2019 IECA AWARDS

ENVIRONMENTAL EXCELLENCE – SUBMISSION SUMMARY

Fulton Hogan Construction

The largest reinforced earth embankment in the Southern Hemisphere using the Maccaferri Green Terramesh® solution

SECTION 1: ABOUT THE ENTRY

The Peak Downs Highway is a vital route connecting the regional city of Mackay to mining and agricultural areas in Central Queensland's Bowen Basin.

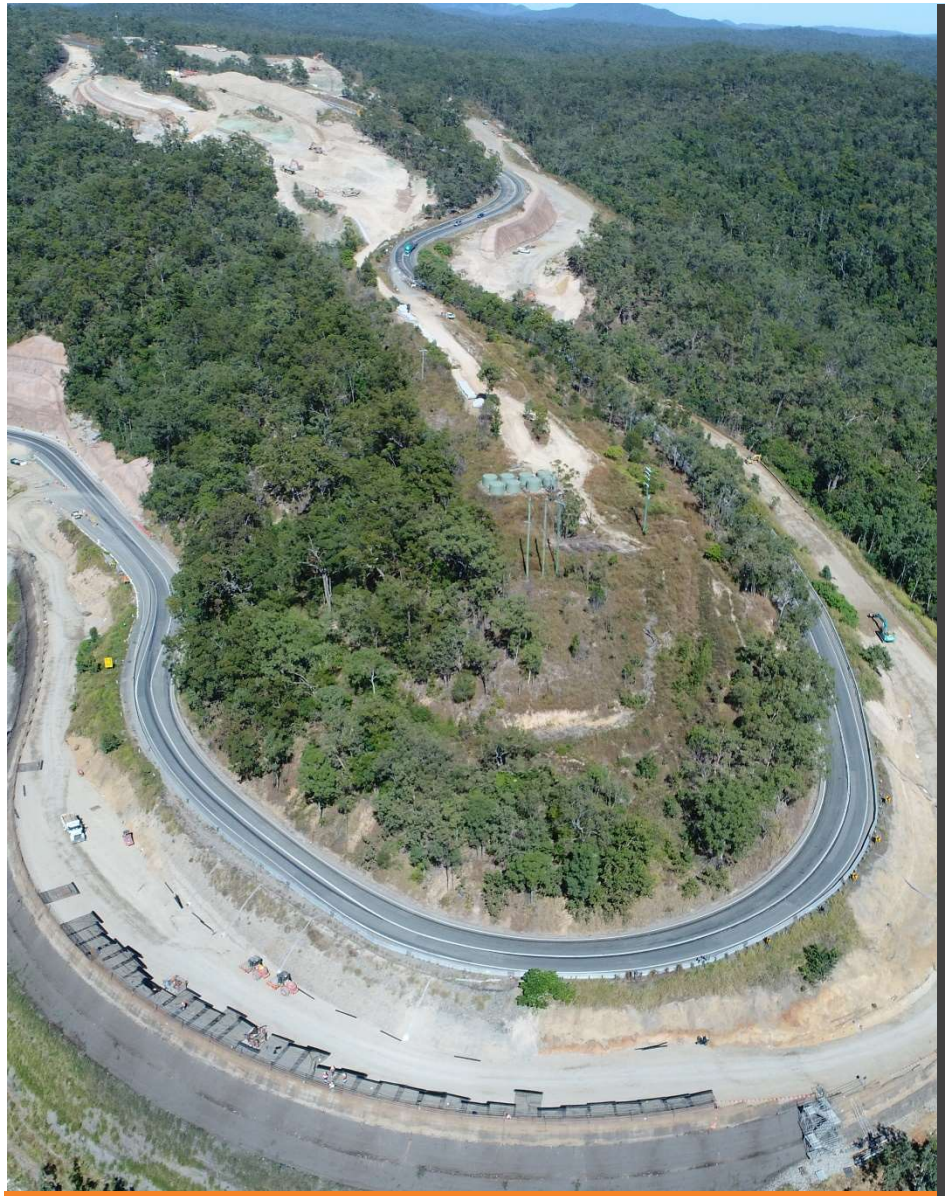
Winding through Spencer's Gap on the Eton Range, the highway carries 3,600 vehicles per day, including around 800 heavy vehicles.

The Eton Range Realignment Project (ERRP) will upgrade the existing range crossing to provide a split carriage way, with two lanes in each direction. The new alignment will reduce the road grade to improve safety for heavy vehicles, increase efficiency and capacity of this key transport route and cater for future growth in the region.

The $189.3 million project is being constructed by Fulton Hogan Construction, on behalf of the Queensland Department of Transport and Main Roads (TMR). The project is part of a $166.2 million commitment by the federal government to improve safety on the Peak Downs Highway.

Following a Guided Tender Alternative (GTA) procurement process in late 2015, Fulton Hogan Construction proposed an alternative solution for constructing a reinforced earth embankment (REE) in a challenging geotechnical environment.

The result—the Southern Hemisphere's largest application of the Green Terramesh system for an REE.



AN AERIAL VIEW OF THE ETON RANGE DURING CONSTRUCTION

Project scope

The ERRP upgrades the existing range crossing to provide a split carriageway, with two lanes in each direction.

Fulton Hogan's scope of work includes:

- Earthworks
- Drilling and blasting
- Reinforced earth embankments
- Crushing and screening of excavated materials
- Subsurface drainage, drainage systems and pit installations
- Temporary and permanent slope stabilisation treatments including soil nails, passive rock dowels, rock netting and shotcreting
- Road rehabilitation
- Asphalt and bitumen works
- Road furniture
- Landscaping and revegetation works
- Traffic, environmental and cultural heritage management.

SECTION 2: SUMMARY

The challenge—and opportunity—was to design and construct a slope stabilisation system that provided a long-term solution for managing the risk associated with landslips in this tropical climate.

The long-term facial instability risk for the REE was significant and without the right solution, could potentially lead to future operational and maintenance issues. Adding further complexity was the highly variable and fractured cut profiles of predominantly metasediments and the poor soil condition of site-won material.

Vegetation plays a critical role in mitigating erosion by reinforcing soil within root systems and controlling the movement of sediment. It intercepts rain, reducing its energy and slowing runoff. In a mountainous area with historical landslips and geological transformation, an effective way of managing the risk of potential failure of landscaping in challenging topology was critical.

At the time, the Green Terramesh system had never been used for construction of an REE, at this size and scale, on a TMR project. By working with the client, Fulton Hogan successfully introduced a large-scale installation of the Green Terramesh system to construct an REE on a steep range crossing.

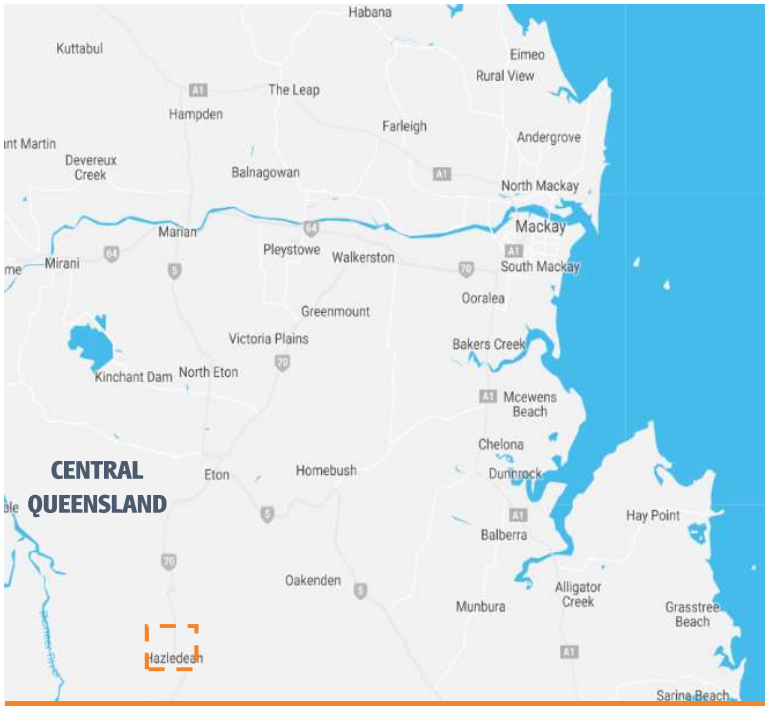
By working with TMR to validate and test the Green Terramesh design, Fulton Hogan has proven that soil science, effective erosion and sediment control (ESC) implementation and successful landscaping can be combined with design innovation to have long-lasting benefits.

Managing erosion and sediment during construction was challenging given the steep terrain. Despite the challenging ESC for this project, since construction began Fulton Hogan has not received any fines or warning notices for from the regulator on any environmental issues, including ESC.

Fulton Hogan's practical use of the Green Terramesh system provided a robust solution to address the problem of how to retain a suitable growing medium on a 45 degree batter, up to 45 metres high, in a humid tropical climate with 1.6m of average annual rainfall.

The baskets created a singular structure to reinforce the fill embankment in a comprehensive way, providing a greater level of surety that facing of the REE would stay intact.

This innovative application of the Green Terramesh facing system for an REE construction has made a significant and innovative contribution to the ESC industry in Queensland and further abroad.

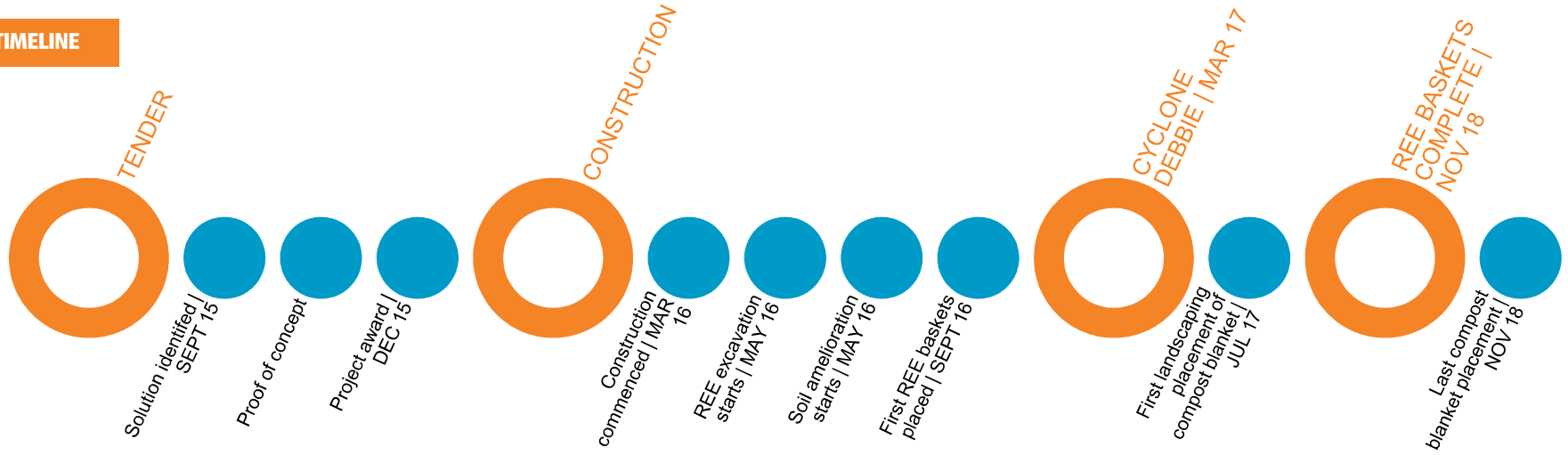


THE PEAK DOWNS HIGHWAY CONNECTS MACKAY TO CLERMONT

"There are very few projects that stand out for me in my career and even fewer that I would consider as 'a feather in my cap' project that I can be loud and proud about being involved in. Fulton Hogan and ERRP is one of these projects."

AARON ASHLIN, Director – Hortus Group

TIMELINE



SECTION 3: LOCATION & MILESTONES

The project is located around 35km from Mackay, at Spencer's Gap on the Eton Range (the Eton Range crossing), between the townships of Eton and Hazeldean.

The Eton Range is part of the Great Dividing Range, Australia's most substantial mountain range. To address the steep gradient and tight horizontal curves of the existing road alignment, an upgrade to construct two 3.5km dual lane carriageways to cross the range was proposed. In late 2015, TMR undertook a GTA procurement process to test their original detailed design against industry innovation for construction of an REE to widen part of the existing range.

The realigned road follows the natural terrain features and ridgeline with the highest point of the REE reaching 45 metres tall and 780 metres long.

INNOVATION DURING TENDER

The GTA process encourages collaboration between tenderers and their clients. Meetings between TMR and Fulton Hogan on were held during the tender phase to discuss proposed alternative tenders, including Fulton Hogan's proposal to use the Green Terramesh solution.

Through the GTA process, the Fulton Hogan team developed an innovative construction solution for the REE with an alternative landscaping design and irrigation system. The solution was to adopt large-scale use of Green Terramesh as the REE facing system.

Using Green Terramesh as the facing system would achieve the design intent, eliminate the need for using temporary precast concrete blocks and deliver a better long-term landscaping solution for mitigating the potentially destructive impacts of tropical rainfall.

Our alternative facing design, using the Green Terramesh system, provided a superior surface for adhesion and establishment of the client's preferred landscaping treatments. Critical to this, was an effective landscaping treatment designed to reduce future maintenance and deliver an improved whole-of-life outcome. The resulting customised landscaping concept ensured growth could be established during the very hot and dry periods and between heavy rainfall events. This significantly mitigated the potentially destructive impacts of tropical rainfall on landscaping during the critical establishment period.

SECTION 4: UNIQUENESS

Mackay has a humid tropical climate, with sunny, dry, cool winters and hot, humid and wet summers. The Eton Range—part of Australia's Great Dividing Range—experiences even higher rainfall than the coastal areas in Mackay due to the rain shadow effect of the range.

At the time, Green Terramesh had never been adopted on any previous TMR project at this size or scale. By working with the client, Fulton Hogan successfully introduced a large-scale installation of the Green Terramesh system to construct and landscape an REE on a steep range crossing.

PROOF OF CONCEPT

Given the challenges of the terrain, a trial REE was constructed by TMR to test and validate design before major construction commenced. This allowed both Fulton Hogan and TMR to test and optimise the REE landscaping design.

During development, multiple options for landscaping design were investigated with expert advice sought on the best native seed mix for the steep slope and ground conditions.

This included considering options such as:

- Multiple geo-synthetic materials with a sprayed compost blanket.
- Direct spray compost blankets on ameliorated subsoils.
- Terramesh baskets containing growth media (i.e. a green facing system) to assist in establishing vegetation.

Fulton Hogan's Green Terramesh facing system was confirmed as the best solution for construction of the REE—one of the highest risk components of the project.

It provided a robust solution to address the problem of how to retain growth media on a 45 degree batter, up to 45 metres high.

During the landscaping program, continuous improvements were made based on regular advice from the Soil Scientist during construction of the REE and monitoring of the progressive revegetation occurring.

AMELIORATION

A customised ameliorated subsoil and landscaping program

Given the criticality of vegetation establishment for erosion protection of the REE, the presence of widespread declared noxious weeds and poor site subsoils meant advanced topsoil management and a substantial amelioration program was required to turn site-won material into suitable growth media.

The subsoil naturally present on site had low fertility as it was acidic, dispersive, with low exchangeable calcium, low exchangeable potassium and had low effective cation exchange capacity.

The team found the soil was of such poor quality that vegetation establishment or

FAST FACTS

16,074

Green Terramesh baskets used for 3 REEs on the project

Laid end-to-end, the baskets would be around 25km long, enough to extend from the project site to the nearby township of Walkerston

216,000m³

of fill material used for the REE

4ha

of landscaping required on a 1:1 slope

With a total of 6.4ha of landscaping and revegetation works on the project

31 blasts

Totalling 147,407m³ of site-won material

8 x 22,000L tanks

Installed for the irrigation system

5.5m

Of rainfall collected on site since the start of major construction

naturally occurring revegetation would not be possible. To address this, an extensive amelioration program was undertaken on site to treat and stabilise the subsoil to ensure optimum plant growth was possible. To assist, the team engaged an experienced Soil Scientist from Hortus Group to provide expert advice and oversee the amelioration and landscaping program. The goal of the amelioration program was to create a hybrid between a topsoil and a subsoil to be placed inside the Terramesh baskets.

Given the construction staging for the REE and the baskets, there was only one chance for landscaping to be completed. As the REE is built, there is no opportunity to return and re-landscape the lower layers. To ensure the successful and progressive growth of the vegetation, a hybrid soil was developed.

With the steepness of the outer slope of the REE, topsoil was not able to be placed. Instead, a compost blanket applied using a hydromulcher, was used on the outer face of the baskets as a replacement topsoil. Typically, compost blankets were applied using pneumatic or blown methods. At the time, application of a compost blanket using a hydromulcher was unheard of. Through research and innovation Lanyonscapes (landscaping subcontractor) modified their hydromulcher to adapt to this unique application of the compost blanket. It resulted in a more efficient application of the product and it was deemed more effective than other methods because the hydraulic forces pushed material into small crevices of the REE. This method is now considered common practice in the industry but at the time, it was a unique application method. MRTS16 has since been updated to reflect this.

The compost blanket was custom-designed specifically for the climate using locally sourced materials. A 300mm layer of ameliorated subsoils, inside the basket face, was used as the growing medium. The ameliorated subsoil also contained a seed mix additional to that applied with the compost blanket to further enhance the germination process.

The landscaping process was a collaborative effort and final solutions were decided upon as a group involving TMR, Fulton Hogan, Lanyonscapes and Hortus. This approach enabled ideas to be shared within industry and this eventuated in the best outcome for the job.

AMELOIRATION CREATED HYBRID SOILS FOR THE REE

A 300MM LAYER OF AMELIORATED SUBSOIL WAS USED AS SUITABLE GROWTH MEDIA

BASKETS INSTALLED AND READY FOR BACKFILL

IRRIGATION SYSTEM

Further design innovation involved incorporating an irrigation system into the REE to ensure the landscaping could establish. With very hot and dry periods between heavy rainfall events, growing conditions were a challenge.

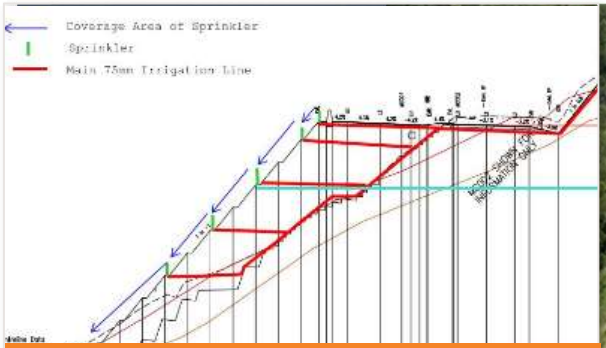
The amount of water that can infiltrate the soil before it runs off is limited by the steepness of the batters. The height and steepness of the terrain meant that normal means of watering, such as by hand or water truck, were not appropriate.

To overcome this, the team developed a sophisticated irrigation system that used large water tanks at the top of the range. The tanks then gravity fed into pipework that runs down the face of the cutting/fill before branching into individual lines that run along the benches. The system used existing drainage lines under the road to connect the main irrigation lines to the lateral irrigation lines on the REE.

The system was programmed to deliver a specified amount of water, at the right time, reducing the effects of evaporation. Programming of the watering regime meant a more efficient use of and control over water on site and ensured the client's watering specifications were met. It also ensured vegetation could progressively establish during construction of the REE.

The system was designed with the long-term in mind. Tanks were strategically located away from the construction areas while a filtration system prevents the sprinkler system from clogging. A combination of both pumped and gravity fed irrigation lines were used with the pump also containing a float switch to prevent water loss in the event of a pipe failure.

Without this innovation a significant cost from water truck usage would have been incurred and the progressive establishment of vegetation may have been impacted by the challenging climate.



A SOPHISTICATED WATERING SYSTEM ON THE RANGE

HOW DOES IT WORK?

TANKS AT TOP OF RANGE

REE SPRINKLER SYSTEM

PROGRAMMED DELIVERY

PROGESSIVE ESTABLISHMENT

VEGETATION AS EFFECTIVE ESC

SEVERE TROPICAL CYCLONE DEBBIE

The effectiveness of the design was proven when Severe Tropical Cyclone Debbie hit Queensland's Whitsunday coast in March 2017 as a large and powerful Category 4 strength tropical cyclone.

After making landfall, the remnant tropical low turned South East, producing damaging winds with torrential rainfall causing major flooding in central and south-east Queensland and north-east New South Wales.

With *Debbie's* eye crossing just 150km north-east of the project site, four days of extreme weather were enough to break March rainfall records at 62 weather stations in Queensland.

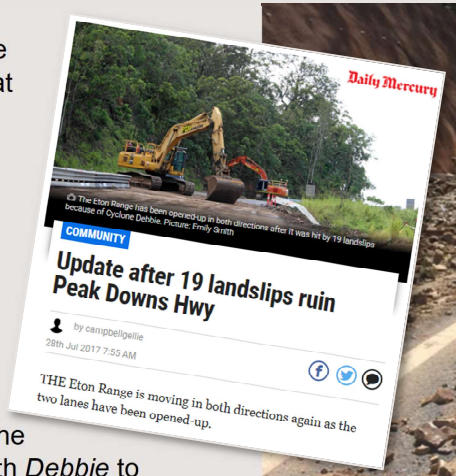
Eton Range received an incredible 1.4m of rain which broke the record set in 2011 with a total more than four times the region's long-term March average of 300mm.

There was extensive, non-project related, slippage of material on the Eton Range with the highway itself losing one lane, reducing the range to a single lane traffic for several months after the event.

The Queensland Reconstruction Authority reported that damage to infrastructure and industry in Queensland following *Debbie* would exceed $1 billion.[1]

Despite widespread damage within the region and in other parts of Queensland and New South Wales, the Green Terramesh baskets remained unscathed with no damage, scouring to the face or loss of material from site at the REE locations. At the time, the REE was only partially constructed and growth on the REE was minimal to none in places. Despite this, the baskets held up and the extent of slippage material was minimal.

Fulton Hogan self-reported the site discharge associated with *Debbie* to the Department of Environment and Science (DES) because of the volume of sediment and debris lost from slips on the upper side of the project. A large amount of this material was lost via Cut Creek, an ephemeral stream located at the foot of the eastern side of the crossing. The regulator inspected the site post-event, during April 2017 however no actions were received from this visit.


Daily Mercury

The Eton Range has been opened up in both directions after it was hit by 19 landslips because of Cyclone Debbie. Picture: Emily Smith

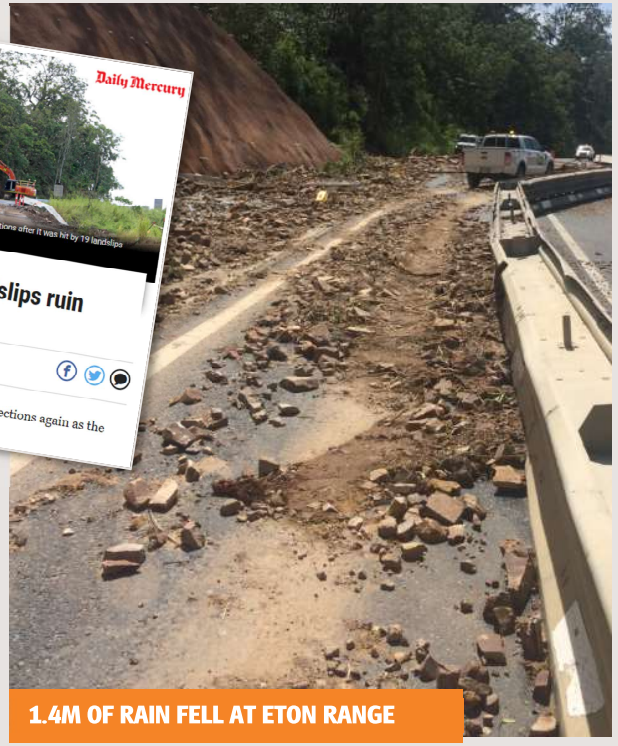
COMMUNITY

Update after 19 landslips ruin Peak Downs Hwy

by campbellgellie

26th Jul 2017 7:55 AM

THE Eton Range is moving in both directions again as the two lanes have been opened up.


1.4M OF RAIN FELL AT ETON RANGE

DAMAGE FROM DEBBIE

[1]Inspector General Emergency Management (Qld), The Cyclone Debbie Review www.igem.qld.gov.au/reports-and-publications/Documents/Cyclone%20Debbie%20Review%20Rpt1-17-18_PUBLIC_WEB.pdf

SECTION 5: BENEFITS

INDUSTRY

This project sets a new benchmark for other topographically challenging projects in Australia. It has been confirmed by AECOM as the largest REE in the Southern Hemisphere and likely one of the largest in the world. It has also been an incredibly successful one, receiving endorsements from both our client and supplier for its ingenuity and practical execution. Both TMR and Fulton Hogan are now able to take lessons learned from construction of the REE with the Green Terramesh facing system and the sophisticated irrigation system and apply these to future projects.

The collaboration between TMR, Fulton Hogan and suppliers Lanyonscapes and Hortus enabled the transfer of this knowledge and sharing of information to industry.

> *"The Terramesh basket system is the best embankment facing treatment we know of to withstand weather events such as Cyclone Debbie."*
>
> **LES COWARD, Contract Administrator, Department of Transport and Main Roads**

COMMUNITY

Through an innovative application of a proprietary product and a bespoke amelioration and landscaping program, the final design solution is one that met the client's original design intent for a revegetated facing REE. The community benefits from the success of the landscaping program with a lush green facing REE that blends an engineered structure into its natural surrounds. The rigorous testing of the landscaping provides confidence in long-term erosion and sediment control protection for this area—providing protection of downstream catchments.

The REE has already proven it can stand up to the toughest conditions and provide protection against future slips that may impact the integrity of the road in extreme weather events.

Ultimately, the upgrade will deliver road network reliability and improve connectivity for residential communities, industry and tourists.

ORGANISATIONAL

Fulton Hogan's team was recognised for these 'above business as usual' initiatives with an internal Engineering Innovation Award in 2017.

The award not only celebrates the team responsible for the innovative thinking and execution of the project, it sets an internal standard for delivery. In turn, it inspires use of similar methods on other projects, directly drawing on the internal expertise and

LONG TERM COMMUNITY BENEFITS ARE CLEAR

experience of our employees to guide design and construction on others.

Completing this project shows that Fulton Hogan can be innovative and undertake complex challenges and output safe, sustainable solutions with regards to cost, quality, safety and the environment in both the short and long term. Fulton Hogan could only have achieved this excellent REE outcome with TMR support. By working together with the client, Fulton Hogan has proven the importance of soil science, smart and cost effective erosion controls, both of which have a focus on successful landscaping outcomes that have long term benefits for vital community infrastructure.

COST & PRODUCTIVITY

Under the original design, using concrete blocks, each lift of the blocks would have been time consuming and require additional plant. Using Fulton Hogan's alternative method, of baskets placed into position by hand, resulted in time and plant savings. Fulton Hogan estimates this could be up to approximately $1M in plant costs alone.

However, the benefits extend beyond hard-dollar savings through the improved durability of this method to withstand heavy rainfall while only partially completed and with minimal growth. With 19 slips reported across the range, including two major slips, following Severe Tropical Cyclone Debbie, it is Fulton Hogan's sole opinion that the vegetated facing system of the REE provided protection during the extreme weather event. Without the innovative application of the Green Terramesh, soil amelioration and effective landscaping program, the existing steep terrain and highly dispersive soil properties could have meant far greater consequences. Without a vegetated facing system, the base erodes and this would quickly be followed by the REE itself. The Green Terramesh system and a small amount of vegetation provided a level of protection for the soil face at this critical stage.

REE UNDER CONSTRUCTION

POLYMER SPRAY PROVIDED STABILISATION OFTEMPORARAY SURFACES

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