MODULAR TREATMENT SOLUTION EFFICIENCIES FOR HASTINGS DISTRICT COUNCIL

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ABSTRACT

Containerised, skid-mounted, and modularised water treatment plants are a cost effective and Drinking Water Standard New Zealand (DWSNZ) compliant solution for existing plant upgrades or new sites, particularly when applied to small to medium sized flowrates.

This paper discusses how Filtec and Hastings District Council (HDC) have worked together in a progressive work model to upgrade six of their small community water treatment plants to ensure safe compliant water is supplied to communities in Hastings. The paper also discusses Filtec's use of a modular approach to create six similar but fit for purpose water treatment plants to suit each site's specific requirements. Furthermore, how Filtec and Hastings District Council collaborated and applied the lessons learned and efficiencies gained as the project progressed from site to site.

With new regulations, many councils and communities will be required to upgrade their current treatment plants, many of which will require similar upgrades. A standardised modular skid-mounted plant can be an effective and fully compliant solution. Standardised pieces of equipment enable lower cost operations, servicing, reduced storage of critical spares, and deployment efficiencies over multiple sites.

Removing the need for bespoke designs by standardising equipment, processes, delivery, and deployment reduces the required engineering/design time, construction and overall project length reducing the capital cost.

Also covered in this paper are the limitations and potential issues that could arise by using standardised modular or containerised or skid-mounted plant and equipment, and how these limitations can be avoided.

KEYWORDS

Containerised , Modular , Water Treatment

PRESENTER PROFILE

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Steve Cave is a Senior Projects Engineer at Hastings District Council. He joined Council's Major Capital Projects team in 2018 to assist in delivering Hastings Drinking Water Infrastructure Upgrade works. Steve has a New Zealand Diploma in Engineering (Civil) and a Batchelor of Parks, Recreation and Tourism Management (Ecology Major). He has 20 years' experience in local government, including managing a wide variety of engineering projects.

INTRODUCTION

Upgrading Hastings' small community drinking water supplies is a significant contributor to meeting the aims of the Hastings Drinking Water Strategy (2018). This strategy was prepared in the wake of the Havelock North water crisis in 2016 and the ensuing Government Inquiry into the reasons for that contamination. This event showed Hastings and the rest of New Zealand just how vulnerable our drinking water supplies can be.

The Hastings Drinking Water Strategy recognises that safe drinking water is Hastings District Council's number one priority and sets out, amongst other measures, a capital works programme of infrastructural upgrades to ensure delivery of safe and resilient drinking water supplies into the future for Hastings' communities. The upgrades have included constructing new trunk mains between Hastings and Havelock North, new booster pump stations, new bores, new water treatment plants, and new reservoirs for Hastings including upgrading eight small community drinking water supplies across the wider Hastings district.

Early in the capital works programme development, six of the eight small community supplies were identified as suitable for combining into a single works package. They were assessed and a preferred plan to improve safety, capacity and resilience was prepared. Several were able to be improved on current sites using existing water sources while others were identified as benefiting from a new water source and new site.

Expressions of interest were sought from eight water treatment plant construction contractors for the design and construction of the six small community water treatment plant upgrades. Of those eight, three contractors were selected to submit bids, with Filtec Limited being successful and ultimately being awarded the design and construction contract. Three of the six new plants are completed, with a further two in commissioning phases and one undergoing the consent process.

Initial thinking was that bespoke designs for water treatment plant buildings would be best to assimilate new infrastructure into community environs and gain community support, however, budget and affordability practicalities rapidly brought thinking to the modular and containerised solution adopted, which forms the basis of this paper.

Addendum: It has been eight months since this paper was originally drafted and while the majority of the content remains relevant and accurate some thinking has evolved since the initial writing.

CONTAINERISED SOLUTION FOR HASTINGS DISTRICT COUNCIL'S SMALL COMMUNITIES

THE SOLUTION

A containerised modular water treatment plant solution was arrived at for the six small communities of the Hastings district. The move from six bespoke designs to a containerised solution resulted in a reduction of 21% of the initial project cost, with various other inherent cost saving initiatives incorporated into the final containerised design.

One size did not fit all, and each site had slight variants to the treatment requirements and flows, resulting in three base designs which are summarised below.

Table 1: Base Design Summary

Site	Cartridge	UV disinfection	Chlorination Storage and Dosing (NaCl)	Treated Water Storage (new)	Treated Water Pumping	GAC	Greensand
Haumoana Clive-Tucker Whakatu		√	√	√	√		
Whirinaki-Eskdale Waimarama	√	√	√				
Waipatiki	√	√	√			√	√

The six treatment plants were designed so that efficiencies could be obtained through standardising instruments and equipment wherever possible. This included chemical dosing boards, analyser boards, brackets and supports and general layout of the water treatment plant.

All six plants were constructed within 12m shipping containers (actual dimensions: 12.200mL x 2.438mW x 2.896mH). Appropriate modifications were made to the containers to allow for suitable ventilation. Low level louvers and whirly bird vents were installed on the roof, allowing air to freely flow throughout the container. A set of double doors were installed approximately halfway down the container to use as the main point of entry to the plant. The double doors allow equipment to be easily removed if required. A single door was installed on the opposite side of the container from the double doors to be used as a secondary and/or emergency exit from the Motor Control Centre (MCC) room. This access was particularly useful for installation of MCC equipment.

The containers were then lined with insulating panels, which consist of a polystyrene core sandwiched between two powder coated aluminium sheets. These panels were also used to create a partition with a personal access door at one end of the container. This partition created a separate room to be used as the MCC room.

Features and benefits of the container linings include:

- Strength: The panel is strong enough to support lighting, cable trays, sample lines, analyser and dose boards without any additional brackets. Collectively this reduces the time required to fit out the container.
- Finish: The panels result in a 'clinical' finish that is easy to maintain and clean.
- Sound proofing: The linings can assist in reducing operational and mechanical noise emanating from the container however this is dependent on the number of container penetrations and / or openings.
- Temperature: The panels can assist in internal temperature regulation.

Each site had different requirements which resulted in slightly different design scopes between each plant. Typically, these were flows (affecting pipe sizes and equipment sizing), treatment requirements and raw water quality (additional process requirements), existing equipment or infrastructure, site location and restrictions.

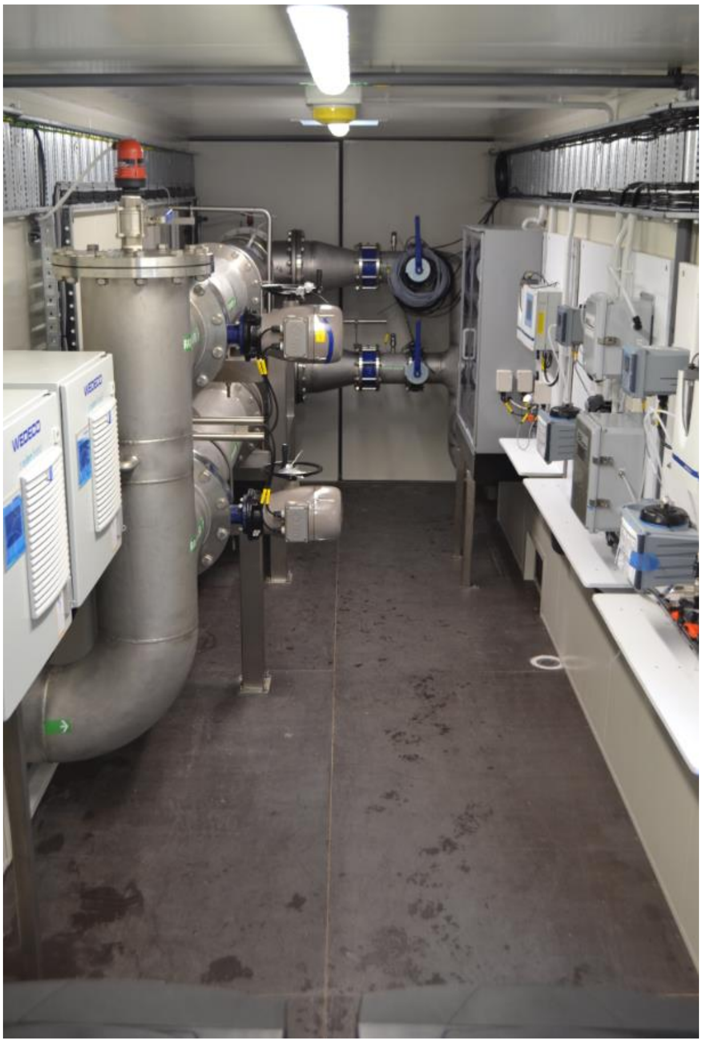

Figure 1: Haumoana WTP: Largest site by flows

All water treatment plants were designed in a way that maximised the limited space of a container. When designing the layout, primary considerations contemplated were accessibility, operability and maintainability. The layouts were replicated over all plants, providing HDC with six water treatment plants with a similar look and feel allowing operators to easily move between sites with minimal additional training.

Externally each site had its restrictions and limitations. Where possible each site was designed in a way that the external layouts were as similar as possible. Location of the chemical storage tank, washdown hose, safety shower, dose points and sample points providing relevant examples. Common equipment, instruments, valves, and analysers were used across all sites reducing the need to carry multiple spares.

Replicating designs also allowed the water treatment plants to be constructed in a way that standardised modules across all sites. An example of this was the sodium hypochlorite dosing board and cabinets. Six identical dosing boards and cabinets were constructed, concurrently reducing fabrication time and increasing efficiencies. The boards were then stored until required. A similar approach was used for the analyser boards and UV support frames.

In parallel with the HDC small communities water treatment plant project, Hastings District Council updated many of their internal standards including:

- SCADA and Electrical Standards Framework
- HMI and RTU Software Standards
- P&ID, Functional Description and Drawing Standards, Preferred Suppliers and Equipment Lists
- Asset Tagging and Document Numbering System.

Completing these changes in parallel with the small communities project allowed Filtec Limited to provide input and recommendations into the detailed design phase of the project. These were then applied and tested in the field. While the concurrent standards development process allowed for 'testing on the fly' it did create time and programme challenges and if the project were to be replicated developing thinking around standards development prior to embarking on plant design and construction would be recommended as a mechanism to realise time savings.

SUCCESSES

The collaboration between HDC and Filtec Limited has worked well and continues to. The collaboration is successfully delivering high quality water treatment plants that will ensure the small communities of Hastings will have safe drinking water now and into the future. Key successes are listed below:

- Invited Tender procurement approach.
- Early Contract Involvement.
- Early identification of areas for improvement and implementing actions to improve on identification.
- The ability to develop software on the first plant and roll out across successive sites
- Container transportability
- Workshop fabrication

HDC small communities journey has highlighted, as is the case with many projects, areas where improvements could be made that will result in improved functionality as well as time and cost efficiencies.

In the small communities example, areas for improvement were largely dealt with at time of identification, with solutions incorporated into successive plants and in most instances retro-applied to plants already completed. The addition of sodium hypochlorite mixing equipment to all plants after inadequate mixing was highlighted as an issue at the first plant, is one specific example. The commitment of the client and the contractor to achieve desired project outcomes, as well as the collaborative nature of the client and contractor relationship, one of the project's greatest successes, has enabled this to occur.

The Early Contract Involvement approach, post tender award has allowed for much better collaboration between client and contractor. Both parties were able to commit more time and resources to the detailed design phase which resulted in Filtec Limited having a much clearer understanding of HDC's requirements and how the best outcomes could be achieved for all parties. This clearer understanding provided the foundation for a good working relationship between contractor and client. This relationship has been reflected throughout all phases of the project to date.

A further example of HDC and Filtec Limited collaboration was in the way software was developed for each plant. HDC drafted and implemented new software standards through the roll-out of the small communities project. Filtec Limited and their sub-contractors worked with HDC to implement these standards on the first site. While this did result in some issues with Factory Acceptance Testing (FAT) and commissioning and these processes taking longer than intended, particularly on the first site, it enabled the new standards to be developed, implemented and tested on the fly and as part of the small communities delivery programme.

Transportability of the product provided the opportunity to fabricate and fit out the containers at Filtec Limited's Auckland workshop. This was significant in that this ability created efficiencies and consistency throughout the fabrication process, resulting in time and cost savings. Having up to three containers in the workshop at one time and at different stages of fabrication allowed the fabrication team to use the other containers as references to ensure consistency in build could be obtained. This combined with the ability to update and detail the fabrication

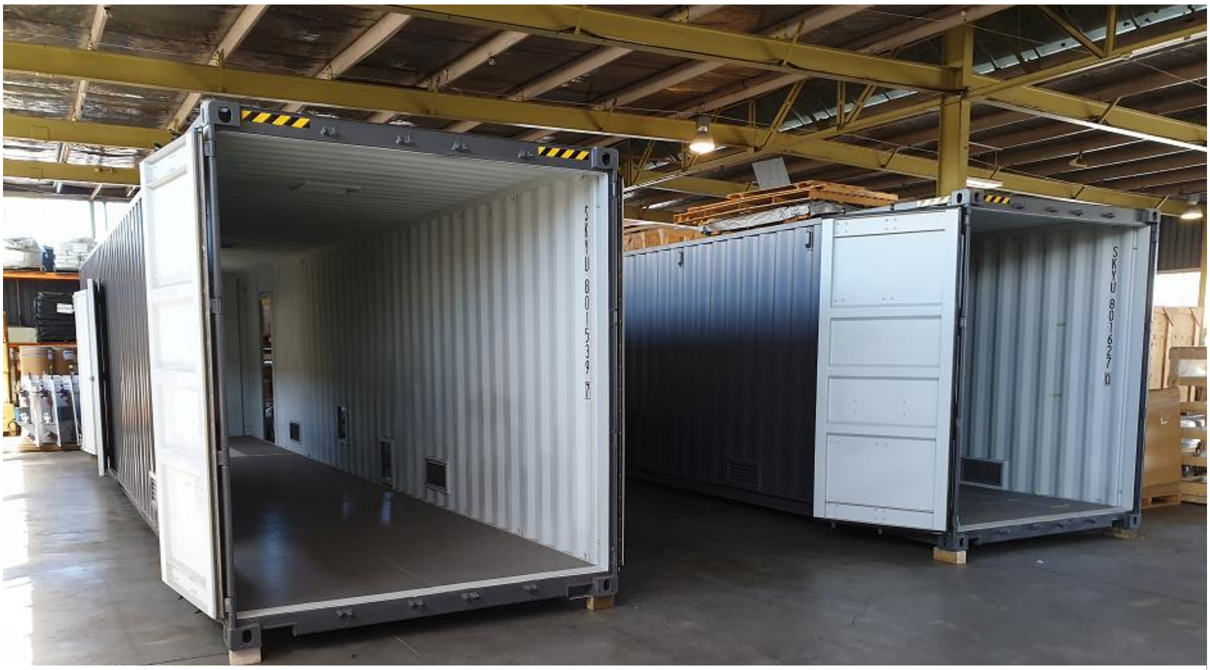

Figure 2: Two containers ready to for fit out.

drawings as the builds moved forward resulted in faster construction times.

With the COIVD-19 pandemic and the introduction of alert levels, travel between regions became restricted and uncertain. The ability to fabricate and fit out the water treatment plants in one location and not rely on travel meant workshop fabrication was able to proceed relatively unhindered. We consider this another success of the containerised water treatment plant solution. It is noted that the nature and importance of the project to Hastings communities enabled the works to be classified as an 'Essential Service', allowing fabrication and fit out of the containers to continue with minimal disruption.

Significant fabrication and installation labour efficiencies were gained as progress was made throughout each site. This was seen in the workshop as well as in the field, with a reduction of approximately 20% of labour hours when comparing the first site to the next site of similar scope. These efficiencies were gained through common designs and layouts, meaning that planning, ordering of material and knowledge of site requirements could be done with more efficiency. Onsite install time was typically reduced by between one and two weeks (site dependent) from the first site. These efficiencies were always expected and were a cost saving initiative during project pricing.

The standardised and consistent look and feel between respective plants means that handover is much smoother process and easier handover from contractor to client. A detailed training session was conducted just before handover of the first water treatment plant with the training covering general layout, operability and specialized training of equipment (pumps, analysers and UV reactors for example). With this in-depth training session completed the amount of training required for following sites has been reduced. After the first site, training has now shifted focus for the remaining sites; from operation and maintenance of the plant to the way the new plant is integrated into the existing system and any observed differences. For plants completed, this has seen, on average, a reduction in the overall training time required from a full day down to only two hours.

Figure 3: Top: Haumoana WTP ; Bottom : Clive-Tucker WTP

LESSONS LEARNT

Throughout the various stages of the small communities project there have been inevitable hurdles and challenges that have arisen, from finding new water sources, acquiring land, navigating consent requirements (both building and resource) . . . the list is long. This paper, however, primarily focuses on those hurdles and lessons learned that presented during construction, fit out and commissioning of the first plant at Haumoana.

This site required the largest upgrade of the six community supplies and was selected to be progressed first, primarily due to historical iron and manganese issues with the existing supply and having the greatest number of residents in the small communities programme. It also required completely new infrastructure from a new water source and bore, new mains (both raw and treated water), new treatment plant, new 600KL reservoir and a new booster pump station. In addition, the new bore was located 700m from the water treatment plant site.

During each phase of the project, frequent reviews were completed to highlight areas that could be improved or made more efficient. After going live with the new Haumoana water treatment plant, a 'lessons learnt' workshop was held with key project team members that saw contractor, consultant and HDC staff participating. The workshop focused on both what went well and what could be improved. The intention being that as Haumoana was the first of six sites, any learnings identified could be applied across the remaining sites.

Through the workshop a total of nine key learnings and areas for improvement were identified. These were:

1. **Factory Acceptance Testing**
   On the first site due to community pressure to deliver the water treatment plant, a new source of water as well as developing and implementing new software standards, Factory Acceptance Testing (FAT) was unable to be completed at the appropriate time. This resulted in an extended commissioning period as well as ongoing commissioning-related issues after the water treatment plant had become operational that would not have been present if FAT had been completed at the correct stage. The fundamental lesson here is that FAT is an essential process that needs to be completed at the appropriate time. This will save time in the commissioning phase. On successive plants within the small communities project, priority has and is being given to completing FAT at the appropriate time. This in most instances (but not all) is seeing a reduction in commissioning periods. Contributing to this reduction also is the growing experience within the project team.
2. **Documentation Standards**
   HDC chose to upgrade its documentation standards through the small communities project. This has been achieved successfully but with time cost to the project. Upgrading documentation standards has required a great deal of commitment from all parties and it is recommended that as much thinking around the end product of the documents sought is completed ahead of project start and that requirements are clearly communicated to all parties involved. Having articulated this, sometimes

the end result and outcome sought only becomes clear once you have embarked on the journey.

3. **Compliance and Internal Checklists**
   Commissioning of the first small communities site was completed without an adequate compliance checklist in place. While all compliance requirements were met ahead of this plant becoming operational, the checks were completed in an ad-hoc manner and the compliance-checking process was protracted. A fully itemised checklist was subsequently drafted ahead of any successive plants being commissioned and this has created both efficiencies and a thorough checklist process clearly establishing what is required in terms of compliance and of respective project team members, ahead of going operational with a new water treatment plant.
4. **Risk Management**
   This lesson relates to changeover management from an old plant to a new plant and to clearly understand requirements to complete a changeover from old to new in the most seamless way possible. In this situation a changeover plan is recommended within the overarching commissioning document.
5. **Hold Points**
   Clear hold points are required for document and drawing review with solid expectations set for reviewing periods. Timelines and work programmes can be severely compromised if hold point and review periods are not adhered to. An important consideration in the hold point mix is workload and adequate resourcing to complete document reviews.
6. **Workload**
   An excerpt from the HDC/Filtec Limited lessons learned workshop... "Due to multiple parallel projects, resourcing and timely response to queries and reviews can be improved by all parties". This was not such an issue with one or two sites under construction, however, with three or four at different stages of construction and commissioning, demands on all staff – client, contractor and consultant - can be intense and should be given an appropriate amount of consideration at project start to avoid staff burnout or walkout. The HDC small communities project has been fortunate to have the passionate and committed project team and operations staff it has, often going above and beyond what is required, to ensure the best possible outcomes for the project and Hastings' small communities.
7. **Snag List and Issue Recording**
   Snag list recording is a vital tool in tracking faults and corrections, particularly through the commissioning phase of the project. The key lesson learned with regard to snag lists is to avoid multiple lists, particularly when multiple parties are involved in identifying snags (consultants, contractor and client). It is recommended that one centralised snag list is maintained per plant.
8. **Communication**
   Maintaining clear lines of communication between contractor, sub-contractors, consultants and client is essential to get the best possible project outcomes. This is a fundamental of project management and can often be challenging to maintain consistently through project, contract, construction lifecycles. One example of maintaining and improving communication for enhanced outcomes was between Filtec Limited and the site civils contractor. During civils construction of the first site, improved

communication was required to ensure both contractors were interpreting the construction drawings correctly and correctly identifying features such as tie-in points and pipe depths. Clarifying these features and understanding of the drawings on the first site between contractors reduced the risk of civils rework on successive sites.

9. **Interfaces**
   Through the small communities project, interfaces where one set of contract works (usually involving different contractors) meets another, such as water mains interfacing with a water treatment plant, have proved to be a 'grey area' on more than one occasion. This can cause issues with commissioning as well as construction, and it is recommended where different construction contractors are working on separate but interfacing works that respective work scopes are made clear to all parties involved.

BENEFITS OF STANDARD/MODULAR SOLUTIONS

Using standardised and/or modular water treatment plant solutions offers many benefits over standalone or bespoke solutions. A module can be installed as an addition to an existing plant or system to increase levels of treatment and performance or a full turnkey package. The following section identifies and discusses key benefits in a general sense and how standardised and modular solutions can benefit the market going forward. Ultimately these benefits lead to enhanced final products for the customer and lower risk for the contractor which in turn creates lower overall cost.

DESIGN

In a project, the design element is typically only a small percentage of the overall cost, usually between 5% and 10%, depending on the complexity of the process. Containerised modular treatment plant designs, like bespoke designs, carry risks and require reviews, HAZOPs and SIDs. The key point of difference here in the HDC small communities context is that if HDC had chosen a bespoke design pathway for each site this would have significantly increased the quantum of review work required and meant less transferrable benefits across sites such as the lessons learned. It also would have substantially increased cost. Using a containerised modular water treatment plant solution reduces both upfront and ongoing design requirements with substantial time and cost saving benefits. Each time a standard module is used, improvements and minor changes can be made to the design through the use of internal reviews and client feedback, which can be used to improve constructability, operability and maintainability.

Drafting is another important element in the design where considerable time and thus cost savings are made through the containerised modular solution. Drafting time consistently reduces through each successive plant design iteration over the design phase.

PROCUREMENT

There are two main procurement benefits identified through using standardised modules with one being the ability to reduce cost of materials and equipment and the other through reducing lead times.

Having standard equipment, valves and or instruments, provides opportunity to negotiate better prices from suppliers. In addition, standardising equipment also means that common spare parts can be kept, reducing the number of different makes or models.

Reducing lead times when ordering is another fundamental procurement benefit that can see significant gains in the overall project programme. Orders can be placed for equipment soon after contract award without the need to wait for detailed design periods, in HDC's case, this was typically several weeks or even months. However, it is noted the effects of the Covid pandemic played a part in equipment delivery delays for the small communities project and continues to.

A further advantage when considering procurement and standardised solutions is that the contractor has increased confidence, particularly where multiple plants are being constructed, such that common items can be sourced, kept in stock and assigned to a job as required. This approach can also assist the client as they will not need to purchase items as spares.

FABRICATION AND FIT OUT

When fabricating a plant, or module of a plant, labour resource provides the most significant opportunity to reduce cost. Improvements can be made in two ways, streamlining of the fabrication process and ability to complete a substantial quantum of the fabrication and fit out in a workshop environment as opposed to onsite.

Modifying the way that the module or part is fabricated can be done by adjusting construction drawings so that a particular module, or part of a module, can be constructed in a more efficient manner. An example of this is the Filtec Limited standard 25m^3 Lamella Clarifier. After the first iteration was constructed the fabrication process and drawings were reviewed. Modifications were made to the way the panels were folded. This reduced the number of welds required to fabricate the unit. Material costs remained approximately the same, however the labour time was reduced by 58%.

Another example is the Wellington resilience project, where 22 containerised water treatment plants were constructed, 13 of these were for surface water sources and nine for bore water sources. Out of the surface water plants. The first two were constructed in parallel and this took 25 days to complete, each time a plant was constructed more streamlined processes were created. More accurate bill of materials and cut lengths were created through each iteration and general similarity of the build meant that the construction time was greatly reduced. This resulted in the final two containers having a 56% reduction in labour costs and related overheads.

The Hastings small communities project was not able to realise the above reductions in fabrication time as significantly, because while each plant was standardised and modular, each site had its own particular characteristics in terms of size of supply, supply water parameters and size and space requirements.

In addition to the above, labour costs can be reduced on fabrication and fit out through completing as much of the build and fit out inside a workshop environment as possible. Typically, it takes 30% longer to fabricate on site when compared to completing the same task in a workshop. This is because inside a workshop generally all the tools and equipment are readily available, for example, lifting gear and overhead gantries. Setup and pack down time is also greatly reduced and, in most cases, removed altogether Also, there are fewer external factors that may cause delays such as other contractors on site, weather and, depending on the location, community constraints and restricted working hours.

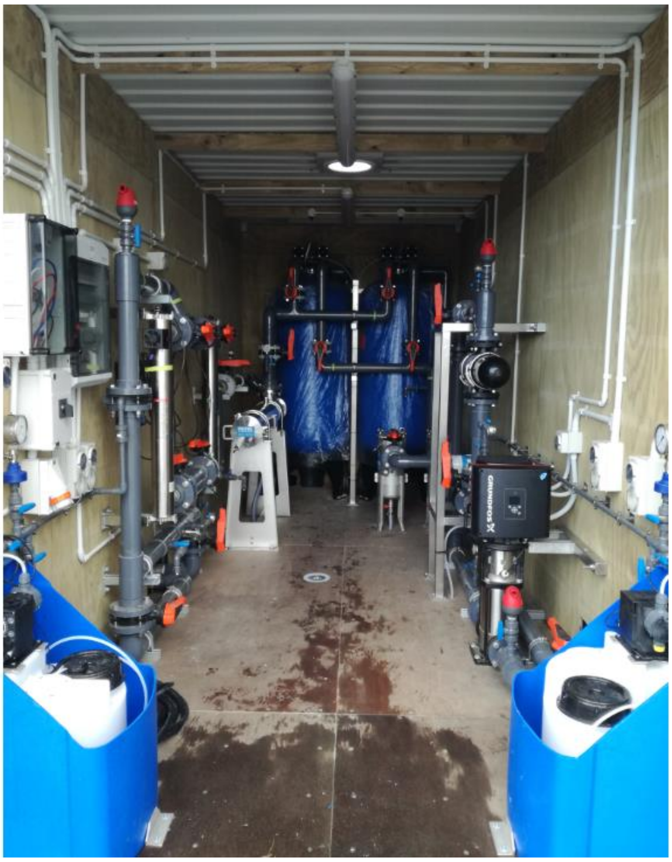

Figure 4: Wellington Emergency Container 1 of 13

The other areas where labour related savings are made through being able to fabricate in a workshop include less travel and less remote work-related expenses, such as accommodation and equipment hire.

CONTROL AND AUTOMATION

Using standardised modules can allow control and automation requirements to be greatly reduced through reusing programming, therefore reducing the labour and time required. Reusing an already proven programme provides much greater certainty that the plant or module will run more reliably and reduce the risk of a failure or unexpected shut down. Gathering feedback and monitoring existing modules or plants will allow the control of the plant to be continuously improved. That gives operators a much higher level of confidence with their plant and its performance.

SITE WORKS AND COMMISSIONING

Container install, associated site works and commissioning are an area of a project that potentially has the highest risk of labour resource overruns. This can often occur during the site install as the contractor has to interact with existing services, equipment and tie-in points that can have unreliable or poor information. Standardising modules allows the contractor to accurately communicate the requirements of the install and gather the required information about any existing tie-in points, reducing the risk and unknowns of a particular site. The Hastings' small communities projects on-site installation time was reduced by approximately 20%, achieved through the ability to plan the install more efficiently so that more items could be prefabricated off site, and a reduction in the amount of on-site fit outs and fabrication. When planning for the site install, site managers had a much more accurate idea of what was required and could plan accordingly. This resulted in a reduction of leftovers and over ordered items.

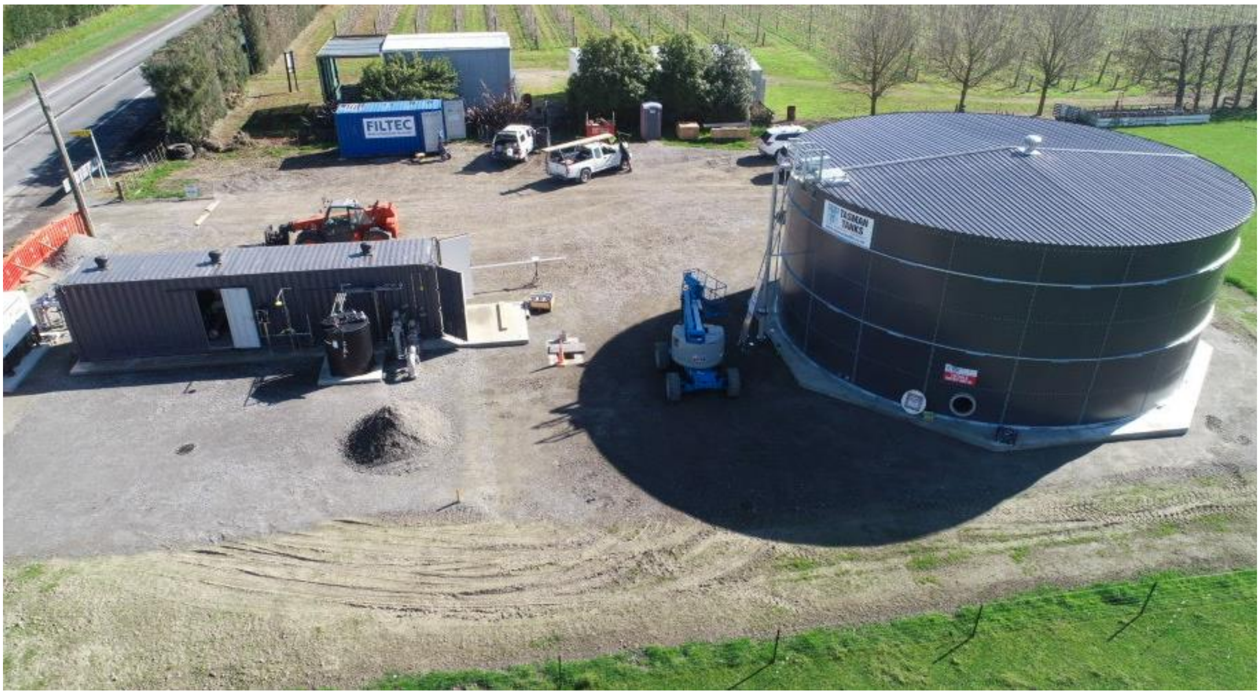

Figure 5: Hastings Small Communities: Haumoana WTP during site install.

Commissioning is an integral and fundamental process in water treatment plant delivery. When a bespoke design is commissioned, there are many unknowns. While expected processes may be documented, the actual operation of the plant has not been tested or proven at the pre-commissioning stage. When using a standardised module or plant, the number of unknowns prior to commissioning can be reduced. In many instances standardised equipment can be tested during the initial product development or will have already been tested and proven on other sites and plant where a particular item, module or plant has been previously installed and is operational. Further, the commissioning engineers' experience and knowledge grows with these modules or plants, as it is likely they have commissioned one in the past, or they have access to people or resources that have.

As multiple plants or modules are commissioned, troubleshooting and setting up equipment becomes a more efficient activity; issues can be preempted and solutions are already in place or known. As experience and familiarity grows commissioning plans and associated documents can be drafted to a much more detailed and thorough standard and the document drafting process becomes more efficient.

During the Hastings small communities project, the site install time was reduced by approximately 20% on sites that had similar levels of scope, and commissioning time was reduced by one to two weeks.

Similarly, on the Wellington resilience project, commissioning of many of the treatment containers was completed prior to sending the containers to site. A commissioning system was set up with the required pumps and tanks so that each container could be commissioned fully before being transported to the final site. This allowed the time required for the commissioning of each site to be reduced from three weeks down to one day. This significant reduction in commissioning time was a direct result of the points raised above. Issues that had taken hours or days to resolve in the earlier plants were reduced to minutes. Having a clear understanding about how the plant needed to be commissioned allowed the commissioning team to set up pumps, hoses and tanks in a way that meant a plant could be set up and commissioned in the most efficient way without compromising quality and the end result.

LIMITATIONS

CLIENT REQUIREMENTS AND STANDARDS

Often clients and councils have their own engineering standards, preferred suppliers, and requirements. This is a limitation when standardising plants, since the design and equipment selection has been completed upfront. Once modifications start to be made to a standard module or plant it no longer becomes standard and can quickly lose the efficiencies gained or sought.

There are, however, minor changes that can be made 'on the fly' and have minimal effect. These could include changing equipment makes for equivalent alternative brands. If changes are to be made through the course of a design and construction project, as has been the case with HDC's small communities project, discussions between the client and the contractor need to be had at a reasonable frequency. That ensures both parties are clear on current expectations and any compromises made, and the effect these will have on the product and project outcomes.

To assist with this the contractor can also review the standard design. If there are common trends between multiple clients the designs can be modified to incorporate these common requirements into future designs. In addition to a client's engineering standards, often input from other stakeholders, such as automation or electrical specialists, is requested and can be included in the designs.

Standardised designs can make a change process more complex, however this can be overcome through clear communication and detail upfront around desired outcomes and the levels of operation and maintainability of standardised modules sought.

SPACE, FOOTPRINT AND VISUALS

Using standard module or full plants can present limitations around space, footprint and visual limitations, compared to bespoke designs.

Pre-designed modules limit the ability to customise the layouts to suit existing buildings or available spaces. This becomes more relevant when using containerised or skid-mounted designs. Bespoke designs can be more easily configured to suit the land and space features of a particular site or existing building, whereas a skid-mounted design is less flexible in that the design is largely predetermined and usually cannot be easily modified.

When containerising a plant, we are restricted by space available inside the container. Shipping containers come in three sizes: 10ft (2.44m x 3.01), 20ft (2.44m x 6.06) and 40ft (2.44m x 12.19m). This can limit the amount and size of equipment that can be installed. Space limitations can also affect the area available for maintenance, storage, and operability. Modifications can be made to the containers to add doors and alternative access points minimising these limitations. Space for other items, such as storage, desks and tables, is often not available. Careful layout planning can optimise space and ensure that the modules and or plant are still safe and operable. When using a containerised plant, the footprint required is a rectangular concrete slab. the length of the slab is dependent of the container size. If space is limited on site there may not be sufficient room for a container.

Shipping containers are not typically associated with being visually pleasing and often these plants are installed in public spaces or in an area where the public is affected. This can present some issues or limitations when presenting the solution to the public however there are considerations and steps that can be taken to minimise the visual impact of containerised plants. These include:

- Using recessive colours such ironsand (a dark matt grey) to shadow the container is one example that helps containers blend into surroundings. HDC is using this colour to great effect with its new drinking water plants and reservoirs.
- Façades: See fig 7 for an example used in Wellington
- Fences: If required, higher fences or different designs can be incorporated to reduce visual impact as well as provide security.

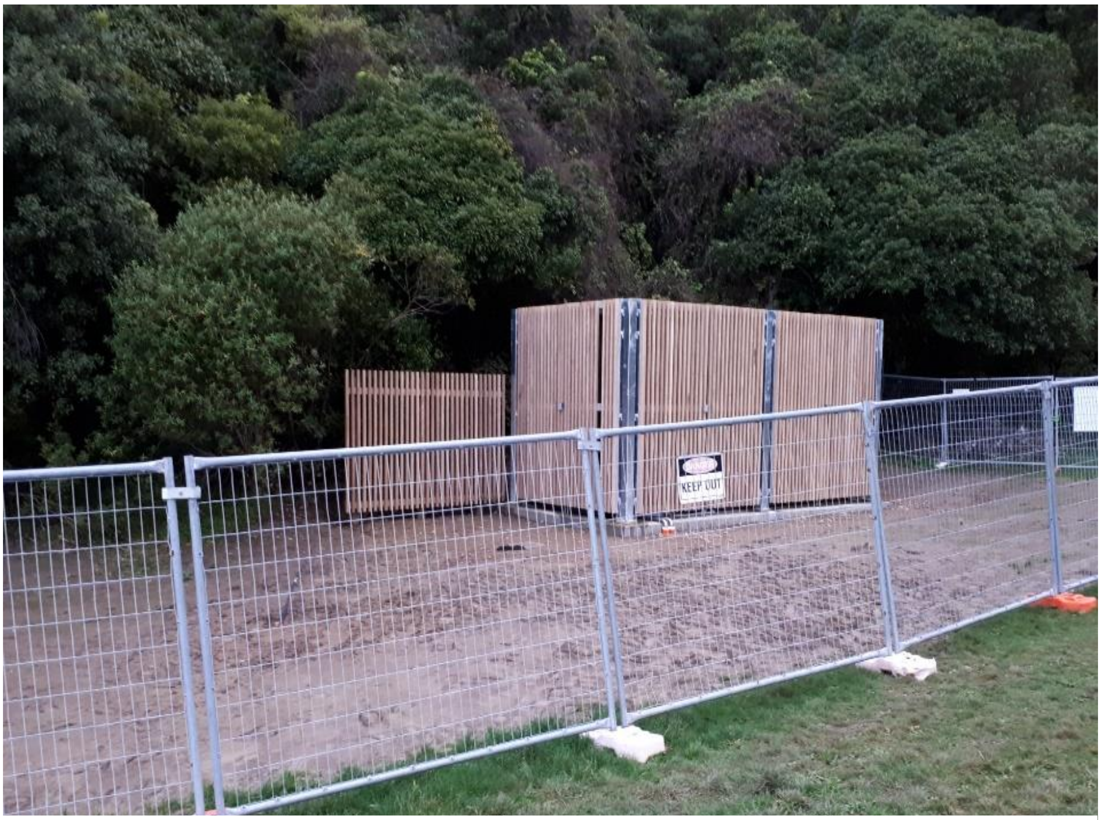

Figure 6: 20ft Containerises Water Treatment plant with facade installed. Wellington Emergency Containers Bore site

MODULE DEVELOPMENT

One of the most significant limitations of a modular or standardised solution is that there may not be a standard piece of equipment or plant that is suitable for a particular space or location requirement. Modules are developed in a way so they can be applied to the largest range of situations. In the event that a standard module or solution is not readily available, then a bespoke design may be required. Constant development of standard modules will mean that in future more options will likely become available, reducing the need for bespoke designs and thus creating further financial efficiency.

NEW REGULATONS AND INCORPORATING STANDARDISATION

As New Zealand moves though the new water reform and the introduction of a water regulator, new regulations will mean many councils and communities will be required to upgrade their current treatment plants. Many of these will require similar upgrades and processes as those seen in the Hastings small communities example. A standardised modular skid-mounted plant can be an effective and fully compliant solution. Standardised pieces of equipment enable lower overall cost and reduce lead times associated with procurement and installation of these modules or plants.

Capital costs: The capital cost can be reduced though the reduction in design, fabrication, and commissioning resources, coupled with the ability to improve fabrication methods and optimise materials.

Operational costs: Operational costs can be reduced through using common spare parts, reducing the number of critical spares required to be kept on hand, and storage associated with that. Training costs can be reduced as both a common training plan and skills training can be applied across multiple sites and plants.

Standardising equipment also allows water entities to forecast future capital and operational expenditure requirements more accurately, compared to bespoke designs or upgrades. Looking to the future, a regional or even national approach to standardisation will deliver economies of scale to the industry, from design and build to capital and operational expense. Resources and equipment could easily be shared between regions in emergency situations.

The reduced time required for design and fabrication and the ability to pre-order equipment will allow for a reduced turnaround time, from the time an order is placed to the contract being awarded, with the ability to combine multiple site and or upgrades into a single contract. That allows more plants to become compliant and safe, more quickly, without compromising quality or increasing risk.

CONCLUSIONS

To ensure Hastings' communities have safe drinking water, Hastings District Council implemented the Hastings Drinking Water Strategy (2018).

As a result, six small community water treatment plants were identified and combined into the Hastings Small Communities Water Treatment Plant Upgrade project. Hastings District Council partnered with Filtec Limited to deliver these six plants.

Throughout the early stages of the contract, budget and affordability constraints were highlighted as an important consideration and the idea of standardising and containerising the water treatment plants was proposed, resulting in the base contract price being reduced by approximately 21%.

Each of the six sites had slightly different requirements and challenges which meant that Filtec Limited was unable to construct a purely standardised plant. The plants were however, constructed in a way that standard modules could be implemented across all plants. Both Filtec and Council have been able to work collaboratively together to ensure the best possible outcomes. The ability for both parties to work together and take on board lessons learnt from one site to the next and implement improvements is ensuring successful delivery of all of the upgrades across all six small community sites.

Standardised modular skid-mounted plants or modules are an efficient and cost-effective way to resolve and deliver on New Zealand Water Treatment requirements, as an alternative to bespoke designs. The ability to reuse already proven designs allows many materials, equipment and labour aspects to be reduced without affecting the safety, quality and reliability of the plant. Using standard designs and equipment reduces the operational cost of all plants. Operations teams are able to reduce spare and critical parts required to be kept on hand, and reduce training requirements as they will be relevant over multiple sites or plants. Standardised modular skid-mounted plants or modules is a cost-effective and reliable way to ensure the communities of New Zealand have safe drinking water.

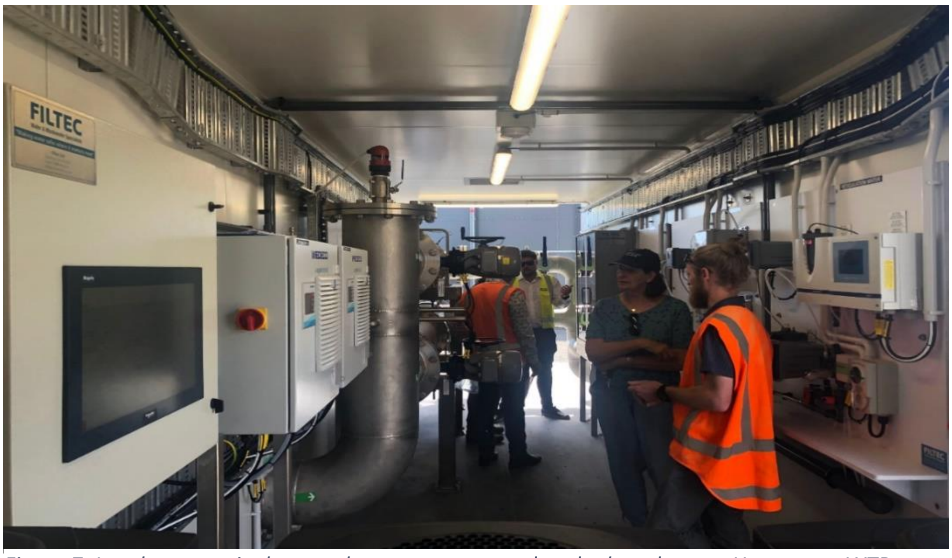

Figure 7: Local community have a chance to get a up-close look at the new Haumoana WTP

ACKNOWLEDGEMENTS

Hastings District Council

Hawkes's Bay Regional Council Works Group

Kinetic Electrical Ltd

iTSi Solutions

Drainways Contracting Ltd

REFERENCES

Hastings Drinking Water Strategy (2018); drafted by Hastings District Council