Prepared by Genex Power Limited

Author: Amy Crowley

Email: info@genexpower.com.au

Website: https://www.genexpower.com.au/

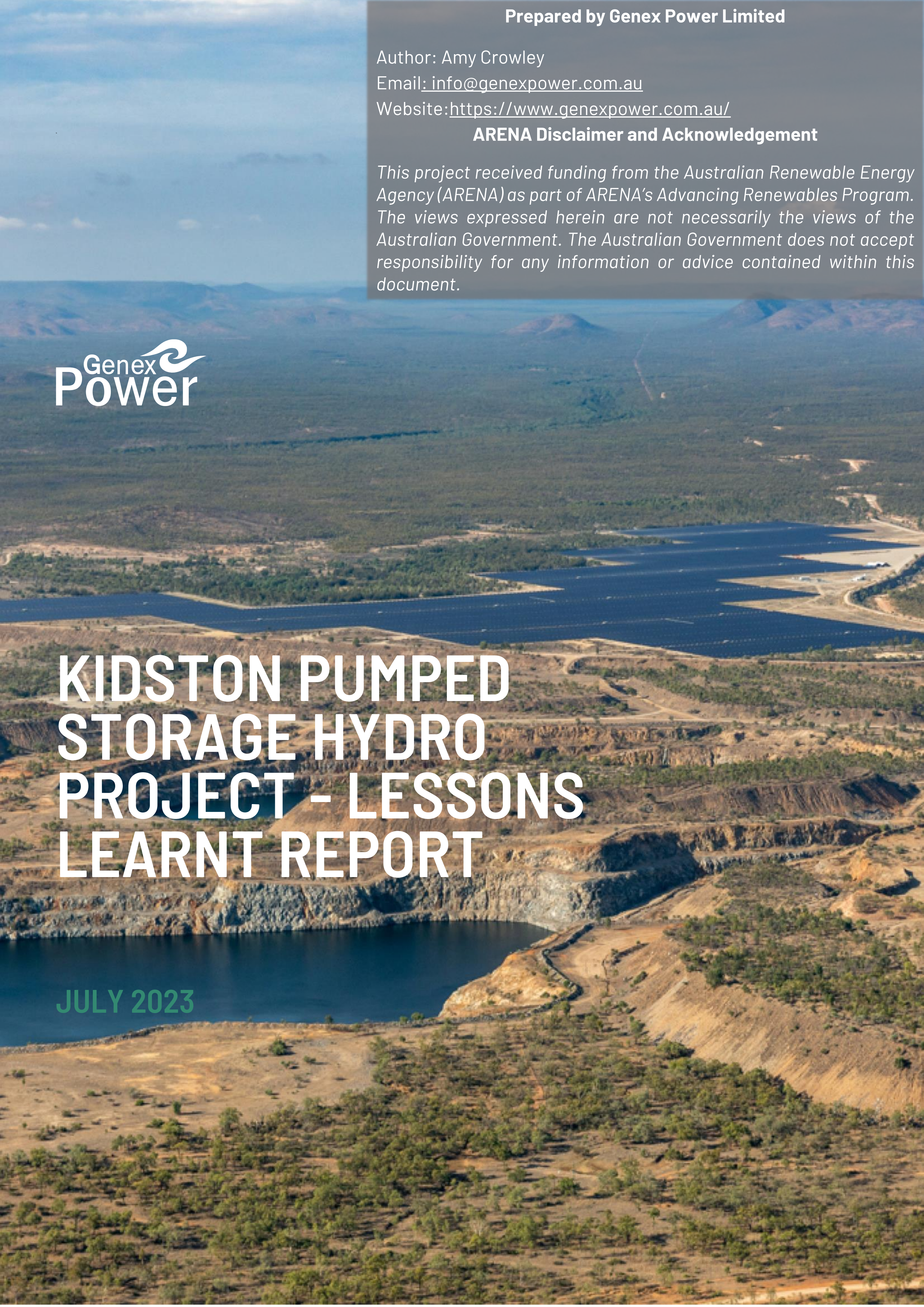
ARENA Disclaimer and Acknowledgement

This project received funding from the Australian Renewable Energy Agency (ARENA) as part of ARENA's Advancing Renewables Program. The views expressed herein are not necessarily the views of the Australian Government. The Australian Government does not accept responsibility for any information or advice contained within this document.

Genex Power

KIDSTON PUMPED STORAGE HYDRO PROJECT - LESSONS LEARNT REPORT

JULY 2023



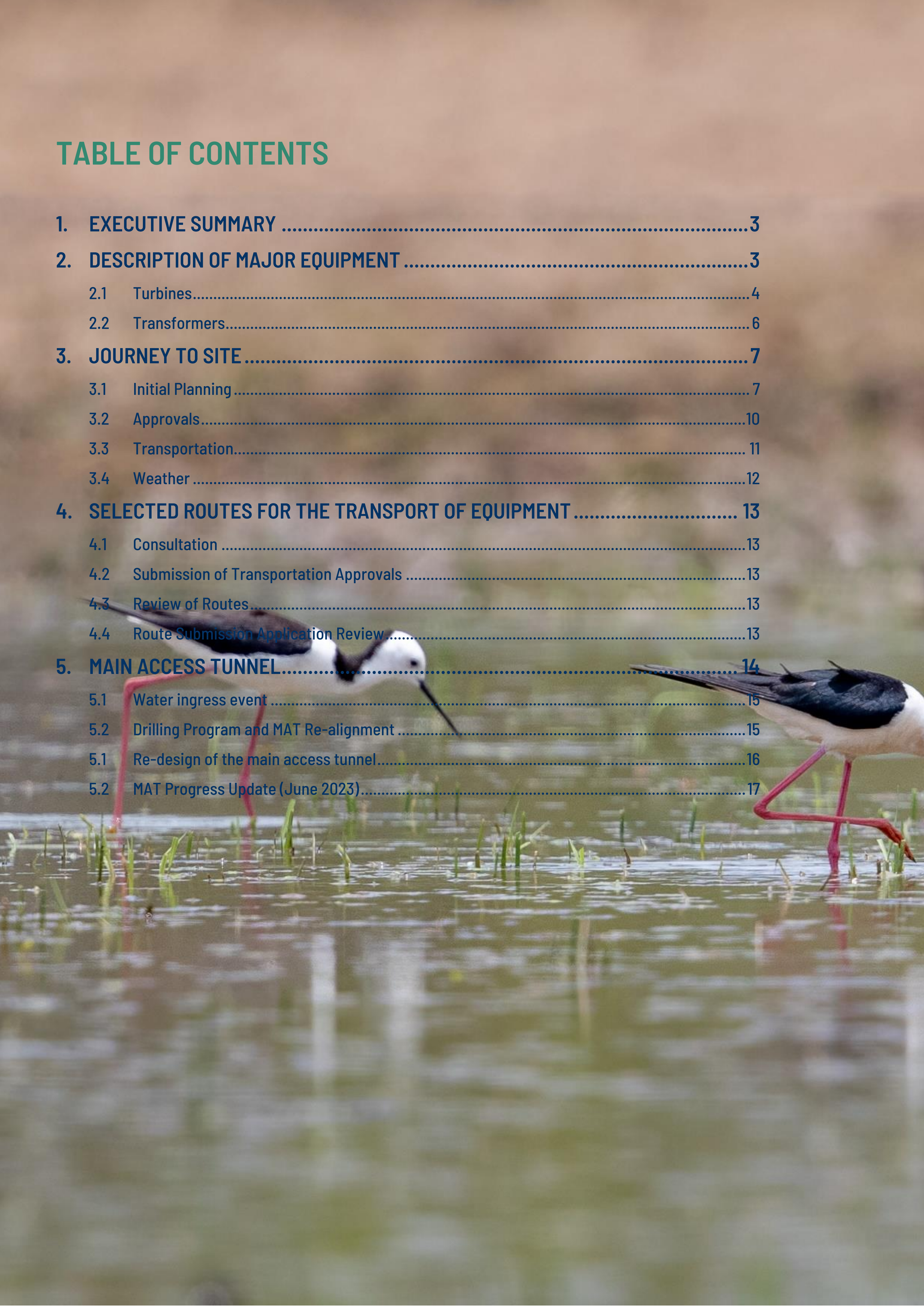


TABLE OF CONTENTS

1. EXECUTIVE SUMMARY

Genex Power Limited (**Genex**, **Company** or **Owner**) is the 100% owner of the Kidston Clean Energy Hub, located in North Queensland (the **Kidston Hub**). Stage 1 of the Kidston Hub was completed in the form of the 50MW Stage 1 Kidston Solar Project, which was energised in November 2017. Stage 2 of the Kidston Hub is the 250MW Pumped Storage Hydro Project (**K2-Hydro** or **Project**) which is currently under construction, having reached financial close in May 2021. A further Stage 3 of the Kidston Hub, being a wind project of approximately 258MW which Genex is developing in a 50:50 partnership with Electric Power Development Co. Ltd (trading as **J-POWER**), is currently in feasibility stages along with a potential co-located solar farm of up to 270MW.

This report will serve as a Lessons Learnt Report, discussing issues around transporting the major Project equipment to site, focusing on the selected journey for transport and challenges experienced in selected this journey. This report will also discuss the Main Access Tunnel (**MAT**), focusing on progress since realignment.

2. DESCRIPTION OF MAJOR EQUIPMENT

The major components of the hydro generator are being fabricated overseas, mainly in China and India, by the supplier – Andritz Hydro. The two 125MW turbines (the **Turbine** or **Turbines**) are manufactured in parts and shipped to Australia via the Townsville Port. To date, three shipments of equipment have been received (mainly steel components that will be embedded into concrete). All shipments to date have been transported by semi-trailer using existing road routes without special conditions or escorts. However, for specific items which are either large or heavy or both, special transportation measures are required. A summary of the largest components is provided in Table 1 below.

HEAVY LIFTS | ODC	TONS	L (CM)	W (CM)	H (CM)
Draft Tube Section (various)	11	660	400	350
Draft Tube Main Gate	91	550	450	330
Bottom Ring	32	430	430	110
Head Cover	56	510	510	150
Main Inlet Valve	91	550	450	330
Shafts	28	660	150	150
Main Transformer	120	900	320	400
Stator Stacked, wound	94 (for ½ section)	762	405	423

Table 1: Preliminary Heavy Lift Details

Of the above, components of the turbine and the transformer are the critical logistical challenges for the Project and are described further in the sections below.

2.1 Turbines

Turbines are a key component of the Project and are used to generate electricity. When electricity demand is high, water will flow from the upper reservoir of the Project into the lower reservoir, passing through turbines that rotate generators to produce electricity.

The Turbine is made up of several components that are placed and fitted together at the Project site. The key components for the purposes of transportation and logistics are as follows:

- The runner
- Bottom ring
- Headcover
- Draft tube cone
- Draft tube liner
- Pit liner
- Stay ring; and
- Spiral casing.

Figure 1 below shows a typical turbine arrangement, where in generation mode, water (depicted by arrows) passes through the main inlet valve (labelled 1) into the spiral casing (labelled 2) which contains the blades that ultimately spin the turbines before the water exits via the draft tube (labelled 3).

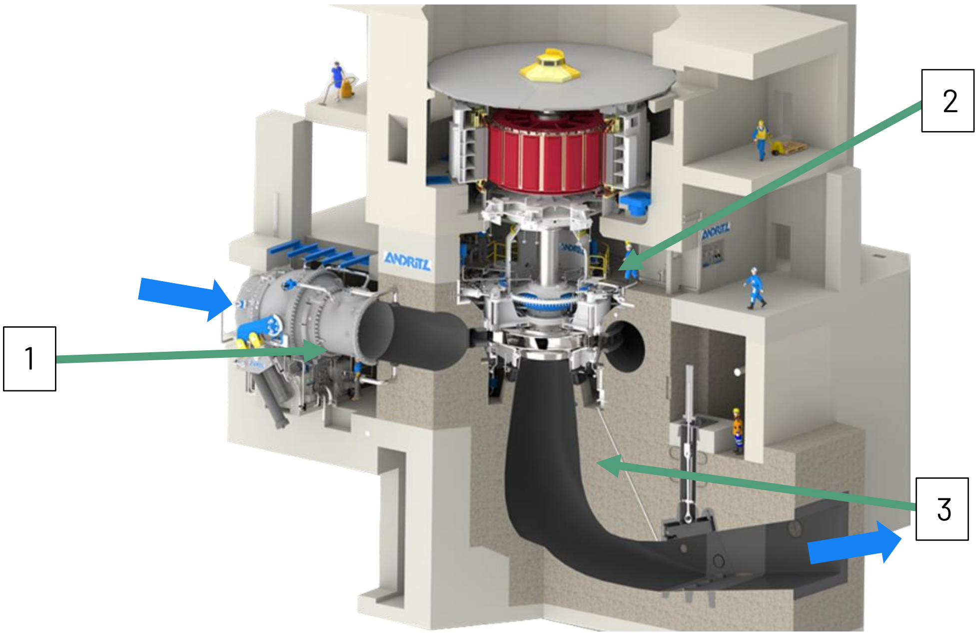


Figure 1: Illustration of a reversible pump turbine

Of these parts, the stay ring is the largest single piece that is required to be transported. Refer to Figure 2 for illustration of the stay ring loaded onto the heavy vehicle low loader that will be required to transport from Townsville to site. The width of the stay ring is such that a wide load permit will be required.

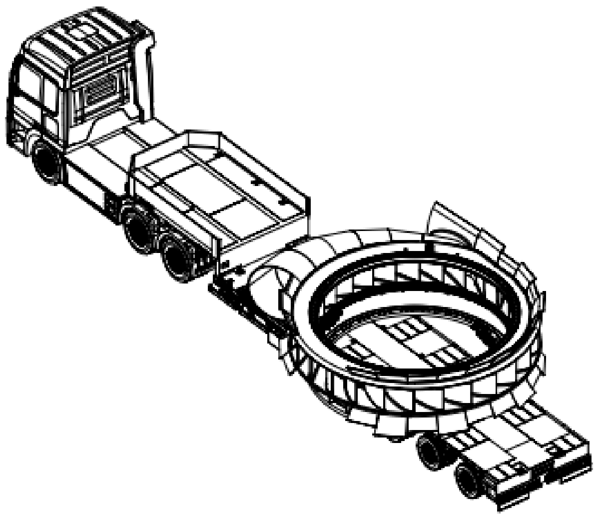
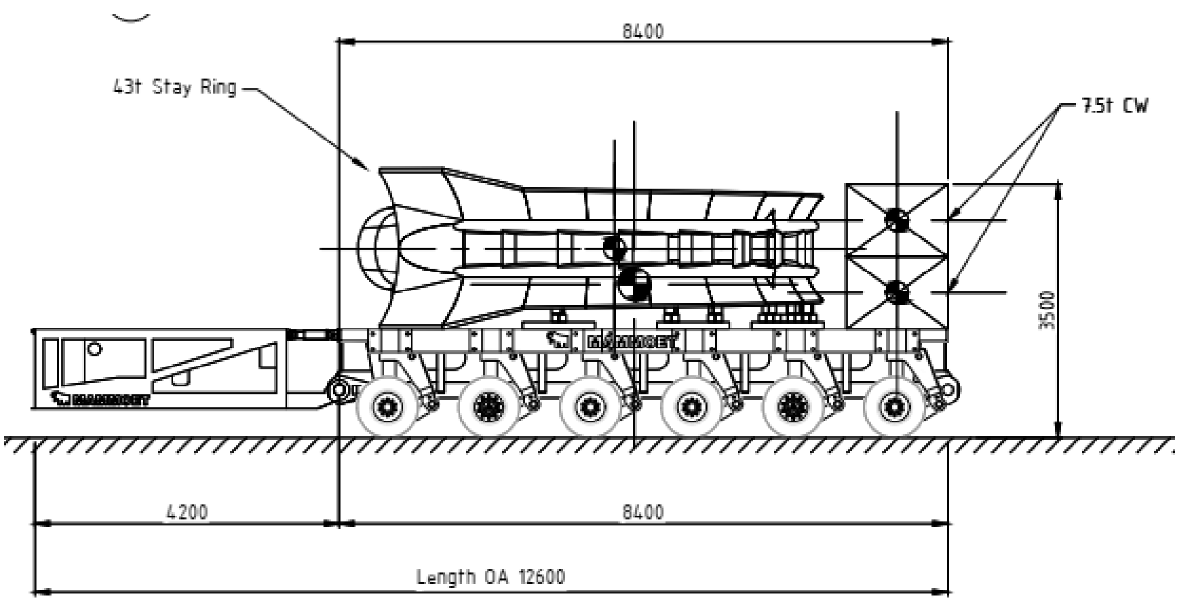


Figure 2: Transportation Configuration of Stay Ring on Semi Trailer – Above Ground

For the journey below ground, the stay ring is required to fit through a 6m high, 6m wide tunnel, having a 7% grade (1 in 14) with curves having a 60m radius. The size and route geometry require the utilisation of specialised transportation equipment for this journey. The stay rings will be transported underground in one piece utilising Self-Propelled Modular Trailers (**SPMT**). A preliminary transportation configuration is provided below in Figure 3 for the stay ring on the SPMT in elevation and plan, noting the tight horizontal clearances to the tunnel profile in plan view.



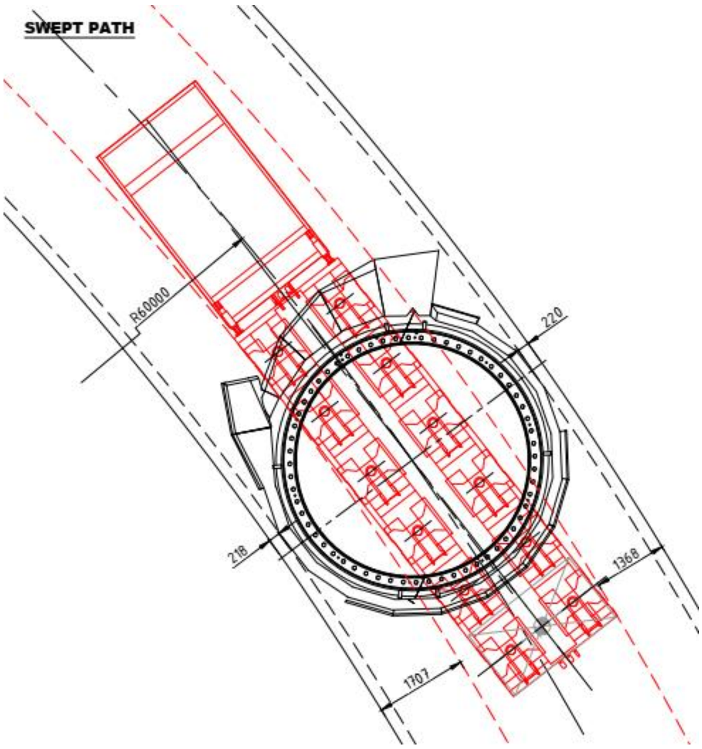


Figure 3: Transportation Configuration of Stay Ring on SPMT – Underground

A key consideration for any underground project is to ensure that heavy logistics specialists are engaged early in the planning phase to ensure route geometry and local available specialist equipment. This approach was undertaken and has resulted in the solution currently being progressed.

2.2 Transformers

Two transformers are required to convert the 16.6kV supply from the turbine generators to 275kV for purposes of connecting into the National Electricity Market. These are ultimately located underground, adjacent to the Turbines. They each weigh 120 tonnes and are approximately 9m long, 3.2m wide and 4m high. Multiple transportation configurations are required to bring the transformers to the Project site, at which they are then transported underground. A preliminary trailer configuration for above ground transportation is shown below in Figure 4.

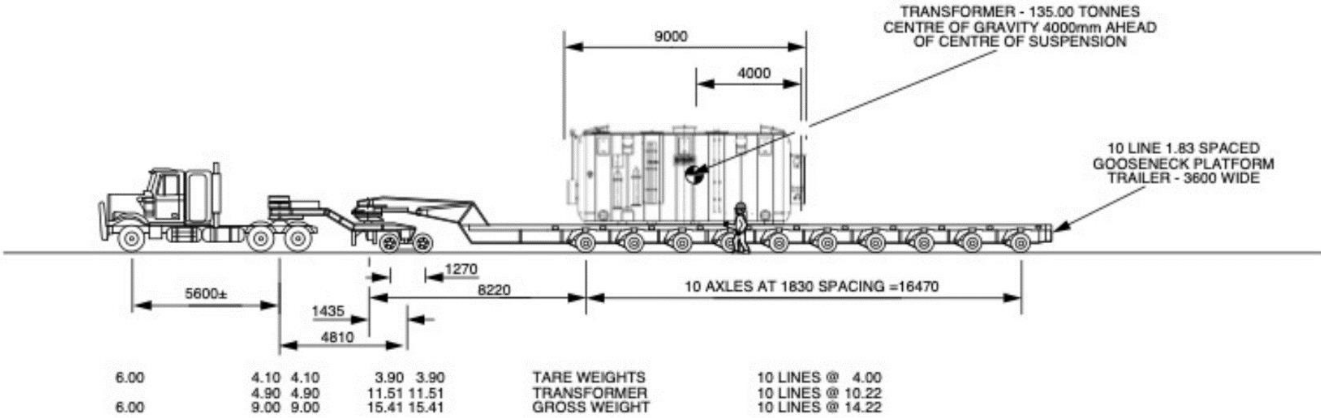


Figure 4: Transportation Configuration of Transformer on Gooseneck

Similar to the Turbines, the transformer is required to fit through a 6m high, 6m wide tunnel, having a 7% grade (1 in 14) with curves having a 60m radius. The combination of size, weight and route geometry require the utilisation of specialised transportation equipment. The transformers will be transported underground utilising SPMT. A preliminary transportation configuration is shown below in Figure 5, noting that due to the weight of the transformer, SPMTs are positioned both front and rear with a drop deck low loader that carries the transformer.

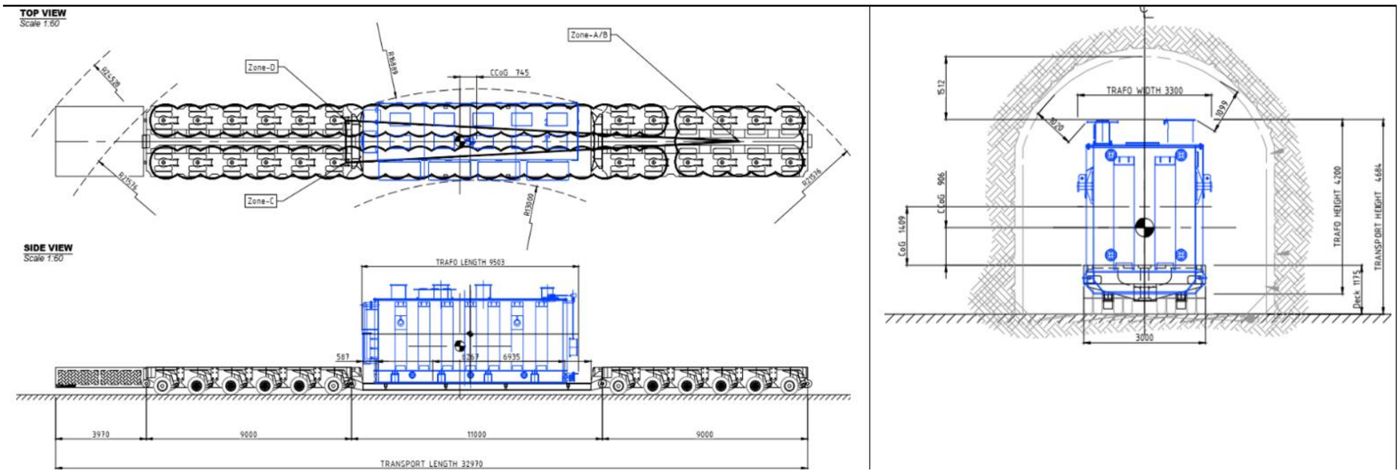


Figure 5: Transportation Configuration of Transformer on SPMT – Underground

3. JOURNEY TO SITE

3.1 Initial Planning

The planning phase for transportation is the most critical phase of the works. During the planning phase, it is crucial to ensure that all routes available are understood and visually proofed, and that all road infrastructure is assessed for load limits, width, road geometry constraints, surface type (sealed or unsealed) and surrounding infrastructure (below ground and above ground).

For the Turbine equipment being provided by Andritz Hydro, a full route survey study was undertaken by professional internal logistics consultants (Hansa Meyer Global and J.H. Bachmann).

The route survey was broken down into:

i) Route from Townsville Port to Conjuboy Intersection; and

ii) Route from Conjuboy Intersection to Kidston site.

The various routes are illustrated in the Figures below.

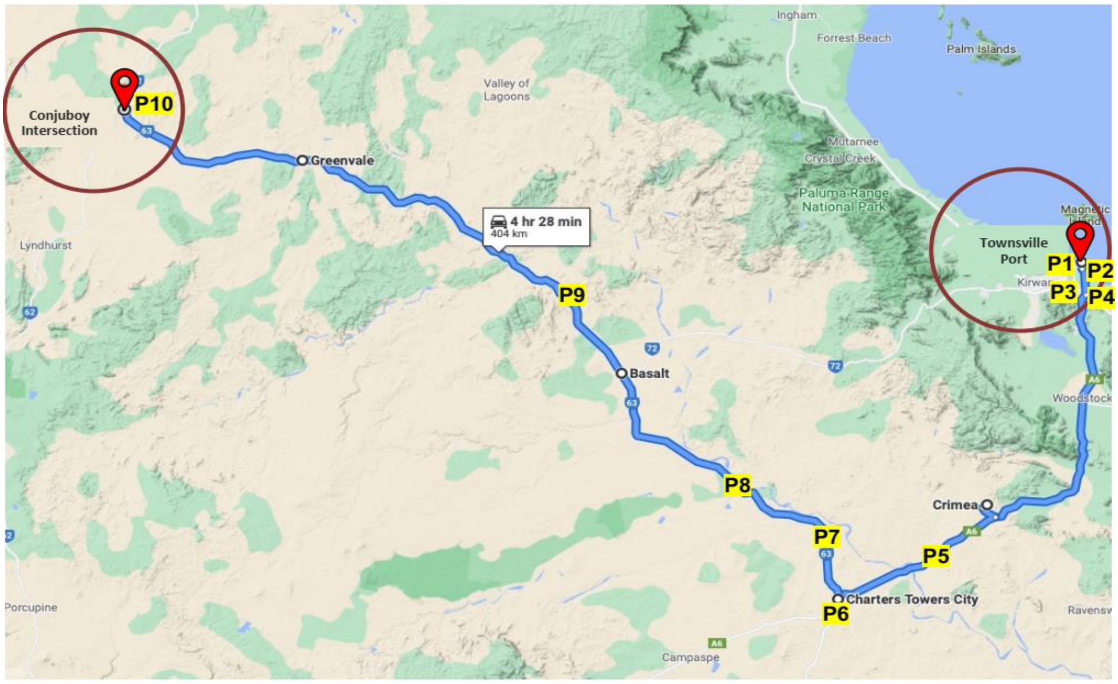


Figure 6: General Route Plan from Townsville Port to Conjuboy Intersection

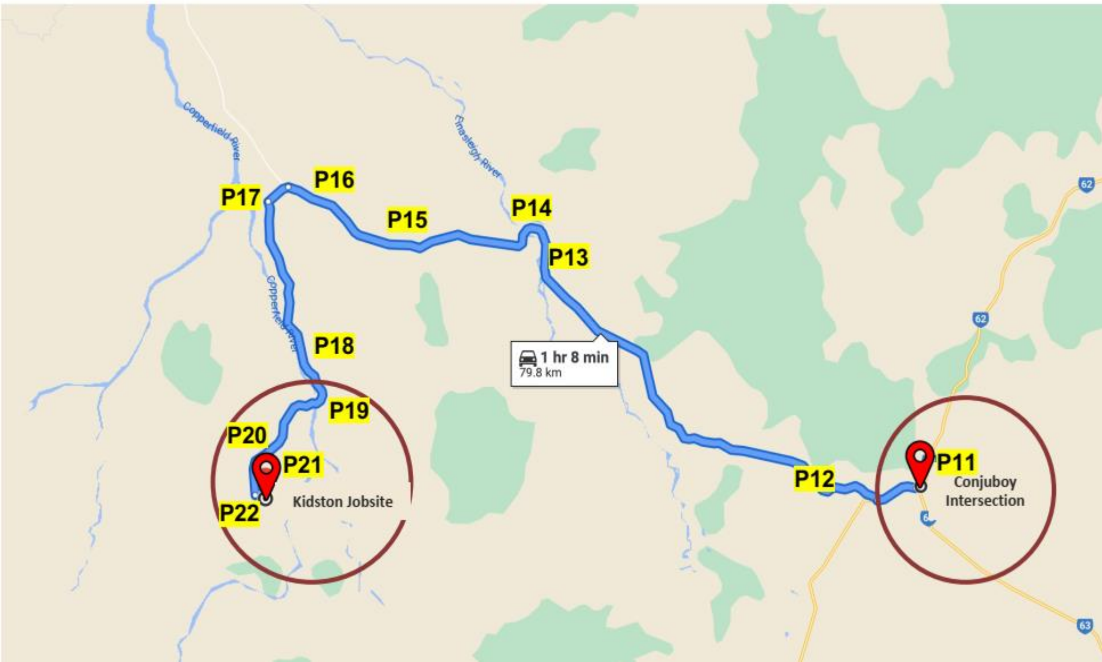


Figure 7: General Route Plan from Conjuboy Intersection to Kidston Site (Option 1 – Short Route)

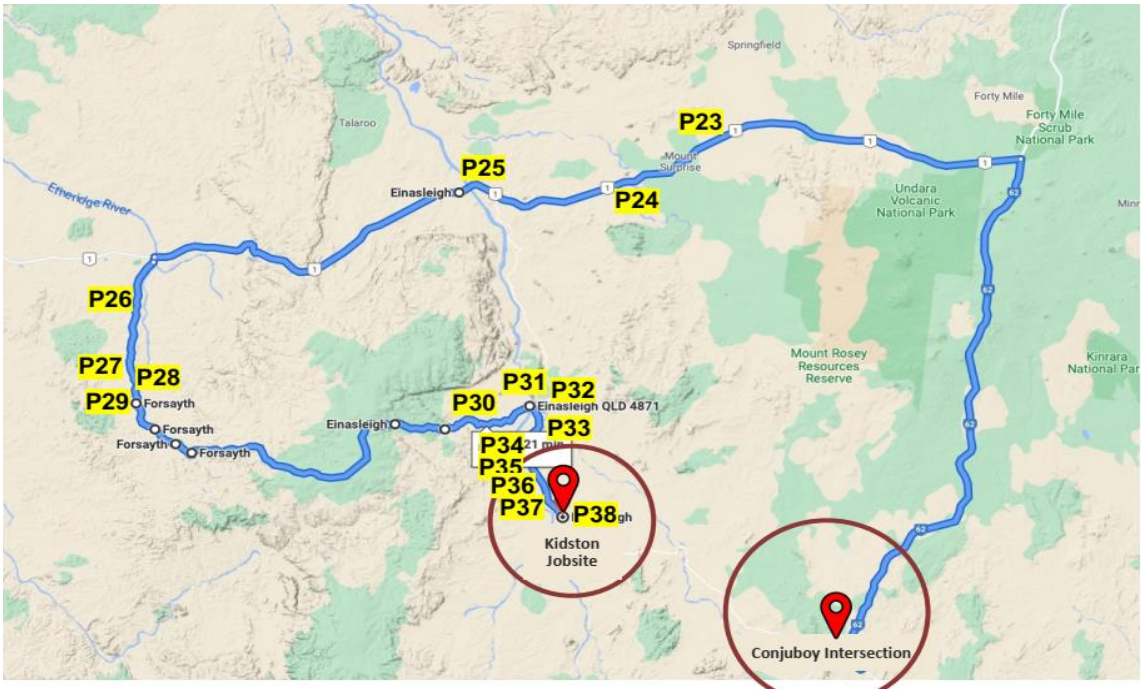


Figure 8: General Route Plan from Conjuboy Intersection to Kidston Site (Option 2 – Long Route)

The main constraint unique to Option 1 for the journey from the Conjuboy Intersection to the Project Site is the crossing of the Einasleigh River Bridge (refer to P14 in Figure 7) along the Gregory Development Road. This bridge is narrow, having a trafficable width of only 3.24m, as seen below in Figure 9.

Figure 9: Einasleigh River Bridge on the Gregory Development Road

During the initial assessment, options to overcome this issue include:

- Avoid the crossing by utilising Option 2 (as per Figure 8);
- Reinstating the bypass road (a temporary track across Einasleigh River located immediately downstream to the bridge in Figure 9) which has not been in use for over ten years, which will require substantial works; or
- Modifying the trailer configuration to bring the width from 4m to 3m for this crossing, however this requires modification works at location.

For the initial planning of loads which are oversized and overweight, utilisation of the Option 2 route was assessed as the preferred option and included in the initial submission for transport permits. Option 2 adds an additional ~200km to the journey the Project site.

> A key lesson here is to commence the planning phase as early as possible and involve local stakeholders and Councils in this process to ensure that no unexpected situations occur when construction commences. Furthermore, opportunities for local upgrades to road infrastructure should be explored at that time to understand whether there is opportunity to bring forward such infrastructure upgrades and possible cost apportionment between private and public.

3.2 Approvals

A table of expected approvals and approving authorities is provided below:

APPROVING AUTHORITIES	EXPECTED APPROVALS
Townsville Port	Wharf loading approvals
Queensland Department of Transport and Main Roads	Oversize and overweight approvals
Queensland Police Service – Oversize Vehicles	Police escort services may be required
Ergon	Overhead Electrical Lines (clearance exemptions may apply)
Optus	Telephone and cable TV services
Foxtel	Cable TV services
Queensland Rail	Railways crossing and electrified overhead line (where appropriate)
Local Councils	Road conditions and approval for minor temporary river/creek crossings (as required)
Department of Environmental Services	Construction of temporary river/creek crossings (as required)

Table 2: Expected Approvals and Approving Authorities

3.3 Transportation

Transportation will generally be via semi-trailer that complies with all legal requirements, without special permits and approvals.

Where special transport configurations are required, assessment of the road constraints is required to ensure geometry compatibility between trailer and road is fit for use and to identify where minor modifications to road geometry are required to ensure safety of the transportation and that road infrastructure is not overloaded (or temporary strengthening undertaken).

An example of such engineering assessment is shown below in Figure 10 where an assessment is undertaken of a heavy vehicle multi-axle trailer traversing a gully in the road and assessing the load impact on remaining axles when the middle axles are off the ground.

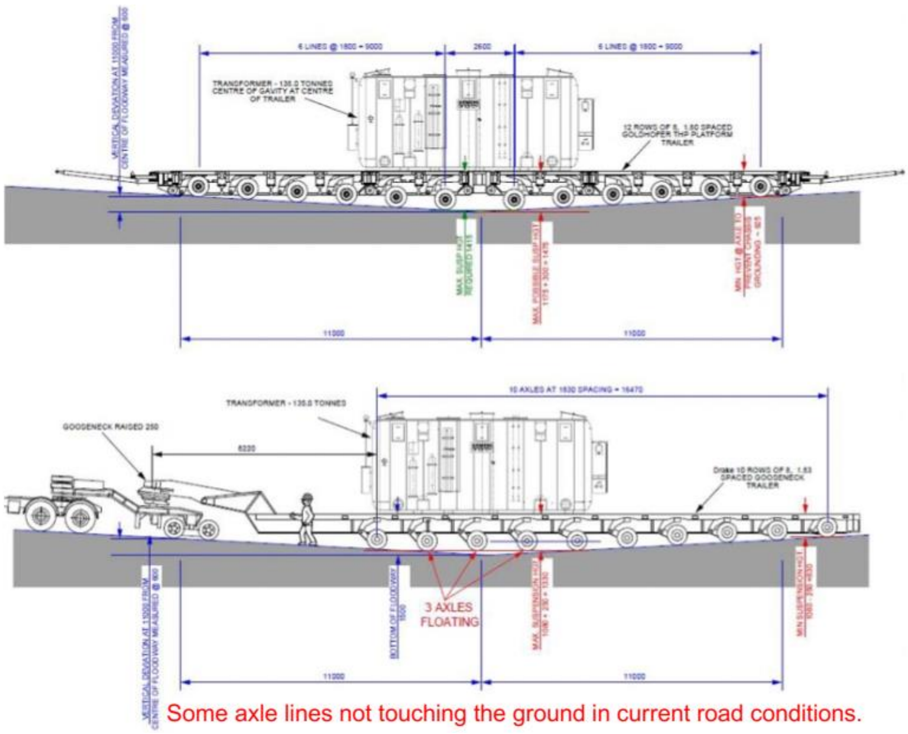


Figure 10: Example of Transportation Assessment for gully crossing (for Transformer)

Once the equipment reaches the Project site, it will be unloaded onto a bespoke laydown pad which is fitted with equipment protection in accordance with preservation requirements. Upon the time the equipment is required to be transported underground, the equipment will be loaded onto a semi-trailer or SPMT (as described above) and transported into the Main Access Tunnel (**MAT**).

The underground transportation route will be via the MAT into the powerhouse cavern. The powerhouse cavern has a uniquely designed floor for the receipt of equipment which will be picked up by an overhead gantry crane and positioned into its final place. Due to spatial constraints in the powerhouse, the overhead crane will also be used to pick up the trailer from the semi-trailer and turn it around such that the semi-trailer drives forward in both incoming and outgoing movements in the MAT.

3.4 Weather

Timing of transport is critical with respect to weather conditions. There are several unsealed roads which need to be traversed and low-level bridge crossings and gullies to be crossed. Hence, it is important that transportation of the key items is undertaken during the dry season (generally April to October in Far-North Queensland). Access to the Project site via road is required over the Copperfield River bridge and causeway located approximately 5km from the Kidston Site.

The Copperfield River is linked directly with the Kidston Dam, which is a raw water storage facility that comprises of an ungated spillway. Telemetry is available for the Kidston Dam which provides water height above the dam spillway, and when the spillway is spilling, this provides a direct correlation as to whether the downstream Copperfield Bridge is passable or not.

Recent weather in January 2023 shows this correlation where the spillway has had up to 2.5m flowing over it (refer to figure 11 below). The spillway level is Reduced Level (RL) 586m.

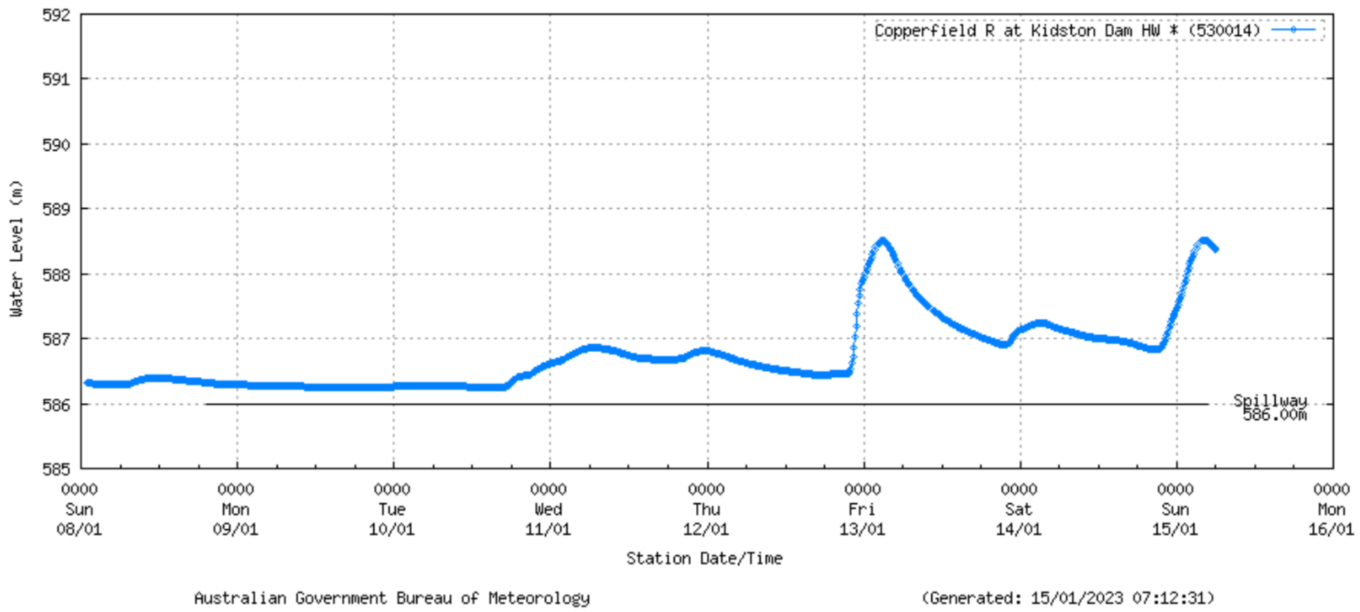


Figure 11: January 2023 Kidston Dam Spillway Levels

A key lesson is that material transportation should take place outside of the wet season and alternate offsite storage should be identified and available if required. The Project has benefited from the first three shipments being delivered to site during the dry season, with remaining shipments planned to also arrive during the dry season.

4. SELECTED ROUTES FOR THE TRANSPORT OF EQUIPMENT

4.1 Consultation

During the initial planning of routes, the heavy haulage company engaged undertook a regime of assessment and consultation with Councils, locals, and various stakeholders to determine the most suitable route for the submission of approval documentation.

4.2 Submission of Transportation Approvals

The approval documentation is submitted through an online portal to the National Heavy Vehicle Regulator (**NHVR**) via a submission of a Heavy Vehicle Access (**HVA**) request. Once the HVA request is received, an initial assessment of the application is undertaken and the application is coordinated out to Department of Transport and Main Roads (**DTMR**) districts and structural engineers for their consent and where applicable, issue to the Queensland Police Service (**QPS**) for their consent around road safety and the allocation of pilots and escorts as required.

4.3 Review of Routes

As discussed in Section 3.1, initial optioneering investigated an alternate route – refer Figure 8 – which was considerably longer.

Upon further assessment, it became apparent that this route would not be appropriate due to the works required to strengthen existing bridge assets.

A review of the preferred route – refer Figure 7 – was undertaken and the Einasleigh River Floodway assessed structurally to ensure sufficient load-carrying capacity for the heaviest items. This assessment was undertaken in conjunction with assessment of the heavy haulage transportation trailer availability. Each trailer manufacturer has unique abilities for load spread on the trailer and axial width. A suitable trailer was identified to both carry the load and fit within the crossing roadway, albeit with minimal clearances to the inside of kerbs. This route then became the route submitted to NHVR.

4.4 Route Submission Application Review

During the application review process, the NHVR identified the following constraints:

- Macrossan Bridge over Burdekin River – 5% overload; and
- Einasleigh River Floodway on Gregory Developmental Road.

A meeting was established between all relevant stakeholders to address these items.

The Einasleigh River Floodway query related to the width of travel was resolved without modification.

The query relating to Macrossan Bridge related to loading limits on the proposed trailer arrangement (3m wide). This resulted in a minor over-loading of 5%. Discussion was held regarding transportation speed, number of prime movers, and positioning of the load on the bridge deck. The resolution was proposed through the use of a wider trailer (4m) to further spread the load across the bridge structure.

Structural review of this option is currently underway but is expected to be accepted with a wider trailer. The impact of using the wider trailer is that a load transfer to a narrower trailer (3m) will be required to allow passage across the Einasleigh River Floodway. The team are working hard to avoid using the wider trailer and adopt the narrow trailer solution for the whole transport route. If a transfer from a wider trailer to a narrow trailer is required, then it would be undertaken under controlled conditions in a suitable laydown area adjacent to the road. In such an event, the two trailers would be positioned side by side and the load slid under controlled conditions from one trailer to the other.

This route submission is currently being assessed and is not yet approved (as of early July 2023).

The heavy load application process relates to the following eight (8) components:

- Two (2) transformers – above 101t;
- Two (2) MIV – which are big valves controlling the water; and
- Four (4) stators (1/2 components) – which are the parts of the generator.

In total the Project is considering eight (8) pieces of heavy loads above 100t requested for transport from port of Townsville to Kidston site.

These loads are anticipated for transportation to site in the months of September and October 2023.

5. MAIN ACCESS TUNNEL

The MAT is a 6m wide and 6.2m high tunnel which provides access to the underground powerhouse. The MAT declines from the portal at a Relative Level (RL) of 490m to RL291m. The MAT is excavated at a grade of 14% (1:7) in a series of straight and spiral geometrical sections having a maximum radius of 60m to access the powerhouse cavern which is approximately 250m below ground level. The powerhouse cavern will house two 125MW Andritz Hydro reversible pump-turbines. The MAT is the primary access route for transporting the pump-turbines and ancillary equipment for installation in the power station cavern.

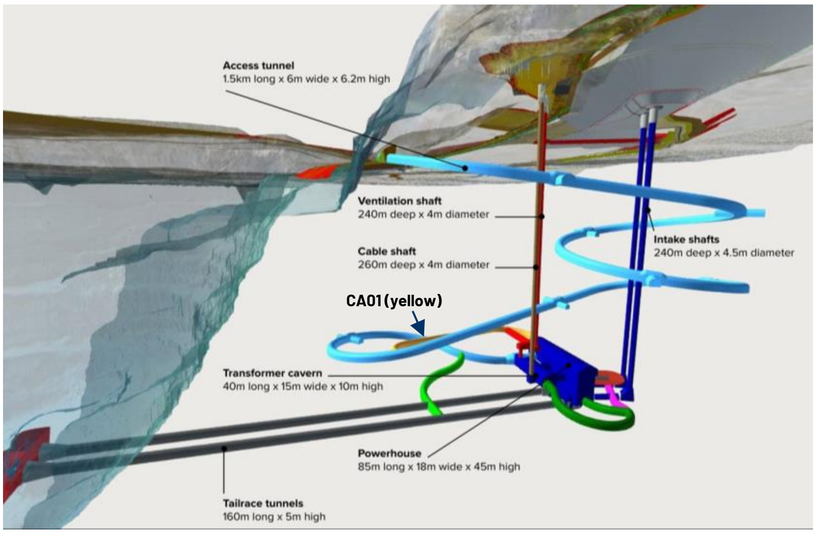


Figure 12: Original MAT design

The MAT is constructed using conventional full-face drill and blast excavation methodology, supported with pattern bolting and shotcrete. Whilst the MAT provides access to the powerhouse cavern operating floor, other construction adit tunnels are required to facilitate and expedite overall underground construction activities. The first of these construction adits is CA01 which branches off the MAT and aligns to connect with and allow the construction of the powerhouse cavern crown (roof).

The Engineering, Procurement and Construction (**EPC**) contractor, McConnell Dowell and John Holland Joint Venture (**MDJHJV**), completed the preparatory works for the MAT including portal face stabilisation in December 2021, and formally commenced underground excavation works in early January 2022 which was signalled by the first major blast for the MAT. Tunnelling operations have since progressed on a 24/7 basis.

5.1 Water ingress event

In September 2022, while conducting drilling in the MAT face for the next round of blasting, an unexpected geological feature was encountered which resulted in a substantial inflow of water into the MAT. No injuries occurred during the event and the MAT was subsequently fully dewatered and the drill holes were successfully plugged. This event resulted in a modest delay to the underground works however, the Project remains on schedule for first energisation in 2H CY2024, as part of the commissioning works.

5.2 Drilling Program and MAT Re-alignment

Following the water ingress event, Genex and MDJHJV undertook an underground drilling program to further characterise the geological feature which was unexpectedly encountered and to determine the most suitable path forward to progress the MAT works. The drilling results identified a significant zone of high quality but fractured rock in front of the MAT face which was charged with high pressure water. While it was technically feasible to continue to progress the MAT on the current MAT alignment utilising grouting techniques to prevent the water ingress through this zone, Genex and the MDJHJV assessed that this would have a significant impact on tunnelling productivity and therefore the overall costs of the Project. The drilling of the boreholes was undertaken from within the MAT at horizontal or near horizontal inclination. The boreholes were drilled through standpipes that were able to be shut off to contain the water when drilling of each hole was completed – refer to figure 13 for a typical standpipe arrangement. The seal of the standpipe was critical to ensure no leakage and a pressure of 25 bar could be maintained.

> The lesson learnt with the sealing of the standpipe was to initially set the standpipe with either grout or chemical adhesive and then undertake a second installation of grout under pressure. Once the second round of grouting was completed, then 25 bar pressure could be easily achieved. A further lesson learnt related to the standpipe, namely the type of valve which should be utilised to allow shutoff. Both ball type and gate type valves were used. The gate type valve is considered the better valve to use in this type of application as damage to the ball type valve can occur when passing drill rods through it even when it is fully opened. Figure 13 shows a typical gate end valve and standpipe.

Figure 13: Gate Valve on Standpipe

5.1 Re-design of the main access tunnel

In November 2022, the final design of the re-alignment of the MAT was completed. The design includes a new "Y-junction" for the new MAT alignment to extend from the existing MAT excavation, and MAT works formally recommenced in early December 2022. Refer to figure 14 for illustration of the MAT realignment (labelled as MAT2). The newly aligned MAT (MAT2) continues the 60m radius spiral for one more loop before turning back on itself and enters the powerhouse cavern in the same trajectory as the original MAT.

The lesson learnt here was to minimise changes to the MAT design and alignments with respect to the powerhouse cavern to minimise rework and introduction of additional support at the powerhouse interface. This approach also ensured that the original construction adits and configuration to the transformer hall remained essentially unchanged.

To minimise impact on project critical path, an additional construction Adit 5 was introduced to allow access to Adit 3 and, in turn, to provide access to the cable shaft and the two intake shafts. It also provides access to the lower portion of the powerhouse cavern allowing removal of excavated material to be undertaken without waiting on excavation of MAT2 to reach the powerhouse cavern, as this was the original route for excavated material to be removed from the lower sections of the power station cavern during excavation. Adit 5 also provides greater flexibility in managing underground logistics for the eventual cavern civil and fit-out works.

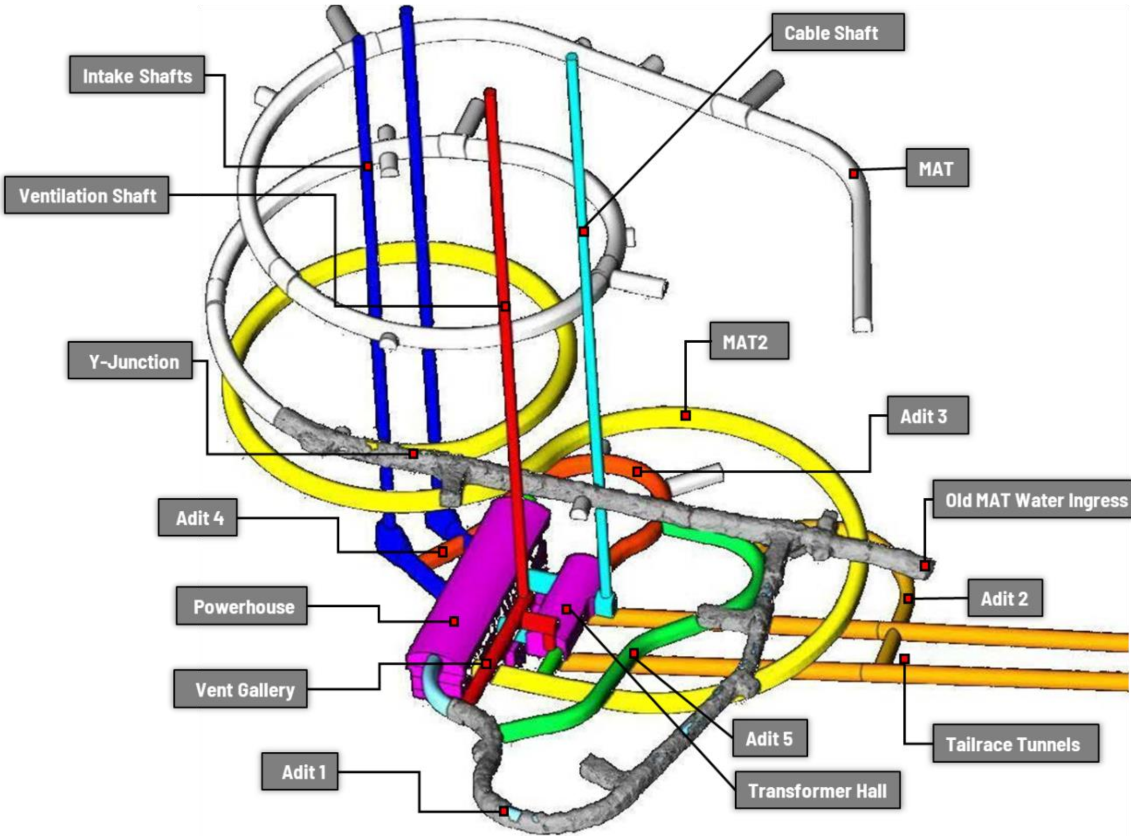


Figure 14: Main Access Tunnel realignment

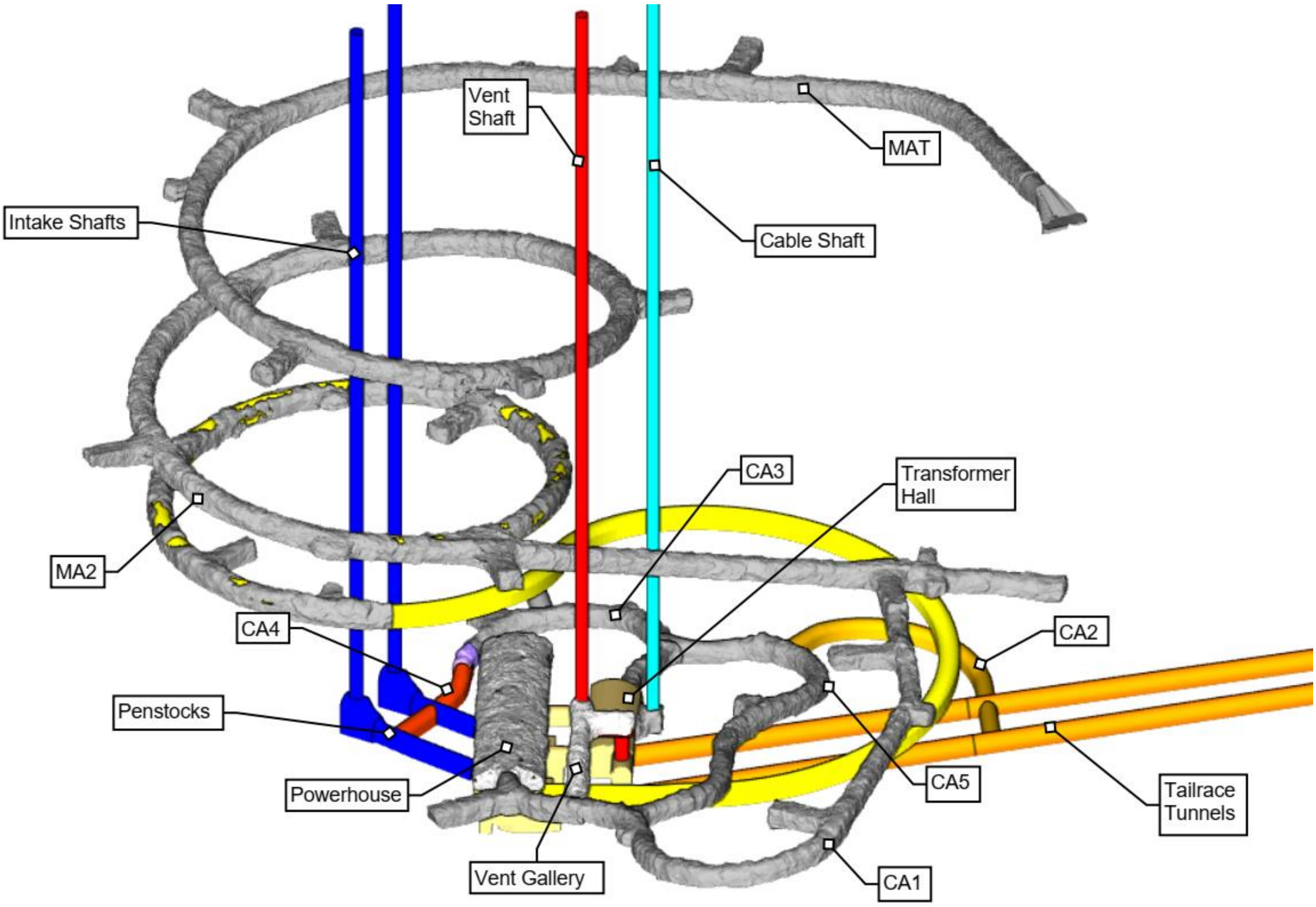
5.2 MAT Progress Update (June 2023)

Since the water ingress event, the progress of the MAT on the new alignment has progressed without incident (ie. MAT2 alignment as identified above in figure 14).

Overall for the Project, other tunnel drives have taken precedence over the MAT, namely CA01 (100% complete); CA05 (100% complete) and CA03 and CA04 (both nearing completion). This allowed access and progress of the powerhouse cavern (which the roof being completed) and the ventilation and cable shafts (both of which are complete).

No further high pressure water ingress has been anticipated. Probing occurs when minor seepage is visible as a precaution. This is undertaken with a bung packer ready to install should high pressure water be encountered.

The as built status of the tunnels is illustrated in figure 15 (as at end of June 2023).



Note: Greyed tunnels are as constructed.

Figure 15: Main Access Tunnel realignment