

## **TRIMBLE CONNECTED SITE SOLUTIONS DRIVE PRODUCTIVITY FOR FLETCHER INFRASTRUCTURE'S NEW ZEALAND KAPITI EXPRESSWAY BUILD**

**TRIMBLE CONNECTED SITE PORTFOLIO, INCLUDING ON AND OFF MACHINE TRIMBLE TECHNOLOGY,  
TIGHTLY CONNECTS OFFICE AND FIELD BASED OPERATIONS**



## Overview

The MacKays to Peka Peka (M2PP) Expressway project is being built by an alliance made up of the New Zealand (NZ) Transport Agency, Beca Planning and Infrastructure, Fletcher Construction. The M2PP Alliance brings together a high performing, integrated team to address this project's complex design, construction, environmental and lifecycle issues. It's a model of contracting that has been successfully used around the world to deliver complex and challenging infrastructure projects.

The Wellington Northern Corridor is one of seven 'roads of national significance' that the New Zealand Government has identified as essential state highways, which have been selected for upgrades. According to the NZ Transportation Agency, the goal of the upgrading efforts is to reduce congestion, improve public safety and stimulate economic growth in the region.

Fletcher Construction is a leading infrastructure, commercial engineering and building contractor, developing projects in New Zealand and the South Pacific. The M2PP Alliance was selected to provide consenting, design and construction services for the 18-kilometer [11.2 mile] stretch of expressway that cuts through the Kapiti Coast in New Zealand from MacKays Crossing to Peka Peka. It's the first of eight sections that will eventually form the larger 100-kilometer [62-mile] Wellington Northern Corridor.



**Source:** NZ Transport Agency  
<http://www.nzta.govt.nz/projects/mackays-to-peka-peka/>

In total, the \$630 million NZD (\$488 million USD) project will deliver approximately 18 kilometers [11.2 miles] of four-lane expressway through Kapiti, including a new bridge over the Waikanae River. To build the expressway, Fletcher Construction, subcontractor Goodmans have been tasked with moving 3.5 million cubic meters [123 million cubic feet] of dirt, including more than 800,000 cubic meters [28 million cubic feet] of peat. This whitepaper will focus primarily on the use of Trimble technology across project management, earthworks, and the construction of the M2PP expressway. Trimble technology used on this project includes the Trimble® Connected Site® portfolio. Fletcher began excavation work in January of 2014 and the road is expected to be open to traffic by 2017.

### Streamlined data flow

Will Newall, survey manager for Fletcher Infrastructure, explains that the company was awarded the \$52 million NZD (\$40 million USD) earthworks subcontract for the M2PP expressway; in fact it's the largest job Fletcher Infrastructure has ever done. In fact, the earthworks subcontract awarded to Fletcher and their subcontractor Goodmans, it is the largest earthworks contract awarded in New Zealand history.

Not only is the scope of this earthworks effort massive, the area where the expressway is being constructed is on culturally sensitive land, which means additional planning and coordination with community leaders. Overall, Fletcher is tasked with moving 3.5 million cubic meters [123 million cubic feet] of dirt. In addition, the project also includes removing 55 existing settlement structures, building 18 new structures (pedestrian and cycle bridges), building an end-to-end cycle way, and building connections to local roads. With all payments being calculated on volume, one of the big issues being faced by the M2PP Alliance was how to manage and account for these movements in an efficient way.



The M2PP Alliance is building the 18-kilometer [11.2 mile] stretch of expressway that cuts through the Kapiti Coast in New Zealand. The project is the first of eight sections that will eventually form the larger 100-kilometer [62-mile] Wellington Northern Corridor.

The roadway travels through wetlands and will include 140 hectares [346 acres] of native planting, specific to the Kapiti Coast. With the large number of moving pieces across the project, Newall explains that early on Fletcher determined streamlined data management and workflow across operations was going to be critical. The team also wanted a single unified view of the project to track progress and drive productivity across the M2PP initiative. Already a power user of Trimble machine control and GPS, Fletcher Infrastructure established a fully connected construction site leveraging the entire Trimble Connected Site portfolio, including on and off machine Trimble technology.

### Data Sharing and Collaboration Across the Connected Project

With the decision to adopt on and off machine technology from Trimble, Fletcher Infrastructure established a Trimble Connected Site leveraging Trimble's Connected Community to share data between the field and office. The Trimble Connected Community is a centralized information management system designed to connect people, sites, processes and devices wirelessly in real time. The web-based system provides the two-way data synchronization backbone for the entire Trimble Connected Site solution. As the communication hub, Newall explains that he can use Connected Community to share and access 3D design files from Trimble's office software Business Center - HCE and asset and site productivity information from the VisionLink web based application.

Using Trimble Connected Site solutions, Newall can communicate in real time with his team and machines across the 18-kilometer [11.2 mile] stretch of M2PP.

### Trimble Connected Site

- **Connected Office:** Trimble Connected office software including Business Center - HCE, VisionLink® and Connected Community are used to create site plans and digital models, track volumes, create mass haul plans, and develop as-builts.
- **Connected Machine:** The GCS900 Grade Control System and other Trimble Connected machines let users send as-built measurements and receive GNSS corrections wirelessly over the Internet. The machines can receive 3D designs from the office so operators can grade and move earth faster and more accurately.
- **Connected Workers:** Mobile connectivity and accurate survey and site measurement tools keep field crews productive and on top of project tasks. The Trimble Essentials Kit includes the Trimble Site Mobile controller, Trimble SCS900 Site Controller Software and Trimble SPS985L GNSS Smart Antenna. The Trimble SPS985 GNSS Smart Antenna and Trimble SPS855 GNSS Modular Receiver sync data between the office and the site. A grade checker can get the design file, create new measurements and check the results with the office. When designs change, the office can

send them over the Internet to the controller so the foreman has up to date data to keep the job moving forward.



The Trimble Connected Site connects projects, workers and machines, enabling contractors to manage and share information in real-time--whether in the office working on a design or in the field working on a machine.

### Site Infrastructure

Robust site infrastructure is key to the success of a Connected Site and requires both communications and GNSS correction infrastructure to be established. As part of establishing this infrastructure, Fletcher divided the project into three separate zones approximately six kilometers each: South, Central, and North. Fletcher is using the Trimble Internet Base Station Service (IBSS)—one for each zone.



Trimble provides GNSS accuracy and reliability for fine grading, paving, and site measurements.

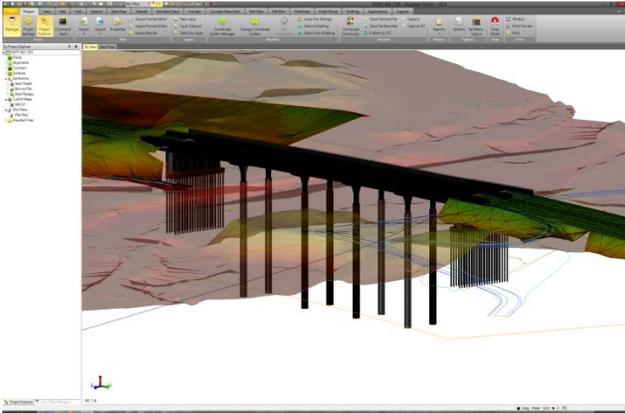
The base station equipment consists of a Trimble GNSS receiver, GNSS antenna, radio and radio antenna. The IBSS base stations enable remote configuration as well as providing corrections and real time data syncing for machine control applications using the SNM940 installed on the machines. Additionally they also provide correction information to GNSS-based Site Positioning Systems across the project.

Real time data syncing between the office and field crews using Site Positioning Systems is achieved using cellular coverage.



Fletcher Infrastructure divided the 18 kilometers [11.2 miles] expressway into three zones: South, Central, and North.

“The data workflow for the expressway project works like this: our project design files and 3D models are loaded into Business Center - HCE for data prep,” said Newall. “Then, those files run through Trimble Connected Community, the synchronizer software that sends the information to the cloud. Our three base stations are connected to the cloud, and our 3D machine control systems can transfer and receive plans and information whenever we want. If I’m in the office or a pub after work I can hit synchronize and everything is all connected to the cloud and into VisionLink, which allows me to see where machines and materials are at any given time. It’s brilliant, and I couldn’t imagine managing a project of this size without it.”



Newall used Trimble Business Center - HCE to import various file formats including the engineering design from Bentley MX, PDFs and other design files to create a 3D model.

### **Data prep, work flow, and building accurate models**

To create the project 3D model, the Fletcher team used the Trimble Business Center - HCE data preparation and takeoff software. Newall imported various file formats including the engineering design from Bentley MX, PDFs and other design files. He was then able to clean up the data, generate reports and publish.

Regardless of the types of files loaded into the system, in Business Center - HCE, Newall is able to view data in multiple ways such as plan, profile, cross section and 3D. From here he can quickly create and adjust 3D earthworks models for excavation and subgrade work.

Newall asserts using Trimble's software enables faster and more reliable earthworks planning, as well as reliable production monitoring to check as-builts compared to plans. This is achieved by using Business Center - HCE and in combination with VisionLink.

The design created in Business Center - HCE is a full 3D model of the earthworks to be performed, for

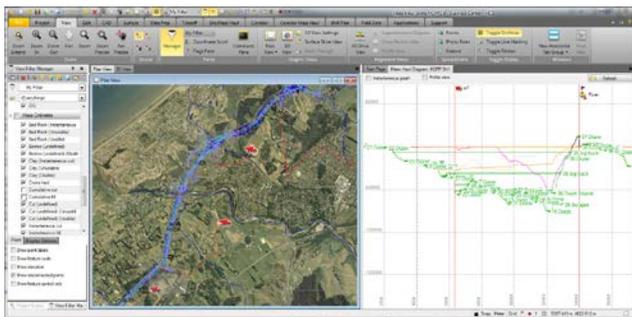
example how much peat will be removed and sand required for laying subgrade. This same model is used in VisionLink allowing Fletcher Infrastructure to integrate site productivity, material quantities, and materials movement with asset and fleet management. VisionLink displays data captured from Trimble machine control. It then feeds the information to Business Center - HCE and lets Fletcher track progress using 3D surface models. Newall can see how much dirt is being moved by each machine and he can quickly view 3D surface models in the show elevation and cut/fill.

This gives Newall and his team a holistic view of the site and simplified the management of on-site operations. It also allows Fletcher Infrastructure to track and monitor machine location, usage, fuel and production—how much dirt was being moved each day.

### **Quickly calculating corridor mass haul**

Mass haul across the entire project can also be analyzed and calculated quickly with Business Center - HCE. Using the subgrade model Newall is able to determine proposed haul zones, haul roads, as well as borrow and waste requirements. He can also add known variables that impact the movement of dirt, for example where bridges aren't yet built restricting the movement of material along the project. The Corridor Mass Haul module in Business Center - HCE uses this information to automatically calculate the most

efficient way to move material from location to location within the job site. The system shows graphical representations and geographic location of borrow pits, waste sites, and haul roads. Newall can then assign import or export locations with cost analysis and volumes of material. He is also able to easily and quickly analyze the results, propose changes and make adjustments as the project progresses and volumes are impacted.



With Business Center - HCE enables Fletcher Infrastructure can calculate the most efficient mass haul routes.

Prior to Business Center - HCE, he explains this type of analysis work would have taken weeks—now it takes minutes. Newall believes one of the most valuable features of Business Center - HCE is the ability to quickly analyze multiple mass haul scenarios using diagrams with multiple charts to see mass haul and instantaneous cuts and fills in relation to the design profile. This type of real-time analysis and mapping of project progress is instrumental in keeping the project on time and keeping all members of the team, from operators to inspectors, informed and up-to-date.

“Across the top of Business Center - HCE we have all of our haul roads; we can add new constraints, remove constraints and rerun our routes,” said Newall.

“Business Center - HCE then recalculates our mass haul in about five minutes, whereas before it would have taken as much as two weeks to plug all of those numbers into Excel. On an 18-kilometer [11.2 mile] expressway project that scenario happens over and over—so that’s a massive savings in time and effort.”

Newall considers Trimble Business Center - HCE the ‘hub’ of the M2PP operation because it’s where all project data is centralized. Business Center - HCE calculates volumes and then that’s used to determine, for example, if there’s enough sand for cut and fill. If not, the team can make adjustments and we know how much material we need to bring in.

He and his team also use the platform to process and adjust the survey data and models as factors change. He explains that this capability has been convenient when his team discovered there was more cut available or that there is an excess of sand, in the northern section of the roadway.

### **Connected Machines: 3D machine control on excavators, dozers, graders and compactors**

Newall explains that his team was looking to reduce re-work and minimize staking across the project as well as to improve material yields with more accuracy.

To help meet this goal, Fletcher Infrastructure and Goodmans equipped several pieces of equipment with Trimble GCS900 Grade Control, including: nine

excavators, three graders, two bulldozers and two compactors. The GCS900 system uses GNSS receivers and solid state angle sensors to measure the precise 3D position of the tip of the bucket or the cutting edge of the blade. The in cab control box displays the precise location of the bucket or blade compared to the 3D design created in Business Center - HCE.

“From the 3D design we also create a subgrade model in Business Center - HCE,” said Newall. “We’re able to send this to our operators and they can see what they are grading to on their Trimble CB460 control box in the cab of the machine; there’s no offsetting needed. Essentially there’s much less room for error, they can just go straight to work.”

Leveraging Trimble Connected Site technology means from the office Newall can monitor everything going on at the job site. He has real-time information on where the machines are and what materials are being moved. And when design changes have to be made, Newall sends them out instantly because he is in constant wireless communication with his team and his machines over the Internet.

“I am responsible for making sure that the correct revision of the design is pushed out to the machines so I can say, ‘that is the correct design and it needs to go to that machine,’” said Newall. “And if changes have to be made, I don’t have to hop in the truck to get the site. I’m in constant wireless communication with our people and machines over the Internet.”

Newall is also able to quickly transfer as built data captured from the machines, all remotely from his office. Because design updates flow wirelessly between the field and office in real-time, Newall believes he’s able to reduce down time and maximize both machine and operator productivity.

Greater accuracy in excavating and trim work with 3D machine control eliminates rework and lets operators finish jobs faster with minimal supervision. With design information in the cab and at operators’ fingertips, the need for stakes is eliminated and operators can spend more time working and being productive, and less time waiting for surveying and grade checking to be completed.

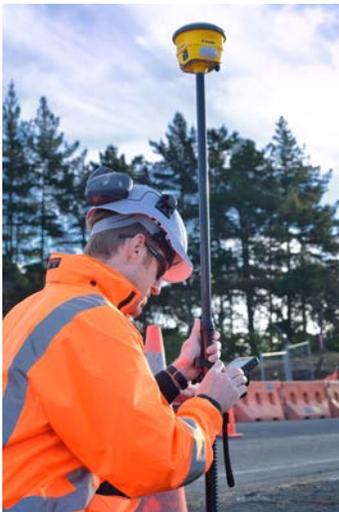
Newall explains that through improved productivity, personnel and machine costs are also reduced. This level of accuracy and precision helps him better control material usage which is critical to keeping the M2PP project profitable in the long run.

### **Connected Workers**

On a project of this scale, keeping workers connected is a top priority. Trimble Connected Site portfolio does this by providing mobile data collection, survey and site measurement tools and other ways to seamlessly share data and stay in touch from the field to the office.

Trimble’s mobile connectivity and site measurement tools enabled Fletcher’s field crews to collect positioning information and perform important

positioning tasks without tying up the professional survey team. They opted for the Trimble Essentials Kit to get more workers access to site positioning technology. The Trimble Essentials Kit includes the Trimble Site Mobile controller, Trimble SCS900 Site Controller Software and Trimble SPS985L GNSS Smart Antenna. The Trimble SPS985 GNSS Smart Antenna and Trimble SPS855 GNSS Modular Receiver sync data between the office and the site.



The Trimble Essentials Kit lets field crews perform everyday survey tasks simply and with extreme accuracy.

“We wanted to empower more people in our organization to perform positioning tasks that are important to the design/build process but where we don’t want to tie up our professional survey team, taking them away from other critical tasks,” said Newall. “We found exactly what we were looking for in the Trimble Site Positioning Systems Essentials Kit!

It is an extremely easy-to-use GNSS solution that our engineers and field crews are actually excited to use. We got them on board and now we’re up to eight Trimble Essential Kits. It’s a game-changer because information sharing is so much easier, and quicker, our decision making is better too.”

The team used a Trimble Site Mobile controller for the M2PP project. This controller is a rugged mobile device that is touch screen and includes an 8-megapixel camera and a built-in cellular modem with voice and data capabilities making it perfect for in-the-field use. A version of Trimble SCS900 Site Controller Software runs on the Site Mobile controller. This allowed Fletcher engineers to accurately collect ground levels, slope, grade and alignment data and then share it other project stakeholders through Trimble’s Connected Community software. Accurate positioning and mobile connectivity allowed Fletcher engineers and the field crew to be more independent and productive. With the ability to take survey points on the fly they can see accurately where a bridge piling should be placed, for instance. And efficient data and information sharing across the project, also allows Newall to track project progress.

**\$100K NZD (\$77K USD) saved plus minimal staking**

Newall explains that Trimble Connected Site solutions have completely transformed the way he is managing

this project. For starters, on the M2PP expressway build Fletcher has only used a handful of stakes across the entire 18-kilometer [11.2 mile] project. Initially his team staked about 1.6 kilometers [0.1 miles] of the expressway, pounding in stakes every 40 to 50 meters. These were used to show where the edge of the earthworks footprint was and to mark where topsoil could be striped. At about \$10 NZD (\$7.70 USD) per stake, for this small section alone, it cost approximately \$10,000 NZD (\$7,700 USD). Newall estimates running and managing survey crews and stakes for the entire project would have been well over \$150,000 NZD (\$77,000 USD).

### **Generating real-time 3D surface models**

With Trimble GPS and machine control now being used across the M2PP project, Fletcher is able to reduce the number of dedicated surveyors needed to run topos, run stringline and check grade for the creation of a 3D surface model.

The team uses VisionLink to centralize and analyze data captured from the machine for 3D project monitoring, and then share the data with Business Center - HCE to generate surface models. Overall, this gives Newall a holistic view of site operations. He can then share more detailed information about cycles and loads to his team and with his general contractor, as well as provide insight about material quantities and materials movement to manage production. Because VisionLink and Business Center - HCE work together to feed and generate updated surface models based on

machine activity, the team always has an up-to-date picture of 3D earthmoving and grading operations and overall project progress against the plan.

### **Improved safety**

Not only does GPS and machine control save hundreds of thousands of dollars in staking and labor costs, the risk to surveyors has also been reduced.

Newall explains that with 3D machine control on his 50-ton excavator, the machine is able to measure the bottom of a peat dig-out to create an as-built survey. Previously, without machine control, this work required a surveyor to get into a boat. This person had to get in the water with a wetsuit and lifejacket and survey the bottom of the excavation site with a five-meter pole. That individual was also required to be out at the site full time because as soon as the peat is removed, operators have to backfill. This is because there's always a risk of collapse with the soil composition of peat.

“We had to have a manual survey of this section done a couple of times early on because our machines were busy and what we discovered is the ‘old way’ of measuring for as-builts is just no good; not only did we have a guy in a precarious situation, we lost our surveyor for two full days to that work,” said Newall. “With 3D machine control I don't have to have a surveyor anywhere near that kind of dangerous situation. The machine does it all, which makes it worth its weight in gold. Now, with machine control, our earthworks subcontractor can dig until they get a

bucketful of clear gravel at the bottom. Then that's it. And, it's measuring all the time to create an as-built of the bottom so no extra work is needed.”

### **10% to 20% cost and time savings**

Newall explains his team has had to perform less rework due to machine control. He estimates that Trimble equipment has delivered somewhere between 10 and 20 percent time and cost savings across the board. He also attributes some 20% productivity gains from using Trimble Connected Site. Both of these benefits are considered critical as Fletcher continues to work towards the successful completion of the M2PP expressway.

“Instead of resetting stakes every 20 meters [65 feet] for a cross section cut across the entire project, now every single millimeter of the job is in 3D. Essentially every single millimeter is cut perfectly, which vastly reduces the potential for rework,” said Newall. “That is a very difficult thing to put your finger on in terms of actual cost savings, but it’s a lot.”

### **Tighter volume tracking and billing**

Newall explains that calculating volume and monthly payouts for subcontractors on the project is much easier with a Connected Site using VisionLink and Business Center - HCE. This is significant because of the agreement, which outlines how Fletcher and its subcontractors are paid for earthworks. Fletcher is paid by each cubic meter of dirt moved; and the rate paid to subcontractors varies by material, distance, and other factors. For instance, cut rates versus haul rates per

section of road vary, as do rates for volume of material in-ground compared to solid volumes extracted. Where dirt is placed for bulk backfill versus where dirt is received and placed for peat replacement can also impact the payout for subcontractors. As a result, all parties want to monitor and manage volumes carefully.



3D volume tracking reports from Business Center - HCE provide documentation for paying contractors for earthworks.

To calculate payments, Newall uses VisionLink for 2D project monitoring to track loads and cycles delivered per machine. The data is then sent to Trimble Business Center - HCE to generate 3D surfaces models and generate real-time volume reports. These reports clearly show how earthworks payouts are tracked—per load, per machine—analyzed, and calculated. He believes this level of documentation gives his business a huge advantage and improves communication between Fletcher and its subcontractors. It also adds accuracy and overall transparency to the billing and payment process.

## Conclusion

Several months into the M2PP expressway build, Newall believes the project is moving ahead quickly and is on track to meet its aggressive timeline of opening in 2017. In fact in March of 2015, the team has successfully moved 2 million cubic meters of dirt (70 million cubic feet). In addition, utility work is nearly complete and final road paving work is starting.

He also believes the Trimble Connected Site portfolio has been critical to driving productivity, cutting costs by reducing rework and survey time, and improving communication and information flow across the project.

"Looking at the sheer volume of information we collect, share and analyze on a daily basis on the M2PP project, Trimble gives us a huge advantage in accuracy and productivity in everything from modeling and earthworks, to mass haul," said Newall. "It's hard to imagine that we would be able to produce these results so quickly without a unified view of the project and without the Connected Site from Trimble."

For more information on Trimble Connected Site solutions, talk to your local SITECH Technology Dealer [www.SITECH-locator.com](http://www.SITECH-locator.com).

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