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

MARCH 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 for the Project, discussing issues focusing on the construction of the Main Access Tunnel (**MAT**) and the recent water ingress event which occurred in September 2022. The primary lessons learnt explored in this report include:

- Initially set the standpipe with either grout or chemical adhesive and then undertake a second installation of grout under pressure;
- The type of valve on the standpipe which should be utilised to allow shutoff;
- Requirement for a holistic assessment as to the impact of the transportation model required to bring in the pumped turbines, transformers and associated equipment down the MAT, and a re-assessment of the risk from both technical, safety and construction logistics perspectives needs to be fully understood.; and
- 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.

2. MAIN ACCESS TUNNEL OVERVIEW

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.

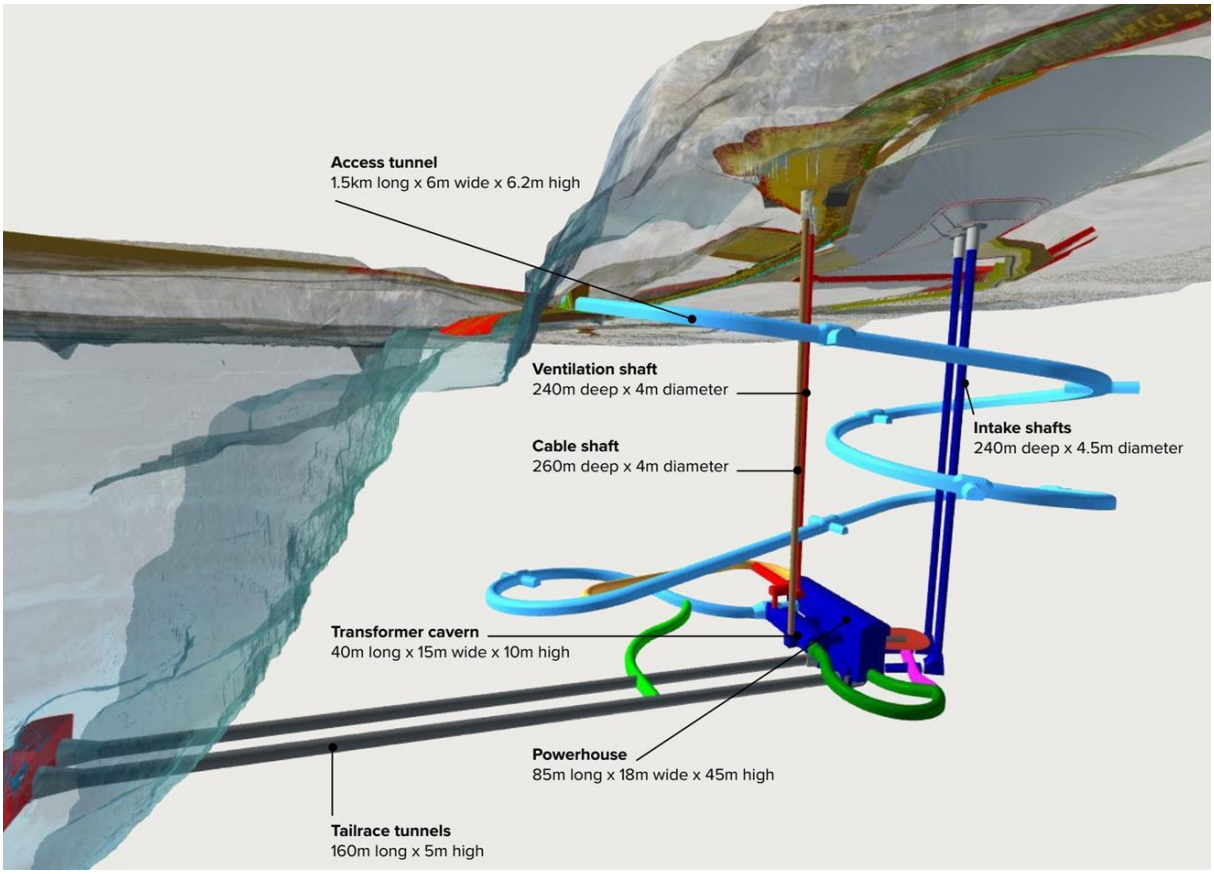

Figure 1: Original MAT design

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.

3. 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.

4. 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. The seal of the standpipe was critical to ensure no leakage and a pressure of 25bar 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 25bar 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 4 shows a typical gate end valve and standpipe.

Figure 2: Gate Valve on Standpipe

4.1 Next steps

Following the results of the underground drilling program, in conjunction with the MDJHJV, Genex considered its options and determined that realignment of the MAT to avoid the high-pressure water zone and continuation within known geology was the most time, cost and risk efficient option. To this end, the MDJHJV and Genex worked towards designing the re-aligned MAT.

In an attempt to minimise the overall length of the realigned MAT, the team challenged initial assumptions and the original basis of the MAT geometry by considering increasing the grade and reducing the tunnel radius. Through the course of these investigations it became increasingly apparent that whilst it might have been technically feasible to tighten these parameters, there would be a significant increase in risk to project timetable and costs and, specifically, significant alternative transportation methodologies would be required to transport the large and heavy machine components down to the cavern.

The key lesson learnt is that, whilst challenging initial assumptions was important in an effort to mitigate the effects of the water ingress event by having the shortest possible MAT route, a holistic assessment needs to be conducted as to the impact of the transportation mode required to bring in the pumped turbines, transformers and associated equipment down the MAT, and a re-assessment of the risk from both technical, safety and construction logistics perspectives needs to be fully understood. As a result, the project's change management process was followed, and to this end, key alignment parameters developed early in the reference design remained unchanged.

5. 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 3 for illustration of the MAT realignment. The newly aligned MAT (MA2) 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 MA2 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.

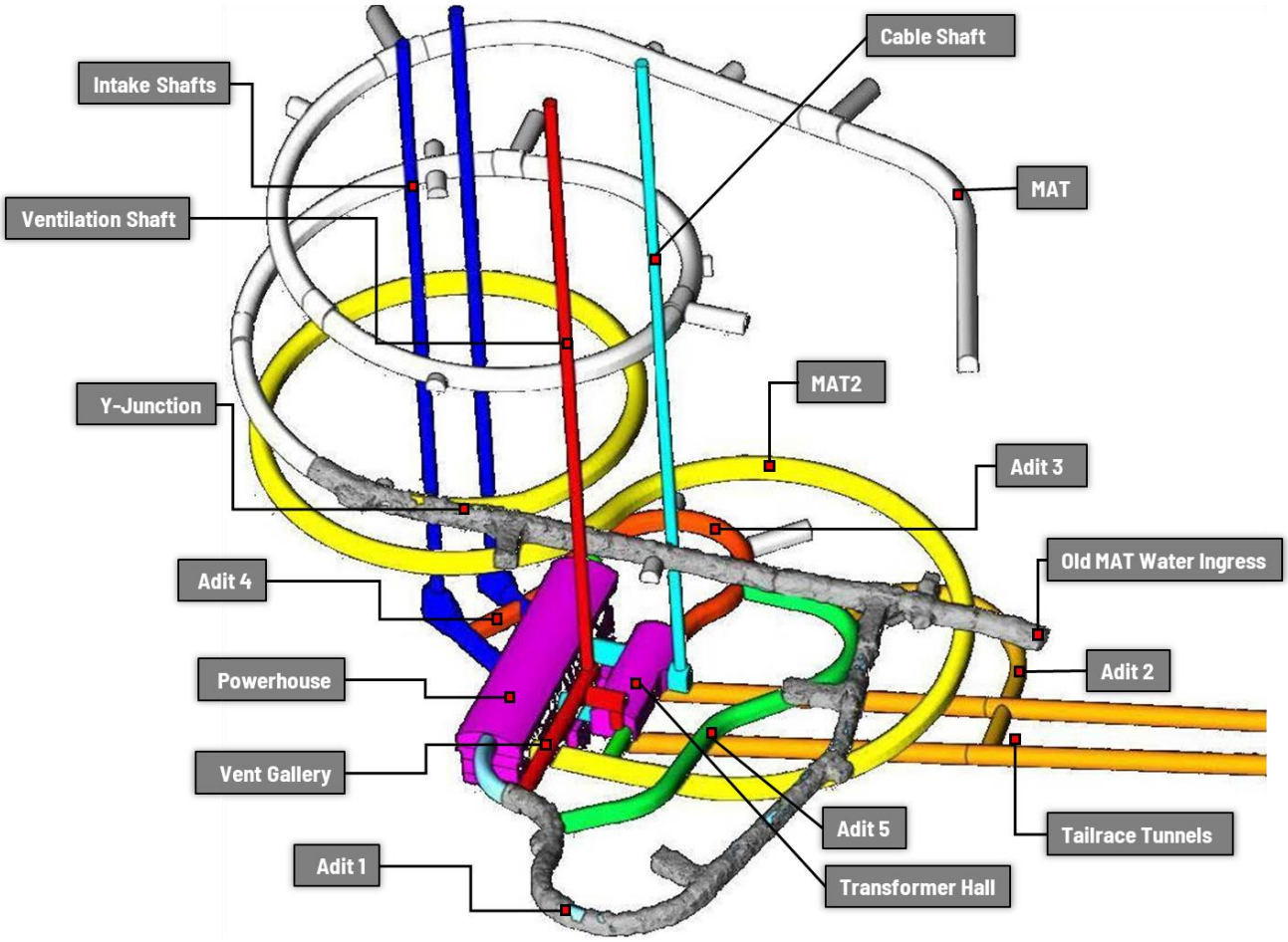

Figure 3: Main Access Tunnel realignment

6. CONCLUSION

To conclude, following the water ingress event that occurred in September 2022, the MAT was redesigned to avoid the high-pressure water zone. No injuries occurred during the water ingress event and the MAT was subsequently fully dewatered and the drill holes were successfully plugged. While the event and the works associated with the re-design of the MAT resulted in a modest delay to the underground works, the Project remains on schedule for first energisation in 2H CY2024, as part of the commissioning works.