. One of them was a huge leak that has surfaced on the ground within a few hours from its time of detection. The final step of the pilot was verification and pinpointing of POI raised by the AQS-SYS. A2A team together with the Aquarius

Aquarius' solutions enable water utilities to proactively monitor their network, trace leaks, and pinpoint their exact locations automatically on a daily basis while analyzing the condition of pipes.

technician used Aquarius' mobile leak detection equipment - the iQuarius™. This system is the first of its kind in the world, allowing non-expert field personnel to perform manual leak surveys, pipe listening, and correlation - with all equipment packed into a portable, easy-to-carry, and operational kit. In total, 20 leaks have been verified and fixed in just a few months (Figure 3).

Thanks to the successful pilot, the utility has purchased 235 AQS acoustic sensors that will allow it to continue monitoring the current area and expand to additional areas.

A2A S.p.A. is considered the biggest multi-utility in Italy with more than 12,000 employees, operates more than 3,000 kilometers of iron water pipes. As part of A2A's intensive efforts to increase their efficiency, they have looked for advanced technologies that will enable them to reduce their water loss and energy costs.

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Thanks to the successful pilot, the utility has purchased 235 AQS acoustic sensors that will allow it to continue monitoring the current area and expand to additional areas. The project continues to be accompanied by the support of Aquarius' technical team.

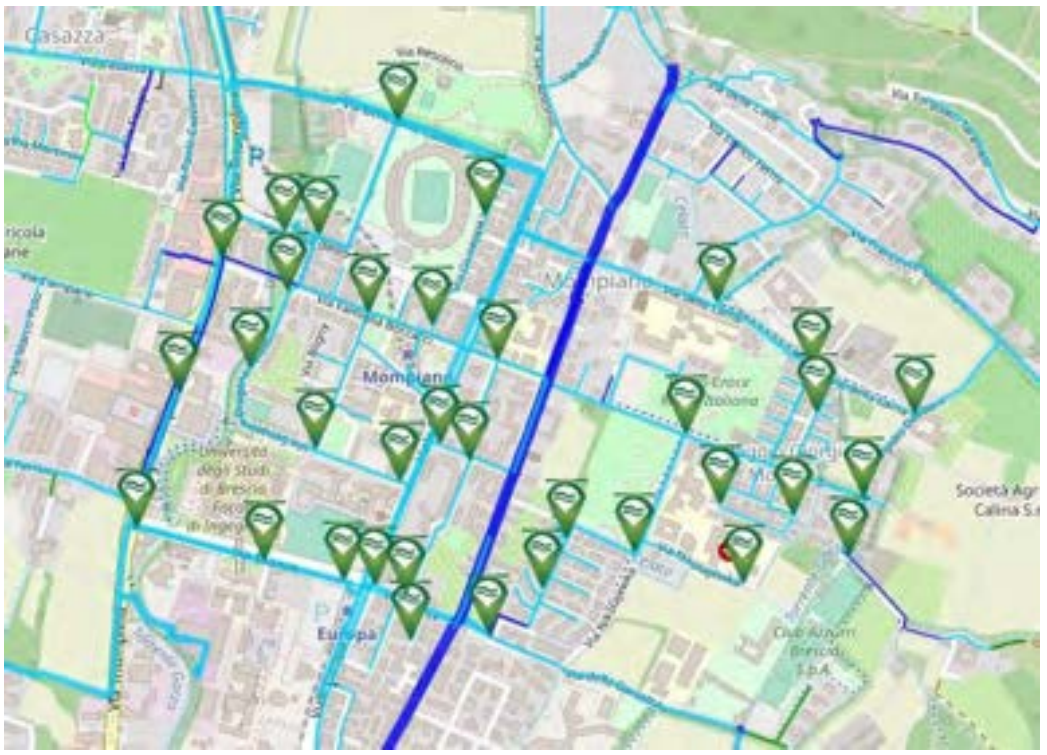


Figure 1: Sensors Installation Planning

The project continues to be accompanied by the support of Aquarius' technical team.

Oded Fruchtman, CEO of Aquarius, said "We are honored to work with Italy's largest multi-utility and to lead innovation in the water industry together with A2A CicloIdrico. We were delighted with the initiative that came from Manuel Intini, from the Innovation team of A2A, who visited Israel and met the Aquarius team. We also cherish Stefania Giacomelli, Luca Massafra, and Anthony Napolitano from A2A's Water Network Operations Unit, for their professional support throughout the project. Hopefully, we will have more common successes in the future as well."

Tullio Montagnoli, CEO of A2 AcicloIdrico noted that "As a veteran company in the water market, we are closely acquainted with the challenges of leakage and know quite a few technologies and solutions in this area. We are very glad about our decision to go with Aquarius' proven technology by which we achieved great immediate and accurate results in a short time. The Aquarius professional team also shows great dedication and responsibility for our projects at all stages".

Aquarius' solutions enable water utilities to proactively monitor their network, trace leaks, and pinpoint their exact locations automatically on a daily basis while analyzing the condition of pipes.

To date, the company's technology is monitoring thousands of miles of municipal water pipelines, helping water utilities reduce their Non-Revenue-Water (NRW) and their Maintenance and Operational (M&O) costs by using highly sensitive fixed and mobile acoustic sensors while applying

Figure 2 A: AQS Underground Acoustic Sensor Installation

Figure 2 B: AQS Underground Acoustic Sensor Installation

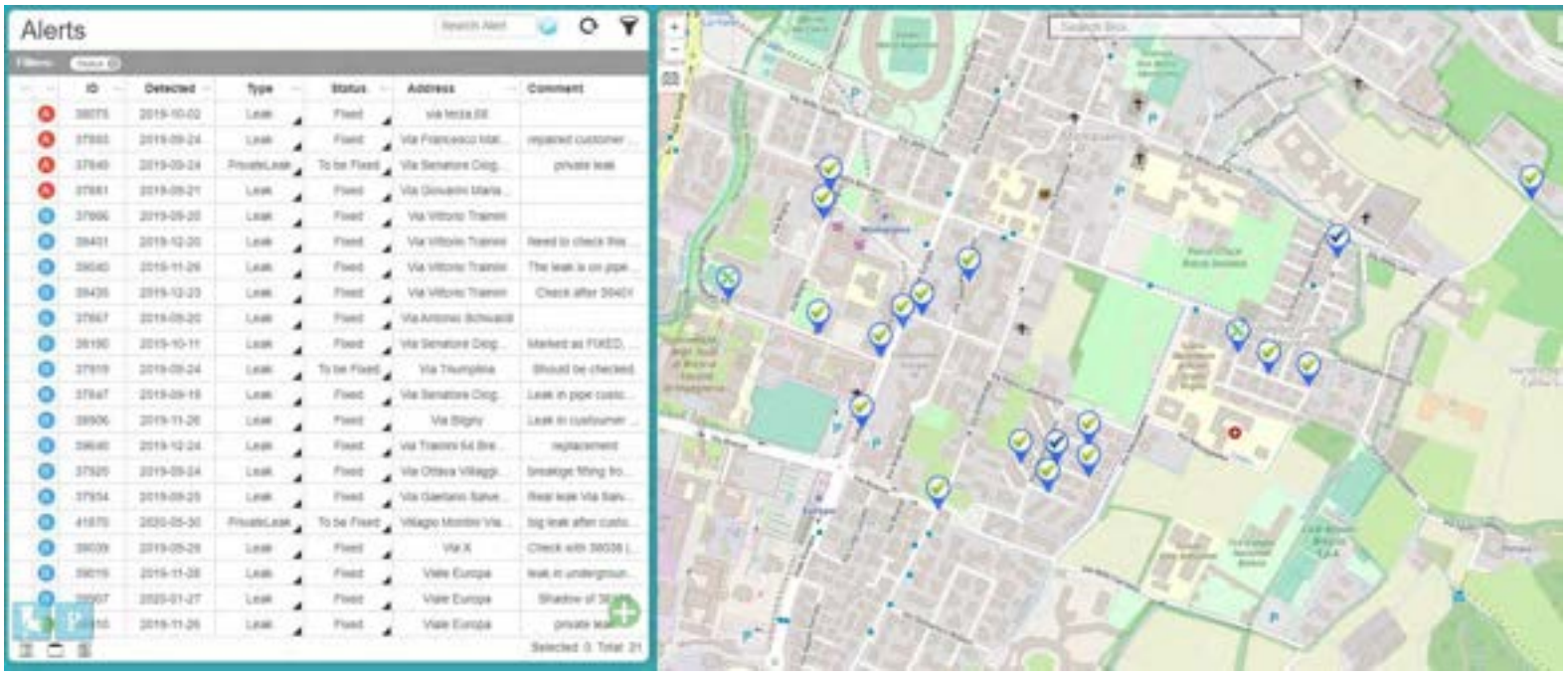


Figure 3: Acoustic Map of Suspected Leaks on the AQS-SYS UI

big data analytics. All this results in billions of gallons of water savings.

About the Contributor

Aquarius Spectrum *is a leading provider of advanced leak detection and pipe condition assessment solutions based on fixed and mobile acoustic sensors combined with AI and big data analytics algorithms. Using its multi-patented technology, water utilities around the world significantly reduce their non-revenue water, and lower Maintenance and Operational (M&O) costs through continuous proactive monitoring of their water distribution network, early detection, and pinpointing of background leaks and accurate analysis of their infrastructure.*

ANALYTICS, SOFTWARE, WATER DATA MANAGEMENT

MIGRATING ENTIRE DATA ANALYTICS TO A NEW MODERN STANDARD

By Nicole Nally

South Australia is the driest state on the driest continent, yet it has one of the world's largest artesian basins in the world, stretching 1.06 million km^2. The Murray River Basin supplies irrigation for large-scale diverse agriculture and supplies drinking water to the 1.3 million residents living in the City of Adelaide.

The Department of Environment & Water (DEW) is responsible for the vitality and sustainability of this water ecosystem which involves monitoring and managing a lot of data to ensure fair water sharing, flood control, and maintaining water quality through controlling barrages that open the lower lakes to the ocean.

In 2015, the Premier of South Australia mandated an open data policy requiring all public agencies to make their data accessible by the public. Peter Baylis, Project Manager at the Department of Environment & Water, said, "Around the same time, we had a public scientist requesting data on the salinity of water as it passes through the system. While we were collecting lots of data, our old system was not capable of analyzing and displaying the information in a meaningful way. After an in-depth search, we still could not find the data he was requesting. It was clear that we needed something modern and intuitive so our employees and other stakeholders could get what they were looking for in a timely manner."

DEW went about the next logical step of upgrading their data management system but determined their aging legacy system couldn't support Open Data or provide the Australian Bureau of Meteorology (BoM) and the South Australian State Emergency Service (SES) with real-time data for emergency flood management. "This was a timely and painful exercise, and the data was unreliable", said Peter.

South Australia's Department of Environment & Water Migrates their entire data analytics to the new modern standard improving reliability, accuracy, and accessibility.

Another challenge that DEW and many of its partner agencies are facing is an aging workforce on the verge of retirement. These personnel hold vast knowledge and a deep understanding of the idiosyncrasies of a legacy system that come with experience. The new generation has been

The Goolwa Barrages are used to reduce salinity levels in the lower reaches of the River Murray

> ***"While we were collecting lots of data, our old system was not capable of analyzing and displaying the information in a meaningful way. It was clear that we needed something modern and intuitive."***
> ***- Peter Baylis, Project Manager, Department of Environment & Water***

raised on cutting-edge technology that is intuitive and user-friendly; learning a legacy system is not only unproductive, it is also demotivating.

The overall legacy system's poor performance came to a head during a severe weather event in 2016 that resulted in a statewide power blackout that caused a major disruption to the water data network and security, followed by flooding from the storm. "This was a wake-up call for us", said Peter, "There was no redundancy in the system to deal with a simultaneous power failure and flood event, and we only had one experienced IT person who was able to jerry-rig a solution on his laptop to access the critical data we needed to manage the flood water."

In the search for an intuitive and reliable data management system, DEW developed a comprehensive wish list of 117 features from all their stakeholders and invited three companies to demonstrate what they could satisfy on the list. "It was by far the most comprehensive two-hour showcasing of the Aquarius capabilities, but DEW has an enormous responsibility in managing the Murray River Basin, and what they were asking for was an absolute necessity to doing the job right." said CEO of Aquatic Informatics, Ed Quilty, who worked with the project team to ensure all the requirements would be met.

With over 3,200 monitoring locations and 17,000+ data sets, DEW delivers critical information to several external stakeholders such as BoM, SES, and Murray-Darling Basin Authority (MDBA). There are also several DEW business units working with that data, including surface

Barrages on the Murray River play a vital role in fresh water irrigation

water operations, surface water science, groundwater operations, groundwater science, and IT. Needless to say, the enormity of the project and the importance of getting it right required two years of product development and another year for deployment to all stakeholders.

The complexity of the project required the use of the full Aquarius software suite to acquire, process, and model DEW's data in real-time. Dedicated team managers from DEW and Aquatic Informatics migrated the old data to the new system to ensure no historical information was lost; this would prove especially advantageous in using the new program's trend and prediction analytic tools. The project team also worked to configure the functionality to meet the specific needs of DEW and its stakeholders.

A critical component of the project involved the enablement of real-time decision-making for the operation of the Goolwa Barrages. The barrages play a vital role in South Australia's ability to provide fresh water for irrigation. Comprised of five low-head diversion dams with gate control, the Goolwa Barrages are used to reduce salinity levels in the lower reaches of the River Murray and the associated lakes, as well as limit the reverse flow of seawater into the lakes during storms, high swells, and high tides.

Prior to this project, essential calculations used in the operation of the barrages were being done in Excel and then emailed to South Australia Water (SAW) operators at Goolwa. The SAW operator then opened the gate and emailed DEW to confirm which gate or gates had been opened. Since moving to Aquarius, SAW operators now access a new Goolwa barrage calculator through a real-time dashboard that is easily accessible. Prior to Aquarius, this process took three hours; now all data and actions are in real-time, and both parties have visibility into gate status through the shared dashboard.

One key issue the new software was required to solve was the ability to quickly process large amounts of data and to subsequently make said data available to stakeholders in an easy-to-understand format. "The old system limited how

many surface water sites we could poll during a severe storm event and also the frequency at which we could pull the data. This meant we sometimes had to make a difficult compromise regarding which sites would be updated during storm events, and which ones would miss out on the regular update cycles" said Peter. Access to all data during times of crisis enables better, more informed decision-making. Access to all network data was a critical requirement for Murray river operations and other surface water sites during significant rainfall events. The new system allows DEW to poll all surface water sites at five-minute intervals with no loss of data, enabling SES and MDBA to act quicker and have confidence in the accuracy of the data.

Auditing and tracking were other important areas that Aquarius was brought in to fix. The old data review and approval process was time-consuming and as a result would sometimes be overlooked, which compromised data integrity. The new program automates this process and gives field managers the ability to audit grade thresholds for uploaded data on a monthly basis. "Now when publishing data to external agencies like BoM or our internal customers, we have greater confidence in the information presented and our ability to trace any adjustments back to the source or raw data", said Peter. This is significant when the MDBA or other Commonwealth agencies question the provenance of the data and processes around data governance.

Project team for implementing Aquarius (from left to right): Peter Baylis, Chuck Springer, Graham Blair, Jennifer Harris

> ***"DEW has an enormous responsibility in managing the Murray River Basin, and what they were asking for was an absolute necessity to doing the job right."***
> ***- Ed Quilty, CEO, Aquatic Informatics***

The new software is designed to automate workflows by extracting data, turning it into meaningful information, and making it available to stakeholders that require it to do their job. By automating processes, human error from manual entry is reduced, and by using complex algorithms the data becomes more meaningful. In addition, the intuitive user interface for the Aquarius platform makes it easy for anyone to input or retrieve data regardless of their device. This is especially valuable for the next generation of employees to easily access information from anywhere and draw insight from the data to improve the management of water resources, without having to learn how to navigate a legacy data system.

"Now I feel confident as I retire, that DEW's data is in good hands and that the new employees have the right tools to ensure the Murray River Basin continues to be sustainably managed for generations to come", said Peter.

About the Author

Nicole Nally *is the Aquatic Informatics Regional Manager for Oceania and Asia. Aquatic Informatics provides software solutions that address critical water data management, analytics, and compliance challenges for the rapidly growing water industry. Water monitoring agencies worldwide trust Aquatic Informatics to acquire, process, model, and publish water information in real-time.*

BIOLOGICAL TREATMENT, DOMESTIC SEWAGE, REED BED, STP

SEWAGE TREATMENT PLANT BASED ON ROOT ZONE TECHNOLOGY AT A RESORT IN RANTHAMBORE

By Manish Choudhary and Mayank Mohit Mishra

INTRODUCTION

Sewage Treatment by Root Zone Technology (RZT) is very unique, adaptable, and economical biological wastewater treatment system that utilizes wetland plants, filter bed media, and micro-organisms to the constructed natural wetland eco-systems processes for the treatment of domestic wastewater with any external energy source.

Root Zone Technology term is used to cover the biological activity among different types of microbes, the special roots of aquatic plants, filter bed media like gravel, sand, and pebbles, and the sunlight.

This technology consists of planted filter-beds containing gravel, sand, and pebbles.

The Root Zone Technology (RZT) system is a nature's way of biological treatment of domestic sewage.

This effective and unique technology is also known as Decentralized Wastewater Systems (DEWATS), which was developed in the 1970s by Germans and has been successfully installed in the entire world.

The root zone wastewater treatment system makes use of both the biological and physical-treatment processes to remove pollutants from wastewater.

Due to its natural process, there is no need to add any input such as chemicals, mechanical pumps, or external energy.

This reduces both the maintenance and energy costs.

WORKING OF REED BED TECHNOLOGY

The reeds are planted one foot in the center throughout the bed.

Aerobically stabilized sludge or effluent is typically applied uniformly through a grid-perforated tile.

Sludge or effluent must be well stabilized, 60% volatilized or less to be used successfully with reed beds.

Optimum application rates range between two and four percent solids. While plants are young they should be watered with plant effluent.

After they are established, they can be fed heavier sludge mixtures. Loading rates in main are typically about 45 gallons per square foot per year for well-established beds.

The Phragmites is one of the most widespread flowering plants in the world.

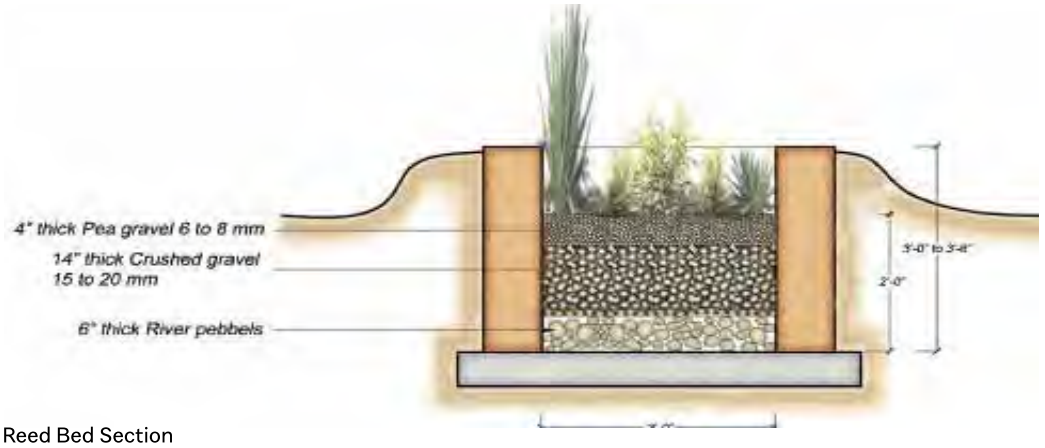
It is a tough adaptable plant, which can grow in polluted waters and find sustenance in sludge.

This reed has a voracious appetite for

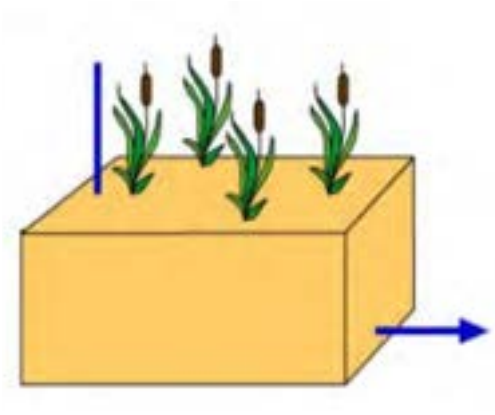
water. The plant is tolerant to low oxygen levels and waterlogged conditions. The reeds hold themselves in the soil through roots and rhizomes, an intricate network of

FEATURES OF REED BED TECHNOLOGY

- **OPERATION AND MAINTENANCE-FREE: The reed bed system has no mechanical/ moving parts. There is no wastage of energy as mechanical aeration is not needed.**
- **CLEAN AND EFFICIENT: Since all chemical, physical and biological changes occur underground, there are no strong odors or sludge formation.**
- **SELF-SUSTAINING AND LONG-LASTING: Once installed and become operational, the reed bed system can sustain itself for more than 40 years.**
- **ADAPTABILITY: The reed bed systems are suitable for concentrations from a few mg/l to 20,000 mg/l of COD and 400 mg/l of nitrogen. Their capacity varies from about 1 m^3/day to more than 10,000 m^3/day.**
- **ABILITY TO HANDLE DIFFICULT EFFLUENTS: As the reed bed system has a diversity of microbes and the wetland and the plants, it can adapt itself to diverse types and varying shock loads of effluents, including difficult wastewaters containing organic compounds like Chlorinated Hydrocarbons, dyes, and Sulfur-containing aromatics. Nitrogen compounds such as Ammonia and Nitrates. Sulfur compounds like Sulfides and Sulfates. Heavy metals and pathogens.**
- **FOR TERTIARY FILTRATION: Agro waste containing fiber and cellulose could be applied. Agro waste easily may be converted as biofertilizer also after use.**



Reed Bed Section



Vertical Flow Wetland

underground stems. New plants in turn will sprout from these stems.

These rapidly growing roots provide air passages through the sludge which in turn provide a host area for many biological communities to develop and continue to mineralize the sludge.

Reed beds perform three basic functions:

Site Plan: Location of 11 Nos. Root Zone Technology Plant

(1) dewater the sludge, (2) transform it into mineral and hummus-like components, and (3) store sludge for several years.

Dewatering is accomplished through evaporation (as in a normal sludge drying bed operation); transpiration through the plant root stem, and leaf structure; and filtration through the bed's sand and gravel layers and the plant's root system.

Leachate is channeled back to the treatment plant through the underdrain. The plants should be harvested annually to prevent drainage backup. The vegetation can be composted or burned.

MICROBIAL ACTIVITY

Micro-organisms attach themselves to the outside of the gravel or soil particles and the plants and plant roots. These organisms metabolize polluting chemicals, degrading and mineralizing them.

Commonly reed beds are used to degrade sewage, but with higher retention times even intractable compounds such as PAH, PCB, dyestuffs, amines, and glycols can be treated.

THE ROLE OF PLANT

The specially selected plant species (Phragmites species e.g. Phragmiteskarka and Typhaangustus) within the reed bed have the following three main functions: They provide the means for secondary restructuring of the soil system.

The very extensive root and rhizome system create channels for the water to pass through and also keeps the soil open through constant growth.

The roots of the aquatic plant introduce atmospheric oxygen down into the body of the soil, facilitating the diversity of micro-organisms to flourish around the plant roots.

It is essential for the effective breakdown of various organic and inorganic compounds. The plants are capable of taking up a certain amount of nutrients from the wastewater itself.

CHOOSING MEDIA

The choice of bed media, gravel, soil, or sand, is dependent upon the particular application requirements. Gravel is less active microbiologically but allows a faster throughput of water.

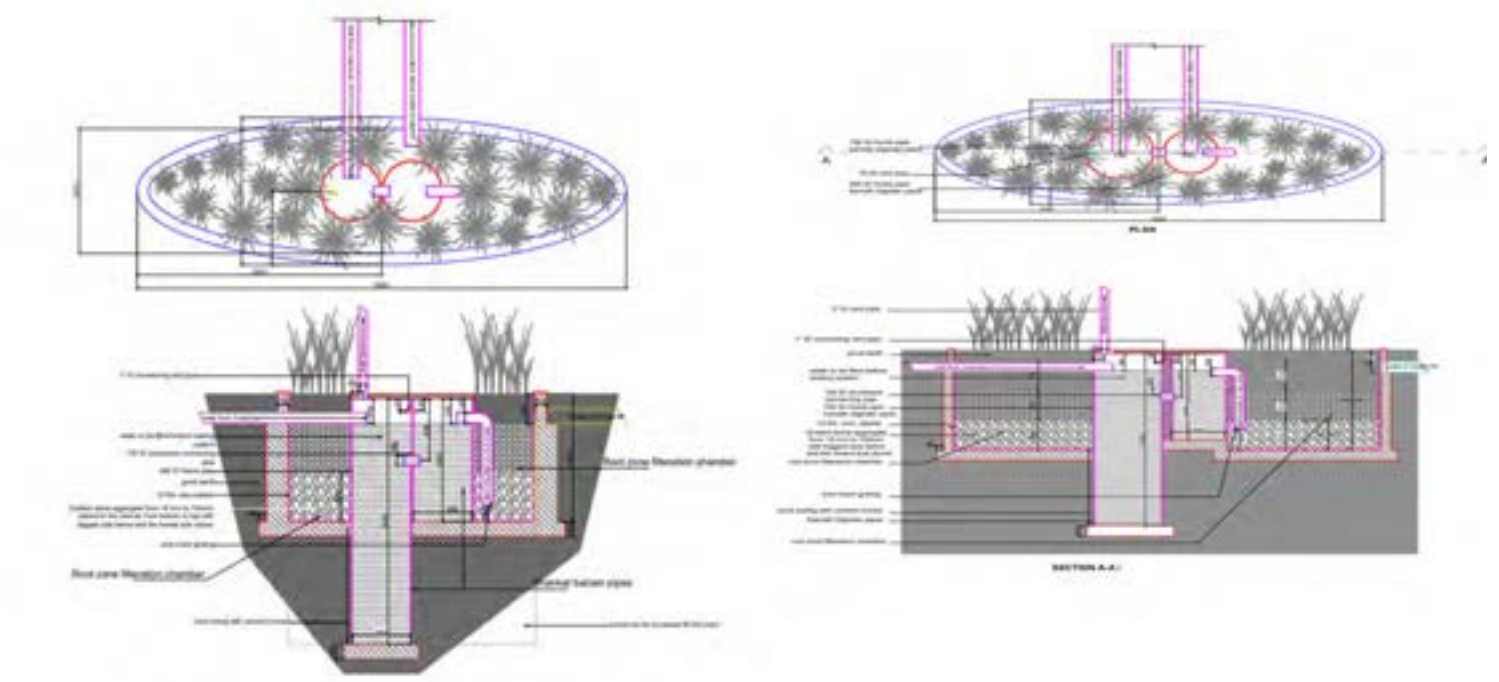
For this reason, gravel has commonly been used in secondary and tertiary sewage treatment applications and in mine wastewater treatment where the plants help to keep the water oxygenated thus encouraging the deposition of insoluble metal ions precipitates. Soil has commonly been used for primary and secondary treatment of industrial effluents.

Certain soil minerals encourage the deposition of metal ions, phosphate, and sulfate. Soils can therefore be custom-engineered to treat particular effluent streams. In addition, the ability of clay particles to entrap polluting chemicals means that the soil system can cope with shock loads.

DESIGN CONSIDERATIONS

Reed beds should have the following:

- Impermeable liner or base to protect groundwater.
- Outer walls 6 to 8 feet high made of concrete with footers.
- Loading of liquid biosolids from manifold and risers along the long sides, typically three per side.
- Beds of up to 100 feet long and up to 50 feet wide.
- Adequate access for bed clean-out.
- The beds should be sized based on allowable loading rate and biosolids production during the winter and early spring dormant phase.
- Design the beds with enough redundancy so that, after six years, one bed at a time can be removed from service to dry out, remove solids and re-establish the plants.



Layout Plan: Root Zone Technology Plant

REED BED BASED ON THE TYPE OF CONSTRUCTION

Down Flow or Vertical Flow (VF), this design requires dosing of the bed's surface using a network of pipes using either pumping or a siphon system. The idea is to flood the surface of the reed bed several times per day. As the water flows down through the bed, it draws air in, creating the right bacterial environment. VF reed beds are very effective in the removal of BOD, ammonia, and some heavy metals and take up less area for similar treatment compared to SSHF. The efficiency of SSHF and VF reed beds may be improved by adding certain chemicals to the water during the treatment. This dosing technique can be used for COD or phosphorous removal in industrial process water, for example. Water can be treated progressively through multiple reed bed stages and some or all of the above systems can be incorporated into a complete treatment system.

ADVANTAGES

- Reed beds have relatively low operational costs compared to conventional biological treatment systems. As flow through the system is governed by gravity, there are no requirements for pumping once the effluent is in the reed bed. Similarly, as aeration is facilitated by the reeds, there is no requirement for blowers to aerate the system. As such, there are no mechanical or electrical requirements.
- They do not produce sludges, a significant problem in the operation of conventional biological systems.
- Due to the low-tech nature of reed beds, there is no requirement for highly trained operators.
- As the degradation of the organic

Various Stages of Construction - Part I

Various Stages of Construction - Part II

content of the effluent occurs within a solid matrix, it should be free from odor.

- High adaptability to both concentration and content of effluents. As reed bed systems have a high diversity of micro-organisms, they may adapt to diverse types and varying shock loads of effluents, including difficult wastewaters containing organic compounds, such as chlorinated hydrocarbons, dyes, sulfur-containing aromatics, and heavy metals and pathogens.
- Established technology
- Natural-looking
- Good pathogen removal due to die off predation
- Minimal maintenance
- Can use a wide range of water plants
- Robust
- Treated water if fit for non-potable use: surface application, irrigation, and discharge to receiving water bodies

DISADVANTAGES

- While capital costs of reed beds vary,

Various Stages of Construction - Part III

the beds can significantly reduce staff hours and costs required to dewater with conventional sand drying beds or with mechanical systems such as a belt press or centrifuge.

- For dewatering equipment, you need a separate building and you also have to pay people to haul the sludge away and landfill.
- It costs a lot to run even a small belt press, so if you have the land available, reed beds may make sense.
- The only disadvantage is there can be some odor in the spring when the ice melts, but that usually only lasts a couple of weeks. So, use a concrete bottom instead of a PVC liner. Operators have to be careful that they don't go through the liner when they clean out the beds.
- The importance of protecting the perforated pipes and the drains from damage. During clean-out or maintenance, the weight of even a small front-end loader can crush the underdrains.
- One misconception is that the reeds can spread and become invasive. It was thought that the roots would start to re-grow in the fields, but that's not a problem if the soils are well-drained.

ROLE OF PLANTS

- Provide beauty, making people more likely to care for the system
- Transport air to their roots, which may enhance treatment locally
- Release selective biocide compounds, killing harmful microbes
- Provide physical filtration and electrostatic attraction of small particles
- Provide habitat for micro-organisms and larger consumer organisms
- Take up some heavy metals

WATER REUSE POSSIBILITIES AFTER TREATED WASTEWATER FROM SOIL BIOTECHNOLOGY

- Gardening
- Toilet flushing
- In construction activities and industrial floor washing
- Car washing
- For HVAC (Heating, Ventilation, and Air Conditioning), cooling towers
- Groundwater recharge after getting desired norms of SPCB
- Release to water bodies

Water Usage for Toilet and Kitchen	2 KLD
Number of Users	30
Area of Reed Bed	11 m^2
Cost of Construction	Rs. 800,000

ROOT ZONE TECHNOLOGY (RZT) AT RANTHAMBORE

At Madhu Shree Tribal Resort, Ranthambore location, vertical flow root zone technology has been adopted to treat the wastewater.

Primary treatment takes place in the settler/ septic tank, where the sludge settles down and scum floats in the top and the clear liquid flows to the collection chamber. From this chamber, water is pumped using a small manually operated pump to the root zone treatment system for secondary level treatment.

The secondary treatment takes place in the root zone system where the removal of nitrates and phosphates takes place by plants and through its root system injects oxygen to the wastewater which flows in the gravel bed.

The final treated water collected in the storage tank is pumped and used for horticulture purposes.

WATER QUALITY COMPARISON

	Raw Water	**After Reed-Bed Treatment**
pH	7.4	6.8
Total Suspended Solids in mg/l	226	18
Chemical Oxygen Demand	335	96
BOD for 3 days at 27°c	69	24
Oil & Grease	4.2	<2

About the Authors

Manish Choudhary *is working in CIPET Lucknow as an Assistant Professor since*

2012. He is an alumnus of IIT Roorkee. Currently he is pursuing his Ph.D. and his research area is polymer composite, biodegradable polymer films, and wastewater treatment.

Mayank Mohit Mishra *works with an MNC as Manager - Proposals. He has a Bachelor's*

Degree in Chemical Engineering, and pursuing Master's degree in Environment with 12 years of work experience in water and wastewater treatment for different industries and has been involved in the selection of technologies, troubleshooting, and cost optimization of the biological treatment in various wastewater treatment technologies.

MUNICIPAL
WATER, SENSORS,
SLUDGE, SOLIDS,
STP

OPTIMIZING SOLIDS DRYING AT WROCŁAW SEWAGE TREATMENT FACILITY IN POLAND

By Jerzy Zarówny, Marcin Pieciuk, Artur Hanc, Marcin Święch and Rafał Polak

PROBLEM

The initial operation of a new solids drying process was plagued with maintenance issues, high-energy requirements, and lower-than-predicted throughput.

SOLUTION

Installing sensors with prescriptive tools to continuously collect and correlate data on nearly 500 variables led to saving more than 3,00,000 USD per year.

In the first few months following the start-up of the Wrocław Sewage Treatment Plant, the operation of the solids drying installation encountered several technical problems.

Uneven operation of the dryer rotor drive and periodically occurring load jumps forced a significant reduction in the feed of dehydrated sludge to the installation, well below its nominal capacity.

Additionally, accelerated erosive wear of the dryer elements was seen, mainly in and on the stator surfaces and blades.

During the initial operation phase, with the support of the technology provider and the implementation of several improvements, continuous operation of the facility was achieved.

However, the design operating capacity was not met. Due to frequent maintenance interventions, the installation consisting of four process lines could not operate at its full capacity.

Because one or even two lines were repeatedly out of service for overhauls, the facility reached 60% of its nominal capacity at the most.

Despite the addition of special, highly abrasion-resistive coatings, the achieved time between overhauls of individual lines was still only about 3000 hours of operation. The energy consumption was approaching the level assumed in the design documentation; the thermal energy consumption index, depending on the season, was between 0.802 and 0.860 kWh per kilogram of evaporated water; the index for electricity was 0.0877 kWh per kg of evaporated water.

However, the team from the Municipal Water and Sewerage Company in Wrocław deemed these values unsatisfactory.

The mechanics of the drying rotor are very complex. Shown here during inspection, this equipment needs to be adjusted carefully to avoid damage and optimize performance.

SEEKING INSIGHTS

The MPWiK team reached out to Elmodis to deploy its prescriptive tools.

It was hoped that these would optimize the operation and maintenance management of process equipment such as pumps, fans, blowers, mixers, and more.

A solution that fully optimized the operation of the system mentioned above.

The system was implemented for the key process drives of the dryer and auxiliary machines. Figure 1 shows the scheme of installation and metered devices.

The Elmodis system continuously collects and correlates data on nearly 500 variables, including electrical signals from motors, vibration signals from sensors, process variables from instrumentation, and other data from the existing programmable logic controllers and distributed control systems.

As a result of the work done and the analytics provided by the Elmodis system, the key parameters determining the proper operation of the solids dryer were identified as follows:

- Stable temperature of the heating source
- Adequate, regulated temperature of the heating source
- Proper, adjustable rotation of the dryer rotor, and
- Proper alignment of the rotor blades

IMPLEMENTING FIXES

To address these issues, the thermal oil heating system was then modernized and additional controls for thermal oil temperature and rotor speed were introduced.

RESULTS OF IMPLEMENTATION

Parameter	Before	After	Improvement	Financial Effect
System Capacity	25,850 Mg	60,000 Mg	~ + 35,000 Mg	
Energy Intensity Index for Thermal Energy	0.83 [kWh/kgH_2O]	0.7 [kWh/kgH_2O]	– 0.13 [kWh/kgH_2O]	$160,700/year
Energy Intensity Index for Electricity	0.0877 [kWh/kgH_2O]	0.055 [kWh/kgH_2O]	–0.0327 [kWh/kgH_2O]	$167,105/year
Inter-Renovation Period	Every 6000 hours; every 3000 hours, in reality	Every 8000 hours	+2000 hours; +5000 hours, in reality	$756,000 (2019-2020)

Table 1 [Note: Values in Polish złoty (PLN) were converted to U.S. Dollars (USD) at a rate of 1 PLN = 0.27 USD]

The Elmodis sensors and controllers were installed throughout the system, such as in this inverter cabinet, to measure more than 500 parameters involved in the dryer system operation.

Process fan capacity control was implemented along with the cleaning cycle of the process air system.

The operating instructions for the system were updated and supplemented accordingly.

The following parameters were established to define the optimal process of solids drying:

- Solids feed rate
- Dryer rotor drive load current
- Final product SM value
- Process air fan efficiency
- Thermal oil temperature (temperature range and stability)
- Rotor speed
- Process air temperature at the dryer outlet, and
- Process air temperature at the dryer inlet

The synergy created by combining Elmodis technology and the utility team's knowledge and experience enabled the development of a prescriptive maintenance solution.

It led to the right control and maintenance recommendations for overall process optimization.

Achieving the described results was possible thanks to several methods:

- Statistical analysis based on the high-frequency time-waves of electrical signals,
- Deep analysis of the correlation of parameters related to the process and technical conditions, and

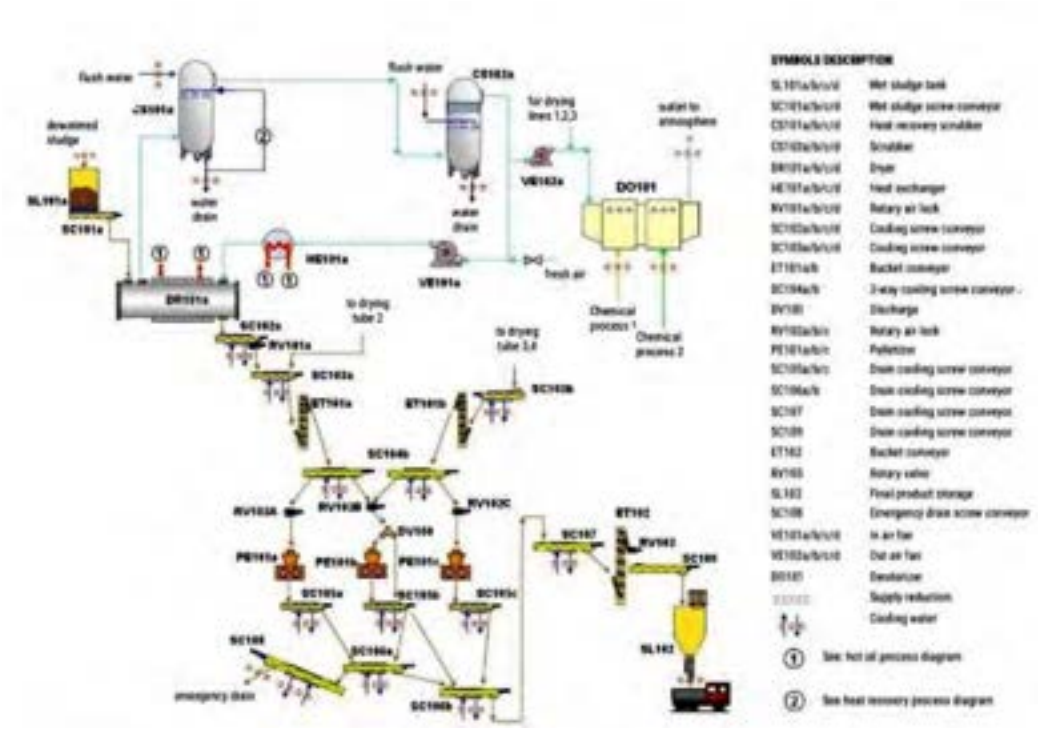


Figure 1: Dryer installation diagram

the change in results after the project implementation. Overall, the estimated reduction of costs resulting from improvement of energy-efficiency indicators is $327,805 per year - that is, $160, 700 saved in heat energy and $167,105 saved in electricity.

Continuous data from the Elmodis system has eliminated the overloading of the drive. It is associated with stabilizing the conditions for solids transport inside the dryer, which reduces the erosive wear of blades and stator surfaces. Consequently, maintenance intervention frequency improved significantly compared to the design assumption of 6,000 h and the actual of 3,000 h, that was being experienced. After almost 2 years of operation in new, stable conditions with the support of the Elmodis system, an operating time between major overhauls of 8,000 h was achieved. The savings resulting from the extended operating time in 2019-2020 resulted in the execution of eight instead of the originally planned 16 overhauls.

- Prescriptive multi-dimensional key performance indicators and process parameter analysis combined with machine learning models.

As the result of the project implementation, currently, the design capacity of four drying process lines is normally achieved by operating three lines. Table 1 shows

About the Authors

Jerzy Zarówny *is Manager of the Maintenance Department and* ***Marcin Pieciuk*** *is Senior Technical Supervisor in the Maintenance Department at the Wrocław Sewage Treatment Facility of MPWiK S.A.* ***Artur Hanc*** *is Co-founder and CEO,* ***Marcin Święch*** *is Co-founder and CTO,* ***Rafał Polak*** *is an R&D engineer specializing in control systems, data processing & simulation, and a Researcher at the Institute of the Polish Academy of Sciences.*

AIRLIFT PUMPS, AQUACULTURE, CFD, FLOATING RACEWAYS

HELPING A LARGE SCALE FISH FLOATING RACEWAY IN ONTARIO

By Dr. Sherif Abdou and Dr. Wael H. Ahmed

INTRODUCTION

An airlift pump is a device that utilizes the principles of buoyancy of pressurized injected air at the base of a submerged riser tube to act as pneumatic pistons to lift the submerged water to the top of the riser tube.

These pumps have been used in the oil and gas industries, as well as in the wastewater industry.

The increase in knowledge and understanding of two-phase flow have made it possible to study and analyze the various parameters that affect the performance of an airlift pump.

This has led to improved pump designs that maximize the efficiency and performance potential.

Using airlift pumps in industries where a supply of pressurized air is readily available, such as in the aquaculture industry, can reduce the complexity of the system while enhancing its performance. The operation of an airlift pump involves injecting compressed gas at a certain depth below the fluid level in a partially or fully submerged pipe.

This creates an interaction between the gas and the liquid, thus creating a two-phase flow system. Since most gases are far less dense than liquids, the gas starts to rise in the up riser pipe. The forces acting on the gas-liquid mixture are buoyancy, which acts as the lifting force, as well as inertia and gravity, which act as the opposing forces. When the lifting forces are large enough, the liquid rises along the pipe to the level at which the acting forces are equal.

The performance of an airlift pump is tied to the submergence level of the airlift system, the up riser pipe diameter, and the two-phase flow pattern experienced in the pipe. The submergence level is quantified through a parameter called the submergence ratio. This ratio represents the amount of static lift in comparison to the total lift of the airlift system. The submergence ratio is the most significant parameter affecting the operation of airlift pump systems.

In this study, FloNergia FloMov™ airlift pumps are used. A 1-inch FloNergia FloMov™ pump was used in a laboratory

Izumi Raceway

system at the University of Guelph to determine the performance curves of the FloNergia FloMov™ airlift pump system and to perform CFD methodology validation. A set of four 4-inch FloNergia FloMov™ pumps were used for the fieldwork.

This fieldwork was carried out at Izumi Aquaculture in Aberfoyle, Ontario, Canada to investigate the operation of such pumps in a floating raceway system designed for depleted quarries using FloNergia FloMov™ airlift pumps measuring velocity profiles across the raceway.

The field study results were then used to verify the results of the CFD model for a raceway simulation.

REUSING DEPLETED QUARRIES AS FISH FARMS

As armor stone and limestone quarries in Ontario, Canada are depleted of their mineral wealth, they create a challenging problem of site rehabilitation for the property owner. Izumi Aquaculture has developed a viable alternative by turning these facilities into steelhead salmon fish farms managed using floating raceway technology.

WHY A FLOATING RACEWAY?

Floating raceways offer a new opportunity to develop aquaculture production capacity. Because raceways provide solid-walled containment of fish, the ability to manage fish and fish wastes is comparable to traditional land-based

Izumi FloMov Pumps Installed

SUMMARY

Currently, very few aquaculture operations are employing airlift pump technology for water recirculation, aeration, and waste removal. This is likely due to the poor design and lower efficiency of traditional airlift design, the limited amount of research effort that has been invested in improving performance capabilities of airlift pumps, and the general lack of awareness of the industry about the inherent advantages of airlift systems. A new efficient airlift pump is hydrodynamically designed by incorporating the Volume of Fluid (VOF) multiphase model along with Computational Fluid Dynamics (CFD) tools.

The pump is designed to offer a substantial reduction in total energy usage as well as an improved quality of the culture products in order to make it attractive to the aquaculture industry. In this case study, both numerical and experimental investigations were carried out for airlift systems operating under two different submergence ratios of 50% and 90% in a lab setting using 2.54 cm diameter pumps.

Additionally, the performance of large-scale pumps of 10.16 cm diameters were tested in an aquaculture raceway to determine its effect on the operation. The numerical results were found to be in agreement with the experiments within ±20% which is considered very reasonable for multiphase flow analysis. The study is in the development of an exceptional tool for modelling the airlift pump performance, and for the successful integration of these pumps into aquaculture systems.

farms and facilitates similarly high rates of feed conversion. Floating raceway technology provides control over water quality, temperature modulation, removal of settle-able solids (uneaten fish feed and fish waste), dissolved oxygen levels, and water velocity. Since the raceways sit in water, pumping and circulating water through the raceways is extremely energy efficient with overall capital and operating costs that are comparable to the low cost of production in net pens. When floating raceways are located within confined ponds with no surface discharge or outflow there is no chance of fish escaping to the broader environment or for any nutrient discharge to nearby receiving waters.

INSTALLATION

An airlift pump system consisting of four 4-inch FloMov pumps supplied by FloNergia was installed at an aquaculture facility in Southern Ontario to study the effects of pumping system on the flow and operation through the raceway. The raceway system is built on a floating dock in a closed lake creating a recirculating system. Frames were built to fit on one end of each raceway and the airlift pump system was attached to it. The pumps lift water from a depth of 1.78m into the raceway and the water then exits the raceway through an opening at the opposite end. The FloNergia FloMov™ airlift pump units have a nominal inner diameter equivalent to a 4 inch (1.016×10−1m) PVC pipe. The air supply was provided by regenerative air blowers that were present on site.

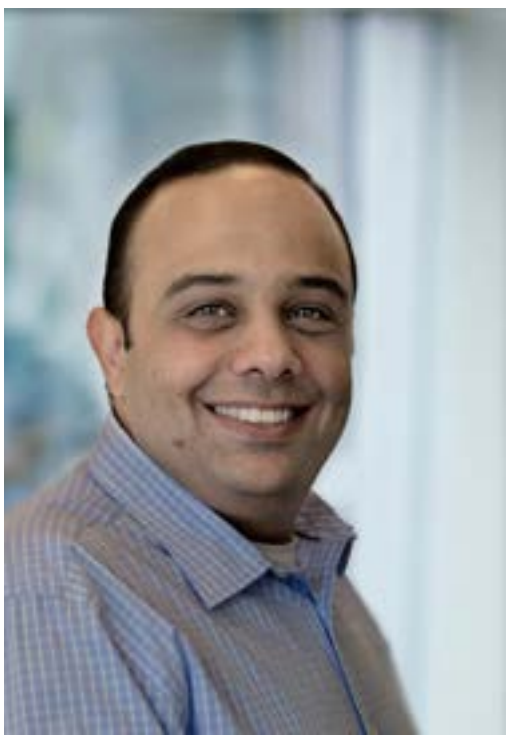
STUDY RESULTS

Numerical simulations were performed on the FloNergia FloMov™ airlift pump system operating under two submergence ratios: 50% and 90%, as well as on the airlift pump systems installed in the aquaculture raceway. The numerical modelling of the airlift pump performance was found to be within ±20% RMS of the experimental values, while also providing better predictions over an analytical model. Other two-phase flow phenomena were also examined to provide deeper fluid analysis. The flow of an airlift pump system integrated raceway was also studied numerically to understand the effectiveness of the airlift pumps performance on the raceway. This simulation analyzed the velocity field across the raceway and compared them to experimental velocity measurements. It was found that the numerical velocity field is agreeable with the experimental measurements and that the operational velocity values were reached.

These results showed that the use of computational fluid dynamics could be used to study the performance of FloNergia FloMov™ airlift pump systems and allow them to be included in the design stages of a project. This would permit the integration of the FloNergia FloMov™ pumps into aquaculture systems by obtaining an accurate prediction of the operating conditions.

About the Authors

***Dr. Sherif Abdou** is a budding entrepreneur with a mechanical engineering background*



and a passion for interdisciplinary sciences. Sherif completed his Ph.D. degree in mechanical engineering from McMaster University in 2014 where he developed a novel micro pump for microfluidic and lab-on-a-chip applications. Since then, Sherif has been involved with a startup company in the automotive field before co-founding his own company in 2017 to commercialize an innovative pumping/aeration technology developed at the University of Guelph. In 2019, he launched a new company to help other businesses adopt and utilize numerical modelling in their product design and development process.

***Dr. Wael Ahmed** is a full professor at the University of Guelph. His expertise in the*

area of experimental multiphase flow analysis of water, food, and energy systems. Wael received his Ph.D. in Mechanical Engineering from McMaster University in 2005. He has over 25 years of academic and industrial experience. He designed efficient airlift pumps for many industrial applications including food, oil & gas, and nuclear energy.

***FloNergia Inc.** specializes in the supply of airlift pumping systems for commercial and industrial applications involving the use of air to efficiently move fluids. FloNergia's FloMov™ airlift pump technology is used in many global markets including water/wastewater, aquaculture, aquaponics, and hydroponics systems for water circulation and aeration.*

This case study was condensed from an in-depth study published in Aquacultural Engineering, Volume 87, November 2019, 101998.

CGE, INDUSTRIAL WASTEWATER, TEXTILE, ZLD

ZLD TECHNOLOGY DISRUPTOR: CARRIER GAS EXTRACTION

By Ravichandran Selvaraj

Industries across India in their endeavor to meet regulatory norms, sustainability objectives and corporate governance goals are beginning to explore and adopt Zero Liquid Discharge (ZLD) standards at their treatment plants and no longer consider wastewater treatment a liability but a key resource recovery system.

Currently, in India, water use efficiency - a ratio of water withdrawal to discharge volumes, is not monitored in industries but with growing consumer pressure for freshwater and scarcity issues, water as a resource simply cannot be used once in the manufacturing processes and discharged.

By leveraging the principle of a circular economy, Zero Liquid Discharge aims to close critical water loops and foster reuse over continuous cycles through extended treatment.

ZLD IMPLEMENTATION

At present, industrial sectors including Textile, Pharma, Pulp and Paper, Chlor-alkali, Sugar, Power, Dye and Dye-intermediates, Petrochemicals, Steel, and Fertilizer have implemented ZLD based on mandates from state pollution control boards.

Currently, ZLD implementation in the country comes from judicial orders and statutory mandates from state pollution control boards based on factors such as:

- **Classification of the industry - Grossly Polluting Industry (GPI)**
- **Water consumption and discharge rates at the industry**
- **Auxiliary chemical usage in the manufacturing process**
- **Challenge in the conveyance of treated effluent for discharge**
- **Impact on the immediate environment due to discharge**
- **Water scarcity issues in the immediate environment**

Thus, as India grips with water security issues, ZLD is rapidly becoming a norm for industries to address through regulatory statutes and drive to reuse treated wastewater.

Figure 1

REJECT MANAGEMENT SYSTEMS

Of the several factors to consider while installing a ZLD system at a facility, one performance parameter standing tall in CAPEX and OPEX considerations is Brine Reject Management.

Brine management of effluent takes up close to 50% in CAPEX of any potential ZLD project. Thus, an evaporator system addressing brine management can make or break the operations. Additionally, reject management systems also weigh heavily in OPEX due to dependence on the constant running of utilities such as power and steam.

Moreover, the evaporators currently available in the market rely on dated legacy solutions and complex system architecture.

Gradiant's Carrier Gas Extraction (CGE) system is proprietary humidification and dehumidification (HDH) based thermal evaporator system that incorporates carrier gas to cause a phase change of feed water from liquid to vapor. The CGE system reimagines the conventional evaporator based on product innovation to suit a wide range of industries.

Some of the key benefits that a CGE system possesses that sets it apart from legacy evaporators are:

- The direct phase change from liquid to vapor unlike conventional systems
- Operates at ambient pressure instead of vacuum pressure
- Ease in overcoming scaling issues without major stoppages of the plant

The advantages and leap in operating

Figure 2

philosophy of the CGE system are made possible by mimicking the humidification and de-humidification operations of the natural rain cycle. Additionally, this principle is translated to an industrial scale process with the help of novel bubble column architecture ensuring minimal rotating parts and an easy-to-operate system.

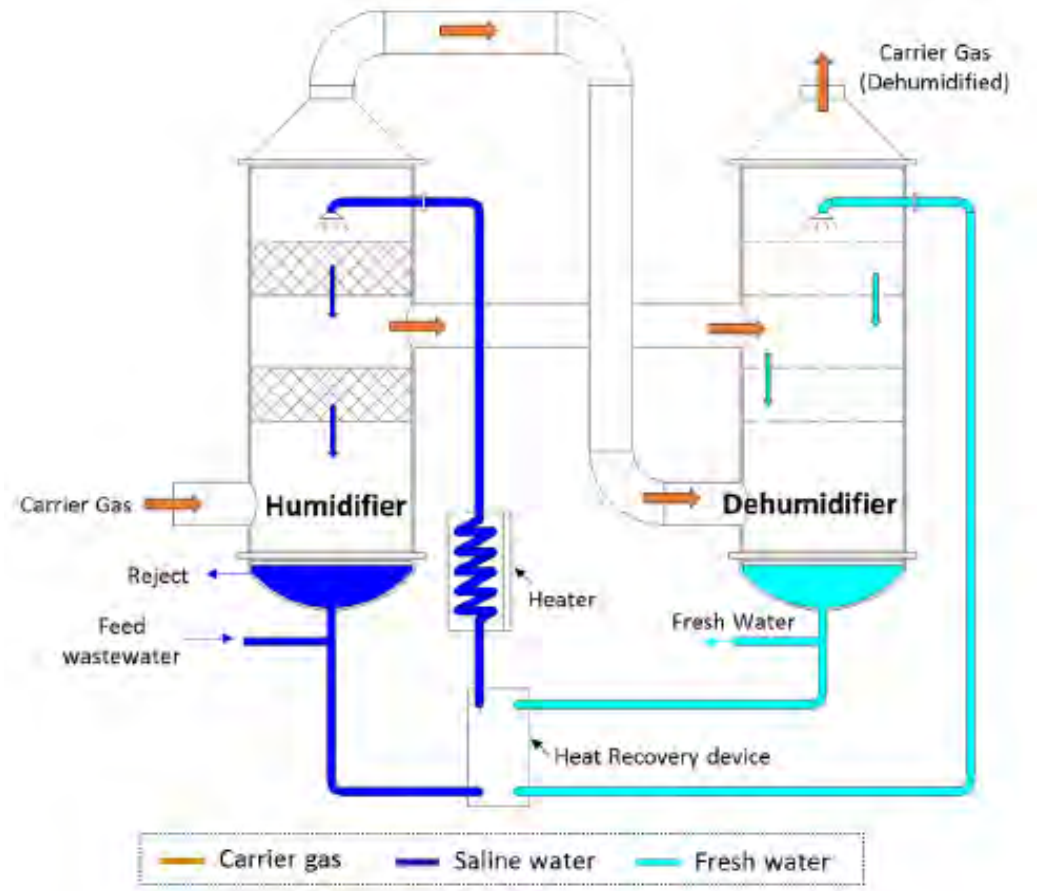


Figure 3

CASE STUDY

A prominent textile processing firm in Tirupur, Tamil Nadu (the textile processing capital of India), while looking for an innovative and comprehensive ZLD solution, engaged with Gradiant to procure a Carrier Gas Extraction (CGE) based system to alleviate their challenging effluent handling needs. The project showcased is the country's first CGE based ZLD system that is commercially scaled and operated successfully for over a year.

Gradiant designed a system comprising of the CGE, crystallizer, pusher centrifuge, and an agitated thin film dryer to effectively handle 200 m^3/day of textile processing effluent with a feed TDS of 55,000 ppm. Furthermore, the scope of the project includes the design, engineering, construction, erection, and commissioning along with operation & maintenance of the ZLD system.

At the outlet of the treatment train, the system recovers freshwater of TDS less than 50 ppm, hardness less than 50 ppm, pH between 6 – 6.5, colorless than 100 on the platinum cobalt scale. Additionally, close to 1.2 tons of salt is recovered per day. The Glauber's salt recovered is reused by

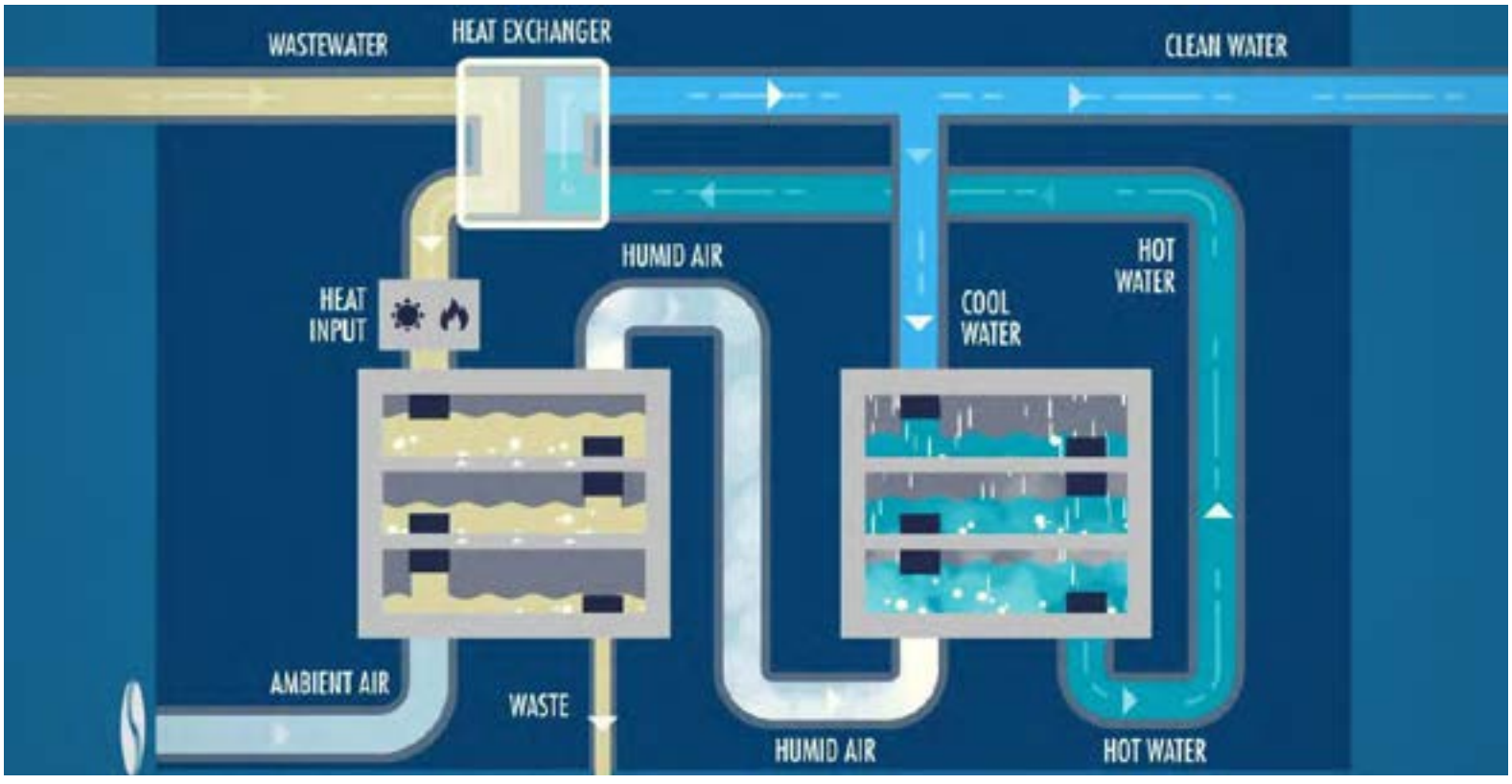


Figure 4: Carrier Gas Extraction Process Schematic

the dyeing process of the textile mill.

HOW DOES IT WORK?

While achieving performance metrics of salt concentration and freshwater recovery in comparison to other legacy evaporator systems, the CGE, with the difference in operation ensures minimal maintenance and downtimes.

With the placement of a heat exchanger outside the main installation, the CGE system minimizes scaling inside CGE towers, overcoming scaling issues while maintaining efficiency and extending the minimal cleaning cycles. A single-pass via the CGE system, as shown in Figure 3 and 4, would constitute the feed wastewater entering via the heat exchanger which then is passed over to the humidifier column, where carrier gas, usually ambient air, is introduced into the system through an air blower. Due to the gradient in concentration and temperature, the air is heated and transfers freshwater as a vapor to the de-humidifier column with concentrated waste being phased out of the system.

With the passage of humid air through the proprietary multistage bubble column and the exposure to cycled cool water, freshwater is recovered, and heat supplied is also recovered.

This phase change of feed water from liquid to vapor including the recovery of freshwater happens seamlessly. Moreover, there is a decoupling of the surface of heat transfer and phase change from liquid to vapor. This results in increased efficiency of the overall system as typically scaling largely occurs in evaporators due to heat transfer. With the decoupling in the CGE system, Cleaning-in-Place (CIP) protocols are greatly reduced.

These benefits when translated to site conditions result in maximum uptime for the CGE system. In contrast to legacy systems, the heat exchanger (twice a month) and humidifiers (once a month) can be easily cleaned. Additionally, the cumbersome process of hydro jetting-based cleaning is not required due to the innate differences in the operation of the CGE in overcoming scaling.

In conclusion, as ZLD norms are getting notified by more statutory bodies across the country for varying industries, there is a requisite of benchmarking currently available technologies to address the normative needs of end-user for economic operation and passed on benefits of ZLD to the environment. The CGE system developed by Gradiant provides avenues as a technology disruptor in this niche space of wastewater treatment with proven commercial scaling in India and abroad.

About the Author

Ravichandran Selvaraj *is the Managing Director of Gradiant India (P) Ltd. He has*

over 30 years of experience in the water and wastewater industry. Prior to Gradiant, he worked at various multinational organizations such as Nalco, Ecolab, Praj Industries, and Ion Exchange. He has built a 50 member strong team that backs him. ***Gradiant*** *has its Indian headquarters in Chennai, with capabilities in Design, Research, Process, Engineering, Project Execution, and O&M. Operations is supported by an in-house lab facility. The sales and marketing team operates from Chennai, Coimbatore, Pune, and New Delhi.*

DESALINATION, ENERGY RECOVERY, SWRO

A FULLY AUTOMATED, CHEMICAL-FREE, AND LOW ENERGY DESALINATION PLANT ON A CARIBBEAN ISLAND

By IDE Technologies

The new Bonaire Seawater Reverse Osmosis (SWRO) desalination plant, based on IDE Technologies' reverse osmosis technology, was recently successfully commissioned. It has added 5,600 m^3/day to the existing desalination units in Bonaire, increasing the total water supply to 7,200 m^3/day. Additional units can be added for future extension to 11,200 m^3/day.

The plant is designed in a two (2) train concept - each train has a production capacity of 3,200 m^3/day, and each train can operate independently of the other train.

LOW ENERGY CONSUMPTION

As low energy consumption was of great importance in plant design, measures were taken to ensure a low guaranteed value. These measures include process design at low recovery and flux, selection of low-energy membranes, and choosing equipment with high efficiency. The design also includes an Energy Recovery System (ERS) that maximizes the energy efficiency of the SWRO process.

MODULAR, PRE-ASSEMBLED

DESIGN APPROACH

The preassembled and modular unit concept is a project delivery strategy developed by IDE Technologies, Ltd. The goal of this strategy is to provide desalination plants that:

- Are the best in class in terms of safety, quality, and performance

PROJECT OBJECTIVES

- **Compliance with product quality requirements at all times, under a wide range of operation conditions.**
- **Flexibility of operation as a result of the IDE modular approach**
- **Low energy consumption**
- **Chemical-free process**
- **Fully automated and highly reliable plant**
- **High-end materials of construction**

Bonaire's New Reverse Osmosis (RO) Plant is Now Fully Operational to Support the Drinking Water Demands of Bonaire's Growing Population.

- Have the lowest total installed cost
- Can be installed in the shortest time
- Minimize site plant execution risks

In the preassembled and modular unit concept, a significant portion of the plant fabrication, assembly, and testing is completed off-site, under controlled plant conditions and precision tooling, using the same materials and designing to the same codes and standards as conventionally built facilities – but in much less time.

The preassembled and modular unit concept allows a reduction in installation schedules and costs, as modules are simpler to install than components delivered loose and assembled on site. In addition, since the total installed cost of the project is extremely well defined in the design process, and the installation scope is clear, the owner is at significantly less risk as a result of construction-related change orders and delays.

As module fabrication can occur simultaneously with site improvements and foundation work, projects can be completed sooner compared to traditional construction. In addition, the need for highly skilled construction personnel (i.e., welders, pipefitters, machinists, etc.) onsite is reduced, as are potential delays attributed to inclement weather during construction.

Shortening the onsite erection time offers considerable potential savings to the EPC contractor, and a shorter overall schedule, which results in an earlier start to the water production.

CHEMICAL-FREE PROCESS

Bonaire's New Plant Produces 5,600 m^3/d of Drinking Water to Meet the High Demands of the Island's Nearly 22,500 Residents.

The WEB Bonaire desalination plant provides the required product quality without the use of any chemicals. This is achieved by Direct Osmosis Cleaning (DOC) - a high-end, patented technology developed by IDE that utilizes osmotic pressure to clean the membranes in a short and repetitive process, removing biofouling and scaling from the membranes, and reducing the intervals between CIP.

MAIN PLANT COMPONENTS

Pre-Treatment

Pre-treatment of seawater prior to the SWRO process, to remove suspended solids and minimize the growth of micro-organisms on the membranes, is of critical importance to the reliability of any SWRO process. Effective pretreatment is thus necessary to increase the efficiency and life span of the SWRO system. Selection of proper pretreatment minimizes fouling and membrane degradation, resulting in optimized product flow, salt rejection, product recovery, and operating costs.

The pre-treatment process includes fully automated Pressurized Multi-Media Filters (PMMF), followed by micronic filters.

Pressurized Multi-Media Filters (PMMF)

Each filter contains different filtration layers including anthracite, garnet, and sand. Each media (layer) has a different size and density. The arrangement of the layers is according to their size, with the larger and lighter layer - anthracite - on the top, and the heavier and smaller layer - garnet - on the bottom. This arrangement constrains the largest particles to be removed near the top of the filter, and the smaller at the end of the filtration process. This allows a longer filtration cycle and less filter clogging between backwashes.

Over time, filtered debris accumulates on the filter media creating a filter cake layer, clogging the filter, and increasing pressure loss. To remove this cake layer and reduce the pressure loss over the media, a backwash process is initiated. The BW process with SWRO brine is fully automatic and is determined by a timer set point in most cases, or according to a pressure difference set point as measured online by the Pressure Differential Indicating Transmitter (PDIT) installed on each filtration unit.

The Plant Offers a High Level of Preassembly of Sub-systems, Allowing Efficiency in Construction and Providing Extremely Low Electrical Consumption.

Micronic Filters

Downstream of the PMMF, the water is distributed to the SWRO units. Before the pretreated seawater enters the SWRO, it passes through micronic filters. One micronic cartridge filter is installed for each SWRO unit. The micronic filters serve as safety filters against fouling agents that could harm the RO membranes, HPP, and the ERS units (PX).

Seawater Reverse Osmosis (SWRO)

The seawater reverse osmosis (SWRO) stage is the core process of the desalination plant. The SWRO process is performed by forcing the seawater through a semi-permeable membrane at high pressure to produce permeate water.

The desalination section is comprised of the SWRO membrane units, High-Pressure Pumps (HPP), and Energy Recovery System (ERS). The system is divided into two (2) trains, one train contains two (2) SWRO units and the other includes three (3) units. Each train is hydraulically independent, and each unit operates with a high-pressure pump, energy recovery system, and ERS circulation pump. Fourteen (14) pressure vessels (each containing 8 elements) are installed on each unit, according to the capacity requirements.

SWRO permeate water quality is monitored by a conductivity meter on each SWRO unit. In the case of quality failure, the permeate will flow automatically into the brine gutter, until quality improves. The SWRO permeate from each unit flows into two suck-back (buffer) tanks.

The low-pressure brine from the ERS flows to the backwash tank, used to BW the PMMFs.

The SWRO units are fully automated and controlled by two set points: (1) Permeate flow rate and (2) SWRO recovery. The permeate flow meter controls the HPP VFD in order to reach the permeate flow rate setpoint. The flow rate of the low-pressure brine setpoint is calculated from the recovery and permeate flowrate set points. The low-pressure brine flow rate is then controlled by the low-pressure brine valve. The valve position is controlled by the brine flowmeter, in order to reach the brine flow rate set point.

Brackish Water Reverse Osmosis (BWRO)

The brackish water flows to the second

Through WEB Bonaire and IDE's Partnership, They were Able to Design and Build the Facility Under COVID-19 Constraints and Complete the Entire Facility Within a Year and a Half.

pass from the suck-back tanks.

The second pass is divided into five (5) units that include a 2nd pass pump and two stages: 1st stage with four (4) pressure vessels and 2nd stage with two (2) pressure vessels.

The brine of the 1st stage is the feed of the 2nd stage and the brine of the 2nd stage blends with the seawater that feeds the same SWRO train.

The operation of the BWRO is automatically controlled by a permeate flow rate setpoint that controls the brine control valve, as well as by a feed flowmeter that controls the feed pump VSD.

The feed flow rate set-point is also corrected according to the level of the suck-back tank in a cascade PID loop.

The permeate of the 2nd stage of each unit is collected and connected to the tie-in point, in order to transport the BWRO permeate through the existing post-treatment towards the existing drinking water tanks of Hato.

Before the tie-in point, the BWRO permeate pressure, flow rate, and the conductivity are continuously monitored.

There is an online conductivity meter in each BWRO unit. If the permitted water conductivity is exceeded, the unit will automatically go off-spec until the quality is corrected.

SUMMARY

With onsite commissioning and training of the local team behind us, IDE is proud to have partnered with WEB Bonaire to provide the island of Bonaire with a reliable SWRO desalination plant to provide drinking water to the population in these challenging pandemic times.

About the Contributor

***IDE Technologies** specializes in the development, engineering, construction, and operation of some of the world's largest and most advanced thermal and membrane desalination facilities and industrial water treatment plants. IDE partners with a wide range of customers - municipalities, oil & gas, mining, refineries, and power plants - on all aspects of water projects, and delivers approximately 3 million m^3/day of high-quality water worldwide.*

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AUTOMOTIVE INDUSTRY, RO, STP, WTP, WWTP, ZLD

INTEGRATED WATER MANAGEMENT FOR A WORLD CLASS AUTOMOBILE MANUFACTURER

By Ion Exchange (India) Ltd.

INTRODUCTION

The customer is one of the leading manufacturers of world-class quality motor vehicles. It expanded its manufacturing set up with its "Greenfield" car manufacturing facility at Anantapur, Andhra Pradesh.

The state is, however, moving slowly from irrigation to an industrial economy and has various challenges related to water use for irrigation and industrialization.

THE CHALLENGES

The major challenges faced by the customer included:

- **Stringent Regulations and Disposal Norms:** The state government enforced stringent regulations and tight norms for the reuse and disposal of wastes. Hence, there was a strong need to maximize the recycling of wastewater and also to introduce environmentally sound, energy-saving techniques for treatment and disposal. The project was mandated to adopt Zero Liquid Discharge (ZLD).
- **Water Scarcity and High Fresh Water Cost:** Anantapur, Andhra Pradesh had no history of any other industry in the vicinity of the said plant, during the setup phase. Availability of water was a major challenge and water would have to be availed from distant sources. This not only made raw water expensive but would also render it the most expensive resource for the unit.
- **Inconsistent Raw Water Quality:** Water in the plant area had been sourced

PROJECT TIMELINES

Ion Exchange completed the detailed engineering, procurement, supply, construction, erection, commissioning, and O&M of the integrated water management project with all required approvals from the customers and consultants, in a record time of just over a year to meet the critical project milestones.

Performance Guarantee (PG) tests were also completed in 2019 in a phased manner to hand over the complete facility to the end customer.

Automotive Plant (This image is for illustration purpose only, not of the actual plant)

from various distant sources making water quality inconsistent and difficult to keep up with production standards.

THE SOLUTION

Ion Exchange mitigated the above-listed challenges using its pioneering concept of Integrated Water Management with the benefits of:

- Source Reduction
- Product Recovery
- Waste Minimization
- Water Reuse

Turnkey execution of the project included:

WATER TREATMENT PLANT (WTP)

The WTP was important to cater to the industrial and potable water requirements of the customer.

The process and technology used for the industrial water treatment plant are pre-treatment, Ultra-filtration (UF), Reverse Osmosis (RO), designed with 80% water recovery.

The RO membrane cleaning system is designed for use with standard cleaning solutions as well as special cleaners.

The capacity for water treatment plant is listed below:

WTP, i.e., Industrial Water (IW) Supply Scheme:

- Raw Water Feed @ 2000 CuM / Day i.e. 100 CuM / Hr

- RO Capacity 56 CuM/Hr @ 80% recovery

The Potable Water (PW) supply scheme for the factory and subsidiary is designed with pre-treatment including Clarifier, followed by Ultra-filtration (UF), Activated Carbon Filter (ACF), and Ultra-Violet (UV) treatment to feed potable water to designated locations within the factory and its subsidiary.

The potable water capacity for the main factory is 750 CuM / Day.

WASTEWATER TREATMENT PLANT (WWTP)

The wastewater which is treated comes from seven sources through car assembly plant namely Phosphate Renewal, Phosphate Rinse, Degrease Press Shop, Degrease Rinse, Misc Wastewater, Electro Deposition (ED) rinse and the water treatment plant, i.e., RO wastewater, CWS wastewater. This is then recycled.

The capacity for wastewater treatment plant is listed below:

WWTP with Multi-Effect Evaporator (MEE) and ZLD:

- Raw Effluent Feed @ 2150 CuM / Day
- RO-Stage-I Capacity – 71.9 CuM/Hr x 2 Nos. Skids
- RO-Stage-II Capacity – 14.4 CuM/Hr x 2 Nos. Skids
- RO-Stage-III Capacity - 14.4 CuM/Hr x 2 Nos. Skids
- MEE Capacity – 150 KLD (CuM/Day)

Key processes under the wastewater treatment plant are as under:

- **For Phosphate Renewal and Phosphate Rinse Wastewater:** Coagulation and flocculation, lamella clarifier, wherein clarified water is collected in equalization tank and the sludge goes to sludge pond, centrifuge and finally to sludge disposal area.
- **For Degrease, Assembly Press Shop and Degrease Rinse Wastewater:** Equalization tank, followed by flocculation, Dissolve Air Flotation (DAF), aeration, sedimentation (sludge removal), UF with 93% recovery, RO-I with 80% recovery, RO-II with 75% recovery and RO-III with 60% recovery.
- Permeate from RO-I and RO-II is directly fed to the Industrial Water (IW) supply pond, while reject is treated in a subsequent stage of RO.
- Reject from the RO-III is collected in a high saltwater pond and subjected to MEE, i.e., Multi-Effect Evaporator (4, in this case) to recover maximum water in form of condensate and thereby disposing of the generated sludge.
- Chemical dosing systems are deployed for pre-treatment, as well as main treatment systems as per need and necessity of the treatment/ scheme.

SEWAGE TREATMENT PLANT (STP)

A state-of-the-art design based on INDION MBR technology treats the sewage collected from various sources. STP plant with the capacity of 900 CuM/d was designed based on INDION MBR technology, thereby providing an alternate source other than industrial effluent recycle for process, utility, and low-end applications.

WATER QUALITY MONITORING SYSTEM

The plant is automated with 24x7 monitoring of critical operations and the critical parameters, through a central Programmable Logic Controller (PLC) system.

It also has various other online quality monitoring systems including the pH meters, conductivity analyzers, etc. installed at various key locations as per the requirement for monitoring of different quality parameters.

The 'permeate' from all stages of RO i.e. RO-I, RO-II, and RO-III for the WWTP as well as the WTP/ industrial water - RO has an online conductivity monitoring system.

The flow measurements are captured through online mag-flow meters.

Apart from the above, monitoring of some critical parameters is done in-house on a continuous and daily basis to maintain a record for future reference.

A local water-testing laboratory setup is provided to do all these routine tests in-house.

At the project's concluding stage, when Ion Exchange was carrying out the commissioning and performance guarantee tests at the site, complete water analysis was done through detailed testing of jointly taken samples, from the NABL-accredited laboratory.

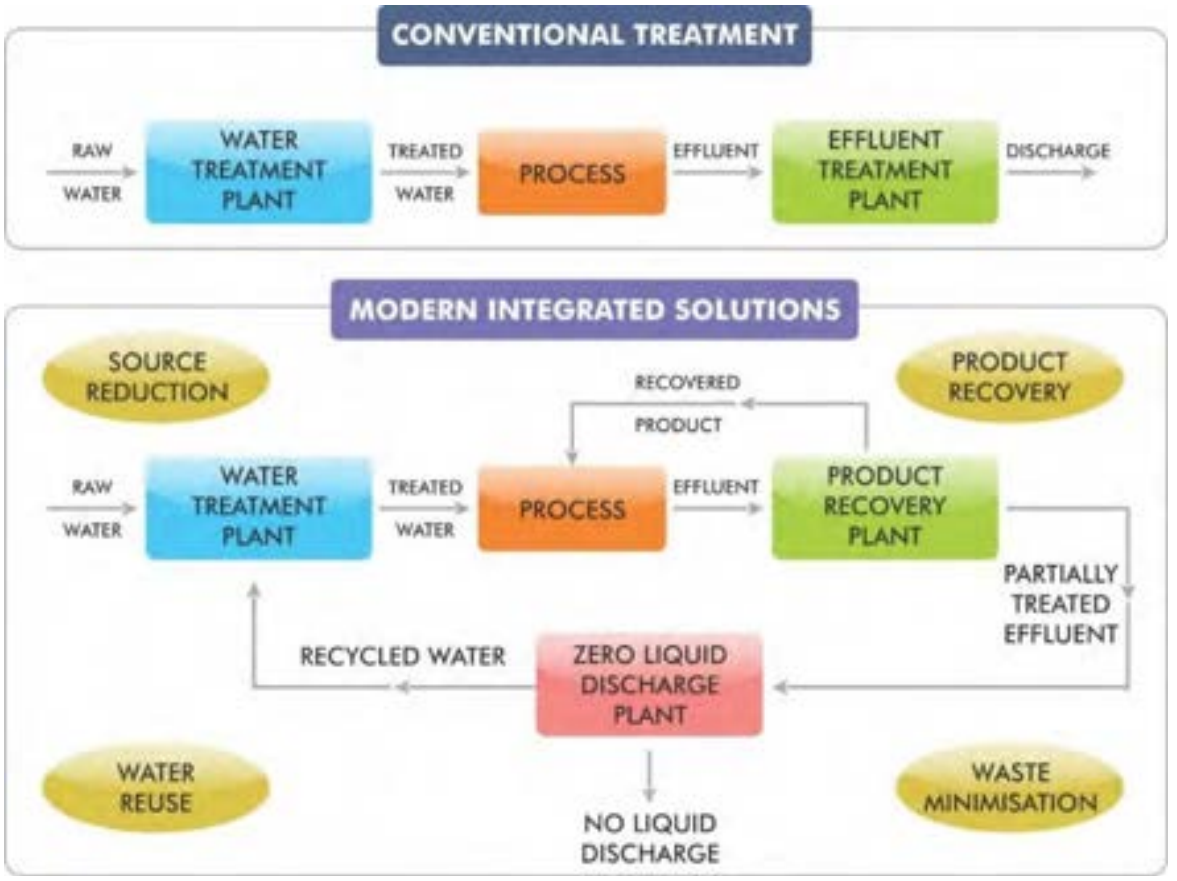
The samples were taken at designated locations (sampling points) at a pre-decided schedule.

After commissioning of the project our O&M team deployed at the site ensured water quality testing and monitoring, apart from the complete operation of the system.

ECONOMIC BENEFITS OF PROJECT

The economic benefits accrued from our Integrated Water Management are given below:

- The customer has been able to reduce



scarce freshwater consumption by saving 2900 Cu Meters/day- by adapting our integrated water management philosophy that resulted in source reduction, product recovery, waste minimization, and water reuse.

- Further they could reduce their water cost as against the cost of Rs 50/KL for buying raw water which is required to be further treated for potable purposes, production, utility, etc.
- Apart from meeting stringent ZLD obligation, the company also save costs related to CESS on water discharge.
- The customer has received excellent payback on investment through:

  o Assured availability of water for process needs as well as low-end uses.
  o Reduced freshwater consumption. Therefore, considerable savings in freshwater costs.
  o Additional savings through the recovery of valuable by-products for reuse in the process
  o Compliance with pollution control regulations and a clean environment through reduced/ zero effluent discharge.

SOCIAL BENEFITS OF PROJECT

- **Zero Liquid Discharge:** The project was mandated to adopt Zero Liquid Discharge. The innovative technologies used by Ion Exchange in the project for achieving ZLD goals have reduced the fresh water cost, conserved precious water in the locality for agriculture and community use. It also ensured the water sources were no longer contaminated from complex liquid effluents, leading to improved ground and surface water quality in the adjoining regions.
- **Achieving the Lowest Specific Water Consumption:**

  o **Zero Wastage:** The recovery of the water in the project, resulted in freeing up tremendous quantities of freshwater for reuse and also the freshwater cost associated with purchasing raw water for the customer and also pressure on local bodies is reduced.
  o **Low Sludge:** The generation of high solid content sludge means that the disposal of the removed suspended solids is much easier and will also reduce the cost, size as well as the carbon footprint of the customer.

- **Waste Recycling and Its Multiple Usages:**

  o The project supports the industries in the area to reduce groundwater and/or surface water consumption
  o Customer has reused the water for industrial processes and low-end applications like gardening, landscaping, etc.
  o ZLD system has helped the customer to maintain greens around the area.

CONCLUSION

The “Greenfield” project was successfully completed on schedule. It is fully operational and meets and supports the ever-increasing production demand with the plant now approaching full capacity utilization. Post commissioning of the integrated water management plant, Ion Exchange also extended its Operation & Maintenance service for 12 months as per the contract.

About the Contributor

***Ion Exchange** is a pioneer of water treatment in India with a legacy spanning over 5 decades. It is one of the very few companies worldwide with a complete range of solutions for water, wastewater management, solid waste management, and now waste-to-energy. It meets the industry’s need for quality supply of goods and services through our ISO 9001:2015 (Quality Management System), ISO 14001:2015 (Environmental Management System), and ISO 45001:2018 (Occupational Health and Safety Management System) certified facilities that manufacture world-class ion exchange resins for water and non-water specialty applications, membranes, water treatment chemicals, and specialty process chemicals.*

CLOSED LOOP REACTOR, WASTEWATER TREATMENT

BOOMING BENTONVILLE PUTS THE BEST TREATMENT SOLUTIONS IN PLACE FOR LONG-TERM

By Dr. Sherif Abdou and Dr. Wael H. Ahmed

In Northwest Arkansas, Bentonville has become one of the most attractive places in America to live. With its rapidly increasing population, it is just as well that those who run the City's Water Resource Recovery Facility are extremely diligent, and a proven group of forward thinkers.

The facility, which mainly receives domestic wastewater, saw its 2019 average daily flow reach 3.7MGD, up by almost one million gallons from 2018.

Bentonville is already well known for being the home of Walmart's corporate headquarters – the first Walmart store having opened nearby back in 1962 - but in the past decade, this enterprising city has seen the opening of several major attractions. These include the Crystal Bridges Museum of American Art and The Momentary – not to mention the Razorback Regional Greenway, a spectacular 40-mile bike-ped trail. The City is also very close to the wonders of Ozark National Forest. We could go on...

The first basic wastewater treatment plant in Bentonville was established in 1940. Today's facility - an Activated Sludge-Extended Aeration plant, was built in 1985. The choice at that time was for Lakeside Equipment Corporation's Closed Loop Reactor (CLR) Process, with its racetrack configuration that provides a straight-line flow pattern for wastewater between the headworks and the final clarifiers. At the core of the CLR Process is the horizontal Magna Rotor, which sustains a high population of microorganisms in the reactor to provide simple process control.

In 2019, the Facility decided it was time to replace these Lakeside Rotors.

Bentonville's Operations Supervisor, Chris Earl, explains: "For us, preventive maintenance is the cornerstone of our industry. Routine oil and belt changes extend the life of bearings and motors. However, you must begin with a quality product".

He added: "Despite the fact that we've had this equipment since it was installed in 1985, none of the rotors have failed! Not surprisingly, after such a long time (34 years), a few bearings have had to be replaced, and the fiberglass covers, but it is an amazing run for a piece of wastewater equipment. Our team could certainly keep this piece of equipment running for several more years, but everything was in place

Bentonville Water Resource Recovery Facility, Operations Supervisor, Chris Earl - and Manager, Nancy Busen

> ***"For us, preventive maintenance is the cornerstone of our industry. Routine oil and belt changes extend the life of bearings and motors. However, you must begin with a quality product".***
> ***- Chris Earl, Operations Supervisor, Bentonville***

with our budgets – and with Bentonville continuing to grow, we decided the time was right to square everything away for the next 35 years or more".

Since the Lakeside Closed Loop Reactor (CLR) was installed in 1985, there have been four upgrades to Bentonville's Water Resource Recovery Facility.

In 1995, additions were made to maintenance and operations buildings. In 2000, two 600,000-gallon aerobic digesters and a blower building were added to improve the solids stabilization process. Also, anoxic basins were added at the North end of the plant for nitrite and nitrate nitrogen removal. Then in 2005, modifications were made to the anoxic basins to accommodate biological phosphorus removal. The chlorine disinfection system was replaced by a U.V. disinfection system. And in 2009, drying beds were converted to a sludge storage area. Two dump bays were also added to provide an area for Vac-Con trucks and vacuum trailers to unload contaminated material removed from the sewer collection system. This material is allowed to dry and then applied to land or sent to the local compost facility. Throughout that entire period, the Lakeside Closed Loop Reactor has kept on working and working.

Always on hand to help Chris Earl at the Water Resource Recovery Facility has been Lakeside's agent, Phil Shupe of North Little Rock's Shupe & Associates.

PROACTIVE MEASURE

"The teams at Bentonville, who are very

easy to work with, run a very tight ship", said Phil. "They set a great example for the wastewater industry and for all engineering by showing that it pays to look after equipment. This latest investment in Lakeside is a very wise, proactive measure that makes perfect sense for the city".

The Lakeside blades, which are die-formed of 10-gauge AISI Type 304 stainless steel to produce stiffness and rigidity that can take a 250 lb impact load without deformation, it is perhaps no wonder that they stand the test of time.

Nancy Busen (Manager) and Chris Earl (Operation Supervisor) at Bentonville Water Resource Recovery Facility

The Magna Rotor provides precise oxygen input into the biological process through adjustment of rotor immersion by raising or lowering the level control weir and by adjusting the rotational speed via VFD. Microorganisms are mixed uniformly – and because mixing velocity is brought to the channel, solids are prevented from settling.

The Magna Rotor's design allows a single rotor to span channel widths up to 30 feet, saving significant costs by eliminating the need for additional equipment to join multiple rotor assemblies.

Phil Shupe added: "The exemplary safety record of Lakeside's equipment also shouldn't be overlooked. With other systems of lesser quality, loosening bolts have seen brushes flying off. These hunks of steel can cause serious harm, so again, as Chris Earl rightly says, preventative maintenance and the need to begin with a top-quality product is very much the right approach and practice".

Indeed, the mission statement of Bentonville's Water Resource Recovery Facility is 'to protect public health and environment through effective treatment of wastewater. Effective wastewater treatment prevents disease, contamination of water supply, maintains clean waters for propagation and survival of fish & aquatic life, and conserves water'.

Lakeside's Closed Loop Reactor at Bentonville

Aeration in mixed activated sludge basins is, off course, a firm requirement and certainly not an option, so the

At Bentonville Water Resource Recovery Facility, Operations Supervisor, Chris Earl - and Manager, Nancy Busen

Bentonville team pulled out all the stops to maintain proper mixing and oxygen levels for maximum treatment quality during the dismantling and replacement of each of the eight Lakeside Magna rotors – determined to protect the local environment by keeping well within permit compliance.

Working closely alongside, Chris Earl is Nancy Busen, Manager of Bentonville's Water Resource Recovery Facility.

PROTECT AND BLEND IN

"The amazing activities we now have in the city are our closest neighbors", she said. "We feel it is our duty to not only protect but also quietly blend into the new ambiance of the surrounding community where beautiful new housing developments are being built as part of the incredible quality-of-life investments that are being made here. In addition to the facility, our state-certified team of 23 also maintain 59 lift stations throughout Bentonville. We are the nation's fifth fastest-growing city, so we need to keep on our toes".

> ***"They (Bentonville team) set a great example for the wastewater industry and for all engineering by showing that it pays to look after equipment. This latest investment in Lakeside is a very wise, proactive measure that makes perfect sense for the city".***
> ***- Phil Shupe, Shupe & Associates, North Little Rock (Agent for Lakeside)***

With a population that grew from 50,000 in 2018 to 55,000 in 2019 – from just 35,000 in 2010, Chris Earl agrees it's imperative to keep investing in reliable equipment that is properly maintained – and reliable staff, who continue to attend industry education classes to broaden and update their knowledge.

"Admittedly the Lakeside equipment is easy to maintain", said Chris, "but with proper care, we expect to see these new Magna rotors last for a long, long time. Seeing the previous rotors last – and in fact, still working after 35 years is the best possible product recommendation".

About the Contributor

Lakeside Equipment Corporation *is an engineering and manufacturing company concentrating on helping to improve the quality of our water resources. Lakeside started in the Spring of 1928 to engineer, develop, and provide water purification systems to municipalities and companies throughout North America.*

LIFT STATION, PUMPS, SEWER SYSTEM

SOLVING LIFT STATION PROBLEMS AT MADISONVILLE UTILITY IN TEXAS

By Landia A/S

LIFT STATION NUMBER 8, CITY OF MADISONVILLE UTILITY SERVICES (WATER, SEWAGE, TRASH & STREET LIGHTS), MADISON COUNTY, TEXAS

"I used to dread coming here", said Mitch Puckett, Director of the City's Water & Sewer Department.

And no wonder. Despite the installation of two pumps that were sold as being able to cope with typical lift station debris, the chore of having to unblock rags became an all too regular occurrence – in less than 12 months from when they were installed.

Then, there was the grease.

LAYER OF GREASE MORE THAN SEVEN FEET THICK

Even with all the grease traps that are in use at food establishments as per code enforcement, it seems that almost every town in America has at least one lift station that its sewer department dreads – and at Madisonville, the layer of grease – for all the hard work to keep it at bay – would at times build up to more than seven feet thick!

"It was unreal", commented Kevin Story, Director of Public Works for the City of Madisonville.

"It was also ridiculous that so soon after the installation, the problems at this, our most recently built lift station, meant Mitch and I having to spend so much time trying to put it right. Pulling these pumps out isn't

Madisonville is not alone in having pumps that either simply don't have enough horsepower for the job or don't have the proper macerating system to handle rags. Standard duty pump specifications are no longer enough for the 'dreaded' lift stations.

Likewise, Landia recommends that Constant Torque VFDs (variable frequency drives) also be included in the next wave of future lift station designs – otherwise, rags sitting at the suction of the pump immediately upon start-up cannot be properly macerated.

This can cause another problematical, messy, time-consuming, and costly pump pull-out. Kevin Story will tell you that it is just better to avoid that if possible.

There used to be a seven feet thick layer of grease at Lift Station #8, but not any more.

easy – and as any small water and sewer team will tell you, we already have more than enough to do with taking care of the City. Coming back time and time again to Lift Station #8 had to change".

Kevin and Mitch acknowledge that the opening of a major new retailer just across the street – complete with 40 restrooms - was certainly going to create challenges for the existing sewer system. Together with grease and rags that inevitably find their way into the sewer from Madisonville's near 4,500 population, the only remedy at times was to bring in the vac truck. Kevin had campaigned hard for the city to invest in its own vehicle – whereas others face a cost of up to $5,000 each time a vac truck is called upon.

Chemicals can also help a beleaguered lift station – but while they provide some respite – inevitably, the grease problem always returns – as does an annual chemical bill – also around $5,000.

For this tough application at Lift Station #8 (of a total of 12 in the city), the failure of the two duty pumps lay in the design of the impellers, which soon became dull and unable to efficiently cut debris. The rags and trash included everything from t-shirts to towels and underwear to mop-heads, to hygiene products – plus the almost never-ending intake of grease.

As Madisonville's very experienced (27 years in the industry) Public Works Director, you won't find Kevin Story sitting behind a desk very often. He's out and about in the City making sure things are right. The exception is when he's at a short school, always learning. He and his dependable colleague Mitch Puckett attain

> ***"Pumps aren't cheap. It was a worry that the float would sit on top of all the grease, leaving the duty pumps running to a possible expensive burnout."***
> ***- Kevin Story, Public Works Director, Madisonville***

(Left-Right) Kevin Story, Public Works Director for the City of Madisonville, Art Savage from Landia, Mitch Puckett, Director of Madisonville's Water & Sewer Department

valuable qualifications through the Texas Commission on Environmental Quality – and keeping up to date on the right equipment.

Frustrated (to put it mildly) with the trials and tribulations of his notorious Lift Station #8, Kevin discussed potential solutions with Waco-based Smith Pump Company. Based on previous successful installations, including the complete turnaround of a very onerous lift station at Llano County, Texas, it was decided to try an AeriGator Chopper Pump from the company that invented it 70 years ago in 1950 - Landia.

PROTECTS THE EXISTING TWO DUTY PUMPS THAT CAN'T COPE WITH HEAVY SOLIDS

Designed with a hardened-steel knife system that stops large solids from entering the pump's casing, the Landia Chopper Pump was an instant success. In fact, it now effectively protects the existing two duty pumps that can't cope with heavy solids, so that the City of Madisonville does not have to eat into its budget to replace them.

Furthermore, to suit the variances in lift station scum, the Landia Chopper Pump is fitted with the addition of a venturi nozzle to create the AeriGator model.

For lift stations that are close to homes, the AeriGator has been particularly effective at reducing odors, which, for example, was very important in Llano County.

"We were satisfied with the Landia AeriGator from day one", said Kevin Story.

"It's a complete 180-degree difference from what we had. Before Landia, Mitch and I were having to take the volute covers off the duty pumps and try to re-shim everything as best we could to get the

No more rags and no more grease. Operators no longer dread going to Lift Station #8.

Kevin Story, Public Works Director for the City of Madisonville in Texas

impeller close to the wear-plate – but try as we did, the volume of grease and debris would find a way of backing up and oozing up and over the lift station walls. My team worked very hard to ensure that this could only happen at a lift station or a manhole, rather than a home or a business, but the grease was terrible. Hard to believe that we had it seven feet thick here (!), but now, at last, that's a thing of the past".

He continued, "Pumps aren't cheap. It was a worry that the float would sit on top of all the grease, leaving the duty pumps running to a possible expensive burnout. We don't want to be using up funds on replacements when the City needs money that can be spent elsewhere on services. Grease damages pumps and we also don't want to be losing out on some of our capacity because of it. Now, thanks to Landia, we look down on clear water – and no longer have to dread going to this particular lift station. And because things are so much better, it also helps our other lift stations".

WE THOUGHT ABOUT THE FUTURE

Kevin Story concluded, "Long after we're gone, I want people here to see that we cared about looking after the City – and that we thought about the future, so I am very pleased that we solved the issues of lift station number 8 for the long-term".

He certainly has a point. Last year, Texas was the American state with the largest growth in population. The need for robust, long-lasting pumps is essential.

About the Contributor

***Landia** uses its nearly 90 years of experience to continue to develop new and efficient products and solutions. Landia had supplied the first mixers for sewage treatment plants in the late 1980s. Many of these have passed the age of 25 – some even 30. And they are still in operation every day.*

Landia was established in Lem Stationsby in 1933, and here you will still find its entire production and head office. Landia also has subsidiaries in the United Kingdom, Germany, Norway, and the USA, as well as its own sales office in China.

INJECTION SYSTEMS, OZONE GENERATORS, UTILITY, WTP

ORLANDO UTILITIES COMMISSION SWITCHES TO SIDESTREAM INJECTION FOR OZONE EFFICIENCY

By Dr. Srikanth Pathapati

Since 1997, the Orlando Utilities Commission (OUC) has been ozonating well water for odor control through the removal of hydrogen sulfide, steadily upgrading its systems in step with technological improvements. In recent years, OUC has replaced older air-fed ozone generators and Fine Bubble Diffuser (FBD) ozonation systems in three of its water treatment plants with newer, oxygen-fed ozone generators Feeding Side Stream (SSI) venturi injection/pipeline contacting systems. The upgrades have resulted in significant improvements in mass transfer efficiency, reductions in operations and maintenance costs, improved turndown capabilities, and the ability to automate ozonation rates for even greater efficiency.

The Orlando Utilities Commission (OUC) is the second-largest municipal utility in the U.S. state of Florida and the 14th largest in the United States, providing electricity, water, and chilled water to more than 240,000 customers through eight water plants and a 2,736 km (1,700-mi) distribution network. The utility conducted a comparison of its old and new ozonation systems at its OUC Conway and OUC Southwest water treatment plants and presented the results to the Florida Section of the American Water Works Association in 2021, earning the conference's award for the best technical paper.

The use of ozone to disinfect drinking water dates back to 1907-1908. At nearly the same time Jersey City, New Jersey, adopted the U.S.'s first chlorine disinfection system, an ozone disinfection system was installed in Nice, France. European ratepayers objected to the odor of chlorine in their water, driving the adoption of ozone on the continent while American utilities installed chlorination instead. For most of the century, the capital and operational costs of ozone generation, coupled with occupational safety measures for operators, were high hurdles for American utilities. However, as ozone generator technology advanced in recent decades, those hurdles lowered, and an increasing number of American water treatment plants adopted ozone for its powerful oxidation, efficiency, and efficacy on taste-and-

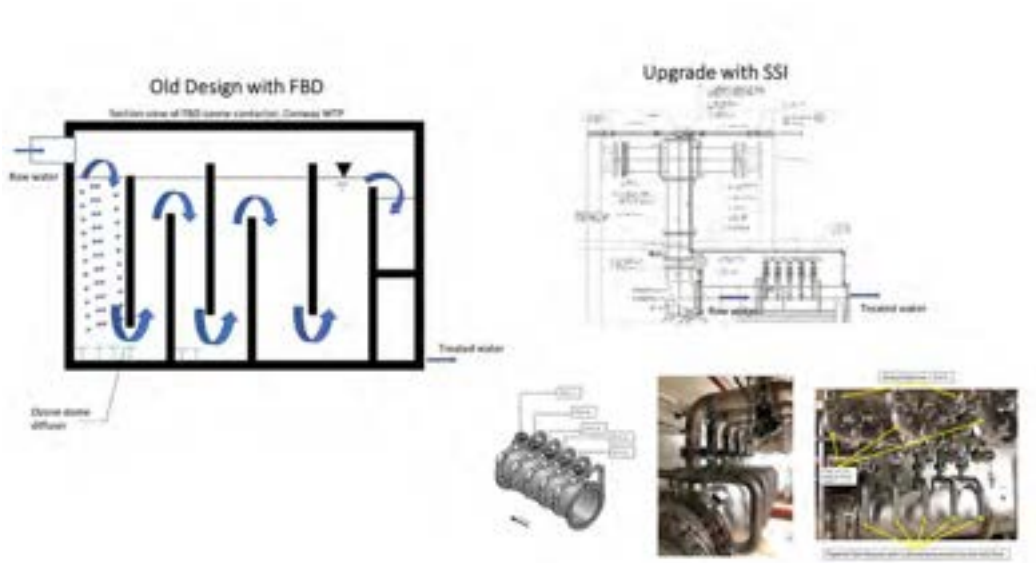
The large American municipality measured significant improvements in ozonation efficiency by replacing fine bubble diffusers with sidestream venturi pipeline injection.

Five venturi injectors ozonate a sidestream flow and mix the treated water into the main flow in a Pipeline Flash Reactor (PFR) at OUC Southwest WTP.

odor compounds, complex organics, and pathogens. Ozone is also less sensitive than chlorine to temperature and pH, making it a more robust option for oxidation and disinfection.

Advances in ozone generators have also spurred changes in mixing systems. Fine bubble diffuser systems require an optimal diffuser gas flow of just 0.12 scfm/ft^2 — higher gas flows would cause significant short-circuiting in basins. Such passive mixing technologies were common in conjunction with baffled contacting basins in the days when air-fed ozone generators could only produce low concentrations of gas. As new generations of ozone generators became capable of producing ozone concentrations as high as 10% from Liquid Oxygen (LOX), venturi sidestream injection systems became a highly efficient alternative to FBD.

Sidestream injection systems divert 3 to 10% of the total flow into a venturi injector, which uses the energy of the flowing water via the Venturi effect to create a vacuum that draws in ozone, shears the bubbles, and creates turbulence that mixes the gas into the stream. The ozonated sidestream is returned to the main flow via a Pipeline Flash Reactor (PFR). The reactor is a length of pipeline that features precisely located and angled mass transfer nozzles for thorough mixing. For high applied doses, the mixing action of the PFR is sometimes augmented by a static mixer and—in the case of the OUC systems—a Westfall 2800 wafer-style static mixer plate. In the OUC plants, just 3.7 meters (12 feet) of the pipeline—barely over 2.1 meters (7 feet) of PFR and 1.5 (5 feet) of the



Upgrades at the OUC Conway WTP replaced fine bubble diffusers with a 5-venturi side stream injection system.

static mixer—replace a 7-meter (21-foot) deep contacting basin while achieving a significantly higher mass transfer efficiency.

In fact, SSI ozone contractors have been demonstrated to deliver velocity gradient values of three to eight times higher than FBD systems, and a coefficient of variation (COV) of 5 to 10%, compared to COV of 20 to 45% with FBD systems.

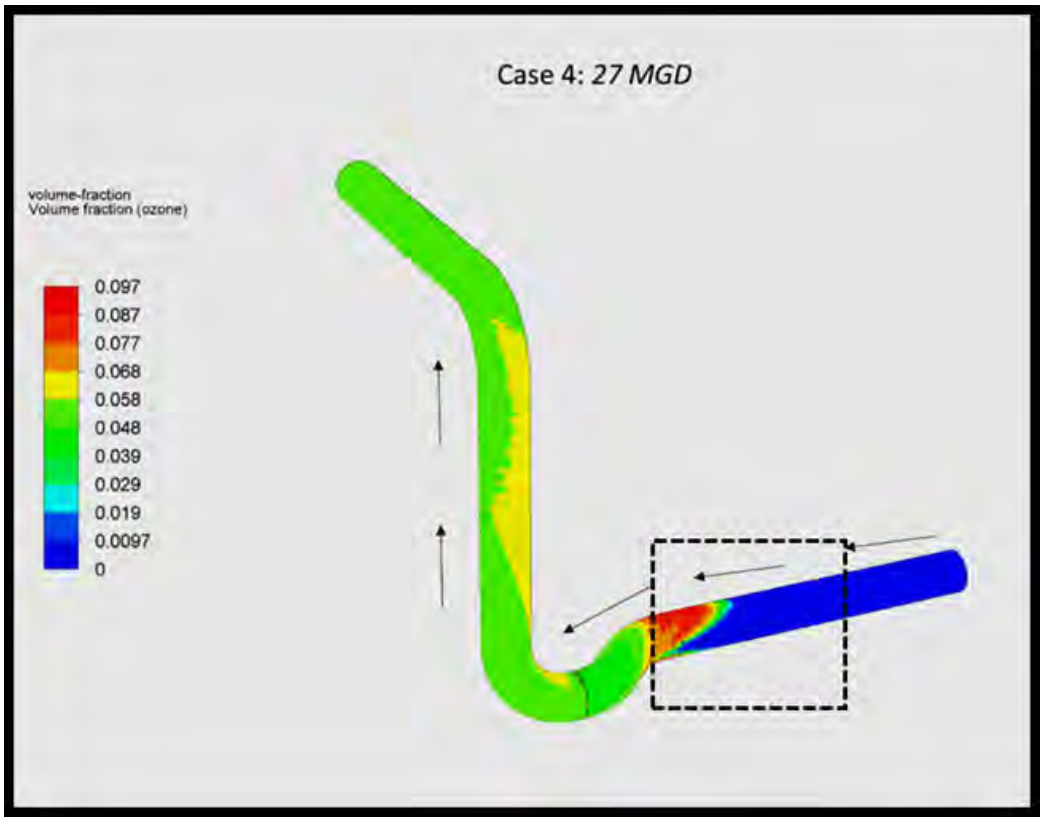
In 2020, Mazzei Injector Company executives conducted a deep dive into industry data collected by the International Ozone Association's Pan-American Group, as well as the company's application engineering files, to explore trends in ozone systems over the past several decades. They found that the OUC's path is consistent with the widespread adoption of high-efficiency ozone generators and side stream injection systems.

OUC Southwest's air-fed ozone system was upgraded with three 1,260 PPD LOX-fed generators in 2010, raising its design capacity from 30 to 40 MGD (136,383 to 181,844 cu m/d). In 2015, the plant's three-train FBD system, which contained 1,656 diffusion stones, was replaced by five small venturi injectors feeding into a single 36-inch (0.9 m) PFR and wafer static mixer plate. Existing over/under baffle basins that served as dissolution chambers for the FBD system now function as reaction chambers.

OUC Conway has a design capacity of 26.75 MGD (121,608 cu m/d). Like OUC Southwest, its air-fed ozone generators were upgraded to a LOX-fed system and its FBD dissolution system was replaced by a five-injector SSI system feeding a PFR followed by a static mixer.

The five-injector design in both facilities allows operators to optimize pump energy costs by turning on or off injectors in response to changes in flow through the plant while applying a consistent dose of 12.0 mg/l ozone to maintain target concentrations of 10% by weight.

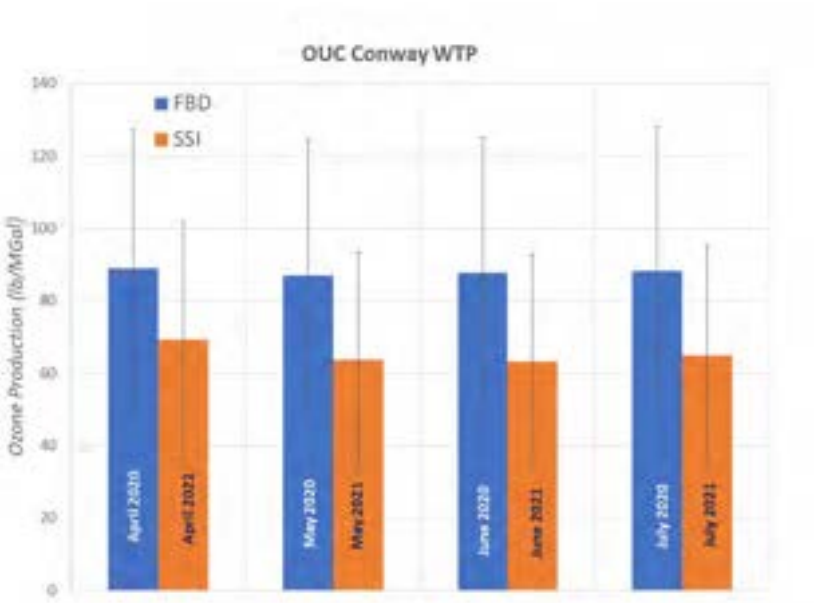
Among the benefits of SSI is the near-plug-flow behavior of the system. Mazzei Injector Company used ANSYS Fluent (v. 19.2) Computational Fluid Dynamics (CFD) software for multiphase, turbulent flow to model the OUC upgrades. Design engineers at CDM Smith, who developed both the FBD system and the SSI system that replaced it, also conducted a conceptual design of five years of data for all seven OUC plants, followed by an analysis of an additional year of data to confirm the five-year study. CFD modeling determined >95% uniformity and coefficient of variation (COV) of <5% at the ozone sampling locations.



This CFD analysis illustrates nearly instant mixing at the pipeline flash reactor, followed by a wafer-style plate mixer.

Modeling results were supported by performance testing of the SSI system at OUC Southwest, which measured ozone concentrations of 11.9 to 12.3% wt., a COV of 5 to 7%, and average mass transfer efficiency of 98.7%. By contrast, the COV of dissolved ozone in the plant's FBD system (detailed in a 2000 paper by Schulz and Bellamy in Ozone: science and engineering) was 21 to 25%. Similarly, a performance test using two analyzers downstream of the PFR and static mixer at OUC Conway recorded weighted mass transfer efficiency of 96.9% and 97.2%.

The ability to sample immediately downstream of the PFR/mixer for almost



Comparison of monthly ozone production per million gallons of treated water for OUC Conway WTP, before and after upgrade to SSI from FBD.

instantaneous readings of ozone residual levels, coupled with high transfer efficiency and thorough mixing, make SSI well-suited for monitoring ozone residual levels through Oxidative Reduction Potential (ORP) sensors. In turn, those sensors can be wired into SCADA/PLC systems to control ozone dosing. By contrast, the sampling port in FBD systems is located well downstream in the contact basin, so instrument readings reflect a 20-to-30-minute delay after changes in dosage, as well as slow-downs in response time during low flows.

In those conditions, the use of ORP sensors for controlling dose is not viable. In fact, OUC operators had given up on ORP monitoring of their FBD systems because incomplete mixing resulted in unstable readings.

Greater efficiency in SSI systems also contributes to reduced energy usage, less material waste, and lower operation cost. The lower COV in the SSI system is easily explained by the extraordinary mixing energy in the PFR/static mixer system—4,800 to 5,300 sec-1 vs. 232 sec-1 for the FBD system.

The total reactor volume and longer contact time required for the passive FBD dissolution system limit the amount of transfer that can occur. Higher doses and a need to compensate for a longer lag time in identifying demand result in significantly larger capital costs.

To enable process control of hydrogen sulfide oxidation and hedge against periodic low residual levels, OUC operators overdosed their FBD systems. A comparison by CDM Smith of five years of FBD system data with 2018 SSI data revealed a 28.23% reduction in ozone dosage in the side stream system, a result of its greater mass transfer efficiency. Comparing daily LOX consumption between an FBD system in May 2020 and an SSI system in May 2021 showed a reduction of 28.30% in LOX (measured as scfm/mg). An OUC comparison between an FBD system in 2020 and an SSI system in 2021 treating water from the same two wells at the OUC Conway WTP measured a 30.1% reduction in ozone production for the SSI treatment.

Operations and maintenance costs are dramatically reduced by upgrading from FBD to SSI. FBD systems require regular shutdown and confined space entry for gasket replacement and diffuser maintenance, as well as labor-intensive, manual checks of each diffuser. A cost analysis for a 14 MGD (63,645 cu m/d) water treatment plant in Kitchener, Ontario, Canada revealed an annual difference of 7 downtime days for FBD maintenance vs. 2 days of downtime to maintain the SSI system, and an O&M cost difference of $13,300 per year for fine bubble diffusers vs. $7,600 per year for the sidestream injector system. Over the 25-year lifetime of the system, the difference was stark—175 down days and $332,500 in costs for the FBD system vs. 50 maintenance days and $190,000 for SSI. A similarly detailed analysis is underway for the OUC plants.

Modernizing its ozone generators and upgrading mixing systems from fine bubble diffusers to side stream injection/PFR resulted in demonstrable savings for the Orlando Utilities Commission in energy, maintenance, and downtime. The switch permitted the utility to reinstate ORP monitoring and use the results to automatically manage ozone dosage control, reducing ozone demand by nearly one-third. Treatment efficacy, system efficiency, and cost savings make a compelling case for the benefits of side stream injection in ozone systems for water treatment plants.

About the Author

Dr. Srikanth Pathapati *is Director of R&D at* ***Mazzei Injector Company*** *and has 15*

years of experience in physical testing, design optimization, and multiphase CFD modeling. The American Society of Civil Engineers (ASCE) recognized Sri for his work in computational fluid dynamics with the 2013 Rudolph Hering Medal for "the most valuable contribution to the field of environmental engineering.", as well as the 2020 ASCE State-of-the-Art of Civil Engineering award for his contributions to the ASCE-EWRI Primer on Computational Fluid Dynamics. He received his Doctorate in Environmental Engineering from the University of Florida, and his Bachelor of Engineering in Electrical Engineering from the University of Madras, India.

AI, REVERSE OSMOSIS, SOFTWARE, WATER TREATMENT

SAVING WATER AND MONEY WITH AI AT RO PLANT

By Devesh Bharadwaj

A multi-billion-dollar international water company (who asked to remain anonymous at this time) invited Pani to do a pilot study demonstrating the capabilities of the Pani platform, a SaaS (software as a service) tool designed to provide analytics and help optimize the water treatment process. During this project, Pani Genius™ was deployed, which includes Pani's proprietary AI Coach™ artificial intelligence technology. The solution was deployed as an offline software assessment at a 6 MLD (1.3 MGD) Reverse Osmosis (RO) plant in Northeastern USA that treats variable river influents for industrial use. This study served as historical analysis and comparison between the plant's operational status quo, which the client assumed to be at peak performance, versus operating with Pani's solution.

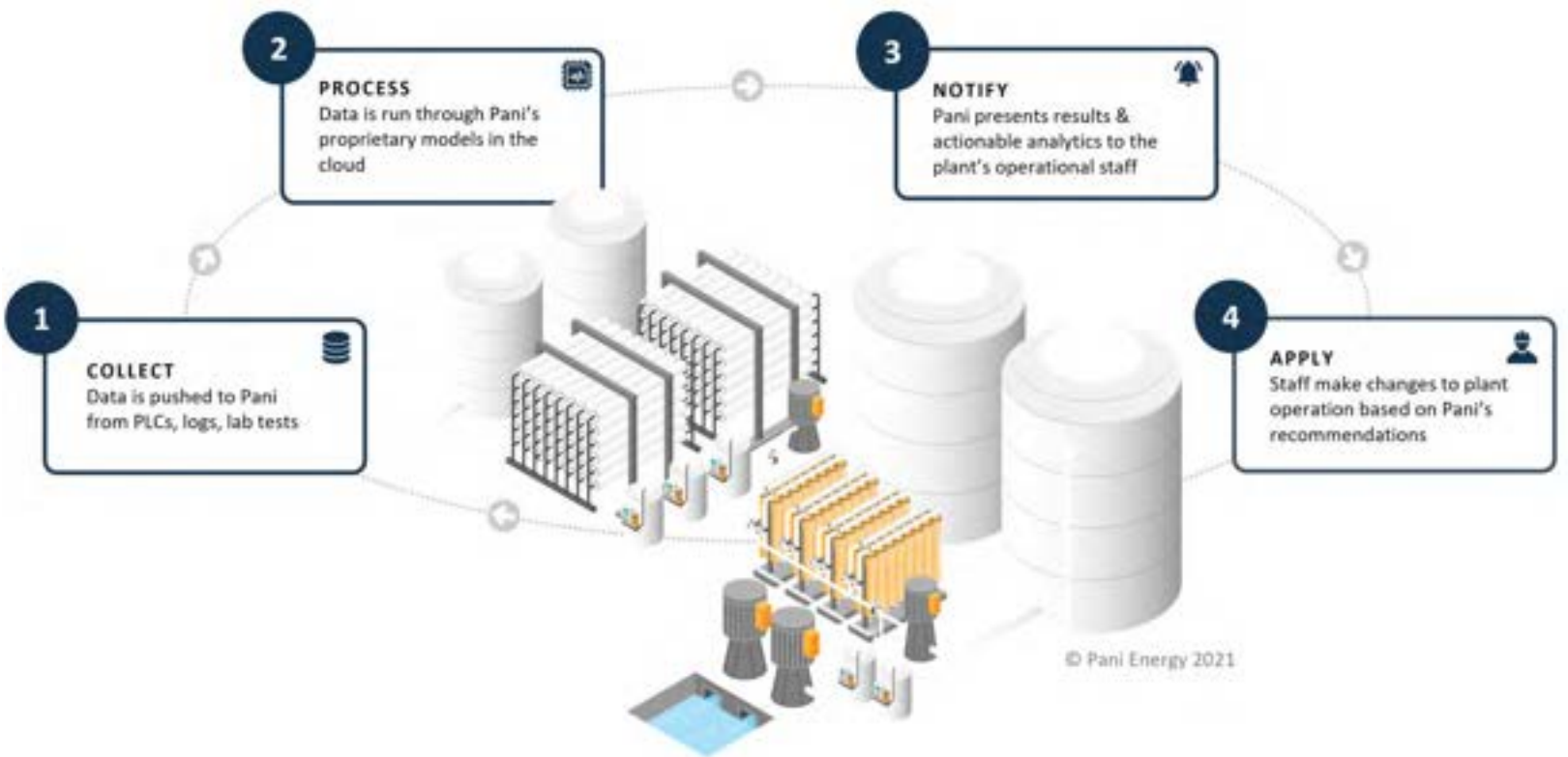
DISCOVERING OPPORTUNITIES USING A DIGITAL TWIN

The Pani solution created a proprietary virtual replica, or digital twin, of the water treatment plant, which provided the platform with a detailed and accurate map of the plant, to the individual asset level.

Cloud-based software models were trained and calibrated using the plant's P&ID information and two years of historical data from the plant's instrumentation. This provided the foundation for the AI Coach™ to learn how each asset and process is connected, such as how upstream Ultrafiltration (UF) pre-treatment affects the Reverse Osmosis (RO) process that follows.

After running thousands of simulations in near real-time, the AI Coach™ found a number of opportunities for improvement. These recommendations were then presented to the operations team advising them on actions to perform to yield the optimal Total Cost of Ownership (TCO) without compromising effluent quality.

- Specific timeframes where the reference operations exceeded the set product water quality limits which demonstrated times when membranes were in poor condition;
- When membrane conditions were normal, Pani found that recovery could be increased without exceeding the plant requirements, physical membrane limits, or chemical saturation limits that would lead to increased scaling;
- Membrane cleaning and replacement



predictions were accurately detected within 30-45 days in advance, giving operators time to order chemicals and schedule maintenance, preventing costly rush orders and unplanned downtime while enhancing membrane performance and health

- Accurate detection and root-cause analysis of high particulate fouling;
- Time periods where the plant demonstrated high product conductivity.

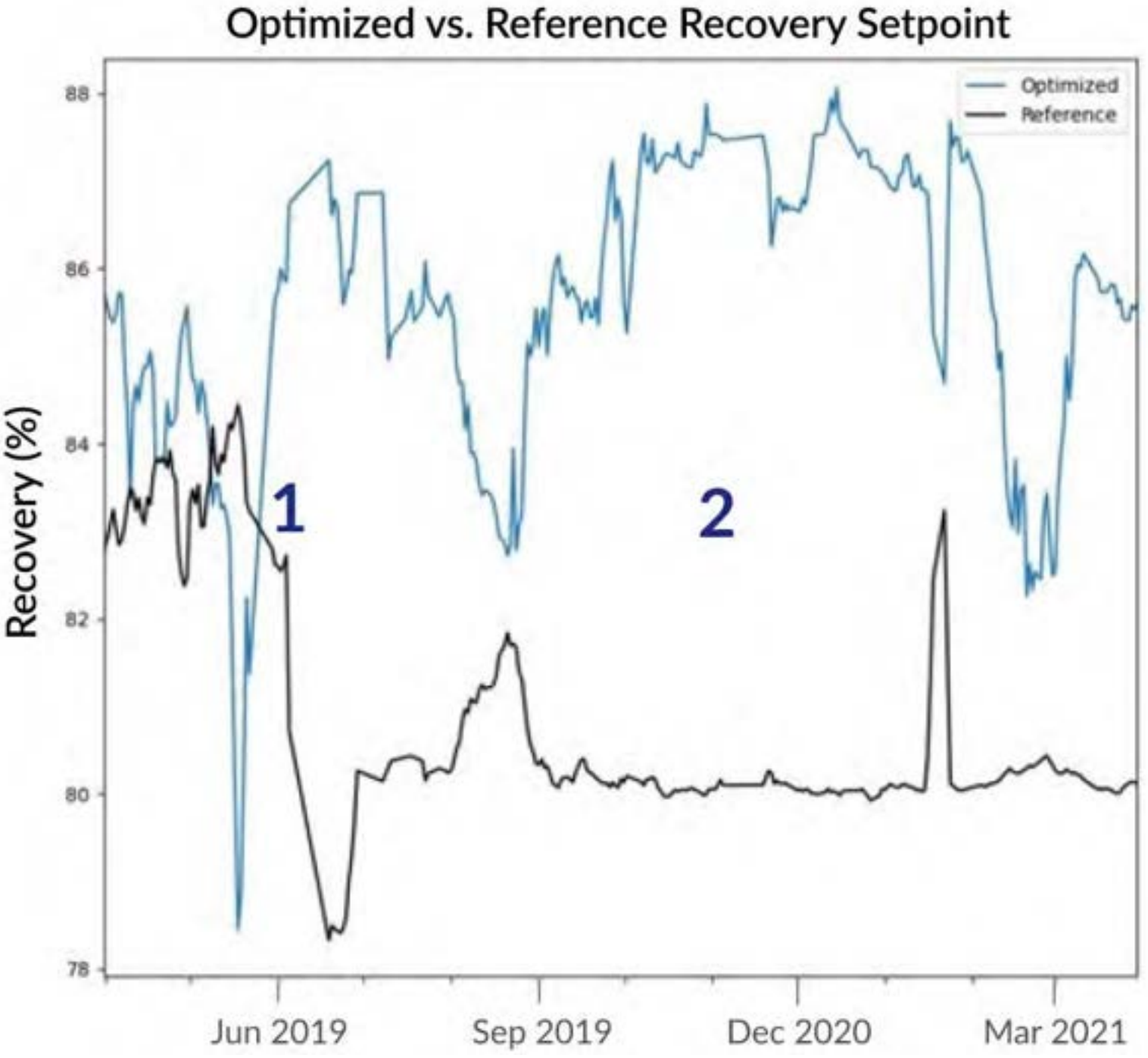
RESULTS OF PLANT OPTIMIZATION

The AI Coach™ supports proactive operations by providing warnings in advance of projected failure or reduced efficiency. Membrane cleaning and replacement are examples of such proactive operations. In this study, Pani predicted product quality, flowrate, and pressure drop issues up to 45 days in advance, giving personnel time to plan logistics.

Optimization reports were provided

> ***"The system was able to find optimization gains in a plant where we had assumed there were none and proved to have an uncanny ability to detect, diagnose, and accurately prescribe action. Pani has placed a marker in the sand with this application and are the ones to beat!"***
> *- Company's Lead Evaluator*

> ***"We have looked at many software providers in the IIOT space that do some of what Pani is capable of doing. There isn't one that can do all of what Pani can do. Their complete feature offering is highly differentiated from competitors and their team is one of the best I've seen. We pushed their software capability through test after test, even through scenarios it wasn't necessarily designed to do, and it held up to a high level of scrutiny."***
> *- Company's Lead Evaluator*

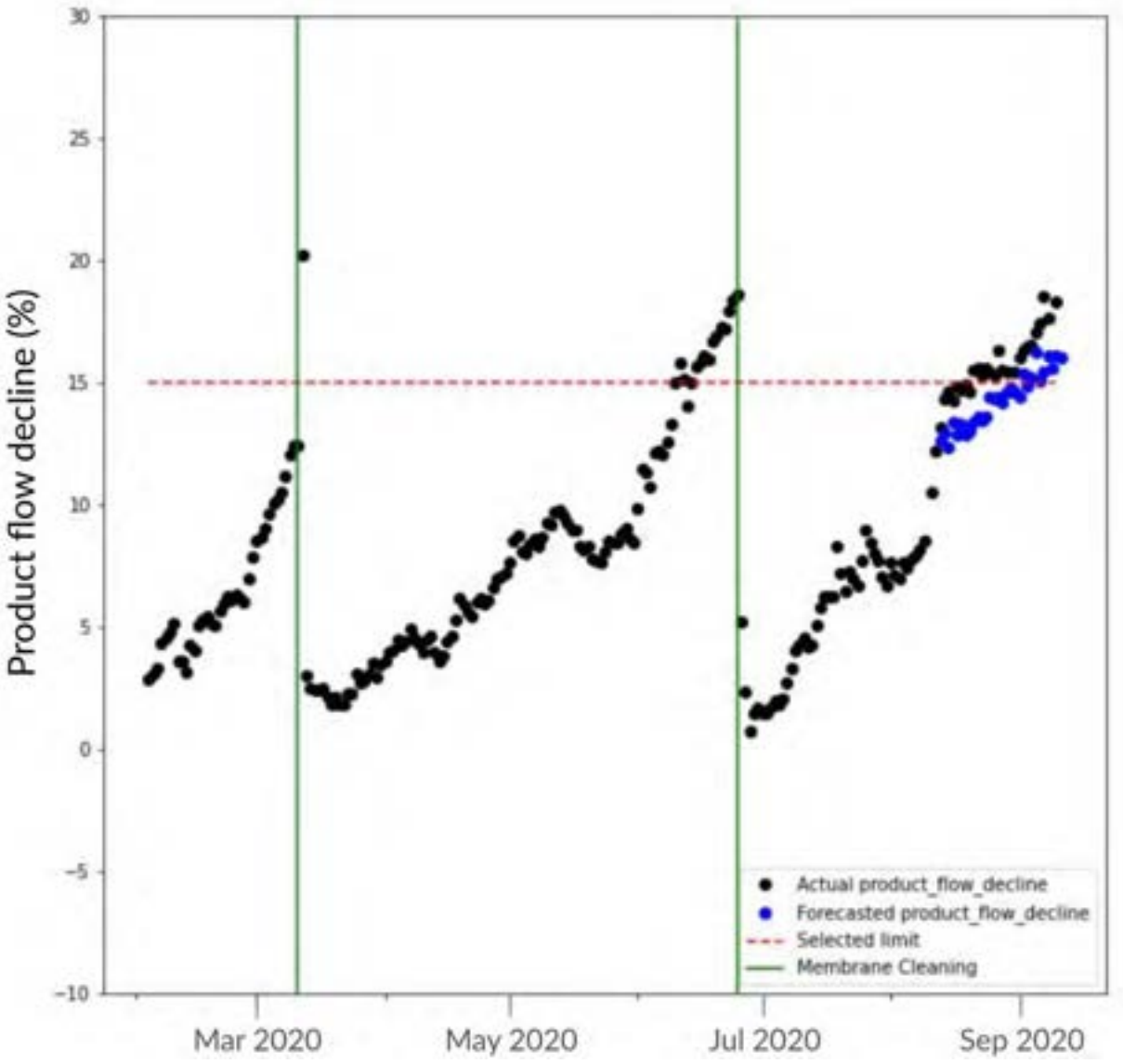


1. Membranes were in Poor Condition and Reference Operation Exceeded Product Water Quality Limits. The AI Coach™ Respected the Quality Limits and Recommended Reducing Recovery Further to Meet Them.
2. When Conditions were Normal, the AI Coach™ Found that Recovery Could be Increased Without Exceeding the Plant Requirements, Physical Membrane Limits, or Chemical Saturation Limits that Would Scale the Membrane Faster.

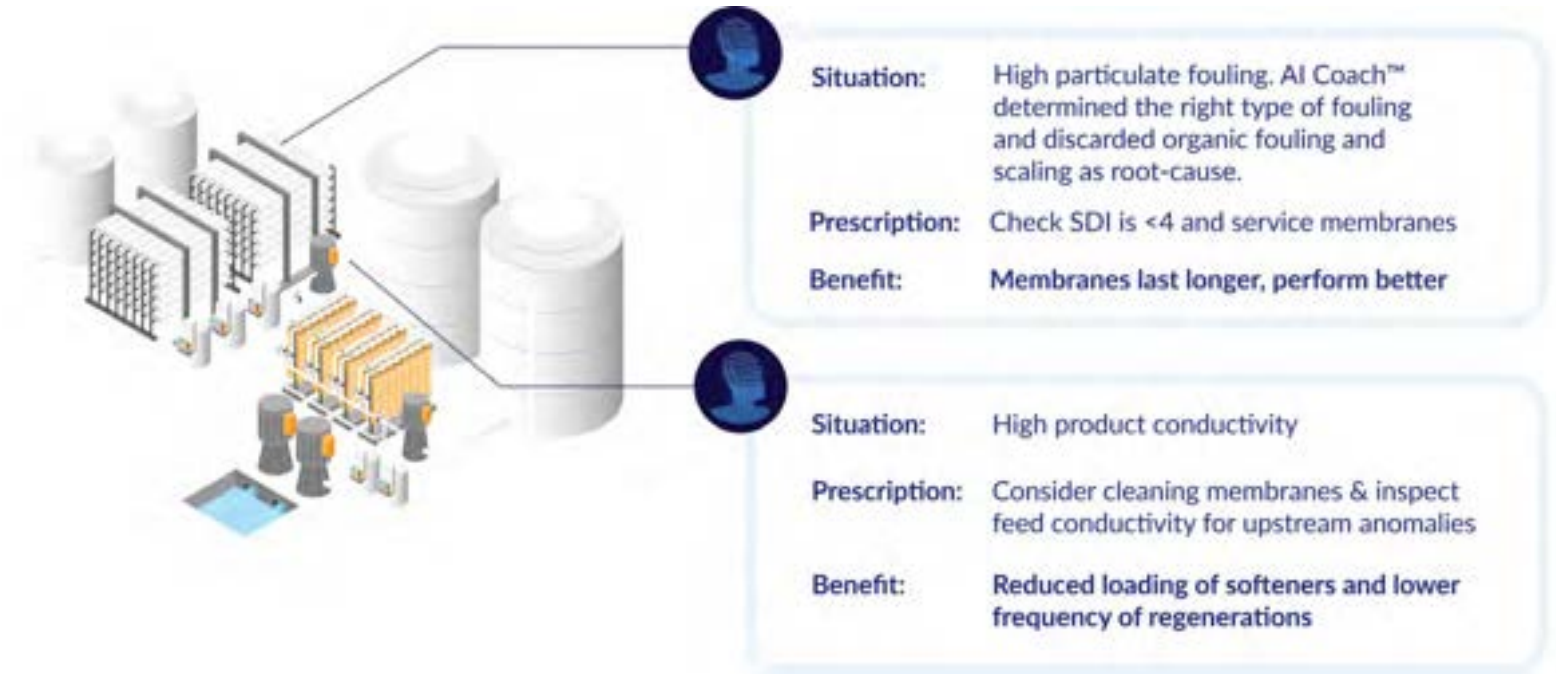
as well as predictive and prescriptive recommendations. The system, tools, and recommendations were evaluated extensively in this study for accuracy and robustness across a range of testing scenarios.

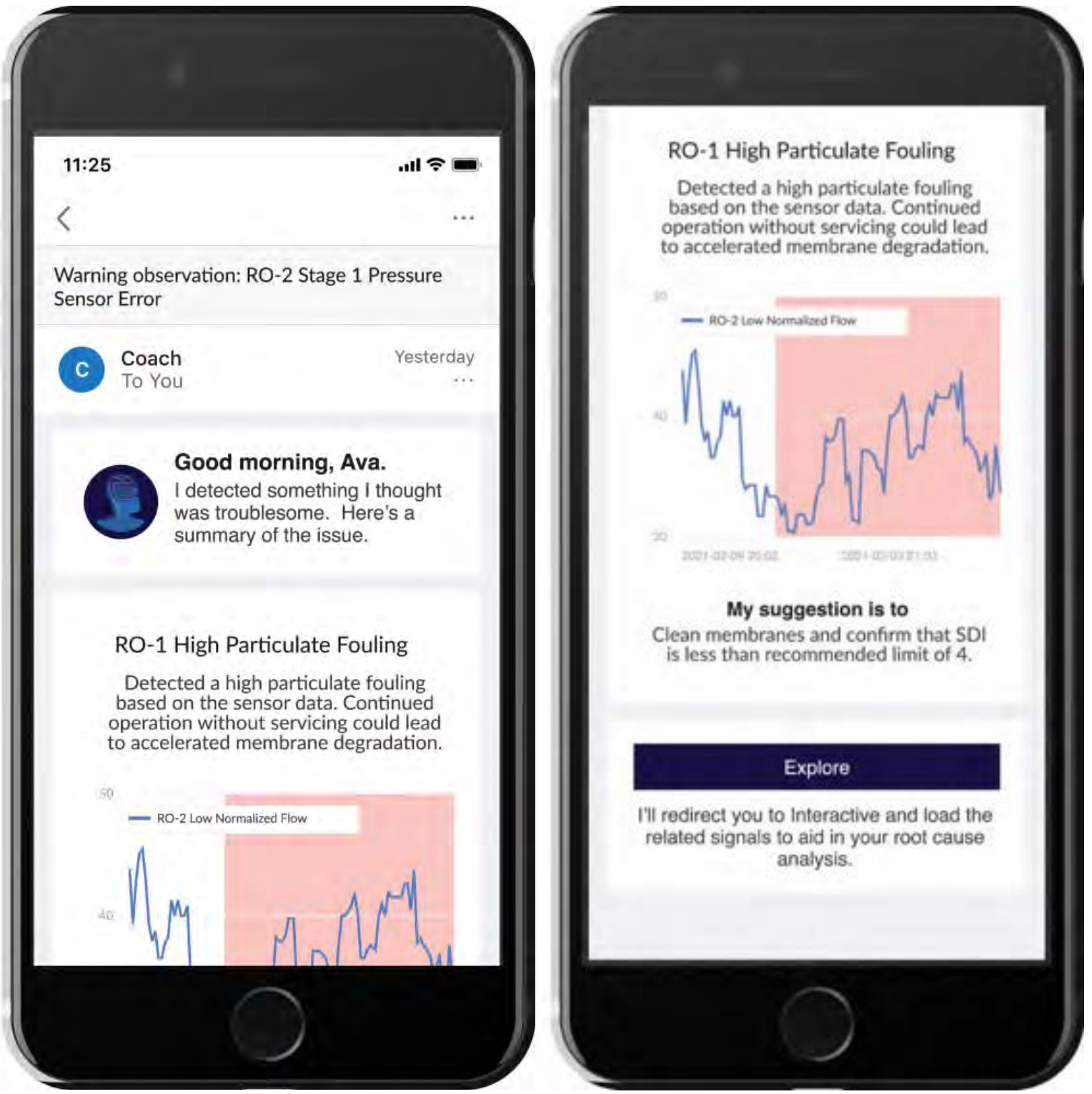
The AI Coach™ also ran cost optimizations in the background to advise operators when to clean and replace. In this study, the AI Coach™ was successful at predicting the optimal time to clean and replace with a consistently high degree of accuracy over the whistorical plant data. The following are estimated benefits for implementing the recommendations from the AI Coach™ retrospectively:

- 2.6% improved water recovery;
- 100 m^3 less daily water use - saving 36.5 million liters of water/year;
- 6.3% lower cost per m^3;
- Over USD 160,000 in savings over a two-year period;
- Up to 30% more successful cleanings, helping to increase membrane life and performance;
- Clear reporting, analytics, and alerts keep operations team informed in real-time;
- 16% more time in healthy operating



Actual Plant Data (Black Points) and the Predicted Data by the AI Coach™ (Blue Points) for Membrane Performance.The AI Coach™ was Able to Predict- with High-Accuracy - when the Flow was Going to Cross the Cleaning Limit and, Therefore, Increase Costs, Giving Operators Time to Respond and Plan.




11:25
Warning observation: RO-2 Stage 1 Pressure Sensor Error
Coach
To You
Yesterday
Good morning, Ava.
I detected something I thought was troublesome. Here's a summary of the issue.
RO-1 High Particulate Fouling
Detected a high particulate fouling based on the sensor data. Continued operation without servicing could lead to accelerated membrane degradation.
RO-2 Low Normalized Flow
RO-1 High Particulate Fouling
Detected a high particulate fouling based on the sensor data. Continued operation without servicing could lead to accelerated membrane degradation.
RO-2 Low Normalized Flow
My suggestion is to
Clean membranes and confirm that SDI is less than recommended limit of 4.
Explore
I'll redirect you to Interactive and load the related signals to aid in your root cause analysis.


2.6% improved water recovery
Status quo: 81%
Optimized: 83.6%
6.3% lower cost per m³
Status quo: $1.74
Optimized: $1.63
16% more time in healthy operating conditions
Extending asset life, reducing OPEX
Up to 30% more successful cleanings
Which would lead to increases in membrane working life & performance

Benefits

100m³ less water used daily

Saving 36.5 million litres of water/year

More than $160,000 in savings

Over 2 years

Clear reporting, analytics and alerts keep operations team informed

The AI Coach™ found 38 different problems & inefficiencies in the historical data that could have been prevented

When applied

For a 5x200GPM food & beverage plant, a **2.6% increase in recovery (26GPM)** could equate to **6.5 million gallons less water** purchased per year or more water converted into product

conditions, extending asset life while reducing overall operating expenditures.

PROJECT SUMMARY

This study demonstrated how the capabilities, accuracy, and value of Pani's solution were thoroughly tested at this RO plant, which was assumed to have been operating at peak as-built performance. The AI Coach™ found multiple significant improvement opportunities in membrane performance, recovery, and water usage that could be achieved with the plant's existing equipment.

Using two years of historical data, the AI Coach™ was able to demonstrate numerous opportunities to reduce water usage and save costs, predict membrane performance up to 45 days in advance with high accuracy, and discover 38 unique problems that were otherwise undetected.

Overall, this project demonstrated that if acted upon, insights from the Pani platform would significantly improve plant performance and reduce downtime, ultimately demonstrating that operations at this facility could be more efficient and reliable.

About the Author

Devesh Bharadwaj *is an entrepreneur, engineer, and the CEO of* ***Pani Energy*** *– a water-focused technology company based in Western Canada. Pani offers a cloud-based SaaS platform using AI and digital twins to optimize water treatment facilities, increasing efficiency while reducing costs, energy consumption, and emissions, all on a low-risk $0 CapEx monthly subscription - no retrofits, downtime, or disruption to operations. Awards and recognition for Pani's technology and Devesh's leadership include Top 5 Most Disruptive Water Technology by Global Water Intelligence at the Global Water Summit in Paris; Top 50 Leader in Water Management Globally by World Water Congress; Imagine H2O Emerging Water Tech Deployment Award in Singapore; Forbes 30 Under 30 for Social Impact, and most recently, Global Cleantech 100 list for 2022.*

ETP, INDUSTRIAL WASTEWATER, MEMBRANE, RO, STEEL PLANT, WHE, ZLD

PIONEERING TECHNOLOGICAL ADVANCEMENTS IN ZLD

By Girish Thorat

The impact of the COVID-19 has been completely unforeseen and global. It has brought the world economy under severe distress to say the least. The environment has made a strong statement against our consuming practices. Amongst the various emergency measures being adopted, water utilities too are globally adapting to the new challenges to ensure water and wastewater services remain intact while also safeguarding the supporting workforce.

Stricter norms from pollution regulatory bodies of the Government of India and increased water consumption are making industries to re-visit the need for greener process technologies, adopt efficient wastewater treatment systems, and strictly monitor adherence to discharge norms. Recycling of maximum quantity of water back to the industries and progressing towards Zero Liquid Discharge (ZLD) is more definitely now 'The need of the hour' if ever.

The methods of ZLD used across industries commonly aim for total reuse of its water resources, zero polluting discharge, and product recovery wherever possible. Regardless of an organization's motivation to ZLD, the results depict good economics, corporate responsibility, and environmental stewardship.

Typical ZLD systems, despite the varying re-usable water recovery percentages, come loaded with operational costs and limitations. With a customized and effective ZLD process installed, costs can be significantly reduced with maximum water re-usage and resource extraction from the waste. The use of specialized membrane solutions such as high-recovery reverse osmosis systems can be customized to obtain such specific treatment goals.

Strongly equipped with an in-depth understanding of industrial wastewaters, Rochem India has continued to pioneer

SUMMARY
Recycling difficult wastewater and ZLD requires:

- **Knowledge of the industrial process and the wastewater generated**
- **Knowledge of treatment processes required/ customization**
- **A sustainable and proven state-of-the-art product portfolio**

in the Research & Development of water recovery and ZLD solutions. We are positively responding to the industrial world's water needs by consistently providing customized and sustainable zero liquid discharge solutions by our robust and energy-efficient product portfolio, i.e., High-Pressure Plate and Tube RO [PT(HP)-RO] and Waste Heat Evaporator (WHE).

CASE STUDY

The following is the summary of Rochem's customized ZLD for one of the leading Steel manufacturing companies in India. Rochem India has successfully designed, installed and been operating this ZLD solution at its unit location near Mumbai, Maharashtra.

- Source of Effluent (Feed to ZLD): ETP Treated
- Feed Volume: 200 cubic meters/day
- Feed TDS: 5000 ppm

Key Highlights of Combination of ZLD Technology Used

A) Plate Tube Reverse Osmosis Systems + High-Pressure Reverse Osmosis Systems (PT-RO + PT(HP)-RO)

The plate tube membrane is specially designed for difficult and high concentration wastewater treatment with exceptional stability and high performance.

Advantages of Rochem India's PT(HP)-RO Systems

- **Reduction in Final Evaporation Cost:** Rochem PT(HP)-RO system can be

RO System

applied on existing RO rejects thereby further reducing the final volume of effluent to be evaporated/ treated for disposal. Lower and more concentrated RO reject volumes mean lower energy/ steam consumption.

- **Lower Operating/ Treatment Cost of HP-RO Systems:** Lesser overall power requirement and no steam consumption when compared to thermal systems applied on upstream RO rejects.
- **Compact and Modular Construction of Membrane System:** Reduced installed footprint, ease in handling, replicability, and isolation in case of fault.

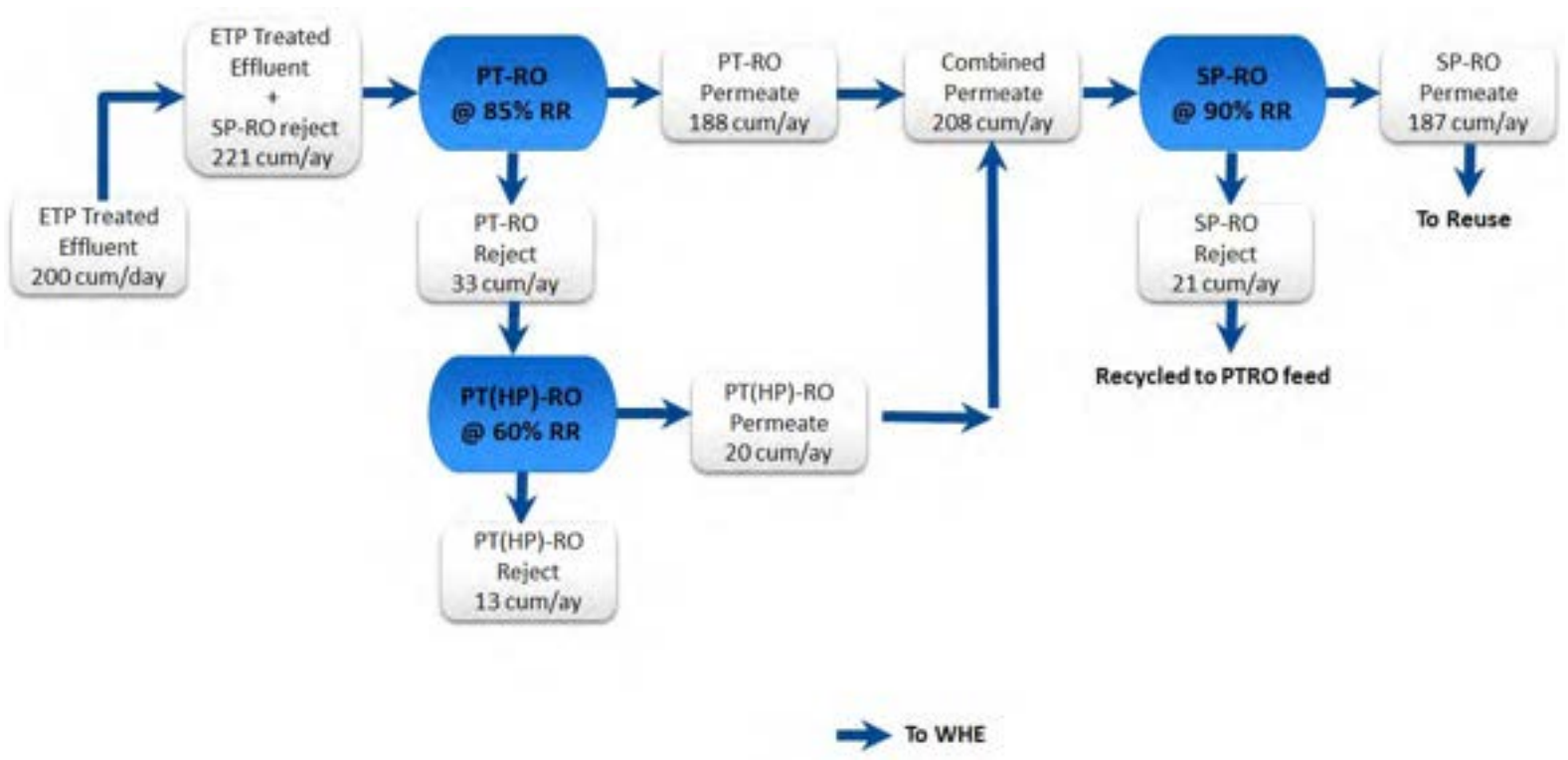
Rochem ZLD System Performance Metric			
Sr. No.	**Parameter**	**Unit**	**Values**
1	Overall Recovery		> 99%
2	Total Permeate Quanwtity	m^3/day	~ 199
3	Combined Permeate TDS	ppm	100 – 150
4	Solids for Disposal	kg/hr	78

- **No Thermal Stress:** Handling higher volumes of RO rejects by HP-RO systems is easier and with lesser mechanical and process failures.

B) Waste Heat Evaporator (WHE)

The Waste Heat Evaporator is a compact and efficient way of evaporating water from wastewater that contains high levels of contaminants and corrosive constituents. As an alternative to the prevailing Technologies predominantly using metallic evaporators, this technology comes at a dramatically lower lifecycle cost due to lower operating and maintenance costs.

The WHE presents an opportunity for an economical and efficient way to concentrate process streams and the brine from RO plants on wastewater. WHE does not necessarily require a fresh source of steam and can effectively use other possible sources of low-grade heat for its operation. The system has the lowest electrical power consumption among current evaporation/ concentration technologies including multi-effect



RO Scheme

Waste Heat Evaporator

evaporators.

Advantages of Rochem India's Waste Heat Evaporator:

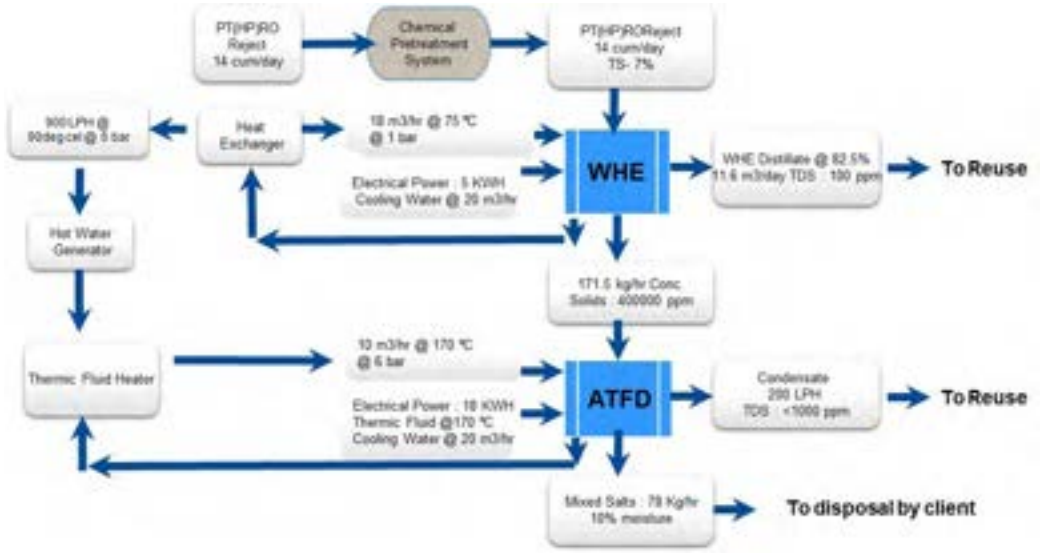
- Lower capital and maintenance costs
- Longer equipment life
- Consistent and high quality of the distillate
- Process reliability
- Reduces equipment size and hence lowers footprint
- Low cost on structural supports
- Easier maintenance and safe operations

Hardness and O&G: High and fluctuating hardness, Oil & Grease values were attended with proper treatment at source and relevant optimizations in ETP operations. Rochem India helped to improve existing ETP performance.

Corrosion and Correct Selection of MOC: Formation of HCl due to $CaCl_2$ hydrolysis at higher temperature can be a plausible reason for ZLD equipment corrosion. Selection of pre-treatment, effluent correction, and appropriate MOC had been instrumental in this regard.

Other teething issues identified during the project execution stage were resolved by closely evaluating the root cause and arresting the same at source or with the proper treatment.

Yes, water can be efficiently re-cycled and technology can be replaced. However, the experience can be only replaced by 'more experience'. Rochem India has been treating all types of industrial wastewater for almost 3 decades now.



WHE + AFTD Scheme

About the Author

Girish Thorat** is the General Manager India at **Rochem Separation Systems (I) Pvt. Ltd.

He has served in the Merchant Navy for 11 years before moving into the corporate sector. His current role is to drive sales and marketing of membrane systems in the industrial sector at Rochem Separation Systems. He has handled senior leadership positions at the National, SAARC, and APAC levels.

AI, SEWERS, SOFTWARES, UTILITIES, WASTEWATER

AI SUCCESSFULLY DETECTS BLOCKAGE FORMATIONS FOR WESSEX WATER

By Brian Moloney

The potential of Artificial Intelligence (AI) technology to transform sewer network management has been demonstrated during a three-month trial of StormHarvester's Intelligent Sewer Suite with Wessex Water in the city of Bath. The technology quickly demonstrated its value, with over 60 early blockage formations detected in real-time and control room alerts reduced by a staggering 97 percent.

Managing sewer blockages represents a significant operational challenge for water and wastewater utilities. As well as problems arising from the blockages themselves, heavy rainfall events often trigger hundreds of alarms simply because of high levels within the sewer network caused by rainfall runoff. The volume of these alarms during wet weather periods can be overwhelming for operational and maintenance teams.

The incumbent rules-based alarm system operating in the Wessex Water control room generated some 4,500 alarms during the trial period, yet StormHarvester's Intelligent Sewer Suite of AI tools was able to mute alarms where the high sewer levels were predicted by the AI software due to rainfall, reducing the total to 138, of which 124 were genuine blockage formations or sensor faults. This gave the utility's operational and maintenance crews the capacity to respond rapidly to each alarm, even during periods of heavy rainfall.

The initiative started in Spring 2020 when Wessex Water invited 16 technology companies from around the world to demonstrate the value of applying artificial intelligence to the wastewater network. As a finalist, Belfast-based StormHarvester was invited to run a three-month trial to carry out proof of concept.

The trial took place from June to August 2020 in the wastewater catchment of the historic city of Bath, Somerset, which comprises 3,500 km of sewerage, representing 10% of Wessex's total. Intelligent Sewer Suite was applied to an array of 98 level sensors already present in the network - 89 at Combined Sewer Overflow (CSO) sites and the remainder at pumping lift stations.

MACHINE-LEARNING

Intelligent Sewer Suite uses machine-learning, an AI application that enables systems to automatically learn and improve from experience without being explicitly programmed to do so. The StormHarvester system's smart machine-learning

Rainy day in Bath - hyperlocal rainfall was a major input into creating dynamic thresholds used to achieve such accurate forecasting.

> ***"Machine-learning technology trialled on part of Wessex Water's sewerage network has identified early forming sewer blockages in real-time with a 92% accuracy rate, whilst also enabling an operational shift to condition-based maintenance approach."***
> ***- Brian Moloney, Managing Director, StormHarvester***

algorithms and predictive analysis tools were applied to catchment sensor data and corresponding hyperlocal rain forecasts to predict the wastewater flow levels and detect potential early blockage formations in real-time.

Wessex Water wanted to test the ability of machine-learning to:

- Predict blockage formations in sewer pipes and pumping stations early and intervene before they became service failures
- Better separate genuine control room alarms from alarms triggered because of high volume rainfall during wet weather
- Dramatically improve the response time to service failures

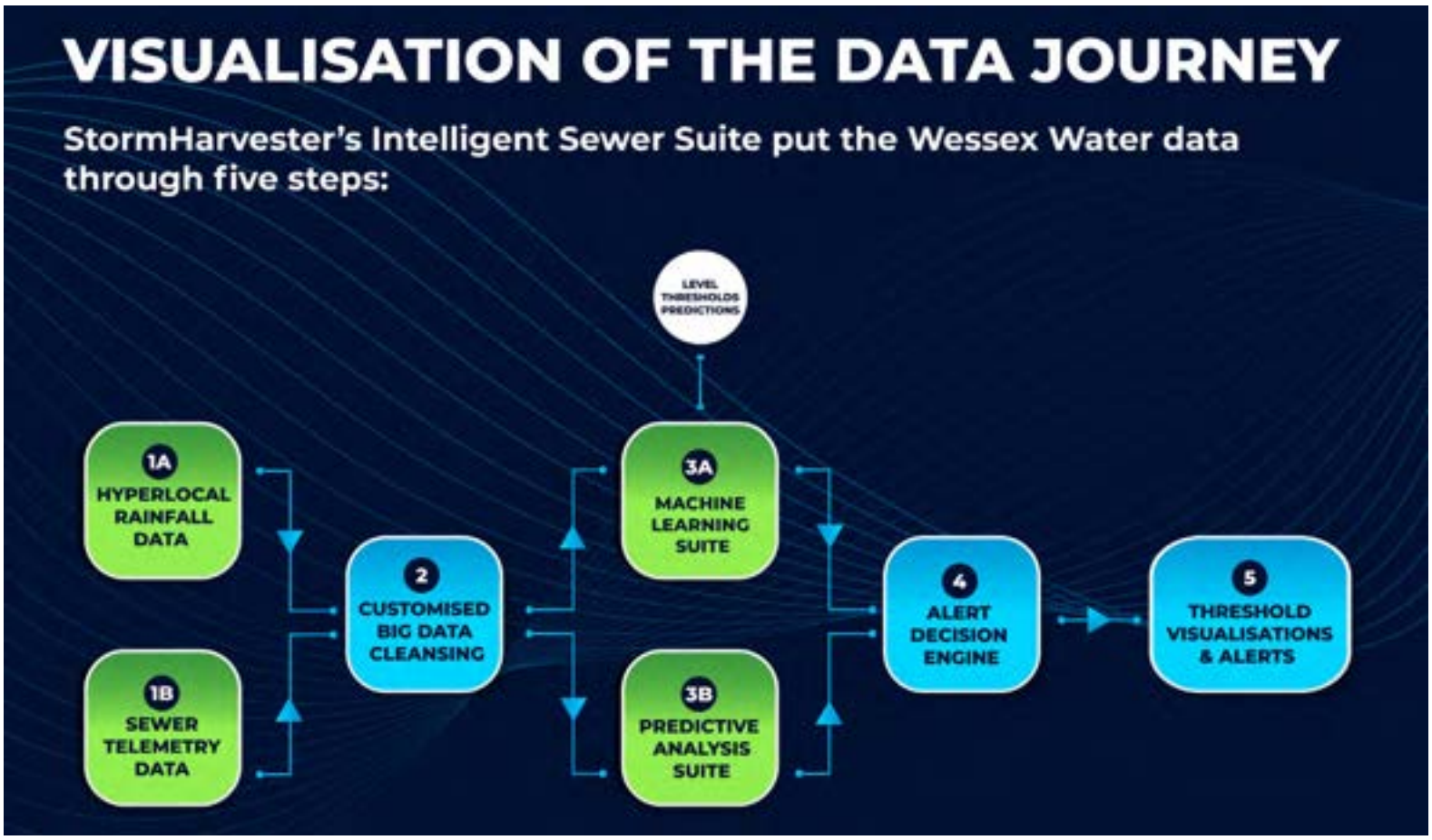
Blockages can lead to costly service failures including pollution or flooding events, but if spotted early enough, they can be quickly remedied. Wet weather makes it difficult to differentiate expected high sewer levels caused by heavy rainfall volumes from those arising from restrictions such as partial or total blockages.

By deploying AI with the capacity to differentiate between these different events, both an improvement in alarm quality and alarm rationalization is made possible.

EASY SET-UP

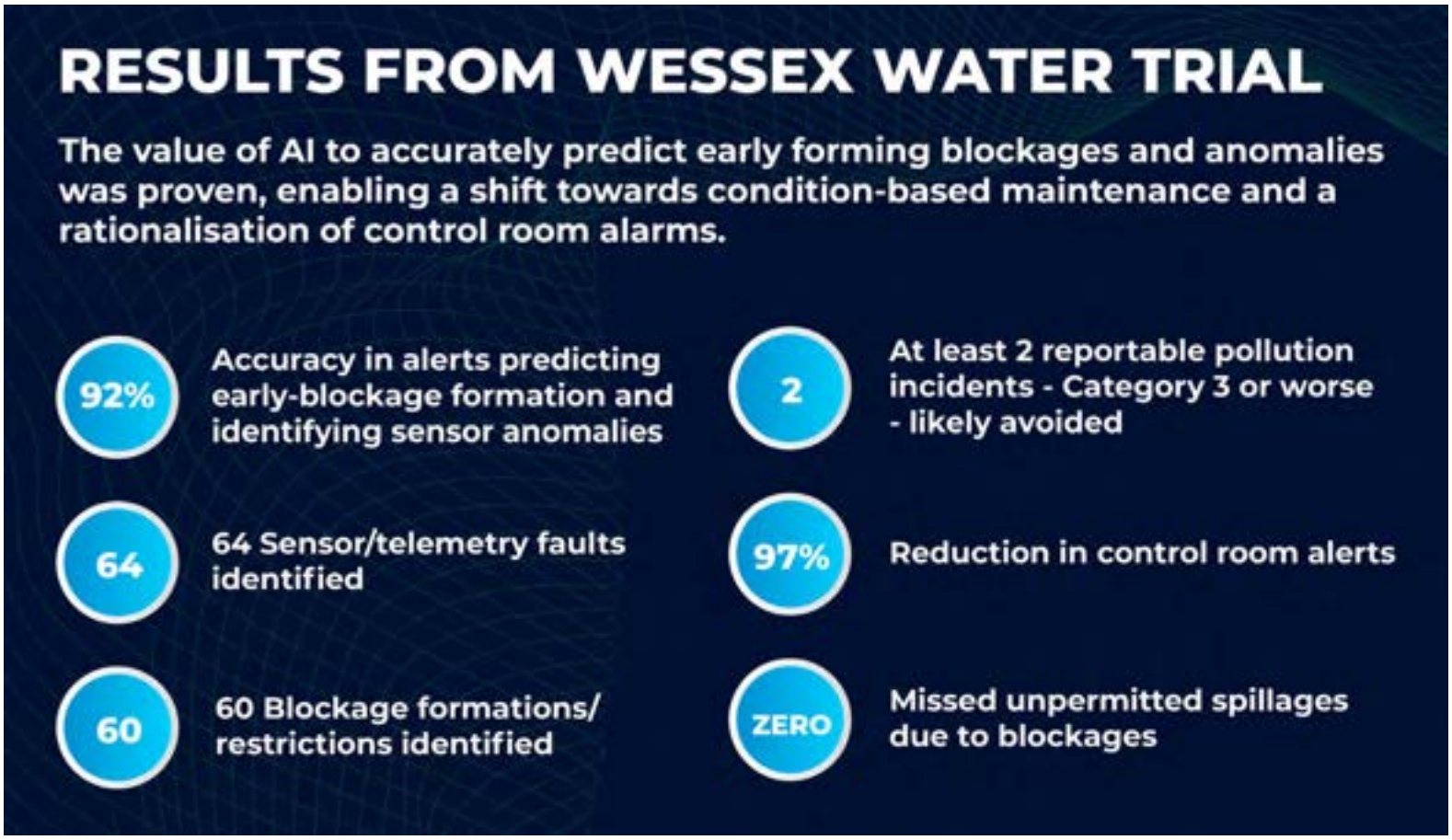
Intelligent Sewer Suite took only three weeks to set up before it started providing usable results and did not require any hydraulic models.

The process included the extraction

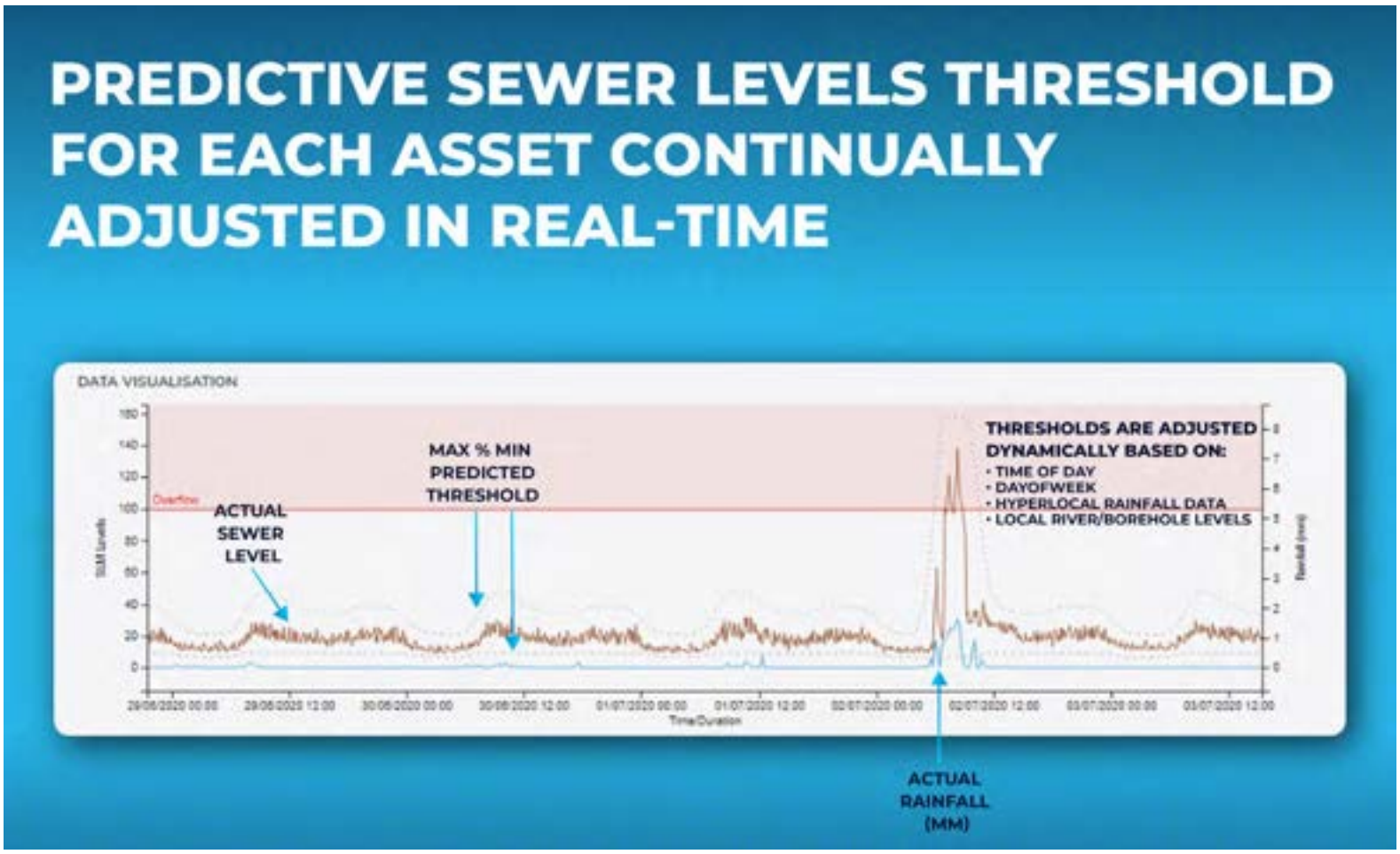


StormHarvester's Intelligent Sewer Suite put the Wessex Water data through five steps.

of historic sewer-level data and rainfall levels within a 1.5 km^2 grid for each of the 98 monitored assets. Tens of millions of iterative machine-learning calculations were then undertaken in order to 'learn' sewer asset behavior in both dry and wet



The value of AI to accurately predict early forming blockages was proven.



Predictive sewer level thresholds for each asset were continually adjusted in real-time.

weather periods.

ACCURATE THRESHOLD FORECASTING

Safe operating windows for assets in the network were predicted based on a number of factors including time-of-day, day-of-week, hyperlocal rainfall, and local river levels. These dynamic thresholds are predicted for six hours into the future and are updated every 15 minutes, at the asset level, which is one of the keys to such accurate forecasting.

The real-time predictions and blockage alerts are used to identify potential non-compliant, out-of-sewer pollution events before they occur. Maintenance crews can be proactively directed to these locations to remedy issues before they arise or worsen, mitigating service failures.

Intelligent Sewer Suite visualization of Bath wastewater catchment divided into 1.5 km² showing sewer assets aligned with hyperlocal weather forecasting grid.

Edmund Willatts, Asset Reliability Engineer, Wessex Water said, "The StormHarvester system used machine-learning to set safe operating windows or thresholds for each asset. Each time these had a significant breach, we received alerts, which in turn were passed to the operations team so that they could respond."

POLLUTION REDUCTION

The Environment Agency is seeking

Unrestricted sewer flow in Bath catchment

a zero level of pollution incidents for the water industry in England and puts incidents into four categories, with Category 4 being the least serious and having no impact on company performance. Category 3 incidents can impact performance commitments and risk breaches of environmental protection and water industry legislation. They can also lead to significant costs, including emergency response charges and penalties from regulators.

Results from the three-month trial showed significant alarm rationalization and a high degree of accuracy in blockage detection. Over 60 early blockage formations were detected in real-time, at least two of which were likely to have caused pollution incidents – Environment Agency Category 3 or worse. Over 60 telemetry and sensor faults were also detected.

Jody Knight, Asset Technology Manager at Wessex Water said, "The StormHarvester team identified sewer blockages that using the normal working processes we may not have spotted until they had resulted in unwanted sewer overflow events."

Deployment of StormHarvester's AI approach was shown to be 92% accurate, with no blockages missed. Additionally, a 97% reduction in control alarms was achieved with only 138 in total – a little more than one-a-day over the period.

Wessex Water considered the alerts provided by StormHarvester to be a major improvement on the status quo, where operational staff was regularly overwhelmed by the large number of high-level and overflow alarms occurring during periods of heavy rainfall. It also makes the potential for predictive maintenance very realistic in the near future.

Willatts said, "This condition-based sewer maintenance versus the scheduled cleaning regime will be key to making operational teams more productive and efficient going forward."

MULTIPLE CAPABILITIES

The Wessex pilot revealed that StormHarvester technology has the capability for:

- **High Blockage Prediction Accuracy:** 92% of alerts were relevant and required and not a single blockage resulting in a pollution incident being missed
- **Few False Positives:** 8% of alerts were false positives
- **Long-Range Blockage prediction:** Early blockage formations identified up to eight weeks before they would have resulted in service failures.
- **Condition-based maintenance:** The three-month trial has enabled a shift in approach.
- **Control Room Alarm Rationalization:** A 97% reduction in control room alerts was achieved versus business as usual.

Knight said, "One of the biggest problems we have serving our customers is not knowing where and when blockages will occur, or are likely to occur, in the wastewater network. During the three-month trial, StormHarvester identified

Reduced flow due to sewer blockage in Bath catchment

at least two incidents that we are fairly confident would have resulted in Category 3 spillages, or worse, if it was not for the early blockage detection alerts received and the subsequent action taken by Wessex operational staff."

Neil Macdonald, Co-founder of StormHarvester said, "The results have been excellent. Wessex Water has been great to work with and this trial has proven that Intelligent Sewer Suite is effective at scale.

"This is further endorsement of our five-year journey and multimillion-pound investment to build an effective AI solution combining machine-learning, predictive analytics, and hyperlocal rainfall forecasting leading to intelligent sewers that serve customers, communities, and the environment."

PREDICTIVE MAINTENANCE

He added, "Our technology proves that predictive maintenance is possible, with early blockage detection occurring from hours to weeks in advance. This represents a significant increase in the available time for operational crews to recover and repair assets.

"StormHarvester sees this as a real game-changer, with a clear route to achieving efficiencies for wastewater utilities, reducing wastewater pollution and both internal and curtilage flooding."

Based on the value brought by the StormHarvester alerts during the proof-of-concept trial, Wessex Water has maintained the solution running on the Bath wastewater catchment into 2021.

About the Author

Brian Moloney *is the Managing Director of StormHarvester.*

StormHarvester *is a leading smart drainage company operating in both the wastewater and stormwater sectors. Its core competency is bringing together our own proven machine learning approach with hyperlocal rainfall forecasting. It makes intelligent sewers a reality by predicting sewer levels/flows, detecting early blockage formations, and optimizing network performance.*

AUTOMOTIVE, HYBRID RO, STP EFFLUENT, REUSE

RECYCLING SEWAGE WASTEWATER AND REUSING FOR INDUSTRIAL APPLICATIONS

By Turbaashu Bhattacharya

Wastewater reuse - recycling and reusing water from our sewerage systems - may prompt what is quite simply known as the "yuck" factor. People are naturally squeamish about the idea of reusing water that comes to the sewage plants, even though it's quite common. Wastewater reuse has been around for thousands of years.

In India, Singapore, Mexico, and Spain, reused water can provide a valuable water source for key industries, reducing the demand for limited water resources. Power plants, refineries, mills, and factories, including, for instance, those in the auto industry, can use reused water.

The need is great. Not only do some 4.2 billion people around the world lack access to safely managed sanitation services, but 80 percent of global wastewater is not adequately treated. As much as 36 percent of the global population lives in water-scarce areas, and water demand is expected to rise to 55 percent by 2050 amid rapid urbanization.

The electric power production industry, comprising hydroelectric, nuclear, coal, and oil-fired power stations account for 50% to 70% of industrial water use. Paper and pulp production, chemicals, mining and metal processing, and petroleum refining all use substantial amounts of water in

BENEFITS UNDER OPEX MODEL

Roserve Enviro Pvt. Ltd. is a FinTech company that provides solutions for wastewater management using cutting-edge technology along with innovative BOOT/BOO models viz., Build, Own, Operate, and Transfer.

We design the treatment system based on the quality and quantity of effluent and the requirement of treated water quality. This system is specially designed for your applications. We are backed with the latest technology and expert service teams with almost 30 years of experience across more than 1800 installations in India and the world.

Roserve Enviro takes care of the entire system including operations, maintenance, manpower, health of the system, etc. We provide assurance for the service as well as treated water quality and quantity.

their operations. The amount of water used in producing various goods and services is called water intensity. Manufacture of a pound of paper takes about 11,400 liters of water, while producing one car takes, on average, about 2,46,000 liters. A pound of aluminum takes about 7,57,000 liters of water to produce and a hamburger around 4,999 liters.

FRESHWATER CONSUMPTION AND WASTEWATER DISCHARGE: COMPARISON BETWEEN DIFFERENT TYPES OF INDUSTRIES

Rather than a disposal liability, recycling

Industrial Sector	Water Discharge (MMC/Year)	Annual Consumption (MMC/Year)	Proportion of Total Water Consumption (%)
Thermal Power Plants	27,000.9	35,157.4	87.87
Engineering	1551.3	2019.9	5.05
Pulp & Paper	695.7	905.7	2.26
Textiles	637.3	829.9	2.07
Steel	396.8	512.6	1.28
Sugar	149.7	`94.9	0.50
Fertilizer	56.4	73.5	0.17
Others	241.3	314.2	0.79
Total	**30,729.2**	**40,008.0**	**100.0**

and reusing industrial wastewater and sewage water onsite is now considered a smart business practice, one that helps companies become more profitable and efficient. The transport of wastewater to offsite facilities is very expensive. When industrial facilities recycle wastewater on-site for reuse in a variety of industrial processes, they are saving substantially on transportation as well as disposal and energy costs. Recycling and reusing wastewater is an economical path to meeting your industry's large-scale water demands because, let's face it, many, many industries are extremely water-intensive.

Sustainability is a term that is heavily used but not necessarily well-understood. In simple terms, it is focused on meeting the needs of the present without compromising the ability of future generations to meet their needs. It has an economic, environmental, and social component.

CASE STUDY - AUTOMOBILE INDUSTRY

At one of our client's facility, an Automotive Industry biggie, their process generates around 300 cubic meters of sewage wastewater. We came up with an idea to recycle this treated STP effluent and reuse it for non-potable applications such as washing, flushing, cleaning, gardening, and for infrastructure applications. Following is the case study which shows how this Hybrid RO technology helps to achieve our targets and gives us a sustainable solution.

CURRENT SCENARIO

- **Wastewater Source:** Sewage from toilets, wastewater from the canteen
- **Quantity:** 300 cub. meters per day
- **Fresh Water Cost:** Rs. 60/ cub. meter
- **Existing Treatment Facility:** Basic

Sr. No.	Treatment Parameters	Recycled Water Costs (in Rs/Cum)	Freshwater Cost (in Rs/Cum)
1	Operational & Maintenance Cost	21	60
2	Manpower Cost	9	
3	Electric Power Cost	10	
4	Fixed Cost of Equipment (6 years)	20	
	Total	60	60
	Cost After 6 Years	40	66

Sewage Treatment Plant (STP)
- **Application of Treated STP Effluent:** No applications - drain out to the river

Based on the last 6 months' analysis reports and subsequent trials we have designed and installed a 300 KLD hybrid RO system with 75% recovery. The treated water quality is better than the freshwater quality which can even be reused for industrial applications in utilities, washing-flushing, etc.

PRESENT SCENARIO

- **Treatment System:** Hybrid RO system
- **Feed Quantity:** 300 cub. meters per day
- **Permeate Quantity**: 225 cub. meters per day
- **Recovery Rate:** 75%

The following table illustrates the breakup of treatment cost and comparison against the freshwater cost:

APPLICATIONS

- Utilities: Cooling tower make-up, boiler feed water.
- Civil infrastructure
- Washing auto parts, cars
- Flushing and gardening

WATER ANALYSIS REPORTS

Sr. No.	Parameters	Freshwater	Treated Wastewater
1	TDS	<100 PPM	< 50 PPM
2	TSS	<50 PPM	< 5 PPM
3	COD	< 25 PPM	< 25 PPM
4	Turbidity	< 10 NTU	< 2 NTU
5	Silica as SiO_2	< 5 PPM	< 2 PPM

HIGHLIGHTS OF 'PLUG & PLAY' RECYCLING MODEL

- Ready to use equipment
- Quick mobilization
- Pay per use model
- Rental options on Zero Liquid Discharge
- Flexible renting solutions along with short-term rental options
- Consistency in quality and quantity of treated water
- Less footprint area
- Technologically upgradable with minimum increase in costs

This Plug & Play recycling model has been initiated by us to provide a strong foundation for the Automotive Industry to ensure they achieve their sustainability norms, while at the same time are able to manage their harmful effluent disposal impact on the environment.

About the Author

Turbaashu Bhattacharya *is the Business Head of* ***Roserve Enviro Pvt Ltd.*** *He heads the sales and business development vertical for Roserve Enviro Pvt Ltd, the Indo-Danish Joint Venture startup offering innovative financial solutions in the field of wastewater recycling and treatment including Zero Liquid Discharge (ZLD) to meet sustainability norms for industries and corporates.*

DMA, RWH, SEWERAGE, SOLID WASTE, STORMWATER, TOWNSHIP, WATER SUPPLY

SUSTAINABLE DEVELOPMENT FOR BENGAL AEROTROPOLIS

By Dilip Sonwane and Umashankar N

The water demand is ever-increasing for Indian cities due to an increase in per capita consumption, population rise, industrialization, and change in lifestyle. The potable water sources are finite, and cities are looking for distant water sources to meet increasing water demand. In many cities, these sources are beyond 50-100 km distance which requires major capital investment in addition to the availability of water. The unplanned disposal of wastewater are also polluting the groundwater and nearby water bodies. The transformation of irrigation or open land for the development of townships adds to the increase in runoff. The judicious planning of water, sewage, and stormwater are essential for making the developments

ACHIEVEMENTS

- **The overall water demand has been reduced by 57% in BAPL township, with no discharge of wastewater resulting in zero discharge township.**
- **Preserved all 22 lakes, the rainwater harvesting through existing lakes, tamla nallah, dug wells will store about 800 ml of rainwater leading to percolation and maintaining the good groundwater level in the proposed township.**
- **The saving in capital cost investment by the authority in the creation of capital assets will be about 17.16 crore. Thus, the township is sustainable from a natural resource and financial investment perspective.**
- **Waste minimization-3R concept in solid waste management has been achieved as the waste generated from the township has been recycled/ reused and the inert material is used for filling the low-level areas inside the project area/ nearby areas.**
- **Disaster management plan has been proposed along with emergency relief operation and organization structures.**

Bengal Aerotropolis Projects Limited (Photo Credit: BAPL)

"sustainable" leading to better usage of available natural resources.

Tata Consulting Engineers Ltd provided integrated infrastructure planning services for 1700 acres BAPL (Bengal Aerotropolis Pvt Ltd) township near Durgapur in West Bengal. An integrated planning approach has been adopted covering water supply, sewerage, and stormwater management. The project is at various stages of construction and TCE is continuing the design services since the concept stage of the project.

WATER AND WASTEWATER MANAGEMENT

The BAPL site lies in between the rivers Ajoy (10 km north of the site) and Damodar River (30 km south of site). The river source requires investment in the form of construction of water system from source to the township and the available water from other sources is limited. The fresh water available to this township from local civic bodies is not adequate to meet the demand. Hence, optimum use of water resources is required.

The requirement of water for various uses was estimated with segregation of potable and non-potable water requirements. A concept of recycling and reuse was proposed. The use of tertiary treated wastewater has been proposed for non-potable applications and the requirement of fresh water was limited to potable use. The judicious planning of fresh water and treated wastewater has resulted in considerable savings in water requirements from fresh water sources without compromising the comfort level of

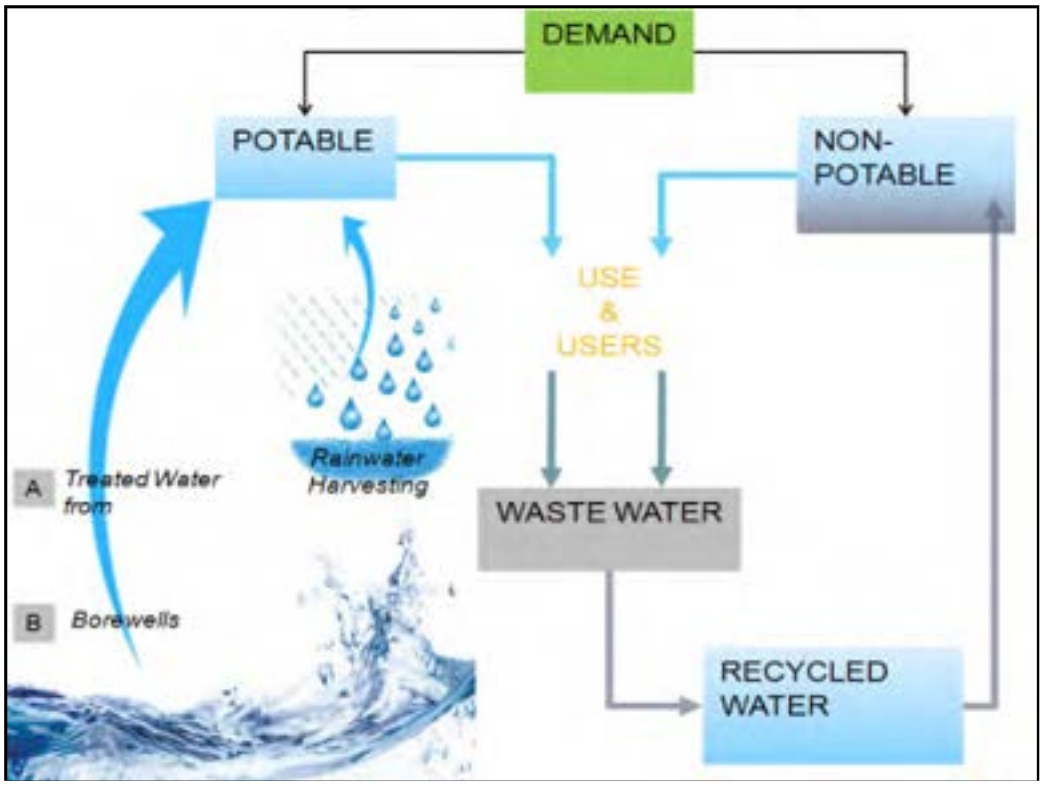


Figure 1: Concept for Water Management

consumers.

This has resulted in the complete reuse of treated sewage water leading to zero discharge.

Apart from the recycle and reuse option, emphasis has been laid on water conservations techniques in terms of reduced water losses in the transmission and distribution system.

- All the water transmission mains have been metered with one at the start and another in the end, and these readings are proposed to be connected/ transmitted to the centralized SCADA center, so that, the exact water usage and losses can be monitored.
- In the distribution system, the water supply network has been designed based on the DMA concept. In this concept, the entire water supply zone is divided into sub-zones called DMAs. Each DMA will have a bulk meter and all Individual House service connections metered. This will help us in micro-monitoring of the distribution zone and thus help the utility company in managing the UFW losses.

The schematic diagram of the DMA is provided in Figure 2.

It is proposed that each household needs to install the water-saving fixtures in their premises including the taps and water closets. This will help in optimizing the water consumption at the consumer end.

STORMWATER MANAGEMENT

Rainfall intensity selected is for the storm of duration equal to the time of concentration (as per IRC- SP 50) of the site and for a return period of one in two years (as per CPHEEO Manual).

The major trunk drains are routed to

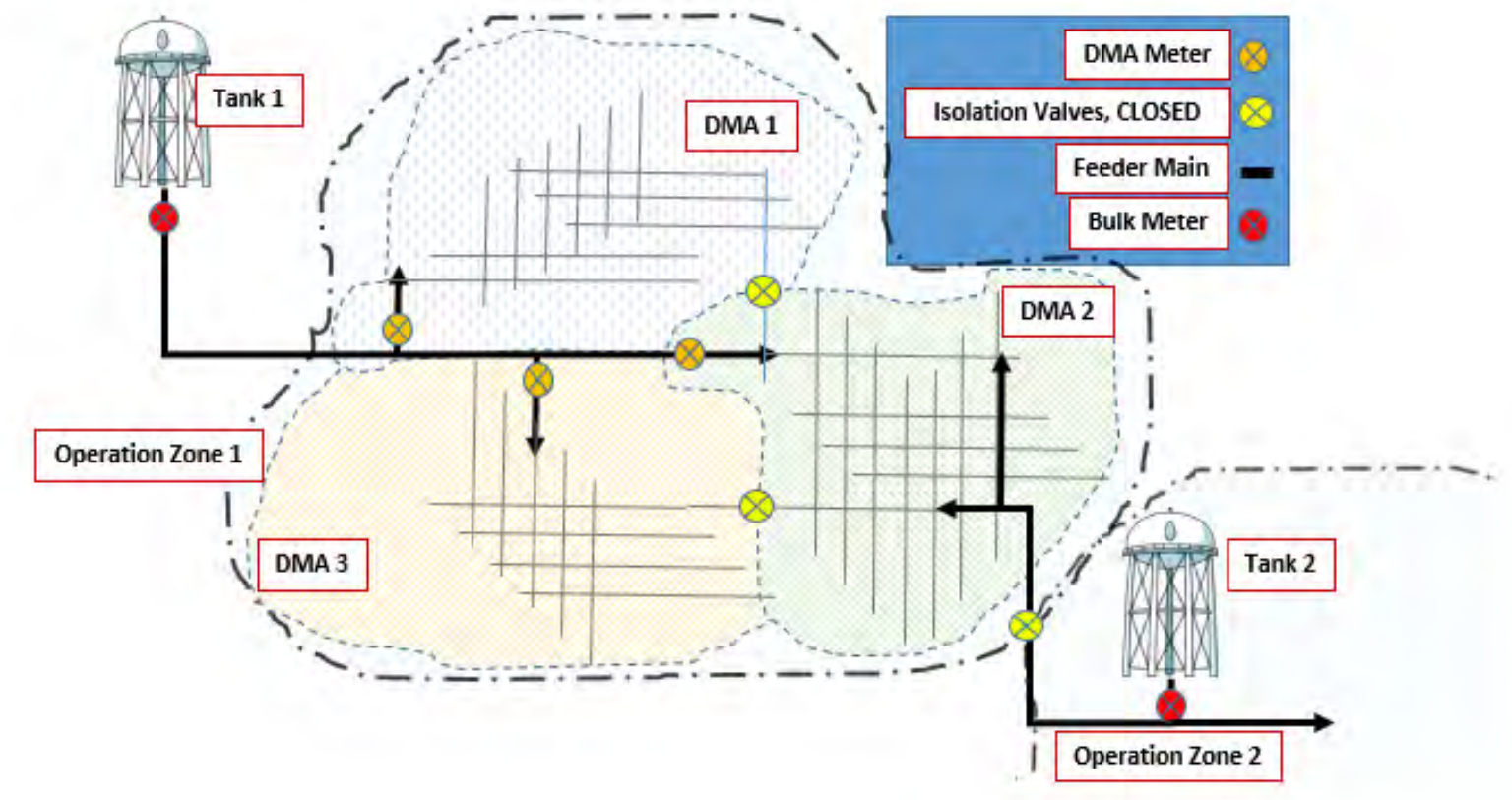


Figure 2: The Schematic Diagram of the DMA

Figure 3

discharge into the three outfalls into Tamla Nala. Groundwater recharge is planned through recharge trench/ drains/ percolation pits/ recharge of abandoned open wells. Following options are proposed for Rainwater Harvesting (RWH) plan:

- Sustainable rainwater water harvesting in Tamla Nala
- Preserve all-natural water bodies to collect rainwater
- Framework of plot-wise rainwater harvesting developmental guidelines

Traditional non-intrusive rainwater harvesting techniques have been proposed in the Tamla Nala without creating submergence of the surrounding or upstream catchments. The widening of the Nala at bottle-neck stretches and cluster of shallow dug wells will provide rainwater storage of almost 500 ML.

These wells will not only alleviate the groundwater level but can also be used by local farmers of adjoining fields in the post-monsoon months. The site contains 22 ponds covering over 11 hectares of area. All these ponds are being preserved and over 300 ML of rainwater will be harvested in these ponds.

COST SAVINGS

The above measures saved the water requirement from the fresh water source and saving in capital investment Rs. 17.16 crore towards transportation of water from the source to the township. All the lakes within the township have been retained with proper planning of drainage system and rainwater harvesting.

SOLID WASTE AND DISASTER MANAGEMENT

The sources of solid waste are residential units, IT Parks, industrial units, offices, commercial establishment, parks, and logistics areas. The quantity of solid waste generation from Phase-I is estimated as 62 tonne/day and from phase-II, 12 tonne/day. Segregation of solid waste at source has been proposed with Reduce, Recycle, Reuse (3R) and waste minimization strategies for effective solid waste management. A pilot, 5 TPD bio-methanation plant has been recommended at the initial stage within the BAPL site.

A disaster means catastrophe, mishap, and calamity. The various scenarios that are anticipated in the cause of major emergencies inside the township are fire, chemicals, explosions, toxic releases, cyclones, storm surges, floods, earthquakes, landslides, and tsunamis. The possibilities of these scenarios are described with respect to geography. The prevention measures to avoid disasters have been listed and the responsibility of various agencies during disaster defined. An organization chart for the emergency management cell has been proposed.

TCE has provided solutions that include preventive measures and mitigative measures along with the guidelines for the disasters management plan. Emergency relief operations and organization structures are also part of the disaster management plan.

About the Authors

Dilip Sonwane *is the Associate Vice President at Tata Consulting Engineers Ltd, Mumbai. Presently, he is heading the Built Environment Group.*

Umashankar N *is the Deputy General Manager at Tata Consulting Engineers Ltd.*

Tata Consulting Engineers Limited (TCE) *is an integrated engineering consultant providing concept to commissioning services in power, infrastructure, resources - hydrocarbons and chemicals, and resources - mining and metallurgy. Established in 1962, TCE has completed about 10,000+ projects in over 55 countries.*

INDUSTRIAL EFFLUENTS, RECYCLE & REUSE, RO, WWTP

COMPLETE WATER SOLUTIONS FOR AN INDUSTRIAL WASTE RECYCLE PLANT IN OMAN

By Toshiba Water Solutions Private Limited (TWS)

INTRODUCTION

Oman is one of the most water-scarce nations in the Middle East and North Africa region with only 416 m^3 of water available per person each year compared with 1,429 m^3/ person/ year average in the rest of the region.

Sohar Industrial Port Area (SIPA) is of strategic and economic significance for the Government of Oman with a huge present investment which is the biggest in Oman, and together with SFZ (Sohar Free Zone) is probably the largest in Gulf. SIPA houses industries like Petrochemical, Power, Fertilizer, and Methanol.

These industries require cooling and treated water for Operation 24/7. Among environmental issues that are currently being addressed, much emphasis has been put on air pollution and liquid discharges.

Customer Overview and the Need for CETRP Project

- Majis Industrial Services SAOC has been providing water and wastewater services at SIPA.
- Majis is responsible for monitoring, collecting, treating, recycling, and reusing the effluent as much as possible at SIPA under the policy-makers of the Government of Oman.
- To prevent discharge of petrochemical, power, fertilizer, and methanol directly into the marine environment Majis decided to implement CETRP-1 Phase I.
- After successful completion of Phase-I, Majis decided to expand CETRP-1 Phase I by developing an additional 10,000 m^3/day phase-II project, and

PROJECT OVERVIEW

20,000 m^3/ Day Design-Build-Operate CETRP-1 Phase-I and Phase-II: Toshiba Water Solutions Private Limited (TWS) is providing turnkey and complete water solutions to recycle effluent into processed water, making the whole project in Oman highly efficient and cost-effective as a viable business model up to complete satisfaction of the customer for a long time now.

Ariel view of CETRP Majis Plant in Sohar Industrial Area, Oman

HMRU at CETRP Majis Plant in Sohar Industrial Area, Oman

this work for the project was again awarded to TWS.

CHALLENGES

- Protect the water environment of SIPA, by providing pollution control measures.
- Recycle the effluent and make it reusable for industries and irrigation.
- Removal of heavy metals present in the water.
- Commercial challenges like providing affordable water tariffs to the customers and implementing cost-effective solutions.
- Providing the solution in a time-bound manner, challenges towards completion of the project.
- Minimizing client risk related to the

Client	**Majis Industrial Services SAOC**
Location	**Sohar, Oman**
Plant Capacity	• **Centralized Effluent Treatment and Recycle Plant: 10,000 m³/day (Phase 1, 2016)** • **Centralized Effluent Treatment and Recycle Plant: 10,000 m³/day (Phase 2, 2018)** • **Operation and Maintenance:** o **Phase 1: 2016-2022** o **Phase 2: 2018-2028**
Plant Description	**Central Effluent Treatment and Recycle Plant (CETRP) is designed to collect, treat, recycle and then pump back the 'Processed Water' produced by the Recycle Reuse Plant. It comprises of biological wastewater treatment plant of 20,000 m³/day capacity and recycling plant (reverse osmosis) to produce process water with very low TDS (less than 25ppm). Wastewater discharged from petrochemical, power, fertilizer and methanol has to be treated with domestic sewerage.**

operation of the wastewater treatment and recycle plant.

SOLUTIONS

Toshiba Water Solutions has provided turnkey and complete solutions with the following key deliverables:

- Survey of the existing challenges, and design through detailed analysis. Studying and maximizing the use of existing assets.
- Optimize plant design that minimizes power, chemical consumption.
- Integration of online monitoring stations and central monitoring stations for effective operations.
- Design, up-gradation, and implementation for conversion of 3 MLD ETP to 10 MLD ETP to cater to the need of refinery-treated industrial effluents in Phase-I.
- Removal of heavy metals present in the water.
- Cooling system provided for effective biological system functioning.
- Installation of membrane-based

RO section inside the CETRP Majis Plant in Sohar Industrial Area, Oman

UF rack inside CETRP Majis Plant in Sohar Industrial Area, Oman

recycle/ reuse plant to produce high recovery water for industrial use.

- O&M of the plant for 5 years in Phase-I and 10 years for Phase-II.

BENEFITS

Majis has been able to minimize the harmful impact of the discharge of untreated effluent on the marine environment and at the same time generate revenue for itself.

PROJECT OUTCOME

The good performance clubbed with efficient and reliable customer services provided by TWS during the implementation and execution of the CETRP-1 Phase-I and Phase-II project has strengthened the client's trust in TWS. As a result, TWS was awarded a DBO Contract (with 1-year O&M) of 81.6 MLD rapid gravity filter for SWRO plant and 1.2 MLD containerized package sewage treatment plant based on MBR technology. Toshiba Water Solution continues to provide the highest valued solutions to make its customer and society satisfied.

About the Contributor

Toshiba Water Solutions Private Limited (TWS) *is an international multi-disciplinary environmental services company, headquartered in India that specializes in providing turnkey services in water and wastewater collection, treatment and disposal, recovery, and reuse plants.*

TWS also takes up comprehensive O&M for their own plants delivered on Design, Build & Operate (DBO) basis as well as taking up O&M for the plants installed by other agencies. TWS O&M team is well equipped with qualified, experienced manpower and adequate resources, to achieve the least operational cost over the operational life of the plant.

TWS is a wholly-owned subsidiary of Toshiba Infrastructure Systems & Solutions Corporation (TISS). TWS provides complete, single-source services from engineering, design to construction, installation, and O&M of water, wastewater, and domestic waste treatment facilities.

DESALINATION, POWER PLANT, SEAWATER, SWRO

SEAWATER DESALINATION PLANT FOR WATER USAGE IN A POWER PLANT

By Dr. V.K. Seth

INTRODUCTION

Availability of fresh water all around the world is becoming more and more acute day by day and the alternate sources for getting it are being looked upon. As seawater is in abundance all around the world so it is becoming one of the major sources, especially in coastal areas having no other sources.

Even recycling of sewage water is also in great use in the present world but it becomes very difficult for persons to assimilate it for use of drinking so recycled treated sewage water is being restricted for the industries around the world. One of the biggest such examples is Changi Airport in Singapore where recycled sewage water is completely being used due to a shortage of fresh water in their country.

Getting fresh water from the sea is quite old as even in earlier days also people were condensing it in a closed chamber to get drinking water. Later on, with the evolution of technologies, evaporators came into use for getting fresh water which is a highly energy-oriented process, thereby it becomes a more expensive process with high recurring costs as well. After the

ACHIEVEMENTS

A. After running the plant big savings had been found in producing different waters as given below due to the adoption of different measures for control of power:
Pre-treated Water: 2.23 KW/m³ instead of 2.5 KW/m³ envisaged
SWRO Water: 3.07 kW/m³ instead of 3.8 KW/m³ envisaged
BWRO Water: 0.88 kW/m³ instead of 1.8 KW/m³

B. The cost of producing different qualities of water from the plant had been found as follows as per rates prevailing at that time:
Pre-treated Water: Rs. 6.82/m³
SWRO Water: Rs. 20.87/m³
BWRO: Rs. 25.28/m³
DM Water: Rs. 31.37/m³

Power Plant (This image is for illustration purpose only, not of the actual plant)

invention of reverse osmosis membranes in the eighties, these are commonly being adopted for seawater desalination all around the world. Many large water seawater plants had already been put up all around the world, especially in Arabian countries where the alternate source of fresh water is scarcely available. Presently, the largest capacity (600 MLD) seawater plant is coming up in Saudi Arabia.

One such seawater desalination plant had been executed long back in 2008 in the coastal area of India in Karnataka for getting water for use in 2x507.5 MW power plant, using reverse osmosis membrane technology to get service water for their power plant and also DM water for their boilers being used to produce power, along with potable water for their plant along with their colony.

DESIGN CONDITIONS

Seawater from the Arabian Sea of the composition as given in Table 1 was used for design with a temperature range of 25 to 32 degrees to get the treated water for different use as given in Table 2.

The design of the plant has been selected after proper optimization mainly to conserve electrical power which becomes one of the main considerations for desalination plants, along with saving of chemicals.

PLANT DETAILS

The plant is designed to produce 675 m^3/hour treated water from seawater RO (SWRO) section working in three streams each to produce 225 m^3/hour along with 175 m^3/hour treated water from Brackish Water (BWRO) section having 2 streams

SALIENT FEATURES

- Use of electro chlorinators are made to get chlorine for chlorination purposes in the plant.
- Use of chloro epoxy paint had been made on all steel including structures and cemented surfaces to protect it from corrosion arising due to coastal environment.
- Use of two-stage filtration only by using RGF and PSF for getting filtered water instead of UF system to get feed water for RO system.
- Use of frequency drive for high-pressure pumps of SWRO linked with TDS of seawater and its temperature, for electrical motors of high-pressure pumps in order to save energy.
- Use of energy recovery turbine for each of SWRO streams by employing the use of pressure coming out of reject, thereby saving of energy to a large extent.
- Automatic control of chemical dosing pumps to regulate the dosing, thereby saving chemicals to a large extent.
- Plant capable of handling seawater having TDS even up to 42,000 ppm to give desired quality and quantity of water.
- Plant designed to give desired water quality even at 32 degrees.
- Use of CPVC pipes for low-pressure system and highly corrosion-proof material super duplex for high-pressure pipings in SWRO system.
- Use of EPDM-lined valves for low-pressure system whereas for a high-pressure system in SWRO system, duplex valves have been made.
- Proper adjustment of LSI in service water by adding chemicals, in order to avoid corrosion in MS pipes being used by the client.
- Automatic flushing system of SWRO stream by means of flushing pump running on emergency power at the time of stoppage of the plant even during power failure.
- Use of suck back tank placed at sufficient height to collect treated water coming from SWRO before it goes to degasser system so as to give water back by gravity to SWRO streams to avoid vacuum conditions leading to damage of membranes.
- Sufficient space provided in the plant for ease in operation and maintenance.

each giving 87.5 m^3/hour and mixed bed section having 3(2+1) streams each of 75 m^3/hour to give total 150 m^3/hour demineralized water to boilers used for producing power. Rest 25 m^3/hour water coming from the brackish water section is being used to supply potable water to the plant and the nearby colony after proper remineralization. A brief sketch of the plant is given in Figure 1.

S.No.	Constituents	Unit	Value
1	pH at 32 Degrees		7.7
2	Temperature (Max)	Degree Celsius	32
3	Odor		Unobjectionable
4	TSS	ppm	198
5	TDS	ppm	34,898
6	Calcium	PPM as Ca	352
7	Magnesium	PPM as Mg	1223
8	Sodium	PPM as Na	8069
9	Manganese	PPM as Mn	0.6
10	Zinc	PPM as Zn	0.7
11	Iron	PPM as Fe	0.8
12	Chromium	PPM as Cr	Less than 0.05
13	Chloride	PPM as Cl	15,922
14	Sulfate	PPM as SO4	2314
15	Bicarbonate	PPM as HCO3	118
16	BOD	PPM	6.2
17	COD	PPM	10.4
18	Kjeldahl Nitrogen	PPM as N	1.4
19	Boron	PPM as B	5

Table 1: Seawater Analysis

THE PROCESS

A. Clarification

Seawater directly from seawater intake is being taken in one underground sump, from where it is being pumped to the water treatment plant by means of one set of 3(2+1)vertical turbine pumps each of 1050 m^3/hour at 32.3 meters heads to feed water to one cascade aerator having 8 steps so as to remove iron by means of air oxidation. Water falling from the aerator is being routed to two clarifloculators each working at the flow of 1050 m^3/hour through the common stilling chamber and flash mixers followed by Parshall flumes for each of the clarifiers to indicate the flow of water going to each clarifier. Parshall flume is placed at the outlet of each clarifier as well to indicate actual clarified water produced from each of the clarifiers.

Sludge slurry water from both the clarifiers is being collected in a common waste disposal sump where the wastewater coming out from both sets of filters, i.e., rapid gravity filters and pressure sand filters are also collected along with SWRO rejects.

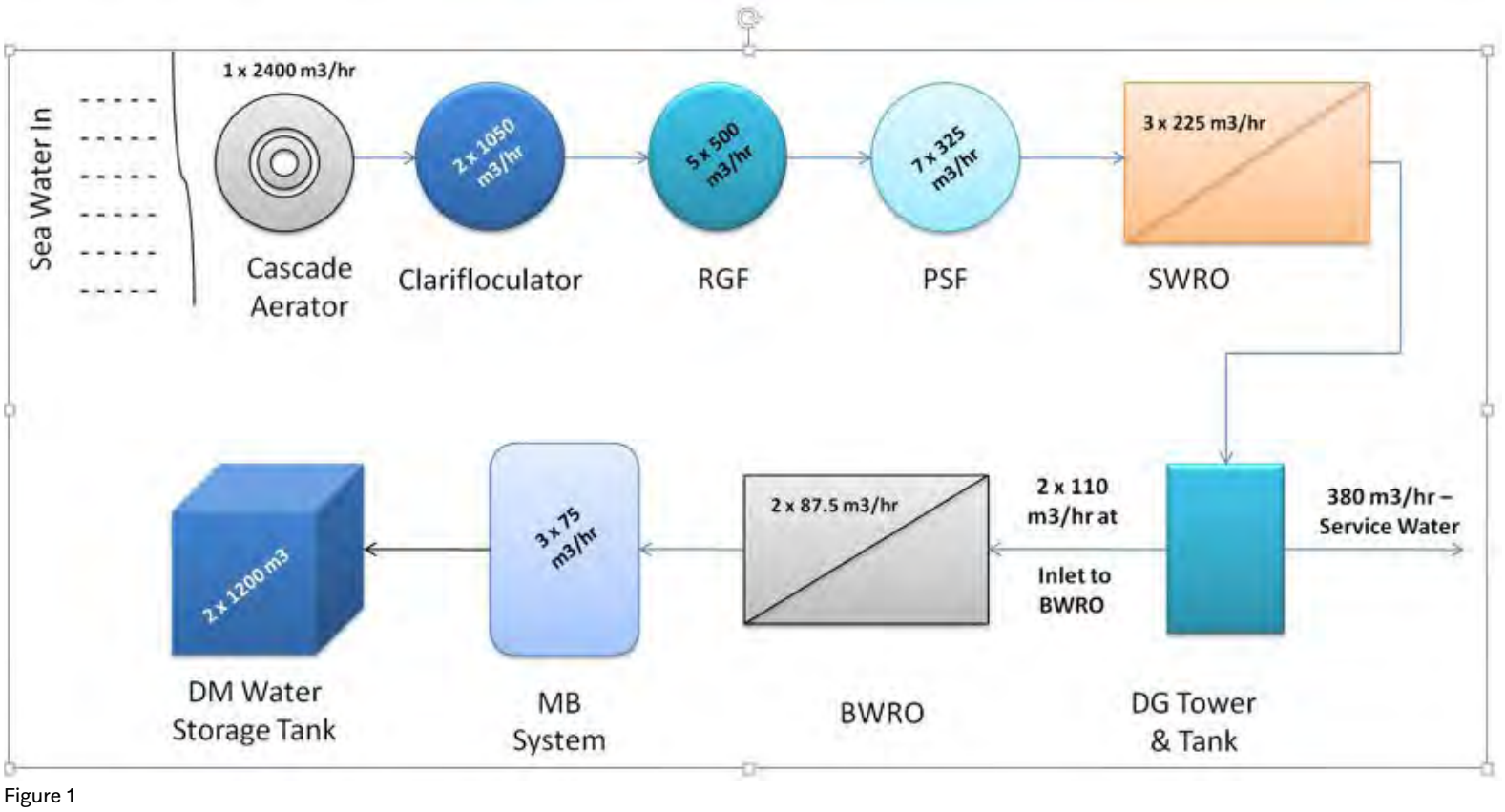


Figure 1

Wastewater from here is disposed off to sea by means of a set of 3(2+1) vertical pumps each of 800 m^3/hour at a 20-meter head.

Chlorination of seawater is also being done for water going to cascade aerator by means of chlorine generated from seawater through Electrochlorinator at dosing rate of 5 ppm. Dosing of chemicals including Lime, Ferric Chloride, and Polyelectrolyte are being made in a flash mixer at the dosing rate of 20 ppm, 40 ppm, and 1 ppm respectively. For lime dosing, one set of centrifugal pumps of a larger capacity of 36 m^3/hour is provided with recycling, so as to avoid any choking of the pipeline due to lime slurry of 5% and to feed to respective clarifiers by means of individual valves operated automatically linked with inlet flow of water. For the other two chemicals, i.e. Ferric Chloride and Polyelectrolyte, separate sets of electronic dosing pumps are used which are linked with the flow of water going to each clarifier.

B. Filtration

Clarified water coming from clarifiers in the common channel is being taken to 5 Rapid Gravity Filters (RGF) each working at a flow of 400 m^3/hour but capable of working at a maximum flow of 500 m^3/hour during the time of backwashing one of the filters. These filters are having gravel as supporting media over which layers of uncrushed sand and anthracite are provided. The filtered water coming out of these filters are collected together in one filtered water reservoir of capacity 5800 m^3, having two compartments.

It is pumped from there by means of one set of 4(3+1) vertical turbine pump of duplex, each of capacity 710 m^3/hour at the 40-meter head to another set of 7(6+1) horizontal Pressure Sand Filters (PSF) each working at a flow of 325 m^3/hour having uncrushed sand layer supported on gravel. Here one filter is kept as spares which are kept ready for service after proper backwashing at all times for giving an uninterrupted supply of filtered water to the SWRO system. The filtered water from these filters is being directly taken to 3 Cartridge filters one each for three streams of the SWRO section.

Common backwashing arrangements for both types of filters, i.e., RGF and PSF are provided. Hence a set of 3(2+1) backwash pumps, each of capacity 645 m^3/hour at the head of 21 meters and a set of 3(2+ 1) air blowers each of capacity 680 m^3/hour, are provided. For RGF backwashing two pumps and blowers are used whereas for PSF only one pump and air blower are used.

S.No.	Source	Item	Value
1	Clarifier Outlet	Organic Matter	Traces
		Iron	0.3, Max
		Turbidity	10 NTU, Max
2	RGF Outlet	Turbidity	2 NTU, Max
3	SWRO Outlet	TDS	500 PPM, Max
4	BWRO Outlet	TDS	25 PPM, Max
		Boron	.5 PPM, Max
5	Mixed Bed Outlet	pH	7--7.5
		Conductivity	0.1ms/cm
		Silica	0.01 ppm, Max
		Organic Matter ($KMnO_4$)	Nil

Table 2: Treated Water

C. Seawater RO (SWRO)

The filtered water coming from PSF under pressure in common header is dosed with different chemicals including SMBS, Acid, and Antiscalant by means of electronic dosing pumps at the rate of 5 ppm, 8 ppm, and 5 ppm respectively so as to regulate its dosing linked with the flow of water which avoids excess chemical dosing, thereby saving chemicals. For each of the chemicals, a set of two dosing tanks each of MSRL are provided along with a set of two dosing pumps so as to have one spare to avoid any interruption in the plant running. For SMBS and antiscalant, 10% solution is used and dosing is linked with water flow whereas 30% Hydrochloric acid is used without dilution linked with pH of treated water.

As any residual chlorine is highly detrimental to RO membranes so protection measure is provided by putting an ORP meter on line linked with the drain valve so that water goes to drain in case any chlorine is being detected as sensed by ORP.

Many other online instruments are also provided on common header including pH meter, conductivity indicator, flow indicator, temperature indicator which are linked with variable frequency drive of high-pressure pumps to adjust the pump rotation.

The chemically dosed filtered water is taken to three-micron cartridge filters of 5 microns each working at a flow rate of 643 m^3/hour to feed each stream of the SWRO system through individual high-pressure pumps. Cartridge filter housing material is selected as SS 316L due to the severity of corrosion from seawater.

A set of 4 (3+1) high-pressure pumps of high-efficiency of 87.2% is provided, each of capacity 643 m^3/hour at a pressure of 279.6 MWC, to feed each of the 3 SWRO streams. Super duplex material is being selected for these pumps to avoid any chances of corrosion due to seawater. Variable Frequency Drive (VFD) is provided for each of these pumps which are linked with the flow of water to conserve energy. Special protection measures are provided for the protection of these pumps to avoid any damage during operation by providing low and high-pressure switches on suction and discharge.

Filtered water from the cartridge filter is pumped through each HP pumps at the flow of 643 m^3/hour to three SWRO skids to give 225 m^3/hour treated water. Each skid is having 441 Toray seawater RO membranes packed in 63 vessels to give an overall recovery of 35% with the aim of producing treated water having TDS of less than 500 ppm. In order to utilize reject pressure the use of energy recovery

turbine of the super duplex is made which boosts the pressure from 28 bar to 57 bar, due to which pressure required from HP pumps gets reduced, saving a lot of energy. The treated water from each of the RO streams is taken to a common suck-back tank placed at a height so that during the stoppage of the plant, the water is sucked back to the membrane vessels to avoid any damage of RO membranes due to vacuum conditions.

In addition, the flushing arrangement is also provided to drive off the concentrate remaining in vessels by means of flushing pumps of 200 m^3/hour, which are driven by emergency power so as to run even during power failure conditions. The overflow from the suck-back tank is separately taken to 3 degasser towers having random packing of PP Raschig rings where the air is being injected from the bottom by means of an air blower to drive off carbon dioxide. All the degassed water is being collected in a large degassed water storage tank from where a portion of water is being taken for service water use whereas another portion is being taken for further treatment in the BWRO section.

Chemical cleaning is required for the membranes whenever the flow gets reduced to more than 10% reduction in permeate flow or pressure drop increases more than 10%. Hence, a separate system is provided having one chemical solution tank of proper capacity with one cartridge filter and a set of CIP pumps each of 200 m^3/hour of 30 MWC. The cleaning of 21 membrane vessels out of the total 63 is being carried out at a time so for one stream three cleanings are required.

D. BWRO Section

Alkali is being dosed in a degassed water tank to increase pH to 7.5 before its supply for the service use and for BWRO feed. Out of total treated water collected in Degassed water tank of 12000 m^3, 220 m^3/hour water is being pumped to BWRO section for which a set of 3 (2+1) vertical centrifugal pumps are provided to feed two streams of BWRO streams having brackish water membranes of Toray to give 87.5 treated water from each streams Service water is also provided from this tank by means of a set of service water pumps each of 380 m^3/hour. Online dosing of antiscalant is made in feed water to avoid membrane fouling. A set of chemical solution preparation and dosing pumps are provided to give desired dosages of antiscalant. This water is then passed through micron cartridge filters of 5 microns, one each for two RO streams, followed by a set of 3 (2+1) high pressure pumps each of 120 m^3/hour at a pressure of 141 MWC to feed water to two SWRO streams having membrane configuration of 8:4 vessels each having 7 elements.

For chemical cleaning of BWRO membranes, the SWRO cleaning system is used after adjustment of proper flow from the system.

The treated water is collected in two separate tanks, one for feeding water to mixed bed section getting 150 m^3/hour and the other for supplying potable water getting the flow of 25 m^3/hour.

E. Potable Water Section

As such the treated water from SWRO cannot be directly used for drinking purposes due to lack of minerals, hence the addition of lime and calcium chloride is being carried out before it is supplied for drinking purposes. A mixed solution of these chemicals is made in a separate tank from where it is fed by a set of dosing pumps to water. A set of potable water pumps is provided to supply potable water for use. Before pumping the water, chlorination is also being carried out for which proper capacity of electro chlorinator is provided in order to take care of pathogens.

F. Mixed Bed Section

Water is pumped to 3(2+1) mixed bed units having mixed ion exchange resins of Amberlite to give highly pure DM water for use in their boilers. Each MB units is designed to produce 3750 m^3 DM water in one regeneration and after 50 hours the unit shall be regenerated by means of acid and alkali. One MB unit acting as a spare is always kept ready for use after proper regeneration.

The DM water is stored in two separate DM water tanks each of 1200 m^3 from where it is pumped to the boiler section of the plant by means of a set of 3 (2+1) DM water pumps each of 80 m^3/hour.

Separate acid and alkali measuring tanks are provided for regeneration of MB, to hold 30% hydrochloric acid and 45% alkali respectively sufficient for one regeneration. By means of separate acid and alkali ejectors, 5% acid and alkali solutions are fed to the MB unit. Online density indicators are provided to monitor the density of dilute solutions of acid and alkali going to MB during the chemical injection.

One separate set of air blower is also provided each of 600 m^3/hour of 5 MWC for mixing both types of resins in MB vessels thoroughly after regeneration of the resins.

Wastewater coming out from MB units during regeneration is being collected in one 300 m^3 neutralization pit of RCC with AR tiles. One each acid and alkali measuring tanks are provided for acid and alkali to be used for neutralization of the water before its discharge to sea. Finally neutralized water from the pit is discharged by a set of neutralized water pumps each of capacity 25 m^3/hour.

About the Author

Dr. V.K. Seth *has vast experience in basic design, engineering, commissioning,*

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EFFLUENTS, SEWAGE, URBAN WATER, WETLANDS

CONNECT CITIES TO THEIR LIFELINES: RETAIN, RESTORE AND PRESERVE URBAN WETLANDS

By Harsh Ganapathi and Dayadra Mandal

With each passing year, more people migrate into urban areas. By 2030 nearly seventy percent of the world's population will live in cities. As the city expands demand for land increases and the tendency is to encroach upon the urban wetlands. They are degraded, filled in, and built upon.

Yet urban wetlands are not wastelands. Mangroves for example sequester carbon and also work as a buffer protecting coastal cities against storm surges and tsunamis, while inland wetlands reduce flooding in cities by soaking up and storing storm waters. The abundant plant and native vegetation found in wetlands can filter reasonable amounts of industry and domestic waste which improves water quality and also helps supply cities with water.

However, the growth of cities must not be at the expense of urban wetlands but rather should be included in urban design and planning. Urban wetlands are prize lands, they improve well-being and make cities liveable. It is necessary to retain restore and preserve urban wetlands.

CASE STUDY OF EAST KOLKATA WETLANDS

Home to 15 million people Kolkata is one of the largest cities in India. It sprawls over 2000 square kilometers across the banks of the Hooghly River in the Ganges-Brahmaputra Basin. This intensely urbanized area still exhibits many splashes of green and blue which are the remnants of the vast wilderness that once dominated the landscape. Made up of rivers, marshes, floodplains, and lakes, the wetlands of

The wetland also supports unique biodiversity. It is flourished with varieties of plants, animals, amphibians, reptiles, and butterflies.

There are more than 10 types of vascular hydrophytes in the wetland that are significant for bio-filtering capability specifically in respect to BOD, COD, nitrates, and phosphates.

Over the few years, a drastic change in biodiversity was noticed, because of the change in the land use land cover pattern, salinity, industrial pollution, and other development activities.

Sewage-Fed Fisheries in EKW (PC: WISA Photo Library)

Kolkata are home to a huge diversity of wildlife. For much of the year, they act like a sponge soaking up excess water preventing floods, a fine example of an ecosystem service: a benefit provided by nature that helps humans to thrive and prosper. Amid an era of climate change, wetlands and their mitigation potential are significant.

In the eastern fringe of the city lies the huge and shallow East Kolkata Wetlands (EKW). The EKW was declared a Ramsar site in 2002 for the ecosystem services it provides and the biodiversity it harbors. EKW is also known as the "kidney" of Kolkata city as it purifies the wastewater that the city is producing daily. It is the largest humanmade filtering ecosystem in the world that recycles nearly a billion liters of sewerage every day. Much of the wetland contains sewage-fed fish ponds that help purify the water. The fish they produce along with small-scale agriculture provides food for millions of people. The ecosystem services of these wetlands are more substantial for the poor. The traditional waste recovery practice provides subsistence opportunities for a large, economically underprivileged population of 0.15 million living in over 37 "Mouza" (hamlets) within its boundaries. EKW is also one of the few natural habitats providing recreational avenues for the urban and peri-urban population.

Sewage-fed fisheries are running successfully at a large scale at EKW, with nearly 300 fish farms locally known as "Bhery" which is doing the dual function of rearing fish and recovering the abundant minerals in the municipal wastewater thereby purifying the wastewater to

Vegetable Cultivation Near Dhapa Landfill (PC: WISA Photo Library)

reach the specified standards. With these functions, the wetland is trying to establish the concept of "Waste as Resource" in front of the world. It is also providing livelihood opportunities to a large number of people and supplies fish to the entire city.

As the nutrient-rich effluent moves through the system, it is progressively cleaned, and nutrients are redirected to the growth of algae or agricultural products grown along the pond edges and agricultural lands. Algae and other aquatic plants are used to feed up to 17 species of fish cultured in these ponds, which in turn create nitrogen and phosphorus-rich water to irrigate the adjacent rice fields. The traditionally evolved natural water purification waste recovery practice saves Kolkata city nearly INR 4,680 million annually in terms of the treatment cost of up to 65% of the city's sewage. These wetlands also lock in over 60% of carbon from wastewater, thus reducing harmful greenhouse gas emissions from the region.

Vegetables are also grown utilizing treated sewage water in EKW. The old Dhapa landfill in the area has been transformed into horticultural farms. The area is beautifully designed with alternate bands of garbage dumping sites and "jheel" (ponds) where the wastewater remains for some time and then the water enters the fields and is used in the further cultivation process. Dhapa landfill produces about 100-200 tonnes of vegetables on a daily basis. Paddy is also cultivated using the treated sewage of the city, about 16,000 tonnes of paddy is generated from the field during the post-monsoon season.

EKW has experienced adverse land-use changes in the past decade. The toxic effluents from the newly established small and medium-scale industries along the wetlands are causing severe impacts on the fish and vegetables that are grown in the area. A major reason is the introduction of several hazardous substances like heavy metals from leather industries that are

Urban Expansion in the Backdrop of East Kolkata Wetlands (PC: WISA Photo Library)

further contaminating the water. Also, the increasing silt load in the canals and in the ponds are reducing the sewage flow and making the ponds shallow thereby resulting in lower fish production.

With the rapid urban sprawl, the rate of groundwater abstraction has been increasing in an unsustainable manner, the hydraulic head falling below acceptable levels is causing land subsidence in several places adjacent to EKW. On the other hand, concrete structures of the permeable land surface are reducing the groundwater recharge rate ultimately affecting the wetland.

EKW is a classic example of peri-urban wetlands that are vanishing fast. With increased encroachment, their ability to provide food, filtration, and flood control is compromised. A comprehensive conservation plan is needed that takes into account not just the need to protect biodiversity but also recognize the welfare of the wetland communities and the services the wetlands provide to the cities. A better appreciation of the huge economic benefits the wetland ecosystem services could fetch may tip the balance in the favour of the wet-landers. A successful conservation model implemented in these wetlands can compensate opportunity costs of the commons with ecosystem services.

About the Authors

Harsh Ganapathi *specializes in the hydrological facet of wetlands & water management and has nearly five years of experience in wetland hydrology, high-altitude systems, and surface water - groundwater modeling. He is currently working with Wetland International South Asia as Technical Officer - Water Management wherein he has carried out hydrological assessments across various landscapes in India and Bangladesh. He holds an M.Tech degree in Water Science and Governance from TERI School of Advanced Studies, New Delhi.*

Dayadra Mandal *is currently pursuing her M.Sc. in Water Science and Governance from TERI School of Advanced Studies. Currently, she is working with Wetland International South Asia as a research intern. She has also worked with Water Sanitation and Hygiene Institute and UNEP.*

CONSERVATION, REUSE, RWH, WATER MANAGEMENT

CITIZEN-BASED INITIATIVES CAN SAVE BILLIONS OF LITERS, ENERGY AND FUNDS

By Hariharan Chandra, Mary Conley Eggert and Ahmed Rachid El-Khattabi

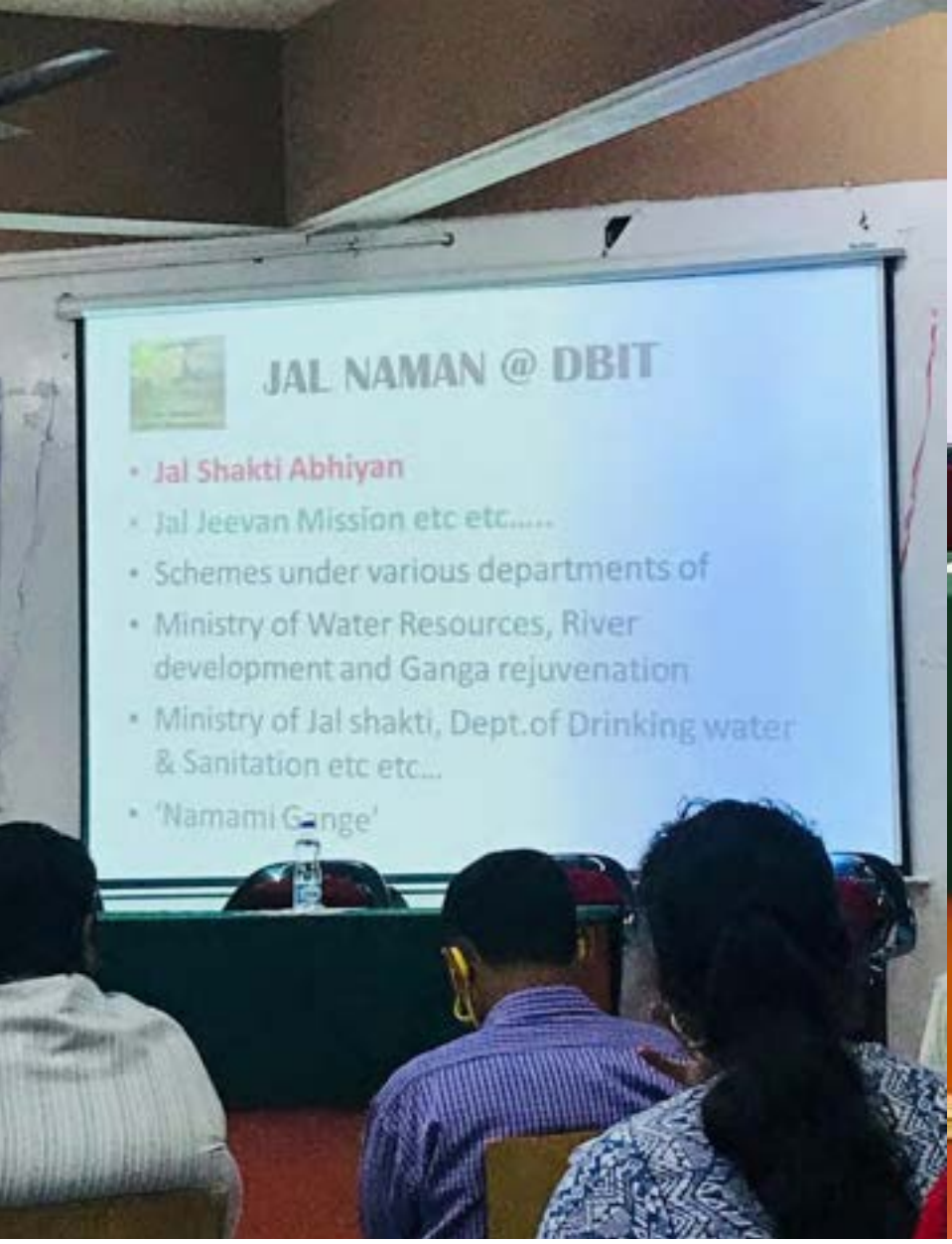
Effective management of water resources is a necessity for the sustainable development of emerging economies in the global south. As these economies develop, water resources are increasingly scarce due to increasing population growth, industrial activity, decreased water quality due to man-made pollutants, and climate-induced extreme weather events. Compounding these issues is an overall lack of awareness and education around local water resources.

In this case study, we describe the efforts that a citizen-based India-born initiative, World of Water Action Forum (WOW-AF), has undertaken to raise local awareness and promote local citizen participation in India and in other countries. In just 12 months of 2021, the organization implemented a programme in Bengaluru that has galvanised and rewarded bulk-water savers up to 4 billion liters to date.

When AWWA member Mary Conley Eggert, of Global Water Works (GWW) was introduced to the WOW-AF, the team had already launched an ambitious campaign to

DIGITAL PLATFORM SUPPORTS GLOBAL EXPANSION

The collaborations on technology innovation between the India-based WOWAF and GWW sparked a new idea. What would happen if all in the world knew of the proven technologies enabling smarter water management? And, what if members also had access to the processes and action plans created to support WOWAF scaling across India? A formal partnership will support World of Water Action Forums being birthed across the globe, available to any citizen, school or city facing water challenges. While in-person meetings will continue where experts on the ground support them, video education will support distance learning and engagement on local efforts. A "members near you" feature in the platform ensures everyone can see experts who are already engaged in any area on the globe.



save 10 billion liters in Bengaluru.

The core team achieved 40% of the savings goal in just 12 months and has raised its target to 25 billion liters for Bengaluru in 2022. The team is planning to add multiple cities across two new continents in 2022. We share their story with an invitation for all to use the examples and resources to establish their own World of Water Action Forum in other cities.

FROM THE SEED OF AN IDEA TO A MOVEMENT

Inspiration for what would become a movement came from a meeting of leaders of the Indian Plumbing Association in 2015. At a meeting of IPA leaders an initiative to bring 'measurable' savings with voluntary compliance by bulk water-users, called I SAVE WATER was launched. By the year 2019 over 1.33 billion liters of water was saved with a few chosen buildings with bulk water consumption taking to the use of aerators. The measure and monitor were simple. IPA could claim, happily, at the end of that year that the mission was successful.

The idea took root. Stalwarts in the Bengaluru chapter took the idea to industry members and at the annual review meeting of the chapter, IPA leaders spoke of the campaign with legitimate pride.

A thought however lingered in the mind: when yearly water demand in a city like Bengaluru exceeds 700 billion liters (Figure 2, Bengaluru city water-user profile), should the target for a year not be in many multiple billions of liters?

Thus was born WOW, the World of Water

Rain Water Harvesting Instructions Being Provided to Citizens with Mobile Truck.

Action Forum. The leaders moved away from B2B industry of business associations, to appealing to lay water-users who either did not see the promise of massive savings in such water solutions as could be installed, or were simply not aware that such savings were at all possible. WOW leaders asked the basic questions: "Why should we look at ceremonial targets that were far smaller than what a city could achieve with citizen action? Can we rouse the collective spirit? Can bulk water users like apartments, malls and offices, hotels and hospitals come together? Can we create an Action Forum to educate water-users on solutions, and galvanize voluntary action to bring a small saving of a mere 2 liters a day from every individual?" Simple math will tell you that a city like Bengaluru with about 15 million (1.5 crore) people could bring a saving of 30 million liters (3 crore) a day, or 11 billion (1100 crore) liters a year if only each citizen saved just two liters a day. But this is easier said than done.

ESTABLISHING A SOLID FOUNDATION

A former Director of Doordarshan Kendra, India's Public Service Broadcaster, was excited by the idea. A small dedicated team set to work on WOW Action Forum in the winter months of 2020 even as the COVID crisis raged across the country. Says Usha Kini, who was the first Mission Director at the WOW Action Forum, "As we thought through the idea, we realized the activities were action-oriented; that it was not so much the gravity of the water crisis that brought us together as much as the multiple solutions that are available and people simply don't know about. Over three decades at Doordarshan, I have hosted several programmes on issues of public interest. And that included concerns on the environment and water literacy. There was nothing like this that came up as an idea in any domain. And there was no follow-up action on the impact that could be gained from viewers after a TV Programme was hosted."

She goes on, "Even at the time, I had a fair notion of the possibilities, though I did not know what could be done until I learned from the Action Forum's leaders of the amazing range of practical ideas that could support more efficient water management. It is important we realize a simple truth: The problem is not water scarcity. It is the lack of efficient management of water resources that impact Bengaluru's water, energy and financial resources."

Another Action Forum participant at WOW, and a key member of one of the city's apartment federations, Vikram Rai, adds, "The fact that the WOW mission

Figure 1: Cities in WOW Mission

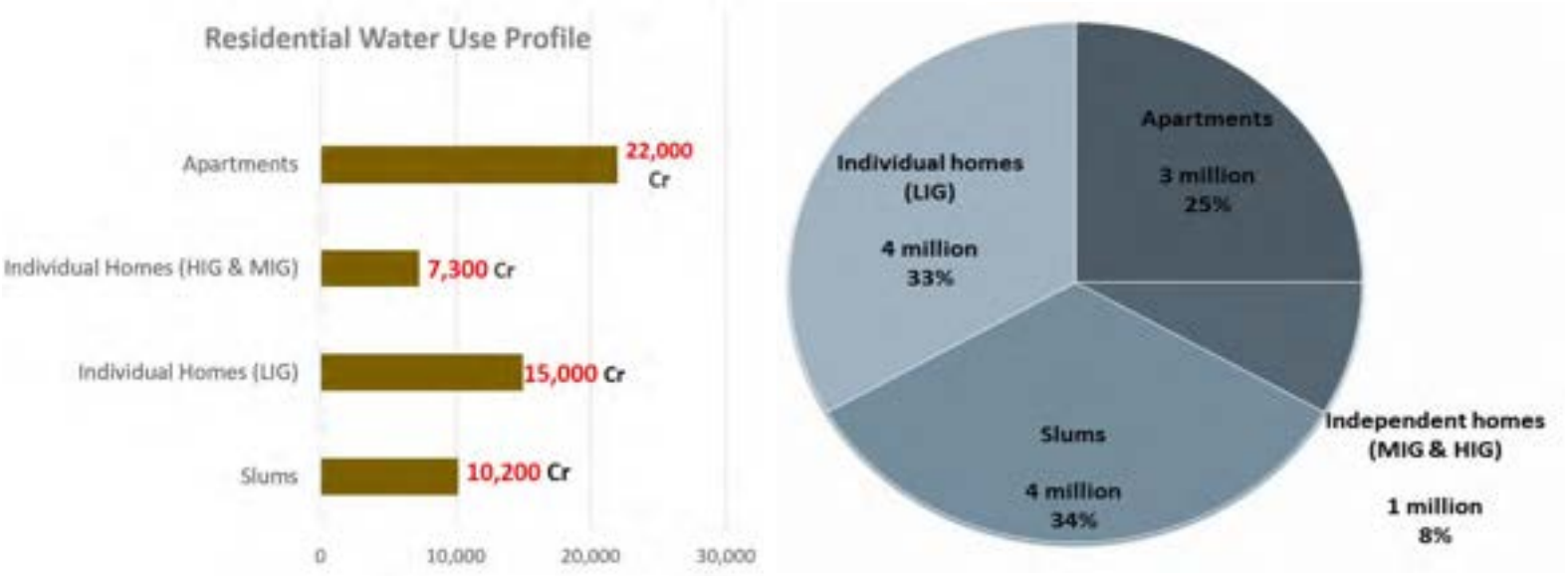


Figure 2: Bengaluru's City Water-User Profile

puts a number on our efforts makes us accountable. The question before the Action Forum is simple: How can we translate that number into sub-numbers? For way too many years, the government or the media has leaned on the challenge of water scarcity being met with greater water supply with tens of crores of public funds invested in pipelines in the name of public welfare." Adds Usha, "We have to turn the conversation to efficiency and look to on-site resources to add to available supplies, while we reuse all water with treatment systems that today even offer securing drinking water on-site at costs with excellent ROI on the investment. It is clearly a contemporary, practical approach, and perhaps the only way forward for cities that are seriously strapped for new sources of water."

DIVERSE SOLUTIONS SUPPORT IMPACT

The initial areas recommended for efficiency are based on a simple intake survey, connecting people to their water to see their savings opportunities, and then action programs to reuse grey water, capture rain, monitor usage and support conservation:

- Use of Sewage Treatment Plant (STP) water for flushing and other uses (car wash, gardening, etc)
- Implementation of rooftop and surface Rainwater Harvesting (RWH)
- Monitoring of water consumption by fixing water meters
- Use of water aerators and efficient fixtures

WOW AF offers technical advice free of cost to water-users, including advice on types of solutions, technologies and approved solution providers. Additional technologies to support in-home water quality, atmospheric water generation and reuse were introduced through the global partnership with GWW.

The key to success is the obvious need for making solutions that are economically viable - providing a return on investment within 1-3 years - and impacting the quality of their lives if they must be accepted by water users. This can only be brought about with awareness and engagement - with outreach and timely, relevant solutions.

Bi-weekly collaboration and learning opportunities with leaders at WOWAF and Global Water Works inviting youth leaders to ask and challenge seasoned pros and

Figure 3: Four Primary Water Solutions That Can Save Upto 75 Percent on Freshwater Demand

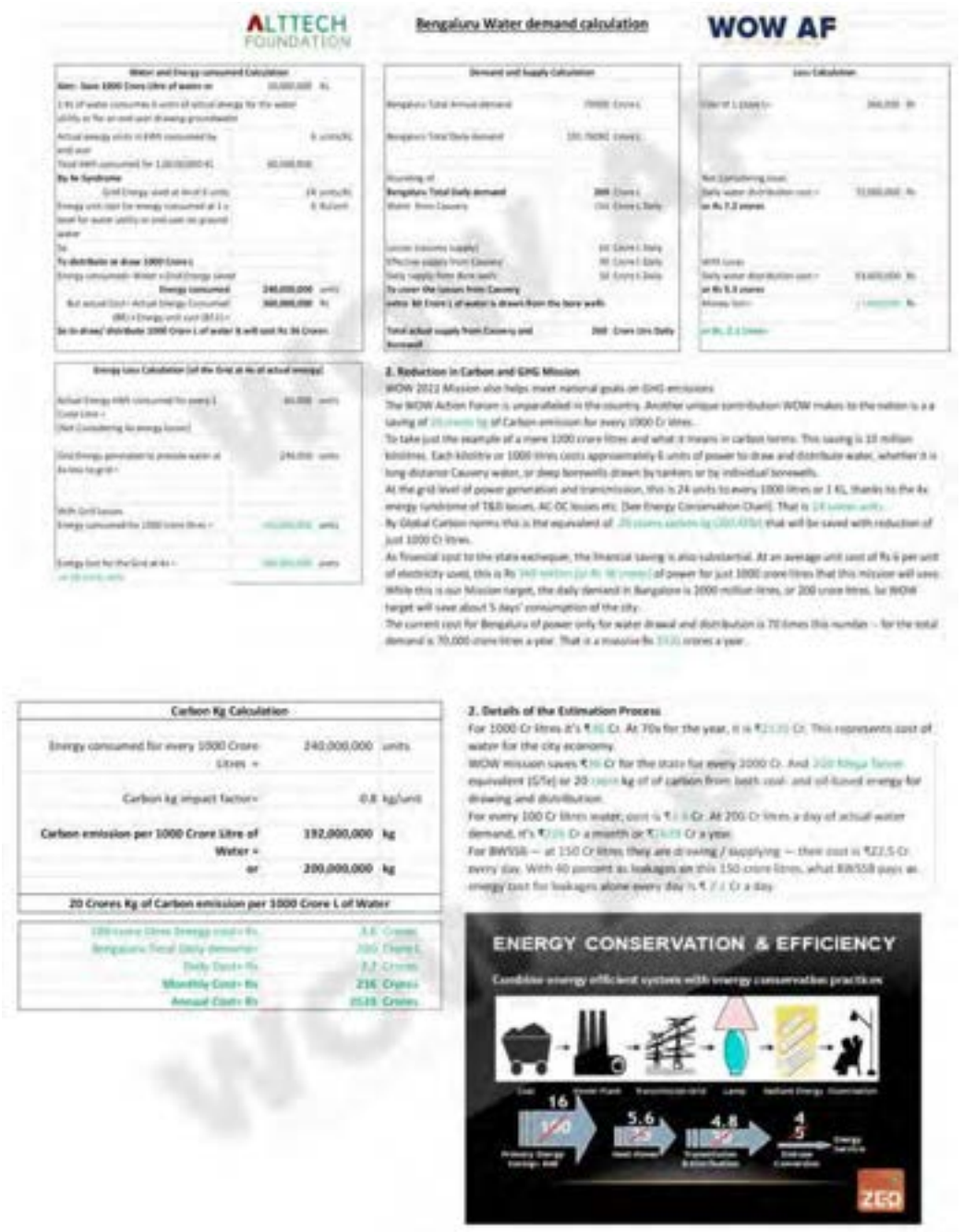


Figure 4: City Saves Rs. 36 Cr (or Approx. USD 5M) for Every 10 Billion Liters

vice versa, is part of the series of WOWAF meetings and of another exciting series called TechTalk that brings Water industry leaders together.

Though technological solutions to support efficient water management may already exist, the major challenge is behavior change. Since most water utilities are government agencies, this can be a critical piece of the puzzle. Government policies can play an important role in shaping behaviour and influence the ways in which people interact with water. However, policy has never been effective across Indian cities on either rationalizing tariffs (and therefore encouraging technology), or on regulations that ensure a reduction in freshwater demand. Any such change among water-users can come about only with the crisis on water reaching epic proportions as it has in many of our cities, with the water-user having no choice but to depend on import of groundwater by tankers from a private sector that is quick to see opportunity in such sale of water. Most cities have less than one-half of the city's daily demand met by the formal grid supply source of the city water utility. Policy, historically, across nearly every federal state in India, has never been able to rationalize water tariffs and enable the spawning of new technologies for localized solutions; and official water tariffs are at one-half the private tariffs of supply by tankers. If policy and government has a role at all, it is in ushering in regulations as Karnataka has done to enforce installation of rainwater harvest systems, IoT meters for measuring and monitoring water use, reuse of water for non-potable applications with tertiary treatment of water, and use of aerators for all faucets and showers. The Pollution Control Boards have a critical role in such implementation and smart use of wastewater, which will reduce freshwater demand – by as much as 50-70 percent.

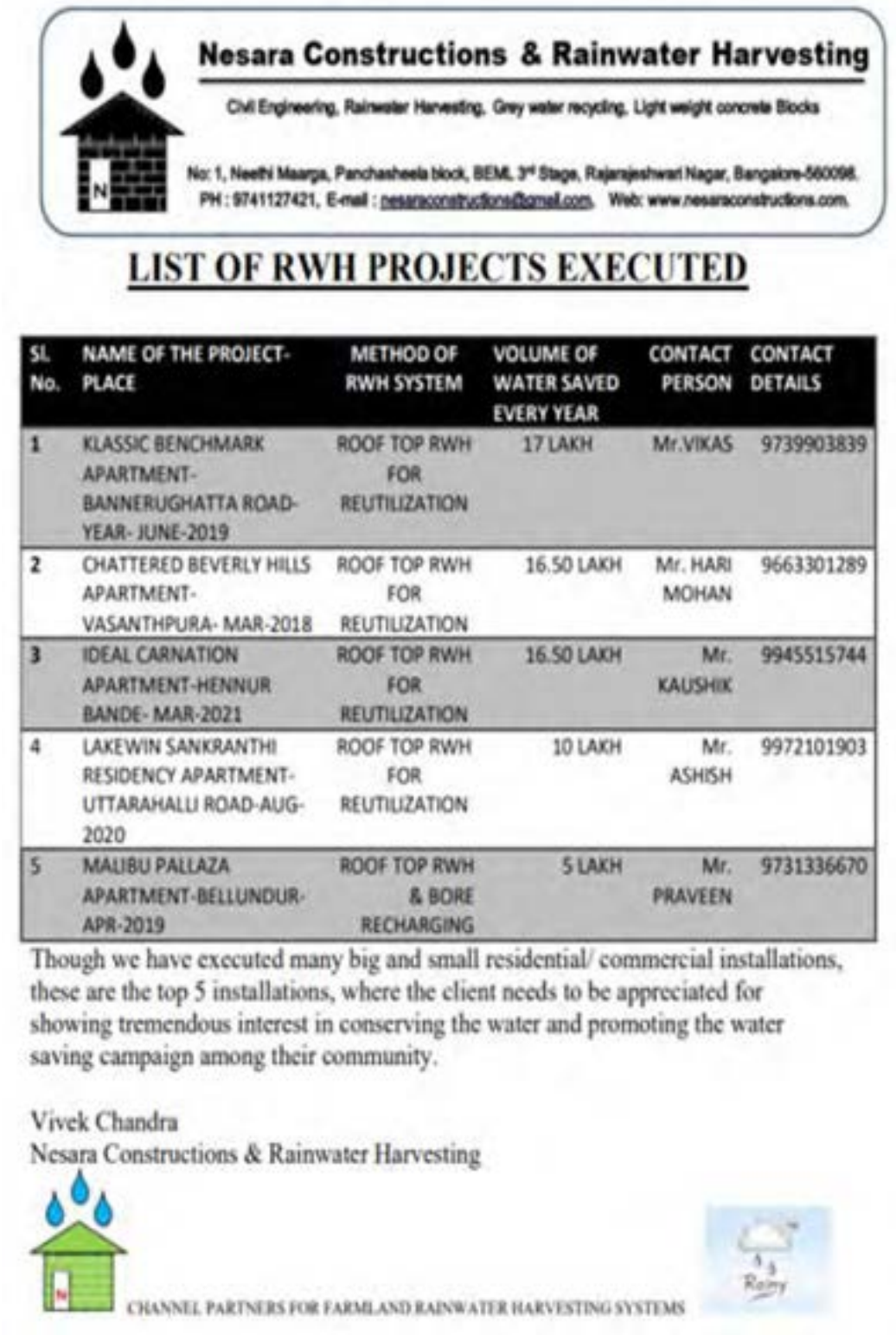
Given that most cities are homogeneous when it comes to water-use in the residential and commercial sector, the impact of such policy regulations are viable to implement. Governments, however, have not focused at all on demand-side management and engaging citizens in promoting conservation or recycle initiatives. This is the deficit that WOW AF is meeting across these cities, with consistent dissemination of information on the multiple solutions available, on the financial and technological viability, and on the attractive payback options that these solutions offer. The other question that remains to be taken up is, how can citizen initiatives create a compelling narrative to engage with the authorities?

WATER SAVINGS = ENERGY SAVINGS

A wake-up call that secured the state wastewater board's attention to partner the WOWAF initiative, was a simple fact: If WOW's savings are achieved, it will mean Rs. 3.6 crore (USD 5M) saved for the water utility in Bengaluru for 2021 for every 1000 crore (10 billion) liters, on energy bills alone (Figure 4).

The water supply board, or the BWSSB in the silicon city, incurs every year, a whopping USD 312M (or Rs. 2,500 crore) on electricity costs alone for pumping water from the river Cauvery, which lies 80 km and 600 m. below the city's altitude of 900 meters. "This is in addition to costs of maintaining infrastructure, salaries of its people and so on," says another former water administrator.

According to the Senior Environment



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LIST OF RWH PROJECTS EXECUTED

Sl. No.	NAME OF THE PROJECT-PLACE	METHOD OF RWH SYSTEM	VOLUME OF WATER SAVED EVERY YEAR	CONTACT PERSON	CONTACT DETAILS
1	KLASSIC BENCHMARK APARTMENT-BANNERUGHATTA ROAD-YEAR- JUNE-2019	ROOF TOP RWH FOR REUTILIZATION	17 LAKH	Mr.VIKAS	9739903839
2	CHATTERED BEVERLY HILLS APARTMENT-VASANTHPURA- MAR-2018	ROOF TOP RWH FOR REUTILIZATION	16.50 LAKH	Mr. HARI MOHAN	9663301289
3	IDEAL CARNATION APARTMENT-HENNUR BANDE- MAR-2021	ROOF TOP RWH FOR REUTILIZATION	16.50 LAKH	Mr. KAUSHIK	9945515744
4	LAKEWIN SANKRANTHI RESIDENCY APARTMENT-UTTARAHALLI ROAD-AUG-2020	ROOF TOP RWH FOR REUTILIZATION	10 LAKH	Mr. ASHISH	9972101903
5	MALIBU PALLAZA APARTMENT-BELLUNDUR-APR-2019	ROOF TOP RWH & BORE RECHARGING	5 LAKH	Mr. PRAVEEN	9731336670

Though we have executed many big and small residential/ commercial installations, these are the top 5 installations, where the client needs to be appreciated for showing tremendous interest in conserving the water and promoting the water saving campaign among their community.

Vivek Chandra
Nesara Constructions & Rainwater Harvesting

CHANNEL PARTNERS FOR FARMLAND RAINWATER HARVESTING SYSTEMS

Figure 5: Matrix of Certified Savings from Solution Providers Who Enabled Bulk Water Users in Water Savings

Officer at the Karnataka State Pollution Control Board, Syed Khaja, "Our data from industry and from other bulk water users shows the construction industry alone uses 520M liters a day of water." That is nearly 200B liters. It's shocking that we don't realize that chiller plants for centrally air-conditioned buildings in Bengaluru need nearly 80 B liters a year as research at WOW Action Forum has shown.

Over the course of the last 12 months, WOW-AF has rapidly transformed into a platform to bring together citizen leaders and volunteers; a range of solution providers in water management, technologies and solutions; and bulk water users, on a range of online and offline action stages that achieved 40% of its 2021 target of 10 billion liters (Figure 5).

COLLABORATION BUILDS COMMUNITY, IMPACT

The action forum is a platform for collective action with discussions and sub-action group dynamics to drive strategies for bringing behaviour change among water users in residential, commercial and industrial segments, with voluntary compliance or by helping them achieve (with pro bono consulting provided by a battery of WOW member experts) full compliance of city regulations with solutions for water efficiency and improved water management.

Says Dr. Ajit Sabnis, Chairman of the Shri Aurobindo Society which runs the Mirambika school with over 1200 children in the south of Bengaluru, "WOW is a movement to usher in a world of water that will focus on private action that will then bring reciprocal public action from the water utility and other Government agencies." He adds interestingly an arithmetic that can be central to the behaviour change strategy that WOW is seeking for 2021:

"The target of 10B liters for the year amounts to about 27.5M liters a day, or about 30M liters a day. If we assume the city's population to be 14M people, it works out to a mere 2 liters a day – a target that is extremely achievable." Bengaluru alone has 1.8 million children over 2000 Schools in slum settlements, other than CBSE, ICSE, SSE and Sarvodaya schools.

Says Niki Nirvikalpa, a documentary filmmaker who has made over a thousand short films in the last 3 years and a strategist for the WOW forum, "We have seen hundreds of webinars in the post Covid months. What happens after? We said that there has to be action that follows every Action Forum meeting. The good thing is that the core brains trust set a 2021 goal a week after the start of 2021."

This has meant that WOW Action Forum has had to understand the size of the challenge it has taken upon itself, as well as the relativity of the size in terms of the segments that need addressing. "The response so far has far exceeded expectations," Niki adds.

The WOW research team came up with a great deal of data on the profile of water use in the city. "The bar chart (see City Water Profile) and those numbers are

Figure 6: WOW Collaboration Meets

definitely useful," says Vikram Rai. "That is something we need to absorb more on a day to day basis as the WOW Forum moves forward. Understanding the comparative consumption daily, across categories becomes important. Naturally, each of those categories needs an action plan." He echoes Niki's thoughts, "How can different sets of people contribute towards each category and take ownership. Not just listening and going away but breaking it down further and working on it."

POWER IN NUMBERS

So, what are the specific translations to the 10B liters goal? How has the WOW Action Forum gone about achieving this target? Says Dr. Sabnis, who heads the WOW Schools Action Group which has other senior educationists and trustees of schools with over 1000 children, "Typically, at a school with an acre of land and with half of it claimed by buildings, the landscape area requires, by my experience, about 6,000 liters of water. That makes for 2.2 million liters a year. If we reduce watering to effectively 150 days, this can be brought down by half, to 1.1 million liters. Our own work at the school has also proven that the usage of some simple smart appliances like aerators has helped us reduce consumption from 4.8 million liters to 2.4 million liters. Between the two measures, savings have amounted to 3.5 million liters."

Dr Sabnis adds a dimension that addresses the challenge of change in behaviour, "What we also have been seeing is that the children go back home and teach the adults. This opens a large potential."

He continues, "If a child comes from a home with even 3 other family members, a thousand such children influence 4000 people back home. And if we add that figure of what the home would save, thanks to the kids, to the saving the school first leads, that is a full 10 million liters that every school can bring!"

There are over 1800 schools in Bengaluru with each of them hosting at least 500 children.

The number of children in schools from Class 1 to 10 in the city is estimated at 1.8 million. The impact will be, in a sense, on 7-7.5 million people of the city's 14 million, at the homes of these school children, rich or poor.

Says Usha Kini, "Beyond the 2021 Mission target of 10B liters, the eventual long-term Goal at WOW is to achieve a water-neutral Bengaluru without long-distance supply beyond what Cauvery

feeds now—without any more projects for long-distance supply."

It is clear that the city needs a combination of reduction, reuse, rejuvenate and harvest approaches with design strategies provided to water users by WOW AF. Usha remarks with caution, "There can be no business motive. A robust market ecosystem has to be created for water solutions with industry players supporting the WOW Programme with their guidance and direction."

Enter Global Water Works, an organisation working on the other side of the globe in Wisconsin and Chicago, documenting water-saving solutions and identifying points of need where these could be implemented.

The partnership has fueled new possible collaborations, exploring the role of innovative technologies for testing, treating, designing and monitoring water systems.

A special session on the atmospheric water generation suggested there is untapped potential with local generators in India. Energy-efficiency is the key to deployment of any World of Water Action, and a challenge has been issued to innovators to identify a renewable energy source to support the atmospheric water generation.

The water solution providers in the US are excited to access a market that has been growing at over 20 percent CAGR for the last ten years, and has urgent need of solutions. The rapidly growing water deficits into the next two decades will ensure that this relentless pace will not abate. How to accelerate the adoption of proven technologies is part of the WOW mission objective.

ENERGY SAVINGS DRIVES ADOPTION

Says Usha Kini, "The Vision objective at WOW AF is also to take this to a dozen other cities that are severely water-stressed over a phased set of programmes with the methodology remaining the same as is now adopted in Bengaluru. We are conscious of the fact that such effort at collective action is also needed to beat the other challenges of energy and waste management in the city, as in other cities."

The demand for energy at any average home claims 20 tonnes of coal at some distant thermal power plant that produces the power you need at home of an innocent 500 units a month, or 6,000 units a year. That's not all: it also needs about 180,000 liters of water at the thermal plant a year to produce those 6,000 units that you need to power your home.

Merely carting waste from your home costs the government about a thousand 6-tonne trucks every day of transporting to landfills, and millions of liters of precious diesel that can be saved with individual action at the source of waste generation.

Says Niki, "I believe these conversations—with simple explanations—need to be taken to people, to sensitize, to act, to unite people in this common cause that can reduce senseless waste of very precious resources," He adds. "On the solutions side, leaders of organizations like IPA should inspire with their presence and their strengths."

About the Authors

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WOW AF *is a multi-city citizen-led initiative now in action in four Indian cities of Bengaluru, Chennai, Trichy, Hyderabad, and moving soon to four more cities in the country, and is led by water experts and citizen leaders who seek to bring water efficiency with water-users adopting solutions to meet a Mission Target of Saving 3000 Crore Liters in these cities.*

FLOATING WETLANDS, LAKE, SEWAGE, WATER BODIES

WETLANDS FOR A BETTER INDIA

By EVOLVE

India is a country full of what could be beautiful water bodies. It boasts of a myriad of lakes, ponds, johads, wetlands, rivers, and streams but most of them have fallen into disrepute owing to huge population growth, lack of infrastructure, and pollution that renders them unrecognizable. Irresponsible public behavior exacerbates the problem and no engineering solution has fully emerged as offering a possible solution. Without a possible solution, awareness campaigns and calls for government action have resulted in little change and an apathetic attitude to the public space.

These types of problems offer engineers an exciting opportunity to innovate, work on challenging projects, and greatly affect the quality of life for thousands of people. Born in the UK these types of opportunities rarely present themselves to a professional engineer and so in 2010 Tarun Nanda left the comforts of a consultancy job in London and took the courageous decision to come to India and work towards his growing passion for building a better India.

The first year in India was spent traveling, meeting people, learning not just about the problems India faces, but also about the reasons behind the problems. This year would turn out to be one of the most valuable as without understanding the culture one cannot begin to attempt to solve the problems. This is why most foreign consultants who come here say India must stop polluting and build more sewage treatment plants and pipelines and projects they design invariably fail.

The conventional model of managing wastewater in urban areas using a drainage network and sewage treatment plants is unlikely to be successful in India and faces a number of challenges in growing urban centers as well as rural areas. This makes it impossible for India to follow what has been done in other countries and an innovative engineering approach is needed in order to solve the water pollution crisis we now face.

The approach taken by Evolve is different from the approach taken in the west, it assumes that pollution will continue unabated, that the maintenance of existing infrastructure will be poor, and that vandalism and theft will be rife. In this way, solutions can be developed that caters to these constraints and provide long-term sustainable change.

Constructed and floating wetlands offer a way to turn existing drains, streams,

Floating island adopted by a private citizen blossuming in Hauz Khas Lake, Delhi (2018)

rivers, and lakes into water purifying eco-systems that not only tackle water pollution but also create large areas of wildlife habitat in urban areas and help to reduce air pollution. They make use of an under-developed space and help to turn neighboring areas into more attractive areas.

GOD'S OWN SEWAGE TREATMENT PLANT

If nature had no way of coping with sewage the earth would be covered with it. In nature, microbes, insects, and the elements, all help to break down waste, and much of it is washed into natural water bodies. Wetlands have developed to cope with the high level of nutrients at the edge of lakes and have evolved to survive with their roots totally submerged.

These properties are taken advantage of and used to construct artificial wetlands complete with streams, ponds, and lagoons, to mimic natural processes and to increase their efficiency in compact engineering systems. Physical filtration, microbes, plants and other natural processes all help to purify water with no chemicals, machinery, or chemicals, and with a big enough wetland even sewage can be turned into drinking water.

Constructed wetlands are an example of phytoremediation and are also known as reed beds or planted gravel filters. The same processes that occur in them can be replicated by placing wetland plants on a floating platform and creating floating wetland islands. These work to purify the water by providing a large surface area for microbes and other biological processes

Before and After Pictures Showing Work at a Slum in Delhi (2014)

to occur as well as using wetland plants to uptake pollutants and nutrients in the water. The media and plant roots also provide a physical filtration system to capture suspended solids.

Before tackling the immense challenge of water pollution and the state of India's rivers and lakes it was necessary to begin somewhere smaller and the first wetland was constructed in Delhi for a private farmhouse in 2012. This allowed the household and staff quarters black and greywater to be treated, recycled, and used for irrigation in the garden.

The same model established here was also used for a farmhouse in Nagpur in 2015 and another in Jaipur in 2018 with absolutely no maintenance besides basic

Constructed Wetland to Treat Wastewater from a Slum in Delhi

Floating Islands at an Installation in Delhi (2016)

gardening being required to date. These types of private projects are a joy to work on compared to the pressures, demands, and workload of public projects, especially those projects carried out in unauthorized colonies but the journey.

TEMPORARY INFRASTRUCTURE FOR TEMPORARY SETTLEMENTS

Every city in India both benefits and suffers due to migrant populations. One problem posed is the lack of infrastructure provided to unauthorized colonies and the difficulty in connecting them to drainage systems. Construction restrictions in these types of areas also usually prevent the use of concrete and metalwork that conventional systems rely on. This has led to a situation where raw sewage flows over piles of compacted garbage into the nearest waterbody or depression.

This may seem like an impossible problem to the uninitiated but to an engineer, it is an exciting challenge waiting for a solution. In what would turn into a number of projects in the public space in Delhi, an innovative long-term sustainable approach to water body revival was designed by Evolve in 2014 for a local NGO at Rangpuri Pahari.

Ten years of neglect had led to a situation where raw sewage flowed in open drains into an old mining pit that was also used as a garbage dump. The 'pond' was saturated with garbage and sewage, so littered with trash it would appear that you could walk across it. That was not the worst of it, the worst of it were the shacks and huts that has been built around it, with ramps and pipes making the lake their latrine and septic tank. Right along the pond's edge, people had made a home where children played and meals were prepared and cooked under the constant buzz of flies that danced between their food and the garbage and sewage that surrounded them.

Here a lakeside view was not an enviable plot to hold but the rest of the colony was in a relatively much better condition,

Floating Islands in Vasant Vihar, Delhi (2016)

Two of the Five Floating Islands Adopted by Pathways School Noida, Delhi

with most residents living in basic brick structures with paved paths and built open drains. Leaders in the colony could be spotted by the split air conditioner units visible on the sides of their houses. Of course, most people were not financially well off and the conditions were well below what would be considered humane.

There was also an unfortunate group of homes located at the bottom of a large pit that had been built on a foundation of trash to keep their homes above the level of their

Floating Island with Plants from the Yamuna in Hauz Khas Lake, Delhi

own sewage that collected beneath them.

The main focus of the project became the heavily polluted pond and the main drains from the colony and it was obvious that only a natural solution would work as it would be impossible to maintain or operate heavy machinery in this area. Constructed and floating wetlands seemed to be an obvious choice and due to construction restrictions, the facility was to be built from bamboo and compressed earth on the banks of the pond.

Although the NGO has appointed a contractor, he had never built floating wetland islands or bamboo-reinforced, compressed earth constructed wetland before as it soon became apparent that a different approach to construction was needed when implementing innovative solutions; one where the engineer must take a more hands-on approach and involve themselves with the construction process and change the design as necessary.

When digging through the ground it was discovered that actually what one was standing on was ten years' worth of compacted garbage, in effect the local community has created their own landfill

An Extra Large Floaitng Island Adopted by a Private Citizen for Hauz Khas Lake, Delhi

Ducks Nesting on the New Floating Islands, Hauz Khas Lake, Delhi

site on their doorstep. With the plastic bags that formed the majority of the waste acting as some sort of mutant reinforcement clinging to the soil and flinging waste on each upstroke of a spade excavations were long and laborious. To top it off, it was the height of summer and the air was filled with the nauseating stench of dogs, pigs, and human excrement that also posed a risk of soiling your shoes with each step.

There are many challenges to working in these areas, some of which could have been avoided if statutory processes that are required in the UK for public projects were to be also followed even at a small scale in local communities. Some things that are a chore for engineers abroad can become an important tool in situations like these and helps one to appreciate health and safety legislation in the UK.

It was unfortunate but soon after completion of the project the colony was bulldozed and everything that had been constructed went to waste. However, it was the first such project to be successfully completed, the first installation of floating wetlands in Delhi, and had shown good results, producing clear odorless water from sewage and eliminating all odor from the lake. Construction took less than six months and cost less than 12 lakhs INR to build a sewage treatment plant for approximately 15,000 people.

It would be two more years before anyone else built a similar system for another lake and by that time Evolve had prepared and helped another local NGO build a constructed wetland for an unauthorized colony in Vasant Vihar, Delhi.

This had meant another summer of working under the sun surrounded by

Inlet at Hauz Khas Lake (Before)

Volunteers Helping to Clean Out the Inlet

The Start of the Wetland in the Inlet Channel

garbage and the heady cocktail of sewage and open defection but with the benefit of previous experience and hardened to the conditions, designs could be improved and construction was less of a challenge.

One important lesson that had been learnd was that stones and sticks would be used to vandalize the floating islands and a new design was developed that used impact-resistant materials and old plastic bottles.

The budget was extremely limited in this case and so no channel was constructed, instead the buried garbage, soil, and waste became the walls of a series of cascading channels that housed the wetlands and directed both sewage and rainfall below layers of gravel and stones into the local polluted pond. Before construction was even completed residents were happy as a simple trench had eliminated local surface flooding that used to occur during the monsoons. This is testimony to how even very simple and basic interventions can make dramatic improvements in the quality of life of people who have essentially built their own houses and with some basic instructions could also be empowered to

Inlet at Hauz Khas Lake (After)

Volunteers Making and Launching Their Own Floating Islands into Hauz Khas Lake

create their own infrastructure too.

The NGO successfully installed and maintained 100 sqm of floating wetland islands creating India's largest floating wetland array at the time and due to some media coverage and in particular social media, the idea soon spread to the rest of India and people began reaching out for help in installing their own floating islands to revive their lakes.

HAUZ KHAS LAKE

It was after these projects and during a presentation at a conference that the possibility of working with the Delhi Development Authority to clean up the ten-acre Hauz Khas Lake in the heart of south Delhi became a possibility. After months of planning and legalese permission was granted for the construction of two wetlands and a number of floating wetlands with funding raised from the public and a corporate sponsor.

There were many problems facing Hauz Khas Lake and with limited funds, it was a huge challenge. The major issue that needed to be solved was that in spite of the original plans, a mix of raw and partially treated sewage was now the main source of water for the lake and a pervasive and foul odor permeated the park and surrounding neighborhoods.

Work started on fundraising as soon as permission was granted with a crowdfunding campaign, volunteers and the launching of the "Adopt an Island" scheme. This allowed members of the public, schools, and businesses to adopt

Volunteer with a Floating Island

Making and Launching Floating Wetlands

floating wetland islands, coming to the lake and making the islands themselves before launching them into the lake. As funds were raised work could begin and the first floating wetlands were installed on Diwali 2017.

As work progressed and the existing drains were cleaned out by volunteers and citizen groups, the work began to

The EVOLVE Team

The Lake

garner media attention and the project was fortunate enough to get the backing of Pernod Ricard. With their support, the major construction of the wetlands could be completed.

Good engineering also means the efficient use of funds and the budget available was never going to match the multi-crore funds available for government projects of lakes of similar sizes. However, innovation and the frugal use of materials can lead to greatly reduced construction times and costs.

For the first time, an existing drain was completely converted to a wetland that both transported and treated the water that was entering the lake. This meant no new concrete channels or tanks had to be constructed and with this step alone all suspended particles and floating sewage were trapped in the wetland and prevented from entering the lake, and within six months of completion all odor around the lake was removed. It took just three months to construct at a cost of ten lakhs.

Whilst the use of constructed wetlands for treating incoming water to a lake has now become common in Delhi, Hauz Khas Lake was another opportunity to go beyond what was already being done and to innovate with an additional dedicated constructed wetland to act as a Lake Filter and Delhi's first floating solar aerator.

As the third year in the clean-up process begins it remains to be seen just what effect all these innovations will have.

About the Contributor

***EVOLVE** was founded in 2010 by **Tarun Nanda,** M.Eng. in Civil and Environmental Engineering from Imperial College, London. After working in the UK for many years, he left a well-paying job to return to his roots and help improve water infrastructure in India. Bringing international engineering expertise, he has focused on the innovative application of engineering techniques to solve water pollution and infrastructure needs for both private and public projects. He was joined by **Debayani Panja**, a researcher in the WASH sector, in 2017.*

AQUACULTURES, FILTRATION, RECIRCULATING SYSTEMS, SLUDGE

ATLANTIC SALMON FROM SWISS MOUNTAINS – INDOOR FARM RELIES ON HI-TECH METAL MESH

By GKD - Gebr. Kufferath AG

Since the start of the millennium, salmon consumption has tripled in Germany alone: According to surveys (December 2019), the annual per-capita consumption of salmon in the Federal Republic is three kilograms. One million salmon are caught around the world each year. The vast majority of them are bred in net enclosures anchored to the seabed – marine aquacultures. This results in crowded spaces, an aquatic environment heavily soiled by excrement and food remnants as well as heavy use of antibiotics and pesticides to treat the animals for illnesses and parasites. For a long time, this type of breeding has therefore been the object of worldwide criticism from environmental, animal welfare, and consumer organizations.

Indoor recirculating systems have existed as a proven yet costly solution to the problem since the 1980s. They can be used to rear fish anywhere – with high environmental sustainability and optimum living conditions for the animals. It is a principle that Swiss Alpine Fish perfected with a total of three recirculating systems and the latest technology for salmon culture from egg to ready-for-slaughter fish, making it an exemplary company in

Throughout the world, around 2.5 million tons of salmon are bred every year under conditions that are often ecologically problematic. Ninety percent of the salmon in supermarket refrigerators comes from these marine aquacultures - primarily from Norway and Chile.

In Switzerland, Swiss Alpine Fish AG is demonstrating a sustainable alternative in environmentally friendly salmon rearing with indoor aquaculture in the middle of the Alps. The core element of the farm is the innovative RAS 2020 recirculating system from Veolia.

Yet with metal mesh from GKD - Gebr. Kufferath AG, the Swiss salmon breeder is also breaking new ground beyond this: In the drum filters for mechanical water cleaning, the company is using stainless steel Porometric mesh, which is unparalleled in terms of flow rate and cleaning.

In the future, two different metal meshes from GKD - Gebr. Kufferath AG will also be used for fish handling.

In Switzerland, Swiss Alpine Fish AG is demonstrating a sustainable alternative in environmentally friendly salmon rearing with indoor aquaculture in the middle of the Alps.

Switzerland and beyond. The spawning station and quarantine station each have one recirculating system.

For the grow-out – the fattening phase, which is the last and most expensive stage of salmon farming – the company uses the pilot system of an RAS (Recirculating Aquaculture System) 2020 system. This is an innovative, compact ring tank system with three concentrically arranged rings and sections of variable sizes. The capacity of the entire system at Swiss Alpine Fish is 3,900 cubic meters of water. Spring water from a 28-meter-deep well is pumped through the system with the constant addition of oxygen. 99.5 percent of the water used is treated every hour in a multi-stage process involving mechanical and biological cleaning and fed back into the system. Only 0.5 percent of water soiled with sediment is channeled into the company's own water treatment plant. After complete processing, it is fed into the nearby Moesa river. The remaining sludge with a dry matter content of around nine percent is recycled in a local biogas plant.

A state-of-the-art control system permanently monitors all parameters, such as oxygen concentration, pH-value, or temperature of the water and units. For instance, reference value settings trigger the automatic addition of base in order to stabilize the pH value. As such, this closed recirculating system guarantees fish farming without antibiotics or chemicals and the production of correspondingly high-grade meat. Twelve generations of salmon are bred in parallel at Swiss Alpine Fish, and six generations of different ages are currently in the RAS 2020.

Swiss Alpine Fish produces Atlantic salmon of the highest quality.

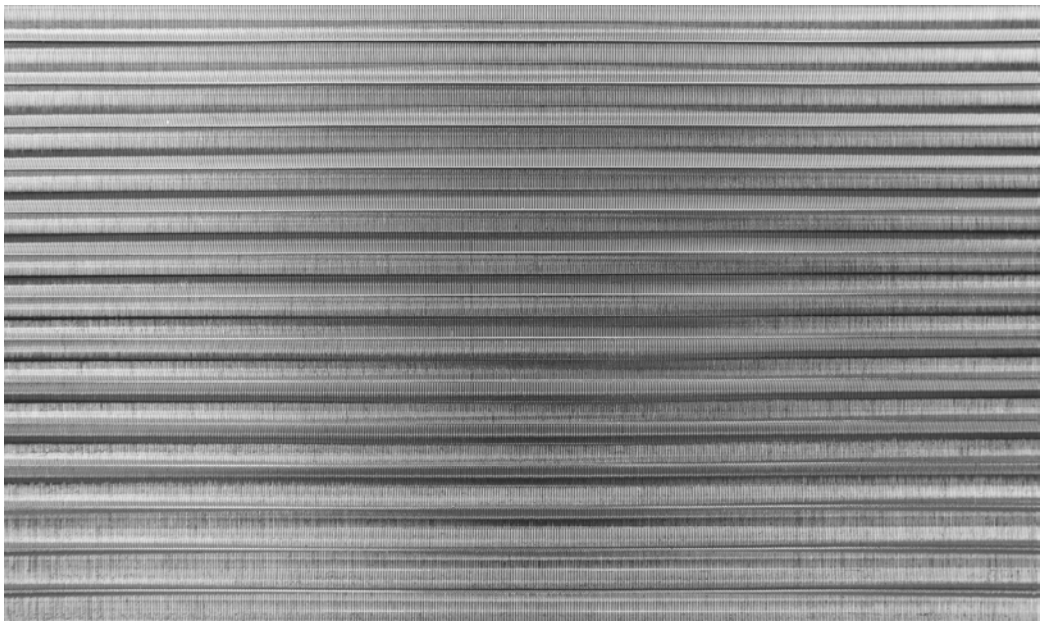
FROM EGG TO READY-FOR-SLAUGHTER SALMON

With the farming system, the young company in Lostallo – a small locality in the Italian part of Grisons, south of the San Bernardino Pass – recreates the natural stages of life of the salmon. Every two months, 50,000 fertilized salmon eggs are imported from a reputable producer in Iceland – exclusively female due to their faster growth and better meat quality.

The six- to seven-millimeter eggs arrive in incubators with pure fresh water flowing through them at a temperature of around eight degrees Celsius. The fish hatch after about ten days. After almost two months, the fish have consumed their yolk sack and have to be accustomed to external food in a larger flow tank.

To do this, salt is added at the end of what is known as the first-feeding phase in order to prepare the fish carefully for the next phase in the first recirculating system at a salinity of 1 ppt.

At the start of this two-month-long first-feeding phase, the fish weighs approximately 0.2 grams and at the end, they are transferred to the hatchery in the first recirculating system with a weight of two grams. In the first two tanks for the fish that are now known as fry, the salinity of the water is 2 ppt. At a weight of 20 grams, they move into the last three tanks of this recirculating system after eight weeks.



Porometric mesh from GKD proves itself in the drum filters for mechanical water cleaning at Swiss Alpine Fish.

Three HDF 2009-1AS drums filters are used at Swiss Alpine Fish to clean the water mechanically.

Another two months later, at the end of what is known as the pre-smolt phase, they already weigh 70 grams. They move to the farm's second recirculating system via a pipeline. This is where the smoltification of the fish takes place – their physiological adaptation to water with 6 ppt salinity. When changing tanks, all salmon are vaccinated by hand. After a further two months, the fish, now weighing 250 grams, move into the third and largest recirculating system, the RAS 2020.

This grow-out system with a diameter of 32 meters and a depth of 4.5 meters holds 2,700 cubic meters of water – 700 cubic meters in the inner ring and 1,700 cubic meters in the outer one. Each of these rings consists of three sections, into which the fish are pumped once they have been there for two months. When they move into the second section of the inner ring, the fish weighs approximately one kilogram, after the first section in the outer ring 1.6 kilograms, and at the end of the last of the six sections 3.5 to four kilograms. At this weight and a length of around 80 centimeters, they are ready for harvest or slaughter. At this stage, they are first moved into the 223-cubic-meter purge tank, where they stay for seven days – now

The drum filters at Swiss Alpine Fish are 3,600 millimeters long and have a diameter of 2,000 millimeters.

45 filter panels with the high-performance Porometric mesh from GKD with the required pore size of 25 µm are used in the drum filters at Swiss Alpine Fish.

in fresh water again – until they have lost the earthy off-flavor of geosmin, which is caused by bacteria.

During processing, the fish are electrically stunned and their gills cut. After gutting, the fish are packed in ice and the next day they are then filleted, vacuum-packed, or smoked for 18 hours at a low temperature (20 degrees Celsius) to delicious recipes by the Scottish smokemaster, depending on the orders received.

Of the 50,000 eggs imported by Swiss Alpine Fish, on average 20,000 fish currently manage to pass through all the stations.

Since the indoor farm, which was set up with an investment volume of 14 million Swiss francs, opened in 2013, the production volume has grown continuously. The aim is to produce 600 tons of salmon per year; in 2019, the output was 400 tons. This year, the company expects annual production of up to 550 tons – due in part to important improvements that include GKD metal mesh. However, plans to expand the plant by a further 1,200 tons in salmon production are already well underway. The first harvest following the capacity expansion is planned in three to four years.

TOP-QUALITY WATER

TREATMENT

The crucial element of every fish farm is water quality. The main reason for selecting Lostallo as the site was the high quality of the spring water. After being drawn from the spring, it is sterilized by a UV system and supplies the various systems with fresh water from a holding tank. In the RAS 2020, fresh water is supplied to the purging tank. From there, it passes into the three drum filters via an overflow and, following UV disinfection, into the biofilter.

This, together with a denitrification reactor that also functions as a second biofilter, is located in a 3rd concentrically arranged ring with a radius of 7.5 meters in the middle of inner grow-out ring. Here, the almost 100% oxygen saturation of the water is reduced virtually to zero, and ammonium, ammonia, and nitrite are converted into nitrate. Due to the permanent water exchange, the correspondingly low nitrate content has no adverse effects on production.

After treatment in the biofilter, a degasser removes CO_2 and nitrogen from the water. Next, three suction pumps each conveys 1,200 cubic meters of treated water per hour into a tank. Some of it is fed into oxygen cylinders and enriched with oxygen at a

The construction of the filter panels from GKD with shovel-like support structure, consisting of many small squares of mesh connected with one another, augments the filter effect.

Some of the cleaned water is fed into oxygen cylinders and enriched with oxygen at a pressure of three bar.

pressure of three bar. Together, with the remaining, unenriched, water, the water processed in this way flows back into the recirculating system.

Three HDF 2009-1AS drums filters are used to clean the water mechanically before the biofilter. With a length of 3,600 millimeters and a diameter of 2,000 millimeters, they each have a filter area of 21.6 square meters. Uneaten food and fish excrement are removed from the intake water at this stage in order to support the function of the biological filters. In each of the three drum filters, there are 45 filter panels, each of them 1.20 x 0.40 meters in size. The construction of their shovel-like support structure, consisting of many small squares of mesh connected with one another, augments the filter effect. The panels are cleaned automatically several times per minute by spray bars.

In addition, the filter panels are cleaned once a week with a pressure cleaner to remove fatty deposits from the fish food. Over time, the synthetic mesh supplied with the system failed to stand up to the strain of this maintenance, which caused increasing problems with the 24-hour operation of the salmon farm, explains Christopher Shaw, Farm Assistant Manager at Swiss Alpine Fish. Holes in the mesh and tears at the edges jeopardized the quality of the mechanical cleaning. “Cleaning quality and filter efficiency are extremely important for our process,” says the expert. He adds, “The salmon need clean water with no suspended sediment for their well-being and optimum growth. Solids and suspended sediment are also a source of bacteria build-up and must therefore be removed from the processing water as quickly as possible.”

When looking for a solution online, he came across GKD and the high-performance Porometric mesh made of stainless steel that it develops with the required pore size of 25 µm. With almost 90 percent porosity, its three-dimensional slit structure achieves an unsurpassed flow rate. At the same pump output, the throughput can therefore be significantly increased. Thanks to the high dirt holding capacity, Porometric also requires fewer cleaning cycles, despite the greater filter performance.

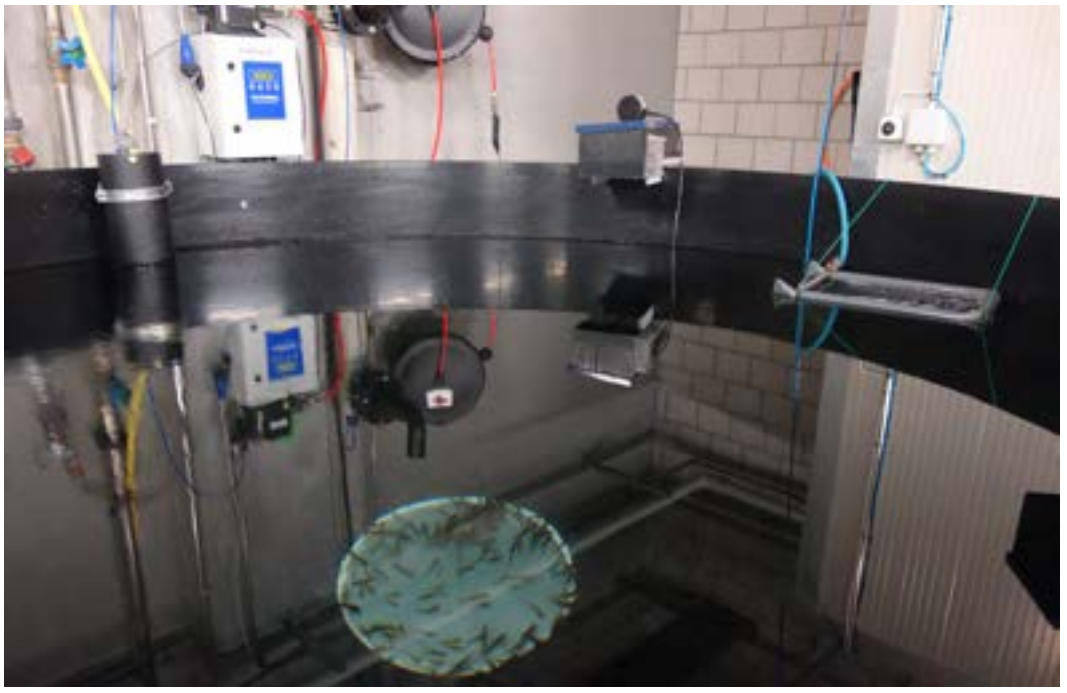
In independent comparisons by the Karlsruher Institute of Technology (KIT), the hi-tech mesh proved to have the best cleaning performance – while also exhibiting a lower backwashing rate. This aspect was also interesting for Christopher Shaw, as the wastewater system at Swiss Alpine Fish was at its limit. As such, he had several panels in a drum filter fitted with this stainless steel mesh from GKD as a test. The global market leader for industrial and architectural mesh developed a new application technology, especially for this purpose.

The subsequent tests under real-time conditions confirmed the expectations

Every two months, 50,000 fertilized salmon eggs are imported from a reputable producer in Iceland.

The six- to seven-millimeter eggs arrive in incubators with pure fresh water flowing through them at a temperature of around eight degrees Celsius.

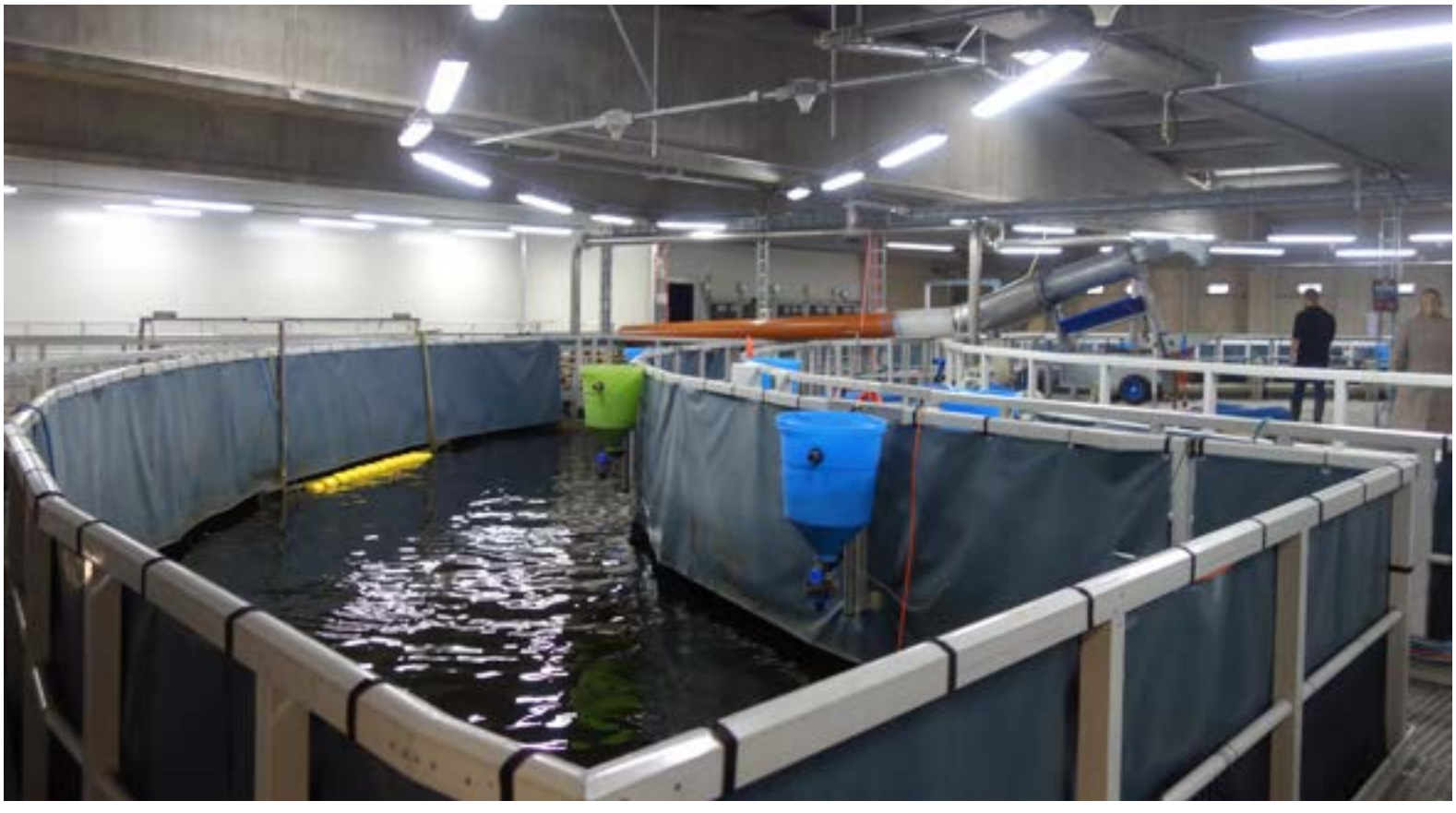
of the Assistant Farm Manager across the board: "The panels can be cleaned much more easily – without the danger of damaging the mesh." The intervals between cleaning cycles were also increased considerably. Although it is somewhat easier to fit the drums with the more flexible synthetic mesh panels, these



After almost two months, the fish have consumed their yolk sack and have to be accustomed to external food in a larger flow tank.

results clearly indicated that it would be wise to expand testing with the metal mesh panels. This is why Christopher Shaw then had the first of the three drum filters fully fitted with Porometric 25. This test will continue for a good month. If it also succeeds in meeting the expectations of Swiss Alpine Fish, the two remaining

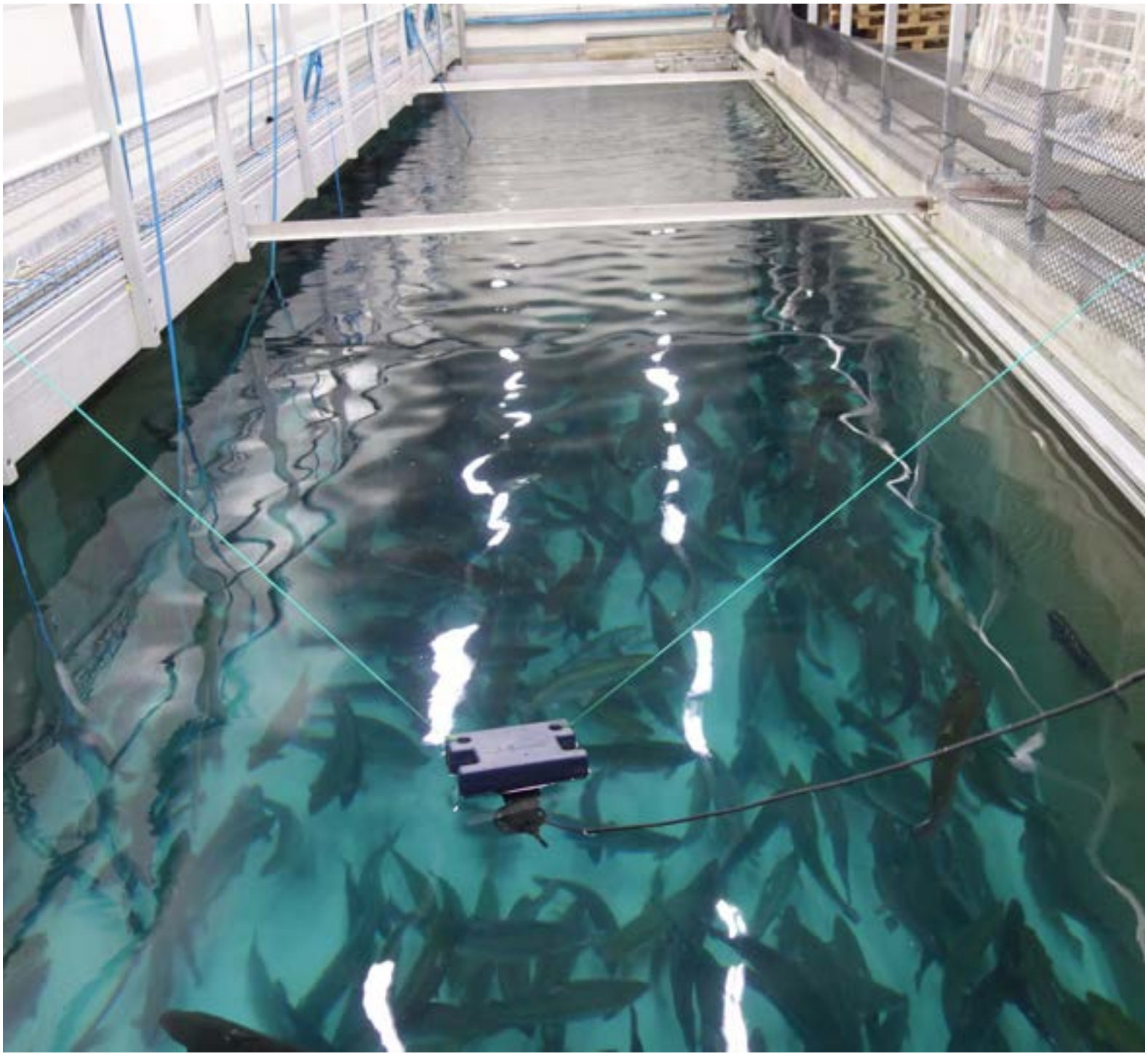
The smoltification of the fish – their physiological adaptation to water with 6 ppt salinity – takes place in the farm's second recirculating system.



The recirculating system, the RAS 2020 with a diameter of 32 meters and a depth of 4.5 meters holds 2,700 cubic meters of water.

The core element of the farm at Swiss Alpine Fish is the innovative RAS 2020 recirculating system.

Each ring consists of three sections, into which the fish are pumped once they have been there for two months.



The ready-for-slaughter fish are moved into the 223-cubicmeter purge tank, where they stay for seven days without being fed - until they have lost the earthy off-flavor of geosmin, which is caused by bacteria.

drum filters will be successively fitted with the Porometric mesh.

GKD produced 55 Porometric panels in total: 45 of them are intended for the drum filters. Ten more of these panels were used on the farm for testing purposes in the drum filters of the wastewater treatment plant. The percentage increase in efficiency is not yet final. However, Christopher Shaw can already envisage equipping all drum filters with the supremely robust and highly efficient stainless steel mesh in the planned expansion of the system right from the start – perhaps at an even higher separation rate, as Porometric is available up to 13 µm.

OPTIMUM FISH-HANDLING WITH METAL MESH

Christopher Shaw is already full of praise for the good cooperation with GKD, "We received a great deal of support in choosing the mesh and producing the panels from the outset." He came to value another aspect of this great expertise and the broad offering of metal meshes of many different types during a visit to the GKD headquarters in Düren near Cologne.
The RAS 2020 has grids that enable the sections in the grow-out rings to be flexibly adjusted. The purpose of this is to set the optimum density for the respective size of fish while also increasing the capacity of the system.

In practice, however, these allegedly movable grids didn't work, so Swiss Alpine

After gutting, the fish are packed in ice.

The fish are filleted, vacuum-packed, or smoked for 18 hours at a low temperature (20 degrees Celsius), depending on the orders received.

In 2019, the output was 400 tons of salmon per year.

Fish had already designed new grids themselves. In GKD, Christopher Shaw again found the right solution partner for producing the grids, opting for Pegasus architectural fabric as the suitable mesh. Its pore size of 50 x 13.7 millimeters holds the fish in the respective section while offering the required lowest water resistance possible.

From now on, four movable barriers with this stainless steel mesh in fiberglass frames will be used in the system in Lostallo, enabling the stress-free transfer of the fish from one section to the next. With Tucana, another metal mesh from GKD, the aquaculture expert identified the third mesh to solve an existing problem: As a retention grid on the overflow of the purge tank, this rigid mesh now prevents fish from getting into the drum filters.

By permanently optimizing what is already the most technically advanced and sophisticated kind of aquaculture, Swiss Alpine Fish produces Atlantic salmon of the highest quality that damages neither the environment nor ecosystems. Considering that the market continues to grow strongly around the world, the company and the metal meshes from GKD are setting benchmarks for other indoor salmon farms with recirculating aquaculture systems that are currently planned or under construction.

With the help of a state-of-the-art control system Christopher Shaw, Farm Assistant Manager at Swiss Alpine Fish, permanently monitors all parameters and units.

About the Contributor

GKD - Gebr. Kufferath AG, *as a privately-owned technical weaver, is the world market leader in metal, synthetic and spiral mesh solutions. It has its headquarter in Germany and five other facilities in the US, South Africa, China, India, and Chile - as well as its branches in France, Spain, and worldwide representatives.*

DRAINAGE, HOSPITAL, PIPES, STORMWATER

STORMWATER DRAINAGE FOR EMERGENCY FIELD HOSPITAL CONSTRUCTION

By Advanced Drainage Systems

As part of New York State's plan to add hospital beds to care for both non-coronavirus patients and those infected with COVID-19, the U.S. Army Corps of Engineers, along with local construction firms, erected temporary field hospitals using the campuses of two Long Island, New York colleges. At Stony Brook University, a $155 million, 255,700-square-foot, 1,038-bed facility built by Turner Construction Company is ready. Just 15 miles to the west is the completed 207,000-square-foot, $118 million, 1,022-bed unit at the State University at Old Westbury built by AECOM Technical Services, Inc. Work on each took three weeks. Both field hospitals were built on turf that would easily flood from roof runoff during even a medium rain event, making the stormwater control system a critical component.

"In order to accommodate the massive flow requirements for stormwater from the tent roofs, we used 12-inch double-wall corrugated pipe to set up a drainage system from the gutters that we attached to the roof of each of the buildings," explained Josh Merrick, construction project manager for EAI, Inc. Environmental Management Services (Jersey City, NJ) at the Stony Brook site. "The majority of the pipe needed to be run under newly built ambulance roadways and into underground swales that were dug to handle the heavy stormwater flow without flooding the surrounding landscape. The system was designed to handle 1,230 gallons a minute."

More than 600 feet of pipe was used at each job. Runoff goes into several swales that contain the water and allows it to percolate into the ground.

The five buildings at Stony Brook are actually tents constructed of heavy-gauge vinyl that is stretched tight over the frame, which makes rain cascade faster. The largest is 140 feet by 300 feet long.

"We selected ADS N-12® pipe because we needed to handle more than 1,000 gallons a minute for our original design, which was to run all the pipes above ground as part of the gutter system to capture the flow of the entire roof's water. Due to the fast-paced "design-on-the-fly" style urgency of the project, we ended up having to change the layout to accommodate the equipment of other trades. We had to completely redesign what we were building out there to make it all work together. The pipe gave us the flexibility to do that in the field, this system also gave us the

The field hospital at Stony Brook University was completed in record time. Photo by U.S. Army Corps of Engineers.

ability to make above-ground 90-degree connections to help route the piping around any obstacles around the tents."

According to Advanced Drainage Systems, Inc. (ADS), its N-12 pipe is certified to meet CAN/CSA Standard

> ***"Due to the fast-paced "design-on-the-fly" style urgency of the project, we ended up having to change the layout to accommodate the equipment of other trades. The pipe gave us the flexibility to do that in the field, this system also gave us the ability to make above-ground 90-degree connections to help route the piping around any obstacles around the tents."***
>
> ***- Josh Merrick, Construction Project Manager, EAI Inc.***

ADS N-12 pipe was used to convey rain water from the roofs of the field hospitals at Stony Brook and SUNY Old Westbury, New York.

Rain water is conveyed from the roof to gutters then to ADS N-12 pipe where it drains into swells.

B182.8, BNQ 3624-120 plus AASHTO Load Resistance Factor Design (LRFD) specifications. ADS N-12 WT IB pipe meets ASTM watertight standards. Because it is lightweight, ADS corrugated pipe can be easily handled with minimal equipment by a one or two-person crew. This benefit also allowed it to be installed differently than normal – a lot of runs basically used zip-ties to attach the pipe to the sides of the buildings. Some runs were 90-degree connections above ground. Due to the pipe's strength and its lightweight, these methods were practical and successful.

Named for its excellent Manning's "n" rating of 0.012, the N-12 pipe was designed in 1987 by ADS specifically for culverts, storm sewers, highways, airports, and other civil design construction and has been used in these applications ever since. ADS pipe is available in diameters from 4-60 inches.

"Speed and time were critical," commented William Maher, U. S. Army Corps of Engineers New York District's mission manager overseeing the project and coordinating with federal, state, and local partners. "We met the challenge of building high-quality patient care facilities in a very short period of time."

"Everything came together fairly easily," Merrick stated. "The hardest part was coordinating with all the other trades because there was so much going on at one time. There were thousands of workers out there. We had about 30 guys doing the gutters and storm drainage and some other jobs that they fed us during the week we were there."

"The importance of having local, stocking dealers in the area to provide N-12 pipe cannot be stressed enough," stated Mike Kennedy, ADS sales representative for New York City and Long Island. "This is one of the quickest, fast-tracked jobs I've ever been involved with during my decades at ADS. These two field hospitals had to be started immediately and finished quickly. This was an emergency situation."

Both field hospitals were fully operational in late April and are ready to accept patients if needed.

The ADS N-12 stormwater drainage pipe was run under roads and parking areas at the U.S. Army Corps of Engineers' Long Island, New York field hospitals.

About the Contributor

***Advanced Drainage Systems** is a leading provider of innovative water management solutions in the stormwater and on-site septic wastewater industries, providing superior drainage solutions for use in the construction and agriculture marketplace. It company operates a global network of 63 manufacturing plants and 32 distribution centers.*

24x7 WATER SUPPLY, INFRASTRUCTURE, NRW, UTILITY

URBAN WATER: CURBING LOSS AND IMPROVING SUPPLY IN DELHI

By Subhash Sethi

The old adage 'Bin Paani Sab Soon' (everything will finish without water) is becoming a reality although slowly. From abundance to scarcity in a few decades, water has become the topic of every discussion.

The availability of both quality and quantity of water is vital to India's economic growth and sustainability for humans and businesses. But the changing scenario suggests that India is becoming a water-scarce country with risks of drought and shrinking groundwater reserves. By 2030, India's water demand is projected to be twice its availability, implying severe scarcity and an eventual loss in the country's GDP by almost 6%.

Clean drinking water has become a precious commodity in most parts of the world and the same is true for India as well. With water being traded alongside gold and oil at international bourses, we can understand the value of it with future ramifications. India which had an abundance of water historically is facing a difficult challenge as over 600 million people have become deprived of a clean water supply. The average annual per capita availability of water has also reduced

THE WAY FORWARD

Given the clear benefits of 24x7 water supply in urban areas, it was clear that developing a successful project would require not only technical skills but also significant communication and social skills. Strong leadership at the government and political level is an important requirement, especially the support of decision-makers.

MVV Water Utility has demonstrated the successful example of making a 24x7 water supply project and the same could be repeated not only in different other parts of Delhi but at any large city in India as it is clear that continuous water supply would deliver significant benefits for addressing water challenges in urban centers with sustainability.

Pumping Station at Shanti Niketan, Delhi

alarmingly in a span of 70 years, from 5177 cubic meters in 1951 to 1486 cubic meters in 2021, and estimated to decline further to 1191 cubic meters in next less than three decades leading up to 2050 or maybe earlier than the estimate.

24x7 URBAN WATER SUPPLY SCHEME

The average water supply time in most Indian towns and cities may last for just one or two hours every day or maybe alternate days or it could be even less in certain locations. The quantity of water supplied by water utilities or municipalities is reducing whereas qualitatively, it cannot be consumed straight from the tap. 24x7 supplies are when water is delivered continuously to every consumer of the area for 24 hours a day, every day of the year, through a robust transmission and distribution system that is continuously full and under positive pressure with intelligent monitoring and preventive maintenance.

24x7 supply reduces the burden on water resources. Continuous supply reduces water wastage arising from overflowing storage systems and open taps. It also saves on stored household water that is discarded when a new supply comes in. Because the network is renewed where needed, it also reduces losses arising from leaks in the old pipes. SPML Infra Limited has been handling a number of 24x7 urban water supply projects in different cities that have shown tremendous results in terms of effective water loss management, efficient pumping, intelligent monitoring,

Pumping Station at West End, Delhi

and significantly better service to all consumers. In an iconic legacy of four decades, SPML Infra has executed several projects that have created a benchmark for the industry. A case study of one of its urban water supply projects in Delhi is presented here.

CASE STUDY: URBAN WATER SUPPLY IMPROVEMENT PROJECT IN DELHI

Project Description

The improvement in services levels of drinking water supply project was awarded by Delhi Jal Board to MVV Water Utility Pvt. Ltd. (Consortium of SPML Infra Limited, Tahal Engineering & Hagihon Water) in September 2012, with the scope of rehabilitation of distribution system, supplying water for over 325,000 residents of Mehrauli (Qutub, Laltanki, Bawaji, and Kishangarh) and Vasant Vihar (Vasant Vihar, Vasant Enclave, Anand Niketan, Shanti Niketan, and Westend) followed by 10 years of Operation & Management (O&M) of the water supply services.

Context and Objective

DJB wishes to enhance service delivery and improved management of water distribution by upgrading Water Supply System and Network Improvement in order to significantly reduce Non-Revenue Water (NRW), conserve energy, improve water quality and collection efficiency of revenue, and extension of water supply in the un-served areas in its jurisdiction. The growing population and increased demand for water in Delhi have put tremendous pressure on its water supply infrastructure.

To address the ever-growing demand and part of the ongoing process of developing amenities and capacity building of water distribution system, Delhi Jal Board had decided to undertake Improvement in Service Level for Water Supply in Mehrauli Project Area and Vasant Vihar Project Area, Delhi on a Design, Build, Operate and Transfer (DBOT) basis, as a project for the reduction in NRW/UFW and improvement in service to the residents through uninterrupted 24x7 water supply.

- Mehrauli area, situated in the South of Delhi, has 16,500 house service connections.
- Vasant Vihar, located in the South-Western part of Delhi, is one of the upmarket and posh residential areas in the city, having 7,400 house service connections.

MVV Water Utility Pvt. Ltd. carried out design/ engineering, rehabilitation of the existing water distribution system to deliver water 24x7, installation of flow and pressure measurement/ control devices for the management of flow and pressure within DMA, revamping/ replacement of service connections, removing illegal connections, replacement and automation of pumping systems, established 24x7 consumer complaint center for improving service levels and managing the water supply to meet the below mentioned KPIs.

Key Performance Parameters

- Continuous water supply
- Reduction of Non-Revenue Water (NRW) to 15%
- Energy efficiency
- 100% connectivity
- Timely complaints resolutions
- Improvement in collection efficiency

Key Achievements

- The water supply increased from less than 2 hours per day to 24 hours per day
- 100% new house service connections
- The distribution network was designed using the latest technology and software solutions to deliver water on a 24x7 basis, designed for the next thirty years
- New technologically advanced pumping station installed for 24x7 water distribution
- The technologically advanced and energy-efficient automated pumping system draws water from the reservoir and pump it into the distribution system as per the demand thus reducing energy consumption
- The pumping system is programmed to run the pumps in combination to meet the peak and average demands in the day and controlled optimum flow during the night
- Non-revenue water in the area is reduced from about 60% to under 10%
- All borewells have been phased out
- Smart water meters have been installed at each household
- Consistent water pressure is provided eliminating individual pumps thus reducing electricity bills

- Dedicated 24x7 complaint management system with the user-friendly consumer service center to receive and resolve any complaints related to water supply, leakages, new connection, disconnection, mutation, billing & revenue, etc.

UNIQUE FEATURES OF PROJECT

24x7 Water Supply

Providing pressurized drinking water supply in the area throughout the day wherein consumers can directly draw water and use it without bothering to store it at their individual premises. The water distribution system is scientifically designed to deliver 24X7 water supplies with adequate pressure without water stagnation in the system.

Feeder Mains properly deliver the treated water into the main reservoir of DMA, then a robust, technologically advanced, and energy-efficient automated pumping system draws water from a reservoir and pump it into the distribution system as per the demand.

The pumping system is programmed to select and run the pumps in combination to meet the peak and average demands in the day and controlled optimum flow during the night. The water distribution system is always under positive pressure to meet the 24X7 water supply. The entire distribution network is programmed as demand-driven resulting in optimal utilization of resources, better demand-supply management, and is self-sustaining.

Advantages of 24x7 Water Supplies to the Citizens

- Need-based usage of water with minimum wastage
- Convenience of availability of fresh pressurized water at the tap anytime
- No water contamination leading to better health and hygiene
- No storage and pumping anxieties at customer point
- Efficient use of water infrastructure such as pumping machinery, storage reservoirs, and the distribution network, among many others.

Pumping Station at Anand Niketan, Delhi

Customer Care Center

Customer complaint management is one of the crucial responsibilities of a water utility company. MVV has established a 24x7 customer care center with state-of-the-art customer care software, to receive, resolve and report customer complaints related to water quantity, quality, billing, and customer service connections. Once the customer complaint is received by the customer care executive, it is logged in the system and dispatched to the respective DMA manager for resolution of the complaint. The DMA manager assigns the job to the network assistant who visits the customer and investigates the complaint, resolves it, and reports back to the DMA manager along with the signed copy of the complaint resolution with the comments of the Customer. The DMA manager after the due verification dispatches the resolved sheets to the customer care executive, who after verification marks the complaint as addressed and closes it in the system. The entire process of responding, resolution, and reporting is completed within the stipulated time frame allocated for different nature of complaints by the DJB.

Pumping Machinery and Automation

Skid-mounted pumping machinery is deployed for pumping water into the distribution system as per the hourly water demand derived from the mass balancing and pressure within the distribution network. The pumping machinery consists of a Jockey pump (1W+1S) used for pumping the water during the lean period and main pumps (2W+1S) are used to pump the water during the peak demand and normal average demands. The automation of the pumps is done in such a manner that the pumps are automatically switched on and switched off depending on the hourly water demand and combination of pumps to pump optimal flow as per the actual water demand. The automation has safety features such as switching off the pump to avoid dry runs and cutting of supply when the pressure within the distribution network reaches 3 kg/cm^2. This combination of the pumping system and automation has resulted in considerable energy saving in West End, Shanti Niketan, and Anand Niketan, where it has already been deployed and the same systems will be installed in the Vasant Vihar pump

house soon after the approval from DJB.

KEY CHALLENGES FACED

Site Permits and Clearances

Too many permissions were required from different government agencies while executing infrastructure works which inordinately delayed the schedule. We have suggested DJB to obtain all permissions as a single-window clearance and allow the companies assigned the job to work freely. If the permits are delayed then men and machinery will be lying idle along with schedules getting delayed.

Design Issues

Water infrastructure such as distribution network, reservoirs, pumping machinery, etc. are designed based on the general guidelines issued in the CPHEEO manual, however, during the execution and subsequent operation, it is noticed that the field data are completely different from the guidelines followed in the design and hence, additional works may have to be executed beyond the scope of works.

Limited Water Availability

Detailed Project Reports (DPRs) are made following the guidelines of CPHEEO and DJB makes necessary arrangements to cater to the bulk water demand as per DPR. Water consumption expressed as LPCD depends on the social status of the population. Affluent class citizens tend to consume more water to the tune of 250 LPCD and above as against the design norm of 150 LPCD. It creates challenges as the quantity of bulk water is not made available and the distribution system, pumping machinery, and storage capacities are not designed to handle such a big increase in demand. Sometimes, it becomes difficult to improve service levels beyond a certain point.

Reluctance by Consumers

There is reluctance from the customers to change the water-drawn habit. The customers have built huge underground sumps (8-10 KL) capacity within their premises and they prefer to draw water into their sumps, pump it to overhead tanks and then use it.

This excess drawing of water from every household results in insufficient pressure build-up within the distribution network and also an unequal distribution of water. The customers who are far away from the pump house and at the elevated area could face a low-pressure supply and may not get water on occasion when there is a short supply of bulk water. This will add an additional burden of piping reorientation and motorized valves for the safe running of pumps within stipulated duty conditions.

Delayed Payments

The company working on the project does their project planning (material, machinery, money, and manpower) considering that the project is implemented without any hindrance and hoping that the bills will be paid on time. If the project is delayed due to delays in getting permits/ permissions, cash flow is adversely affected leading to financial stress to the company. The client needs to look into such matters and suitably compensate for such delays to keep the project running.

Project Status

The hydraulic model of the distribution network has been designed with the latest software, WATER GEM to deliver water on a 24x7 basis for the next thirty years. The robust distribution system with instrumentation control for better flow and pressure management has been installed, hydro-tested, and commissioned. Individual House Service Connections pipelines are provided in all blocks and shifting of individual house service connections from the old network to the new network is nearing completion.

Dedicated, state of the art Customer Care Center (CCC) has already been functioning to receive, resolve and report the customer complaints such as water supply, leakages on main pipe and HSC, disconnection, new connection, mutation, billing & revenue, etc.

About the Author

Subhash Sethi *is an industry veteran in the water sector, having been in the business for over 40 years and leading SPML Infra Limited. Under his leadership, SPML Infra has completed over 650 projects and currently providing drinking water facilities to more than 50 million people in the country.*

FECAL SLUDGE, FSTP, ODF, SANITATION, ULB

GEOTUBE BASED FECAL SLUDGE TREATMENT: A PILOT PLANT STORY

By Rajarshi Banerjee

INITIATIVE AND ACTION

The Government of India, with the prime focus on safe sanitation services initiated into, is not only providing toilets but also embarked on the treatment and management of fecal sludge. With such a focussed mission, certain cities were identified to have taken initiative and reflected on the potential of setting examples for others.

Warangal, the second largest city of Telangana, was declared Open Defecation Free (ODF) in 2017 and achieved ODF++ status in 2019. With a population of 810,000 (2011 census), and growing by leaps and bounds, its sanitation coverage in terms of toilets, was about 94% (158,384 out of 167,636 households have toilets). Although it was also depicted by the Warangal shit flow diagram (SFD) that 42% of waste was being safely disposed of, or reused, leaving 58% of waste that was not being treated. With concrete partnership and efforts by Swachh Bharat Mission (SBM), the Greater Warangal Municipal Corporation (GWMC), and

THE STATE OF AFFAIRS

Ensuring universal access to safe, reliable, and affordable sanitation for city residents is pivotal in the urbanization process. Such assured services would lead to productive, healthy, and thriving lives. Defecation and urination are a basic need, proper management of which is of utmost urgency in any city.

With an estimated population growth projection of 6.5 billion by 2030 in the Global South (especially, cities in Sub-Saharan Africa and South Asia), WHO reports that while only 45% (3.4 billion) people have safely managed sanitation service, wherein 74% (5.5 billion) people use at least a basic sanitation service, while almost 2 billion people still did not have access to basic sanitation.

However, India's ambitious project Swachh Bharat Mission (SBM), or Clean India Mission launched in 2014, in its first phase targeted to attain 100% in toilet provision to its citizens, with 36 States/ UTs declaring themselves Open Defecation Free (ODF). The next phase II of SBM, i.e., ODF-Plus focuses on reinforcing ODF behaviors and a prime focus on providing interventions for the safe management of solid and liquid wastes both in urban and rural India.

Figure 1: Panoramic/ Wide Angle Views of the FSTP

the Administrative Staff College of India (ASCI), the city took to the level that a comprehensive plan for enhanced sanitation by engaging the private sector was initiated.

Under this same project, state-level Project Management Unit (PMU) and city-level Project Implementation Unit (PIU) were also set up within GWMC in 2017. A Non-Sewer Sanitation (NSS) cell was established in 2018, with the responsibilities of marking the progress of ODF, sustaining of ODF, conversion of insanitary toilets to sanitary ones, scheduled desludging, waste management, and monitoring Fecal Sludge Management (FSM). In 2018, a Sanitation Innovation Hub (the land was identified for the purpose) was approved by GWMC, with the aim to promote innovation, test new technologies, encourage collaborations to develop an ecosystem of innovation and private sector players in the non-networked sanitation sector.

SETTING UP DEMO/ PILOT PLANT: PLANNING DESIGNING AND COMMISSIONING

Banka BioLoo Limited (BBL) is one of the companies that set up its demo/ pilot Fecal Sludge Treatment Plant (FSTP) based on Geotube technology. After land allotment and signing of the necessary agreements, construction of the FSTP began. Land assessment, soil quality testing, etc. were done, parallelly, with the civil works. The major civil work was laying the Geotube bed, and constructing a few collection tanks. The rest of the items within the plant were designed and commissioned in

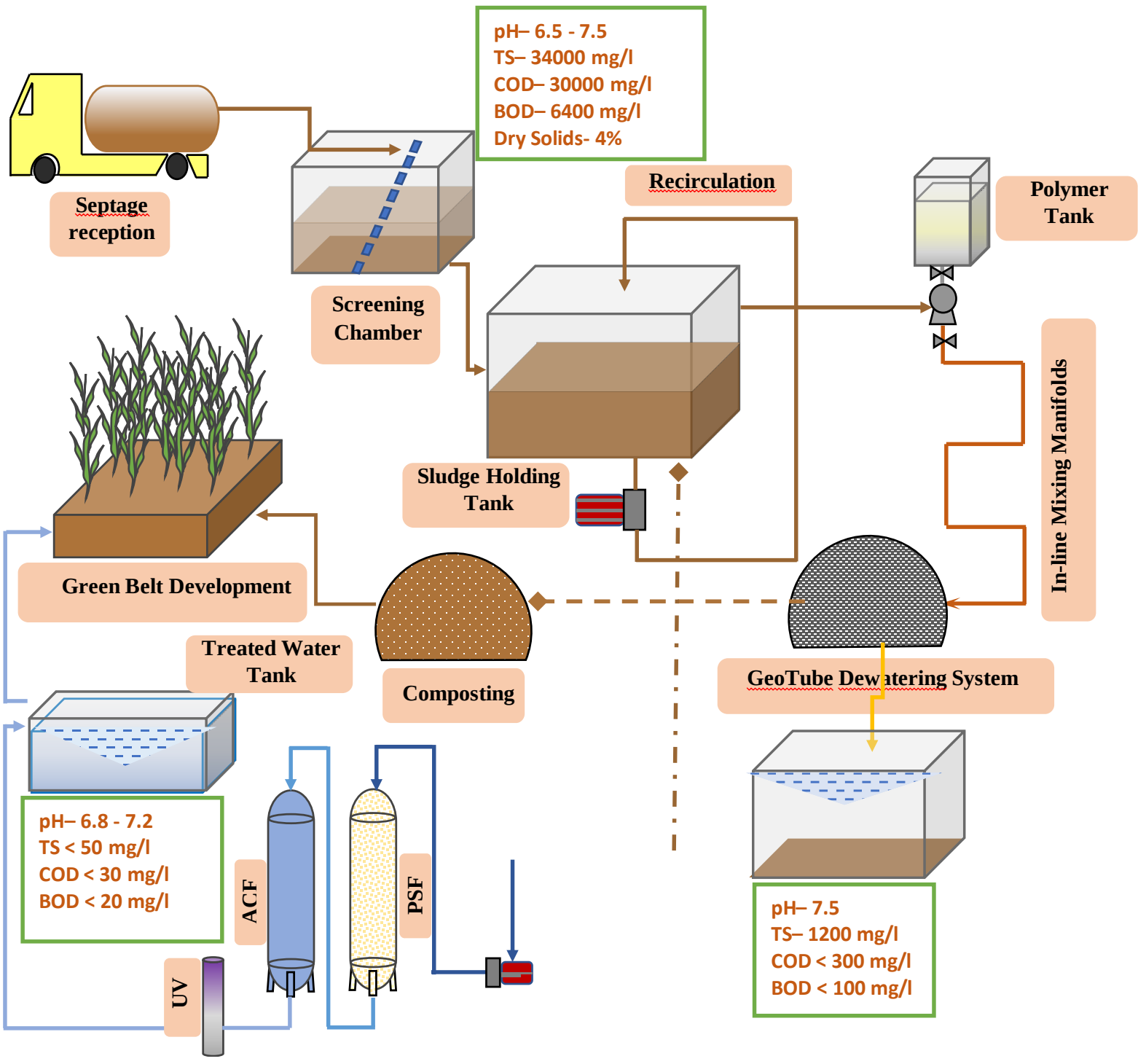


Figure 2: Process Flow Diagram of FSTP

a modular fashion. The sludge holding tank, the water storage tanks were made of Fiber Reinforced Plastic (FRP) in BBL's factories in Hyderabad, and transported to the FSTP site.

Pumps and pipes were procured and with the help of local masons and construction workers, the plant was set up in a span of 60 days. The commissioning was thoroughly checked, and the operation of the FSTP began in October 2018.

SETTING UP OF THE PLANT:

OPERATIONS

Geotubes (procured from TenCate) with a 10 kiloliters/day treatment capacity were used. Principally, a non-mechanical technology is implemented for the dewatering process (solid-liquid separation) of fecal sludge (95-97% water and 3-5% biosolids). Fecal sludge from the onsite sanitation systems (septic tanks or latrine pits) is transported to the FSTP, homogenized, treated with a biopolymer for efficient flocculation, and is pumped into the Geotube. The Polypropylene Geotubes (pore size of 600 nanometers) entrap the solids and ooze out the water which is further treated. Up to 65-70 kiloliters of sludge can be pumped into the bags. Once filled to the maximum capacity, the bags are left for sun-drying for a period of 60 days. The water (leachate) is further passed through a sand filter (to remove residual suspended solids) and an activated carbon filter (for removal of volatile matter/ solids). Finally, the water is passed through an ultraviolet treatment system for disinfection and stored for

	TS (in ppm)	TDS (in ppm)	TSS (in ppm)	pH	EC (mS/ cm)	BOD (mg/L)	COD (mg/L)	TKN (%)	Phosphates (mg/L)	Coliforms (MPN/100 ml)
Sludge	26333.33	8260.87	18237.04	7.17	0.47	106370.5	18835.84	49.88	2.73	1200
Geotube Filtrate	2012.766	1404.25	609.92	7.18	1.65	113.16	165.12	6.67	0.96	550
Final Filtrate	1539.123	1187.23	344.92	7.18	1.51	68.43	123	6.30	0.81	150

Table 1: Reduction of Pollutant Level in Sludge, Geotube Filtrate (Leachate), and Final Filtrate (Recyclable Water)

Sampling Period	Parameter	Biosolids
Samples were Collected after Geotubeswere Opened for Drying and Pulverizing (Jan 2019-Oct 2019) [Average of Samples Collected Shown Here] *mg/kg		
	pH	7.43
	Color	Dark Brown to Black
	Odor	Absence of Any Foul Odor
	Electrical Conductivity	0.87
	C: N Ratio	9.57
	Total Nitrogen (%)	0.93
	Phosphates (%)	1.95
	Metals	
	K_2O (%)	0.03
	Arsenic as As_2O_3*	<0.10
	Cadmium as Cd*	0.3
	Chromium as Cr*	3.58
	Copper as Cu*	101.24
	Mercury as Hg*	<0.10
	Nickel as Ni*	3.24
	Lead as Pb*	2.81
	Zinc as Zn*	201.46
	Total Coliforms (MPN/ 100 ml)	Below 100
	Helminths	0.9 cells/g (No Live Cells or Eggs)
	Viruses i. HCV ii. HPV iii. HIV	Not detected in any sample by RT-PCR

Table 2: Analytical Quality of Dried Biosolids

further use/ recycling. An Indian patent has been applied for the process (Application Number 201941024890), which has cleared the first round of scrutiny and awaits confirmation.

QUALITY ASSURANCE OF TREATED WATER AND REUSE POTENTIAL

Till July 2020, the plant has treated more than 1.5 million liters of fecal sludge, and the treated water suffices the Pollution Control Board (PCB)/ National Green Tribunal (NGT) norms (Table 1) of being recycled/ reused for agriculture/ horticulture purposes.

This water is, primarily, used for green-scaping within the FSTP area (a proposed norm of maintaining 40% greenery within the FSTP premises). The water, rich in nutrients (organic soluble form of Nitrogen and Phosphorus, Figure 1), enhances plants' growth.

After 60 days of sun-drying (dehydration and evaporation), the Geotubes are cut open and the biosolids are crumbled with a shovel for further sun drying for another 7-10 days. The biosolids are, then, pulverized and packed in sacks for distribution, to be used as a soil conditioner.

An analysis of the quality of biosolids with reference to Fertilizer Control Order (FCO) compost standards was done to understand the safety and benefits (Table 2). Based on the laboratory analysis, it was found that the biosolids could be used as a soil conditioner, as they had sound water-holding capacity. They increase the porosity of the soil, they have an appreciable Carbon: Nitrogen (C: N) ratio, along with good organic nitrogen and phosphorus content. Further, these biosolids are of human origin and do not have a high presence of heavy metals, which is well depicted in the results. Absence of pathogens, and more precisely helminth cells/ eggs (live/ dormant) also back up the quality of the dried biosolids.

The biosolids were distributed to the local farmers (10) to be used as a soil conditioner. 515 bags (12,875 kg) of biosolids were distributed. Kakatiya Urban Development Authority (KUDA) took 2,250 kg of biosolids for the healthy propagation of plants/ trees for their Harithaharm projects. After the distribution of biosolids, the experience of farmers was noted through qualitative assessment of the biosolids' usage benefits. The assessment was conducted through closed-ended questionnaires. The farmers had been using the biosolids in their fields at an average of 5.4 kg per sq. ft. Many farmers had used for growing food crops such as rice and maize, vegetables such as chillies, and cash crops such as cotton and fodder grass. It was also sowed in coconut, mango, and lemon orchards. A farmer, also, reported using it for horticulture fields. Most farmers reported observing beneficial effects, both in terms of quantity and quality of the produce. A challenge in the study was that we could not assess the soil quality before or after cropping, because of the distances of the fields. Another challenge in assessing the benefits, purely, of the biosolids was, some farmers reported using it along with conventional inorganic fertilizers. Although farmers who had used them in mango orchards reported no observable benefit.

As stated earlier, the biosolids were distributed among the farmers as well as Urban Local Bodies (ULBs). After being sanguine with the beneficial effects of

their use in agriculture, the farmers as well as ULBs agreed to purchase the biosolids at a nominal and subsidized price. The income from the sales of the biosolids has contributed to the operations' cost of the plant. The Geotube, after drying, pulverizing, has the potential of being shredded, to be used as recyclable plastic material. BBL, alternately, has found several buyers of these used Geotubes, who can use this as a base material for rainwater harvesting. Detailed feedback on the usage of the Geotubes is awaited.

THE IMPLICATIONS

Since the FSTP was developed as a demo/ pilot plant, the operating expenses are borne by BBL. The setting of this demo plant helped bag orders for FSTPs in the states of Telangana and Andhra Pradesh, and BBL is deploying 21 such plants, altogether, in both the states. Additionally, the learnings from this can be developed into strong business models, to develop, and to scale up at the city- and state- levels, encouraging such innovative technologies and private sector participation.

Setting up FSTPs in Andhra Pradesh and Telangana is on Hybrid Annuity Model (HAM). As per HAM, half the capital cost of the FSTPs would be paid to the developers on completion of construction, and the remaining half to be paid over a 10-year period, as annuities along with Operations and Maintenance (O&M) costs. Based on this model, another plant has been completed by BBL, and has been functioning successfully in Rajam, Andhra Pradesh. An important feature of this model is, both the annuity payments and O&M payments are also linked to the performance of the FSTP. This would ensure continued performance of the assets created, leading to higher accountability, responsibility, and optimal performance by the private sector developers.

About the Author

Rajarshi Banerjee *leads the R&D division of* ***Banka BioLoo Ltd****. As a trained microbiologist and human resource management professional, he has been in academia and research for more than two decades. With a knack for developing R&D and training ideal human resources for scientific contribution in the FSM sector, his experience in technical/ scientific nuances of FSM he has been instrumental in setting up the country's first public FSM laboratory at AAETI, Nimli (for CSE, New Delhi). Right now, with his association with BBL, he has developed Chadwick's FSM laboratory in Hyderabad which shall serve not only the purpose of sharing the scientific know-how of FSM but would also focus on developing apt human power in FSM.*

Figure 3: Panoramic/ Wide Angle Views of the FSTP

CHEMICALS, EFFLUENTS, PIPELINES, SEWAGE TRANSPORTATION

INSTALLATION OF 12 KM LONG POLYETHYLENE EFFLUENT PIPELINE OF MARINE OUTFALL PROJECT IN GUJARAT

By Borouge

India is one of the world's global manufacturing hubs for the chemicals and petrochemicals sector. The industrial clusters in this sector generate chemical sewage streams that must be adequately treated before discharge into the sea or river. While the proper treatment of chemical sewage streams is important, the pipelines used for transporting sewage are also crucial and should be robust, leak-free, and with a long lifespan to minimize any environmental risks from potential leakage of hazardous effluents.

In April 2019, India's National Green Tribunal set out strict requirements for plant discharges, which the Supreme Court of India subsequently endorsed in June 2021. These discharge standards are on par or even more stringent than that of many developed nations, sending a clear message that the country is serious about improving the quality of its water bodies.

More than half of India's chemical industry is currently located in its western state of Gujarat. Borouge, a leading petrochemicals company that provides innovative, value-creating plastic solutions, recently collaborated with Sangir Plastics Pvt Ltd and successfully completed a marine outfall project to install a 12-kilometer long polyethylene effluent pipeline for Gujarat Fluorochemicals Limited (GFL) in Dahej, Gujarat.

Gujarat Fluorochemicals Limited (GFL), an Indian chemicals company producing fluoropolymers, fluoro-specialities, refrigerants, and chemicals, commissioned a project that involved the manufacturing, supplying, and laying of marine outfall polyethylene (PE) pipelines to transport treated industrial effluent from the GFL plant in Dahejinto the sea, which is about

KEY TAKEAWAYS

- **Material selection is critical when project pipelines are situated in challenging aquatic environments.**
- **BorSafe™ polyethylene is lighter and has high resistance to corrosion and abrasion versus traditional materials, offering the lowest life-cycle cost.**
- **BorSafe™ polyethylene's leak-proof welded joints can withstand pipeline movements due to tidal waves without snapping.**

Installation of HDPE Pipeline with Concrete Sinker-Blocks to Sink and Secure the Pipeline in the Sea

12 kilometers away. The project also involved a polyethylene diffuser at the end of the outfall discharge pipeline, complete with duckbill valves – a check valve or component used to prevent backflow.

Sangir Plastics Pvt Ltd, a leading manufacturer of piping solutions in India, was selected to deliver this project with a marine installation contractor. As a trusted partner, Sangir Plastics chose Borouge'sBorSafe™ HE3490-LS PE100 material for its reliability to accomplish this task, having used the same PE100 pre-compounded raw material successfully in numerous intake and outfall lines projects for the past 17 years.

Borouge is a leading manufacturer of black pre-compounded PE100 raw materials for large diameter High-Density PE (HDPE) pressure pipes and assures its materials can be used for 50 to 100 years of service life. The same materials have been used in many critical marine intake and outfall lines projects for over 20 years in the past, and they continue to operate efficiently.

To meet the challenges of installing and operating in aquatic environments, HDPE is an environmentally sustainable and cost-effective choice for outfall pipelines because of its advantages such as:

- Lightweight (floats in water) and flexible for ease of installation
- High resistance to corrosion and abrasion for long-term protection of the environment

Sangir Plastics produced the HDPE pipeline required for this project, which

HDPE pipeline weighed down by concrete sinker blocks in the inter-tidal zone

included a nine-kilometer pipeline of 315 millimeters (mm) in diameter, and another three-kilometer pipeline of 280mm in diameter. The last three-kilometer pipeline was installed in the inter-tidal zone – an area where the ocean meets the land between high and low tides.

Due to the extreme tidal situations, the installation of the last three kilometers of pipeline was a major challenge with various hurdles but was eventually successfully completed by Sangir Plastics using a thick pipeline with a Standard Dimension Ratio (SDR) of 9 which is an indication of the high amount of pressure the pipe can handle.

The superior product performance of BorSafe™ HE3490-LS PE100 as well as the expertise and quality assurance offered by Borouge are the reasons Sangir Plastics counts on Borouge as a long-time, trusted partner to succeed in such demanding projects.

Borouge will continue to support the infrastructure industry in India to deliver safe, durable, and reliable piping solutions that create value for the businesses and communities in the country.

About the Contributor

***Borouge** (a joint venture between ADNOC and Borealis) is a leading petrochemicals company that provides innovative plastics solutions for the energy, infrastructure, mobility, packaging, healthcare, and agriculture industries around the world. Following the fourth world-scale expansion of our integrated polyolefins complex in Ruwais, UAE, Borouge will become the world's largest single-site polyolefin complex by 2025, with an overall production capacity of 6.4 million tonnes annually.*

CERAMIC MEMBRANES, EFFLUENTS, ETP, FILTRATION, SLUDGE, STEEL MILL

CERAMIC MEMBRANES FOR EFFICIENT REMOVAL OF OIL & ORGANICS AND HANDLING EFFLUENTS

By SM Chakrapani

BACKGROUND

We are aware that trends in water treatment are oriented towards the use of membranes, either to filter suspended particles, colloids, organic material, bacteria, macromolecules, and even salts.

Hence, membranes cover the separation spectrum according to the size and nature of the pollutants.

Basically, membranes are classified into organic and inorganic membranes.

Organic membranes are usually used for lightly polluted water, as the materials they are made of (e.g. polysulfone, polyamide, PVDF, cellulose, etc.) do not tolerate high concentrations of pollutants or extreme pH or high-temperature values. Polysulfone allows easy manufacturing of membranes, with reproducible properties and controllable size of pores down to 40 nanometers.

Such membranes can be used in applications like hemodialysis, wastewater recovery, food and beverage processing, and gas separation.

Though research has shown that polysulfones are a family of high-performance thermoplastics and that these polymers are known for their toughness and stability at high temperatures, they have failed in practical applications that have a heavy and dense effluent which are discharged at high temperatures, such as in metals and minerals industries.

Inorganic membranes are required for the treatment of complex effluents, and increasingly, we observe ceramic ones being used in various industries, because of their high efficiency, durability, and resistance to the most extreme media.

FRONTAL FILTRATION AND TANGENTIAL FILTRATION

The pressure required to pass the flow through the membrane is called the Trans Membrane Pressure (TMP). The TMP is defined as the membrane pressure gradient or the mean inflow pressure minus the permeate or filtrate pressure. As the filter surface becomes clogged, this parameter has to increase if the process is to continue functioning adequately, until it reaches a limit at which the cleaning process should be started.

This means that the filtration process is considered discontinuous while ensuring that the operating cycle is as long as possible and the cleaning is quick and effective. Therefore, this type of filtration has certain drawbacks but maybe a good solution for many applications, such as for

A Steel Mill (This image is for illustration purpose only, not of the actual plant)

CERAMIC MEMBRANE FEATURES

Ceramic membranes are mainly manufactured with tabular alumina (αAl2O3) and silicon carbide (SiC) at high sintering temperatures (1,800 - 2,000°C).

Although there are also flat membrane models for specific applications, these membranes usually have a tubular shape and different configurations, according to the number of channels within them. Thus, for loaded or higher viscosity effluents, a smaller number of membranes with large channels are usually used; while, for more fluid and less loaded effluents, membranes with more, smaller size channels are used.

The set of membranes to carry out the treatment is housed inside protective stainless steel covers with elastomer joints suitable for the media and for cleaning (usually Viton or PTFE).

The liquid to be filtered is treated beforehand in a pre-filtration/ pre-treatment system to prevent obstruction of the membrane channels. The liquid to be treated is fed through the channels that traverse the membrane longitudinally. The permeate is obtained by passing the liquid through the walls of the channels and collecting it on the outside of the membrane. The concentrate remains in the channels and passes through the recirculation loop.

When applied for effluent treatment in the steel industry, for example, in the permeate, we will get a caustic solution of around 2.8%. Say if the steel manufacturing plant uses a 3% solution, they would require only 0.2% and the balance shall be available in a recovered caustic solution. Besides with smart segregation of effluent streams and application of ceramic membranes, we will be able to recover a significant amount of caustic, which brings in significant savings of several crores of rupees annually. This can also be used in a dense sludge system for pH correction.

PRACTICAL CONSIDERATIONS

Ceramic membrane equipment is very robust and resistant to extremes of temperature, pressure, alkalinity, acidity, and chemical attacks. However, there are some disadvantages too that are to be taken into account and they are as follows:

- **Avoid water hammer and impacts because, although the ceramic membranes are very hard, they are also fragile.**
- **Avoid accidents and valves and instruments that are not strictly necessary in the circulation lines, to avoid load losses resulting in high energy consumption.**
- **Take into account the equipment construction materials when cleaning or performing a treatment (e.g. not working with HF when there are glass electrodes).**
- **Do not stretch the filtration cycles, because then cleaning is more difficult.**
- **The cleaning effluents are usually very contaminated. They should be sent for authorized disposal or concentrated by evaporation and sent to a waste dump suitable for their properties.**
- **The recirculation pump should have a frequency inverter so that it consumes the energy strictly necessary at all times.**
- **When assembling and dismantling the membranes in their casing, special care must be taken to ensure the seals are properly positioned and adjusted.**
- **Due to the nature of the effluents and reagents handled, the safety regulations must be observed by using the appropriate PPE and additional measures necessary.**

concentrating components.

In ceramic membranes, tangential filtration is carried out. Here, the retentate or concentrate is recirculated and becomes part of the supply flow parallel to the membrane through a feedback cycle.

Thus, this type of filtration has working pressure ranges much lower than those of total filtration. Only a small part of the flow will cross the membrane and become permeate (filtered), with most going to the concentrate tank. The chance of clogging in this filtration system is reduced and the formation of the solid film is delayed and reduced. Tangential filtration management can achieve stable flows. However, contamination still occurs and the membranes have to be cleaned, which, in the case of ceramics, involves temperature values oxidants, solvents, and extreme pH.

The Linear Velocity (VL) or tangential flow is the feed flow within the membrane. For a tubular membrane, the linear velocity can be defined as the ratio between the inflow and the inner section of the membrane. The higher the linear velocity, the more deposited material is removed and, consequently, the lower the hydraulic resistance across the membrane leading to more permeate flow. Higher feed rates also reduce the polarization phenomena of the concentration by increasing the mass transfer coefficient.

SCOPE OF APPLICATION OF CERAMIC MEMBRANES

Ceramic membranes have a wide scope of application especially in the food, pharmaceutical, chemical, and petrochemical industries, for metal separation in precipitation processes, in pickling and degreasing baths, for beverages (especially wines and beers), and in metals and mining. They are used as process water pre-treatment for facilities that require very low turbidity values, such as reverse osmosis. In many countries, they are already being used to filter water for use in microelectronics, as drinking water or in the chemical industry.They have a very wide range of applications for wastewater. In addition to obtaining high-quality permeate, they have many advantages over other classic purification processes, e.g. flotation, decantation, and sand filtering which produce significant waste, have a high consumption of reagents (e.g. coagulants, flocculants, and for pH adjustment), widely occupy surfaces and need a lot of manual labor for their maintenance.

In recent years, low-cost membranes have been manufactured that can be used in water treatment at competitive costs.

The main sectors in which these membranes are used are:

- Separation and recovery of cutting fluids, fibers, and additives.
- Recovery and purification of degreasing baths, in the paint industry, of acids and alkalis in the metal industry.
- Separation and recovery of inks, solvents, the concentration of sugar effluents in sugar factories, the concentration of products in the chemical industry, separation and recovery of metals and additives in the electroplating industry.

This type of equipment has a relatively high initial installation cost: as well as the membranes, the recirculation pumping units of significant size are also needed, to achieve adequate tangential speeds to make the process viable. In addition, the materials have to be highly resistant to the media being processed (AISI 316L stainless steel or a higher grade are usually used). However, the expected lifetime of the membranes is very high (> 10 years) and, once the filtration cycles are regulated, they are usually highly reliable, providing few maintenance problems.

RECOVERY OF FILTRATES AND CONCENTRATES

Discharging the most polluting effluents into the environment needs to be minimized, and these are precisely the ones treated with ceramic membranes. The trend is towards so-called “zero liquid discharge”, as there is no better treatment than zero contamination.

There are many cases in the industry where effluent filtering carried out at the indicated level provides filtrates that are

reusable to a greater or lesser extent in the production processes or services of the same company. In addition, the retentate could be reused on many occasions if it had the required concentration and quality, according to the manufacturer's specifications.

The most suitable technologies to achieve these effects without polluting effluent are evaporation and crystallization. High purity distillates are obtained with vacuum evaporation and can often be reused in factory processes. Evaporation temperatures are often around 50°C, and the heat energy from the condensate can be used for other processes via heat exchangers. Concentrates can reach high levels of dryness, as several stages of evaporation can be implemented. To the extent that the concentrates acquire significant recycling, their concentration is more justified if crystallized using specific equipment (crystallizer).

The combination of ceramic membranes with evaporation and crystallization provides a highly evolved and efficient technical solution that, when reused, can be considered more as a production process stage than as waste or effluent treatment. Also, the investment cost of the equipment can be viable within an overall financial study of the factory. The application framework of these solutions is becoming increasingly broader, as technologies are perfected and renewable energies are used.

Equipment Cost

Although a single casing of 99 membranes is more economical than 2 casings of 55, both the recirculation pump unit and the pipes, valves, and fittings are more expensive for the single casing version, as well as the power and electrification panel; so, the cost of both options is quite similar.

Energy Consumption

A flow rate of 1 m^3/h/membrane and a recommended circulation velocity in the membranes of 3.5 m/s gives:

- For 1 casing with 99 membranes: QR = 1 m^3/h/membrane/m/s x 99 membranes x 3.5 m/s = 346.5 m^3/h. Using this flow and, to reduce the pressure drop, a circulation speed in the loop of 1.5-2 m/s is taken, then the diameter of the recirculation loop should be 12". Assuming the minimum number of valves and pipeline accidents, the load loss of the assembly is approx. 12 mwc. Power of the pump motor: Power = (Q x P x 75) / 10000. = (346,5 m^3/h x 12 m.c.a. x75) / 10000 = 31,18 CV) => We take a 40 HP motor and add a frequency inverter.
- For 2 casings of 55 membranes arranged in series: QR = 1 x 55 x 3.5 = 192.5 m^3/h and the recirculation loop would be Ø 8". Under these conditions, the load loss for the 2 casings arranged in series would be approx. 18 mwc and the pump motor power. Power = (192.5 x 18 x 75) / 10000 = 25.98 HP ≥ taking a 30 HP motor. Thus, it is more energy-efficient to use two casings in series

Equipment Flexibility

Although faults are rare in this type of equipment, there may be a leak in a

membrane (e.g. in a seal) or a membrane may burst (much less likely). For 2 casings, we could cancel one and work with the other at half flow, which provides flexibility.

CASE STUDY

Practical implementation of ceramic membranes for efficient removal of oil and organics, handling effluents from the Tandem Cold Mill and alkaline wastewater, and from Roll Shop/ EDT

This is based on project implementation for one of the largest greenfield steel manufacturing units in South-East Asia. Ceramic Membranes were used for the DM plant package, the effluent treatment package, the effluent recycling package, and the cooling tower blow-down treatment package.

Removal of iron, heavy metals, and traces of oil and organics from the dense sludge was achieved using ceramic membranes. A notable achievement was smart segregation of effluent streams which resulted in a recovery of a significant amount of caustic solution of around 2.8% from the permeate. This, in turn, resulted in great annual cost savings in the procurement of enough caustic solutions to prepare a 3% mix for use in the plant.

In this project, three major treatment systems were implemented as follows:

- Effluent treatment plant with recycling Reverse Osmosis plant – RO-1.
- Cooling tower blow-down effluent treatment and recycling unit – RO-2.
- RO Reject handling system – ZLD – RO-3 – is the RO system for treating combined RO Rejects from RO-1 and RO-2.

The following were the treated effluent characteristics at the inlet of the UF: See Table 1.

Moisture Content in Solid Sludge

- Biological Sludge: 70%
- Chemical Sludge: 60%

Reverse Osmosis Parameters - Combined Mix Quality of all ROs with Overall Plant Recovery More Than 95%: See Table 2.

Circulating Water Quality: See Table 3.

Note:

- The cooling tower make-up water quality was equal to or better than raw water quality.
- Chlorides and Alkalinity in cooling tower make-up water were not more than 50 ppm and 100 ppm respectively.

Sl. No.	Parameter	Achieved and Guaranteed for Performance	Unit Of Measurement
1	pH	7 to 8	
2	TSS	< 30	ppm
3	TDS	< 4000 at 25o C	ppm
4	BOD	< 20	ppm
5	COD	< 200	ppm
6	Oil & Grease	< 5	ppm
7	Iron	< 0.2	ppm
8	Chlorides	< 1500 at 25o C	ppm
9	Zinc	< 0.5	ppm
10	Chromium	< 0.5	ppm
11	Chromium as Cr+3	< 0.5	ppm
12	Color	Colorless	
13	Odor	Odorless	

Table 1

Sl. No.	Parameter	Achieved And Guaranteed For Performance	Unit Of Measurement
1	pH	6.5 to 7.5	
2	TDS	< 150	ppm
3	Chlorides	< 40	ppm
4	Iron	BDL	

Table 2

Sl. No.	Parameter	Achieved and Guaranteed for Performance	Unit of Measurement
1	pH	7.0 to 8.2	
2	Conductivity	< 1500	µS/cm
3	TDS	< 900	Ppm
4	Total Hardness	< 400	ppm as $CaCO_3$
5	Total Alkalinity	< 300	ppm as $CaCO_3$
6	Turbidity	< 20	NTU
7	Chlorides	< 150	ppm as Cl
8	Reactive Silica	70	ppm
9	Iron	1	Ppm as Fe
10	Calcium	240	ppm as $CaCO_3$
11	Magnesium	160	Ppm as $MgCO_3$
12	TSS	20	ppm

Table 3

About the Author

***SM Chakrapani** is based in Chennai, Tamil Nadu. He has around 28 years of experience in the areas of BD, sales, and marketing, top-line/ bottom-line management, having exposure to pan India marketing. His specialty is in project/ SPC sales and business development, especially in the water treatment sector. His last assignment was with Wipro Water, a business division of Wipro Infrastructure Engineering, of Wipro Enterprises Group of Companies.*

ECOLOGICAL RESTORATION, LAKE, MUNICIPAL PROJECT, WATER BODY

A SPIRITUAL JOURNEY OF KASHI'S RENAISSANCE: LAHARATARA LAKE REJUVENATION PROJECT

By Madhukar Swayambhu

Laharatara – as the name suggests, "Lahar" means "waves" and "Tara" means "attained salvation", the name itself explains the significance of the lake, where the saint, the poet, the epitome of religious harmony, the institution of spiritual correction – Sant Kabeer was found, floating on a lotus flower as a newborn infant to Neeru and Neema, the couple who adopted him as foster parents.

After Kabir, his followers formed the Kabir Panth, to follow the principles and teachings of the great teacher and master, and the global headquarters of this sect is situated at the same age-old water body, which is believed to be the lake of appearance of Kabir. This is Lahartara lake, the global headquarters of Ancient Kabir Math.

Unfortunately, like Kabir's philosophy of universal brotherhood, today even his lake of appearance was also in great peril due to Gross encroachments, massive urbanization, and excessive sewage dumping. Therefore, NOC Foundation along with NOC & Research took upon this seemingly impossible task for reviving and reinstating the lost glory of the water body as the start point of their campaign for "Resurgence of Kashi" with a program called "REWAMP - Reviving & Reinstating Waterbodies of Archeological Importance". The idea was to resurrect, restore and rejuvenate the native ecology of this historic and spiritual lake of appearance of the Messiah, the legend, the Indian mystic poet and saint called Kabir.

THE SKEPTICISM

The Project team of NOC Foundation along with NOC & Research contemplated with many prevailing technologies of the conventional approaches like physical cleaning with de-weeding, decantation, dredging, and refilling the water, but that had already been done many times in the past and the lake used to return back to its decaying process.

They explored many chemical treatments as well, but NOC & Research being dedicated to the environmental restoration domain, understood the overall negative environmental impact of the chemical treatments, thus left the ideas.

Then came the latest buzz words like bio-remediation, phytoremediation, floating islands, constructed wetland approach, decentralized wastewater treatment (DEWATS) techniques, nano-bubble technology, and so on. They did research on

Figure 1.1: Sludge Deposit can be Seen on the Surface

all these approaches but nothing seemed to be proving sustainable and ecologically viable, since all of them happened to be anthropogenic interventions to the limnology.

They wanted something that was ecological, nature-based, non-invasive as well as sustainable and, thus the research went on and on, searching for the most apt and suitable approach. Like always, a herculean task always receives its share of public wrath and skepticism.

There was a lot of dissuasion and caution warnings given by all the well-wishers around, but the determination of the core team of NOC Foundation, Delhi and NOC & Research, Kashi lead them to reach Vaidic Srijan LLP – the organization that invented the Cownomics™ Technology, based on Vaidic Science for "resurrection of native ecology for wetlands/ water bodies".

They studied this new emerging indigenous technology and their success stories across the country, interacted with the Vaidic Srijan team, took presentations, has brainstorming sessions, invited them for site survey, discussed the possibilities, and evaluated them from all angles for over two quarters. But then finally both the teams of NOC Foundation along with NOC & Research decided to go ahead with Cownomics™ technology.

THE PRE-TREATMENT CONDITIONS

A physical site survey was conducted jointly by teams of NOC Foundation, NOC & Research, and Vaidic Srijan before the launch of the project, wherein there was a lot of interaction done with

THE LAUNCH

On 18th November 2021, at the Old Kabir Math, Lahartara, Kashi, the inaugural symposium for the launch of the city-wide project on building water awareness and abundance in the city of Varanasi was organized. The project was divided in two parts called PAWS and REWAMP, wherein PAWS was "Public Awareness on Water through Symposiums", and REWAMP stood for "Reviving and Reinstating Waterbodies of Archeological Importance".

The organizers of the event were – NOC Foundation, Delhi and NOC & Research, Kashi, while the strategic alliance partners included - UP Pollution Control Board (UPPCB) - for laboratory testing parameters for pollution abetment, Environment Department, Banaras Hindu University (BHU) was an academic partner for carbon sequestration study, Vaidic Srijan LLP Delhi was the technology partner for Cownomics™ technology for the resurrection of native ecology of wetlands and water bodies, Central Ground Water Board (CGWB) was the groundwater impact study partner, Archaeological Survey of India, Uttar Pradesh division was an archaeology and heritage restoration partner since the Lahartara lake was under their jurisdiction, Centre for Ganga River Basin Management & Studies (cGanga) was our study partner for an impact assessment on in-situ rejuvenation, and Central Mine Planning & Design Institute (CMPDI) Ranchi was our strategic alliance partner for hydro-geological impact assessment.

The inaugural session was chaired by Dr. Ram Boojh (CEO Mobius foundation, Stalwart Environmental Scientist and Ex-representative of India to UNESCO for over a decade), and our Hon'ble Chief Guest was Gopal Arya, Sanyojak – Paryaavaran Sanrakshan Gatividhi, (Rashtriya Swayam Sewak Sangh), whereas Dr. Tapan Chakravarty (Veteran Geologist) was our special guest and Padm Shri Anuradha Paudwal, the famous Bollywood playback singer and environmental enthusiast was the celebrity guest, who did the inaugural dosing treatment on 19th November 2021.

Both the events (18th symposium & 19th inaugural dosing treatment) were widely covered by media, in spite of many other programs going on in the city. And a huge population of the vicinity of Lahartara and Madwadih, were quite hopeful of some positive changes in the lake, primarily because they were suffering the most. In spite of so many attempts in past, and even the ongoing beautification attempts from Varanasi Development Authority, the problem in the vicinity were intact - like the massive foul smell in the vicinity, and the enormous mosquito population in neighborhood.

local communities, administration, political leaders, industries, and other social associations. Data was captured from the site and a detailed study was conducted. Following were some of the key observations of the site:

- Varanasi Development Authority was getting beautification work done at the lake, by getting the stair and ghat made. Their contractor was also getting the hyacinths removed physically.

Figure 1.2: Black Water is Observed in the Water Body

Figure 1.3: De-weeding Being Done by the VDA Contractor for Hyacinth Removal

Interacting with the contractor's representative, our team came to know that they had pumped out water too for their construction work.

- Massive sludge deposition was spotted.
- Water was black in color.
- Foul smell was observed, possibly due to the ongoing de-weeding and decantation work.
- Weeds: Hyacinth, Azolla (duckweeds) were observed.
- Insects: Aquatic insects were spotted in the lake. Additionally, a lot of dragonflies were seen hovering over the lake, which means there was substantial feed for them too.
- Mosquitoes: There was a massive population of mosquitoes.
- Sewage: Domestic sewage was coming into the lake from both ends.

THE TREATMENT METHODOLOGY

As the satellite imagery shows in Figure 2, the present leftover remains of the lake is spread over 13.62 acres of area and is all surrounded by a dense population. The encroachment plan is executed to the extent that this remaining part of the lake has already been dissected at four places with the placement of walls in between the water.

And the rejuvenation is supposed to happen in situ conditions. Therefore, the treatment started with 10,000 liters of fresh water from the old Kabir math campus, being poured in the first open segment of five acres, as shown in Figure 2.

Figure 1.4: Azolla, FOG Layer, and Insects, etc can be Spotted in This Image

Figure 3 depicts the exact structure installed at the old Kabir Math, through which the regular dosing treatment is being done on a daily basis, since the inception of the project in November 2021.

Vaidic Srijan team did the detailed site survey and their research team prepared the medicine, which they call the "Cownomics™ Concentrate", which is a liquid medicine made up of 100% botanical extracts.

This concentrate is amalgamated with

Figure 2: Complete Satellite View of Lahar Tara Lake

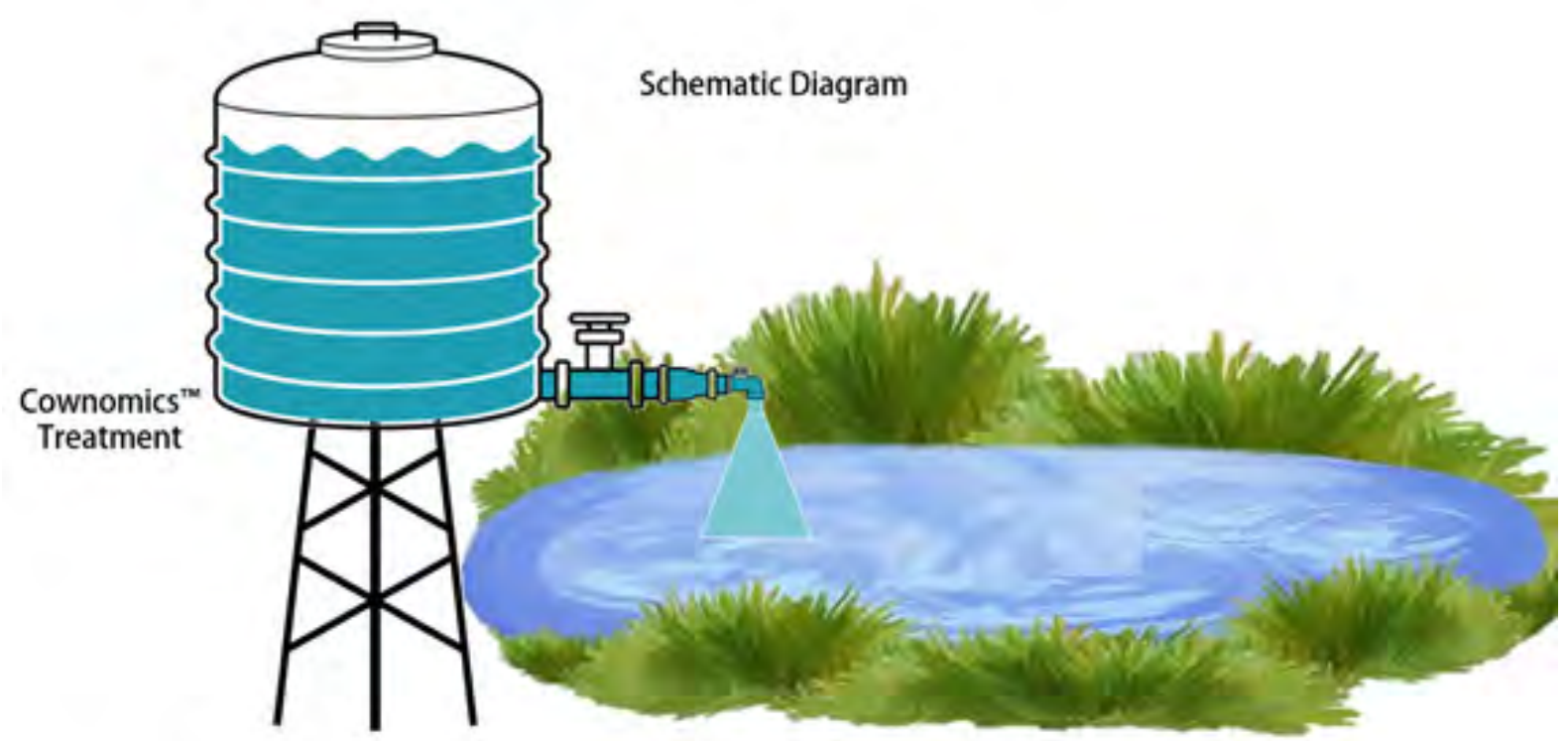


Figure 3: Basic Schematic Diagram for the Rejuvenation Treatment

fresh drinkable water from the same agro-climatic zone as the water body. This homogenous mix of concentrate diluted in fresh water is poured into the water body at the time of sunrise. In presence of sunlight, the medicine gets synthesized in the aqua-ecology and the resurrection of limnology starts to happen. This is the treatment dosing process.

Dosing treatment is done every day for the first quarter (3 months, the resurrection phase). The testing for water, sludge, and air quality monitoring is to be done on a regular basis throughout the project tenure of 12 months, by UPPCB regional office at Varanasi. IIT-BHU shall be conducting the study, after completion of the first quarter, for the amount of carbon

Present Day Rejuvenated Lake

being sequestered by the lake.

Every month the reports given by UPPCB shall be compared to arrive at the efficacy of the treatment.

THE RESULTS

Although the results started showing immediately after the treatment started, the major communication and press release was done for the first time on 18th December 2021, i.e., exactly one month after the launch of the program.

While that was for the complete media community in a holistic and channelized manner, our team's interaction with the local community on a day-to-day basis, in itself, was very gratifying.

Within the first week of the treatment itself, the following was experienced by the community around the lake:

- **Foul Smell Eradication:** Was observable from the third day of dosing.
- **Improvement in Water Viscosity:** The first waves were spotted in about 4-5 days.
- **Increased Transparency:** The water was able to show the bottom by end of the week itself.
- **Mosquito Colonies Abolishment:** By the end of the second week, the mosquito population was substantially reduced.
- By third week, a remarkable improvement in aquatic life was, clearly evident.
- By approximately the 20th day of treatment, flocks of birds returned to the lake.
- In between (around the 15th ~ 20th day) there was a sudden influx of dragonflies around the lake, after which the mosquito population was observably negligible.
- The Water level started receding every day from the first week itself, and by end of the month, it was down almost by 2 feet.

The second event for monitoring the progress of the Laharatara lake rejuvenation project was held in Old Kabir Math, Laharatara on 18th December 2021.

The event was under the chairmanship of Mr. Anupam, Regional Organizational Minister, Bhartiya Majdoor Sangh (UP, Uttaranchal, Delhi, and Nepal). The test reports for pre-treatment and post-treatment, measured and monitored by UP Pollution Control Board, Regional Office, Varanasi were made public during the meeting and the sea change difference in the water quality was reflected in the report. With over 100% improvement in the dissolved oxygen level, the lake water for the first time in recorded history exceeded the levels of river Ganga. A 90% drop in fecal Coliform denotes the improvement in sanitation.

About the Author

***Madhukar Swayambhu** is a TED speaker, awarded by Jal Shakti Mantralaya as Water Hero, having published many articles in various water and environment magazines and given many lectures in national and international institutes including IIPA, NIFTEM, FSM, NEERI, ADRI, etc. He, along with his colleagues in **Vaidic Srijan LLP** have developed an indigenous technology, based on Vaidic Sciences which they call Cownomics® Technology for the resurrection of native ecology of wetlands and water bodies.*

MBR, SCREENING, WILDLIFE SANCTUARY, WWTP

WASTEWATER FINE SCREENING TECHNOLOGY AS FRONT-LINE SAFEGUARD

By CST Wastewater Solutions

Advanced fine screening technology from CST Wastewater Solutions features in a prize-winning wastewater treatment plant project that has transformed the area surrounding it into an environmental wetland wildlife sanctuary and community recreational asset.

CST's internationally applicable horizontal in-channel rotary drum screening technology – designed as the vital first step in processes to curtail environmental spills, maintenance, and associated OH&S issues in Wastewater Treatment Plants (WWTPs) – is used in the $A116.7 million project delivered by a public and private sector partnership involving the Logan Water, Economic Development Queensland, Downer, Cardno and sustainable water infrastructure group WSP.

Logan is one of Queensland's fastest-growing areas. Cedar Grove Environmental Center features the state's first WWTP to benefit the environment through membrane bioreactor technology and constructed wetlands to achieve record low nutrient levels and offsetting remaining nutrients through catchment restoration. A total of 37,000 trees have been planted on the restoration site to offset vegetation removal by developers across Logan. The site is also a center for research and a community recreation reserve.

The project won the Australian Water Association (AWA) Queensland's Infrastructure Project Innovation Award (Metro) at the Queensland Water Awards this year. The award follows the Queensland Australian Engineering Excellence Award win in September and wins in the 'Innovation' and 'Sustainability and Environment' categories at the Institute of Public Works Engineering Australasia Queensland (IPWEAQ) Awards.

CST Wastewater Solutions Managing Director Mr. Michael Bambridge says the Cedar Grove project has transformed a

The project features WWTP headworks designed for easy-installation, high screening efficiency, and low maintenance over diverse municipal and industrial wastewater treatment applications encountered throughout Australasia and globally.

Logan City Council has revealed increasing wildlife populations are flocking to the recently developed wetlands on the site of the Cedar Grove project, in which community and environmental uses occupy 95 percent of the 204-hectare site.The project's Cedar Grove Environmental Centre is open daily to the community along with a 2.5 m walking loop along the Logan River with shaded seating and picnic tables.

sewerage treatment plant from a type of development attracting community concern to one that has become an outstanding community asset.

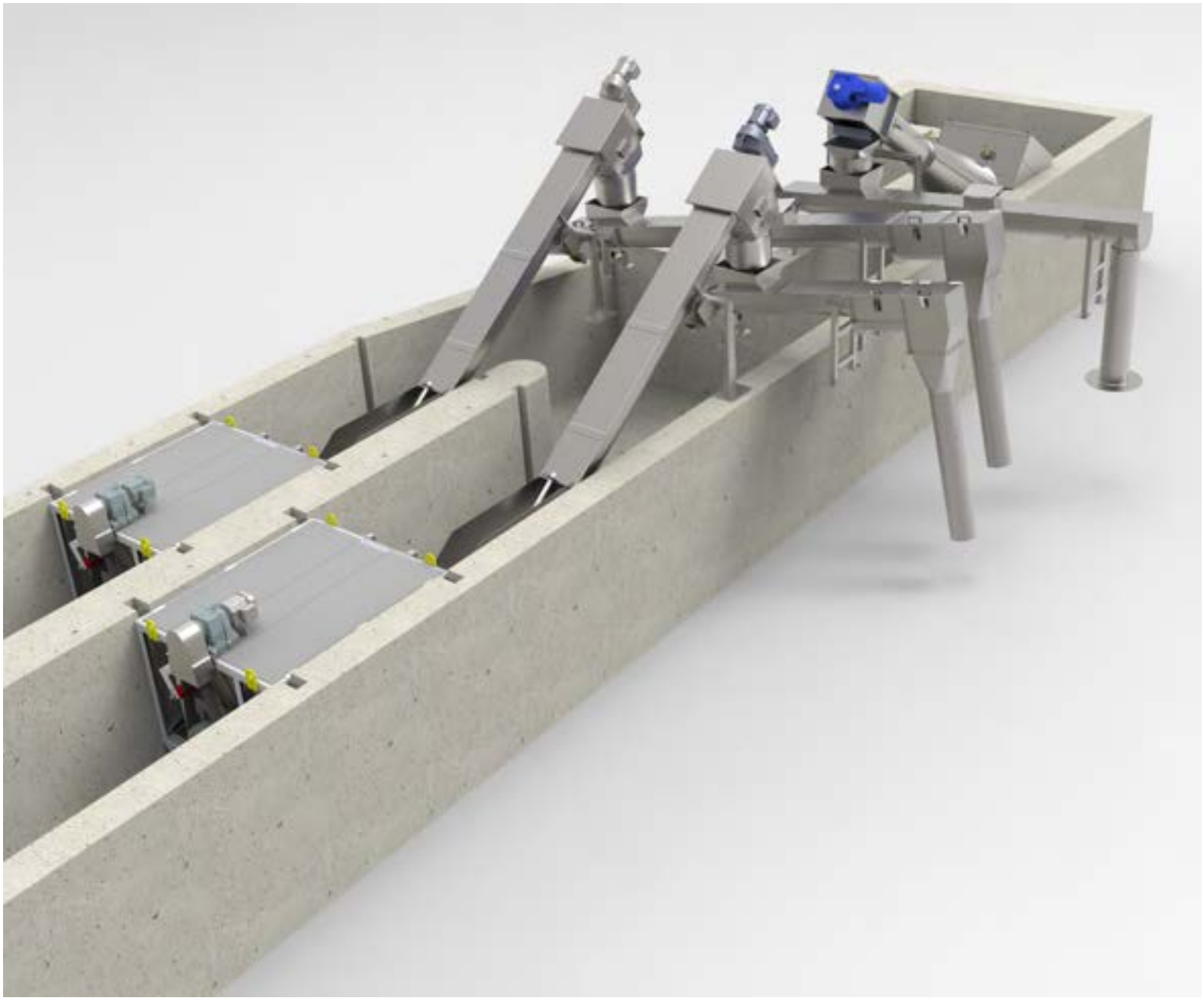
The project features WWTP headworks designed for easy installation, high screening efficiency, and low maintenance over diverse municipal and industrial wastewater treatment applications encountered throughout Australasia and globally.

"Efficient headworks are vital to all the downstream purification and recycling process stages in a wastewater treatment

ADVANTAGES OF HORIZONTAL DRUM DESIGN

"The benefits of an efficient engineering concept and thorough detail engineering have combined to produce very low whole-of-life costs when compared with most other screens, with servicing required only every 4-6 years," says Mike Bambridge.

"These are very important considerations when dealing with local municipal authorities with budget constraints, as well as those with limited engineering resources, to whom ongoing reliability and minimal operating costs and risks are important," said Mr. Bambridge, whose international and regional experience includes both municipal and industrial WWTP engineering and green energy initiatives in partnership with local suppliers.



The clean, low-maintenance fine screening headworks design

plant, regardless of the location and input. Unless solids are efficiently separated out from wastewater at the start of the purification process, you are inviting trouble into the system – and this can cost operators dearly in terms of downtime, environmental risk, clean-up costs, and OH&S hazards for the teams involved," says Mr. Bambridge.

The horizontal in-channel rotary drum screening has already been proven in some of the notoriously variable conditions of its native Australasia, where it has been installed to perform cost-efficiently while curtailing blockages, environmental spills, maintenance, and associated OH&S issues in conditions that can quickly switch from drought to flood, from sandy and stony to muddy and lush.

"We are especially mindful of the fact that many lean and efficient municipalities can't afford the luxury of technologies that need the engineering support that many local bodies don't have on-staff these days. This is the same in Australasia, and the broader Asia-Pacific, where CST has been operating for more than 30 years."

"So we have designed and built our low-maintenance, quality stainless steel technology to provide the simplest but most efficient technology available, proven on multiple MBR plants to perform outstandingly well in the diverse separation tasks of inlet headworks."

"The system is built to be versatile, flexible, and robust because these tasks vary not only from place to place but day-to-day and week-to-week as loads on the system change. As with the Cedar Grove project, efficient headworks are integral to an end-to-end quality engineering process designed for enduring and highly sustainable performance."

About the Contributor

***CST Wastewater Solutions** specializes in the design, construction, and provision of wastewater solutions for the treatment and recycling of industrial wastewater. Its equipment is generally manufactured in Australia and Europe to ISO 9001 and EEC standards of safety and design.*

EFFLUENT, ETP, FISH PROCESSING, FOOD INDUSTRY

AN EFFLUENT TREATMENT PLANT FOR COSMO SEAFOODS IN GHANA

By Econo Services

Cosmo Seafoods has a tuna fish processing plant located at Tema, Ghana.

The factory was under construction and no effluent samples or test results were available when we were invited to quote, only indicative values from the literature were given.

They wanted an ETP to treat 1,500 m^3/day of fish processing effluent from the factory to meet their EPA guidelines.

Fish processing effluent is not as simple as sewage, as everyone would know. One of their constraints was their factory was very closer to the main road leading to the country's main port.

So, in case of any smell, foam, or such issues with the ETP, they would have to face a serious problem from the public and the Government.

Also, their factory producing EU export food item and their office building were located very next to the ETP site and so, they wanted the odor and any impact of microorganisms to be eliminated completely in the surrounding.

Taking all these factors into account, we designed an ETP for them.

The client preferred to do the erection by themselves, as they were building their factory anyway.

We generally recommend RCC keeping in view the cost advantage it brings. They have built the ETP using steel.

Since their fish processing production capacity has not reached 100% capacity, the first phase of commissioning was done only for 500 m^3/day of effluent.

Since our system is modular, we could commission part capacity without impacting the efficiency of operation.

With almost any other technology, the efficiency of operation would have suffered,

The client chose not to do the tertiary treatment as the same is not mandated. If it is done, the treated water could be made even better, esp with respect to Coliforms. The client's engineers who have worked in different ETPs said they had never seen such crystal clear treated water at the time of commissioning or later, in any other fish processing plant's ETP installation.

Ariel View of Pre-Treatment Process

FAICR Reactors

Primary Clarifiers

and the client would have been spending a lot on electricity alone.

Initially, we proposed a scheme of an anaerobic reactor, followed by FAICR, followed by AICR reactor.

But the client did not want an anaerobic reactor due to its minimum 6m height requirement, so we offered chemical additives to coagulate, settle in a clarifier and add an extra stage of FAICR reactor, in the place of an anaerobic reactor.

In the pre-treatment, we gave an oil skimmer (2 of them running parallel) to remove the oil floating in the effluent.

The removed oil is stored in a collection tank for further testing and reusing.

Following the oil skimmer are 2 coagulant tanks for dosing with HCl and Poly Electrolyte to remove the colloidal effluent.

The effluent that comes out of these tanks is then taken to primary clarifiers.

We designed two primary clarifiers of about 8m height and parallel arrangement.

The treated effluent from the clarifier was

Inlet Pipes to the Clarifier

then taken to the FAICR reactor.

For the first phase, we used only one of the two clarifiers.

FAICR is Fluidized Advanced Immobilized Cell Reactor.

Because of the complex nature of the effluent, and also because of the absence of an anaerobic reactor, we included two stages of the FAICR reactor.

In each of the two stages, we included three identical reactors, each of them with the capacity to treat 500 m^3/day of effluent.

A special activated carbon catalyst was added to the FAICR reactors and an air blower was used to aerate the reactors.

For the first phase, we used only one of these three reactors in each stage.

After the FAICR reactor, the final stage of treatment was the AICR (Advanced Immobilised Cell Reactor).

Here again, we provided three Identical reactors with the capacity to handle 500 m^3/day of effluent each. In this again, we

Comparison of Raw Water and Treated Water Samples

S.No.	Parameter	Raw Water	Treated Water
1	BOD (mg/l)	2640	31
2	COD (mg/l)	4280	300
3	TSS (mg/l)	1760	116
4	TDS (mg/l)	1710	1147
5	Oil & Grease (mg/l)	533	<3
6	Total Coliforms (MPN/100ml)	70000	1100

Table 1

added our proprietary activated carbon catalyst and used air blowers to aerate the system.

For the first phase, we used only these three reactors.

The treated water coming out of the AICR was colorless with no visible suspended solids and odor-free and was stored in a treated water tank and finally discharged into the existing drainage line.

The client has plans to reuse the treated water at a later stage.

Table 1 shows the comparison of key raw water and treated water parameters after about a month from the date of commissioning.

About the Contributor

***Econo Services** is a 20+ year-old company, promoting worldwide modern and cost-effective AICR technology, which makes wastewater treatment plants "profit centers" for clients. AICR technology has been successfully implemented in sewage treatment plants and effluent treatment plants in Malaysia, Ghana, Namibia, Sri Lanka, and India, treating some very complex effluents.*

AICR Reactors

GIS, IoT, NRW, WATER LOSS, WATER SUPPLY

ENABLING THRISSUR MUNICIPAL CORPORATION FOR WET (WATER EFFICIENT THRISSUR)

By Esri India

PROJECT SUMMARY

Thrissur Municipal Corporation's Water Efficient Thrissur (WET) is an integration solution of GIS technology with the Internet of Things (IoT) to optimize the water utility management and to provide a data-driven decision support system to reduce the Non-Revenue Water. This solution affords Thrissur the luxury of becoming resilient to future water shocks.

To enable a better overview, less risk, and more reliability in water management, Thirussur corporation used GIS technology as the spine for water management. The technology has proven itself to be an excellent plug-in to pre-existing systems. It is based on the capabilities of Esri's ArcGIS software - an integrated GIS platform that lets users discover, create, use, and share location-based insights, on any device. WET is an authoritative GIS-based repository for the assets and operational data of Thrissur's water supply network which helps efficient decision-making on water network management and its operations. Through the utility network capabilities of Esri ArcGIS with help of IoT Sensors, the Non-Revenue Water and unauthorized connections which has led to pilferage and loss of revenue to TWA have been easily rectified.

CHALLENGES

Thrissur Municipal Corporation was facing many challenges in water distribution. Various studies have consistently revealed Non-Revenue Water (NRW) to be more than 50%. City administrators have had difficulty grappling with the problem because of the hidden and underground nature of water assets.

The other challenges included the unavailability of authoritarian data of under and over-ground assets.

- Faulty meters and absence of smart metering devices
- Inefficient water outage identification and management
- Absence of updated customer and consumption data
- Pilferage, leakage, and poor monitoring of water assets
- Nonexistent customer redressal mechanism
- Unavailability of an integrated platform connecting the distribution management with legacy systems like Customer Information, Outage Management, Meter

HIGHLIGHTS

- **GIS integration helped reduce Thrissur's water loss by providing a Data-Driven Decision Support System.**
- **An efficient outage management and workforce management system enhanced the operational efficiency.**
- **Dashboards provided an interactive visual platform to analyze maintenance requests.**
- **GIS layers added richness to the data by improving queries through attributes.**
- **Water network simulation enabled authorities to ensure uninterrupted water supply to the consumers in Thrissur city.**

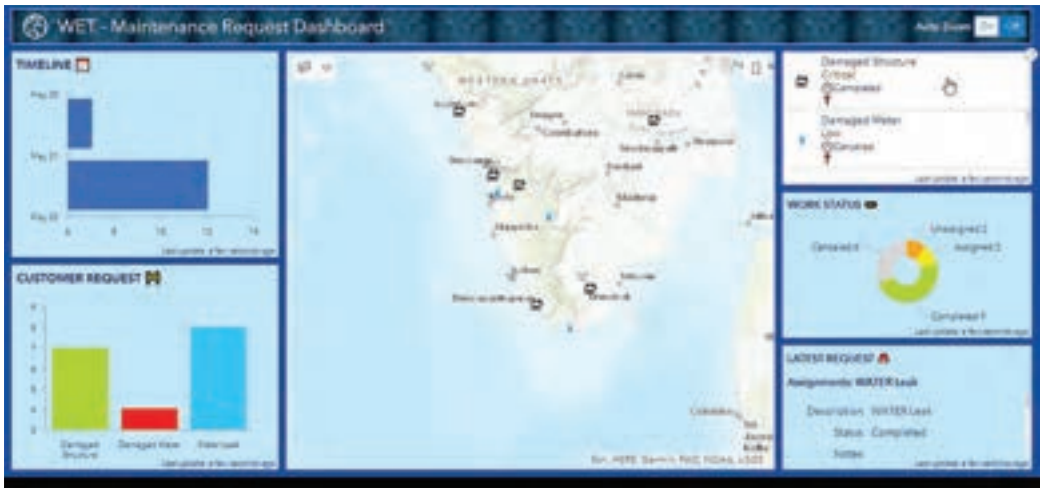
Data Management, and Workflow Management.

Thrissur Municipal Corporation needed a solution that could equip public water supply, especially within the old municipal area of Thrissur, with the most modern systems. One of the main objectives of this project was to reduce public water loss by bringing Non-Revenue Water below 15%.

SOLUTION

The solution uses GIS and is based on the capabilities of Esri ArcGIS software - an integrated GIS platform that lets users discover, create, use, and share location-based insights, on any device. It has mapped asset data such as pipes, valves, hydrants, meters, and other network features, as well as operational data such as pressure zones, work routes, main breaks, and inspection locations.

- **A Central Repository of Water Pipelines and Consumer Networks:** GPR, Drone, GPS, DGPS, and ground-based asset surveys helped build an authoritative network of supply pipelines.
- **Water Meters:** Smart meters at critical network junctions access pipeline flow. Meters log any drop in water flow; smart utility applications use IoT and sensors to determine pipeline fractures quickly. Such deviations are updated live into central repository, alerting municipal authorities to the possibility of water loss.
- **Customer Redressal and Billing System:** Hand-held equipment like



WET Maintenence Request Dashboard

POS machines make on-the-spot billing and on-site logging of repairs a reality. GIS system integration with flow-meter reading, billing, and complaint redressal helps identify Non-Revenue Water at the neighborhood scale. An online portal registers consumer complaints and escalates pending complaints periodically to higher authorities.

- **Outage Management System:** Dashboards provide a view of leaks and outage management. They also help trace and isolate leaks so that they do not disrupt the network, or citizen routines.
- **Hydraulic Modeling:** GIS predictive analytics power WET to estimate and ensure the feasibility of new user connections, based on existing consumption loads, water pressure, and other parameters.
- **Mobile applications:** Are helping notify maintenance crews of maintenance work. A Water Service Assignment platform connects supervisors to their crew and enables them to communicate field assignments promptly and effectively.

Benefits

GIS system integration helped reduce Thrissur's water loss by striking at the root of the problem.

- Incorporation of various technologies like GIS, IoT Analytics, and administrative applications like Billing Systems, Customer Feedback System helped in reducing the NRW by providing a Data-Driven Decision Support System.
- An efficient outage management and workforce management system enhances operational efficiency by reducing the response time to attend to any disruption/ customer grievance.
- Dashboards provide an interactive visual platform to analyze maintenance requests. Map views, timelines, and pie charts communicate data to citizens in the simplest formats.
- GIS layers add richness to the data by improving queries through attributes.
- A geo-tagged digital database ensures that maintenance and future updates to the water network are proactive, and not piecemeal.
- Water network simulation enables authorities to ensure uninterrupted water supply to the consumers in Thrissur city.
- Most importantly, the WET Project pushes for accountable governance. It provides authorities with the tools to visualize and assess where they stand, in terms of water supply infrastructure. It gives citizens an interactive platform to air their grievances. Simple graphics and processes make the platform accessible to everyone, sans barriers of age or ability. It allows authorities to take charge of their assets and respond to how their city is growing.

Workforce Dashboard

Organization Profile

Thrissur municipal corporation came into being on 2nd October 2000 with a total area of 101.42 sq km. The total population of Thrissur Corporation in 2001 was 317474 consisting of 154188 males and 163286 females. The total number of households in the city is 66827 and the sex ratio is 1092/1000 males.

According to census 2001, the average population density is 2868 persons per sq km. In the central area of the town, the population density is as high as 3130 persons per sq km, while it is 1458 persons in the outer fringes of the city.

About the Contributor

***Esri India** is a leading end-to-end Geographic Information Systems (GIS) software and solutions provider. Since 1996, it has been leading various initiatives in the industry resulting in the growth and adoption of GIS technology solutions by the government, businesses, academia, and NGOs in India.*

INDUSTRIAL PUMPS, LANDFILL, WATER LEACHATE

AS CITIES GROW, SO DOES THEIR WASTE – AND HIGHLY POTENT WATER LEACHATE

By Grundfos Holding A/S

THE SITUATION

Shenyang, China, a city of around 8 million people, is mostly flat. But just north of the city in Daxing, a mountain rises from the plains. This is a mountain of rubbish, supplied by the city's residents. It is one of two landfills that serve the municipality. As the city grows, the landfill grows with it – along with the corresponding environmental challenges.

Every day, garbage trucks bring about 3500 tonnes of rubbish to the landfill from Shenyang. Some of the garbage contains liquids. Rain and snow add more. All of this seeps to the bottom of the landfill pit, where it is collected into a water leachate accumulation pond for treatment.

The treatment system was built and operated by Jiangsu WELLE Environmental Company. WELLE is one of the top companies in China specializing in research, engineering, and processing of domestic and organic waste. WELLE's on-site Programme Manager, Xu Chuang, participated in the design and construction of the Daxing landfill. He says Chinese municipalities and treatment companies are facing ever tougher challenges. The first one is urban growth.

IN BRIEF

- **Topic: Landfill Water Leachate Treatment**
- **Location: Shenyang, China**
- **Company: Jiangsu Welle Environmental Company**

PRODUCT SUPPLIED

Grundfos has supplied a full range of industrial pumps to WELLE for the Daxing landfill leachate water treatment.

"Increased urban population increases the amount of domestic waste," says Xu Chuang. "So the amount of leachate also increases.

We have to operate at full capacity to meet the standards for discharge water. Further, those standards are getting stricter. So, the requirements for technology are getting higher. If the equipment fails, our output is greatly affected."

The leachate processing system works like this: WELLE pumps the leachate water into a regulating pond, where it settles.

Xu Chuang, Programme Manager of WELLE, says the standards for treating landfill water leachate are getting stricter, so the technical requirements are getting higher. "That's why we use Grundfos pumps," he says.

The deep membrane treatment facility for leachate water at the Daxing landfill for Shenyang, with Operations Manager Zhang Shuai of WELLE.

"Grundfos pumps are very adaptable when it comes to high-potency waste leachate." - Xu Chuang, Programme Manager, Jiangsu WELLE Environmental Co."

Just a few of many Grundfos pumps (these are CRN and CMs) in the WELLE membrane treatment facility.

The Daxing landfill, with Shenyang city in the background.

The membrane treatment facility at WELLE's leachate processing plant north of Shenyang.

From there, it goes into a biochemical reactor system for processing. From there, it goes through a deep membrane treatment. When it meets the standards, it is discharged.

THE SOLUTION

"This landfill is under a lot of pressure," says Xu Chuang. "WELLE requires its equipment to be stable. That's why we are using Grundfos pumps."

The Daxing treatment plant uses a range of Grundfos industrial and water treatment pumps – from heavy-duty, multistage CRN pumps to NKG and NBG end-suction pumps to BM high-pressure booster modules.

"We have cooperated with Grundfos for more than 10 years. Grundfos pumps are very adaptable when it comes to high potency waste leachate," says Xu Chuang. "The pumps are very reliable in operation. And Grundfos offers a very timely after-sales service. This ensures stable operation of our systems."

Plant Operations Manager Zhang Shuai adds that there are very few breakdowns during operation. "Operation is very stable," he says. "And the Grundfos equipment is easy to use. It's very easy to understand."

THE OUTCOME

Xu Chaung says that the treated water from the Daxing landfill meets both the strict provincial and national standards. "The treated water can be discharged directly," he says. "Some of the water is reused."

He says that to him it is quite obvious why WELLE and Grundfos have cooperated for so many years. "We have a common philosophy. Both companies want to protect the earth and create more sustainable development."

He says he feels proud to be doing his small part in caring for the environment at the Daxing landfill. "This kind of work is very dirty, hard, and exhausting. But I love my job. Because I'm making a contribution to environmental protection."

About the Contributor

Grundfos, *as a global pump and water solutions company, provides expertise in energy- and water-efficient solutions and systems for a wide range of applications, including water utility, water treatment, industries, and buildings.*

INDUSTRIAL WASTEWATER, RECYCLING, SEMICONDUCTORS, SOFTWARE

EVALUATION OF WATER RECYCLING OPTIONS AT A SEMICONDUCTOR FABRICATION PLANT USING PROCESS SIMULATION

By Amir Mustafa and Demetri Petrides

INTRODUCTION

Water is essential for life as well as industrial growth. In industry, water plays a variety of roles as a cleaning agent, cooling/heating medium, reaction solvent, etc. In the process industries, heavy users of water include the following sectors: oil refining, petrochemicals, specialty chemicals, pulp and paper, electric utilities, food and beverages, mining, etc. The electronics industry uses large amounts of highly purified rinse water to produce circuit boards and semiconductors.

As "good quality" water is increasingly a scarce resource and wastewater treatment costs rise, the once-through use of industrial water is becoming uneconomical and environmentally unacceptable. Instead, recovery and recycling of industrial wastewater are becoming more attractive from both an economic and environmental perspective. Industrial wastewater recycling can result in substantial savings through reduced wastewater disposal costs and city water requirements. Further, it improves the environmental image of a company in the surrounding communities.

The design and operation of industrial and municipal wastewater treatment and recycling processes, however, presents a number of engineering challenges for several reasons:

- The composition of wastewaters varies widely.
- A wide variety of technologies are available for treating and purifying water. Each technology is suitable for certain tasks.
- A large manufacturing facility (e.g., a petrochemical complex) may generate hundreds or even thousands of wastewater streams (of different compositions) and may have needs for different qualities of feed water.

To address the need for efficient design, evaluation, and operation of integrated wastewater treatment and recycling processes, engineers at Intelligen, Inc. (Scotch Plains, NJ) in collaboration with Lucent Technologies (Murray Hill, NJ) have expanded the scope of a software tool called SuperPro Designer®. SuperPro Designer® is a comprehensive process simulator that facilitates modeling, evaluation, and optimization of a wide variety of chemical, pharmaceutical, food, and related processes. The expanded version (also available as EnviroPro) can,

Semiconductor Manufacturing (This image is for illustration purpose only, not of the actual plant or process)

in addition, handle water purification, wastewater treatment, and air pollution control processes and enables engineers to design and evaluate zero-discharge plants. The development of these new features in SuperPro was funded in part

PROCESS SIMULATION

The simulation engine of SuperPro helps users analyze and evaluate integrated processes for water purification, wastewater treatment, air pollution control, and chemical manufacturing processes. Flowsheets can consist of any number of unit procedures, material streams, and chemical components.

SuperPro performs material balances on individual components and, based on stream composition and contribution factors, estimates collective stream properties, such as TDS, TOC, CaCO3 (hardness), BOD, COD, etc., Contribution factors for such properties as TOC, COD, CaCO3 are calculated based on the elemental composition of various components. Contribution factors for such properties as BOD, which cannot be calculated based on the first principles of thermodynamics, are retrieved from the component database or provided by the user based on experimental data. This feature allows users to track the fate of individual hazardous chemicals in integrated water purification and wastewater treatment processes. Information about water hardness expressed in CaCO3 is used in water purification processes for sizing Ion Exchange columns and characterizing the purity of water.

For an integrated water purification and/or wastewater treatment process, SuperPro calculates the purchase cost of equipment, the fixed capital investment, the annual operating cost, and carries out a thorough economic evaluation. An illustrative case study that demonstrates how SuperPro can be used in practice is presented here.

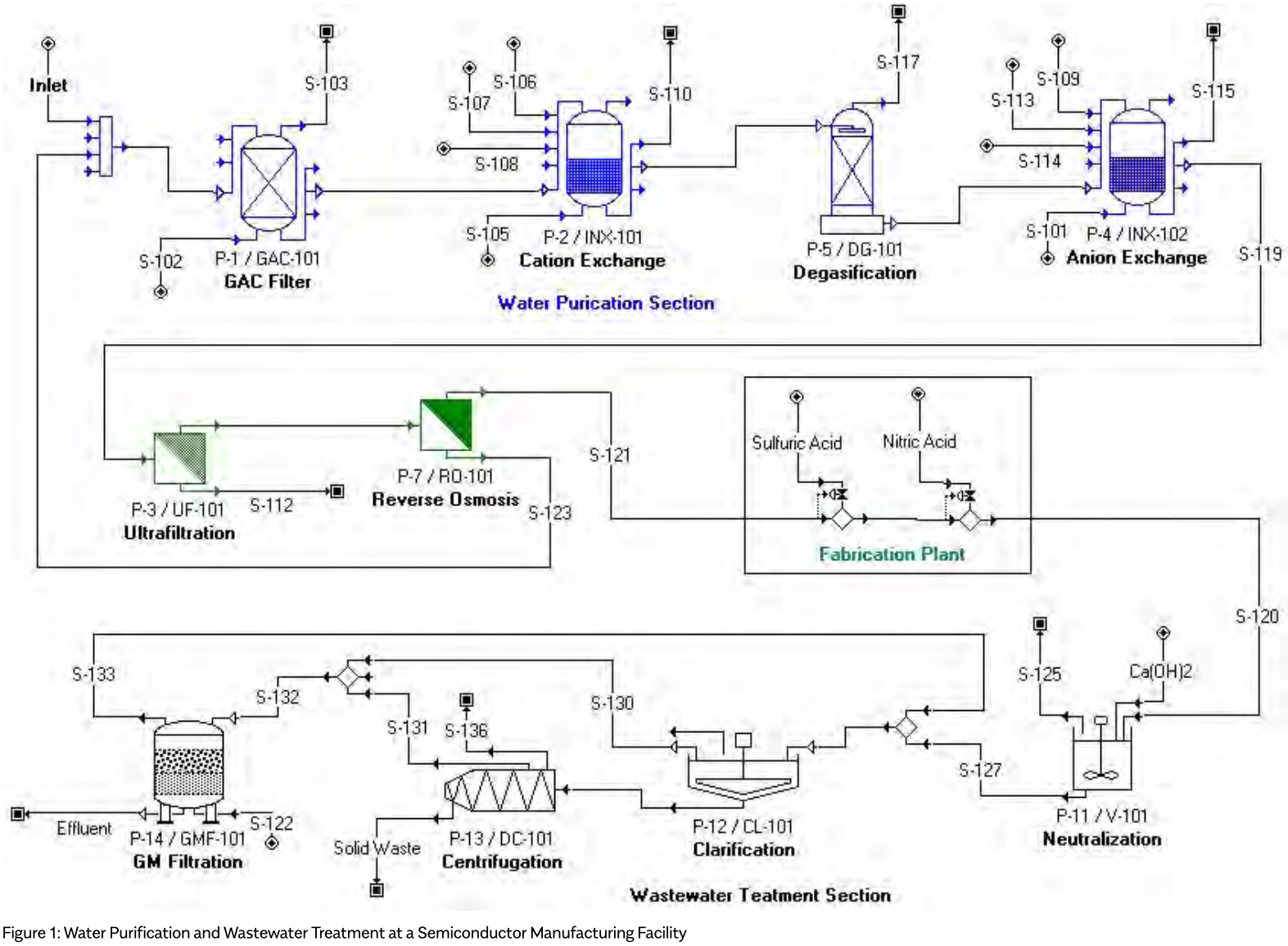


Figure 1: Water Purification and Wastewater Treatment at a Semiconductor Manufacturing Facility

by Lucent Technologies with the objective of developing a standard tool that will facilitate water recycling efforts at their semiconductor fabrication plants.

SuperPro can handle equally well biological as well as physical treatment of wastewater and it is equipped with models for all water purification unit operations. Besides water recycling applications, SuperPro can be used to calculate Volatile Organic Compound (VOC) emissions from manufacturing (batch as well as continuous) facilities and treatment plants (secondary emissions). Further, it can be used to predict the fate of hazardous chemicals (e.g., heavy metals and VOCs) in integrated environmental processes. This is particularly important for industrial wastes because the U.S. Environmental Protection Agency (EPA) regulates the amount and concentration of discharged priority pollutants (various organic chemicals, heavy metals, and ions).

CASE STUDY

This case study deals with generic water purification and wastewater treatment plant that is associated with a semiconductor manufacturing facility. It processes 500 m^3/h (around 2,200 GPM) of city water and produces 470 m^3/h of purified water for use in the fabrication plant. Figure 1 shows the flowsheet of the overall process. The total solids content of the inlet stream is around 225 PPM.

PROCESS DESCRIPTION

City water (Inlet) is combined with the concentrate of the RO unit and sent to a granular activated carbon filter to remove organic compounds (expressed as TOC) and a fraction of the particulate components. Next, a cation exchange column is used to remove metal ions (e.g., Na^+, K^+, Ca^{+2}, Mg^{+2}, etc).

In the purified water stream, the metal ions are substituted by hydrogen ions. The enrichment of the treated water with hydrogen ions (its acidification) converts the bicarbonate and carbonate ions to carbonic acid. The acid decomposes readily to release carbon dioxide.

$$H^+ + CO_3^{-2} \leftrightarrow HCO_3^-$$
$$H^+ + HCO_3^- \leftrightarrow H_2CO_3$$
$$H_2CO_3 \leftrightarrow H_2O + CO_2$$

Most of the generated CO_2 is removed using a vacuum degasifier. Next an anion exchange column is used to remove negatively charged ions (e.g., Cl^-, NO_3^-, SO_4^{-2}, CO_3^{-2}, HCO_3^-, etc.). For simplicity, these are represented by the Anion-Hardness and Anion-Other components.

A set of ultrafiltration units are used to remove any particulate components

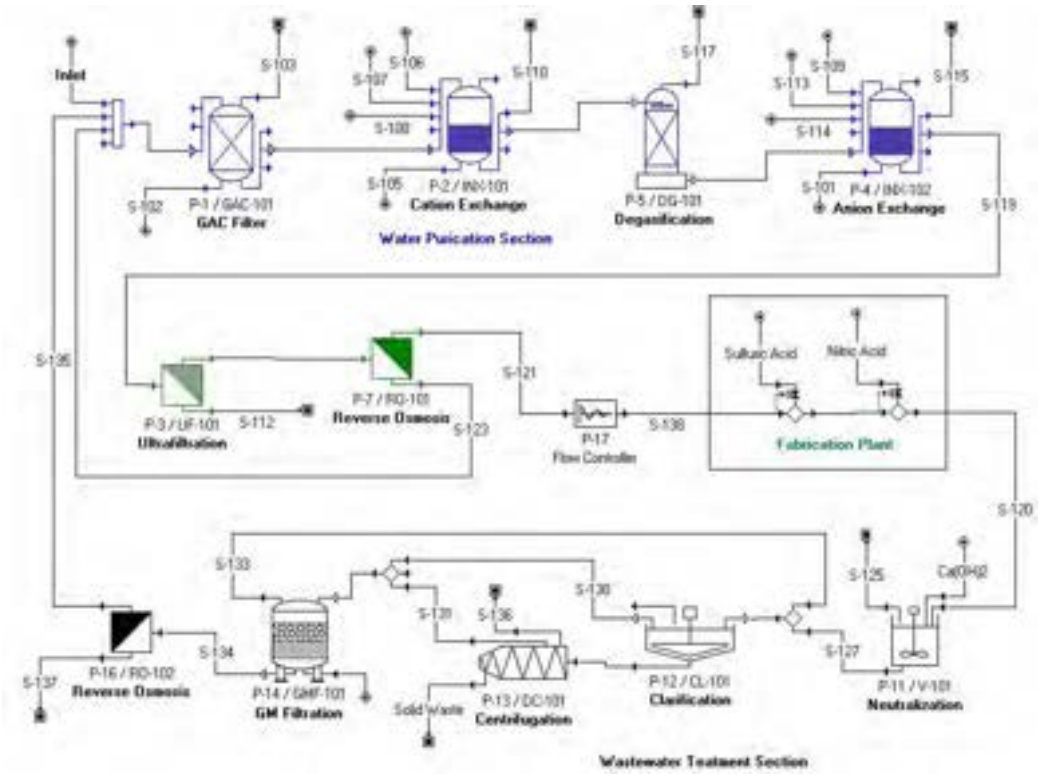


Figure 2: Water Purification and Wastewater Treatment with Wastewater Recycling

and a small fraction of TOC. A recovery of 95% was assumed, which means that 95% of the feed water goes through the membrane. A set of reverse osmosis units are used to remove ionic species and remaining particulate components. A recovery of 95% was assumed for this membrane filtration step. The concentrate of the RO units is recycled back to the beginning of the process.

Two custom mixers are used to represent the contamination of the purified water in the fabrication plant. The first represents the contamination by sulfuric acid and the second the contamination by nitric acid. The custom mixers offer a convenient way to calculate the flow rate of an added contaminant by specifying its concentration in the outlet stream.

To treat the wastewater which is generated by the fabrication plant. First, the acidic stream is neutralized using a solution of $Ca(OH)_2$. The salts that precipitate are removed using a clarifier and further concentrated using a decanter centrifuge The clarified streams are combined and sent to a granular media filter for polishing. The final effluent is discharged into the network of a POTW. The backwash stream is sent back to the clarifier.

The recovery of the overall system is almost 95%. In other words, almost 95% of the feed water is sent to the fabrication plant as purified water. The remaining exits the system as the reject of the UF unit. The total averaged flow rate of the cleaning solutions in these two sections is around 12,500 L/h. More than 99% of that is used for washing and regenerating the two ion-exchange columns.

The neutralization step generates 13,416 kg/h of $CaSO_4$ (Gypsum) and 315 kg/h $Ca(NO_3)_2$. Due to the low solubility of $CaSO_4$ (less than 2 g/L), more than 96% of the formed $CaSO_4$ precipitates and is removed using a clarifier. The formed $Ca(NO_3)_2$ is highly soluble in water and remains in solution. The amount of sludge (Solid Waste) generated by the decanter centrifuge is around 25,250 kg/h. The final effluent has a total hardness of around 3,890 mg $CaCO_3$ per liter.

PROCESS MODIFICATIONS

To minimize the amount of city water as well as the amount of disposed wastewater of the plant, it was decided to evaluate options for recycling most of the treated effluent. Figure 2 shows the modified flowsheet. A second RO step was used to remove around 95% of the dissolved solids from the treated effluent. The permeate of the RO unit, which is around 85% of the feed, is sent back to the main inlet of the water purification section. For a constant flow to the fabrication plant of 473,500 L/h, the recycling of the treated wastewater reduces the inlet flow rate of city water from 500,000 L/h to 96,000 L/h (80.8% reduction) and the amount of effluent wastewater from 475,350 L/h to 71,280 L/h (85% reduction). The flow rate of the purified water that is fed to the fabrication plant is maintained constant using a flow controller.

Besides the requirement for additional RO units, the recycling of wastewater results in a 60% increase in the regeneration frequency of the ion exchange columns. SuperPro was used to evaluate the process modifications from an economic point of view.

A summary of the results is shown in Table 1. Key assumptions made for the modeling and economic evaluation include:

- Purchasing price of city water = \$0.5/m^3 for city water

Cost Item	Initial Plant ($1000/Year)	Modified Plant ($1000/Year)
Raw Material	4,581	3,226
Equipment	10,628	13,682
Labor	990	1,318
Consumables	595	779
Lab/QC/QA	148	198
Waste Trtm/Disp	8,071	4,899
Utilities	3,459	6,534
Total Oper. Cost	28,472	30,636
Unit Cost ($/$m^3$)	7.6	8.2
Total Capital Investment	\$60 million	\$77 million

Table 1: Operating Cost Summary (Year 2000 Prices)

- Average disposal cost of wastewater = $1/m^3
- Average disposal cost of sludge = $20/metric ton
- Entire fixed capital investment was depreciated over a period of ten years
- UF membranes that treat purified water have an average flux of 30 L/m^2 - h, and are replaced every 20,000 hours
- RO membranes that treat purified water have an average flux of 20 L/m^2 - h, and are replaced every 35,500 hours
- RO membranes that treat wastewater effluent have an average flux of 13 L/m^2 - h, and are replaced every 20,000 hours
- Ion exchange resin is replaced every 20,000 hours
- Resin unit cost is $1.5/L and $4.5/L for cation and anion resins, respectively
- Unit cost of RO membranes is $15/m^2 (this contributes to the consumables cost)
- Unit cost of UF membranes is $60/m^2 (this contributes to the consumables cost)
- Equipment-dependent operating cost includes the depreciation and maintenance of the facility.

Recycling reduces the cost of raw materials and waste disposal but results in increased equipment-dependent operating costs. This cost covers the depreciation and maintenance of the facility and goes up by around 29% because of the cost of the second set of RO units. The cost of utilities also increases because of the additional power consumed by the RO units.

At a first glance, it appears that recycling wastewater is not an attractive process modification since it increases the unit cost of purified water by 7.9% (from $7.6/m^3 to $8.2/m^3). This conclusion, however, can be readily reversed with a modest increase (of around 20%) in the unit cost of city water and wastewater disposal.

In addition to potential future financial benefits, the main selling point of wastewater recycling in such a facility is the reduced dependency of the company on the supply of city water and the improved public image of the facility in the eyes of the surrounding communities.

CONCLUSION

In the first part of this case study, we discussed the role that process simulation can play in facilitating the recycling and reuse of industrial and municipal wastewater. We also presented the features of SuperPro Designer, a comprehensive process simulator that can be used to model, evaluate, and optimize water purification, wastewater treatment, air pollution control, and a wide variety of chemical manufacturing processes.

A water recycling effort in a semiconductor manufacturing facility was analyzed in the second part of the paper to illustrate the process of developing a simulation model and the potential benefits stemming from it Based on the assumptions made in the example, we concluded that the reduced dependency on city water supply and the improvement in the company's public image would be the main benefits of a water recycling effort. With a modest increase (of around 20%) in the unit cost of city water and wastewater disposal, a water recycling effort would become attractive even from an economic point of view.

About the Authors

Amir Mustafa *is working as a sales and applications engineer at* ***Intelligen, Inc.,*** *an engineering software company that develops and markets simulation and design tools for the process manufacturing, water purification, and wastewater treatment industries. He has over 15 years of experience in sales, support, and training for various process simulation and modeling tools for chemical, biochemical, wastewater treatment, and related processes. Amir Mustafa holds a B.Tech degree from Aligarh Muslim University in Chemical Engineering.*

Dr. Demetri Petrides *is the president of Intelligen, Inc., an engineering software company that develops and markets simulation and design tools for the process manufacturing, water purification, and wastewater treatment industries. He has extensive experience in modeling and optimizing biochemical, water purification, wastewater treatment, and related processes. Dr. Petrides holds a B.S. from National Technical Univ. of Athens (Greece) and a Ph.D. from MIT, both in chemical engineering.*

A detailed version of this case study is also available for download on the literature section of the Intelligen Inc. website.

DRINKING WATER, IoT, WATER ATM

WATER ON WHEELS

By JanaJal

THE CHALLENGES

Recent data from the Central Ground Water Board (CGWB) shows the water level has been depleting in Noida at an average rate of 1.5 meters every year for the past five years leading to a severe water crisis. Municipal water is also unable to cater to growing demands.

In view of lack of awareness about the water crisis, developing a mechanism to communicate and spread WASH (Water, Sanitation, and Hygiene) related awareness and information at specific target locations also becomes important.

Smart water stations (JanaJal Water ATM) and decentralized water delivery via tech-enabled three-wheel vehicles (JanaJal WOW) evolved in response to the need for interventions to address the serious water problems, which had silently existed among us for several decades now.

As observed, in semi-urban and remote areas there are very limited water sources and people draw their daily drinking water from unsafe and unhygienic water points. Hence, the shift from a traditional to a

JANAJAL WOW

JanaJal WOW is an IoT-based environment-friendly three-wheeler that operates on clean fuel to deliver safe drinking in every home in Ola/Uber manner. Effective use of IoT technology backed by JJSUITE tech platform made it attractive for all stakeholders as well as beneficiaries who now have ease of access to quantitative and qualitative data.

The development of the JanaJal WOW (Water on Wheels) which is considered as the ideal tool for delivery of safe water to the doorstep of households not only enhances the capacity utilization of every water ATM but also causes behavioral change and adoption of safe water as an integral part of daily survival of communities.

JanaJal WOW is one of the five innovative technology approved by the Ministry of Drinking Water for implementation under Jal Jeevan Mission across India to ensure HarGharJal.

JanaJal WOW Delivery

technology-driven approach had a massive community-based impact on people.

BENEFICIARY SUCCESS STORY

The proactive use of responsible technology to create a positive impact can be seen, as highlighted for 13-year old, Yash. A resident of Noida Sector 45, he has been regularly consuming safe drinking water from JanaJal WOW for the last two months. With the onset of the Covid pandemic, Yash was desperately looking for safer and economical alternatives to drinking water, which was previously sourced from a local water filling station. He was introduced to the safe water point (JanaJal Water ATM) and JanaJal WOW by one of his friends, since then Yash and his family have regularly been ordering safe drinking water to be delivered at his doorsteps.

He has continued to benefit, not only because the water much is more economical as compared to the other sources, but has also benefited his uncle who is a severe asthma patient and has observed a marked improvement in health and vitality since their family started consuming water from JanaJal. His family found the water to be safer than the traditional bore-well water that other suppliers tend to provide. Additionally, the need to boil water has also been eliminated due to the pre-filtered high-quality water which is periodically tested at NABL accredited lab on a periodic basis.

As mentioned, Yash has not only saved money per canister water purchased but his domestic gas and electricity bills have also gone down significantly due to decreased


JANAJAL
WELCOMES YOU TO THE
WATER KNOWLEDGE RESOURCE CENTRE
TO ACCELERATE
AWARENESS, KNOWLEDGE AND ACTION
AROUND SAFE DRINKING WATER!
SUPPORTED BY
Safe
JANAJAL

use of Natural Gas/ LPG for the mundane yet necessary pasteurization job at home. With continued orientation and awareness spread via hand-outs and by JanaJal WOW operator, our young beneficiary is now also fully aligned with the Go-Green mantra associated with all of the JanaJal water ATMs and JanaJal WOW, reducing the dependence on unsecured water sources and expensive packaged drinking water.

Yash appreciates the fact that his continued efforts to refill water from JanaJal WOW have also helped reduce plastic consumption. Not only is he willing to now use his own Food Grade canister, but also promotes the same to all his friends and family knowing the ecological and economic benefits. He has also directed his friend, who operates a water vending cart to come and fill up water from the JanaJal campus only, due to the associated time and cost benefits.

The overall impact on the end-users' life

(social impact) as a result of JanaJal WOW:

- **Better Health and Wellness:** Unpackaged safe water has eliminated the interface of plastic from water during the storage and distribution chain thus eliminating causes for deadly diseases such as kidney failures and even cancer.
- **Reduced Generation of Single-Use Plastic:** Protecting the environment, saving of time and effort for women and children who have usually been entrusted the task of fetching water for their households.
- **Considerable Reduction in Energy Consumption:** With safe treated water now being delivered to our beneficiaries, they are no longer required to boil or pasteurize drinking water. They save substantial time with reduced travel time to the safe water point and also don't have to spend on big containers to store their water since JanaJal WOW delivers water on an ongoing basis and even subscription basis for many customers.
- **Creating Employment:** JanaJal WOW also enables the creation of jobs and social entrepreneurship opportunities, democratizing society through equitable availability of safe water.

About the Contributor

***JanaJal** is Asia's premier tech-enabled water services company that is working to make "Right to Safe Water" a reality in the lives of people. Founded by Dr. Parag Agarwal, JanaJal has received national and global recognition for its contribution in reducing the single-use plastic bottles that is considered to be the biggest contaminant to the environment globally. Over the past 8 years, over 100 million liters of safe water have been dispensed to millions of people through various clusters of water ATMs installed through association with public bodies and corporates and with the support from local administrative bodies. It presently has over 750 water ATMs and safe water points operating across India, all of which are remotely managed and supervised in real-time through secure cloud servers that help monitor the quality and quantity of safe water dispensed besides enabling cashless transactions by consumers using UPI and 122 e-wallets through a single QR-code.*

DATA, WATER QUALITY, MONITORING, WATER TREATMENT

WATER AUTHORITY MONITORS ARSENIC AND CHROMIUM LEVELS WITH SMART WATER SOLUTIONS

By Meena Sankaran

BACKGROUND

The Southern Nevada Water Authority (SNWA) was founded in 1991 to address regional water issues, and its member agencies serve more than 2.2 million residents in Southern Nevada.

As the wholesale water provider, SNWA is responsible for water treatment and delivery, as well as acquiring and managing long-term water resources for Southern Nevada.

Including in its scope of responsibility, SNWA manages the Searchlight water treatment and distribution system which services Searchlight, Nevada, a small town roughly 50 miles from Las Vegas. Given Searchlight's geological characteristics, along with its past and current land use, the Searchlight Wells produce arsenic.

To ensure that only high-quality, potable water is being served to the Searchlight community, a chromium/ arsenic ion exchange process is in place, including several arsenic canister contactors.

The canisters must be consistently and frequently monitored for an arsenic breakthroughs so that media regeneration can be scheduled and performed.

Monitoring the Searchlight system requires an operator to travel the 100 miles roundtrip to collect a water sample, send the sample to a lab, and review the results.

SOLUTION

The KETOS Smart Water Intelligence Solution, which included the flagship

CHALLENGE

Conventional water monitoring relies on manual sampling and lab testing. Particularly in high-frequency testing scenarios (like Searchlight), the expense required, and lengths to which operators went, to test water at the Searchlight water treatment facility meant that SNWA:

- **Did not have real-time data about Searchlight's water quality**
- **Was incurring significant expenses for time and travel to and from the facility**
- **Did not have data-driven process controls or alerts in place**

KETOS SHIELD was installed at the Searchlight arsenic/ chromium ion exchange facility.

The solution was easily configured to accommodate SNWA's high-frequency testing requirements.

Water quality was monitored remotely and the data collected was aggregated in a centralized database so that real-time reporting and alerts could be automated.

After installing the KETOS Solution, SNWA was able to review real-time results on critical contaminants - multiple times a day and have better controls in place for internal processes on Arsenic removal.

Both chromium and arsenic are regularly monitored with a lower sensitivity level of 2 ppb by the KETOS Shield solution.

As a result, SNWA is able to pre-empt potential compliance issues through real-time feedback and alerts, and significantly reduce the time and expense associated with manual sample collections and lab testing.

In addition, a system was set up in a lab setting and monitored several physical parameters like pH, EC, TDS, Salinity, DO, and temperature at a 60-sec level continuously while Nitrates were measured on an hourly basis as a scheduled test.

Several other inorganics and heavy metals were also measured as desired.

Ideal for high-frequency water quality sampling, the KETOS SHIELD solution provides operators with lab-accurate results for over 30 parameters.

Because the KETOS SHIELD is part of a fully integrated solution, operators have access to automated reporting, real-time alerts, EPA-compliant or custom

threshold-based diagnostics, custom reports, historical trends, and mission-critical insights by continuously analyzing water data in conjunction with advanced machine learning.

The total cost of this solution, including unlimited testing and analysis, is comparable to the cost of 2-4 lab samples per month.

These insights are vital for the public and private sectors and are used for water quality, safety assurance testing, protecting liability, understanding process optimization in industrial plants, improving crop yields and water data for farming, besides overall consumer health.

About the Author

***Meena Sankaran** is the Founder & CEO of KETOS, a water intelligence startup that delivers actionable metrics and predictions on water safety and overall availability.*

Founded in 2015, Meena launched KETOS to help make water safer and sustainable today and for future generations.

***KETOS** delivers smarter, safer, and more sustainable water solutions to change the way the world thinks about water.*

This is done through a comprehensive offering of industrial-grade patented hardware, an IoT communication framework, and a robust software platform to address global water management issues.

Real-time monitoring and understanding of water, both quantitatively and qualitatively, helps address both water efficiency (leak-detection & usage) and water quality (safety), ultimately increasing water availability.

With the power of actionable and predictive water intelligence on a global scale, KETOS seeks to solve a number of the world's water challenges with the goal of preserving this quintessential resource for generations to come.

DRINKING WATER SUPPLY, PUMP STATION, WTP

A NEW WATER PUMP STATION FOR CALGARY

By Bryan Orchard

INTRODUCTION

Calgary is one of Canada's fastest-growing metropolitan cities and is the major urban center for the southern half of the province of Alberta. Calgary is located in the foothills of the Canadian Rocky Mountains, at the confluence of the Bow and Elbow Rivers. The city is perhaps best known internationally for its annual July rodeo and outdoor show, the Calgary Stampede. Originally founded around agriculture, Calgary is now the heart of Canada's energy sector, with much of the current economy driven by oil and gas production.

With an expanding population of over three million and a continued diversification of industry and commerce, the ever-growing demand from Calgarians for potable water has to be met. To satisfy both current and future demands for safe and reliable drinking water, The City of Calgary has recently embarked on a $35M CAD project to replace the most critical water pump station in the city. The existing Shaganappi Pump Station, originally constructed in 1978, supplies drinking water to over 200,000 residents of Calgary and surrounding communities. Shaganappi Pump Station is Calgary's largest pump station and is a vital component of the City's water transmission network, which consists of 41 pump stations and 23 storage reservoirs, connected by over 4,500 km of underground piping. This large

PROJECT SUMMARY

From the original RFP process through construction of the new facility, KSB Canada has worked closely with The City of Calgary, the consultant engineer (Associated Engineering), and the contractor (Graham Infrastructure LLP). Fast response, technical assistance, and project management were key contributions from KSB Canada. "We were faced with a very exacting RFP issued by The City of Calgary," explains Barazandeh. "We identified the most appropriate and proven pump types and customized them to the City's specifications. Providing optimum hydraulics to meet or exceed these requirements, along with configuring the pumps to meet the duty conditions, were major factors in delivering a successful project."

The requirements for Shaganappi involved the supply of three large RDLO 600-600 pumps rated at 80ML/d and three smaller Omega 300-560 pumps rated at 30ML/d.

number of pump stations and reservoirs is required due to the varying and often rugged topography of Calgary, which divides the city into many smaller water pressure zones based on elevation.

THE PROJECT

The City of Calgary owns and operates two water treatment plants: the Bearspaw Water Treatment Plant and the Glenmore Water Treatment Plant. These state-of-the-art treatment facilities draw their source water from the Bow River and the Elbow River, respectively. Both treatment plants combined can produce a total of 950 ML of clean drinking water per day. Treated water is stored on-site at the treatment plants before being pumped into the transmission network for distribution throughout the city. The Bearspaw plant, located in the northwest quadrant of the city, pumps water into three separate underground feeder mains. One of these feeder mains is the 1950mm diameter South Feeder, Calgary's largest and most critical feeder main. Shaganappi Pump Station draws water directly from the South Feeder and then effectively splits the flow, adds hydraulic energy via pumping, and redirects the water to both north and south Calgary.

The existing Shaganappi Pump Station is over 40 years old and is past its useful life expectancy. Many of the mechanical and electrical components within the existing pump station are now obsolete, creating operational and maintenance challenges. Given the critical nature of this pump station and the extensive upgrades that would be required to ensure efficiency and

> ***"It was necessary for us to modify the pump hydraulics to maximize efficiency for the most frequent operating conditions. This led to delivering the lowest lifecycle costs and optimum operating reliability."***
> ***- Pasha Barazandeh, Regional Sales Manager, KSB Canada***

The new Shaganappi Pump Station which was completed in January 2022, has a design capacity of 220ML/d (Image courtesy of The City of Calgary)

reliability, the decision was made to replace the existing pump station with a new pump station.

The new Shaganappi Pump Station, which was completed in January 2022, is located approximately 200m west of the existing facility. This will allow the city to reuse much of the existing underground infrastructure, including the original piping connection to the 1950mm diameter South Feeder. This location was chosen to reduce construction costs, minimize disruption of the water system and surrounding communities, and facilitate a smooth transition between the existing and new facilities.

Calgary's water pump stations are considered critical infrastructure and are designed with redundancy to allow them to continue to operate in an emergency situation. The existing Shaganappi Pump Station utilizes natural gas engines to drive back-up pumps in the event of a power outage. The new pump station will utilize a 944kW natural gas generator that will be capable of starting and running one or more pumps in the event of a utility outage. The use of natural gas generators in new pump station installations offers an efficient, flexible, and safe solution that meets the city's critical infrastructure requirements.

THE CHALLENGE

Establishing a strong working relationship between KSB Canada and The City of Calgary has been advantageous to both parties. The City issued a Request for Proposal (RFP) in late 2017, in search of a vendor to supply pumps and drivers for existing and new water pump stations. KSB Canada was the successful proponent in this stringent RFP process, which saw the contract awarded in May 2018. The contract included the supply of pumps and drivers for the new Shaganappi Pump Station project, along with other projects such as the Palliser Drive Pump Station retrofit.

"The Palliser Drive project enabled us to demonstrate to The City of Calgary the capabilities and benefits of our Omega pumps", reports Pasha Barazandeh, Regional Sales Manager, KSB Canada. "For this project, we supplied two electrically driven pumps and one natural gas engine-driven pump to meet a pumping requirement of up to 60 ML/d. The City was pleased with this installation and 12 months on it continues to run well."

While the Palliser Drive Pump Station project was underway, details for the new Shaganappi Pump Station were being finalized and the pump supply was put into motion. The requirements for Shaganappi involved the supply of three large RDLO 600-600 pumps rated at 80ML/d and three smaller Omega 300-560 pumps rated at 30ML/d to give a station design capacity of 220ML/d. This allows for a total capacity of over 300ML/d with all six pumps in operation. However, such a situation is not anticipated to happen. "For 80% of the time only one of each pump type might be working at the same time, servicing two different pressure zones for the water supply system," explains Pasha Barazandeh.

One of the key challenges for KSB Canada was the size of the natural gas generator at Shaganappi Pump Station. "The configuration of the pumps and their power requirement had to be modified to meet and exceed the duty condition. To meet this condition, it was necessary for us to modify the pump hydraulics to maximize efficiency for the most frequent operating conditions," states Barazandeh. "This led to delivering the lowest lifecycle costs and optimum operating reliability."

The City of Calgary specifications stated that they required between-bearings, axially split case centrifugal pumps. Other specific requirements included suction and discharge nozzles provided with integrally cast flanges to ANSI/ASME B16.1, the impeller trim diameter to be no more than 98% of the full size, and removable wearing rings on the impeller and casing. There were also a number of specific material requirements to satisfy national and international standards relevant to the handling of potable water.

THE SOLUTION

Proven in many water applications around the globe, the RDLO and Omega pumps were identified as being more than capable of meeting the customer's specific demands. KSB's axially split, single volute casing RDLO and Omega pumps feature a double-entry radial impeller and are ideally suited to the requirement of the water pumping stations. They transport fluids with a minimum of flow resistance, thus lowering the energy and life cycle costs of the systems in which they are installed. CFD optimized hydraulic systems deliver both the best duty point and give operating efficiency levels of above 86%. The double entry impeller balances the axial forces so the load on the maintenance-free bearings is minimal. The combination of solid bearing brackets, a short and rigid shaft, and pre-loaded bearings guarantees low vibration and extended operating life for the bearings, seals, and coupling. Being axially split case pumps simplifies maintenance procedures, enabling ready access to all parts for a thorough inspection. The drive may be positioned on both the left and right of the pump without additional parts or modifications to the casing being necessary.

About the Author

***Bryan Orchard** is an independent technical author and journalist who has been working*

in the global pumps and valves industry for over three decades.

INDUSTRIAL WASTEWATER, PROCESS WATER, VACUUM DISTILLATION

MAN NUREMBERG CLEANS INDUSTRIAL WASTEWATER 3 TIMES BETTER

By LiquidSky

Within the MAN Truck & Bus Group, the MAN site in Nuremberg is the international competence center for the development, production and, sale of diesel and gas engines with an output range from 37 kW to 1,397 kW (50 hp to 1,900 hp).

MAN engines have always been a reliable source of power for the group's own MAN and NEOPLAN trucks and buses. In addition, they also go to work with all their energy in road and rail vehicles, yachts and work ships, power generators and combined heat and power units, construction, and agricultural machinery.

During the production of many of the required components, approx. 4,000 m^3 of cooling lubricant emulsions and parts washing water are produced annually. These were previously separated using an ultra-filtration plant and the treated wastewater was then discharged into the public sewer system. Here, MAN was striving for a more environment-friendly solution. The company decided to optimize the process and to ensure a sustainable treatment of the process water produced. For example, a call for tenders was launched in search of newer and more efficient methods. H2O GmbH offered a VACUDEST vacuum distillation system individually adapted to the requirements.

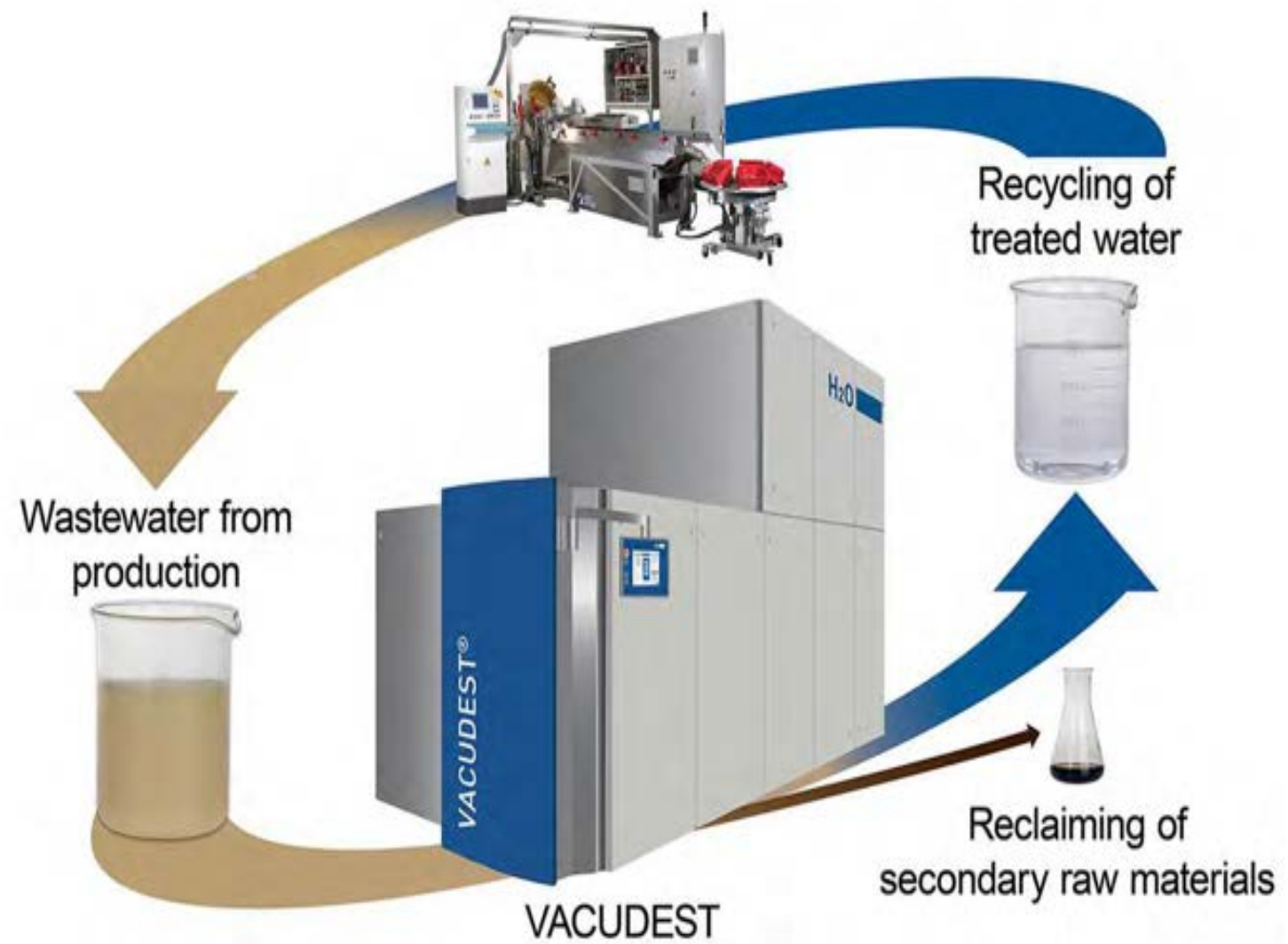
The analysis of the customer's process water in H2O's own laboratory confirmed that the treatment using vacuum distillation can be successfully performed. These results were the first step in the right direction. The quality of the results in the laboratory also exceeded the strict requirements at MAN.

The evaporation rate also showed the customer that he only has to dispose of 2.7% of waste from his process water and can expect a concentration of almost 1:37.

Vacuum distillation with VACUDEST

Activepowerclean stands for a technology development that uses small (6 mm) ceramic balls for continuous heat exchanger cleaning.

Due to the natural circulation of the process water in the heat exchanger, the ceramic beads are constantly "boiled along" and clean the surface during the process. Therefore, this applies...coating avoidance instead of coating treatment.



is a very efficient separation process for separating high-boiling impurities from industrial process water. Nevertheless, certain physical effects prevent oils in particular from being completely separated by distillation and lead to traces in the distillate. This effect is known to all plant manufacturers and can often lead to a clouding of the distillate. Common after-treatments are based on coalescence

Thanks to energy recycling, VACUDEST vacuum evaporators are leaders in optimizing energy-efficiency and lowering operating costs.

Formation of deposits without Activepowerclean

separators and activated carbon stages. In addition to the running costs, there is also the follow-up treatment.

Not so with the patented H2O Clearcat system - it guarantees the highest distillate quality without the use of the usual follow-up treatment and consumable materials. This additional option for the innovative VACUDEST vacuum distillation system allows the safe and efficient treatment of industrial wastewater containing oil and grease in a single process step.

The operating principle of the Clearcat condensation stage is based on physical and catalytic effects. Therefore, this cutting-edge technology requires neither energy nor auxiliary or operating materials. H2O improves the quality of treated water and sets new standards. In the end, H2O also convinced the responsible employees at MAN Nuremberg.

Another decisive factor for the VACUDEST plant was the lower operating costs due to the simple chemical cleaning.

Activepowerclean prevents the formation of deposits.

Everyone knows the problem with the iron or coffee machine: Hardeners in water and other impurities can occupy the heat exchanger and ensure increased energy requirements and additional expenditure for maintenance and cleaning. With vacuum evaporators, the risk is many times higher. Although chemical rinsing equipment can often delay cleaning, it can only completely replace it in a few cases. The proven Activepowerclean technology helps here.

Mr. Neumann, Head of Media Supply at MAN, and Mr. Klein, Project Manager at MAN, were very enthusiastic about the performance and treatment from VACUDEST and hope for many years of successful environmental protection and that MAN could decide in favor of recycling in the future.

About the Contributor

***LiquidSky** is a Pune-based company which licenses and supports the latest technologies to build a better world. With a focus on water, it brings to India, technologies that treat industrial wastewater, cleaning, and reuse through zero liquid discharge. It is an authorized business partner for H2O GmbH & Eco techno Italy in India, Bangladesh, and Malaysia.*

CONTROL VALVES, DMAs, SCADA, WATER SUPPLY

WATER AUTHORITY SWITCHES TO VALVE AUTOMATION FOR COMPLETE REMOTE PRESSURE CONTROL

By Kevin Callaghan

Warrington Township in Pennsylvania is home to 25,000 residents and over 375 businesses. The Township's water comes from seven wells and five interconnections from another water supply district. In total, there are five District Metered Areas (DMAs) with dedicated pressure zones to effectively serve customers in each zone by providing consistent pressure flow. One of the pressure zones also has an elevated tank.

Due to a contaminant entering the groundwater from a military base in a neighboring municipality, Warrington was required to discontinue the use of their wells. This placed more demand on the supplemental interconnections to now fully feed those areas previously supplied by the well system. Through a cooperative agreement with the Department of Defense, Warrington installed two additional interconnections.

The change in the water supply to the township's system resulted in fluctuating pressure that the mechanical control valves were designed to respond to maintain constant pressure in the DMA. With so many fluctuations, when one control valve changed, it would cause other control valves to react or close – effectively fighting themselves to maintain constant pressure throughout the system.

System operators chose to outfit the two new interconnects with Singer® Control Valves from Mueller to match the existing valves in the system. The new valves came with an electrical pilot system and control panels giving operators the ability to be controlled by the SCADA system in the central control room. This gave operators in the control room the ability to manage both pressure and flow, and in the event of a power failure, an independent fixed pressure setting would kick in.

The two new valves operated in the portion of the system originally serviced

Upon commissioning of the new valves all sites were put to the test and gave a consistent steady control, even when open just a 1%.

For the operators of Warrington's water system, less time is now spent in the field monitoring and managing flow requirements.

The electronic valves help with monitoring and diagnosing the water system so they can operate remotely and in real-time.

Mueller works side by side with their partners and end-users to commission the system and train operators how to make most efficient use of the technology.

"North Wales Water Authority can now see all aspects of the system and have complete remote autonomy to adjust flow or pressure control as needed."
- Richard Zeitler, Bucks County Operations Manager, North Wales Water Authority

by the wells and elevated tank. Pleased with the result, Warringtonoperators then modified the original five Singer mechanical fixed pressure valves to mirror the new valves and operate through the SCADA system. By adding electrical pilots to the existing mechanical valves that had been in operation for years, operators could now independently control each valve and monitor the pressure and flow. This also gives the ability to change the operating parameters to meet the demand without producing fluctuating pressures throughout the system. The SCADA system is programmed to communicate with the Singer controls and has alarms that will notify the operators of any changes defined in the operating parameters.

"North Wales Water Authority can now see all aspects of the system and have complete remote autonomy to adjust flow or pressure control as needed," said Richard Zeitler Bucks County Operations Manager with North Wales Water Authority.

The Singer control valves also have a single rolling diaphragm that provides smooth, steady, and precise pressure control from maximum to virtually zero flow without the need for low-flow bypass valves. The effective area of a Single Rolling Diaphragm (SRD) remains constant, so the bonnet is much smaller and lighter than a flat diaphragm version. A measured quantity into the bonnet control chamber always gives the same smooth movement of the inner valve through the entire stroke. By eliminating the seat chatter at low flows, the SRD avoids injecting small pressure pulses into the piping, which, over time, may increase leakage, losses, or pipe bursts.

Singer Control Panel

Upon commissioning of the new valves all sites were put to the test and gave a consistent steady control, even when open just a 1%. For the operators of Warrington's water system, less time is now spent in the field monitoring and managing flow requirements. The electronic valves help with monitoring and diagnosing the water system so they can operate remotely and in real-time.

There is often a tendency to view things as disposable and simply replace the old with something new. This is not always necessary, especially when it comes to good existing infrastructure that still has plenty more years of service life. Sometimes, a simple upgrade can bring on a whole new world of possibilities. This is the case for many water control systems, by adding instrumentation and automation you can often streamline operations and significantly reduce costs without the big expense of a complete replacement for the same functionality.

North Wales Water Authority has the added benefits of lowering water pressure and monitoring water consumption throughout the different pressure zones to reduce "non-revenue" water.

"With these practices in place we can help to conserve water which reduces operating costs and keep water rates stable," concluded Zeitler.


The valve can be controlled locally or through the end-user's SCADA system.

About the Author

***Kevin Callaghan** is an Engineering Application Specialist for **Mueller Water Products** with expertise in non-revenue water, hydraulic control valves as well as leak detection and pipe condition assessment.*

DECENTRALIZED PLANTS, SANITATION, TOILETS

WASTEWATER TREATMENT HANDLED DIFFERENTLY AND UNCONVENTIONALLY

By Lalit Bajare

Like any other cities or towns in India, Sangamner had the same challenge of treating wastewater and improving sanitation. There are around 20 public toilets and wastewater is being discharged to the open spaces or nullahs nearby leading to mosquito and all sorts of insects breeding, foul smell and deterioration of the soil. These toilets are also consuming heavy amounts of fresh water for the toilet flush.

Taking the wastewater from this public

STUDY BACKGROUND: WHAT INSPIRED TO CONDUCT STUDIES

Water is getting dearer day by day. The world is facing water scarcity and India is not left behind. It is not that we are running out of water but the lack of treatment facilities for both fresh water and wastewater has added to the problems today.

Almost 80% of water supply flows back into the ecosystem as wastewater. This can be a critical environmental and health hazard if not treated properly but its proper management could help the water managers in meeting the city's water demand. Currently, India has the capacity to treat approximately 37% of its wastewater, or 22,963 Million Liters per Day (MLD), against a daily sewage generation of approximately 61,754 MLD according to the 2015 report of the Central Pollution Control Board. Moreover, most sewage treatment plants do not function at maximum capacity and do not conform to the standards prescribed.

Lack of treatment options lead to two problems: not treating wastewater (i.e. sewage) before discharging and again not adequately treating it, creating significant public health problems: 21% of communicable diseases in India stem from unsafe water. A Yale University study released in late January ranked India 124th out of 178 countries on the 2014 Environmental Performance Index (EPI) in terms of access to water and sanitation.

Figure 1

toilet to a centralized STP would have needed sewerage network and funds for the same. Also, pipelaying would have needed studies related to slope available etc. Also, we are not sure if any centralized STP is existent in Sangamner or not. In short, for a small amount of wastewater to be treated, ancillaries would have consumed 90% of time, efforts, and funds as well. That is where wastewater recycle at source was considered by the local government.

An excellent initiative from highly-efficient government officials at Sangamner municipal corporation has set an example and showed one of the ways we can contribute to the Swacchh Bharat mission.

A public toilet at Jorwe Naka, Nayakwadpura, Sangamner In 2019, Sangamner corporation went ahead with installing a 20 KLD "FBTec® in the space adjacent to the public toilet. The technology "FBTec®" later on went to get a recognition as an innovative technology from the Jal-Shakti ministry in November 2020 as the idea of installing small plants and reusing wastewater at source was unique and was considered as innovative and need of the hour by the panel of experts from reputed organizations like PSA (Principle Scientific Advisor), IIT, Neeri, DRDO, Niti Aayog and more. As can be seen in Figure 1, a compact plant with least possible footprint is serving both water recycle and health and sanitation.

THE ECONOMICS

It has been observed that the plant operating expenses are close to Rs.0.01 per

Figure 2

liter where-as a tanker costs Rs 0.08 per liter.

THE RESULTS

- The treated water from the 20 KLD FBTec unit is being reused for the same toilet flushing at which it is installed. This results in saving 20,000 liters of fresh water being taken into the toilets and the saved water is being for better purposes like drinking in the town.
- The foul smell in the nearby is addressed and the insects / mosquito breeding as well. This should result in reducing diseases as well.
- The prevention of wastewater getting into nearby water body has saved the water body pollution to a great extent.

INDIRECT BENEFITS OF THE PROJECT

- It would have taken years to estimate project cost and implement it had the municipal corporation decided to lay a pipeline and carry the toilet wastewater to another place and treat it.
- For the want of funds, land, power..etc, the project may not have come-up at all as its been happening in many other towns.
- Wastewater recycle from a centralized or non-decentralized plant would have required additional funds for pumping or carrying treated wastewater to another place for reuse.

IMPACT

This particular case set an example and was taken as a case study. Some other local body governments in Maharashtra installed such units to recycle and reuse wastewater at source. We need to look at wastewater treatment differently. We need to move from centralized to de-centralized plants as the study has shown.

A revolutionary initiative by Sangamner municipal corporation has set an example and this new approach and thinking should be adopted by others. The initiative flashed in local newspapers as well creating awareness.

This particular case set an example and was taken as a case study. Some other local body governments in Maharashtra installed such units to recycle and reuse wastewater at source. We need to look at wastewater treatment differently. We need to move from centralized to de-centralized plants as the study has shown. We are focused and aware in case of wastewater in cities but 2nd tier cities and towns, villages need more focus that what it gets today.

About the Author

***Lalit Bajare** is the Managing Director at Nixie Engineers Pvt. Ltd. **Nixie Engineers** is*

a growing water treatment company based in India. It is a part of group of companies having more than Rs. 30 crore turnover, having an engineering office at Pune, and a factory at Belgaum. It builds its plants at the Belgaum factory spread across an area of 4000 sq. ft. It focuses on wastewater recycle and containerized RO/UF systems.

SEWERS, SOFTWARE, UTILITY, WATER NETWORK

ASSET PLANNING SOFTWARE BRINGS UTILITY COST SAVINGS

By Ovarro

Finnish multi-utility Alva is the first in Scandinavia to fully implement Ovarro's PIONEER asset investment planning software across its water and sewer networks.

The implementation comes after a six-month trial for Alva's water distribution network generated capital expenditure cost savings of 10%.

Alva serves the city of Jyväskylä and its surrounding area in central Finland, where it produces, sells and distributes electricity, heat and water to the local population and industry.

PIONEER is a web-based decision support platform that can optimize asset management planning and operational strategies, supporting utilities in reducing costs and improving services for customers.

Utilities can decide how and when to survey, refurbish or replace assets at minimum overall cost, across a single asset group or an entire company network.

The same software can be used to plan day-to-day operational activities effectively.

As part of the new agreement with Ovarro, the scope of assets covered by PIONEER will be extended to cover the whole of Alva's water mains network, plus their foul and surface water sewers.

As a result, the platform will be able to forecast events such as water main bursts, interruptions to supply and leakage, as well as sewer blockages, collapses, pollution events and internal flooding.

These forecasts can then be used by PIONEER to target interventions at the most cost-beneficial locations.

George Heywood, Analytics Innovation Lead for Ovarro, said: "Alva is a visionary company and we're proud they have chosen to fully embed PIONEER to support their schedule and programme of works, across both water and wastewater.

> ***"With this extended asset scope, Alva will see even greater savings, as the PIONEER optimiser will co-ordinate work on assets laid in the same trench, reducing the number of excavations needed."***
> *- George Heywood, Analytics Innovation Lead, Ovarro*

"With this extended asset scope, Alva will see even greater savings, as the PIONEER optimizer will co-ordinate work on assets laid in the same trench, reducing the

> ***"The Ovarro team established a convincing proof of concept on our water distribution networks, with clear cost-saving benefits. This is why we have moved forward to implement the technology not only on our water network but also across our sewer networks."***
> *- Tero Ponkkala, Project Manager & Development Engineer, Alva*

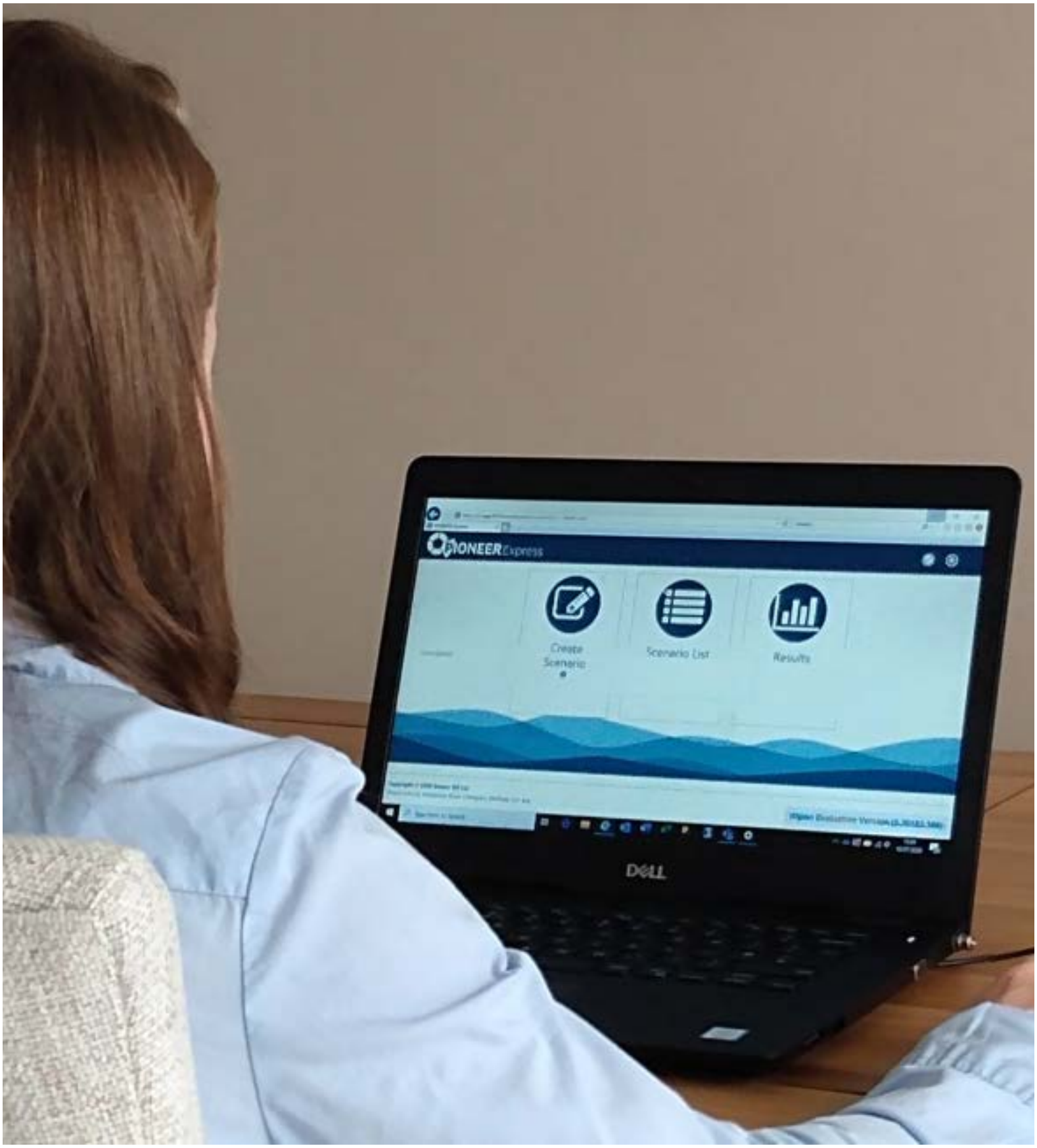
number of excavations needed."

Tero Ponkkala, Project Manager and Development Engineer for Alva, said: "The aim of the PIONEER trial was to assess whether our data is adequate and whether our capability and maturity as an organisation is sufficient for introducing this new approach. We also had an important requirement for the tool to improve Alva's long-term, risk-based investment planning.

"The Ovarro team established a convincing proof of concept on our water distribution networks, with clear cost-saving benefits. This is why we have moved forward to implement the technology not only on our water network but also across our sewer networks."

Alva was also Ovarro's first customer to benefit from the simplified functionality of the PIONEER Express interface, which makes it easier for non-specialists to use the technology's powerful planning capability.

PIONEER has been in use in the UK for over 10 years, with five water companies making use of the platform.



The software mentioned in this case study can be used for all utility asset types including potable water and heat distribution mains, sewers and electrical cabling, as well as point assets such as pumping stations, treatment works and transformers.

About the Contributor

***Ovarro** is the new name for Servelec Technologies and Primayer. Ovarro's technology is used throughout the world to monitor, control and manage critical and national infrastructure. It collects and communicates data from some of the most remote locations and harshest environments on the planet, enabling the businesses to work smarter.*

CLARIFICATION PLANT, SELF PRIMING PUMPS, WWTP

98 PUMPS OPERATING AT ONE OF THE WORLD'S LARGEST CLARIFICATION PLANTS

By Pumpenfabrik Wangen GmbH

The major wastewater treatment project was completed in Mexico City, one of the world's largest cities. It includes a total of 98 WANGEN pumps, which have been running reliably since 2015.

Its size and output are definitively two of the challenges facing this clarification plant. The Atotonilco clarification plant is responsible for the country's capital Mexico City and parts of the federal states of México and Hidalgo.

This region has a population of around 21 million people and, as a result, the plant needs to have a very high output. Atotonilco is one of the ten largest clarification plants worldwide.

WANGEN Pumpenfabrik progressing cavity pumps pump a massive volume of 50 m^3/sec every day.

By comparison, Germany's largest clarification plant has four digestion towers, while Atotonilco boasts a total of 30 digestion towers.

Five different WANGEN pump models are used in the Mexican clarification plant. Their hard-wearing design and reliable construction for a long service life perfectly

WASTEWATER TREATMENT PUMP SOLUTIONS: FIRST-CLASS QUALITY FOR LOW-MAINTENANCE AND FAULT-FREE CONTINUOUS OPERATION

Wastewater is purified in multiple stages, and clarification sludge and purified water are produced at each stage. The clarification sludge is very abrasive and fibrous, with up to 45% dry matter content. Pumping this sludge places extremely high demands on the quality of the pumps used.

WANGEN Pumpenfabrik offers extremely durable and reliable solutions for this to guarantee the low-maintenance and fault-free continuous operation of the clarification plants. Key features to meet these requirements include the sleeve-protected Cardan joint, which protects the pump from blockages and abrasion.

The pump housings are also optimized in terms of flow, further preventing blockages, and the large inspection openings enable the interior of the pump to be easily cleaned.

Clarification Plant, Atotonilco, Mexico

meet the above exacting requirements.

The self-priming pumps are used in this projct at the Atotonilco clarification plant in Mexico:

- 24 x KL30S 68.0 for the metering of additives, for instance, flocculants
- 4 x KL50S 92.0 for the metering of additives, for instance for lime and calcium

WANGEN Pumps

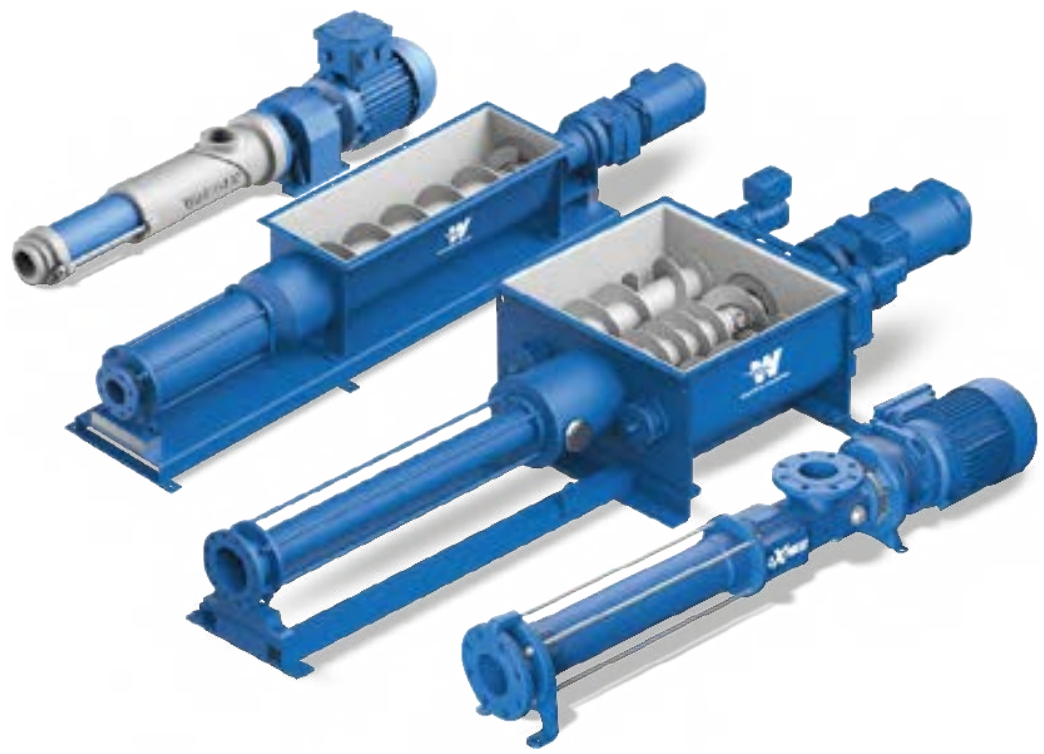
- 34 x KL65S 114.2 transfer pumps used for transferring sludge into the fermenters
- 24 x KL80S 140.2 to pump sludge into the dewatering plant
- 12 x KL100S 140.3 to pump sludge into the dewatering plant

Self-priming pumps are an integral part of the WANGEN product range for wastewater treatment and clarification technology.

In addition to these models, WANGEN Pumpenfabrik also supplies a comprehensive range of robustly constructed and extremely reliable progressing cavity pumps.

The product range is rounded off by special developments for pumping highly dewatered sewage sludge.

Customers worldwide appreciate and have confidence in the above features and other benefits of WANGEN pumps.



About the Contributor

Pumpenfabrik Wangen GmbH *designs, develops, produces, and markets pumps for the most diverse sectors and media at the company's headquarters in Wangen in the Allgäu region of Germany. The company's broad-based product range includes progressing cavity pumps, twin screw pumps, and modules that meet the quality standards demanded by customers and markets. WANGEN pumps perfectly meet customers' requirements worldwide. Since it was set up in 1969, the company has grown from being a small trade operation to becoming a mid-sized company that currently employs over 250 people.*

DIGITAL WATER, GIS, SCADA, SOFTWARES, UTILITY

COST-EFFECTIVE DIGITAL WATER TWIN FOR THE CITY OF WATERLOO, CANADA

By Luke Butler, Sam Ziemann, Todd Chapman, and Tim Sutherns

PROBLEM STATEMENT

Setting up a digital twin can be a lengthy process with high costs.

The team developed a viable solution that maximizes the use of existing technology solutions implemented by the City and their open data platform.

REQUIREMENTS OF DIGITAL TWIN

While the existing hydraulic model and modelling software allowed for master planning and other long-term strategic projects, it was thought that a digital twin that could be used for operational and maintenance purposes would have a wider impact on day-to-day use.

As the digital twins' primary intended audience was operators in the field and those in the control room, the user interface had to be simple and intuitive to use.

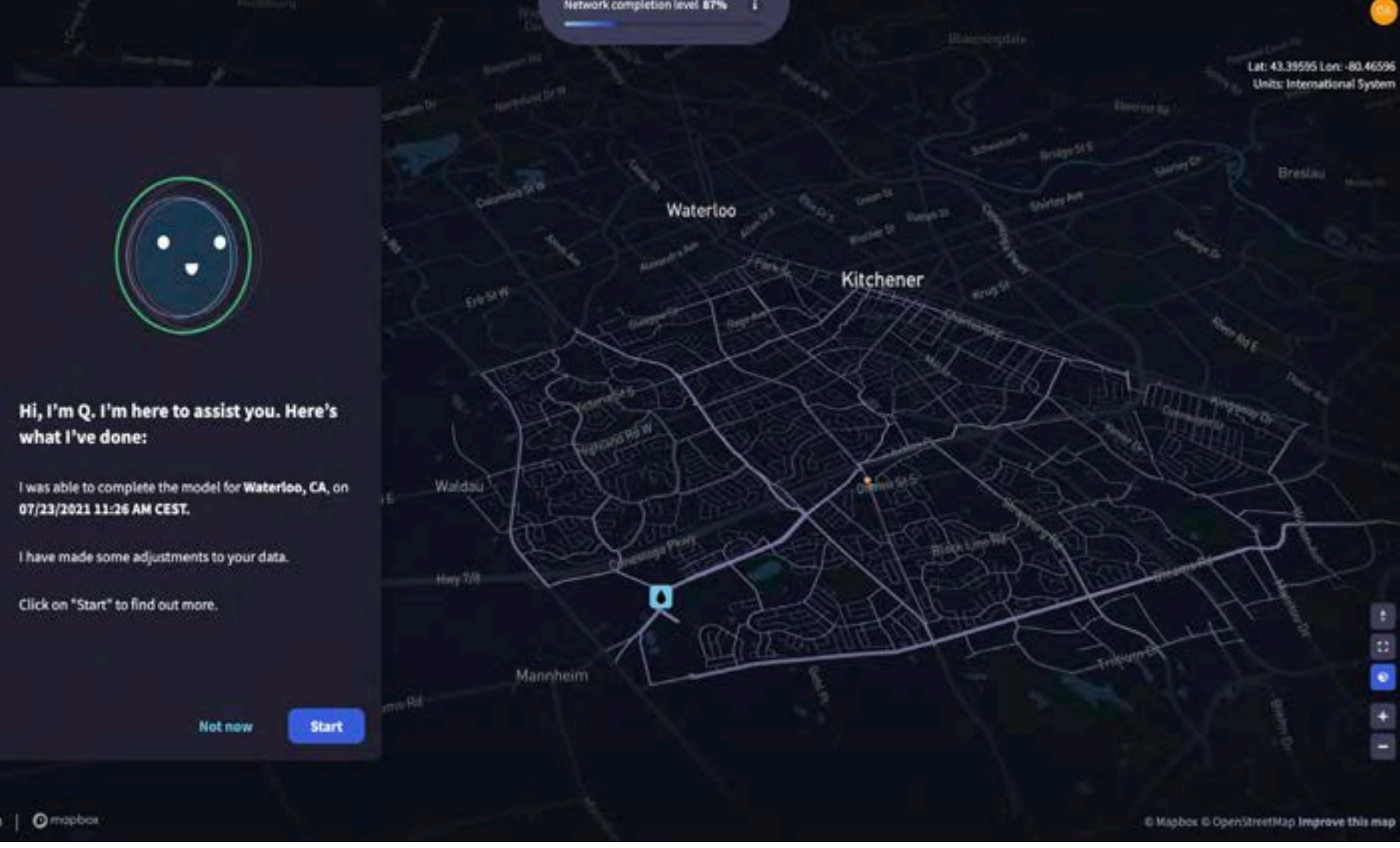
The philosophy is that the normal operating conditions should be completed in a web-based tool, while any specialized work would be deferred back to the hydraulic modellers with the traditional tools.

The following requirements were included in the digital twin:

- Verification of the hydraulic model by comparing observed sensor data against simulated results
- Allow multiple data sets to be incorporated into the live model. The City owns 40 permanent pressure and acoustic DWS dataloggers. Utilize the region's SCADA data.
- Mimic system operational changes, e.g. moving zone boundaries, closing/ opening system valves, in the virtual

ABOUT THE CITY OF WATERLOO

Waterloo is a city with a population of 137,420 located in Ontario, Canada. The Waterloo Region owns and operates all supply and transmission infrastructure including water treatment plants, supply wells, pumping stations, storage facilities, boundary valves, and transmission water main instructure. The City owns and operates 430 km of water distribution mains, 2,509 fire hydrants, and 3,8092 main valves which are all included in their digital twin.



environment before changing the real system
- Plan flushing operations and optimization of chlorine dosing to maintain water quality
- Testing fire fighting capacities of hydrants

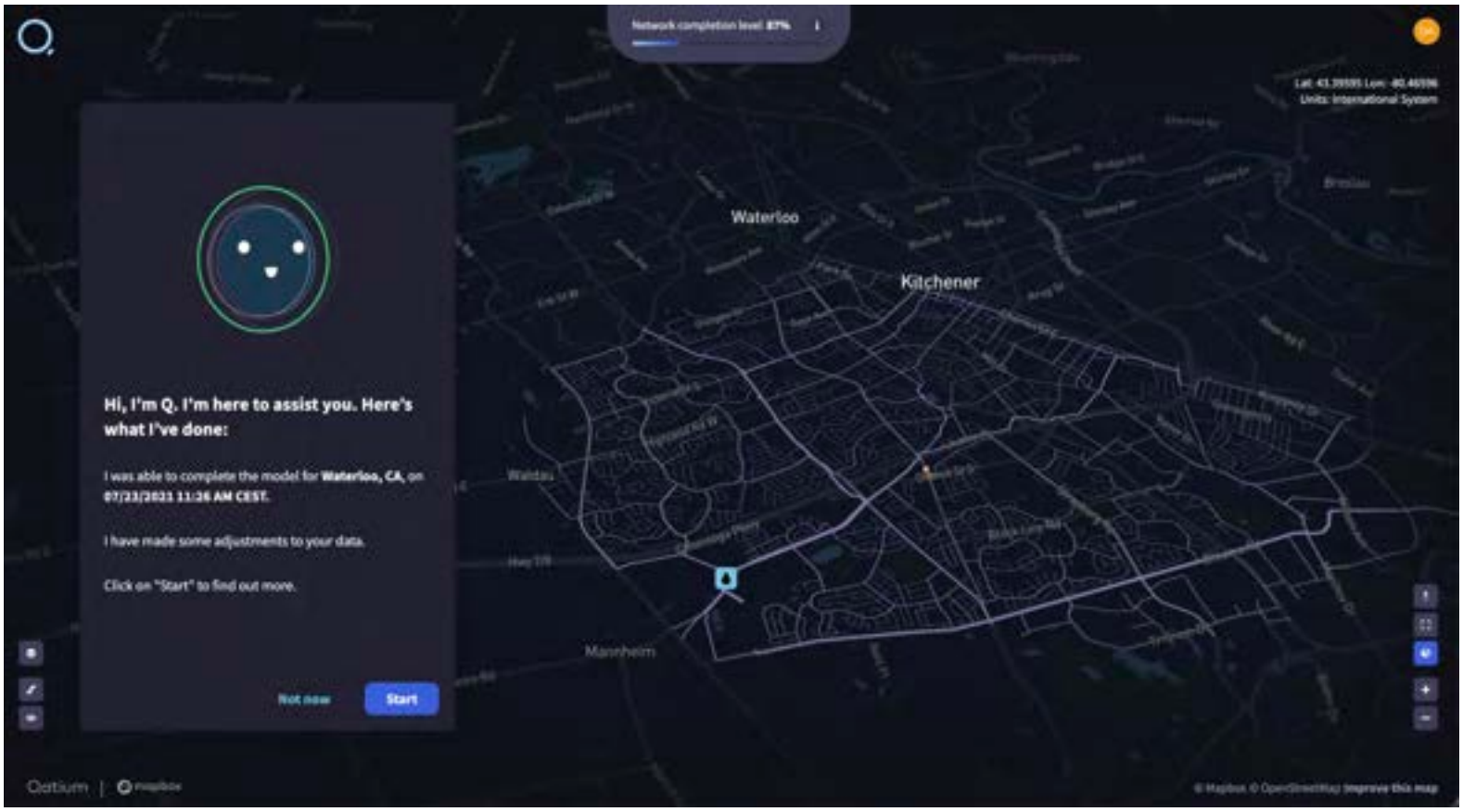
THE SOLUTION

Qatium was chosen as the hydraulic

NEXT STEPS

The team plans to continue to further implement the digital twin. The following tasks have been identified as still needing to be completed:

- **Work with Qatium to implement further features for use by the City of Waterloo's operations team**
- **Use billing data and SCADA data as part of the generation of demands in the model,**
- **Improvements to the automated model build**
- **Identify energy savings opportunities by optimizing the use of water pumps**
- **Complete the connection to the region's SCADA data through eRIS.**
- **Utilize the model to better understand the water system and test future water system improvements.**

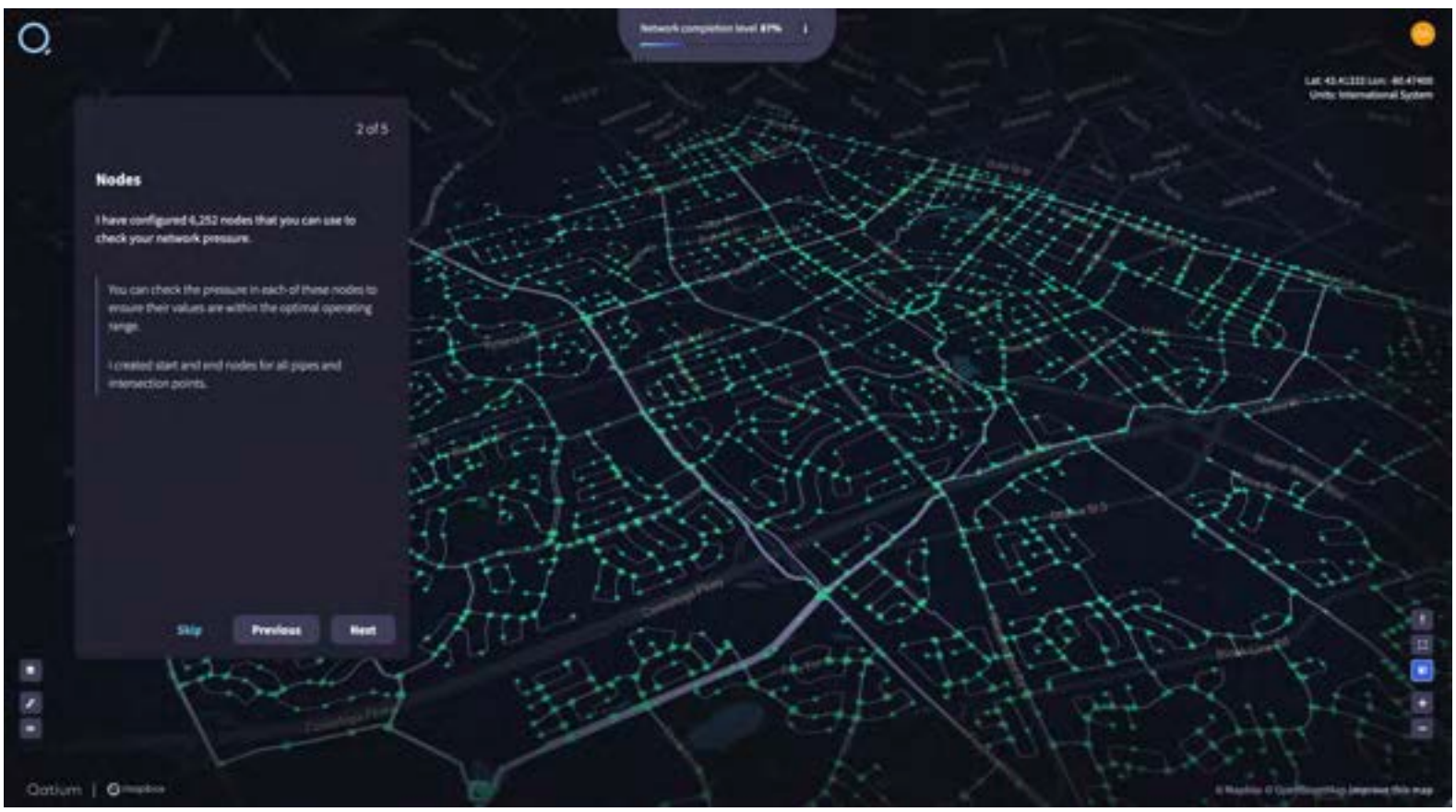


The City of Waterloo's Water Distribution Network in the Qatium Platform

modelling engine as it is a free and open platform that provides good model building and data connectivity tools, is web-based, and does not have licensing restrictions.

The solution makes use of 40 city-owned data-loggers and their SCADA system that provides a live stream of data through an existing web-based dashboard called eRIS.

The planning hydraulic model of the Waterloo system was updated using their open data to become an operational hydraulic model and links between the hydrant monitoring system, SCADA and the model have been enabled through an API layer.



Qatium also allows users to import their networks with the help of an AI-powered assistant that guides them through the process, providing insights and suggestions for possible improvements as the model is automatically built:

- Qatium is the hydraulic engine and data visualization layer using epanet-js
- The hydraulic model was built automatically by Qatium using the City of Waterloo's hydraulic model and open GIS data sets
- The City of Waterloo can access real-time pressure and acoustic monitoring data in hydrants using Digital Water Solutions
- SCADA data can be accessed through a data analytics platform eRIS

Visualization layer showing variation of available pressure within the network

RESULTS

The City of Waterloo saw benefits of its digital twin within a short period of time, key highlights realized were:

- Access to a hydraulic model to City staff for the first time
- Allow field-based staff to complete simple hydraulic simulations
- Verification of the hydraulic model in real-time
- Capital cost savings compared to traditional software installed on-premise
- Allowed remote workers to access operational technology in a controlled environment
- Hydraulic requests typically had a three to five business day turnaround from the Region, now some simulations can be completed in-house.

REPLICATION BY OTHER UTILITIES

Todd Chapman presented the cost-effective digital twin solution to the Ontario Water Works Association and multiple municipalities in Canada and the United States have begun replicating Waterloo's implementation.

Any utility using an EPANET based model (InfoWater/WaterGEMs) can use the Qatium platform directly with their model or Qatium can automatically build a water network from GIS data, so those with limited models could also attempt to use it.

The most difficult aspect of any digital twin implementation is the access to real-time SCADA data, and leveraging existing historians with API access should be considered.




About the Authors

Luke Butler *is the Director of Innovation at Qatium.* ***Sam Ziemann*** *is the President at C3 Water.* ***Todd Chapman*** *is the Manager of Programs, Water Services at the City of Waterloo.* ***Tim Sutherns*** *is the President of Digital Water Solutions.*

INDUSTRIAL REUSE, WASTEWATER, MBR, MEMBRANE, RO

RECLAIMING PUBLIC DRAIN WASTEWATER FOR INDUSTRIAL REUSE WITH MBR-RO IN MALAYSIA

By Satish Chilekar

INTRODUCTION

Malaysian authorities raised water rates to encourage wastewater recycling due to freshwater shortages in some industrial locations. One industrial zone responded by recycling wastewater discharge. This case study summarizes the treatment plant's operations, issues, solutions, and outcomes.

PROBLEM STATEMENT

One industrial cluster went for alternatives with water scarcity and high water prices. Industries couldn't operate or expand with high water prices. A tiny river nearby carried wastewater from industries and untreated sewage from surrounding houses, and workshops. The river was open to all contaminants and precipitation for 3-4 months a year. The cluster management decided to reuse the wastewater because it was the only nearby alternate supply.

THE SOLUTION

The industry wanted a simple and low-cost river water treatment option. This task was tough due to the lack of control over river water quality. Rains exacerbated the issue by increasing suspended particles and turbidity while reducing other contaminants.

The treatment plant comprised a large pond to contain a day's wastewater followed by an automatic strainer, Membrane Bio-Reactor (MBR), and Reverse Osmosis (RO) system of 120 m^3/h permeate capacity.

THE TREATMENT SCHEME

A 1 mm opening screen removed hard sand particles, fibers, and hair from raw wastewater (Figure 1). The screen is followed by an extended aeration biochemical process with anoxic and oxic tanks. They worked together to degrade BOD and nitrogenous chemicals to CO_2 and N_2. While motorized submersed mixers thoroughly mixed the anoxic tank contents, air blowers continuously aerated the oxic tank contents (Figure 2).

The treated oxic water is then pumped into an MBR membrane tank. The MBR modules are constantly cleaned with compressed air.

RAS pumps returned MBR sludge to anoxic and oxic tanks three times the inlet flow to maintain anoxic tank DO and oxic tank MLSS concentration. MBR filtrate was stored in a tank for treatment in a RO system. See Table 1 for biochemical parameters.

Figure 1: Anoxic Oxic Tank

FUTURE IMPROVEMENT AREAS

No treatment plant design and operation is 100% perfect. There is always some way the plant designer can fine-tune the design, eliminate errors, and improve the performance. Following are the improvement areas based on three years of operational experience:

- A sludge age of 5 days could be the basis for designing the biochemical plant instead of the current value of 10 to 15 days. Benefits will be lower Capex with smaller anoxic and oxic tanks and lower Opex with reduced air requirement. The sludge handling system will be marginally expensive, but savings in fossil fuel-generated electricity consumption will outweigh it.
- Sludge accumulated on the anoxic tank top surface, dried out, and became thick muck. Water jets can be used to moisten, break up muck, and remove it.
- MBR filtrate pipeline is designed considering low velocity; hence the valves are large sized. The MBR filtrate pump automatic bypass valve took more time to open and close. Therefore, it could not maintain the timing of 7 + 1 minutes accurately. Next time, 7 + 2 minutes timing would be used in the control logic.
- MBR filtrate piping should be rigid to prevent integrity problems affecting filtrate quality.

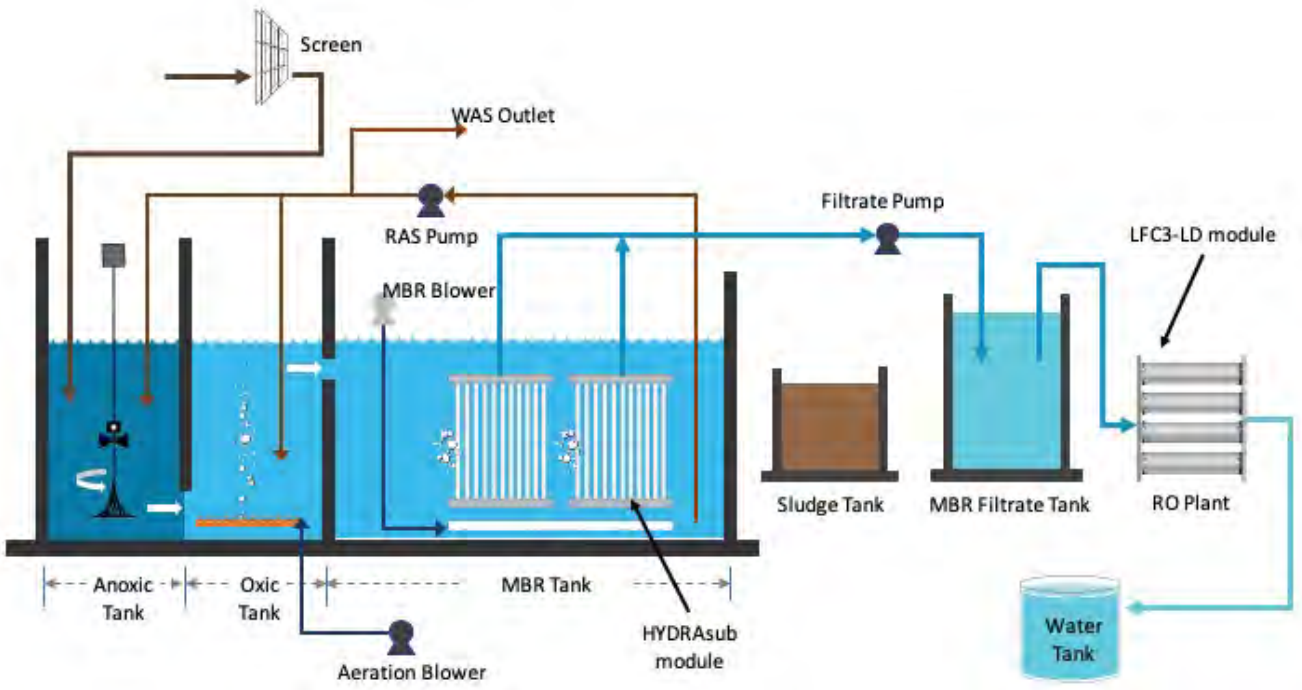


Figure 2: Treatment Plant Schematic Diagram

Parameter	Units	Value
MLSS	mg/l	3000 – 4000
MLVSS	mg/l	1500 – 2500
Anoxic Tank DO	mg/l	0.4 – 0.8
Anoxic Tank ORP	mV	- 50 to +100
Oxic tank DO	mg/l	1.5 – 2.0
Sludge Age	Days	10 – 15

Table 1: Biochemical Parameters

The RO train contained a High-Pressure Pump (HPP), a set of pressure vessels, and membranes.

RO permeate flowed to storage tanks for further distribution to the industries (Figure 3 and Table 2).

Hydranautics' HYDRAsub modules were used. These submerged hollow fiber modules are manufactured of high-strength PVDF with 0.05-micron pores. They were chosen for their proven track record of producing high-quality RO filtrate.

A neutrally charged hydrophilic RO membrane, Hydranautics' LFC3-LD, was used to reduce organic and colloidal fouling. When unsure about the nature of organics, neutral membranes are chosen.

CHALLENGES IN DESIGN

Several challenges were faced in designing the plant, as described below:

Parameter	Units	MBR	RO
Permeate Flow	m^3/h	206	120
Recovery	%	99.7	75
Feed TDS, max	mg/l	-	1000
Permeate TDS, max	mg/l	-	200
RO Array	-	-	18 x 8 - 7
Membrane Module	-	HYDRAsub2400 ES	LFC3-LD
Module Quantity	-	5	182
Design Flux	lmh	17.2	17.8
Maintenance Clean	-	Once a Week	-
Recovery Clean	-	Once in Three Months	

Table 2: RO Parameters

- During the non-rainy season, raw wastewater averaged 1000 ppm TDS, 150 mg/l BOD, 270 mg/l COD, and 240 mg/l TSS. BOD decreased to 50-75 mg/l during the rainy season. BOD is a food supply for bugs, hence low BOD is not good for a biochemical system. We had to add a glycerine solution dosing mechanism to augment the BOD.
- The raw water pond was earthen, and the wastewater might gather up silt. To avoid this, the pond was lined with polyethylene sheets.
- Low bacterial counts in RO feed water reduce membrane cleaning frequency and extend membrane life. While MBR would remove almost all bacteria, the MBR filtrate tank could grow them. The tank was sized for a maximum of 30 minutes retention period because bugs developed slower in plants than in a laboratory. This eliminated the need for chlorine or SMBS dosing.
- The MBR filtrate tank was outside while the RO system was inside the building. The HPP was to be directly connected to the filtrate tank. The HPP suction pipe had to cross a road to reach the RO building. The tank height, suction pipe sizing, and routing were decided to meet the NPSH requirements of the HPP. This

Figure 3: RO System

arrangement eliminated the need for the feed pump and cartridge filter.

PLANT DESIGN FEATURES

The plant design and construction were simplified to make the operation and maintenance easier and reduce costs. The following paragraphs mention some of these features:

- Waste Activated Sludge (WAS) pump was eliminated. An outlet pipeline connection from the RAS pump delivery line with an automatic valve served as WAS discharge.
- RAS pumps delivered MBR tank sludge to anoxic and oxic tanks. An online DO meter controlled the anoxic tank RAS inflow through an automatic butterfly valve. The balance RAS flow was taken to the oxic tank with a fully open butterfly valve reusing high DO coming with the sludge and controlling oxic tank MLSS.
- HYDRAsub membranes required 7 minutes of filtration followed by 1 minute of relaxation in which the MBR filtrate pump is switched off. Switching a standard induction motor every 8 minutes is not a good idea. The motor windings go through thermal stress, insulation weakens, and the contactor loses life every time the motor is switched on because of the high starting current. A bypass valve connected the MBR filtrate pump's suction and discharge to stop filtrate flow. Instead of stopping the motors, this valve was opened during the relaxation step.
- MBR membrane maintenance and recovery cleans are performed every

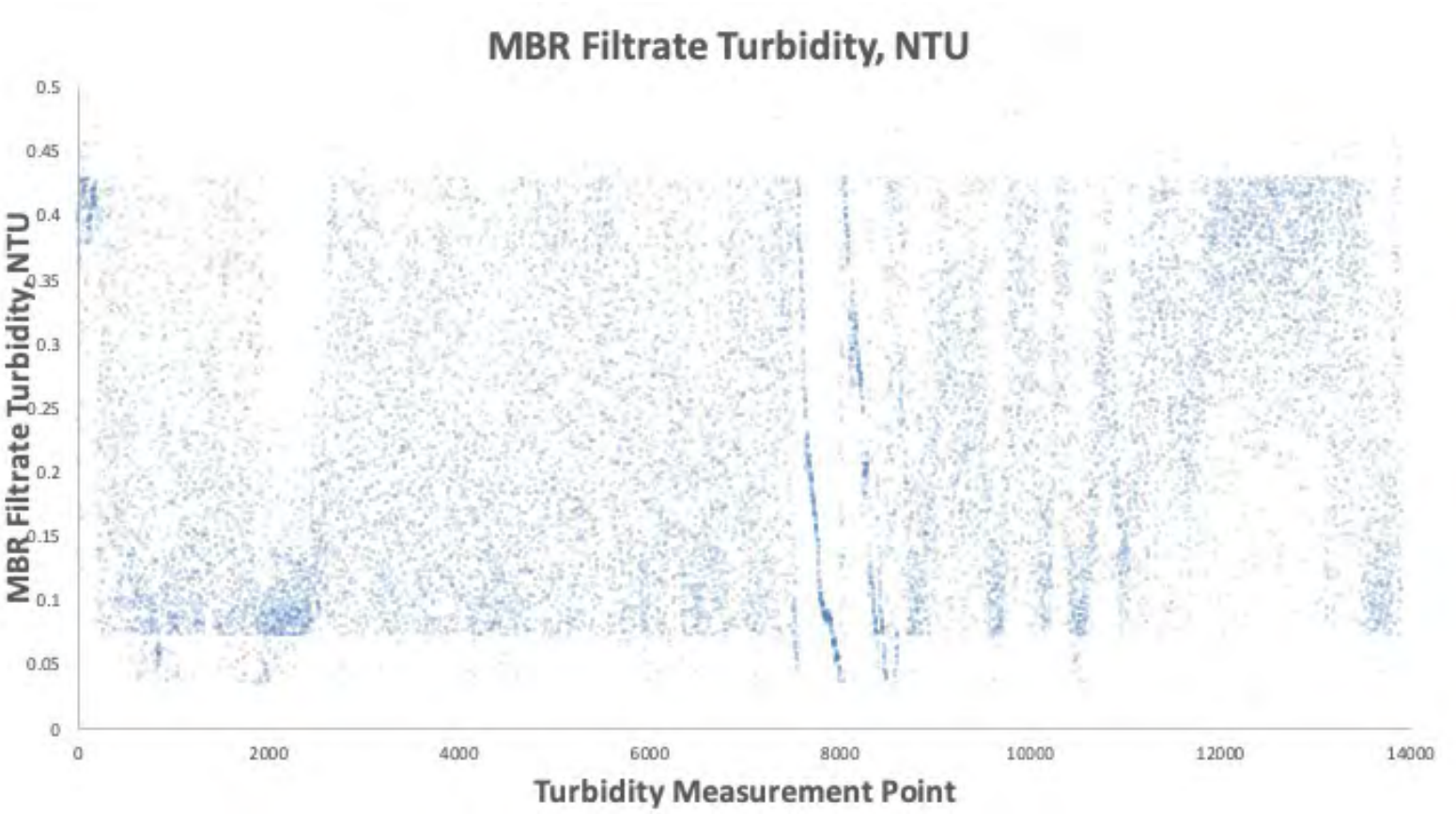


Figure 4

week and three months, respectively. The chemical solution is diffused inside the hollow fiber lumens during these operations. The fibers can sustain only 0.5 bar of backpressure. Both the cleans were designed for

Figure 5: Foulant on Membrane

Figure 6

operations under gravity to prevent excessive back-pressure. Chemical solutions were prepared in the tank and were transferred to the modules under gravity, eliminating pressure overshoots.

CHALLENGES DURING OPERATION

Some challenges were faced during the plant operation.

The following paragraphs list them along with the remedial actions and results obtained:

- The pond water included red oxide paint one morning and an iron (Fe) concentration of 39-45 mg/l the next. MBR membranes filter iron oxides. But when maintenance clean (MC) is used with sodium hypochlorite, Fe catalyzes membrane oxidation. To extend life of MBR membranes, acid MC was performed before every chlorine MC to eliminate Fe from membranes. This novel procedure performed well and is still used after 3 years.
- Although the pond bottom and sides were lined, the lining gave away, and silt started coming in the raw wastewater. MBR membranes filtered this silt, but it remained in the biochemical system. The presence of silt reduced the ratio of MLVSS to MLSS in the oxic tank and negatively affected its performance. Increased discharge of WAS controlled the silt level.
- Low alkalinity in raw wastewater made maintaining DO levels between 0.4 and 0.8 ppm difficult. The anoxic tank's insufficient DO control had no effect because the raw wastewater was low in ammoniacal nitrogen.
- Because of BOD variation, WAS valve needed to be adjusted regularly to control MLVSS levels in the range of 1500 to 2500 mg/l.
- Antiscalants did not work at this plant. Since commissioning, sulfuric acid is dosed to get RO feed pH 5.4 to 5.6. No antiscalant is used.
- MBR filtrate turbidity started increasing after measurement point number 12000 (Figure 4). This increase was due to cracks in the flexible plastic pipe carrying filtrate. The cracks developed in the hot sun and passed solids. Rigid PVC piping replaced all the flexible piping.
- Biomass fouled RO membranes due to MBR filtrate piping integrity loss and increased RO feed pressures. The foulant was uniformly found coated on one lead membrane during autopsy (Figure 5). An 80% weight reduction in foulants indicated organic biomass. Balance foulant composed of silt and other foulants (Figure 6). A sticky EPS layer was not found over the membrane surface. Therefore, it could not be considered biological fouling. It was more like suspended solids fouling. Membranes were cleaned with high pH cleaning solutions that restored the performance.

PLANT PERFORMANCE

HYDRAsub MBR membranes produced filtrate in the range of 0.07 to 0.45 NTU turbidity. Every three months, membranes were cleansed with 5000 mg/l sodium hypochlorite solution with soaking. Aside from the filtrate pipe breaking issue,

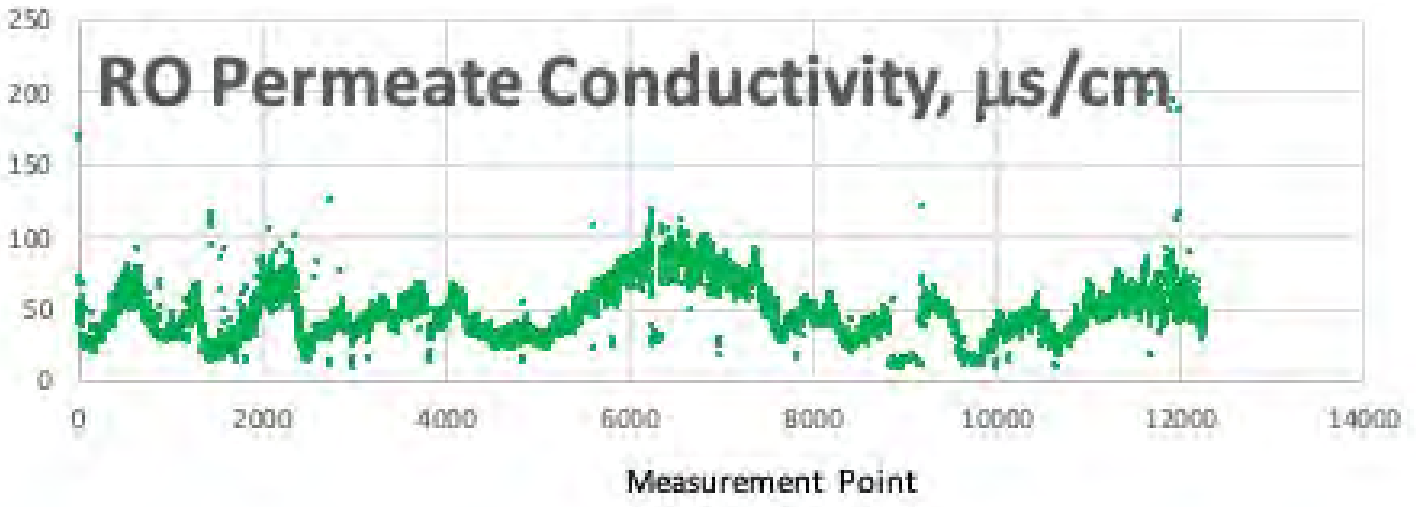


Figure 7

there was no unscheduled MBR system shutdown in three years. Overall, the MBR system performed effectively round the clock and withstood various high fouling industries money.

CONCLUSION

In this case, a treatment plant processes wastewaters and events. See Table 3 for operational performance.

Parameter	Units	MBR	RO
Filtrate Turbidity	NTU	0.07 to 0.45	-
Trans Membrane Pressure	bar	-0.1 to 0.4	-
Feed Conductivity	µs/cm	-	250 to 2200
Permeate Conductivity	µs/cm	-	25 to 100

Table 3: Operational Performance

The RO membranes have produced permeate with less than 100 µs/cm (Figure 7). Because of rains, the conductivity values increased during the non-rainy season, but they came down during rains.

Two cleanings were performed on the RO membranes during the initial two-month period when different antiscalants were tried out. But later, for seven months, membranes did not need any cleanings despite the plant treating wastewater from an open public drain. Overall, LFC3-LD RO membranes have worked very well.

THE IMPACT

This plant has been treating raw wastewater for three years. The running cost per m^3 of RO permeate was RM 0.98/m^3, including MBR-RO operation, manpower, electricity, and chemicals. Raw water from the government costs RM 2.5/m^3. This proves that this plant is saving valuable water, but it is also saving uncontrolled public drain wastewater and generates safe water for the industries. This plant's experience was not without problems. But they were dealt with and neutralized.

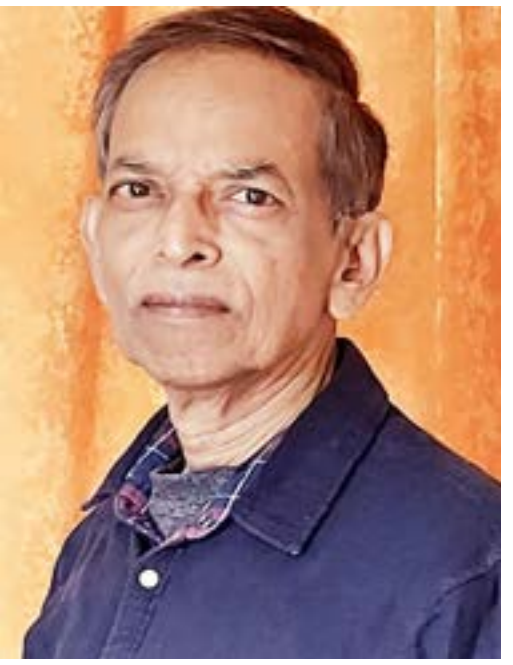
It is a common understanding that the addition of more unit operations increases the reliability of a treatment plant. But this is not true. Every piece of equipment we install increases the risk of failure. This treatment scheme has been running for three years with minimal equipment.

This wastewater treatment system is rare without chlorine, SMBS, and Antiscalant dosage. The risk of membrane oxidation by chlorine is eliminated in this plant. About 50% of RO permeate quality problems arise due to chlorine oxidation.

Finally, RO membranes hate water storage tanks. If provided, their retention time should be 30 minutes, insufficient for bacterial multiplication. The smaller MBR filtrate tank capacity eliminated chlorine and SMBS dosing requirements while reducing bacterial membrane fouling.

About the Author

***Satish Chilekar,** a membrane technology advisor, is recognized as a pioneer in the*



Indian membrane technology sector, having engineered and commissioned India's first RO plant in June 1980. For 44 years, he has been actively working in the industry in India and abroad. Mr. Chilekar worked in a water treatment company for 22 years. After leaving as Vice President - Technology, he started providing technical consultancy to industries and utilities in water management with a special emphasis on membrane technology. He has traveled extensively in SE Asia and worked on the NeWater plants in Singapore. He has been conducting training programs in Singapore for 20 years.

GIS, SATELLITE REMOTE SENSING, WATER RESOURCES, WWTP

WASTEWATER PLANT'S SITE SELECTION USING SATELLITE REMOTE SENSING

By Pranav Pasari and Umang Buddhdev

INTRODUCTION

Nature does its best to purify wastewater but there is too much to be safely disposed of by itself, without causing environmental damage and hazardous conditions. Due to the growing global population that is often densely concentrated, we see an ever-growing need for Wastewater Treatment Plants (WWTP), especially in developing countries. There are several contrasting factors that need to be considered while selecting a suitable site for the construction of a WWTP. The main aim being to maximize environmental and social benefits while ensuring the long-term financial stability of the entire wastewater management systems including collection, treatment, reuse, and disposal. This case study highlights the use of satellite data for selecting optimal sites for constructing decentralized WWTPs in several towns and villages in Haryana, northern India. The example of one such town is presented here.

SITE SELECTION

The site selection process includes the evaluation of potential building sites and assessing their relative advantages and disadvantages. The most favorable location is selected and unsuitable areas that may incur additional social or economic burdens are avoided. In the case of site selection for wastewater treatment plants, this involves a variety of technical and non-technical (e.g. environmental, social, and financial) factors and criteria that need to be considered carefully and adequately.

It is important to construct a wastewater treatment plant in a favorable geographic location to reduce the cost of excavation and embankment and reduce costs associated with discharge of water into ponds and streams. Constructing it in close proximity to residential clusters can generate complaints regarding noise and smell, turning the local community against the project. On the other hand, a very large distance between the site and residential clusters increases the overall cost of laying and maintaining sewer networks. The chosen terrain also influences long-term running costs related to lifting stations and the cost of electricity. It is also important to

This case study highlights the use of satellite data for selecting optimal sites for constructing decentralized WWTPs in several towns and villages in Haryana, northern India.

Figure 1: Location of wastewater pollution within the area of study

identify the most favorable site location for the plant that reuses treated wastewater and fecal sludge to make the whole process sustainable. The goal is to maximize environmental and social benefits and ensure the long-term financial stability of the entire wastewater management system, including collection, treatment, reuse, and disposal.

REMOTELY SENSED FACTORS

Satellite remote sensing is a powerful, comprehensive, and economical technology for evaluating several of the factors that

FACTORS COMMONLY CONSIDERED IN WWTP SITE SELECTION PROCESS

- **Environmental parameters (e.g. present and future land use, buffer from environmentally sensitive zones, etc)**
- **Social parameters (e.g. distance from residential areas, land availability, etc)**
- **Geological and Hydrological criteria (e.g. slope, soil type, surface and underground water sources, flood plains, permeability, etc) and**
- **Economic parameters (e.g. distance from the main road, natural drainage patterns, etc)**

FACTORS THAT CAN BE EVALUATED AND MAPPED USING SATELLITE REMOTE SENSING

- **Location and intensity of wastewater pollution**
- **Slope, elevation, topography features, and natural drainage patterns**
- **Land use and land cover, residential clusters and agricultural fields**
- **Environmentally sensitive zones**
- **Location and extent of water sources, flood plains, and permeability of surfaces**
- **Existing infrastructures, such as roads, drains, and canals**

Figure 2: Natural drainage patterns mapped within the area of study

need to be considered for WWTP site selection. These key factors can be mapped over the area of study easily and efficiently, allowing different decision criteria to be applied to arrive at an optimal site selection for constructions of WWTPs.

Examples of a few evaluated factors are explained below.

The location of wastewater pollution can be seen in Figure 1, this is identified by measuring chlorophyll-a concentrations of the water and therefore assessing the trophic category of the water body. In Figure 1, we see several highly eutrophic water bodies (in green) and one pond with good water quality (in blue). Wastewater pollution is also seen (in green) along the canal on the top left.

Slope, elevation, and natural drainage patterns are evaluated using satellite-derived digital elevation models. Drainage patterns mapped over a town are seen in Figure 2. This terrain profile is a critical component to be included in the site selection process to reduce the required number of sewage lifting stations and the related electricity costs. The WWTP also needs to be located at an elevation that reduces the risk of flooding but also allows discharge of effluent by gravity to the receiving streams.

It is important to identify and implement feasible reuse options to develop a sustainable wastewater management system and establish a circular economy. Nutrient-rich solid waste can be used in fields; hence wastewater treatment plants can be planned near agricultural land, land qualified for rehabilitation, potential treated wastewater reuse industries, etc. WWTPs should be built at such a location that the cost of transportation of treated water and sludge is minimum. In Figure 3, this factor is applied to select a site near agricultural fields.

Figure 3: Land cover map over the area of study

WWTPs carry a risk of odor nuisance if a proper buffer is not maintained between existing residential clusters and the plant. In Figure 4, we see how this criterion can be factored into decision making and optimal sites are kept a certain distance away from residential clusters. Using buffers productively for community and environmental benefits makes sense but requires proper land-use planning. Geospatial analytics can be effectively used to provide the required buffers from residential clusters, groundwater sources, etc to eliminate hazards and ensure smooth functioning of the plant.

GEOSPATIAL ANALYTICS

In order to evaluate all these factors together, all these parameters are stacked together into a GIS system. Weights are assigned to each of the factors based

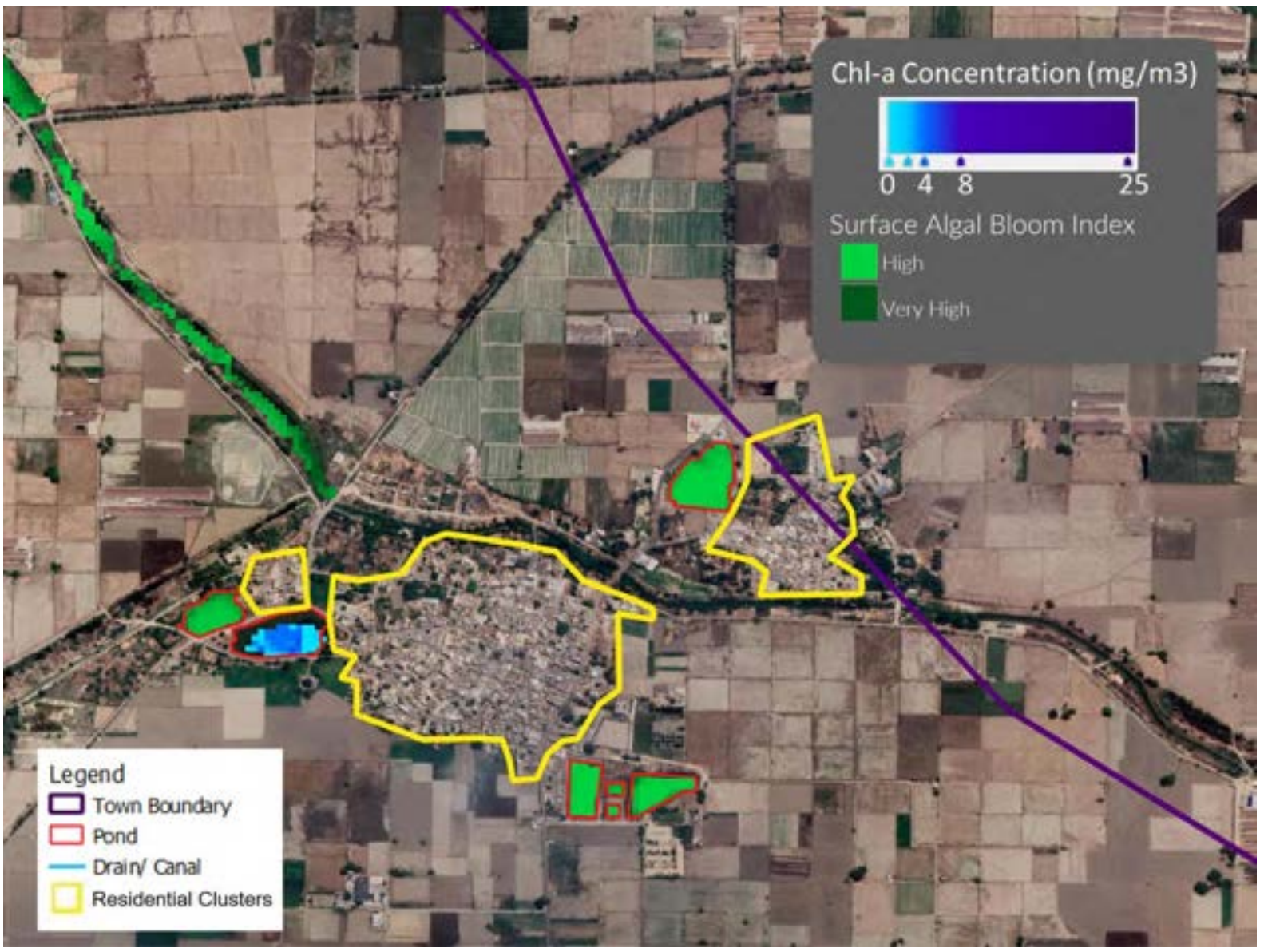


Figure 4: Residential clusters, water bodies, existing infrastructure demarcated within the area of study.

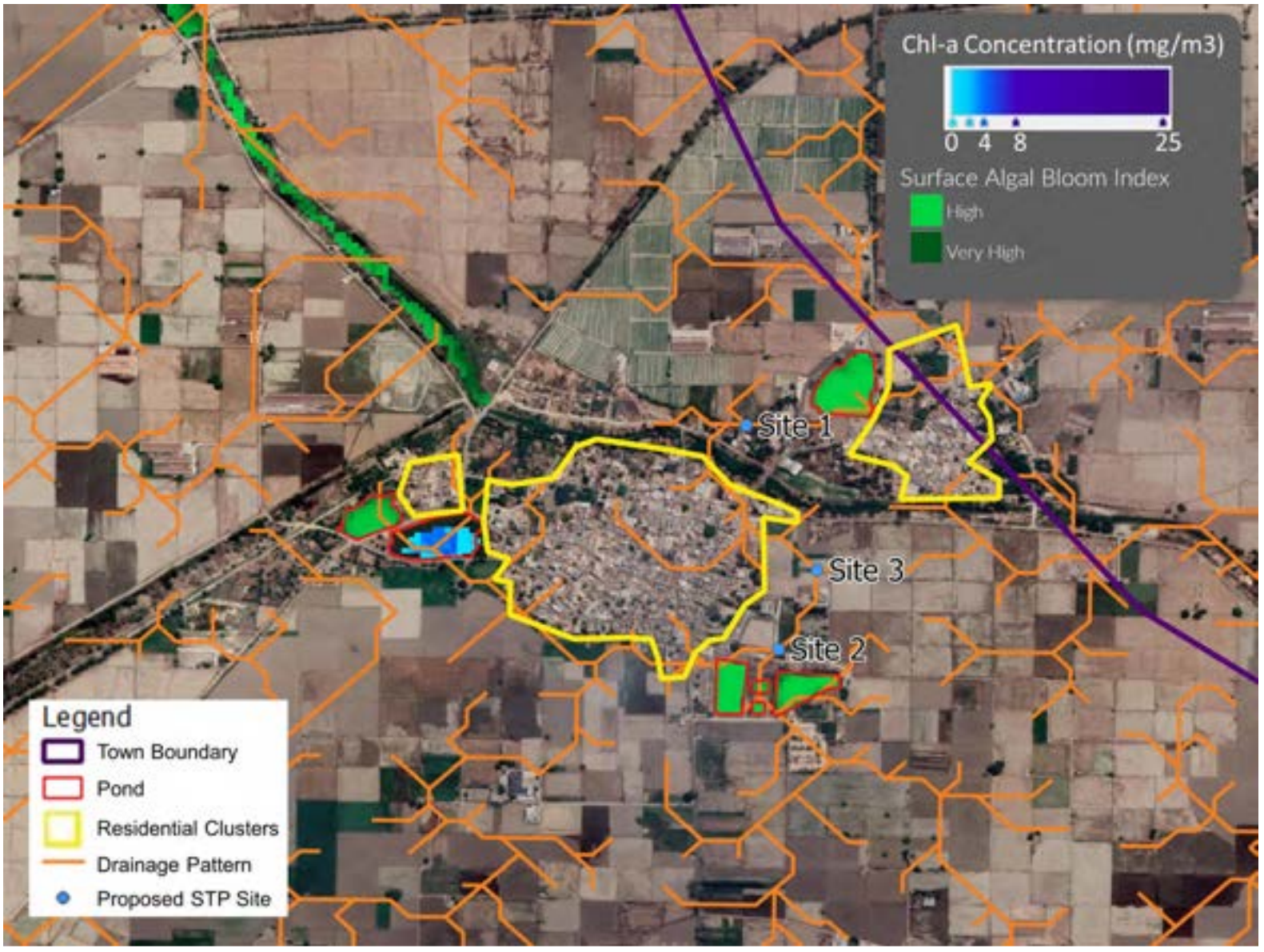


Figure 5: Final result, indicating optimal sites for WWTPs based on geospatial decision matrix.

on their relative importance. An iterative method can be used to compare results based on various weights assigned to the different factors to arrive at the optimal location for constructing a WWTP. In Figure 5, we see an example of the final output of the analysis, where some sites are indicated for further field surveys and validation.

CONCLUSION

The methodology outlined above showcases a superior process for short-listing optimal sites for the construction of WWTPs. It provides a great roadmap and precursor to on-ground field surveys and can make such surveys easier and more efficient. It was determined by stakeholders and plant manufacturers that such a process can result in cost savings of around 30% on project costs, including operating costs. In addition to economic benefits, it can also provide social benefits such as community acceptance and support.

About the Authors

Pranav Pasari, *Director - Technology is the Remote Sensing Specialist at Satsense Solutions and has several years' experience working with Satellite Remote Sensing data products. He is responsible for developing business applications using Earth Observations data. He has previously worked in Technology Consulting.*

Umang Buddhdev *is a GIS specialist at Satsense Solutions and a trained Civil Engineer. He is responsible for translating satellite analyses into maps and on-ground recommendations.*

Satsense Solutions *uses satellite remote sensing to develop business and governance solutions for the natural resources and infrastructure sectors. It has developed and deployed solutions for Fortune 500 companies and government agencies in the water resources, infrastructure, hydropower, and mining sectors.*

DMA, NRW, SOFTWARE, UTILITY, WATER LOSS

CONSERVING WATER AND DELIVERING REAL VALUE TO CUSTOMERS

By TaKaDu

BACKGROUND

Unitywater was established in 2010 when the water operations of Moreton Bay Regional Council, Sunshine Coast Regional Council, and Noosa Shire Council were amalgamated.

From the start, reducing Non-Revenue Water (NRW) was a priority. As a first step, Unitywater created 200 District Metered Areas (DMAs) across the network and connected flow meters and pressure sensors. Along with that, it sought a management solution to enable it to efficiently utilize the information provided by the sensors.

GOALS

In 2013, Unitywater began working with TaKaDu, a global leader in providing Central Event Management (CEM) solutions to water utilities. With the TaKaDu CEM solution, Unitywater aimed to reduce water loss, shorten repair cycles, improve customer service and increase operational efficiency. Unitywater CEO George Theo noted that with 65% of Queensland drought-declared and the South East Queensland combined water grid dam levels hovering around 55%, water conservation and efficient water management are among the utility's most important undertakings. It is continuing to advance its digital journey to further reduce Non-Revenue Water (NRW) and costs and improve its network performance and customer service.

GOALS

Continually reduce NRW, improve network performance and customer service.

Solution

Leveraging big data analytics, TaKaDu enables water network owners to respond to network problems in near real-time and manage the full event lifecycle: from event detection, through classification, prioritization, resource allocation, until event closure. "TaKaDu provides the technology and some best practices, but what Unitywater does so well and has perfected over the years is the processes,

SOLUTION

TaKaDu CEM has been deployed at Unitywater since 2013.

and they have the people that know how to use it and to make a real difference," said Amir Peleg, TaKaDu CEO. "All the benefits of network efficiency and improved water management lead to real value, with higher uptime of the water service and reduced cost of operations."

Insights gained through TaKaDu's vast experience with utilities continually enrich the solution, bringing additional value to Unitywater (and all other TaKaDu customers).

Amir added: "Reviewing performance data from utilities across the world, we have established industry benchmarks against which Unitywater can objectively evaluate its performance. It's enlightening to see how they lead in multiple areas and to work with them to prioritize areas for further improvement."

RESULTS

Combining Unitywater's network operations and processes with TaKaDu's CEM paradigm and its strong analytics technology enables an efficient process for detecting network incidents and managing their cycle until resolution. It also provides Unitywater with full visibility into its water network.

Unitywater's nine-year partnership with TaKaDu has delivered significant customer service improvements and helped save thousands of megalitres of water and millions of dollars for the utility's service region in South East Queensland.

Since 2013, TaKaDu has detected more than 10,413 ML of water leakage and unauthorized use in the Unitywater network. That's equivalent to 4,160 Olympic-sized swimming pools of

RESULTS

- **Over 10,000 ML of water saved in 2013-2021, saving about AUD 28 million**
- **1,400 ML saved in the last year alone, saving AUD 4.2 million**
- **Leak repair times reduced from 11 days to 2**
- **Most problems are detected before customers notice them**
- **Unitywater can prioritize repairs, reducing the need for emergency response**

water saved, had the hidden leaks or unauthorized use gone undetected for 12 months. The reduction in NRW loss equates to AUD 27.9 million of savings over the period.

In the 2020-21 financial year alone, TaKaDu helped Unitywater detect 1,400 ML of potential water loss at an annualized savings of AUD 4.2 million. That year it recorded just 3.6 water main breaks and leaks per 100 km of mains – significantly below the industry median of 25.1 water main breaks and leaks per 100 km of mains.

The partnership has led to other benefits, with Unitywater's average repair time for leaks being cut from 11 days to 2 days, more than AUD 11 million in savings from operational improvements, better pressure monitoring, and reduced knowledge loss from an aging expert workforce.

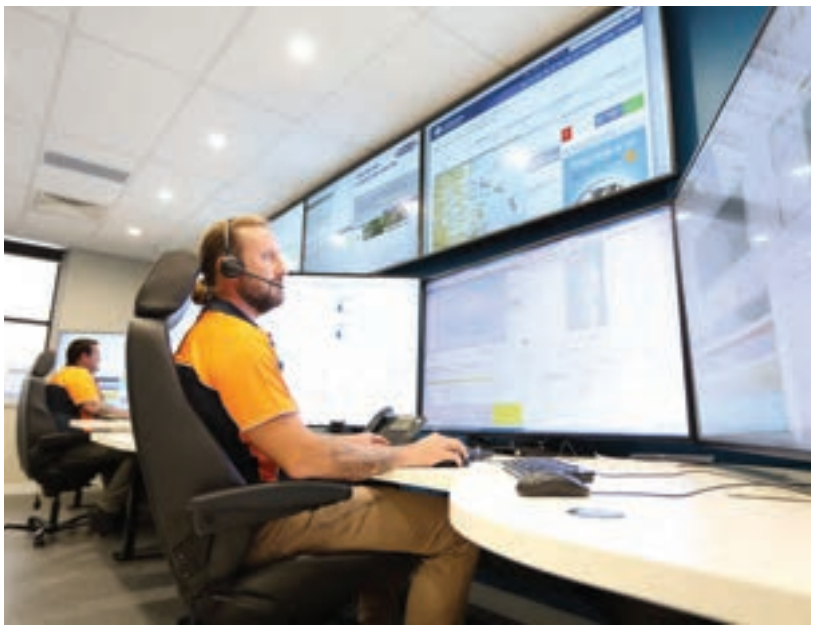
Additionally, Unitywater has been able to improve data availability by efficiently detecting and fixing meter issues, and it now typically knows about problems before customers report them. Unitywater can now intelligently prioritize events and take planned evidence and risk-based approach to maintenance, with less need for emergency response. All this has had flow-on benefits for improved customer service.

Unitywater's operational excellence has led to water and sewerage usage charges frozen for seven consecutive years as part of the utility's ongoing commitment to keeping customers' bills low. George Theo said: "We aim to continuously reduce water lost due to leaks and bursts across our extensive network wherever we can. Not only does this help us to conserve and protect this precious resource, but it also helps keep our prices as low as possible for our customers. There's no question that our nine-year TaKaDu partnership has helped us deliver on this ongoing commitment."

"Our focus is to adopt a data-driven approach to our decision making and utilize our digital assets to solve complex problems by delivering customer benefits and better environmental outcomes while continually improving our operations," he continued. "TaKaDu has been instrumental in helping position Unitywater as an industry leader in innovation and technology, which has delivered exceptional outcomes for our environment and our customers."

THE VIEW AHEAD

As Unitywater continues its digital journey, it is investigating additional ways to work with TaKaDu to gain more visibility in its water network and beyond. It is considering adding new systems such as pressure transient sensors, acoustic loggers, and Advanced Metering Infrastructure (AMI), and integrating them into TaKaDu. It is also exploring options for using the TaKaDu system to monitor the Unitywater sewerage network.



Additionally, water scarcity and security across Queensland has motivated Unitywater to leverage its long-time experience with TaKaDu CEM to help other regional utilities in Queensland overcome challenges in starting their own digital journey.

"We take a 'we're all in this together' approach to conserving water and providing an essential service that is economically and environmentally sustainable," said George.

"Unitywater is exploring opportunities with other utilities with smaller customer bases who could leverage and benefit from the expertise and investment we have made in managing network leakage and providing 24/7 network monitoring. "It is exciting to think that we can share our knowledge and expertise with other water utilities in Queensland so that they too can experience similar benefits that would have been otherwise out of reach."

As a first step, in 2021, Unitywater and TaKaDu created a partnership to provide network monitoring, leak detection, and network prediction services to other service regions. The offer combines the TaKaDu system with the Unitywater data, its 24/7 control room and operations, and its vast expertise and knowledge. It will provide regional water utilities with a highly cost-effective and risk-free way to quickly establish a fully operational network monitoring and management system, with high potential for water and cost savings.

About the Contributor

***TaKaDu** is a global software provider of Central Event Management solutions for the water industry. Its automated cloud-based service enables utilities to DETECT, ANALYZE and MANAGE network events and incidents such as leaks, bursts, faulty assets, telemetry and data issues, operational failures, and more. Converting raw data into knowledge, TaKaDu provides visibility and actionable insights for increased operational efficiency and reduced Non-Revenue Water (NRW) loss.*

AI, CCTV INSPECTION, SOFTWARE, UTILITY, WASTEWATER PIPES

STREAMLINING AND AUTOMATING THE PIPE INFRASTRUCTURE MANAGEMENT

By VAPAR

THE ANGLIAN WATER PROJECT

About the Client

Anglian Water operates over 113,000 kms of water and sewer pipe asset, which services 6 million people across East of England.

Anglian Water is one of the biggest water companies in the UK and a leader in water industry innovation.

The Challenge and Opportunity

With an extensive network of over 76,000 kms of wastewater pipes, Anglian Water was seeking opportunities to leverage new market technology to gain efficiencies in their current network management process. The review of CCTV pipe inspection footage is a costly, resource-intensive, and time-consuming manual task and Anglian Water is not alone in seeking alternative solutions that can streamline this important part of managing and renewing gravity sewer pipes.

Anglian Water partnered with WaterStart, putting forward a proposal for innovative solutions to help solve the challenge. VAPAR was selected in round 14 of WaterStart's request for proposal, as the technology provider for this project.

At the core of VAPAR.Solutions platform is a powerful AI algorithm trained on over 2 million pipe defect examples. The automated condition grading of the inspection footage is aligned to regional standards and guidelines, producing results that met Anglian Water's requirements.

The Solution

A total of 10,000 meters of wastewater pipe inspections were processed with VAPAR.Solutions automatically identifying over 2,200 pipe features directly from the inspection footage using its AI engine. Anglian Water assessed the success of

PROJECT SNAPSHOT - ANGLIAN WATER

- **Automated review of 10,000 meters of wastewater pipe footage with over 2,200 pipe features digitized in less than 4 hours**
- **Improvements on accuracy and workflow turnaround**
- **Identified opportunities to optimize pipe renewal prioritization**

Anglian Water

> ***"It has been a great opportunity for Anglian Water to work with VAPAR, an established organization that understands both the underground network and the A.I. technology, through the WaterStart partnership. As this is a true digital solution, we were able to complete the first trial despite the current pandemic through true global collaboration. Combined with recent technological advances in CCTV data capture/storage systems, the potential future benefit in using an A.I. system is to improve the accuracy and consistency of the data processing whilst also making it faster and cheaper. We have had some extremely promising results from the initial work and look forward to the potential expansion of trials."***
> *- Asset Manager, Anglian Water*

the trial, and suitability for broader market uptake by focusing on three distinct measures: accuracy, workflow turn-around, and asset renewal optimization.

Key findings from the pilots include:

- VAPAR.Solutions showed approximately 80% agreement between manual assessment and AI.
- VAPAR.Solutions showed the potential to decrease the auditing effort required by as much as 30% compared to the current auditing workload.
- Based on the results, there is an opportunity to optimize renewal spending by as much as 20% by deprioritizing or deferring certain inspections that do not require immediate remediation.

What's Next?

Building on the success of this pilot, Anglian Water is now actively investigating new opportunities with VAPAR by providing the organization options for improved supply chain engagement. Specifically, implementing the automated verification process into the workflow and software ecosystem, providing a streamlined process for Anglian Water teams and their contractors.

THE UNITED UTILITIES PROJECT

About the Client

- One of the largest water companies in the UK.
- Wastewater network of 78,000 km (approximately 3x the size of the

largest network in the Southern Hemisphere, which belongs to Sydney Water.
- Reviews over 500 km of CCTV pipe footage annually (and this is increasing every year).

The Challenge and Opportunity

United Utilities is one of the largest water companies in the UK, with a wastewater network of 78,000 kms, which is approximately three times the size of the largest water utilities in the Southern Hemisphere, Sydney Water.

With such a vast network to maintain, United Utilities are challenged by a manual process to make assessments of which wastewater or drainage pipes to repair and when. United Utilities reviews over 500 kms of footage per year and this increases each year as more and more properties are connected to the growing reticulation network.

This massive amount of proactive inspection activity creates a large amount of rich data that needs to be centralized, organized, and stored. Furthermore, since condition data is determined manually and can be a subjective, objective comparison between data sets involving different operators is difficult to establish. In addition, this manual process is time-consuming – causing unwanted delays between inspection and assessment dates.

PROJECT SNAPSHOT - UNITED UTILITIES

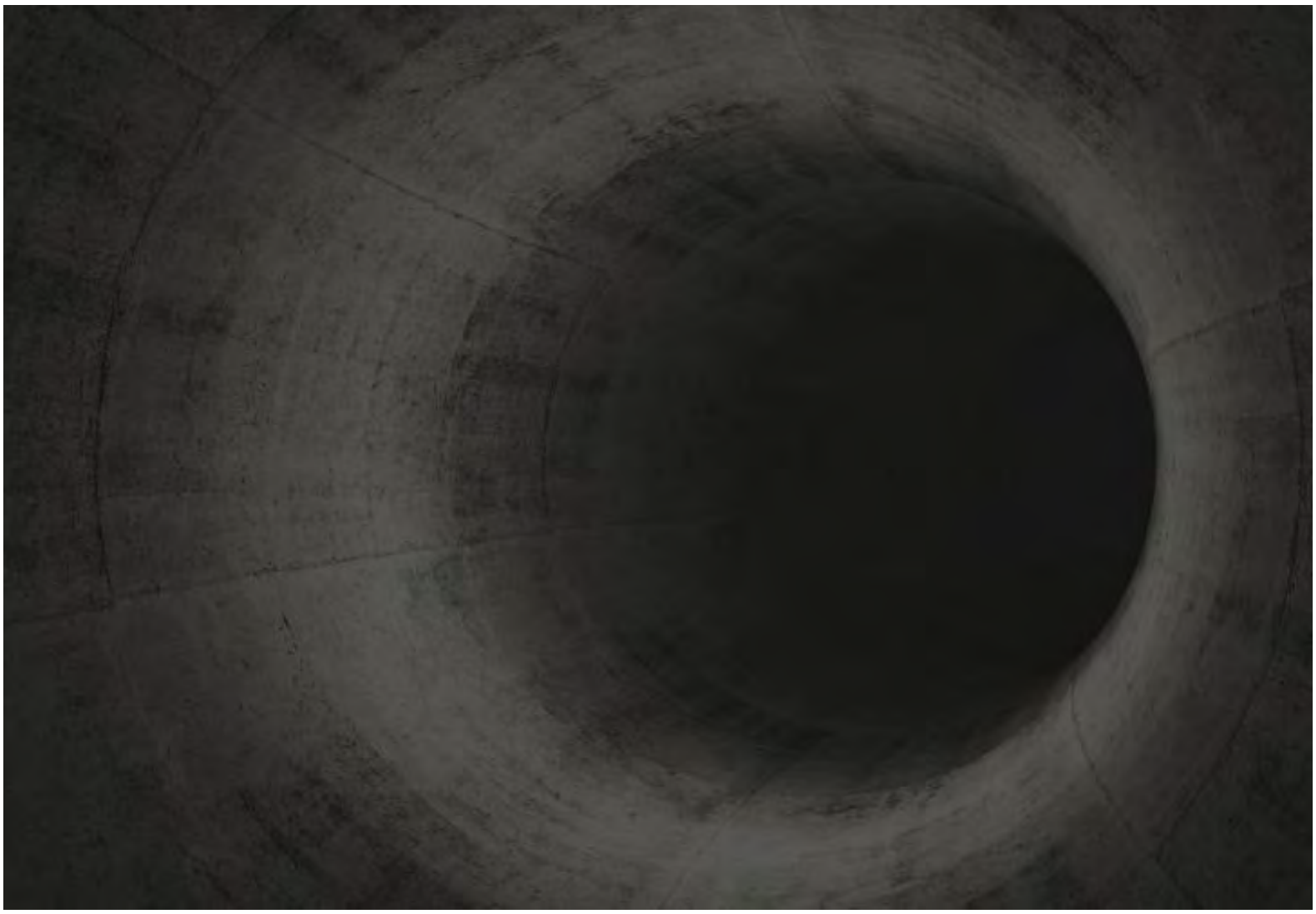
- **VAPAR is selected as one of eight companies to take part in United Utilities' Innovation Lab.**
- **Accuracy of AI models proven for CCTV Pipe Inspections proven, with improved results achieved over time.**
- **United Utilities and VAPAR worked collaboratively to align AI models to UK water standards.**
- **United Utilities and VAPAR now working together to implement the usage of VAPAR platform into UU's regular review process.**

As one of the world's largest utility companies, United Utilities are continually searching for innovative new tools and platforms to improve their processes and enhance their service offering to customers. As part of this proactive approach to business improvement, United Utilities funds and hosts an Innovation Lab initiative, offering companies from around the world a chance to offer innovative value-add solutions and technologies, prove the concept and value – leading to accelerated roll-out and adoption.

> ***"United Utilities is always on the lookout for ways we can provide world-class services to our customers. Using artificial intelligence to provide insights that can be actioned before issues arise is why we are interested in partnering with companies like VAPAR, who stand out because of their agility, technical skill, and willingness to work collaboratively."***
>
> *- Kieran Brocklebank - Innovation Manager, United Utilities*

United Utilties and VAPAR - Working Together

In September 2019, from hundreds of applications, VAPAR was selected as one



of eight companies to take part in United Utilities' Innovation Lab.

The Innovation Lab followed a 10-week structure, which saw a VAPAR team member temporarily co-located with the other participating companies at the United Utilities offices in Warrington, UK.

Based on numerous extensive observations of the end-to-end process delivered by United Utilities and their independent contractors, VAPAR delivered a comprehensive report to the United Utilities Transformation team detailing actionable improvements which could be made to reduce time and increase the efficiency of their end-to-end processes. Emphasis was placed on how VAPAR's automated defect detection system could be integrated to provide objective third-party assessments in a fast, scalable, centralized, and standardized way to benefit both United Utilities and their contractors.

Working together through the Innovation Lab, United Utilities and VAPAR were able to establish proven accuracy of AI models for CCTV Pipe Inspections, and also make significant improvements to the accuracy of these models. Crucially, United Utilities and VAPAR also worked collaboratively to align these models with UK Water standards, creating profound future implications for not only United Utilities, but the UK water industry as a whole.

Since the Innovation Lab, VAPAR and United Utilities have continued to work collaboratively. With United Utilities providing regular user feedback, VAPAR has continued to customize its platform, adding features to optimize its usefulness to users.

United Utilities has also undertaken software trials in three key areas for business improvement to ascertain current Business-As-Usual (BAU) readiness and map a plan for implementation into their operational processes. The two organizations have also worked together to develop and deliver documentation and training for use of the VAPAR platform.

What's Next?

United Utilities believe that VAPAR can act as an effective, innovative value-add to their service offering. United Utilities believe that the core operational benefits of the VAPAR platform involve:

- Time saved compared to a manual CCTV review process, allowing inspectors to allocate time to other priorities
- Standardization in the identification and classification of sewer defects, allowing for consistent recommendations to be made.
- Significant reduction in the turnaround time for surveys submitted by clients

Since the Innovation Lab, United Utilities has since taken the lead on driving the UK water industry towards software accreditation as a standard. During this

United Utilities

period, United Utilities have also since completed platform trials with VAPAR, with the two organizations now partnering to develop a pathway towards Business-As-Usual (BAU) implementation. United Utilities has partnered with VAPAR to build upon the accuracy of the VAPAR platform through training models, develop new platform capabilities, and ensure that VAPAR is meeting current and future requirements and integrations.

About the Contributor

VAPAR *builds software to streamline and automate the management of pipe infrastructure. VAPAR uses AI to review stormwater and sewer pipe inspections and hosts utilities' data on their cloud platform to make decision-making quicker, easier and more objective. In 2021, the VAPAR platform processed over five hundred thousand meters of wastewater infrastructure and delivered 497 projects across Australia, New Zealand, and the UK. Since its establishment, VAPAR has received over $1.2 million in funding from the Australian Government, NSW Government, and some of Australia's most ambitious investors.*

DOSING PUMPS, WATER DISTRIBUTION, WTP

PUMP SOLVES PIPELINE PRESSURE CHALLENGE AT A WTP IN FRANCE

By Watson-Marlow Fluid Technology Group (WMFTG)

The Villejean water treatment plant near the city of Rennes in Brittany faced a structural challenge in adding sodium hypochlorite to a drinking water storage reservoir due to the unusually long length of the pipeline transporting the chlorine.

Watson-Marlow Fluid Technology Group (WMFTG), which is the world's leading manufacturer of peristaltic pumps for water treatment, has worked with most of the water treatment plants in the Collectivité Eau du Bassin Rennais (Rennes Basin Water Authority) for several years. The authority manages the entire local water system from abstraction to tap, with responsibility for maintenance, monitoring, and repair for 11 treatment plants.

These assets include a 5,000 m^3 drinking water storage reservoir, which serves around 500,000 people in the region, distributing an average of 25,000 m^3 of water through the network each day. This reservoir is fed by both the Villejean plant and the Rophémel plant, which is nearby, and the water requires chlorination at 0.3mg/liter.

The plant already employs a number of Qdos pumps, each fitted with a ReNu pumphead optimized for sodium hypochlorite, sulphuric acid, and hydrogen peroxide applications, with discharge pressures up to 4 bar.

The use of Qdos pumps for both sulphuric acid and hydrogen peroxide at the plant enabled fast, simple and safe maintenance compared with the diaphragm pumps deployed previously. Replacing ReNu pumpheads requires no tools, specific training, or maintenance technician intervention.

However, the discharge pressure for the 15% sodium hypochlorite dosing when being added to the storage reservoir remained a concern and a priority for improvement.

IN BRIEF

- **Water purification plant in France experiencing chlorine degassing issues in 80m pipe run**
- **Qdos CWT chemical metering pump overcame an issue with an innovative operational concept**
- **Maintenance interventions reduced by 75%**

Qdos CWT Installed at Villejean Water Treatment Works

"The QdosCWT pump easily withstands overpressure in the long pipe run, as well as the aggressive nature of chlorine. As a result, its service life is significantly longer."
- Kevin Brard, Operator, Villejean Water Purification Plant

For structural reasons, the sodium hypochlorite tank is located inside the Villejean plant with chlorine distributed to various injection points throughout the facility via pumps at an adjacent location. However, the linear pipe run that brings chlorine to the water storage reservoir is 80m long and along this length chlorine degasses in the pipeline, raising the discharge pressure beyond 7 bar and causing pump accuracy problems.

WMFTG's Qdos CWT (Conveying Wave Technology) chemical metering pump, launched globally in 2021, was initially introduced at Villejean on a trial basis in December 2020. It proved ideal in meeting the abnormally high-pressure constraints of the installation. The Qdos CWT™ pump offers all the advantages of a standard peristaltic pump, but with significantly longer service life.

To achieve the peristaltic pumping action, the Qdos CWT pump incorporates an EPDM element rather than a tube, which acts against a PEEK track. The element in contact with the fluid is subject to very low-stress levels, which means that the Qdos CWT pump offers a significantly longer service life than a conventional alternative, even at high pressure.

In addition, Qdos CWT pumps allow the dosing of chemicals, including sodium hypochlorite for post-chlorination cycles, with high precision and regularity over the entire life of the pump. This means overdosing practices often required by other technologies to achieve a constant level of accuracy are avoided.

The Qdos CWT pump runs at 2 liter/hr on average, with a 4-20 mA input signal. The

pump has already reduced the frequency of maintenance interventions at the Villejean plant, which produces 7-11 million m^3 of drinking water per year, by 75% since its installation in December 2020.

Trials with Watson-Marlow's new Conveying Wave Technology (CWT™) pump at a water treatment plant in Northwest France proved it was ideal for meeting abnormally high-pressure constraints, explains Philippe De Miranda, industrial sales engineer, Watson-Marlow Fluid Technology Group, France.

Kevin Brard, the operator of the Villejean water purification plant, says: "The Qdos CWT pump easily withstands overpressure in the long pipe run, as well as the aggressive nature of chlorine. As a result, its service life is significantly longer."

"We were already satisfied with the performance of Watson-Marlow's Qdos pumps for metering of sulphuric acid and hydrogen peroxide, as well as two Bredel 50 hose pumps for lime slurry. Now we have a new Qdos CWT pump model to feed the bleach solution into our tank reliably."

About the Contributor

Watson-Marlow Fluid Technology Group (WMFTG) *is a leader in peristaltic pumps and associated fluid path technologies. The group comprises ten established brands, each with its own area of expertise. Together they provide leading engineering solutions across the food, pharmaceutical, chemical, and environmental industries. WMFTG is headquartered in Falmouth, UK with international operations in 44 countries and employing over 1750 people globally. Watson-Marlow is a wholly-owned subsidiary of multi-national industrial engineering Group, Spirax-Sarco Engineering plc, a constituent of the FTSE 100, with strategically located manufacturing plants around the world and almost 8,000 employees, including 1,900 direct sales and service engineers.*

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