RAPID DELIVERY OF FLUORIDATION SYSTEM UPGRADES AND RENEWALS

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ABSTRACT

In 2022, Wellington Water engaged Stantec, Lutra, and Brian Perry Civil to design, construct and commission new fluoridation dosing systems for two water treatment plants (WTPs), and to identify and implement improvements to the existing systems at its other two plants. The new systems had to be fully compliant with the Fluoridation Code of Practice (Water NZ, 2014), automated, safe and user-friendly for the operational teams. They also had to integrate seamlessly into the existing treatment plants.

The greatest challenge was meeting these objectives within a very tight timeframe for the two new systems. Wellington Water set a delivery target of five months from project initiation to dosing fluoride, much tighter than the 12-18 months a project like this would usually take.

The project's key driver was the rapid re-instatement of full fluoridation of the Wellington region's drinking-water supply. Dosing facilities at the Te Marua and Gear Island WTPs had recently been shut down on account of operability issues. An ensuing review of all fluoridation assets found that the dosing facilities at the Waterloo and Wainuiomata plants had limited capacities and did not meet the Fluoridation Code. With the support of its council owners and stakeholders, Wellington Water committed to restore reliable fluoridation as a matter of urgent priority. For the Te Marua and Gear Island plants, a solution of new containerised hydrofluorosilicic acid dosing systems was devised in collaboration with consultant and contractor partners Stantec and Lutra. The other two facilities were to be refurbished to bring them into conformity with the Code and to improve capacity and reliability.

Given the fast-track nature of the project, regular and effective communication between the implementation stakeholders throughout the project was essential. Workstreams which would typically be executed in sequence occurred in parallel. While necessary for achieving the deadline, such accelerated delivery can increase the risk of missing key design elements as implementation steps took place simultaneously. Other challenges faced by the project included equipment, materials, and labour shortages and extended delivery timeframes caused by COVID-19. In some instances, temporary measures had to be applied while awaiting delivery of the permanent components.

A tight timeframe for restoring fluoridation required the development and implementation of a highly efficient and flexible delivery framework complemented with robust risk management. This approach helped to focus and streamline

organisations and teams to successfully deliver both on their respective roles and the overall project outcomes. It also fostered development of local skills and capabilities, which will be essential given the attention now being directed towards fluoridation across the country following recent legislative changes.

Through it all, the parties involved worked closely in a truly collaborative, best-for-project approach to achieve the project goals. With the success of implementing this approach on a high-stakes project with public health implications, we believe it could and should be adopted on more public projects across the water sector. This is particularly so as we confront the stark contemporary challenges we face in drinking-water quality, environmental protection and climate change.

KEYWORDS

Fluoride, fluoridation, project delivery, expedited delivery, efficiency, risk management, public health.

PRESENTER PROFILES

Julian was formerly the Sustainable Water Supply & Demand Programme Manager with Wellington Water. His primary role was concerned with water resource management, particularly demand and water loss management, smart water metering, promoting water conservation. He also took the lead on the Wellington Regional Fluoridation Improvement Programme and the corresponding CAPEX facility upgrade project.

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INTRODUCTION

Fluoridation is a key aspect of drinking-water supply, providing protection against tooth decay and associated broader public health benefits. In light of its proven safety, effectiveness and affordability, fluoridation of drinking-water supplies has been written into legislation to provide for a nationally consistent approach to fluoridating drinking-water supplies and promote its adoption across New Zealand (Ministry of Health, 2023). The Health (Fluoridation of Drinking-water) Amendment Act 2021 enables the Director-General of Health to direct local authorities to add fluoride to a drinking-water supply to improve oral health outcomes.

In 2021, not long before the legislation was passed, Wellington Water was confronted with fluoride dosing issues at two of its four water treatment plants. Public and worker safety concerns related to the performance and reliability of aging dosing facilities at their Te Marua and Gear Island water treatment plants (WTPs) led to operational decisions to cease fluoridation at those sites on 24 June and 24 November 2021, respectively. In response to this, Wellington Water initiated a technical review of the fluoridation systems at its four metropolitan

WTPs. It was found that the two non-functioning systems required immediate replacement as they were in a state where they could not be modified to be made fit for purpose. All four facilities had issues with capacity and redundancy and exhibited non-conformances with the Fluoride Code (Water NZ, 2014).

In addition, the three sodium silicafluoride (SSF) dosing facilities (at Te Marua, Waterloo and Wainuiomata WTPs) were found to have material-handling problems caused by inferior quality SSF powder. Most importantly, over the four years prior to dosing being stopped at the Te Marua and Gear Island WTPs (July 2017 to June 2021), the facilities at the four plants combined met the recommended fluoride residual concentration of between 0.7 and 1.0 mg/L just 38% of the time, and the facilities had been out of operation 40% of the time (Jaduram, 2022).

Wellington Water acted quickly to bring their fluoridation facilities up to code under a renewed commitment to maintaining consistent fluoridation across its drinking-water network. In the first quarter of 2022, Wellington Water engaged Stantec, Lutra, and Brian Perry Civil to design, construct and commission two new package fluoridation dosing systems for the Te Marua and Gear Island WTPs. The Te Marua WTP produces drinking-water for the Hutt Valley and Wellington metropolitan reticulation networks. The Gear Island WTP provides a continuous top-up dose of chlorine and fluoride into the treated water being pumped from the Waterloo WTP in Lower Hutt into Wellington City. The Gear Island WTP also operates as a small production back-up WTP fed from a nearby well-field.

These package plants became the focus of an expedited project delivery model. Essential to the project delivery was a clear and robust project roadmap and close collaboration. They also formed part of a broader project scope that included refurbishments of the facilities at the Waterloo and Wainuiomata WTPs and upgrades of the fluoride analysers and associated controls at all sites.

This paper outlines the approach taken to delivering complex and comprehensive replacement upgrades to fluoride dosing systems safely and effectively at a highly accelerated pace. This experience is one that is anticipated to need to be replicated across New Zealand as more water servicing entities are issued with directives from the Ministry of Health to start to fluoridate or improve fluoridation of their water supplies. With the imminent nationwide changes required through Water Reform, other water-related projects would also benefit from the efficiencies of implementing this project approach.

PROBLEM STATEMENT

Whilst the cessation of fluoridation at the Te Marua and Gear Island WTPs did not result in disruption of the water supply, it did amount to a reduction in Wellington Water's committed level of service and a breach of the duty of care under the Water Services Act 2021. Hence the key objective of the Regional Fluoridation Improvement Project was to restore effective and reliable fluoridation of water being supplied from the Te Marua and Gear Island WTPs as quickly as practicable. The target for delivery was for both plants to be safely and reliably dosing by 1 September 2022.

Secondarily, the project was to identify and implement improvements to Wellington Water's other fluoride dosing facilities at Waterloo and Wainuiomata WTPs, which also had issues with aging hardware, reliability and capacity.

Underlying all improvement works was the need to ensure that the solutions would meet the standards contained in the incoming Ministry of Health regulations that were anticipated to be drawn from or refer to the Code of Practice for the Fluoridation of Drinking-Water Supplies in New Zealand (Water NZ, 2014). They also needed to:

- enhance the reliability of the fluoridation systems, including monitoring, controls, and reporting;
- be acceptable to the asset owner, Greater Wellington Regional Council;
- be able to clearly demonstrate compliance with the new standard to stakeholders, including the Ministry of Health, Taumata Arowai (2022) and Wellington Water's other council owners.

SCOPE AND DELIVERY METHOD

As a member of the Wellington Water Consultancy Panel, and with an appropriate understanding of the treatment facilities, Stantec was engaged by Wellington Water to deliver fast-tracked investigations, optioneering, procurement and project delivery for the two new fluoridation facilities, and refurbishment of the existing ones. Wellington Water made a commitment to its stakeholder councils that it would resume fluoridating in a continuous manner at the Te Marua and Gear Island WTPs by 1 September 2022. This commitment was also communicated publicly.

To facilitate this, a collaborative working agreement (CWA) was formed between Stantec, Lutra and Wellington Water. The primary aim of the CWA was to design, install and commission two new package (containerised) fluoridation systems at the Te Marua and Gear Island WTPs within five months. Given that each of the WTPs was a live, operating WTP, and the scope of project work involved, this type of project would ordinarily have taken 12-18 months to complete.

In light of the fast-track nature of the project, an atypical delivery approach had to be developed. It was also essential that, given the media and public scrutiny of the fluoridation issue and Wellington Water's commitments, there was appropriate project governance, transparency, and accountability in place. The dosing systems being developed had to be to best practice, and the project needed to be supportive of, and not a hindrance to, the normal operation of the two treatment plants.

To achieve these goals, the following approach was taken:

- Vigilant monitoring and reporting on progress against the programme, identifying key constraints and tracking critical path activities.
- Ongoing search for innovations and opportunities to shorten the project timeframe.

- Appointment of a Project Leadership Group, external to the project team, that worked to remove barriers to delivery whilst ensuring responsible investment of public funds for realising Wellington Water's commitments.
- Adherence to a robust design process, despite the unusual brevity of the project, including design reviews, risk workshops, stakeholder engagement workshops, and contractor engagement.
- The handover of assets and documentation followed Wellington Water's Project Delivery Toolbox process, to ensure continuity of operation and maintenance of the assets.

The secondary aim of the CWA was to review the fluoridation processes at the Waterloo and Wainuiomata WTPs and provide recommendations for improvements to ensure compliance. Following acceptance of the recommendations by Wellington Water, the improvements were to be implemented. Because this part of the scope was not fully defined, and the primary aim took precedence, implementing the recommendations for the Waterloo and Wainuiomata WTPs did not have the same 1 September deadline. The main discussion of this paper concerns the approach taken to meeting the primary objective of the CWA, namely rapidly restoring fluoridation at the Te Marua and Gear Island WTPs. It is also intended that this project provides a model for how other projects can be delivered on expedited timeframes across the water industry.

Normally for a capital project of this size, an activity brief would be developed internally by Wellington Water, sometimes with the assistance of a consultant, and issued to the Major Projects team to oversee delivery. The Wellington Water project lead would then engage a consultant partner to develop and implement a project management plan that covers the full lifecycle of delivery, including asset handover.

The main difference in this instance was that the activity brief was superseded by the CWA between Wellington Water, Stantec and Lutra. The CWA comprised a simple, high-level description of the project objectives, scope and requirements designed to ensure alignment between the parties. Its purpose was to:

> *establish a collaborative working arrangement that enables the formation of a high performing team that can maximise the opportunity to work at pace, providing a reliable solution to the restoration of fluoridation, in the shortest possible time.*

Typical contracting arrangements were established with Lutra for the design and build of the package facilities through a NZS 3916 contract, and with Brian Perry Civil for supporting civil works through a NZS 3910 contract. The 3910 contract was later varied to include refurbishment works on the Waterloo and Wainuiomata facilities.

Importantly. the Wellington Water Network Management Group (NMG) was closely involved in project delivery, playing key roles in all facets of the work whilst continuing to operate and maintain the existing infrastructure. *Figure 1* shows the scope and involvement of the main parties.

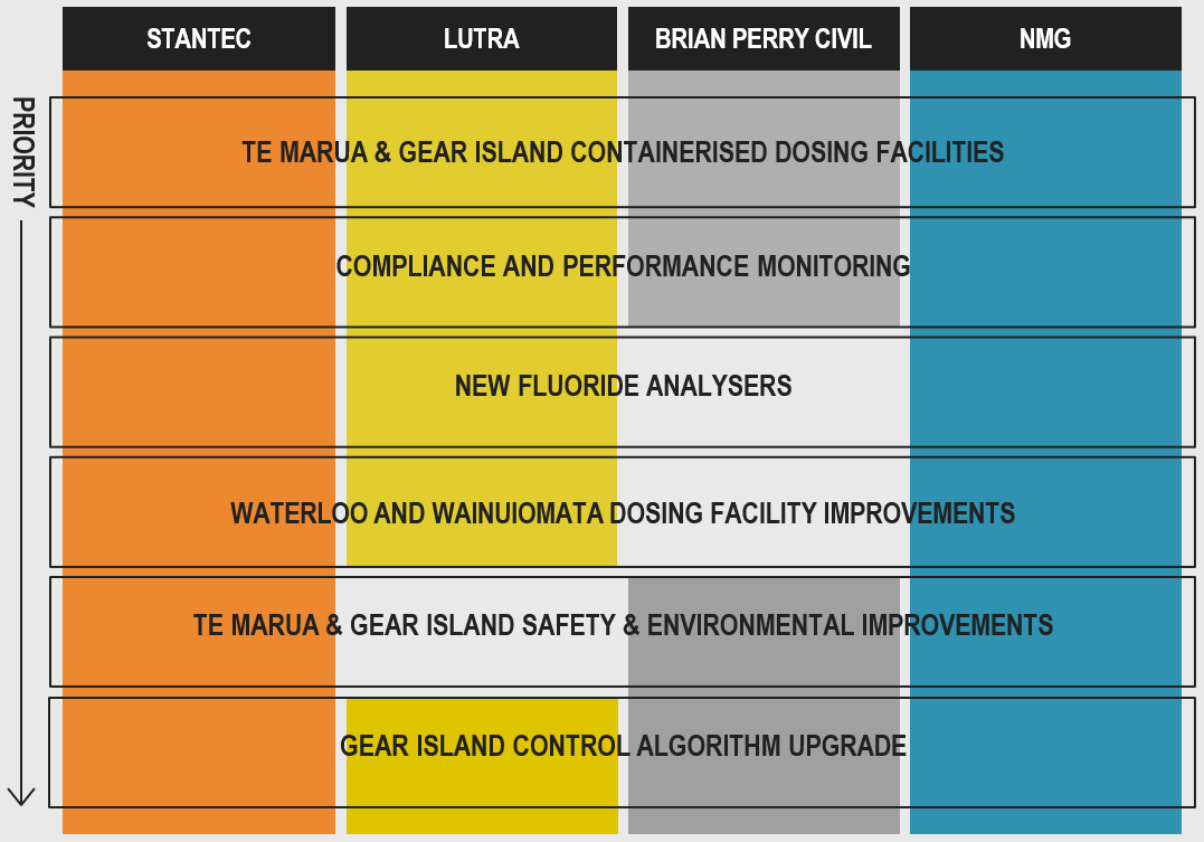

Figure 1: Scope and Involvement of the Main Delivery Parties

Project governance was provided by a Wellington Water Steering Group comprising the Chief Executive, members from senior leadership, the head of Communications and Engagement, and director of Regulatory Services. The Group monitored the project as a component of the broader Fluoridation Improvement Programme that encompassed an independent review, stakeholder engagement, public reporting and communications, responding to official information requests, and long-term planning.

The Project Leadership Group (PLG) was separate to the Steering Group, comprising senior leaders from the three parties to the CWA and an independent chair. As per the CWA priority, the PLG's focus was the rapid delivery of the package facilities. It was tasked with addressing external matters and high-impact project complexities, removing project barriers, and fundamentally ensuring project delivery met the expectations of stakeholders. The governance structure of the project is given in *Figure 2*.

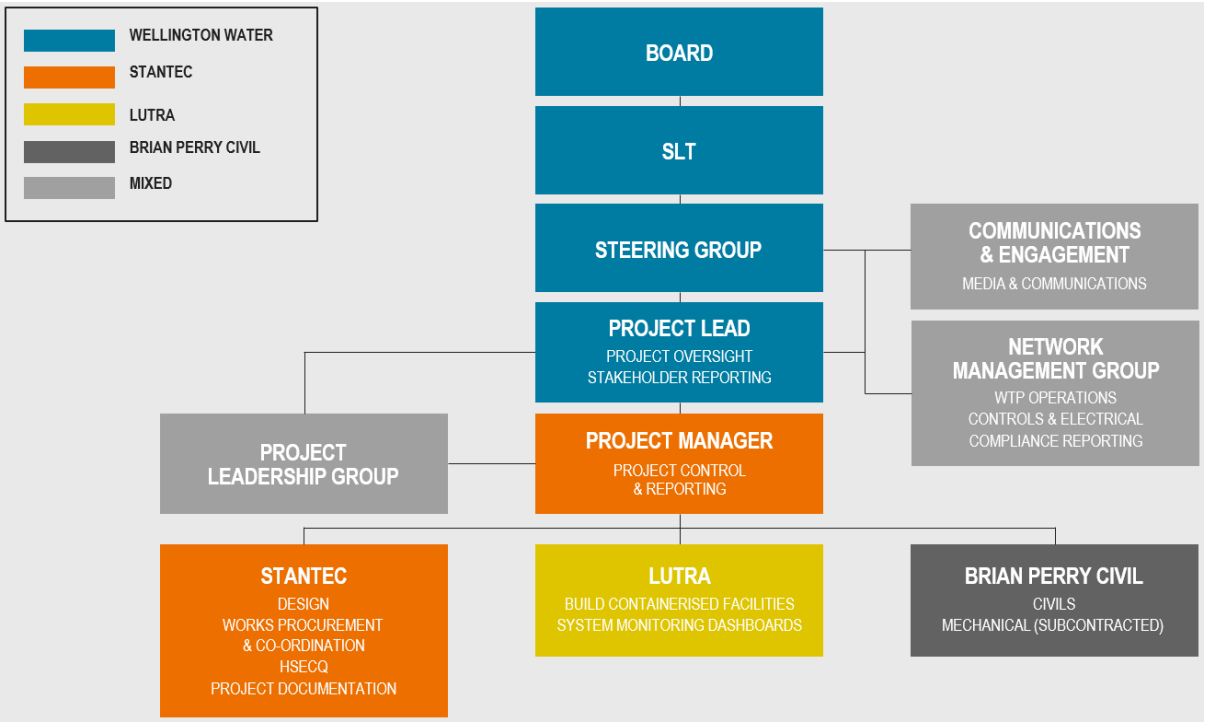

Figure 2: Project Governance Structure

DESIGN CONSIDERATIONS

EXTERNAL DRIVERS

Prior to the introduction of the Health (Fluoridation of Drinking Water) Amendment Act in 2021, there was no legislation in New Zealand that required the addition of fluoride to a water supply. Wellington metropolitan councils had elected to fluoridate their combined water supply voluntarily, but it was clear that under the new legislative and regulatory framework they would be compelled not only to continue to do so, but also to meet more stringent performance standards. Whilst the Fluoridation Code had not been formally adopted by the Ministry of Health, it was assumed that it would become the basis for any future regulations or standards.

Fluoridation in the region, however, was not universal. At the request of the community, the suburbs of Petone and Korokoro in the lower Hutt Valley had been carved out of the fluoridation scheme, receiving unfluoridated water from the Waterloo WTP. Thus a key consideration for the project was the potential for the Director-General of the Ministry of Health to issue a mandate to Hutt City Council to fluoridate the water supply to those suburbs. This affected the scope and design of both the new Gear Island WTP facility and the refurbishment of the fluoride dosing facility at the Waterloo WTP.

DESIGN DEVELOPMENT

It was intended that the two containerised fluoride systems be designed and constructed to provide an immediate solution to the fluoridation issue, but with a design life of at least ten years to provide the buffer to allow Wellington Water to properly plan for investment in a permanent solution. As largely containerised

systems, they also provided the flexibility to be recommissioned in other areas, if required.

The design development process is depicted in *Figure 3*. Project requirements were derived from the review of the dosing facilities in 2022. Out of the requirements came the scope, which was also dictated by the incoming regulations. Design and subsequent implementation were informed by detailed site investigations. Central to the entire process was the Fluoridation Code. Site investigations were also used to guide the refurbishment of the Waterloo and Wainuiomata fluoride facilities.

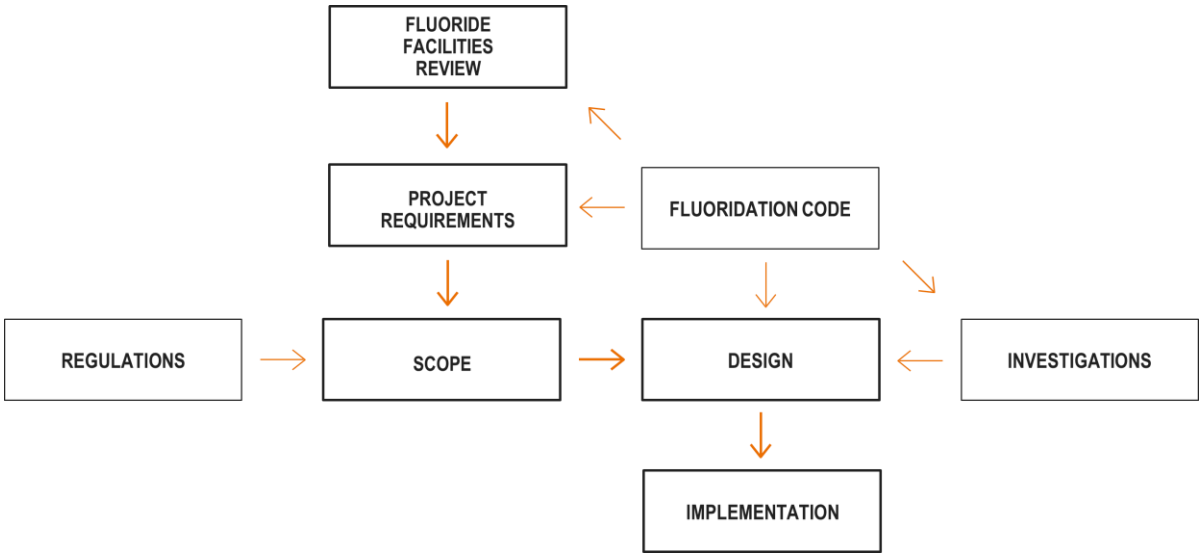

Figure 3: Scope Development

Key design parameters for the systems were as follows:

- Provide a fluoride residual within the recommended range 0.7-1.0 mg/L (Water NZ, 2014).
- Ensure that 95% of water supplied contained residual within the recommended range (monitored over the timeframe of a month).
- Provide sufficient redundancy (duty/standby equipment) and automation to ensure the performance requirements are met.
- Provide the required fluoride residual at all treated water production rates at the two WTPs: up to 140 ML/d for the Te Marua WTP and up to 80 ML/d for the Gear Island WTP.
- Provide alarming and control for ensuring no overdosing of fluoride.
- Provide the required level of safety to minimise risk to operational and maintenance personnel. The fluoridation chemical is highly hazardous and requires appropriate safety barriers.
- Integrate the systems into the sites' control systems.

Additional project requirements included the following:

- Incorporate enhanced reliability over the previous systems in the areas of monitoring, controls and reporting.
- Meet the incoming standards, as far as practicable.
- Be acceptable to Greater Wellington Regional Council as the asset owner.

- Meet the requirements of all users, including WTP operational staff, chemical delivery personnel, and maintenance staff.
- The systems are ergonomically designed for internal and external movements.
- The upgraded sites need to be environmentally responsible.

FLUORIDATION CHEMICAL SELECTION

Even though they were planned to be short-term systems, an important consideration was the fluoridation chemical, which can potentially be beholden to supply chain issues and determines ordering systems, chemical management, emergency response and personnel training. It can also set precedents for future chemical selection.

Three of the existing dosing facilities used sodium silicafluoride while the fourth (Gear Island WTP) used hydrofluorosilicic acid (HFA). The project team was tasked with investigating and proposing the fluoridation chemical to be used by the two new facilities. An assessment was undertaken and HFA was selected as it is easier to use operationally at this scale, fewer process elements are required, and an HFA facility would require the least design time and lower associated design cost. More importantly, it also has some safety advantages over SFF, most notably that there is less material handling required by operations staff, fewer moving components and only one phase of material to be processed.

FLUORIDE ANALYSERS

Integral to monitoring performance and demonstrating compliance of the fluoride dosing was the selection and installation of new fluoride analysers. New analysers were needed as the existing analysers employed older technology that required more operator attention, had higher maintenance costs and resulted in more downtime. Additional new analysers were installed to provide redundancy in all monitoring locations, i.e. two analysers per location.

The fluoride analysers subproject entailed:

- a comparative assessment of the various analysers available on the market;
- providing assurance to the stakeholders that the recommended analysers would be the optimal selection;
- procurement, installation and commissioning of the selected analysers;
- monitoring the performance of the new analysers and building a robust track record to support full change-over to the new analysers.

The analysers subproject was not constrained by the same project timeline as the containerised systems. However, the performance of the analysers was essential to the overall project outcomes.

PROJECT RISKS

A project risk register was set up before commencing with the project and it was maintained throughout the project's life. Actively managing the risks through the project was important for achieving the project objectives within the tight project

timeframe and ensuring a high quality and operationally safe outcome. The key project risks and their mitigations are highlighted in *Table 1*.

Table 1: Key Project Risks and Mitigations

Risk	Mitigation
Area: Insufficient budget to fund the project. **Causes:** • Project was initiated prior to developing solution. • Scope growth as project progressed. • More expensive resources due to supply chain constraints[1]. **Result:** • Project not completed. • Failure to meet dosing commitment. • Reputational damage.	• A robust strategy document was prepared, outlining the scale of the works required, including initial cost estimate and budget limit. • Engagement with the Wellington Water service planning team was maintained throughout the project. • Regular project expenditure updates were provided to maintain transparency.
Area: Programme – failing to meet the delivery date. **Causes:** • Asset documentation unavailable / incorrect. • Competing demands on operational resources and contractors and due to normal operational activities and parallel projects at the plants. • Delays in approvals. • Insufficient resources due to supply chain constraints[1]. **Results:** • Failure to meet dosing commitment. • Reputational damage.	• Worked directly with NMG. • Comprehensive coordination for site work with local presence. • Project team was part of the regular Wellington Water shutdown planning meetings. • Following the shutdown planning process. • PLG played an important role in tracking and responding to evolving risks. • Regular public communications on progress (Wellington Water communications team).
Area: Working on live, operational plants and interfacing with existing systems. **Causes:** • Operational personnel unavailable for normal or project responsibilities. • Competing demands on operational resources and contractors and due to normal operational activities and parallel projects at the plants. • Delays in approvals. • Insufficient resources due to supply chain constraints[1]. **Results:** • Injury to personnel. • Plants' operation compromised. • Project completion delayed.	• Worked directly with NMG. • Comprehensive coordination for site work with local presence. • Project team was part of the regular Wellington Water shutdown planning meetings. • Following the shutdown planning process.

Risk	Mitigation
Area: Overdosing of fluoride. **Causes:** • Design not adequate due to fast-paced delivery. • Dosing system and control issues. • Insufficient attenuation in dosed streams. **Results:** • Public health compromised. • Wasted water and operational resources in flushing network. • Higher operational costs.	• Design process included design review, HAZOP, CHAZOP, safety in design, incorporating multiple stakeholders. • Multiple barriers of safety implemented on dosing systems. • Te Marua WTP: Baffle curtain in reservoir replaced to improve mixing and attenuation. • Gear Island WTP: New fluoride analyser locations for faster system response.
Area: Insufficient chemical. **Causes:** • Insufficient HFA due to lack of production (facility offline)[2]. **Results:** • Failure to meet dosing commitment. • Intermittent dosing.	• Regular communications with chemical supplier. • Obtaining IBC[3].
Area: Quality of delivered systems unacceptable. **Causes:** • Employing parallel workstreams to meet expedited project delivery date. **Results:** • Inferior quality systems, leading to poor performance and unreliable operation. • Limited barriers to prevent dosing accidents. • Injury to personnel during implementation and operation. • Failure to meet dosing commitment. • Cost overruns and/or failure to complete project.	• Regular communications with project team, suppliers and NMG. • Experienced personnel included in project team with local and chemical systems knowledge. • Design process included design review, HAZOP, CHAZOP, safety in design, incorporating multiple stakeholders. • Iterative, agile approach implemented for expedited project delivery. • Multiple barriers of safety implemented on dosing systems.
Area: HSNO[5] certification not obtained. **Causes:** • Insufficient resources due to supply chain constraints[6]. • Due to expedited project delivery, systems incomplete for certification. **Results:** • Unsafe operation. • Failure to meet dosing commitment. • Reputational damage.	• Early engagement with HSNO assessor. • Alternative HSNO assessor sought. • Early engagement with Water NZ and WorkSafe for temporary certification measures (Improvement Notice). • Ensuring design process followed for functional safety, ready for certification.

1. Supply chain constraints post the COVID-19 lockdowns were a significant impairment. Issues faced during the project included having insufficient personnel (project and operational), contractors having too much work and therefore being unavailable, difficulties in obtaining equipment and materials in reasonable timeframes, and costs being higher than in previous years.
2. HFA is produced as a co-product in the manufacture of phosphate fertilisers (Water NZ, 2014). There have been HFA supply fluctuations in the past as fertiliser production has varied based on seasonal demand. HFA availability was a concern based on the project delivery occurring during the winter months, when fertiliser production may be lower. In addition, the Director-General of the Ministry of Health was issuing directives to local authorities to fluoridate their water supplies, increasing demand for HFA.
3. When it came to securing a chemical order for meeting the dosing date, chemical was available for one site, but not the other. A sudden chemical shortage arose due to the fertiliser production plant being offline for its annual maintenance shutdown. The full chemical volume that was ordered could not be supplied, and what could be supplied was going to be delayed. Therefore, a small volume was supplied in an IBC for the second site. This was sufficient for uninterrupted dosing until a larger volume was delivered.
4. The fluoridation systems had to be certified in accordance with the Health and Safety at Work (Hazardous Substances) Act 2017. As a matter of compliance, the chemical systems could not be commissioned without certification.
5. Hazardous Substances and New Organisms Act 1996.
6. Obtaining the services of a HSNO assessor in time for both sites was challenging due to their availability. HSNO certification was obtained for one of the sites prior to dosing. However, to meet the requirements of WorkSafe for the other site, as it had not yet received HSNO certification, required the implementation of a WorkSafe Improvement Notice. This was obtained so that commissioning could commence, and the fluoridation deadline was achieved. Two months after dosing commenced, HSNO certification was awarded for that site.

EMERGENT SCOPE

Whilst the objectives of the project were clearly established from the outset, the scope of works evolved over time as new information and needs came to light. Some of the emergent scope included improving operational conditions that changed with the introduction of the new systems.

CHEMICAL SPILLAGE HANDLING

At the two primary sites, it became clear as commissioning approached that improvements were needed to better manage HFA spills. The bulk tank filling area at the Te Marua WTP needed a catch tank to drain the area and help keep HFA spills separate from potential caustic soda spills from deliveries to the adjacent storage tanks. The catch tank could also take drainage from the HFA bund inside the new dosing container. At the Gear Island WTP, a connected was made from the container bund to the existing sump tank in the floor of the old HFA dosing system.

GEAR ISLAND WTP DOSE CONTROL

The Gear Island WTP fluoride dose is primarily used as a top-up dose for the treated water passing by the plant from Waterloo WTP and sometimes from Wainuiomata WTP. The required fluoride dose has been calculated from the

fluoride residuals from the two sources and the flow rates in the network. This method of calculating the fluoride dose had been employed for a number of years prior to the project. When the Gear Island WTP operates in production mode itself, this flow rate also needs to be taken into account, but was not taken into account in the old calculation method due to the intermittent operation of the Gear Island WTP as a production facility. While the new dosing system has resulted in improved fluoride residual performance, the old calculation method has resulted in fluoride residual fluctuations that risk not meeting the 95% compliance target.

To address this, a new dosing algorithm was developed as the project progressed. The algorithm depends on measurements from the newly installed upstream fluoride analysers and therefore the algorithm's implementation was delayed until the fluoride analysers had completed their proving period. At the time of writing, the new algorithm had not yet been implemented. It is anticipated to be implemented in October 2023 and will undergo a rigorous commissioning, testing and performance proving period. It will enable the fluoride residual to achieve Wellington Water's performance targets consistently.

WATERLOO AND WAINUIOMATA WTP FACILITIES

The scope of the refurbishment works at the Waterloo and Wainuiomata facilities was defined as the project was being delivered, informed by detailed site investigations and consultation with the operations. In a sign of sound project planning and foresight, the provisional budgets for the work were sufficient to cover the full scope, which included re-purposing an existing chemical tank, new piping, valves, pumps, motors and instrumentation, and updates to control programming.

FLUORIDATION OF PETONE AND KOROKORO

During the course of the project, a workshop was held concerning the potential fluoride dosing needs for Petone and Korokoro, in Lower Hutt. These suburbs have historically been unfluoridated. However, in anticipation of an imminent directive to fluoridate, consideration had to be given to how that would be achieved. Providing fluoride to the water supply to these suburbs informed the scope of works for refurbishment of the Waterloo WTP's fluoride system, particularly with respect to a second day tank to increase dosing capacity. By installing a second day tank, the Waterloo WTP facility would be able to double its dosing capacity, thus being able to fluoridate all the water produced by the plant, some of which would be used to supply Korokoro and Petone. It would also provide additional capacity for meeting the fluoridation needs during summer peak demand periods.

OUTCOMES

The project was successful in achieving reliable dosing of fluoride at the Te Marua and Gear Island WTPs by the delivery date of 1 September 2022, five months after commencement. Key elements to the success were:

- Early engagement and regular communications with stakeholders, and integration of stakeholders' requirements.
- Streamlined governance within Wellington Water allowing clearly defined project ownership and prompt decision making.

- Employing the right personnel for quality assurance throughout the project.
- Employing an iterative approach and parallel workstreams.
- Project oversight provided by the PLG.
- Learning from mistakes and moving forward as a united team.
- Innovating collaboratively when supply chain constraints arose.
- Maintaining a commitment to excellence to ensure the end result would consistently achieve the performance specifications.

The two containerised dosing systems are shown in *Figure 4* and *Figure 5*.

Figure 4: Te Marua WTP Fluoridation System

Figure 5: Gear Island WTP Fluoridation System

A graphical summary of the fluoride residual performance for all four sites is shown in *Figure 6*. For Te Marua WTP and Gear Island WTP, the impact of the commissioning (August) and optimisation (August through October) of the containerised treatment plants is evident through the graph period.

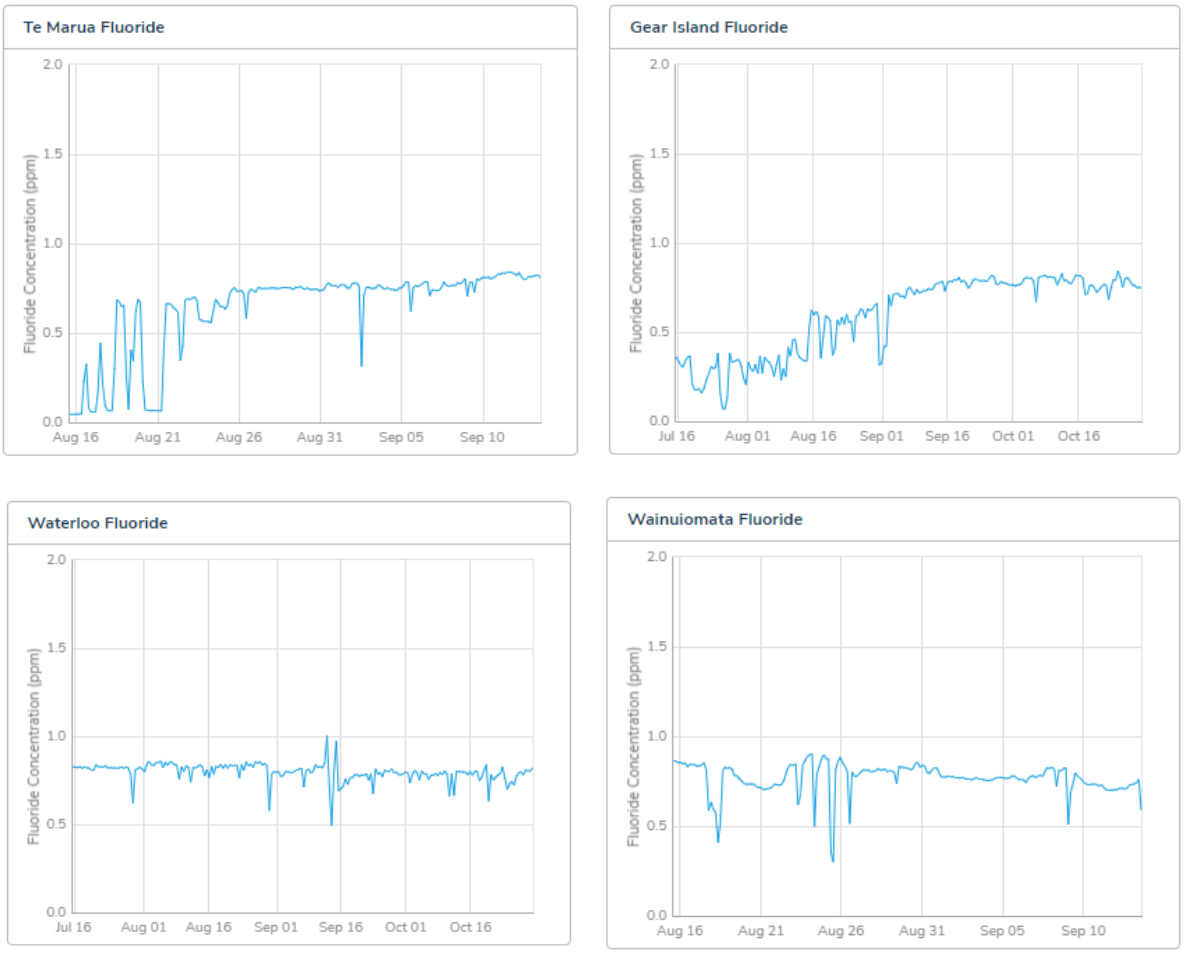

Figure 6: Fluoride Residual (mg/L) *Performance Before and After the Project*

As detailed in the Emergent Scope section, a new fluoride dose control algorithm was developed for the Gear Island WTP. At the time of writing, the old calculation method was still being used, awaiting the completion of the fluoride analysers' providing period. Upon implementation of the new algorithm, it is expected that Wellington Water's fluoride residual performance targets will be consistently met.

LESSONS LEARNED

One of the more challenging aspects of delivering the project was the handover process following commissioning and proving of the assets. Two main issues arose as the project team shifted focus from the containerised facilities at the Gear Island and Te Marua WTPs to the analysers and the other sites. First, a new process and system for project delivery and the transferral of asset documentation and data was being trialled by Wellington Water over the course of the project, causing a degree of confusion amongst the parties and delays to passing project gateways. Second, a responsibility gap began to form between the project team and the operations team in relation to monitoring and maintaining compliance with the dosing standard.

The first matter would not have arisen had the new process/system been wholly developed when the project commenced. Nonetheless, it could have been ameliorated by better and earlier handover planning, which was somewhat

neglected in the acceleration to undertake the works, and by greater engagement and expectation setting between the project team and the stakeholders that were not directly involved with delivery.

The second matter centred around contention over the fact that the NMG were accountable for compliance of the new systems but were not in a position to address non-compliances that were occurring when the new facilities were operational but still effectively under the control of the project. This situation stemmed from the CWA and Lutra's 3916 contract being focused on delivery of working facilities with limited emphasis on compliance outcomes. As such, assurance centred around the functionality of the hardware (and avoiding overdosing) rather than the consistency of the final fluoride residual. Whilst the contractual requirements were closely aligned with compliance needs, it would have been beneficial to explicitly refer to compliance expectations and roles in both contractual documents.

This demonstrates how the contractual approach for expedited projects of this nature needs to be supported by an element of trust and commitment from all parties that exists outside of the contract(s). Due to the constrained programme schedule, not all components of the existing system, or the upgrade methodology and integration could be fully evaluated prior to commencement. To mitigate these risks, one approach is to put all contractual requirements and liabilities on the suppliers and designers, although this introduces a significant amount of contingency consideration to the cost of their services. The takeaway is that the success of these expedited projects relies not only on the contractual foundations, but also the strength and dynamics of the working relationship (and desire to maintain this working relationship into the future) to ensure successful delivery.

The project also had to overcome difficulties associated with achieving HSNO certification of the facilities. Despite early engagement of HSNO inspectors and certifiers, the expedited delivery programme required the involvement of multiple HSNO certifiers. Due to differences in how each certifier interpreted the legislation requirements, the project received inconsistent advice, direction and remedial actions to achieve certification. Ultimately, the more stringent requirements were applied to both sites, but the issue resulted in project inefficiencies and complications. This highlights the importance of the relationship between the HSNO inspector, designers and asset operators.

CONCLUSIONS

Wellington Water's commitment to safety, its review of its metropolitan fluoridation facilities, and its recommitment to public health via effective and reliable fluoridation culminated in the conditions that necessitated an expedited project delivery of two new containerised fluoride dosing systems for the Te Marua and Gear Island WTPs.

A project that would typically require 12-18 months to deliver had to be completed within five months. Thorough planning at the start of this fast-track project was critical to its successful completion within this timeframe. Essential elements included the development of a robust delivery framework, oversight provided by

the project leadership group, a relationship of trust amongst the contracting parties, an experienced and local project team, early engagement with stakeholders, a detailed and continuously updated project programme, regular communications with stakeholders, and an adaptive approach for mitigating risks and maintaining the quality of delivery and safety.

Achieving the dosing date to which Wellington Water was publicly committed required innovation and close collaboration to overcome the challenges that arose during the project. These challenges included working on live, operational plants and interfacing with existing systems; managing parallel workstreams while maintaining high quality outputs; solving issues that arose due to supply chain shortages concerning personnel, materials and hydrofluorosilicic acid; implementing robust control systems for ensuring no overdosing of fluoride; and working through HSNO certification delays in line with compliance requirements.

In addition to the containerised systems, improvement works were performed at the fluoridation facilities at the Waterloo and Wainuiomata WTPs. These resulted in fluoridation system performance that met Wellington Water's fluoridation commitments. Other works additional to the original project scope were also performed for improving system performance and the safety of operational personnel.

Based on the success of this project, it is recommended that more public projects across the water sector consider adopting this delivery model when faced with an urgent upgrade/renewal need, provided fit-for-purpose governance settings are in place. Immediate benefits realised by Wellington Water included the early rectification of the issues identified through plant reviews and a demonstrable commitment to public health through reliable fluoridation of the water supply. While an analysis comparing the cost and benefits between this project delivery approach and a traditional delivery approach was not performed, it is believed that the approach adopted would offer overall cost savings due to the abbreviated project timeframe.

Implementing an expedited delivery model does not require extensive modifications to a traditional approach. The key modifications include enabling wider collaboration, more parallel workstreams, continuous and active management of project risks and their statuses, and providing continuous project oversight to ensure that quality and safety are maintained, and project goals are achieved.

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