The Value of Wastewater Data

The Value of Wastewater Data

What's in this white paper?

What follows is a breakdown of some of the key applications of real-time data access in the wastewater sector.

The discussion will look at some of the primary operative challenges wastewater-related service providers - primarily utilities and local authorities - face, and how wastewater data can provide vital insight that would otherwise be inaccessible.

Understanding our wastewater is the backbone of value creation from wastewater data. All the value areas discussed in this paper rely on better understanding effluent, determining the actions required to protect the world we live in by looking at the data that flows beneath it.

Wastewater data is changing how we live, improving water quality, supporting advanced public health programs, and optimizing infrastructure assets all over the world.

It's a strong statement, and while true, wastewater data is far from the universal tool it could be. While used increasingly widely across Europe, North America, and some areas of the middle east, wastewater data systems are still a relative rarity.

Technologies that extract live condition data from wastewater collection systems and provide real-time analytics to support data-driven decision making have only become a practicable reality over the last decade. Recent developments have seen data service providers overcome many of the barriers inherent to operating complex technological systems in the harsh and changeable environments associated with wastewater.

Where these systems are in place, the operational benefits they support are clear, with key value areas including:

Water quality improvements

Supporting increased water availability, smart resource management, treatment optimisation, and enhanced environmental health.

Public health management

Providing policy makers and public health authorities with rapid and reliable data concerning the wellbeing of the communities they serve, and supporting them to allocate resources efficiently, adapting plans to match real-world needs.

Asset and operational optimisation

Enabling wastewater service providers to make the most of resources, focusing their team's efforts where they're needed most, and investments are directed for maximum impact.

Wastewater Data explained

What do we mean by wastewater data?
Putting it simply, wastewater data is the empirical information gleaned by the close examination of industrial and municipal effluent, generally conducted either in a laboratory setting or remotely using in-line sensors.

This discussion will primarily focus on the latter - data gathered directly from within wastewater collection networks, and the benefits that access to such data resources can bring to those operating wastewater systems, or associated operations.

On the edge of a data revolution

The wastewater sector is used to operating with limited real-time information about what's happening within collection networks from moment to moment, largely because the data services that can support that oversight have not been available.

This is no longer the case, but we're still in the early period of adoption and adaptation; the sector is being introduced to new technological possibilities that have the potential to change operating modes entirely.

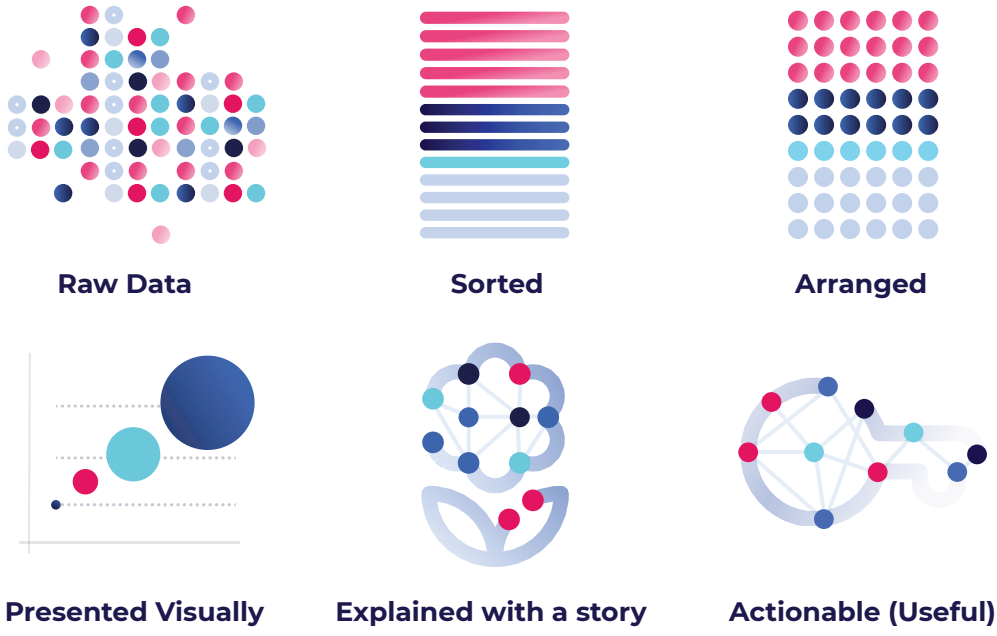


Fig. 1, Turning data into a tool – Turning wastewater data into an effective operative tool is not as simple as extracting raw data from the network; that is only the beginning of the process. Kando Pulse is an end-to-end system, enabling optimized data extraction, communications, and processing, supporting data to become valuable asset users need.

In short: we're on the edge of a data-driven operational revolution.

A close analogy to think about the impact this change may have is to consider how the addition of a smartphone has changed how individuals conduct themselves day to day. Every aspect of your life can be impacted by rapid access to services and information, increasing the 'operational' convenience of your days.

You can pre-order and prepay for your lunch without ever needing to carry cash. You can check live traffic conditions before planning your route home. You can locate your lost keys. You can check your bank balance, your credit rating, or what the weather is like on the other side of the world, all in less time than it takes to brush your teeth... which is, incidentally, another process that can be optimized using a smartphone.

There are very few aspects of our lives that haven't been touched by the addition of ready data access. It's almost hard to imagine life without it, but rewind just 15 years and the world was a completely different place. The iPhone had just appeared on the market, and few would have predicted the impact it and similar devices would soon have on our daily lives. As consumers, we were focused on operating in the world we knew with the tools we had available to us, so we didn't recognise the immense value we weren't accessing.

A limited number of people working in the right departments of Apple, Nokia, Intel, or HP would have excitedly told you what was possible, and just around the corner, but you'd have been forgiven for ignoring them.

Then our collective reference frame changed and there's no going back.
We're in the same moment in wastewater right now.
We're on the edge of a data-driven value revolution, and what we think of as normal will never be the same again.

Data application - Value areas

01 / Water Quality

Water resources are finite, and clean water is an essential part of almost every human and natural process.

Ensuring high quality water outputs from treatment systems is vitally important if we are to maximize the value of available water resources and minimize the potential negative impacts of human water use on the world in which we live.

The 2018 edition of the UN World Water Development Report stated that nearly 6 billion people will suffer from clean water scarcity by 2050 as a result of increased water demand and water resource degradation driven by population increases and economic pressures.

Understanding wastewater quality and when conditions change within networks can have a significant impact on the quality of water produced through the treatment process, providing a higher quality effluent for reuse and the safe reintroduction of outflows into external water systems.

Quality data from inside the network

Recognizing when wastewater quality within collection networks deviates from ideal norms is key to improving wastewater quality outcomes and optimizing the overall quality of water produced by human processes - water that ultimately feeds back, whether directly or indirectly, into the natural water cycle.

There are several key applications for wastewater quality data that can lead to improved water quality at the end of the treatment process.

Contamination detection	Real-time event fingerprinting	Live mapping	Pollution prevention

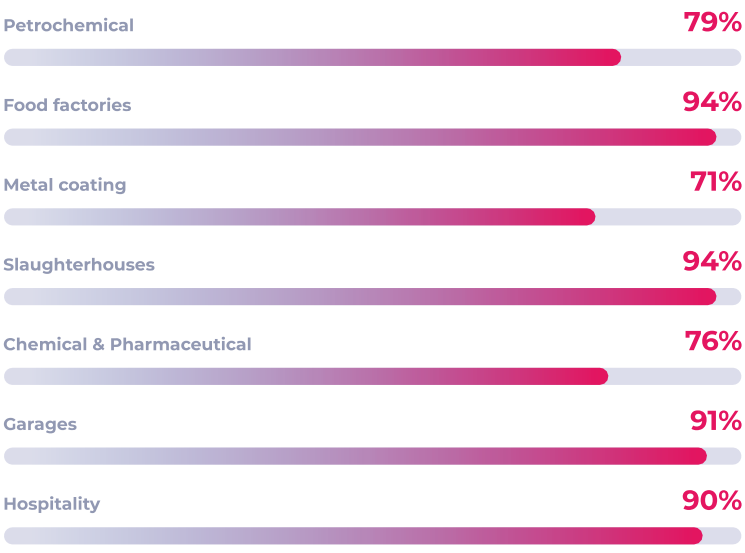
Wastewater quality monitoring forms an important part of regular operations for wastewater utilities, determining treatment processes, community communications, and investment strategies. To now, the process has been largely based on a schedule of manual sampling, whereby utility field operatives extract samples from the network at set locations at set times prior to these being examined in a lab.

The process is laborious, slow, and, given the unpredictable nature of influent to the network and wastewater treatment plants, prone to oversights. Using these methods utilities and treatment authorities will not know about detrimental changes in wastewater conditions before the contamination has already arrived at their treatment facilities and begun to negatively impact their processes and outputs.

Automation has been a part of wastewater sampling processes for some years, but these systems have, until recently, simply been an extension of conventional, regular testing regimes. Rather than a field engineer going to a target site and collecting a sample at set intervals, the process is transferred to an on-site, remote sampler. Nonetheless, these remote units have largely operated to the same set schedule as their human counterparts and suffer from the same limitations.

Real-time wastewater analytics and data-driven smart systems are the next step

Using in-network data acquisition and communications, users receive live, moment to moment feedback from sensors within their collection systems. When conditions within the network change, these developments are immediately reflected in the data, improving user oversight tenfold.



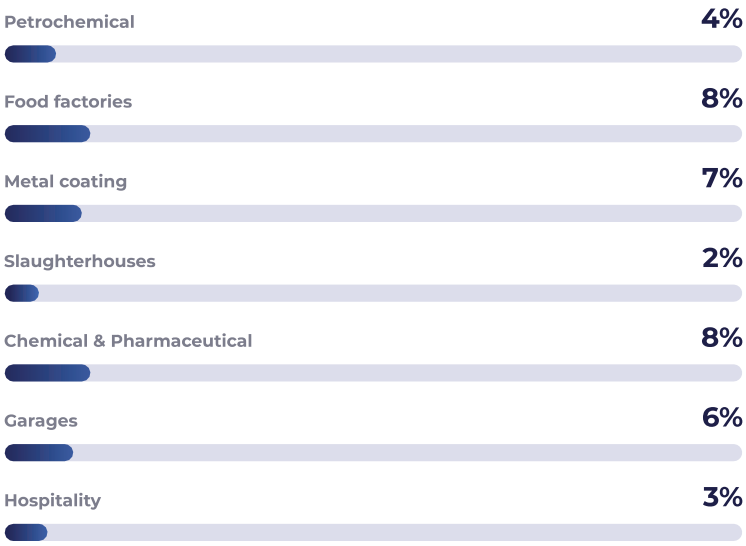


Fig. 1, Turning data into a tool – Turning wastewater data into an effective operative tool is not as simple as extracting raw data from the network; that is only the beginning of the process. Kando Pulse is an end-to-end system, enabling optimized data extraction, communications, and processing, supporting data to become valuable asset users need.

Users see every change, not only those that happen to correspond with scheduled sampling structures. By coordinating between data acquisition locations, they can see where in their network changes originate, and improve inputs in their network by user communications.

By gaining access to live data inputs and better understanding the changing conditions inside their network, wastewater system operators can optimize the effluent quality entering the system, their handling processes, and the output resources they achieve.

56% of monitored factories saw reduced pollution intensity and duration, leading to...

Wastewater Data and Water Quality in a Nutshell

Real-time wastewater condition insight supports utilities and wastewater service operators to:

01 /

Identify when networks conditions change and adjust treatment and handling processes to meet real-world needs

02 /

Conduct active contamination mapping, source detection, and pollution prevention through positive user engagement

03 /

Provide high quality wastewater outputs for advanced reuse applications, maximizing water resource optimization

02 / Public Health

A second key value area for wastewater data is public health improvement, this is mainly through optimizing an established epidemiological process known as wastewater-based epidemiology, or WBE.

WBE uses wastewater analysis to identify pathogens and key health indicators in wastewater, outlining trends and profiling issues that may be endemic in a population.

This technology has developed rapidly during the COVID-19 pandemic, with public health authorities all over the world turning to WBE to supplement more conventional clinical testing within their populations to identify disease outbreaks.

While at time of writing, in-network wastewater data inputs are as yet unable to determine specific public health indicators in wastewater, real-time wastewater condition reporting can form a vital tool for optimizing the samples used for lab analysis.

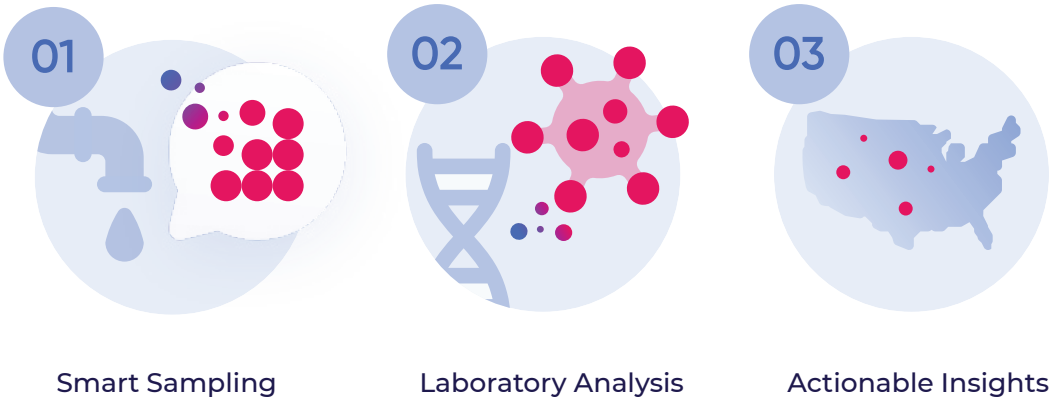


Fig. 4, Data optimization - WBE systems are only as good as the samples that are used in their analysis. Deploying effective condition data reporting and analysis from within wastewater collection systems enables public health authorities to act with confidence. Conditions within networks can impact the representative quality of wastewater samples, reducing the effectiveness of a WBE system to report real-world public health conditions accurately.

WBE systems' effectiveness can be impacted significantly by the quality of wastewater used for analysis. Poor wastewater conditions may have a negative effect on the vitality of any organic indicators - bacterial or viral materials, for example - potentially reducing the representative quality of any WBE test results.

The application of in network quality data analytics reduces the risk of any false or misleading results from WBE testing, enabling policy makers to act with confidence to protect the communities they serve and develop improved public health outcomes.

Using optimized wastewater data, public health authorities can do a number of things over a number of different time scales.

In the short term, they can operate WBE testing to monitor the real-time health condition of communities within their jurisdiction.

Data can be anonymized to protect personal privacies and requires no extraordinary inputs from those being tested, while simultaneously enabling authorities to achieve 100% coverage across communities and identify specific health conditions as they emerge and develop in real time.

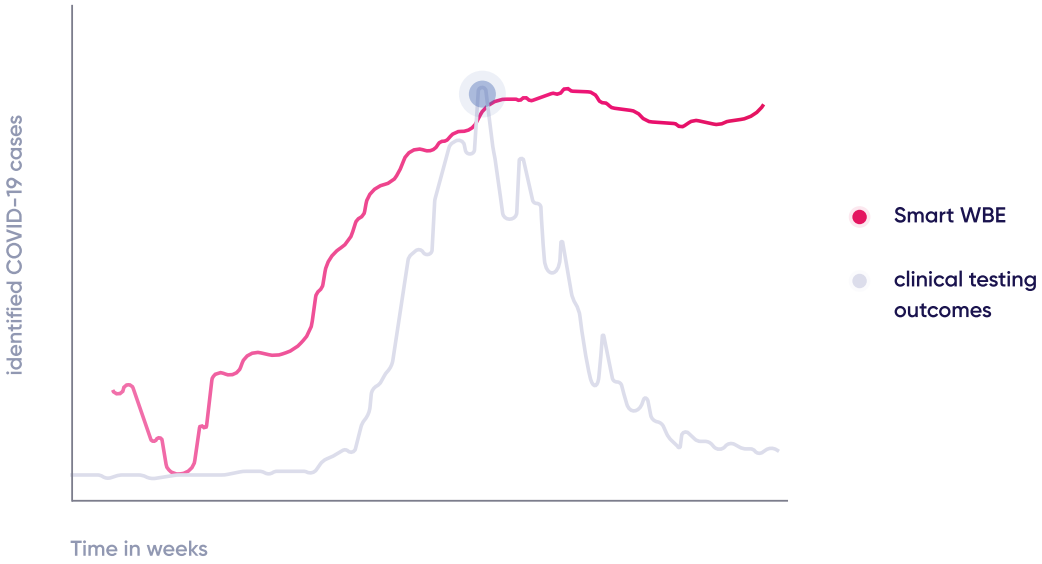


Fig. 5, Complimenting Clinical Oversight – The above graph is based on representative data consolidated from WBE projects across the world.
When conducted using smart wastewater condition monitoring for data optimization, WBE projects can be used to corroborate the effectiveness of clinical testing, ensuring clinical engagement represents the cross-community reality of any public health circumstance. While clinical, individual testing will remain a vital tool for epidemiology processes and for determining public health protocols at moments of acute or novel outbreak, WBE testing can be an effective, cost-effective, long-term tool for public health monitoring and data oversight.

WBE testing can be used to supplement clinical testing methods, maintaining an accurate, cost-effective and efficient method of monitoring a population's health status in both the short and long term.

By extracting representative data from multiple defined points throughout a community, smart WBE systems also support outbreak and public health indicator mapping, alerting authorities both to emerging hotspots and improvements in community health.

This data can be vital for determining responses, as well as developing and evaluating the efficacy of public health policy, both for long and short term expediency.

During the COVID-19, aggregated data from real-world applications suggests that optimized WBE systems could have saved public health authorities around $200 per capita in individual testing costs.

$200/capita | savings over individual testing

A tool for the long term: multi-target applications beyond COVID-19

In 2022, the primary driver of this application remains the COVID-19 pandemic, supporting governments and public health authorities to direct resources effectively and achieve unparalleled oversight over the health status of the communities they serve.

In the long term, as COVID-19 becomes endemic, the applications of this technology will expand, along with the value return offered.

In the US, the CDC has already outlined a list of potential targets for future focus, focussing on pathogens that:

- Shed 'visibly' in stool
- Are not commonly shed post-recovery
- Remains stable enough for nucleic acid detection
- No significant challenges to molecular detection

The pathogens ear-marked to be of immediate interest are:

- Norovirus
- Candida Auris
- Influenza
- Respiratory Syncytial Virus
- Shiga toxin-producing E. Coli
- Campylobacter sp.
- Salmonella spp.
- Cyclospora
- SARS variants

For each of these, present techniques for WBE optimization through wastewater data applications can provide a useful complement to current epidemiology and clinical processes, enhancing the accuracy and representative validity of WBE testing, and supporting users to act with greater confidence and speed.
Beyond pathogenic epidemiology, the next step will be to build data analytics systems that can identify health indicators such as antimicrobial resistance, chronic health trends (diabetes, stress, depression, hormonal disorders, etc.), and nutritional profiling, that can be used to optimize health spending and community health outcomes.

Wastewater Data and Public Health Value in a Nutshell

By applying wastewater data analytics to support improved public health outcomes and oversight, authorities can:

01 / Determine multi-target disease prevalence in specific areas, mapping outbreak intensities for target indicators

02 / Target responses and resources for maximum effect, identifying when and where financial and practical assets should be applied for maximum benefit

03 / Improve overall public health oversight without compromising personal data privacies

04 / Complement clinical community testing with rapid representative condition reporting and data communication.

05 / Improve public communications - using data-supported resources to show the public the real-world state of community health, and the results of directed public health policy.

03 / Asset optimization

Asset optimization means making the most of the resources users have at their disposal to achieve their goals.

Whether infrastructure systems or their vital human team, wastewater data can be used to optimize the tools available to service providers, extracting maximum value from investments and resource applications.

With wastewater service providers constantly being asked to return ever more impressive performance with ever more limited resources, data-driven insight systems can provide a vital tool for optimizing resource application.

For asset maximization, value return areas breakdown into two key groupings:

01 /

Infrastructure and capital expenses

02 /

Human resources and operational expenses

Infrastructure and capital expenses

Within the directed wastewater management sector, infrastructure and capital assets include collection networks and treatment facilities, as well as water reclamation and storage facilities. Each is subject to detrimental effects associated with prolonged contact with potentially harsh effluent, and each is liable to suffer the impact of fluctuating wastewater conditions.

Prior to and without the application of wastewater data extraction and analytics systems, potentially harmful contaminants arrive at wastewater treatment facilities with minimal warning, leading to potentially crippling damage being caused to treatment systems. These events limit treatment processes effectiveness, often leading to protracted environmental damage events, or compromised wastewater resource quality with limited reuse application.

c.$17billion | yearly global CAPEX saving potential based on 2022 spending forecasts

With global wastewater utility CAPEX projected to exceed $167 billion in 2022, even fractional savings can have significant financial impacts, with independent market analysis, estimating the impact of wastewater data driven solutions at around 10%.

These savings are spread between asset renewal and expansion cost mitigation, resulting from improved wastewater behavioral understanding and the resulting increases in quality.

Between 2016 and 2020 | data-driven CAPEX savings potential was upwards of $68 billion.

Improved wastewater has a reduced impact on collection and treatment infrastructure, minimizing renewal costs, while at the same time improving the effectiveness of existing, heritage systems. This in turn reduces the need for investment in additional capacity, lowering the necessary CAPEX required to achieve optimal outcomes.

Human resources and operational expenses

Perhaps even more significant is the application of data systems in day-to-day operations, and the positive impact data tools can have on OPEX and human resource deployment.

The data-driven enhancement of wastewater quality can reduce treatment costs significantly, being used to improve influent quality prior to arrival to wastewater treatment plants, or redirect harmful flows to limit the negative impact of contaminants on treatment systems.

Looking at treatment energy costs alone, real-world applications suggest a reduction of 10% in systems where data-driven insights are used to support process optimization, together with an additional 6% savings through chemical and other operational cost reduction.

Accounting for all process optimization, between 2016 and 2020, independent market analysts, Global Water Intelligence estimate around $74.2 billion in data-driven savings potential across key utility applications - a potential that went largely unrealized.

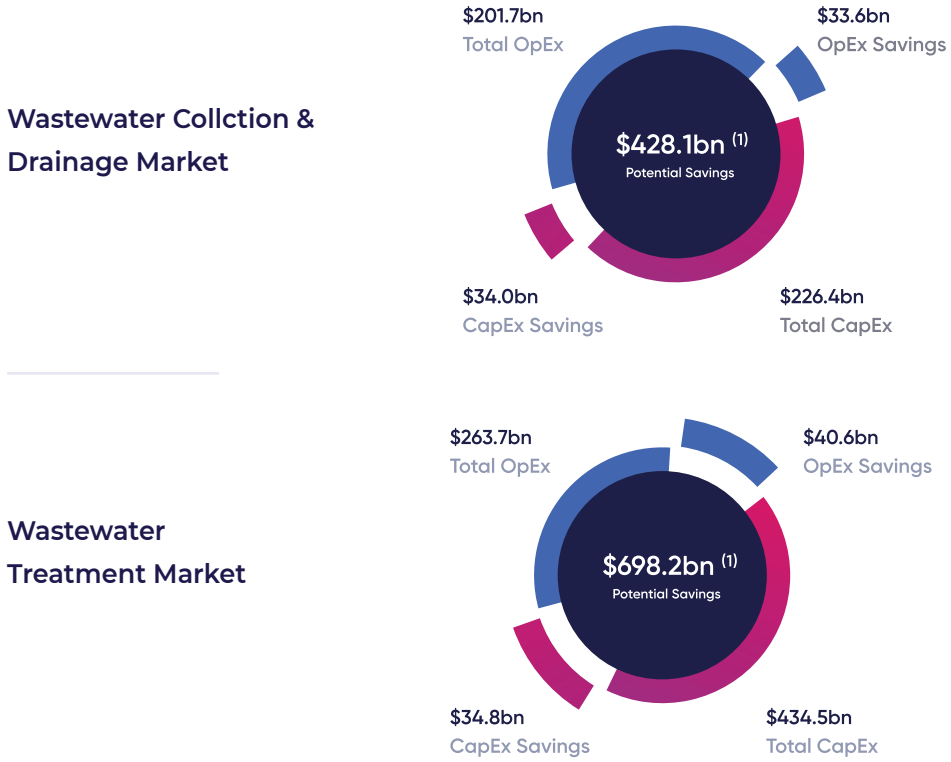


Fig. 6, Wastewater data for cost reduction - Wastewater data is projected to have a huge potential impact on wastewater spending globally. The chart above represents spending in key sector areas over the 5 years between 2016 and 2020, with the estimated cost savings that could have been achieved had data-driven optimization been implemented. Source, GWI

Utility personnel are also key assets that cannot be ignored.
These individuals are vital for the optimal operation of utility systems. They can have a mutually supportive relationship with the application of a data-driven system, both benefiting the system, and contributing the benefit of their experience to making the system more effective.

Workforce turnover is high in the wastewater sector, with many of the sector's most highly experienced workers reaching retirement age.

With reduced personnel numbers and a potential dearth in experience, digital systems can provide a vital tool for supporting staff in their work, augmenting smaller workforces to be as effective as larger ones without compromising personal wellbeing, and digitizing the expertise and insights that might otherwise be lost as key personnel retire.

With comprehensive digital systems to support augmented workforces, systems optimization will extend to human as well as infrastructure assets.

Wastewater Data and Asset Management in a Nutshell

By applying wastewater data analytics to maximize asset value realization, users can:

01 /

Achieve significant data-driven cost optimization, reducing TOTEX by between $1M $10M/year in a qualified city (population equivalent c. 250,000)

02 /

Optimize capital investment, reducing unnecessary treatment capacity increases through wastewater quality improvements while minimizing damage to existing assets

03 /

Digitize vital operative experience,
minimizing the impact of staff turnover

04 /

Ensure human resources are used most effectively, automating and augmenting processes with data systems where possible

Delivering Wastewater Data: Kando Pulse

Hand-in-hand with the data revolution, Kando enables cities, water utilities, and nations to see the full picture, gain control, and be proactive based on data

> *"Authorities and service providers have a hard time tracking up the pipe to find out where [pollution] came from and when conditions change. A technical advance that would be really terrific would be to have sensors along the pipe, so you would know when something was coming and mount some kind of defense [to protect assets and maximize value outcomes"*
>
> Rick Reibstein | Boston University & member of the board of the National Pollution Prevention Roundtable

Data can show you what you can't see

Kando has developed an unparalleled data extraction, analytics, and communications tool to maximize and deliver data-based value from wastewater.

The wastewater intelligence solution, Kando Pulse, uses IoT connected data collection units positioned within client networks to monitor wastewater conditions in real time. Kando then analyses the data, and provides a detailed, minute-by-minute view of what's happening inside wastewater collection systems.

The tool identifies fluctuations in wastewater conditions within collection networks, enabling users to respond and optimize parallel systems in light of real-world conditions.

With this insight, users can:

01 /

Limit decreased wastewater quality damage of all kinds, improve treatment outcomes, and enhance water availability for all applications

02 /

Optimize WBE systems for disease control and improved public health responses

03 /

Engage in effective, data-supported public engagement programs

04 /

Maximize the effective application of vital - and often limited - resources of all kinds

It also supports improved stakeholder engagement at every level, providing utility teams, municipalities, relevant authoritieis, and those contributing to the networks with a transparent frame of reference, describing conditions and condition trends in close detail. Users can use data-driven insights to prioritize actions and create a wider and more transparent dialogue for behavioral change between them and contributing dischargers.

In-network Wastewater Data Extraction

Rather than depending upon entirely sample derived wastewater quality insights, Kando's smart wastewater intelligence system uses a system of 'internet of things' (IoT) enabled data gathering units positioned within client wastewater collection networks.

Real-time data gathering is central to maximizing wastewater data value. Condition sensors, data loggers, and automated event-triggered samplers (ISO 5667-10:2020) installed around collection networks provide the data needed to support an array of smart wastewater data applications.

Kando's smart IoT units continuously collect wastewater data from the sewage network and transmit it into the cloud, where machine learning algorithms transform the data into actionable insights.

If the data-gathering unit is also equipped with a remote sampling unit, this same feedback determines the precise moment when grab samples should be taken in order to generate a representative profile of real-world wastewater contamination.

Some IoT units also include an automatic sampler, calibrated to collect samples whenever contamination events are detected, ensuring acute changes in condition are not only registered and described by the in-network sensors, but an effective sample, profiling its exact nature is captured for further analysis and data validation. This is central to effective WBE systems, with suboptimal sample conditions automatically postponing representative sample collection.

Ground-breaking analytics

Extracting good data is only half the story. That data is only as valuable as how it is handled, understood, and applied.

After data is extracted from wastewater networks, it is transmitted to Kando's cloud-based analytics engine and 'cleaned' using comparative big data analysis. Building on more than a decade's experience and data records from projects all over the world, Kando are able to draw on unique tools and expertise for understanding patterns and trends in wastewater behavior. This enables the company's analytic processes to model uninterrupted data flows based on sometimes limited or patchy data inputs from the network.

Once a dataset has been 'cleaned' in this way, Kando's AI algorithms process the inputs to provide real-time analysis, enabling rapid event and trend identification which is then transmitted back to users.

Kando's online dashboard provides users with easy access to live oversight of their whole network, mapping developing wastewater conditions, profiling discharges, and alerting operators to potentially damaging events in real time.

Armed with this base of understanding, all the benefits discussed above can be achieved. Wastewater discharges can be better managed, improving wastewater quality and water availability all over the world. Viable samples can be extracted, enabling unparalleled accuracy for WBE, improving public health outcomes for millions.

Upgrade, maintenance, and renewal projects can be optimized to meet real-world needs, and utilities can make the most of the valuable expertise contained within their workforces.

Realizing the Value of Wastewater

Wastewater is changing. With the introduction of advanced, data-driven digital systems, operators and wastewater service providers are able to see and understand their networks, the wastewater they collect, and the impact those flows will have as never before.

This is a smartphone moment - changing the way we look at data availability and applications. Live data reporting and optimisation will change how we think about wastewater.

It's a resource, not a pollutant.

It's a tool for better public health, not something to be flushed and forgotten.

It's an asset that can be handled in a targeted way, reflecting real-world needs and producing enormous real-world benefits.

We're on the edge of a data revolution, and Kando are at the cutting edge of what's possible, maximizing value in ways we hadn't imagined before.

Data is enabling real-time oversight and understanding that will change the world for the better, building ever more efficient systems for improved public health, community welbeig, and environmental sustainability, all while reducing costs.

For a long time, technology has lagged behind our needs, but that's no longer the case. The moment for change is now. The key is to recognize the opportunity that has quietly snuck up on us, recognize that the revolution has started, and to loudly make the most of it.

kando.eco | info@kando.eco

This report is published by Kando Environmental Services Ltd.