Bruce Highway Upgrade – Cooroy to Curra, Section C: Traveston to Woondum

IECA 2017 AWARDS FOR ENVIRONMENTAL EXCELLENCE

Contents

SECTION 1 Marketing Statement

CPB Contractors together with the Department of Transport and Main Roads (TMR) and GHD are proud to be an entrant in the IECA Awards for Environment Excellence 2017, showcasing best practice and innovative erosion and sediment control (ESC) management on the Bruce Highway – Cooroy to Curra (Section C: Traveston to Woondum) Project . Substantial environmental, time and cost benefits have resulted from a strong Project focus on best practice ESC planning and implementation, fortified with the successful incorporation of innovations and initiatives. The Project has been able to present outcomes and learnings to contribute to the knowledge and development of erosion and sediment control throughout the broader industry, reflecting on the tangible results of innovations including adaptive tendering and non-standard contractual frameworks, passive treatment processes, in situ soil amelioration, and specialised drone survey and mapping.

BRUCE HIGHWAY: COOROY TO CURRA – SECTION C

SECTION 2 Abstract

The Project consists of a 10.5km, 4-lane divided highway on a greenfields alignment just south of Gympie, Queensland. The Project involves 1 .9 M m^3 Cut-to-Fill, 13 bridges, 4 major waterway diversions, and is situated within a high rainfall, undulating hinterland area amongst underlying dispersive soils. The Project's key success areas are discussed below.

Planning

Using an innovative tendering and contract framework, the Project had the strategic foundation to deliver best practice ESC management. A strong focus was put on detailed planning to maximise whole-of-program ESC measures, including modelling all basins and incorporation of passive treatment processes.

Additionally, environmental approvals and staging for four major waterway diversions were beneficially altered to reduce environmental risk and construction timeframes.

Implementation

Best practice techniques were implemented including minimal disturbance and sequential clearing approaches, early basin installation, maximising the installation of permanent clean-water diversions and cross-drainage, and driving progressive stabilisation.

Innovation

Some notable innovations included:

- **In situ topsoil amelioration:** incorporating amelioration agents into topsoil through broadcasting prior to stripping.
- **Drone technologies:** for detailed survey and to ground-truth ESC installation, maintenance needs and progressive stabilisation monitoring.
- **Basin design:** the Project standardised basin design for most of the 98 basins to include shot-creted forebays, gravitational risers and lockable release valves. Critical basins included flow-activated dosers as well as in- and out-flow quality sensors.
- **Passive treatment process. Broadcast gypsum:** this involved pre-loading catchments with broadcast gypsum to enhance treatment efficiencies and reduce labour.
- **Sprinkler systems:** more efficient watering than that of water carts.

Tangible Outcomes

Substantial Project outcomes were achieved, including:

- Avoiding risks to waterways through removing temporary diversions, redesigning permanent diversions and designating additional resources to fast track works during low-risk erosion months.
- Minimised cost and treatment times using passive treatment process, which included 20% cost saving compared to batch basins per event, a reduced (<8hrs) average treatment time and an average active discharge quality of 17.83NTU for 98 basins.
- Enhanced revegetation outcomes following in situ topsoil amelioration which avoided double-handling costs.
- Effective management of 3 EVNT species not identified throughout previous ecological assessments.

Industry Leadership

Drawing from the Project's innovative contract framework, future projects will assess the use of this approach for strategic focus on environmental risks including ESC, with at least one upcoming project integrating the use of a similar Provisional Sum payment method for environmental items.

Our basin trial outcomes, which will include basin performance, cost and time aspects between batch, passive treatment processes and HES basins, will provide an industry-sharing opportunity to expand current understandings of basin capabilities and ESC awareness.

The environmental culture on the Project has provided a significant learning and up-skilling platform for the construction teams. This transpired into diligent planning that incorporated best practice ESC, and a continual focus through daily activities, and preparedness for rainfall events. These efforts contributed to successful avoidance of environmental incidents, and culminated with commendation by the Department of Environment and Heritage Protection for the Project meeting our obligations through a high-degree of site preparedness, contingency planning and effective risk management.

SECTION 3 Location, beginning, milestones and completion dates

Project description

The Bruce Highway – Cooroy to Curra (Section C: Traveston to Woondum) Project consists of a 10.5km, 4-lane divided highway on a greenfields alignment just south of Gympie, Queensland.. The Project is located within the Mary River catchment, and intersects 16 mapped waterways – four of these are major waterways of Traveston Creek, Kybong Creek, Cobbs Gully and Jackass Creek.

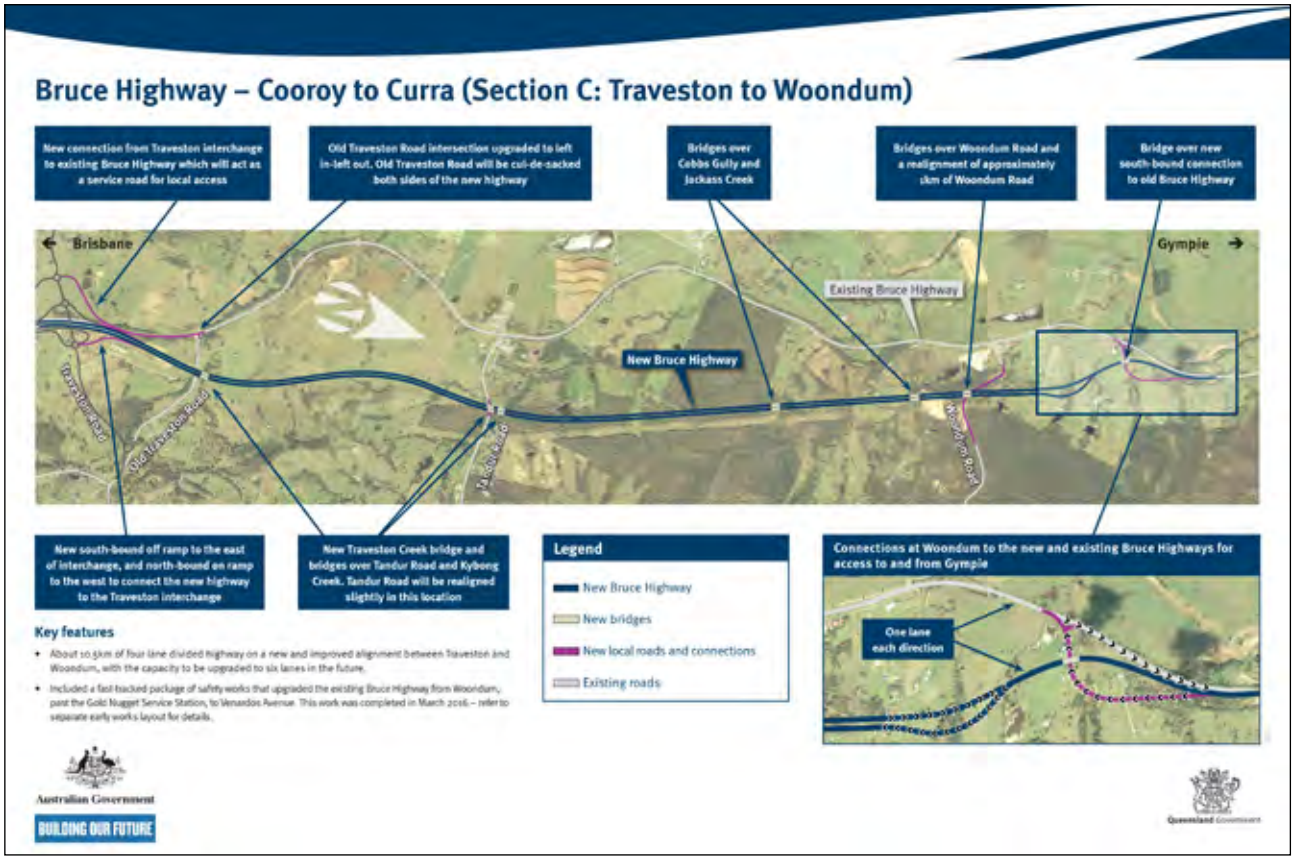
Surrounding the Project are critical habitats supporting an array of threatened species listed under federal or state legislation including the Mary River Turtle, Mary River Cod, White- throated Snapping Turtle, Cooloola Sedge Frog, Wallum Sedge Frog, Swamp Crayfish, Koala, Grey-headed Flying-fox, platypus and echidna. Accordingly, the Federal and State government approvals incorporated stringent erosion and sediment control and water quality compliance requirements.

Project team

- Department of Transport & Main Roads (Principal)
- GHD (Contract Administrator)
- CPB Contractors (Civil Construction Contractor).

PROJECT ELEMENTS

- Protection of water quality is a key environmental priority for the Project.
- 1.9 M m^3 of cut to fill
- 13 bridge structures at seven locations
- 34 transverse culverts up to 2,100mm diametre
- Four permanent creek diversions
- 98 temporary sediment basins at key locations
- 700,000m^2 of soil binder applied to date
- >1,100t of gypsum broadcast



C2C PROJECT ESC MILESTONES

Contract awarded to CPB Contractors
6 Feb '16

Bulk Earthworks Completion
31 Jul '17

Practical Completion
Early 2018

2016 | **2017**

FEB | APR | JUN | AUG | OCT | DEC | FEB | APR | JUN | AUG | OCT | DEC

PLANNING MILESTONES

17 Feb '16 **Detailed ESC Planning commences**
Mar '16 **Waterway Diversion Review Workshops commence**
Apr '16 **Permissible Changes to Waterway Environmental Approvals authorised by Agencies**
May '16 **Monthly Independent Verifier Audits for ESC commence**

IMPLEMENTATION MILESTONES FOR ZONES 2, 3, 4 (REPLICATED OVER 6 CONSTRUCTION ZONES)

30 Mar '16 **Zone 2 – Pioneering works for installation of ESC measures commences**
31 May '16 **Zone 2 – Topsoil amelioration & strip commences**
28 Jun '16 **Zone 2 – Culvert / Cross drainage commences**
5 Jul '16 **Zone 2 – Bulk earthworks commences**
5 Jan '17 **Zone 2 – Temporary basin removal following rehabilitation**
15 Apr '16 **Zone 3 – Pioneering works for installation of ESC Measures**
16 May '16 **Zone 3 – Topsoil amelioration & strip commences**
22 May '16 **Zone 3 – Culvert / Cross drainage commences**
6 Jun '16 **Zone 3 – Bulk earthworks commences**
14 Jan '17 **Zone 3 – Temporary basin removal following rehabilitation**
6 May '16 **Zone 4 – Pioneering works for installation of ESC Measures**
4 Jul '16 **Zone 4 – Topsoil amelioration & strip commences**
10 Jun '16 **Zone 4 – Culvert / Cross drainage commences**
8 Jul '16 **Zone 4 – Bulk earthworks commences**
27 May '17 **Zone 4 – Temporary basin removal following rehabilitation**

WATERWAY DIVERSION MILESTONES

20 May '16 - 1 Jun '16 **Traveston Ck Diversion Works**
31 May '16 - 7 Jun '16 **Kybong Ck Diversion Works**
10 Jun '16 - 1 Jul '16 **Cobbs Ck Diversion Works**
1 Aug '16 - 16 Aug '16 **Jackass Ck Diversion Works**

SECTION 4 Distinctive features, accomplishments, challenges and unique aspects

This section of the submission will demonstrate how the Project incorporated five distinct areas to achieve beyond compliance environmental outcomes, which were Planning, Implementation, Innovation, Tangible Outcomes and Industry Leadership. A visual key of these five distinct areas will be provided in the left-hand margin alongside each discussion topic to demonstrate where these were integrated to deliver environmental outcomes.

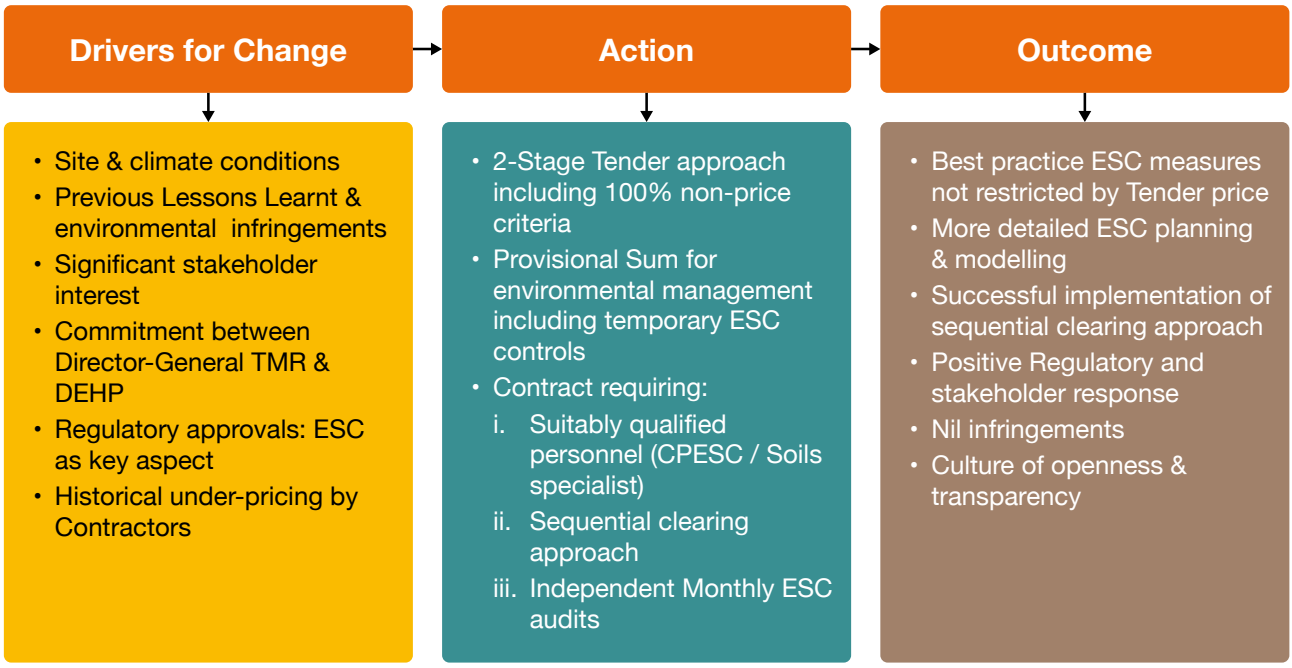
Innovative contractual framework

TMR incorporated lessons learnt from previous sections of the Cooroy to Curra upgrade works to apply an innovative 2-stage tendering process with the initial stage comprising a 100% non-price criteria with substantial weighting on historical Contractor environmental performance. Additionally, in order to remove the risk element of under-pricing critical environmental management aspects in a competitive tendering process, a Provisional Sum for environmental management was built into the Contract .

The Contract structure embedded a collaborative approach throughout delivery, whereby Contractor-developed management measures were negotiated and agreed upon by both Administrator and Principal adopting a "best for Project" outlook . This enabled a concerted and transparent approach to managing environmental challenges but moreover enhancing the outcomes.

The factors influencing this innovative contractual framework and the beneficial outcomes are demonstrated in the flowchart below. Drawing from the improved elements of this contract, future TMR projects will assess the use of this approach for strategic focus on environmental risks including ESC, with at least one upcoming project integrating the use of the environmental provisional sum item.

Cooroy to Curra Provisional Sum Method



Detailed planning and modelling

Given the surrounding sensitive environment and the considerable terrain challenges, extensive planning was undertaken prior to construction works commencing. Detailed modelling was undertaken for all ESC measures, with additional effort devoted to individual basin modelling. The planning and modelling included:

- ESC design certainty: CPESC designs were modelled and overlaid onto existing and finished levels prior to installation to minimise design-flaws and delays throughout installation.
- Long-term installation: sizing and positioning ESC measures so they were functional from pioneering stage to landscaping and pavement works wherever possible, thus avoiding the need to decommission and reposition temporary measures.
- Maximising design: basin capacities were constructed to accommodate all stages of construction (clearing through to revegetation), and were strategically orientated to provide a whole- of-program control accounting for ongoing changes to sub-catchment areas.
- Permanent design measures: permanent drainage and bio-retention footprints were incorporated into the ESC Plans, minimising the total disturbance area and reducing the construction effort

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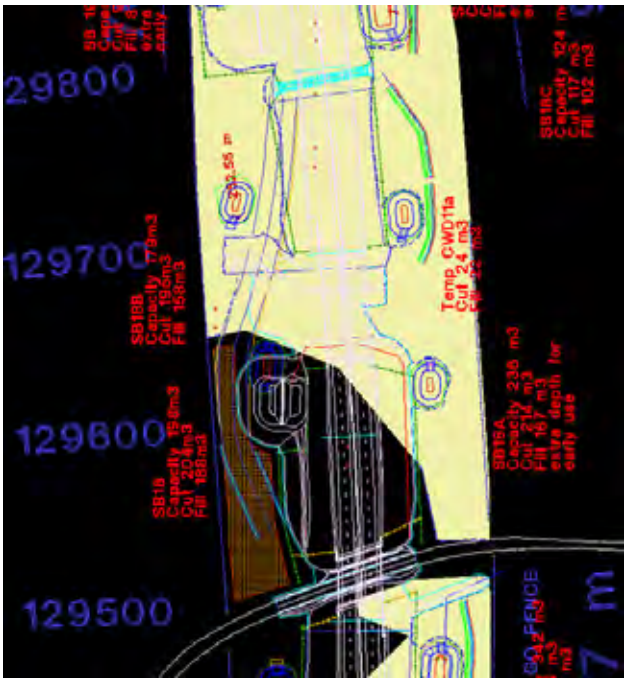


Images (above and left): examples of the modelling tools utilised throughout planning phases.

Waterways: fast-tracking methods to avoid risk

By undertaking a detailed assessment of the bridge construction sequences, the Project team identified an opportunity to eliminate an unnecessary temporary diversion stage for four ephemeral waterways that were originally authorised under the initial Project environmental approvals.

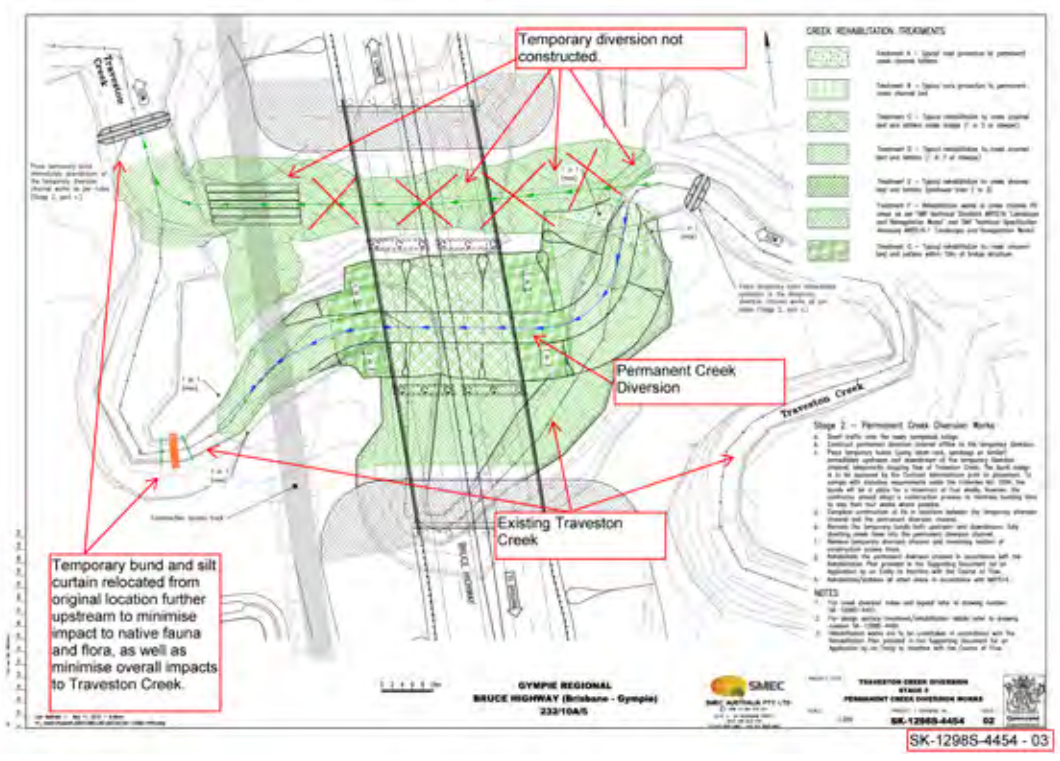
The Project team proposed an alternative construction sequence that fast-tracked permanent works to substantially reduce working durations and disturbance footprints within sensitive riparian zones (image below). This sequencing, although reducing the timeframe did result in a smaller window of potential higher risk – of which the Project incorporated a number of contingency measures including:

- Planning work for low-risk erosion periods
- Clean water bypass
- Stabilisation treatments that immediately followed channel excavation
- Wet weather preparedness procedures.

Following approval by the regulatory agencies, the Project prioritised these critical works and mobilised additional equipment and resources. The permanent diversion works were successfully completed without environmental incident to water quality or aquatic fauna, which was fortified by significant cost and time savings to both the Contractor and Principal supplied by Table 1.

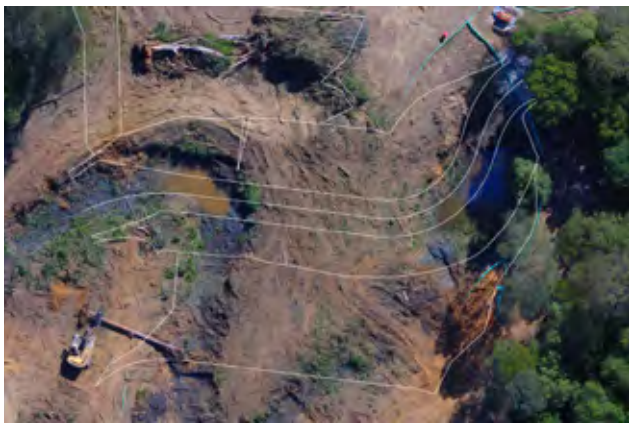
Table 1. Time and costs savings from fast-tracked waterway method

Time and Cost Savings	Original Diversion Completion	Fast-tracked Diversion Completion	Time saving
Traveston Creek	11 Nov 2016	24 May 2016	**172 days**
Kybong Creek	26 Nov 2016	30 May 2016	**177 days**
Cobbs Gully	16 Jan 2017	21 Jun 2016	**210 days**
Jackass Creek	6 Feb 2017	9 August 2016	**181 days**
Final Savings			**$1,296,040**

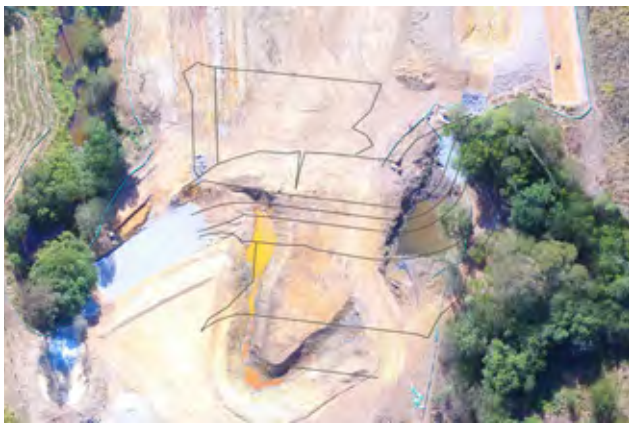


Traveston Creek Permanent Diversion Staging

1. Pre-works



2. 20 May 2016



3. 24 May 2016

4. 1 June 2016 - diversion online)

5. 30 Aug 2016 - pier works

6. 7 April 2017 - temporary access removed, bridge constructed.

Waterways: fast-tracking methods to avoid risk

Success in delivery: various stages of stream rehabilitation materials included biodegradable coir matting, planted native tube stock and, re-installation of aquatic habitat salvaged prior to diversion works. To minimise environmental risks, each diversion was 100% constructed prior to remobilising resources to the next waterway. This reduced the exposure during rain events, ensured resources were available and lessons learnt shared throughout the process.

Right: stabilisation achieved, re-planting occurring, snags re-installed.

Below: native species 6 months following planting.

By eliminating the temporary diversions at each of the four major creeks, the Project was able to significantly reduce the overall potential impact to aquatic fauna by a combined total of 740 days.

Planning to Practice: Pioneering with preservation

The Project team worked collaboratively to develop an ESC Plan specifically for Pioneering Works which included: boundary fence installation, light vehicle access, and installation of major ESC measures (clean-water diversion drains and sediment basins) .

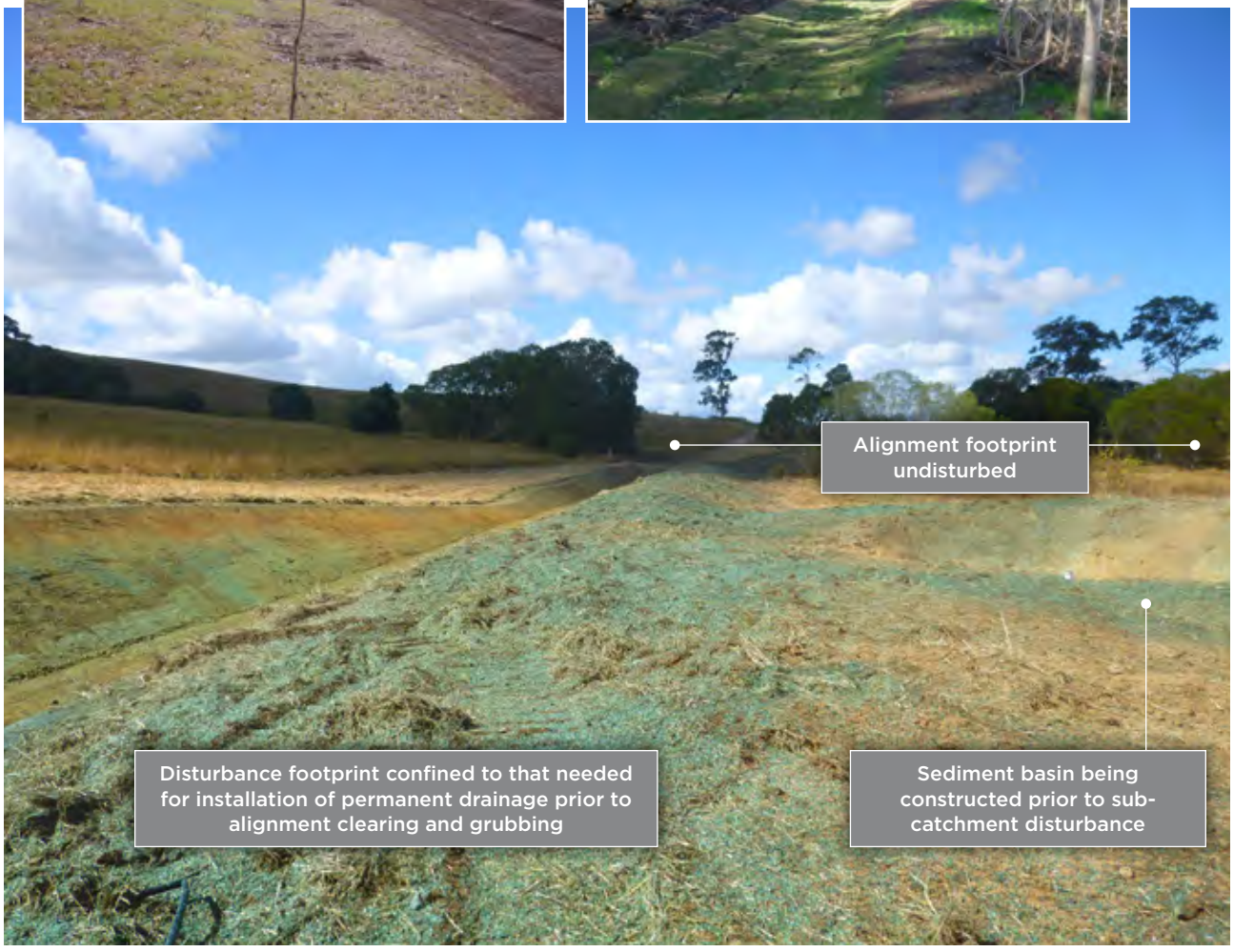
The planning approach mandated that all ESC measures were fully functional prior to clearing and earthworks commencing. . To achieve this a **sequential disturbance approach** was employed that focussed heavily on limiting footprints to that needed to install ESC measures, leaving topsoil in place and root balls intact, followed promptly by stabilisation .

Sequential boundary fence installation:

- *Left:* clearing limited to fence and permanent drainage footprint only – using in situ mulch as groundcover;
- *Middle:* subsequent cutting of clean-water permanent drainage;
- *Right:* promptly followed by turf installation (photo from opposite end of drain).

Planning to Practice: Pioneering with preservation

Keep it clean and on its way. Planning focussed on installing clean-water diversions, especially permanent longitudinal drainage to minimise upstream flows onto the construction footprint. This avoided potential impacts to surrounding environments, reduced costs associated with additional water treatment, and avoided costs associated with retrofitting temporary drainage into permanent drainage at the back-end of the construction program.



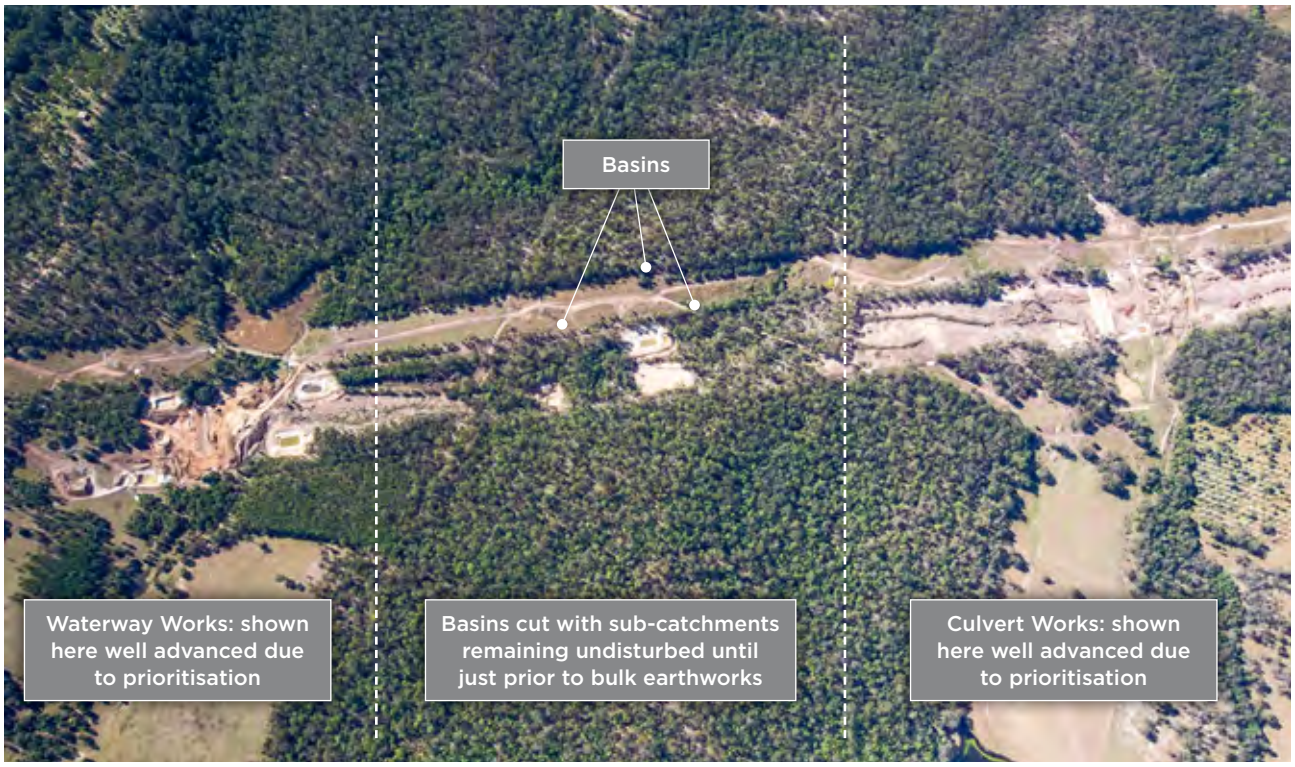
Planning to Practice: Pioneering with preservation

Basins, basins, basins. Installation of basins using minimal disturbance approach so that basin installation preceded clearing and earthworks. This process was repeated for 98 construction-phase basins. Most basins included forebays as seen shot-creted in images below. Forebays were used to enhance efficiency through retention of coarse solids, to act as an inlet velocity control, and to allow for easier maintenance access. Wherever possible, basins were designed and constructed with a balanced cut to fill ratio. This reduced the requirement to open borrow pits during pioneering works, as well as saved considerable time and costs during decommissioning phases .

Sediment basin installation prior to clear and grub, with downstream Type 3 controls in place until basin batters were stabilised

Basin installation amongst heavy vegetation: in-situ mulch used for groundcover and berm at toe of basin until batters were vegetated

Basins, basins, basins. The Project's **sequential disturbance approach** can be seen here with basins in place prior to clearing and significant works commencing. This avoided clearing and disturbing the entire alignment and consequently avoided unnecessary environmental risks.

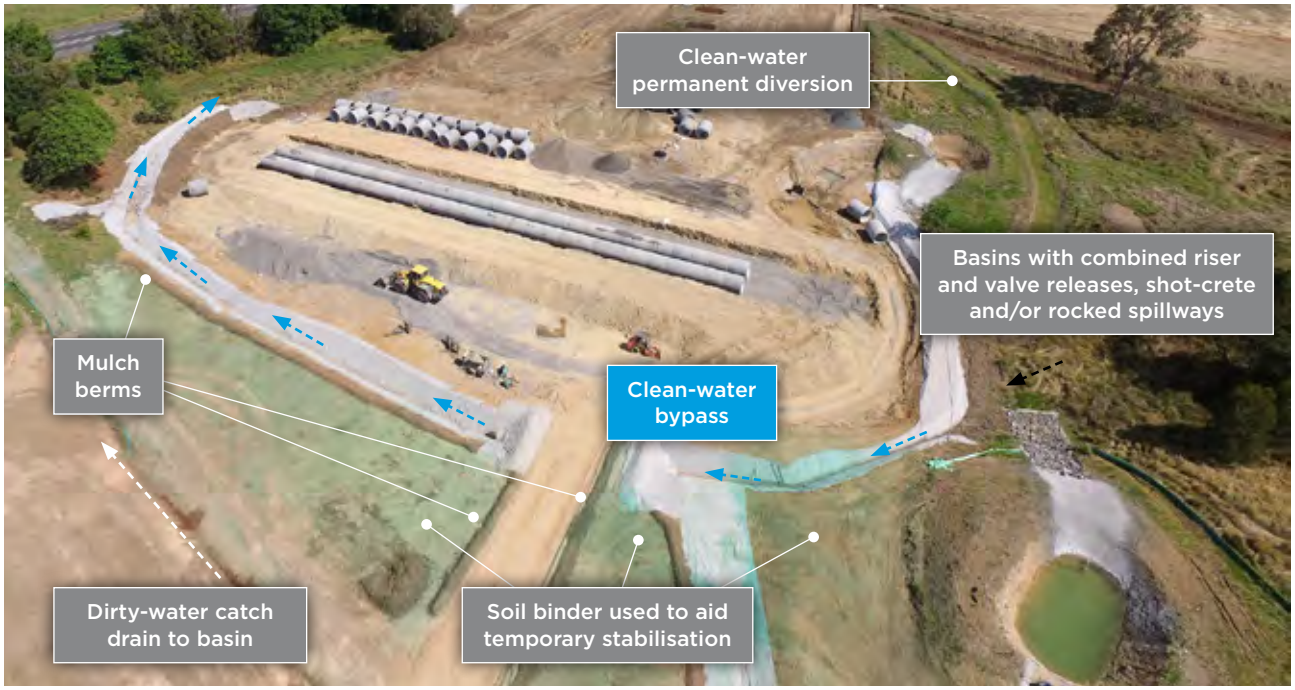


Planning to Practice: High velocity, high priority

Permanent treatments for high velocity drains were prioritised and completed prior to bulk earthworks commencing in the main alignment wherever possible. This included procuring materials earlier and mobilising extra equipment to avoid re-works and potential impact to water quality.

Planning to Practice: Separating the good from the bad

Given the large upstream catchments and undulating terrain, effective transverse drainage was required. Clean-water bypasses were installed to minimise water quality risks and provide dry-working conditions until permanent culverts were constructed.



Temporary clean-water cross-drainage

Planning to Practice: All the ingredients

Progress photos showing ESC controls installed as the first activities, then followed by a ramp-up of bulk earthworks.

Planning to Practice: Get it green

Situated in a high-rainfall hinterland area, a key Project focus was progressive rehabilitation supported by quality irrigation. This ensured stabilisation timeframes were reduced, lowering the environmental risk and decreasing maintenance and rework costs.

A number of very steep batters were stablised, exemplified by Cut 4 below.

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Innovation: Preparation is the key

In situ topsoil amelioration: this process involved collecting soil samples at 100m intervals during Pioneering Works to assess amelioration requirements. The Project's agricultural spreader then broadcast ameliorants following grubbing and was able to track the area and volume used throughout spreading for quality control. The topsoil was then stripped and stockpiled, which assisted in creating a more homogenous mixing outcome.

This process not only saved a significant amount of time and cost, but allowed ameliorants additional time to break down and incorporate into the topsoil providing a better growing medium. This process also avoided risks of topsoil pulverisation associated with screening and other conventional methods.

The entire Project team was required to work together to achieve this unique, non-standard solution which continues to provide excellent landscaping results over difficult terrain.

Innovation: Eyes in the sky

Drone survey technologies with 4K imagery capabilities were used to assist with designing ESC measures, and were built into the construction modelling to ensure accuracy of catchment sizing and contouring. This technology also helped in ground-truthing the installation of ESC measures to ensure their geometry and construction were built according to design, as demonstrated by these aerials.

Further, the aerial imagery assisted with monitoring progress of revegetation. It allowed an accurate ongoing determination of disturbed catchment and stabilisation areas which was used to appropriately risk assess and time the removal of major ESC controls following rehabilitation works.

Innovation: Brains into basin design

Being conscious of the importance of long-term sediment basins, in addition to the challenge of managing 98 construction-phase basins, the Project team incorporated smarter basin designs. The below design saved considerable time, cost and provided a better environmental outcome for water quality.

This included:

- Shot-creted inlets, forebay and outlets to prevent scours that could incur unnecessary maintenance issues to unlined basins. Forebays also used to enhance retention of coarse solids, with the shot-crete assisting when removing deposited material (refer No. 1 below);
- Installation of gravitational risers and lockable release valves (refer No. 2 below) on all basins to control dewatering and avoid use of pumps as much as possible;
- Flow activated treatment dosing systems (refer No. 3 overleaf);
- On critical basins the use of water quality sensors on inflows and outflows to determine treatment efficiencies (refer No. 4 overleaf).


3


4

Innovation: Passive, practical treatment

Passive application through broadcast gypsum:

- Broadcasting gypsum was an extremely successful solution to pre-loading catchments reporting to basins to enable passive treatment (refer No .1 overleaf);
- Type 2 Sediment Traps were also pre-loaded with broadcast gypsum (refer No .2 overleaf);
- Basin passively treated overnight following rain event (refer No .3 overleaf).

Although this treatment required significantly more pre-rain event preparation, the passive treatment significantly reduced post rain treatment costs, turnaround time (average < 8 hour timeframe), equipment and man-hours (see Table below). Water quality results collected to date also show passive gypsum application significantly increases water quality being discharged from site during an above design rain event when compared to a traditional batch basin.

Basin Flocculation Treatment: Cost per Rain Event

	Pre-Rain Event Costs	Pre-Rain Event Treatment Costs	Post-Rain Event Treatment Costs	Post-Rain Event Treatment Effort	Days Accrued from Treatment to Complaint Release Post-Rain Event
Passive Treatment (98 Basins)	Broadcast gypsum: Approx. $12,000 ($122 per basin)	1.5 days to broadcast gypsum (9 minutes per basin)	$0	Nil	1 day
Batch Treatment (98 Basins)	Nil	Nil	Approx. $55,000 ($561 per basin)	5 days using multiple crews (2hrs per basin)	4-5 days

The above figures have been estimated from trial costs tracked over a 12 month period. The figures have then been extrapolated across 98 basins (being the total number of construction-phase basins required) for comparative purposes.


1


2


3

Innovation: Diligent dewatering

The Project had a number of lakes and ephemeral streams that required careful dewatering. With an array of conservation species, a heavy focus was placed on dewatering processes. The below innovations were developed by site personnel following briefings around the dewatering and environmental approval requirements.

Right: a re-used IBC refurbished as a fauna-exclusion device to ensure aquatic fauna was not injured throughout pumping activities. This also eliminated the risk of vacuuming mud from the bottom of lake/stream.

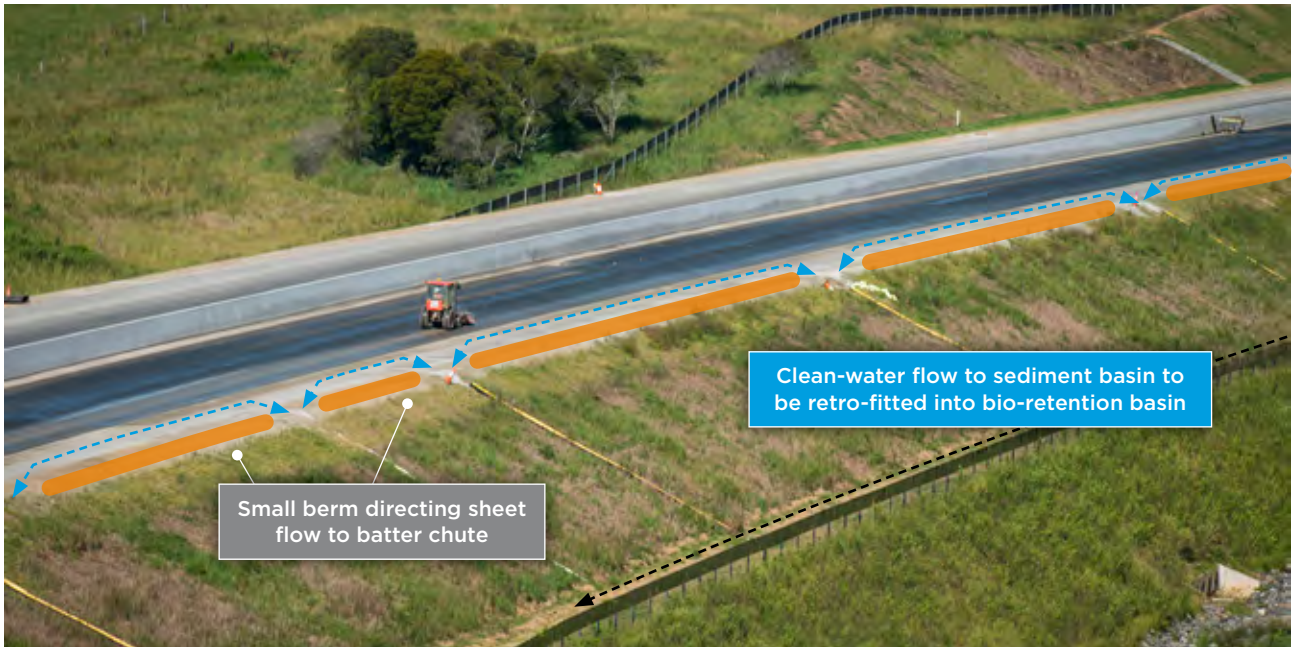
Below: a device developed by an environment crew member to eliminate the risk of vacuuming silt from bottom of basins, and to skim highest quality water from top of water column .

Innovation: Enhancing rehabilitation

Efforts to enhance rehabilitation

To avoid batter erosion through early strike, berms were installed to direct sheet-flow from road surface to designated batter chutes made from re-used HDPE piping. HDPE piping chutes allowed for cost-effective, quick installation, avoided deterioration and ongoing maintenance and minimised disturbance during removal.

Sprinkler watering systems were installed to enhance rehabilitation watering efficiencies and avoid reliance on water carts.



Industry leadership: Enhancing knowledge to achieve success

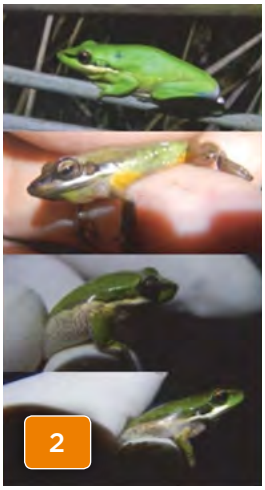
Mock Wet Weather preparation

Given the stringent ESC and water quality requirements under environmental approvals and contract documents, to ensure the Project personnel were prepared for rainfall and runoff management, Mock Wet Weather drills were rolled out. During these drills, work zone supervisors were told to prepare for a pending rain event, due in 2-3 hours.

Following the mock drills, the management team then inspected the work area to identify improvements. This allowed for internal training of supervisors, machine operators, environmental staff and labourers in a controlled environment. These trials proved highly successful in preparing and managing rain events across the Project.

Fauna management

The Project had a large dewatering component of pre-existing farm dams and larger lakes, which required a robust fauna management processes. Prior to dewatering, aquatic ecologists identified an endangered Swamp Crayfish (*Tenuibranchiurus glypticus*) (refer No. 1) and two vulnerable amphibians: Cooloola Sedgefrog (*Litoria cooloolensis*) and Wallum Sedgefrog (*Litoria olongburensis*) (refer No. 2). These species were not previously identified during the design-phase ecology surveys and had not been mapped in this area based on preferential habitat. Following the relocation of these endangered species, new ecosystem datasets were provided to the regulatory agency for future conservation purposes.



Industry leadership: Gauging performance

High Efficiency Sediment (HES) Basin trial

Recently, HES basin requirements have been drafted into a number of industry guidelines. The premise of HES basins are to operate as continuous flow-through systems, therefore offering greater sediment retention efficiencies than traditional batch basins.

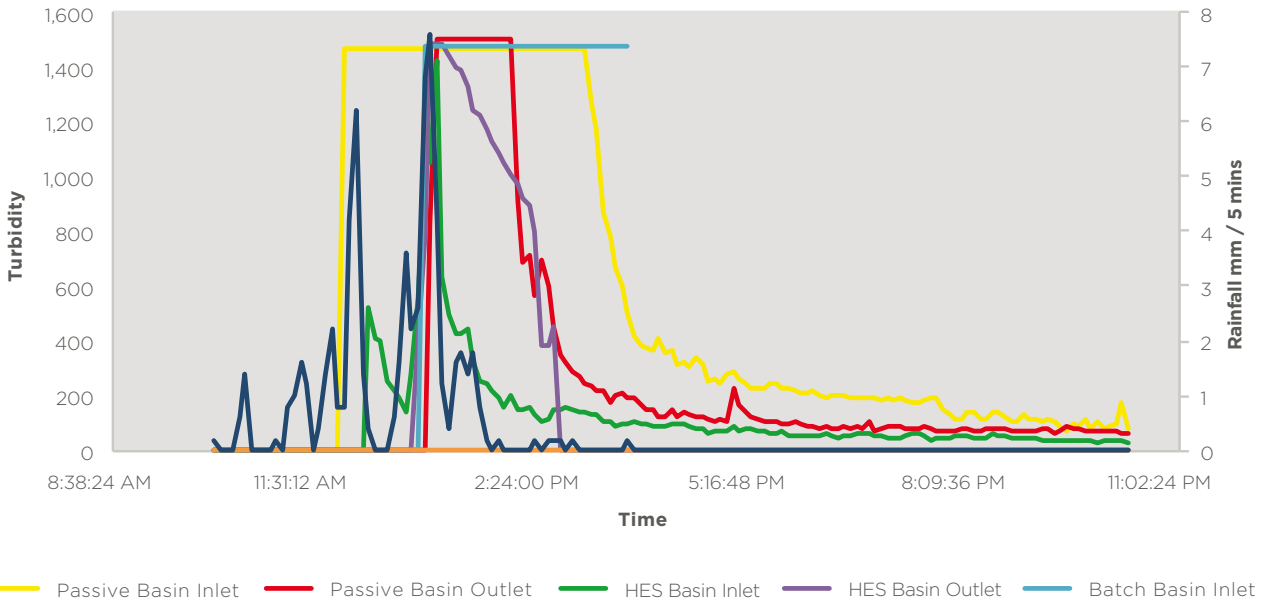
Although this premise is widely accepted, there was an absence of widely-tested site data from linear infrastructure in Queensland to support this.

Subsequently, the Project developed a trial scope to retrofit 3 existing basins with flow-activated inlet and outlet turbidity sensors to record both design and above-design rainfall events to compare performance of:

- a HES active treatment (Type A),
- a HES with passive treatment (Type B), and
- a traditional batch treatment (Type D) .

Additionally, the trial included tracking basin construction and maintenance costs to compare performance to overall cost. It is the Project's aim to be able to provide the trial outcomes (water quality data and cost evaluations) back to industry at the trial's completion.

The graph below plots turbidity results recorded at basin inlets and outlets which were recorded during a 60mm rain event. This data allowed the Project to monitor in real-time how each type of sediment basin performed during different rain events, and as sub-catchments changed.



Industry leadership: Getting the outcome

The efforts of the Project team across the 5 distinct areas of Planning, Implementation, Innovation, Tangible Outcomes and Industry Leadership has resulted in delivering a challenging, linear construction project with a high level of environmental performance. This is underpinned by:

- TMR's innovative contractual model being incorporated into future projects to continue the collaborative, transparent and heightened investment in environmental management.
- More detailed habitat mapping for 3 EVNT species for government agencies.
- Data collection and evaluation of HES basins compared to traditional batching and passive treatment processes to contribute to further industry ESC knowledge and management options.
- A significant increase in the knowledge and up-skilling of ESC and environmental management requirements throughout both the Project construction teams and the broader company employees .
- A project delivered without infringement or significant incident; and
- Positive feedback from external parties as provided below:

"As the Project erosion and sediment control independent auditor I have been repeatedly impressed by GHD and CPB's willingness to trial and embrace industry innovations. I have also been very pleased with the excellent rehabilitation outcomes they've achieved under quite challenging climatic conditions".

Andrew Macleod (SEEC) - Project Independent Auditor

"...EHP compliance officers have observed a high degree of site preparedness and contingency planning with regard to erosion and sediment control (ESC) measures in advance of forecast events as well as timely and effective actions in response to these events...CPB has demonstrated an internal culture of proactive identification of risks and effective management of those risks".

Compliance Delivery Manager, Sunshine Coast, DEHP.

SECTION 5
Quantifiable benefits

By incorporating best practice ESC measures and innovations, substantial benefits were achieved, including:

Environment

- Upfront planning ensured basins and other ESC measures were design and constructed to avoid environmental impacts and meet IECA requirements.
- Substantial avoidance of potential offsite sedimentation risks due to a strong focus on clean water diversion and implementing minimal disturbance and sequential clearing approaches.
- Significant re-use of site-won mulch for sediment control, thus reducing waste.
- Waterway diversion outcomes:
  - Avoidance of unnecessary risks and potential impacts to four major waterways due to the amendment of environmental approvals and staging, coupled with designating additional resources to fast-track construction of permanent diversion throughout low erosion risk periods.
  - Building permanent diversions immediately also reduced disturbance footprint within sensitive riparian environments.
- Passive treatment and basin dewatering process:
  - Use of more benign flocculant product as opposed to chemical flocculants.
  - Reduction in the need to use additional mechanical intervention for post-rainfall flocculant application and pumping, due to plumbing basins with gravitation riser and release valves .
  - Average turbidity throughout construction-phase basin releases was
  - 17.83 NTU providing high quality water to downstream aquatic environments.
- Enhanced stabilisation and revegetation outcomes following successful in situ topsoil amelioration. This provides certainty to the success of rehabilitation and thus avoids risks of ongoing water quality impacts.
- Successful management of 3 EVNT species not identified throughout preliminary ecological assessments. This information has been used to bolster DEHP habitat mapping and records for future projects and conservation efforts.

Community

- Increased waterway connectivity through construction of permanent diversions which reduced extent of in-stream works.
- Through strong attention to progressive stabilisation and interim suppression techniques through active work areas, the project avoided dust and air quality impacts to the surrounding community.
- A broader environmental management focus including fauna management throughout dewatering, weed treatment, and avoiding clearing wherever possible has maintained the environmental aesthetics of a valued hinterland area.

Industry Contribution

- TMR's innovative contractual model has provided a concept for consideration to broader industries dealing with environmental management requirements. As such, this model is being incorporated into other TMR projects.
- Our HES Basin Trial will provide an insight to industry as to the benefits and constraints to particular types of basins not only including HES basins, but also passive basin treatment approaches and traditional batch basins. This will further the knowledge-base around HES basin and ESC in the industry.
- Demonstration of the topsoil preservation and rehabilitation benefits of using non-standard in situ topsoil amelioration approaches not widely applied in traditional road construction methods.

- Contribution to DEHP habitat mapping and records for future projects and conservation efforts for species found throughout the project that are inhabit areas well outside of their known habitat range.
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CPB Contractors

- The team had an internal goal to deliver the Project without significant environmental incidents or infringements, and through commitment to best practice environmental techniques and a collaborative approach with TMR and GHD, this goal has been achieved.
- The continual focus on ESC through planning and execution has enhanced the greater construction team's understanding of the importance of ESC management and the need to incorporate these into construction methods and daily activities to avoid offsite impacts .

The Project has been used internally as a demonstration of "what good environmental practice looks like" for CPB Contractors employees, which has brought with it a greater appreciation of the benefits of planning for and integrating ESC into construction methods.