FEARNA STORAGE

Fearna Pumped Storage Hydro Scheme - EIA Report

Additional Information

Appendix G – Loch Quoich Temporary Works Proposal

December 2025

Quality Information

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Revision History

Revision	Revision Date	Details	Authorised
01	December 2025	Issue to ECU	Fraser Allison

Contents

1. Introduction

This document provides information pertaining to the proposed temporary works to facilitate the construction of the lower works of the Fearna PSH plant. The lower works allow water to be transferred to and from Loch Quoich from the upper reservoir. These reinforced concrete structures will be fitted with fish and debris screens and isolation gates for maintenance purposes.

This document provides clarification on the current operation of Loch Quoich, the modelling work undertaken to review potential drawdown scenarios and the environmental and operational constraints that have been applied.

The document should be read in conjunction with the EIAR Report, submitted in support of the Section 36 application.

2. Existing Conditions

2.1 Loch Quoich

Loch Quoich is a very large reservoir which was created in the 1950s by damming the Gearr Garry River where it flowed out of Loch Quoich. Two further dams were constructed at the western end of the Loch.

2.1.1 Storage

The storage volume across this range is approximately 360Mm^3. Refer to the storage curve in Figure 2.1 below:

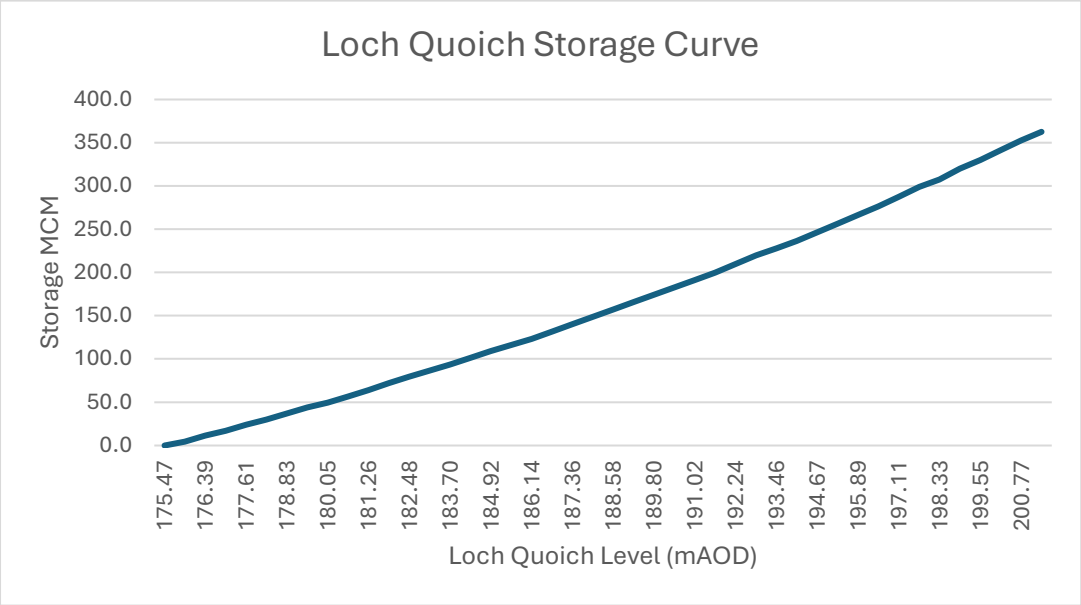

Figure 2.1 Loch Quoich Storage Curve

2.1.2 Operational Range

Loch Quoich was raised from it pre-dammed level of approximately +169mAOD to create an operational range of 26m, between +201.380m (spillway level) and +175.380m (minimum operating level.

2.1.3 Average Level Profile

Loch Quoich is managed on an overarching annual regime, with additional rules applied to maintain environmental compliance and to protect the operation of the Quoich Scheme and the downstream system.

The scale of Loch Quoich combined with the available discharge from the Loch via the hydro turbine and compensation flow creates inter-seasonal storage.

The annual regime generally aims to achieve a high loch level at the end of March each year, thereby providing a reserve of water through the summer season. A low loch target level is applied at the end of September, to allow volume to store the increased flows over the winter period.

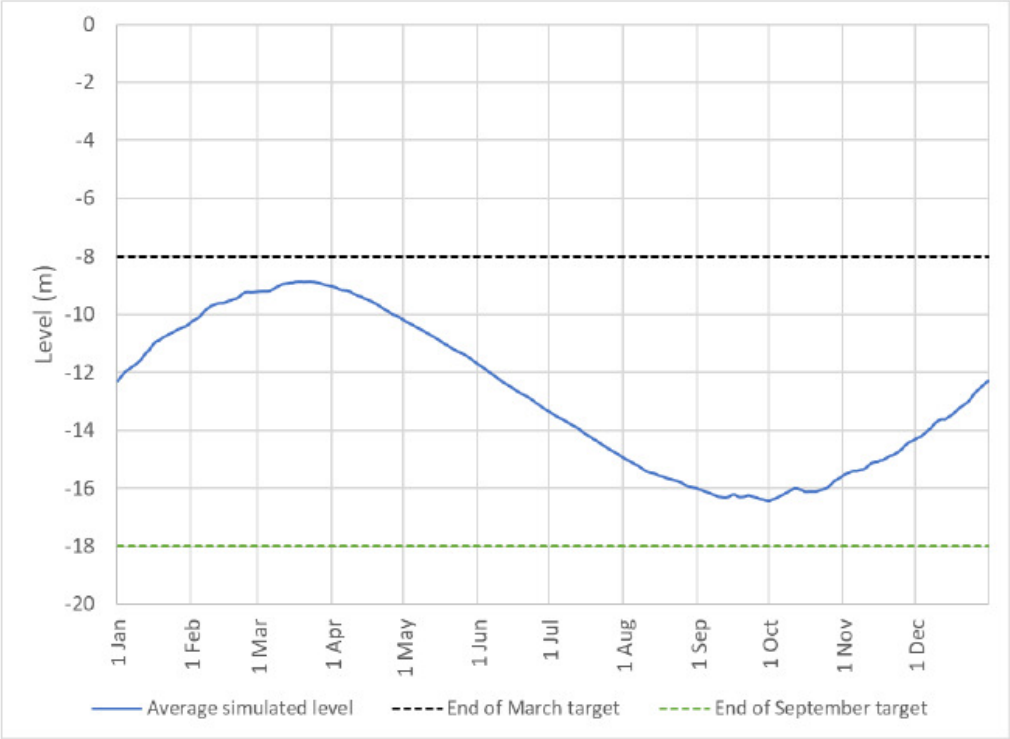

Figure 2.2 - Average Loch Quoich Level (1981 to 2024)

Figure 2.2 shows the average Quoich level profile between 1981 and 2024. Review of the data for individual years does however show significant fluctuation vs the average in some years.

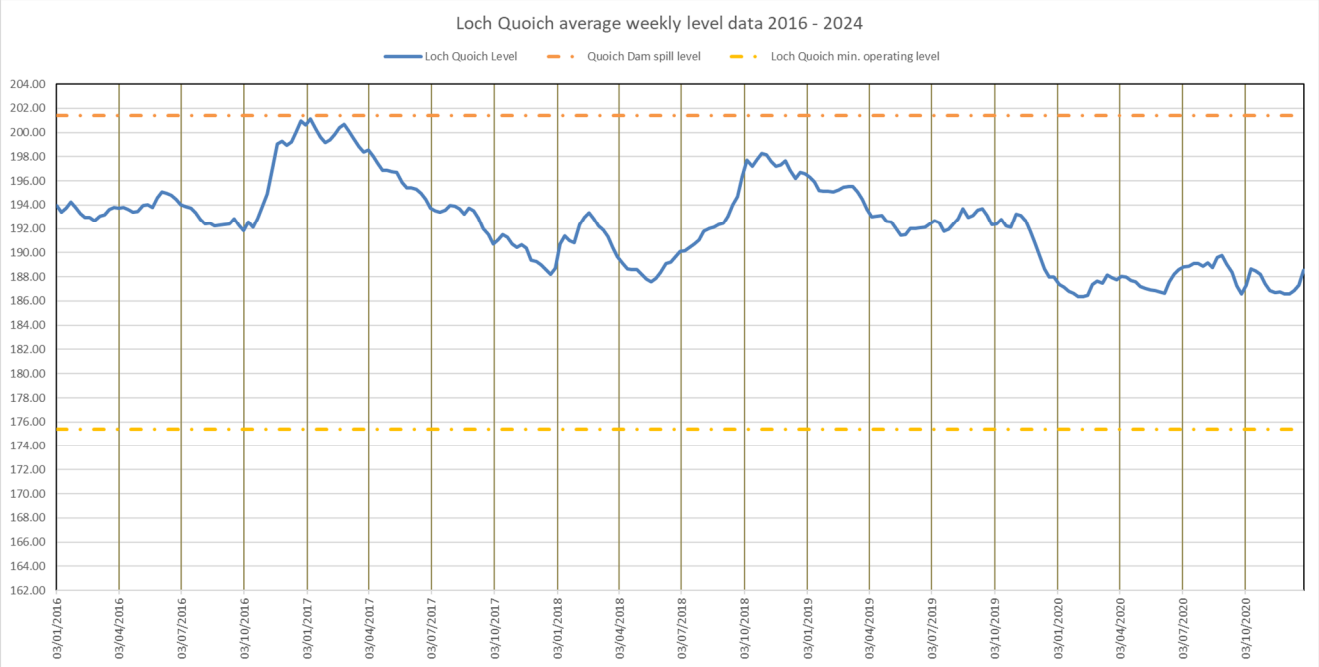

Figure 2.3 Quoich Level 2016-2024

Figure 2.3 shows the variance in Loch Quoich between 2016 and 2024. Fluctuations from the annual regime are influenced by:

- Unseasonable or extreme weather conditions
- Outages either at the hydro stations due to maintenance
- Transmission network outages
- Energy markets

2.1.4 Quoich Dam

Quoich Dam is a Concrete-Faced Rockfill Dam (CFRD) which is approximately 40m high and with the following features:

- Side spillway to the Gearr Garry
- Two culverts through the base of the dam for the purposes of
  - Compensation flow
  - Discharge valve
- Isolation gate tower

The intake to the Quoich hydro tunnel is separate from the Dam and located on the northern shore of Loch Quoich.

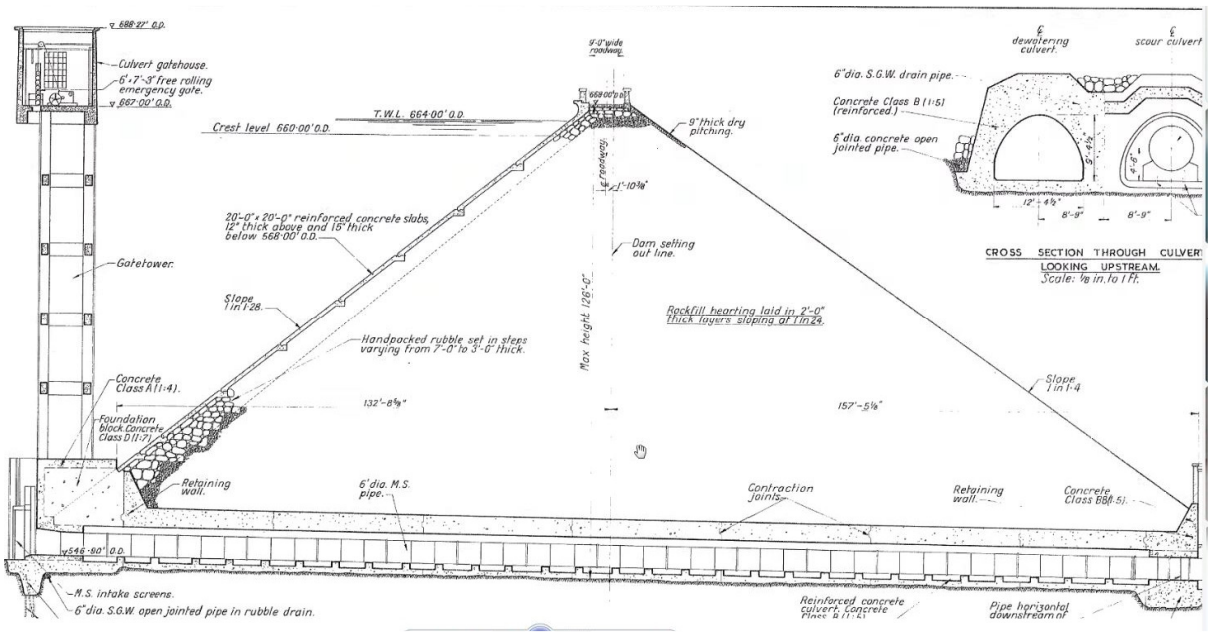

Figure 2.4 – Section through Quoich Dam

2.1.5 Existing CAR Licence

Quoich is covered by the CAR Licence CAR/L/1011471 V2, which covers the Great Glen Cluster of hydro stations.

The Quoich Dam is required to pass 0.09Mm3/day at all times, which is equivalent to 1.04m^3/s.

In addition, Loch Quoich is required to pass a flow equivalent to 5.67m^3/s when Loch Quoich is at very low level i.e below -20m from the dam spillway level (+181.380mAOD) to supplement the Ness catchment. Analysis of the Quoich records shows that this a very infrequent event.

2.1.6 Discharge Capability from Loch Quoich

Loch Quoich has four available means of discharging water, with the following maximum discharges:

- Compensation flow though Quoich Dam – 1.04m^3/s
- Discharge valve – assumed to be maximum – approx 18m^3/s
- Quoich hydro turbine – approx 20m^3/s
- Dam spillway – 283m^3/s (maximum flood)

Spill at Quoich dam is avoided by the management of the loch to prevent this occurrence.

The maximum discharge for the purposes of drawing Loch Quoich down is approximately 39m^3/s, subject to the compensation flow, discharge valve and hydro all in operation.

2.2 The Garry Cascade – Summary of Operations

The Quoich hydro scheme forms the upper scheme in the Garry Cascade, with Loch Garry, the Garry dam and Invergarry Hydro station all located downstream. The two schemes within the Cascade must be managed closely by SSE to maintain environmental and operational compliance. See below for a summary of key points to note:

1. Loch Quoich (360Mm^3) has a much greater storage capacity than Loch Garry (38Mm^3). Quoich cannot therefore discharge if there is insufficient capacity in the downstream Garry system to cope.
2. Further to point 1, there is significant catchment between Quioch Dam, which provides additional flow to Garry dam, further exacerbating the requirement to closely manage the discharge of flow from Quoich Dam.
3. Loch Garry requires to be maintained within a specific range between 10th May and 31st July to support breeding birds. This therefore requires the discharge from Loch Quoich to be controlled, depending on water levels and weather conditions in the downstream catchment.
4. The Gearr Garry, River Garry and Ness catchment downstream of the Garry Dam provides key migratory salmon habitat and initiatives to support the increase of the salmon population such as the Upper Garry Salmon Restoration Project are ongoing.
5. The Garry dam must pass compensation flow of 0.3Mm3/day (summer) and 0.14Mm3/day (winter). Additionally, planned freshet releases are required to simulate the flow that would occur in a natural catchment.
6. Quoich dam spilling would cause the loss of control of the downstream catchment. Spill is avoided via the operational regime applied by the scheme operator, generally by maintaining sufficient storage capacity to hold high volumes of inflow within Loch Quoich at all times.
7. If levels in Loch Quoich and/or Loch Garry reach higher levels, operational rules are applied which allow the controlled discharge of water through the cascade to the downstream catchment.

The operation of the Garry Cascade and the downstream Ness catchment as a whole must therefore be considered during any temporary drawdown of Loch Quoich.

3. Fearna Operational Interface with Loch Quoich

Fearna PSH would use Loch Quoich as the lower reservoir and requires to transfer approximately 41Mm^3 of the total of 360Mm^3 available within Loch Quoich to fill the upper reservoir.

Fearna PSH has developed an Interface Agreement with the operator of the Quoich Hydro scheme, SSE. SSE is also a JV partner in Fearna PSH, which has been beneficial to allow the gathering of accurate hydrological and operational data, understand the various environmental constraints and model these accordingly in the permanent and temporary construction scenarios.

During operation, several key principles apply to the operation of Fearna PSH and its co-location with Loch Quoich and which are captured within the Interface Agreement:

- Compliance with current environmental conditions, such as CAR compliance and downstream constraints remain paramount and will always be maintained
- The operation of Quoich Hydro takes precedence over the presence of Fearna PSH
- Fearna will not cause Loch Quoich to spill (Fearna cannot release water when Loch Quoich is within 5m of Quoich dam spill level)
- Fearna will not cause Loch Quoich to run short of available water for i) CAR compliance or ii) Quoich generation (Fearna cannot abstract water from Loch Quoich when it drops below 20m from Quoich Dam spillway level

The above parameters result in an operational range of 15m for Fearna PSH, within the mid-range of the total Quoich range of 26m. Refer to Figure 3.1 showing the typical section through the powerhouse and the Fearna and Quoich operational ranges.

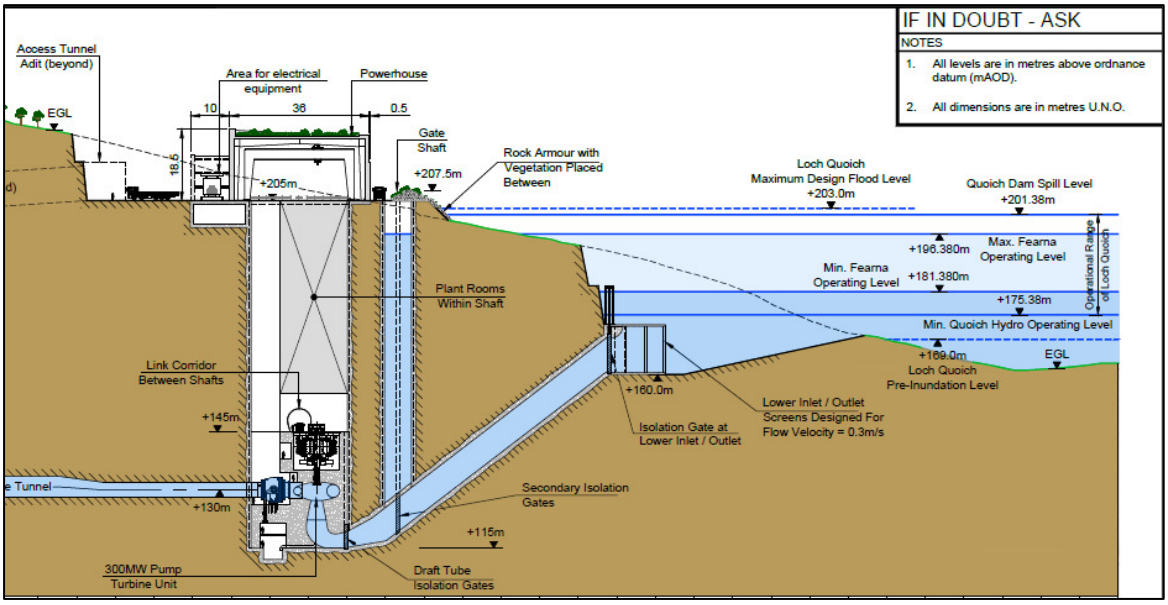

Figure 3.1 – Typical section showing Quoich and Fearna PSH ranges (EIAR Figure 2.13)

4. Construction Interface with Loch Quoich

The main construction interface between Fearna PSH and Loch Quoich is the construction of the lower control works. These structures transfer water to/from the underground waterway system and the pump-turbine units. There are three primary design considerations for these structures as described in sections 4.1 to 4.3. Figure 4.1 shows the lower control structures located within Loch Quoich.

Submergence

With Fearna being a pumped storage hydro plant, the function of the pumps drives the design of the lower works. When the pumps are in operation, the drawing of air into the units must be avoided, therefore the structures require to be located sufficiently below the minimum PSH operating water level for Loch Quoich. This 'submergence' dictates the level that the structures must be sited at.

Design on Plan

The key driver of the size of the lower control structures on plan is the flow approach velocity at the fish and debris screens. This has been set at 0.3m/s, in accordance with SEPA guidelines. The lower control structures therefore require to be sized to accommodate sufficient screen area to achieve the desired velocity.

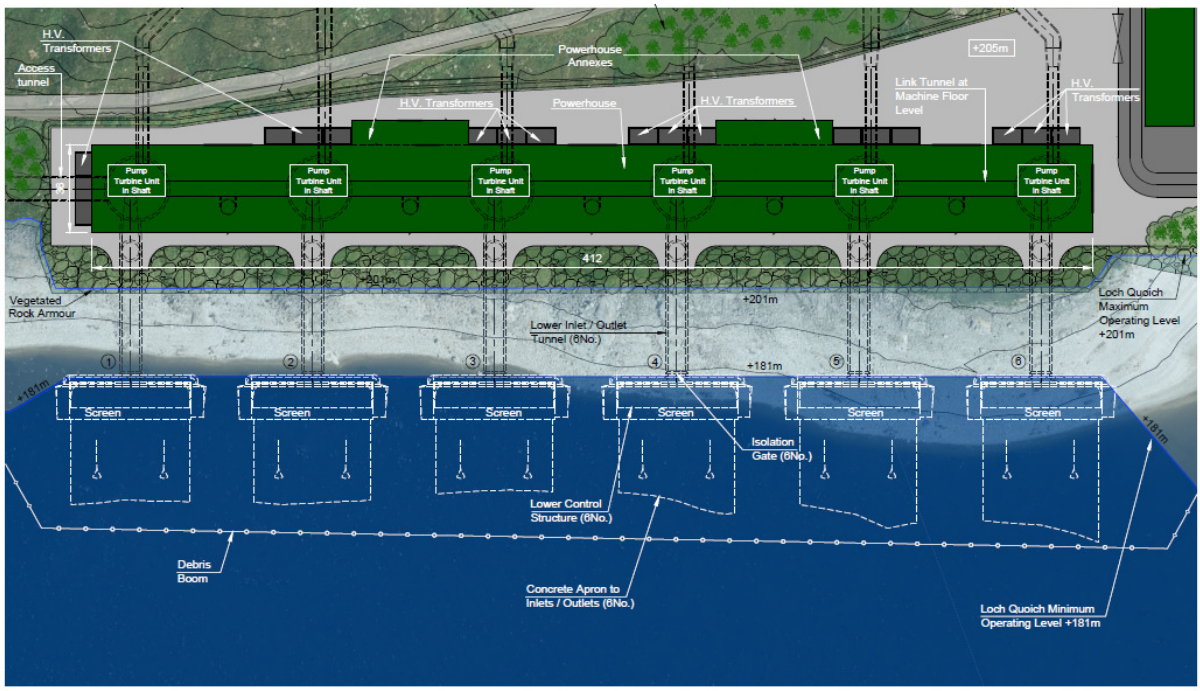

Figure 4.1 – Powerhouse and Lower Control Works Plan (EIAR Figure 2.11)

Hydraulic performance and isolation

The lower control structures require to transfer water whilst maintaining good hydraulic conditions, to prevent turbulence in the system.

Isolation gates require to be provided to prevent water entering the underground system during maintenance. This is typically provided using isolation gates.

4.1 Planning Stage Design Approach

During the Planning Stage Design, the design sought to achieve a balance between minimising the required excavation and any drawdown of Loch Quoich. At this stage, limited geological data was available and the scheme designer, Gilkes Energy Ltd. (GEL), took a conservative approach to retaining rock mass between the main powerhouse shafts and the lower control works excavation. The lower control works were therefore offset a distance of 75m from the pump-turbine unit centrelines into Loch Quoich.

4.2 Loch Quoich Temporary Drawdown

Modelling of the extent to which Loch Quoich can be drawn down and the duration that drawn down levels may be maintained has been ongoing, primarily to better inform the design and the CAR application process. The modelling work has incorporated the following:

1. The hydrology of Loch Quich and the Garry Cascade
2. Compliance with the Ness CAR Licence CAR/L/1011471 V2 at all times
3. Nesting bird constraints in Loch Garry, namely Common Scoter
4. Discussions with Ness District Salmon Fisheries Board re. angling conditions in the downstream system
5. Available drawdown discharge through the Quoich Dam (except the use of the spillway)
6. Operational regime of Quoich and Invergarry Hydros
7. Avoidance of spill at Quoich and Garry Dams

4.2.1 Modelling Results

The drawdown modelling by Mott Macdonald Ltd. completed in June 2025 provides useful data on the potential to draw down loch Quoich and maintain low levels during the summer months.

The results are summarised in table 4.1.

Drawdown period	Drawdown option				Target level				
	Max generation from 1 May	Dispersal valve when levels >-8m	Dispersal valve from 1 May	Stop indirect catchment inflows	177.5mAOD	180mAOD	185mAOD	190mAOD	195mAOD
July – Sept (3 months)	✓	×	×	×	9%	18%	73%	95%	100%
	✓	✓	×	×	9%	18%	86%*	100%	100%
	✓	×	✓	×	43%	84%*	100%	100%	100%
	✓	✓	✓	×	50%	93%*	100%	100%	100%
	✓	✓	✓	✓	50%	95%*	100%	100%	100%
June – Sept (4 months)	✓	×	×	×	0%	0%	20%	82%	100%
	✓	✓	×	×	0%	0%	20%	98%	100%
	✓	×	✓	×	7%	16%	64%	95%	100%
	✓	✓	✓	×	7%	16%	80%	100%	100%
	✓	✓	✓	✓	7%	18%	82%	100%	100%

Drawdown period achieved in all 44 years (1981-2024) of the model simulation
Drawdown period achieved in more than 90% of years in the model simulation (≥ 1 in 10 years)
Drawdown period achieved in 80%-90% of years in the model simulation (≥ 1 in 5 years)
Drawdown period achieved in less than 80% of years in the model simulation

* Indicates years where simulation indicates a risk of drawdown being achieved by the start of July but levels increasing above target in September

Table 4.1 – Quoich Drawdown Modelling Summary

The results show that the drawing down of Loch Quoich below a level of +195m using the available means of discharge cannot be guaranteed, which introduces risk to the project. The analysis also assumes that the 'Max Generation' option assumes that the Quoich Hydro turbine would be in operation 24/7 through the drawdown period, which cannot be guaranteed.

+195mAOD represents a relatively high level within Loch Quoich which is typically not breached during the summer months and based on analysis of the Quoich level data from 2016-2024, would not be breached in a dry winter.

Based on the above, it is proposed that Loch Quoich is not drawn down for the purposes of the lower control works construction and a temporary cofferdam solution could be provided instead.

The design of the cofferdam would be developed by the appointed contractor, however at this stage GEL proposes that it would have a crest level of a minimum of +198m. The contractor should also provide appropriate mitigation measures in their design and construction operation to address the potential for high loch levels to impact the works. Measures may include:

- Cofferdam sufficiently high to cover all flood scenarios
- Staging of the works
- Planning of the works to allow inundation during the winter months
- Alternative design or construction methodologies which avoid the requirement to draw down Loch Quoich

4.3 Design Development

The project has moved into the Reference Design phase, with the lower control works design and potential construction methodology being developed in further detail.

In order to reduce the required level and duration of the temporary drawdown of Loch Quoich, it is proposed to move the lower control works structures have been moved further up the shoreline.

This would allow the civil contractor to carry out the excavations for the structures whilst using the existing shoreline rock to isolate the works from Loch Quoich, with an additional temporary cofferdam placed above, allowing Loch Quoich to operate as normal. The temporary cofferdam would likely be constructed from rock material excavated from the adjacent powerhouse site immediately adjacent.

The cofferdams would be removed towards the end of the works. This may be carried out when Loch Quoich is already low to maximise the amount of excavation that could be done on-shore. The remaining rock beneath the surface would require to be removed by underwater techniques. The rock material would be used to create the switchyard area within the disused quarry immediately adjacent.

It is typical for the civil engineering contractor to design the temporary works and methodology required for construction. GEL has however developed indicative designs for information, as shown figure 4.2, showing a cofferdam to +198mAOD.

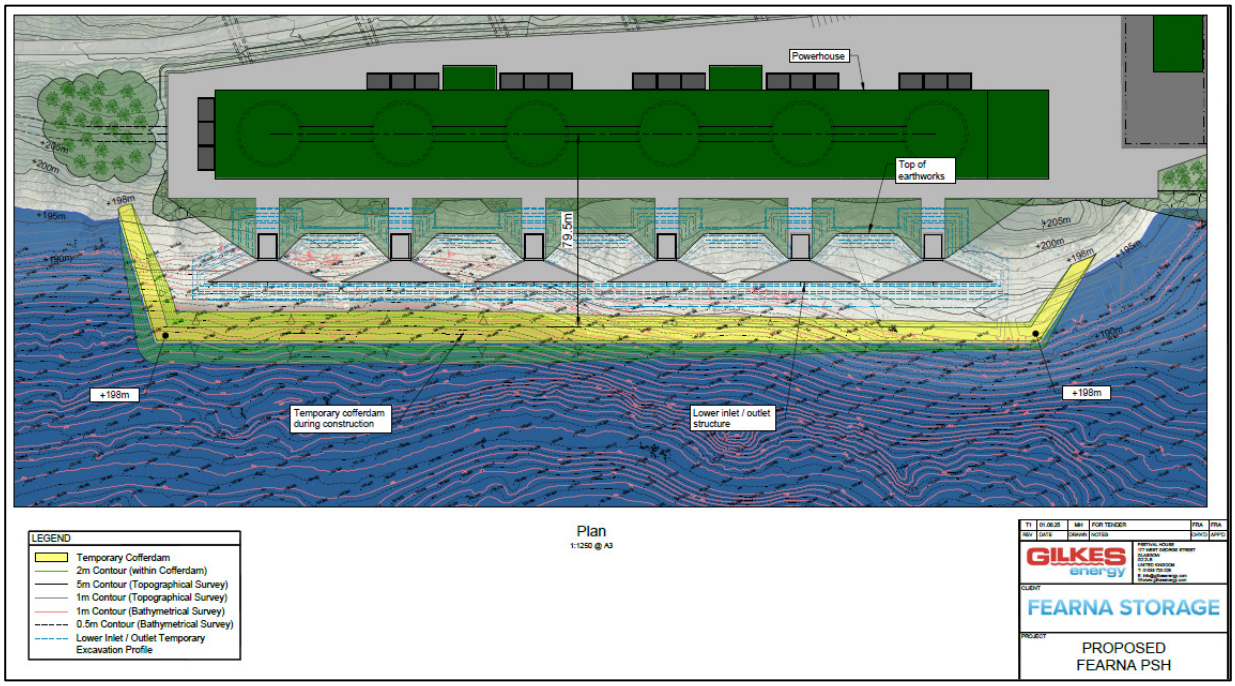

Figure 4.2 – Powerhouse and Lower Control Works Plan showing Cofferdam

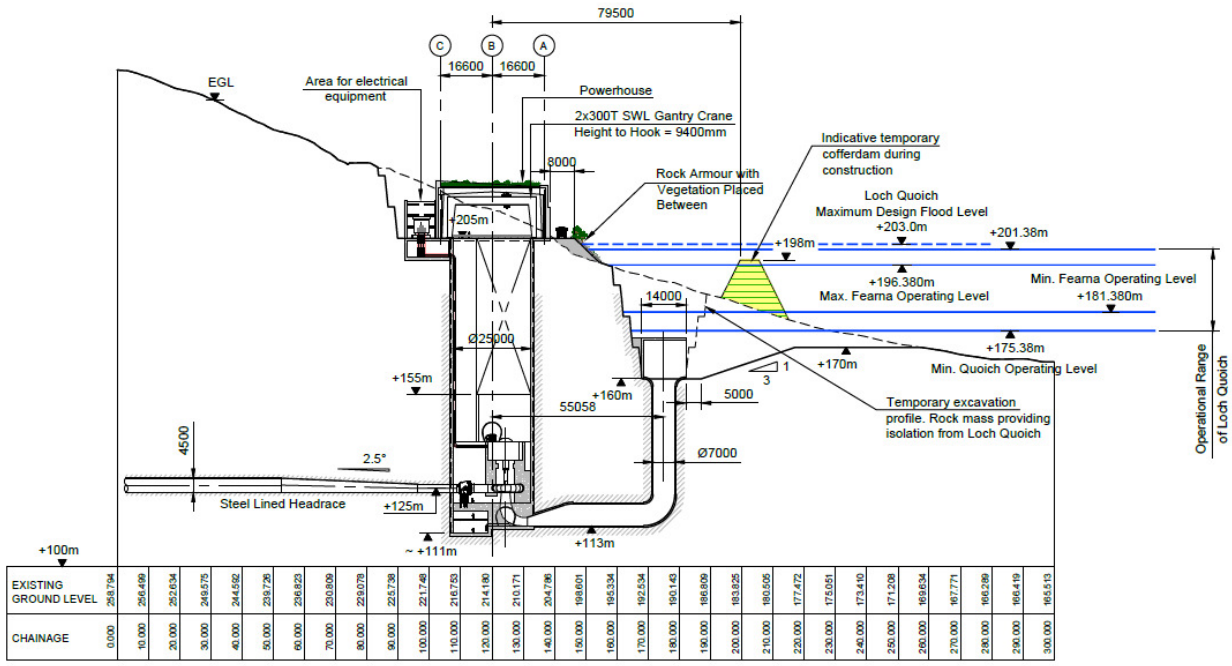

Figure 4.3 – Section through Powerhouse and Lower Control works showing Cofferdam

4.4 Alternative Designs

The proposed cofferdam solution is deemed to be robust and relatively conservative at this stage of the project. It should however be noted that civil works contractors may provide alternative design proposals during the tender and detailed design stages, which may require less excavation and temporary works.

Lake Taps, for instance, require potentially less excavation and temporary works. This solution would require further geotechnical investigations to be carried out, so in the meantime remains an option which may be analysed when more data is available. Other techniques may also be considered.

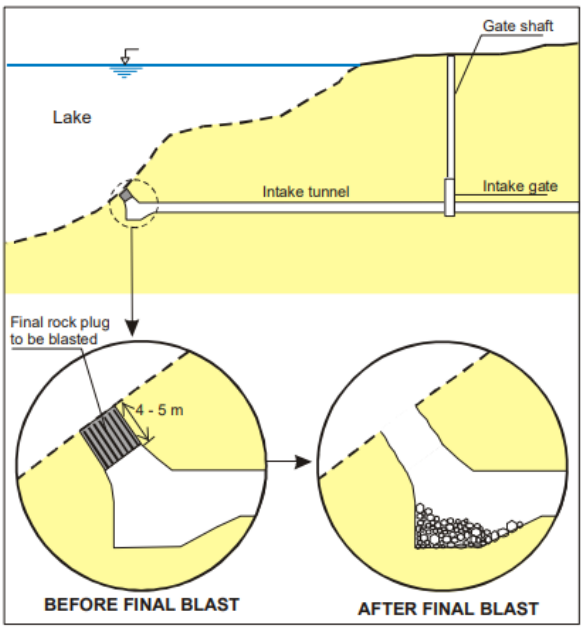

Figure 4.4 – Lake Tap (www.rockmass.net)

5. Conclusion

This document has described to operational and construction interface between the proposed Fearna PSH scheme and the existing operational reservoir Loch Quoich.

Analysis of the potential temporary drawdown on Loch Quoich during the summer months whilst also achieving compliance with the various environmental and operational constraints is challenging and cannot be guaranteed. The Fearna lower control works design has therefore adopted a temporary cofferdam solution, which provides robust isolation between Loch Quoich and the lower control works. The lower control works have been moved further up the shoreline to use the natural topography and rock conditions to minimise the temporary works requirements.

Whilst this is a robust solution, there is scope to further optimise the design and potentially minimise the required temporary works in later stages in the project.