THE TALE OF TWO SUPPLIES, THE SOLUTIONS TO THE HAVELOCK NORTH WATER CONTAMINATION EVENT

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ABSTRACT (500 WORDS MAXIMUM)

This paper will demonstrate the solutions implemented by Hastings District Council (HDC) in the aftermath of the Havelock North contamination event to improve security to their drinking water sources and supplies using a multi barrier approach. Stantec worked with HDC to bring to reality a vision of producing a robust, resilient, and secure water supply to the population of Hastings and Havelock North. Working with Lutra, Tonkin and Taylor, Wayfinder, Reliant and HDC, Stantec designed two modern water treatment plants for two very different locations.

The paper will discuss the dilemmas faced by Council in needing to both reduce the visual impact of large-scale new water structures while trying to promote the importance of this key infrastructure. Stantec produced two designs in two different "tales" to deliver improved treatment standards. One is a tale of a location trying to blend and minimise the impact and hide large infrastructure within a premier park location, while the second tale is about a central city location near the Council main offices which looks to include significant educational and experiential opportunities for the public to interact with all facets of water. This site includes water treatment facilities, along with an education building and associated groundworks and water features using a "mountains to sea" concept of the journey of water, titled Waiaroha.

The paper will outline the threads needed to interlink the supplies, how water is distributed to newly created zones within the Hastings network and how the Council intend to move from an aquifer-based source feeding directly into the water network, to one with two centralized treatment plants with storage capacity that disconnects the source water from the network. Additional storage at each plant acts as a buffer within the network to significantly reduce abstraction rates during periods of high demand.

This tale of two supplies looks to share how the impacts of the Havelock North water contamination event has influenced and guided Hastings District Council in its approach to delivering a new, safe, and resilient drinking water supply to its city, and the important role this is playing in supporting the wider drinking water direction within New Zealand. HDC's vision, along with Stantec's design solutions demonstrate how improved security can be provided to New Zealanders drinking water in ways to suit their environment while utilising the educational value of these assets to drive community awareness.

KEYWORDS: Water Treatment; Drinking Water Quality; Source Water Management

PRESENTER PROFILE

Rico Parkinson has over 14 years' experience in the water engineering industry. He is Chartered with Engineering New Zealand and the team lead for Stantec's Christchurch Water Civil Team. Coincidentally, two years ago, whilst attending the Water NZ conference, Rico was finalising the Concept Design Reports for these two Hastings water treatment plants.

1.0 INTRODUCTION

Hastings District Council (HDC) has invested a significant amount into the upgrade of their water supplies to provide modern treatment processes that ensure future security to the communities of Hastings and Havelock North. Council's priority on drinking water safety was a result of the Havelock North water contamination event, where an untreated supply sourced from secure bores was compromised and resulted in contamination of the water supply and widespread sickness of more than 5,500 people including 45 hospitalised and contributed to the death of 4 people.

In carrying out these significant water safety upgrades HDC needed to consider both the impact of large-scale new water structures and promote the importance of this key new infrastructure to the community. Stantec have produced two designs in two different "tales" to deliver improved treatment standards. The two treatment plants outline the role Council's play in promoting and educating the public through showcasing the infrastructure against the desire to minimise the impact, provide security and reduce cost wherever possible for the public they service

2.0 BACKGROUND AND SYSTEM CHANGES

As part of the treatment upgrades the new treatment plants needed to be integrated into the existing network and the network operation changed to suit the way they provide water to various zones within the Hastings and Havelock North areas. As part of these changes the Council intend to modify the system from an aquifer-based source, feeding untreated water directly into the network, to one with two centralised treatment plants with storage capacity that will disconnect the source water from the network, while also providing firefighting storage and a buffer within the system to reduce the abstraction peaks from the source aquifer during periods of high demand.

An intermediate stage was required to address the immediate issues around safety, until the treatment plants are built and commissioned. The changes to the network are shown in three stages; the first outlining the system prior to the Havelock North water contamination event, the second explaining the current system, abandoning the contaminated bores from the network, and the final stage that outlines the proposed system at the completion of both treatment plants. These three stages are outlined below to share the full journey HDC have taken to get from where they were to where they need to be.

2.1 ORIGINAL NETWORK CONFIGUATION (2016)

The network at the time comprised of 12 bores that were deemed secure under the drinking water standards and there was no treatment or disinfection carried out prior to distribution into the network. Figure 1 outlines the arrangement of the network at the time of the contamination event.

Seven supply bores were located within Hastings, with three bores in Havelock North and a two within Flaxmere. Connectivity was via a single trunk main from Hastings supporting Havelock North when demand required it, and two mains between Hastings and Flaxmere to support the demand in those areas. Reservoir storage is situated on the hills above Havelock North to enable the system to operate successfully, the pressures throughout the network are high, operating in excess of 1000kPa.

The contamination event occurred via the Brookvale bores in Havelock North. The findings from the Government enquiry determined it is highly likely that heavy rain inundated paddocks neighbouring Brookvale Road causing contaminated water to flow into a pond about 90 metres from Brookvale Road bore 1. On 5 and 6 August 2016, water in the pond entered the aquifer (now determined to no be confined) and flowed across to Brookvale Road bore 1 where the bore pump drew contaminated water through the bore and into the reticulation system.

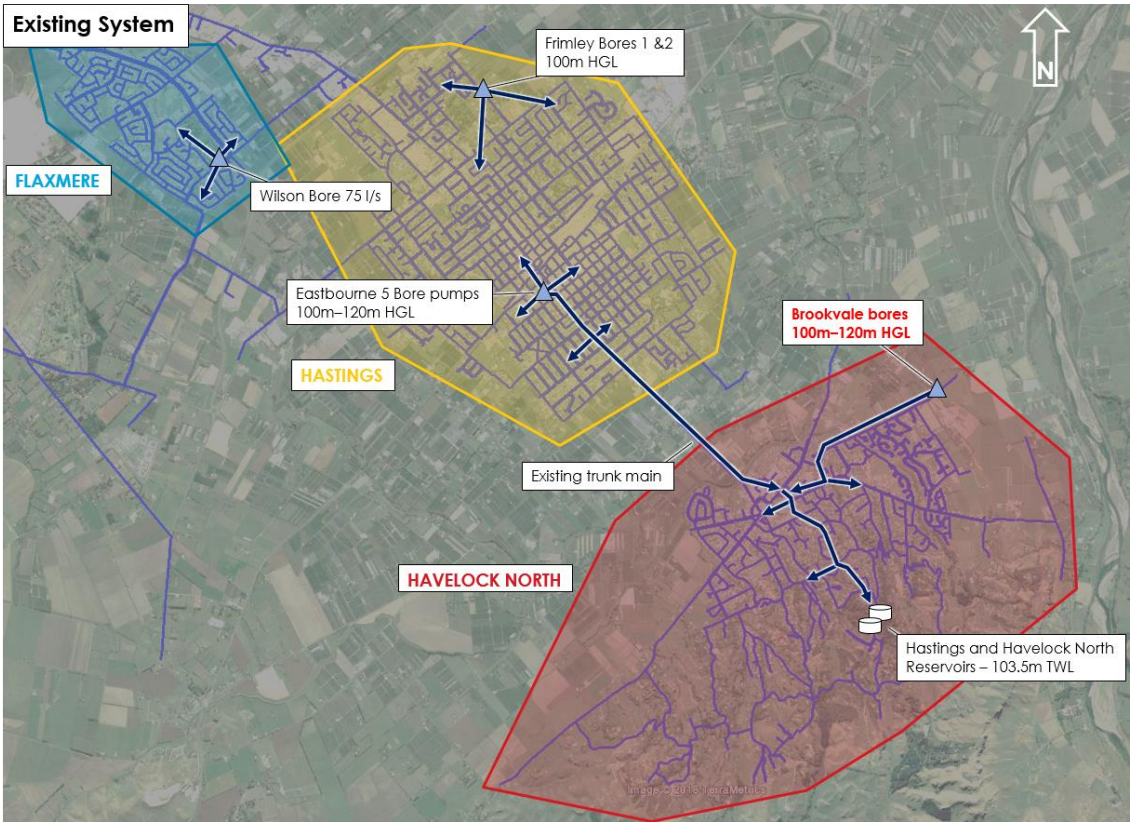

Figure 1: Original Hastings and Havelock North network configuration

2.2 CURRENT NETWORK CONFIGURATION

Following the contamination event, chlorine dosing was implemented across the entire supply and a temporary treatment plant was constructed to allow bore 3 at Brookvale Rd to continue to supply Havelock North with support from Hastings. Decommissioning of Brookvale Bores 1 and 2 followed thereafter. In 2017 a new 500mm diameter trunk main was laid to Havelock North and a Booster Pump Station (BPS) was completed in 2018 to enable all water to be delivered to Havelock North from Hastings. The last remaining Brookvale Bore will be decommissioned at the completion of the upgrade project. The current system layout is shown in Figure 2 below.

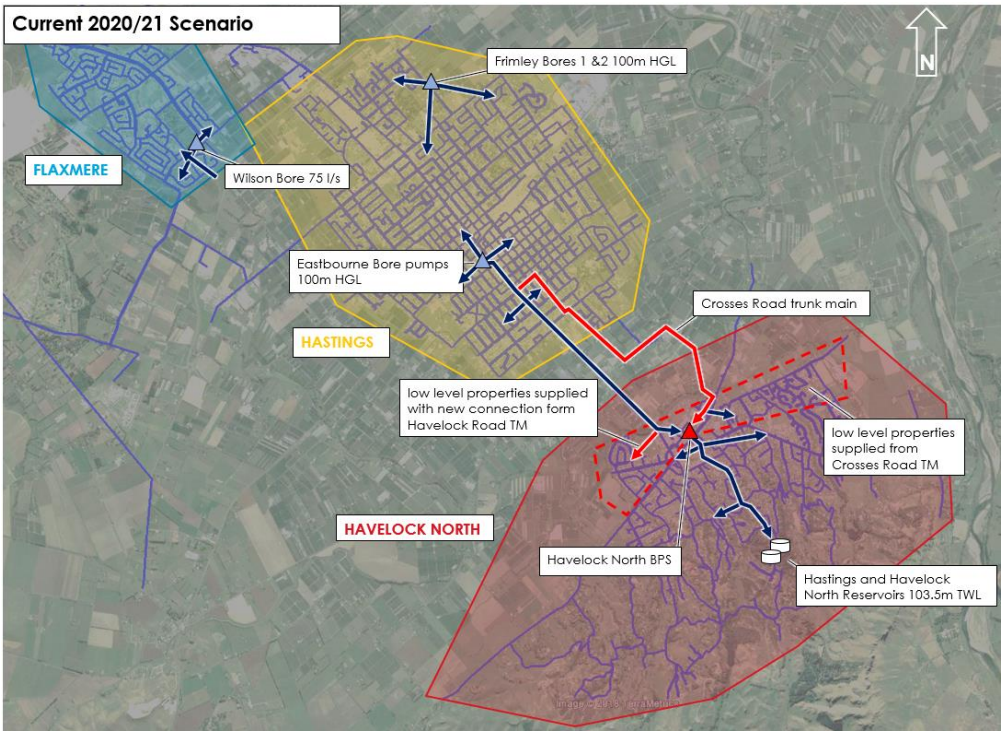

Figure 2: Near Future Hastings and Havelock North network configuration

This current system utilises the existing bore pumps in Hastings to feed into the new Booster Pump Station in Havelock North which then lifts the water to the Havelock North Reservoirs located above Havelock North. This arrangement will enable operating pressures to be reduced as the BPS will provide the additional lift to the reservoirs rather than the bore pumps in Hastings doing all the work.

This system is heavily reliant on the Eastbourne Bore pumps and trunk mains. The additional trunk main to Havelock North has increased resilience and capacity to the supply from Hastings and allowed the decommissioning of the 2 Brookvale Bores from the network. Emergency storage is still limited, and the only treated storage reservoirs are above Havelock North. The peak daily demand on the aquifers is unable to be buffered due to most of supply being on demand direct from the bores into the network causing large drawdown effects at the abstraction points. This ultimately increases the risk of contaminants migrating from the surface into groundwater and is an identified risk to the supply.

2.3 FUTURE NETWORK CONFIGURATION WITH TREATMENT PLANTS

The proposed Hastings network includes the new Eastbourne and Frimley treatment plants and the establishment of four separate pressure zones across the network. This is shown in Figure 3.

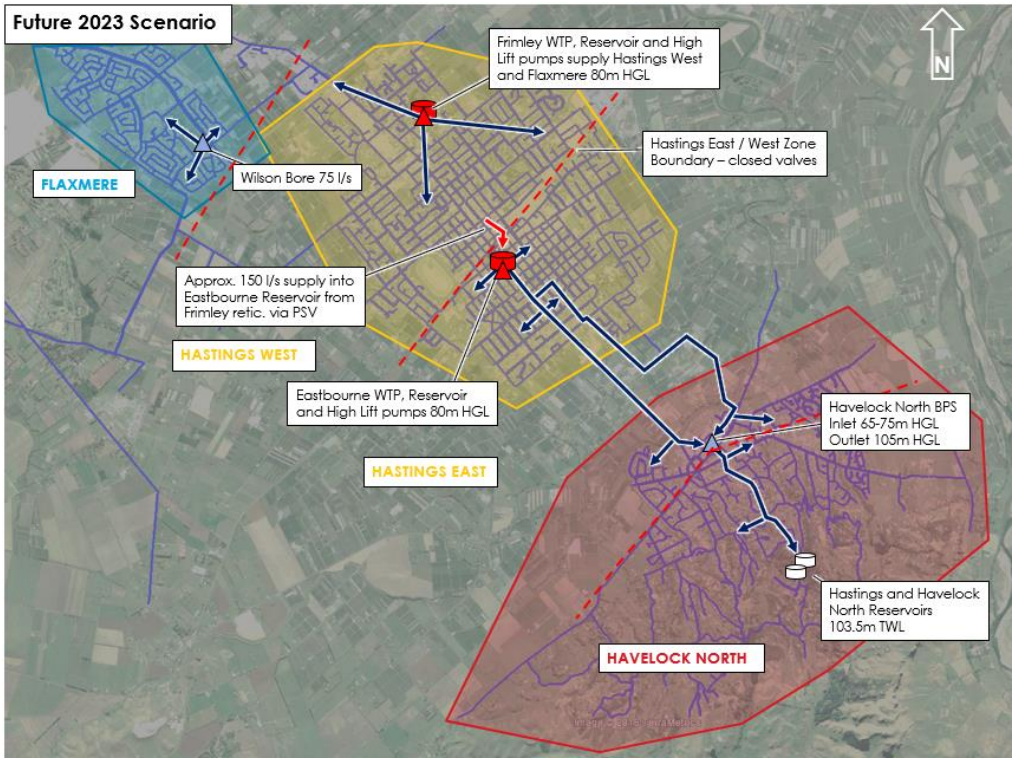

Figure 3: Future Hastings and Havelock North network configuration

This arrangement allows for a reduction in pressure over the entire Hastings network. The treated water storage at Frimley Park and Eastbourne buffers instantaneous demand, while allowing the abstraction rates on the aquifers to remain relatively constant. This demand on the aquifer is also able to be spread over all the Hastings Bores with the ability to supply the Eastbourne treated water storage directly from the Frimley treated network with a dedicated supply line.

3.0 FROM SOURCE TO CUSTOMER IMPROVEMENTS

The new system consists of two treatment plants similar in nature, comprising the following components.

1) Source - New and existing bores are utilised with new bore pumps.
2) Water Treatment – New processes of UV, Chlorination, and fluoridation.
3) Water Storage – New treated water storage reservoirs
4) Network Upgrades – Improve resilience, connectivity and enable pressure reduction

These components bring improvement to the water supply along its journey from source and abstraction through to the supply to the public. This journey is an aspect which the HDC wish to educate the public on, to help achieve a greater understanding of the value of water and the infrastructure that delivers it to their tap.

3.1 SOURCE SECURITY IMPROVEMENT

Each treatment plant has several dedicated bores which supply the treatment plant with water. Frimley Park will install up to four new bores and abandon two existing bores in the area, while Eastbourne will retain three existing bores, install one new bore and two will be abandoned.

All existing bores are currently connected directly to the network and operate on-demand therefore when pressure drops in the network the bores turn on and off as required with no ramping up or down of flow rates. This means that abstraction from the aquifer fluctuates with the demand from the network.

Tonkin and Taylor worked with HDC to carry out hydrogeological modelling of the aquifer against potential demands and different bore configurations to determine the best arrangement to utilise existing bores and where to install new ones. A primary focus of these studies was to maintain positive artesian head within each bore field under current and future demand scenarios as a means of minimising the potential for contaminants to enter the aquifer under drawdown conditions. At the Frimley Park site, the existing bores were not considered suitable by HDC due to the proximity to wastewater storage and distance to the new water treatment plant site.

The Eastbourne bore field has always operated as the primary source supply for Hastings. The T&T study showed that drawdown conditions at Eastbourne under current abstraction rates were significant but that the proposed Frimley Park source supply presented more favourable conditions for increased production with less drawdown effects. Based on this analysis, HDC has proposed to reduce abstraction at Eastbourne and increase production at Frimley Park to meet current and future demand projections. Two of the five bores at Eastbourne are to be abandoned and one new bore will be drilled at the new treatment plant to provide resilience and minimise drawdown across the bore field.

The installation of new bores and split of four Eastbourne and four Frimley bores instead of two Frimley and five Eastbourne (previous arrangement) allows the abstraction to occur at a more even rate throughout the aquifer. This will improve the source security as it will reduce point demands at a rate that maintains artesian pressure. This operation reduces the contamination risk, particularly with the Eastbourne bores which are located within an urban area and have a higher risk of surface contamination potentially being drawn into the source water.

The two treatment plants will operate the bores in a similar arrangement. With four bores located at each site, they are designed to act with a slow ramp up and ramp down of flows controlled to the treated water reservoir and daily volume demand. Pumps are controlled with Variable Speed Drive's (VSD) and soft starters to minimise turbulence in the aquifers, minimise stop/start and turbidity spikes and reduce water wastage as there will be a run to waste set up in the treatment plant. The bores act in a duty/duty/duty/standby, with one of the four bores acting as a standby bore to ensure peak demand can be achieve even when failure of one pump may occur. The operation of the bores in a steady state manner rather than the current hard start single flow operation will limit the start/stop mode of operation and any risk of turbulence and the resultant turbidity in the source water.

3.2 WATER TREATMENT IMPROVEMENTS

At both treatment plants the fitting and materials are similar, to ensure continuity of approach while incorporating best practices and suitable treatment for the source water. HDC carried out the initial concept design to determine suitable ultraviolet (UV) reactors and directly procured these. Lutra then worked with HDC to produce a process Basis of Design for the treatment plants to accompany and inform the Stantec Designs.

The quality of the source water from the aquifer in general is considered excellent, with consistently low turbidity and high ultraviolet transmissivity (UVT). Based on the raw water quality data, no filtration stage was required.

The treatment process consists of UV treatment system, sodium hypochlorite dosing and hydrofluorosilicic acid dosing. The UV treatment will be controlled by turbidity and UV transmissivity (UVT) meters prior to the UV reactors. The treatment plant will incorporate a divert-to-waste facility, where on start-up, after passing through the UV disinfection stage, a divert valve will be opened and the water will be discharged to the stormwater system. The treatment plant will continue to discharge until the compliance criteria are met at reduced flowrate to limit water losses and avoid surcharging the stormwater system.

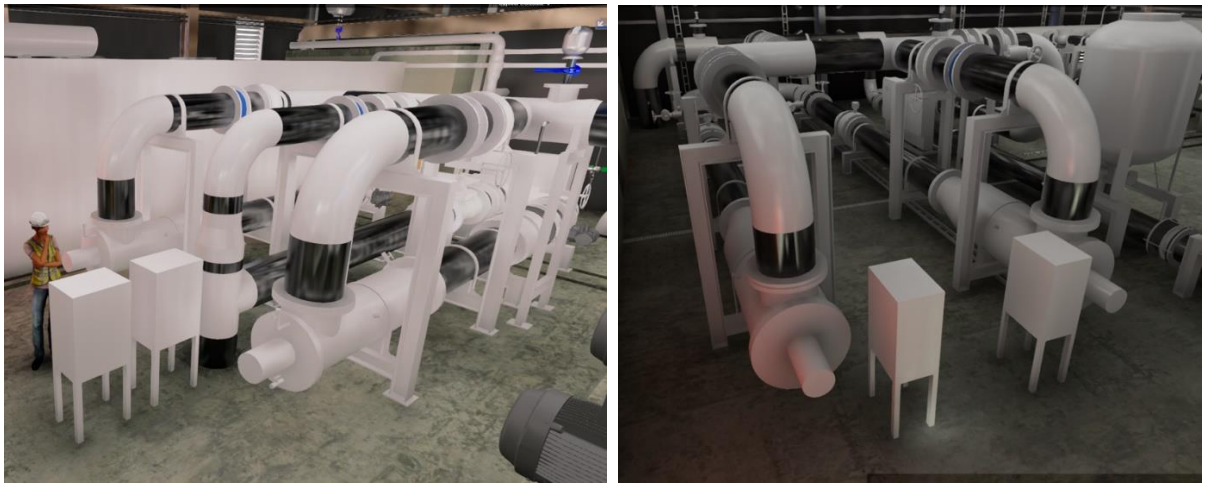

Figure 4:UV Reactors at Eastbourne WTP (Left) and Frimley Park WTP (Right)

Chlorination of the treated water will be fully automated with flow-pacing and free available chlorine (FAC) residual feedback control. Sodium hypochlorite (NaOCl) stored in two bulk storage tanks will be dosed into the water downstream of the UV disinfection stage via two dosing pumps in a duty / standby arrangement. Because Sodium hypochlorite decays faster at higher temperatures it is be kept below 25°C with the use of air conditioning in the dedicated storage room.

After the sodium hypochlorite dose-point, hydrofluorosilicic acid (HFA) is dosed into the water for providing a fluoride residual in the treated water. The setup is similar to the chlorination with flow-pacing and residual feedback control, although only one bulk storage tank with dosing pumps in a duty / standby arrangement.

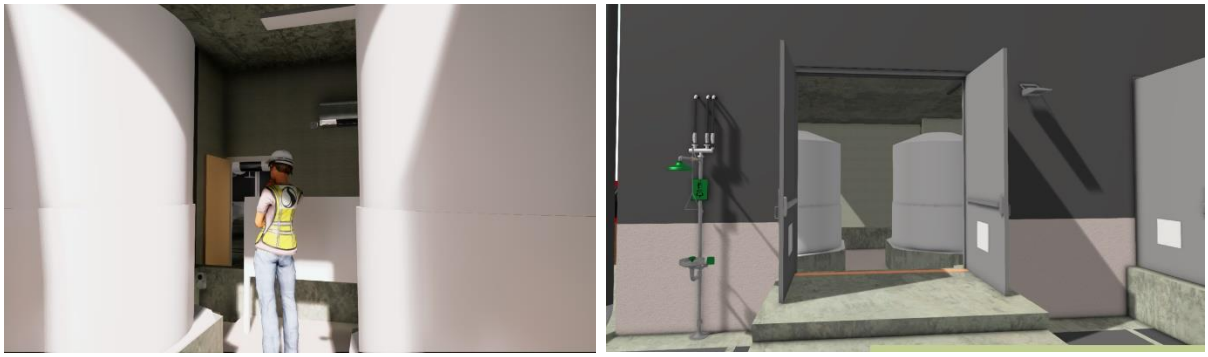

Figure 5: Chlorine Dosing within Eastbourne WTP (Left) and Frimley Park WTP (Right)

Prior to the Havelock North water contamination event, the existing bores were considered secure in accordance with the DWSNZ, and no treatment was provided prior to delivery into the network. After the contamination event the addition of sodium hypochlorite at all bores was added to provide a disinfection residual but this does not provide protozoal treatment. This is now achieved with the UV treatment in the treatment process.

This new treatment process brings improved treatment security when compared to existing system, in addition, the operation of the existing bores directly into the reticulation is inefficient, as there is no buffering capacity within the network, and bore pumps must meet high-demand conditions that arise due to fires and summer demand.

3.3 NETWORK STORAGE IMPROVEMENT

The addition of two centralised treatment plants provided an opportunity to install centralised storage as well. This storage will buffer the treated water demand and provide additional firefighting storage capacity. Generators will be located at both treatment plants to supply power during network outages to the entire treatment plant along with the raw water pumps to ensure network supply is maintained.

The storage selected differs between the two treatment plants, with Frimley Park having a single 8ML steel tank and Eastbourne having two 5ML steel tanks. This difference was due the height diameter ratio not being suitable for the original architectural concept for the Eastbourne site, and new a concept created with two reservoirs.

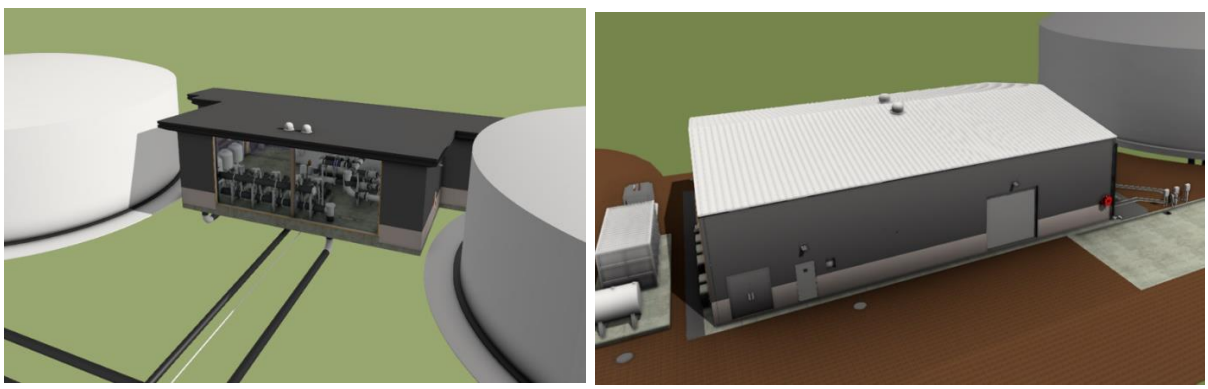

Figure 6: Eastbourne WTP overview (Left) and Frimley Park WTP overview(Right)

Steel tanks supplied by Reliant were selected after Stantec carried out a reservoir material and size assessment. This concluded that concrete and steel tanks were both feasible options for the storage of potable water and both materials have a track record of being implemented in NZ. The final reservoir selection was made by HDC, taking account of financial considerations (balance of initial costs versus whole of life costs), aesthetic considerations, importance of programme, and the desired level of ongoing maintenance.

These tanks provide the network with storage and buffering abilities that are currently not present in the Hasting network. This storage allows HDC to create four distinct network pressure zones enabling an overall reduction in pressure throughout the network. This pressure reduction delivers increased network security as lower pressure typically reduces leakage and breakages within the network.

3.4 NETWORK SUPPLY IMPROVEMENT

Along with the improved network security through pressure reduction in the whole of Hastings, additional security has been achieved in the network through several other features.

The first to improve network security is both treatment plants have a duty / assist / assist / assist / standby arrangement for the treated water pumps and duty / standby arrangement for the UV reactors. This ensures the future peak and firefighting demand can be achieved even when one treated pump is out of operation. The flows and pressure that this combination of pumps can achieve allows for successful supply during periods of low demand (45L/s) all the way through to firefighting demand during future peak demand periods (600L/s).

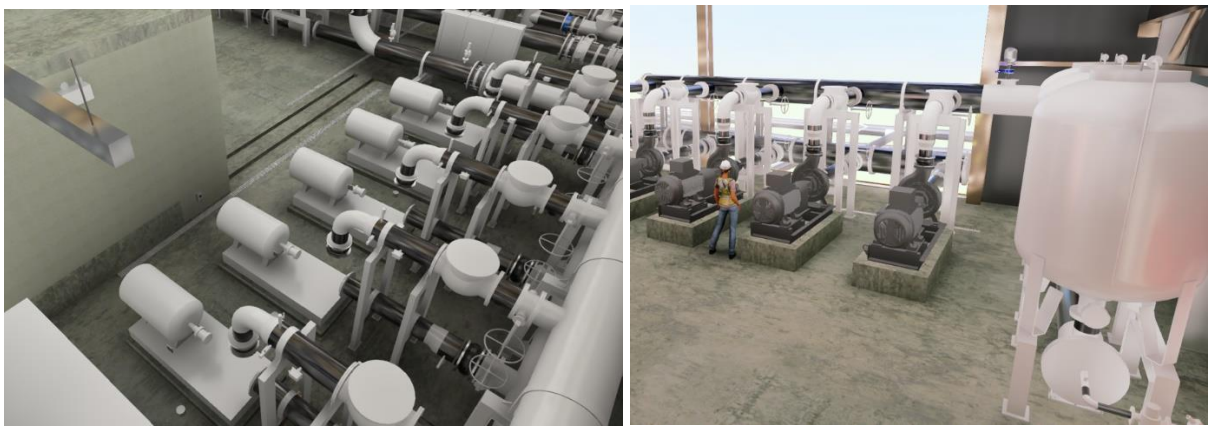

Figure 7: Frimley Park Water Pumps (Left) and Eastbourne Surge Vessels (Right)

The second feature is the prevention of surge effects, with the newly created Hastings west supply zone supplied by the Frimley Park treatment plant protecting the network from possible surge effect with the use of 2x3m^3 Surge Vessels and two of the four treated water pumps having Uninterrupted Power Supplies (UPS). This combination prevents any scenario of pump trips or power outages creating a sub atmospheric pressure in the network. Which if occurs, risks causing possible contamination being drawn into the network.

The Eastbourne treatment plant protects the network from possible surge effect with the use of 1x3m^3 Surge Vessel (with the space for one additional vessel as demand grow in the supply zone) and one of the five treated water pumps having Uninterrupted Power Supplies (UPS) initially. This combination prevents any scenario of pump trips or power outages creating a sub atmospheric pressure in the newly created Hastings east supply zone.

With the creation of the two treatment plants, network improvements involving the installation of 2.5km of trunk watermains ranging in diameters between 355-800mm have been installed for the following reasons:

1) To ensure that flows into different parts of the network are not limited by the existing infrastructure and flows are delivered to key points and mains within the existing network.
2) New pipelines to connect new and existing bores to the treatment plants
3) Creation of the four supply zones and installation of valving to achieve isolation.
4) Creation of a new dedicated supply line from the Frimley Park WTP through to the Eastbourne WTP to supplement high demand and even the abstraction from sources through-out Hastings.

These network improvements, along with the storage, treatment, and source improvements, bring increased security, capacity, and resilience to the Hastings water supply. HDC want to utilise this infrastructure and minimise the impact it has on the local environment, but also want to encourage a greater understanding of where the water comes from and the treatment involved, to provide the public with reassurance that investment in water is a necessary and important priority for the Council and its communities.

4.0 THE FRIMLEY "TALE"

The Frimley Park treatment plant is located within Frimley Park, which is an 'Old English' style reserve noted for its many beautiful and rare trees and more than 5500 roses set out in formal gardens. It would be hard to find a more beautiful place to build a 9m tall reservoir and treatment building within Hastings. To gain public support, HDC partnered with landscape and architectural specialists of locally based Wayfinder Landscape Planning & Strategy Ltd (Wayfinder) and Designgroup Stapleton Elliott (DGSE).

Figure 8: View from Frimley Road (Image by Wayfinder/DGSE)

HDC and Wayfinder have worked together to find a way to integrate large scale infrastructure within the park, by minimising the visual impact of the structures, maintaining the parks pristine nature, protecting the parks from further infrastructure buildings, and minimising the removal of existing trees within the park, while also proposing further tree plantings. This "Tale" of Frimley Park highlights how HDC has been successful in establishing large core infrastructure into a premier urban park with community engagement and support.

4.1 OUTSTANDING TREES

Frimley Park is home to several significant and outstanding trees. Positioning the treatment plant to be hidden among trees, while minimising the removal of well-established trees and allowing new pipelines to be installed clear of trees and without damaging tree roots during construction was like threading a needle through the park.

Below is an image during the concept design used to position the treatment plant in a location that avoided all outstanding trees (labelled in orange), while reducing the number of trees to be removed and keeping the treatment plant surrounded in trees to reduce the visual impact.

Figure 9: Frimley Park Concept and Tree locations (Image by Wayfinder)

A pipe alignment was then selected to avoid damaging any outstanding trees, while trying to keep a near direct alignment to reduce the cost of installing the pipelines. Once a location was finalised, the work in reducing the visual impacts further was be carried out.

4.1 MINIMISING IMPACT

Wayfinder and HDC worked together to further blend the infrastructure with the planting of more specimen trees to improve the boundary along the edge of the

park and improve and strengthen the avenues along the existing path and entrance way. These upgrades are outlined in the image below.

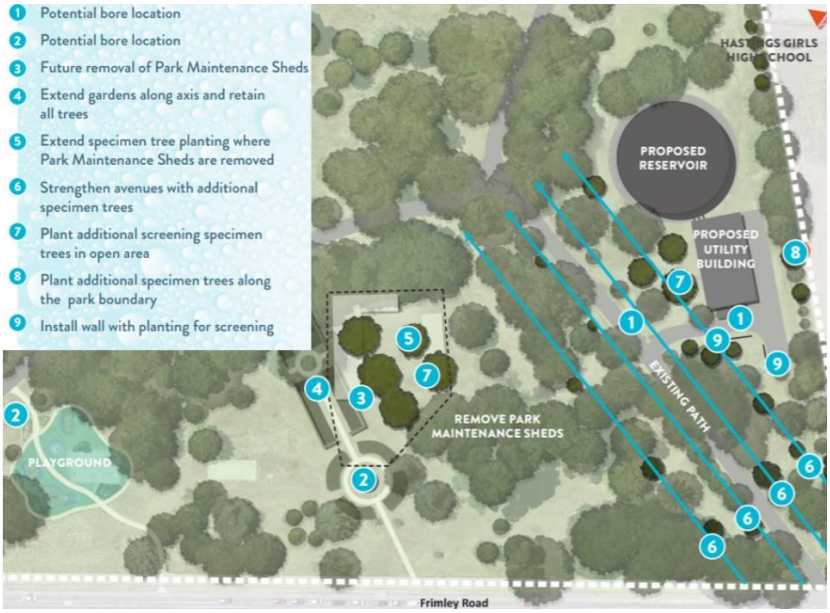

Figure 10: Frimley Park Landscaping Upgrades (Image from Wayfinder)

4.2 FRIMELY PARK STATUS

Frimley Park was gifted as "one of the most wonderful and magnificent gifts" to the then Hastings Borough Council, it originally housed the homestead of James Nelson Williams, one of the original settlers of the Heretaunga block. Ironically the original homestead burnt down in a devastating fire in 1950, when at the time of the fire the closest water main was Pakowhai Road nearly 600m away and the brigade did not have enough hose to reach the fire. It is now home to one of the two major supplies for the town and brings improved firefighting capabilities to Hastings and Flaxmere.

Recently the Council approved a Reserve designation for Frimley Park; the bulk of it as Recreation Reserve and the 1.2-hectare area to be used for water infrastructure as Local Purpose Reserve, this was carried out, because during public consultation, the public raised concerns that the Park was not protected against further infrastructure being built on it. HDC agreed with the concerns and agreed that the Park should be formally protected. Providing it with Reserve designation gives long-term protection to a Park that is held in very high regard by both Hastings residents and Council and enabled a way forward on delivering safe drinking water.

4.4 VISUALISATIONS OF A HIDDEN INTEGRATION

This "Tale" of the work carried out by HDC reinforces the need for Councils to work with the local environment to build infrastructure in a way suitable with the history of the area. Below are some final visualisations from various positions before and after the installation of the treatment plant.

Figure 11: Visualisation before / after from closest path (Image Wayfinder/DGSE)

Figure 12: Visualisation before / after from Entrance (Image Wayfinder/DGSE)

5.0 THE EASTBOURNE / WAIAROHA "TALE"

The Eastbourne treatment plant was given this name initially as the project would be located near the existing bores located on Eastbourne Street East. The new site is located near the centre of Hasting near the Councils main office, in an existing area designated for Civic Purposes. The site on the corner of Southampton Street East and Hastings Street South is near the existing Eastbourne Street East drinking water bore sites and near the existing pipe infrastructure network. These aspects helped to reduce the cost of the project by minimising the new pipe work required to connect it to the existing network. The site was also selected as the land parcel was large enough to accommodate the treatment plant, reservoirs, and additional features, on land already owned by the council.

This "Tale" of the work carried out by HDC highlights opportunities that Councils have in utilising infrastructure as features and potential educational opportunities. HDC and Wayfinder have worked together to find a way to integrate large scale infrastructure by making it a feature for the Council as both a piece of critical infrastructure and an asset with public amenity value.

Figure 13: Site Overview and proximity to HDC office (Image Wayfinder/DGSE)

5.1 SHOWCASING INFRASTRUCTURE

Following the Havelock North water contamination event, the Council wished to involve the public in the project and improve engagement and confidence in the service and water they provide. The Council has worked closely with mana whenua to understand the cultural importance of water. From that has come the name Waiaroha (love water) to help bring the numerous values of water to a more tangible position for the public from this project.

The most tangible way this treatment plant showcases what is normally hidden, is the glass front to the treatment plant, allowing the public to walk up to and

observe the inner working of the treatment process. Alongside this, educational information will be on display to explain the processes involved.

Figure 14: Visualisation of glass front of the WTP (Image Stantec)

5.2 EDUCATION ENHANCEMENTS

The Waiaroha site has been designed to be particularly attractive to school groups, providing a space for community, and will provide a new public "green" space within the central city.

The community space will feature a public education building and landscaping features where the people can learn about the water sources and how they are used and replenished, how the water is treated to be made safe for drinking, along with sharing its cultural importance.

Figure 15: Educational building (left), water features (right) (Image Wayfinder/DGSE))

5.3 VISUALISATIONS OF A PROMOTING INTEGRATION

This "Tale" of the work carried out by HDC highlights how Councils can successfully utilise their asset as both infrastructure and public features with amenity and functional values. Below are some final visualisations from the Waiaroha project and treatment plant.

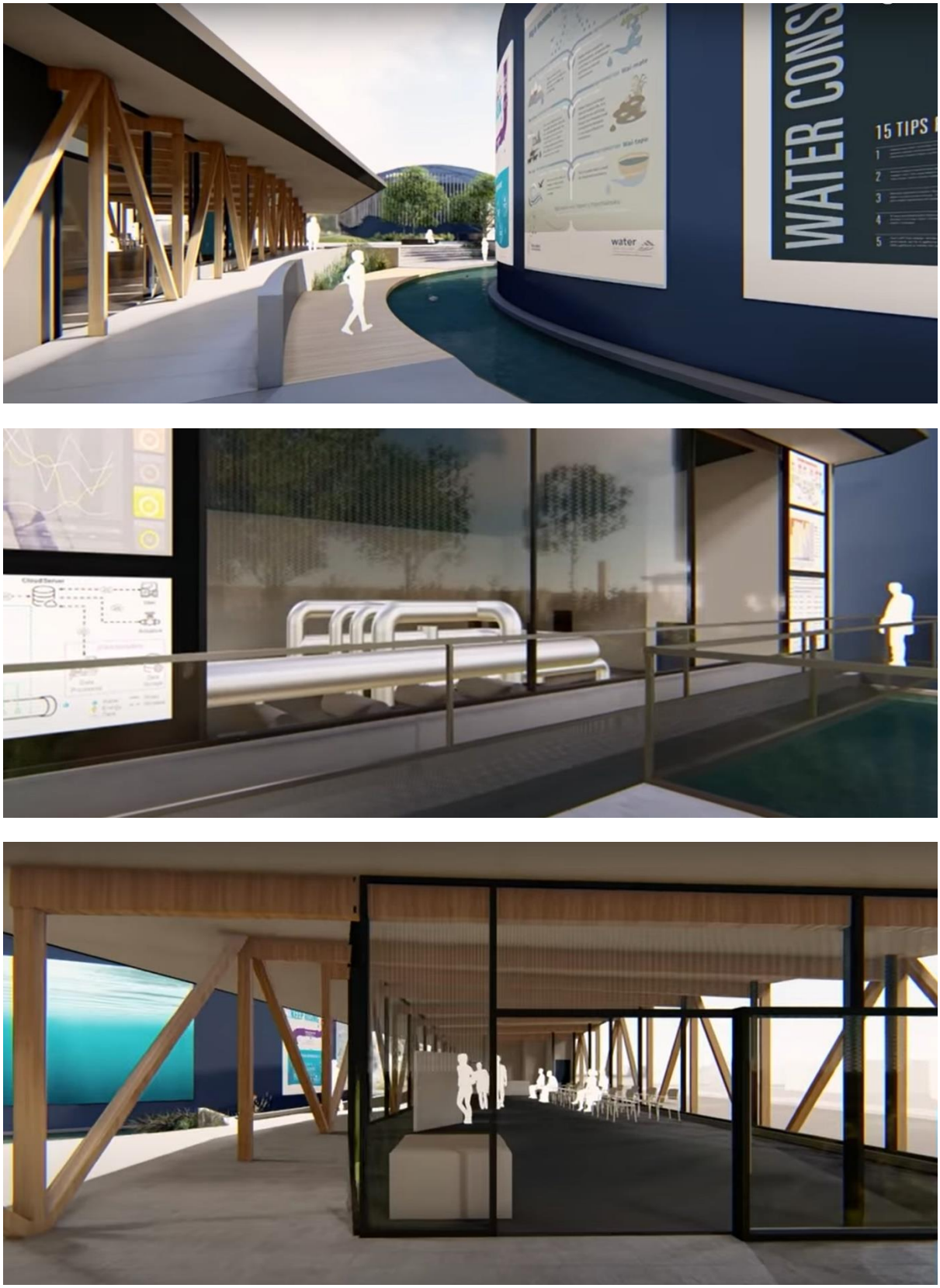

Figure 16: Reservoir and walkway (top), Treatment Plant (middle) and Educational building (bottom). (Images Wayfinder/DGSE)

6.0 CONCLUSIONS

From out of the Havelock North water contamination event, Hastings District Council have been on significant journey - from investigating the cause of the event, considering different options as to how critical infrastructure is provided and addressing them in a way that enabled them to continue to supply safe drinking water to the public, while considering new forward thinking for their infrastructure, to designing and now constructing two modern treatment plants.

The Havelock North water contamination event has influenced and guided HDC in its approach to delivering a new, safe, and resilient drinking water supply to its residents, taking the pubic on the journey with them to a greater understanding of the water treatment process and build trust in the work they are carrying out and trust in the water they provide.

Out of the contamination event, the Water Reform has been initiated and the Water Safety Plan process upgraded and implemented. These have meant changes for water that was once considered secure in Hastings, where even though it was considered secure there were still risks that needed to be addressed and protected against. HDC's effort in installing these treatment plants is an important step in the wider journey that New Zealand is on, and in supporting the wider drinking water direction within New Zealand.

Hastings have shown how new infrastructure can be incorporated into the environment where its located and not only hidden and its impact minimised as in occurring in Frimley Park. But how it can be highlighted and publicly promoted and utilised by the public as well as is intended for the Waiaroha project, where this can gain amenity and educational value along with its functional importance.

A simple metaphor that demonstrates this change in focus, is through the glass fronted treatment plant displaying the inner workings and processes of the treatment process. The glass window brings transparency to the Council, through accountability of the assets installed, the maintenance they carry out and the condition they keep the treatment plant in. While the window also showcases the water the public pay for and brings accountability to the public for the source water and their own pipes within their properties through with the education on display at the window.

The window will rebuild the trust lost in the "past" during Havelock North water contamination event. It will showcase the "present" state of water investment and can be considered a window of how infrastructure and water treatment will look in the "future".

Similarly, the journey New Zealand is on nationally with its water is in line with the Charles Dickens quote "I will live in the Past, the Present, and the Future. The Spirits of all Three shall strive within me. I will not shut out the lessons that they teach."

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