EARBA STORAGE

A GILKES ENERGY COMPANY

Earba Pumped Storage Hydro Scheme

EIA Report

Appendix 2.4: Mass Balance Strategy and Borrow Pit Plan

February 2024

Quality Information

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Revision History

Revision	Revision Date	Details	Authorised
01	February 2024	Issue to ECU	Gavin McGill

Contents

Executive Summary

This document provides information on the volumes of earthworks materials generated by construction of all of the elements of the Proposed Development including borrow pits, and the subsequent management and use of all materials within the site to avoid the need for disposal off-site.

The Proposed Development would operate by transferring water between a lower reservoir, (Loch Earba) and an upper reservoir (Loch Leamhain). The maximum water level of these existing lochs would be raised by constructing dams to increase their natural storage capacity. The reservoirs would be connected by an underground waterway system including up to three headrace tunnels.

The gravity dams and underground works would involve large volumes of earthworks and so this Earthworks Mass Balance and Borrow Pit Plan has been designed for the Proposed Development which would maximise the use of materials generated from within the site for use in the construction of the permanent works; and put any surplus materials to beneficial use within the site in the form of reinstatement and restoration of habitat areas.

This would minimise the environmental impact of the Proposed Development by avoiding the need to transport bulk materials to the site wherever possible and by minimising the generation of any waste material that would need to be taken off site for disposal.

Further, it would be very important to minimise the haulage of bulk materials across the site, which would be relatively expensive and less environmentally sustainable. In order to achieve this, the intention would be that there would be a material balance strategy achieved locally and separately in each of the lower Earba reservoir and upper Leamhain reservoir areas.

The dam elements for the lower Earba reservoir would be the main recipients of all of the excavated materials from the underground works and would be built to shallow gradients with engineered embankment fills which could tolerate a relatively broad grading curve. This means that these fills could include a range of sands, gravel and rock fill of various particle sizes, including a proportion of fine-grained materials. The total volume of materials estimated to be generated and re-used in the lower Earba area is in the order of 3.34Mm3 including 0.5Mm3 of surplus spoil. The spoil would be put to beneficial use within the site in the form of general fill within the landscaped promontories, reinstatement of borrow pits and creation of habitat areas close to the works, thus achieving a mass balance of earthworks in the lower area.

In the upper Leamhain reservoir area, up to 7Mm3 of rock fill materials would be required for the dam construction, which would be sourced from local borrow pits in the Leamhain reservoir, close to the dam. An estimated 1.1Mm3 of unsuitable engineering fill – rock spoil - would be used to backfill the borrow pits, with the top level of the fill being below the lowest water level of the reservoir. In addition, 1.3Mm3 of sand and gravel superficial materials would be processed from the borrow pit and dam foundation areas and used locally to form site compounds and working areas within the Leamhain reservoir, also below the lowest operating water level of the reservoir. A mass balance of earthworks materials in the upper area would also be achieved within the reservoir footprint.

1. Scoping Responses

1.1.1 The following Scoping Responses were received from SEPA and NatureScot, and are addressed by the contents of this document.

SEPA	In relation to section 8 of the attached appendix (borrow pits, see 92 below) and rock and overburden excavation generally as outlined in section 13 and elsewhere in scoping report: The applications should include a spoil management plan outlining the mass balance strategy. This should include information in relation to the type and volumes of material that will be excavated on site accompanied by clear information on temporary storage (which is likely to require an extensive area), reuse on site and use or disposal elsewhere. Any material that cannot be appropriately used within the site works will be considered waste and waste management legislation would apply; In view of the extensive volume of excavated material being produced we do not expect the development to include additional borrow pits unless it is subsequently demonstrated that there is a need for additional material; The information requirements outlined in section 8.1 of the appendix should be provided insofar as they are relevant to the excavation works proposed.
SEPA	8.1 In accordance with Paragraphs 52 to 57 of Planning Advice Note 50 Controlling the Environmental Effects of Surface Mineral Workings (PAN 50) a Site Management Plan should be submitted in support of any application. The following information should also be submitted for each borrow pit: a) A map showing the location, size, depths and dimensions; b) A map showing any stocks of rock, overburden, soils and temporary and permanent infrastructure including tracks, buildings, oil storage, pipes and drainage, overlain with all lochs and watercourses to a distance of 250 metres. You need to demonstrate that a site specific proportionate buffer can be achieved. On this map, a site-specific buffer must be drawn around each loch or watercourse proportionate to the depth of excavations. If this minimum buffer cannot be achieved each breach must be numbered on a plan with an associated photograph of the location, dimensions of the loch or watercourse, drawings of what is proposed in terms of engineering works; c) You need to provide a justification for the proposed location of borrow pits and evidence of the suitability of the material to be excavated for the proposed use, including any risk of pollution caused by degradation of the rock; d) A ground investigation report giving existing seasonally highest water table including sections showing the maximum area, depth and profile of working in relation to the water table; e) A site map showing where soils and overburden will be stored including details of the heights and dimensions of each store, how long the material

	will be stored for and how soils will be kept fit for restoration purposes. Where the development will result in the disturbance of peat or other carbon rich soils then the submission must also include a detailed map of peat depths (this must be to full depth and follow the survey requirement of the Scottish Government's Guidance on Developments on Peatland - Peatland Survey (2017)) with all the built elements and excavation areas overlain so it can clearly be seen how the development minimises disturbance of peat and the consequential release of CO2; f) Sections and plans detailing how restoration will be progressed including the phasing, profiles, depths and types of material to be used.
NatureScot	In section 3.6.1, it is stated that: '*It is proposed to use the rock and other materials generated from excavation of the tunnels, powerhouse and dam foundations in the construction of the dams, so that no excavated material would require to be transported off site'.* We know from other schemes of this nature that the material excavated from works is often not suitable for re-use. Therefore we agree with SEPA's request, in their response dated 13 March, that the applicant provide a spoil management plan. We welcome that a Construction Method Plan will be included in the final report.

2. Introduction

2.1.1 This outline Mass Balance Strategy and Borrow Pit Plan has been designed for the Proposed Development, which would maximise the use of earthworks materials generated from within the site for use in the construction of the permanent works to avoid the need for disposal of earthworks materials off-site.

2.1.2 The layout of the Proposed Development, including the infrastructure and proposed borrow pits, site compounds and working areas is shown in **Figure 2.2 – Scheme Arrangement**. Within this document borrow pits are referred to as BP1, BP2, BP3 etc. and site compounds as SC1, SC2, SC3 etc.

2.1.3 It is proposed that almost all of the rock, sands and gravels generated from excavation of the tunnels, powerhouse and dam foundations will be processed, screened and selected to be suitable in the construction of the dams, with the spoil balance used as fill within the local landscaping and reinstatement works. These would be supplemented by borrow pits located within the reservoir inundation areas and adjacent to the dams where possible.

2.1.4 The dam elements for the lower Earba Reservoir would be the main recipients of all of the excavated materials and would be built with shallow engineered embankments which could tolerate fill material with a relatively broad grading curve. This fill would include sands, gravel and rock fill of various particle sizes, including some fine-grained materials.

2.1.5 Any surplus fine-grained materials generated from construction of the permanent works which may be unsuitable as engineered fill, would be put to beneficial use within the site in the form of general fill within the body of the landscaped promontories. These promontories would be planted and would provide valuable visual enhancement to the lower reservoir and maintain similar to the existing views along the Earba glen.

2.1.6 This local material balance would minimise the environmental impact of the Proposed Development by avoiding the need to transport bulk materials to the site wherever possible and by minimising the generation of any waste material that would need to be taken off site for disposal.

2.1.7 Further, it would be very important to minimise the haulage of bulk materials across the site, which would be relatively expensive and less environmentally sustainable. In order to achieve this, the intention would be that there would be a material balance achieved separately in each of the lower Earba reservoir and upper Leamhain reservoir areas.

2.1.8 This means that the fill requirements for the powerhouse and dams in the lower Earba area would be balanced with the excavation of the powerhouse and all of the underground works, since it is currently assumed that all of the rock arisings from the underground works would be taken out via the lower tunnel network near the powerhouse.

2.1.9 Similarly, all of the rock fill materials required for the dam construction in the upper Leamhain reservoir area would be sourced from local borrow pits in the Leamhain reservoir, close to the dam.

2.1.10 In the lower Earba area, unsuitable engineering fill materials would be used for bulk fill in landscaping around the Earba Reservoir and to backfill the borrow pits below the lowest operating water level of the reservoir.

2.1.11 In the upper Leamhain area, unsuitable engineering fill materials would be used to backfill the borrow pits below the lowest water level of the reservoir.

2.1.12 Following development of the scheme sizing and initial engineering design calculations, the sizing and volumes of the main reservoir and waterways elements of the scheme have been defined in order to estimate the bulk material requirements.

2.1.13 In addition, preliminary geological studies, some site investigations and material sampling have been carried out in key areas to estimate the in-situ material parameters for the rock and for the superficial sands and gravels in the works footprint.

2.1.14 Using the data from these studies, a preliminary mass balance of bulk earthworks materials including unsuitable spoil materials has then been calculated. This has been carried out separately for the lower Earba and upper Leamhain areas - as described below.

2.1.15 For the superficial deposits in all areas, the proportions of cobbles, gravel, sand and fines have been assessed based on particle size distribution curves obtained from sampling and material testing. These tests were performed during a programme of preliminary trial pitting and borehole investigations, carried out in summer 2023. These indicated a range of gravel proportions of 30-50%, sand between 30-55% and fines of between 10-20%.

2.1.16 For the excavated rock from the underground works using drill and blast methods, useable rock material has been assessed as 90%, with 10% spoil. Similar proportions have been used for the rock in borrow pits below the weathered zones.

2.1.17 A typical bulking factor of 1.6 has been taken for the excavated rock and a re-compaction factor of 1/1.2 for roller compacted fill material, giving an overall bulking and re-compaction factor of 1.33 for re-used rockfills. This will vary in practice, with sufficient available space in the rock borrow pits BP5A and BP5B at Leamhain Dam, to allow adjustment of the depth and the volume excavated to suit the final rock requirements.

2.1.18 Topsoil up to 0.5m in depth in all areas would be carefully stockpiled and re-used for landscaping and finishing of the tracks, the construction compounds, the dams and powerhouse area. This is discussed further in **Appendix 12.2 - Peat Management Plan**.

2.1.19 Peat depths greater than 0.5m depth would only be encountered in the vicinity of Shuas and Leamhain Dam areas and borrow pit BP5A, plus some short sections of the access tracks, (which could be floated across). Peat would be removed and stored locally at site compounds SC2 and SC8 prior to re-use, The majority of this peat would be used for landscaping and local peatland reinstatement in the Shuas, Leamhain and Pitridh peatland areas, with the balance used for peatland reinstatement across the estate as part of the habitat and peatland improvements. This is discussed further in **Appendix 12.2 - Peat Management Plan**.

3. Overall Balance of Material in Lower Area

3.1 Material Sources in Lower Earba Reservoir Area:

3.1.1 The estimated volumes of material which would be sourced from the various elements of the works in the Lower Earba area are summarised in **Table 3.1 - Volumes of Material Sources in Lower Earba Area** on page 9 below.

3.1.2 It is expected that the majority of the required bulk earthworks materials required for the dams and landscaping in the lower Earba area would be generated from the powerhouse cutting and underground works.

3.1.3 However, the initial access and construction works in the lower area would require sand and gravel material in advance from a small number of borrow pits in order to create aggregates, tracks and working compounds as well as allowing initial dam works to commence early. This would minimise the requirement to import graded stone for tracks as far as possible.

Initial Borrow Pits

3.1.4 Borrow pit BP1 near the site entrance at Moy would be excavated to a depth of approximately 3-4 m and yield approximately 60,000m3 for the main access tracks to the site. BP1 would subsequently become the site entrance compound SC1, set low into the borrow pit for noise and visual screening.

3.1.5 Borrow pit BP2 to the north-east of the powerhouse area was initially considered as a possible rock borrow pit for concrete aggregates close to the powerhouse, but was found to be overlain by peat depths greater than 0.5m. In addition, preliminary site investigations indicated that the rock levels at the powerhouse cutting towards the north end are expected to be higher than early estimates. And so BP2 was deleted from the proposed works and rock aggregates would be sourced from the powerhouse cutting and underground works as described below.

3.1.6 BP3 in the lower Earba middle area between the Earba Lochs would yield up to around 135,000m3 of sand and gravels. BP3 would also be reinstated with surplus spoil material in the lower area, which was not used in the promontories and associated reinstatement works.

3.1.7 BP4 at Shios Dam would yield around 72,000m3 of rock, plus around 40,000m3 of sand and gravel, mainly for use as aggregates in the Shios Dam construction.

Powerhouse Excavations

3.1.8 Based on the planned powerhouse cutting profile shown in **Figure 2.19 – Powerhouse Typical Cross Section** as well as ground investigations carried out in summer 2023, it is estimated that in the order of 300,000m3 of rock, as well as 700,000m3 of sand and gravel aggregates would be sourced from the powerhouse cutting and lower control works excavations.

Spoil from Surface Excavations

3.1.9 Spoil from the screening of superficial materials based on percentages of fines from initial particle size distribution testing, are estimated at around 250,000m3.

3.1.10 Rock spoil from the powerhouse cutting and BP 4 would be in the order of 40,000m3.

Underground Works

3.1.11 Approximately 1,547,000m3 of rock would be won from the excavation of the underground powerhouse shafts and waterway tunnel systems, with tunnel and shaft excavation spoil in the order of 214,000m3.

3.1.12 This would give an overall volume of rock spoil in the order of 250,000m3.

Lower Area Material Sources – Summary

3.1.13 In summary, in the lower Earba area, approximately 2.85Mm3 of selected sand, gravel and rockfill material would be sourced from the permanent works plus the supplementary borrow pits, with remaining spoil volume of approximately 0.5Mm3 being used for filling the promontories and reinstatement of the borrow pits.

3.1.14 The **Table 3.1 - Volumes of Material Sources in Lower Earba Area** below summarises the breakdown of earthworks material sources in the Lower Earba Area.

Table 3.1 - Volumes of Material Sources in Lower Earba Area (m3)

		Superficial Materials			Rock	(Bulking & re compaction Factor = 1.6/1.2)			
		Cobbles and Gravel	Sand	Spoil	Rock	1.33			
Material Sources in Lower Earba Area (Excavation)		**Volume of Cobbles and Gravel m3**	**Volume of Sand m3**	**Volume of Spoil m3**	**In situ Volume m3**	**Bulked then re-compacted Volume m3**	**Useable factor**	**Useable Rock m3**	**Rock Spoil m3**
Borrow Pit 1 at Compound SC1 at A86		31,050	31,050	6,900	-	-		-	
Borrow Pit 3 - Earba Middle Borrow Pit		73,500	61,500	15,000	-	-		-	
Borrow Pit 4 - Shios Dam West		22,050	18,450	4,500	60,000	80,000	90%	72,000	8,000
Permanent Powerhouse and Lower Control Works - Excavation		263,900	427,700	218,400	245,700	327,600	90%	294,840	32,760
Underground Workings		-	-	-	-	-		-	-
Access Tunnels		-	-	-	95,550	127,400	90%	114,660	114,660
Powerhouse Shafts		-	-	-	225,000	300,000	90%	270,000	30,000
Headrace Tunnels		-	-	-	755,250	1,007,000	90%	906,300	100,700
Surge Shafts		-	-	-	144,000	192,000	70%	134,400	57,600
Tailrace tunnels		-	-	-	72,000	96,000	90%	86,400	9,600
Gate Shafts		-	-	-	30,000	40,000	90%	36,000	4,000
Total Dig for Lower Area m3		**390,500**	**538,700**	**244,800**	**1,627,500**	**2,170,000**	-	**1,914,600**	**255,400**
Gravel and Rock (m3)	**2,305,100**	**390,500**	-	-	-	-	-	**1,914,600**	-
Sand (m3)	**538,700**	-	**538,700**	-	-	-	-	-	-
Total re-useable in Lower Area (m3)	**2,843,800**	-	-	-	-	-	-	-	-
Total Spoil in Lower Area available for landscaping (m3)	**500,200**	-	-	**244,800**	-	-	-	-	**255,400**
TOTAL Material Produced in Lower Earba Area (m3)	**3,344,000**								

3.2 Material Required in Lower Earba Reservoir Area:

3.2.1 The following sections describe the approximate volumes of required earthworks materials within the site, as summarised in **Table 3.2 – Material Used in the Earba Area** below.

Access Tracks and Site Compounds

3.2.2 Around 152,000m3 of selected sands and gravels would be required for the construction of access tracks and site compounds, which would be sourced from BP1, BP3, BP4 and the powerhouse area cuttings described above.

Dams and Reservoir Landscaping

3.2.3 Selected rock, sand and gravel fill materials would be sourced from the powerhouse cutting and underground works, with some additional material from BP3 and BP4, for construction of the:

- Shuas Dam = 1,436,000m3;
- Shios Dam = 717,000m3;
- Promontory areas in the centre of the Earba Reservoir to re-create the landscape impression given by the existing separation between the two Earba Lochs. = 122,000m3.

Concrete Aggregates

3.2.4 Concrete aggregates for the site manufacture of concrete would be screened from excavated rock or from on-site sources of sand and gravel at BP1, BP3, BP4, and from the excavation of superficial sands and gravels at the dams and powerhouse. This would include:

- 252,000m3 coarse aggregate (gravel from 4-20mm size) and
- 123,000m3 fine aggregate (sand 0-4mm size).

Cement for concrete would be imported.

Spoil Materials

3.2.5 The balance of spoil / bulk fill material produced, once the engineering materials have been selected would be used for bulk filling within the promontories, with the engineered fill used around the perimeters to contain and cap the general fill. A volume of approximately 400,000m3 of spoil material would be used as general infill within the promontories. In addition, the remaining balance of around 100,000m3 or so of spoil being used to backfill the borrow Pits BP3 and BP4, so in total the volume of spoil used would be = 500,000m3.

Table 3.2 – Material Used in the Earba Area (m3)

Material Required in the Lower Earba Area (Fill)		Volume of Stone (m3)	Volume of Sand (m3)	Spoil Used (m3)	Selected Fill Used (m3)	Spoil Used (m3)
Access Tracks						
from SC1 to SC2 and Powerhouse	6km	19,200	4,800	-	24,000	-
from Powerhouse to Leamhain	7km	15,680	3,920	-	19,600	-
from Powerhouse to Shios	6km	15,360	3,840	-	19,200	-
Other Tracks nominally 6m wide	10km	19,200	4,800	-	24,000	-
Preparation and Reinstatement of Site Compounds		-	-	-	-	-
SC 1, 2		12,800	3,200	-	16,000	-
SC3, 4,5,6		6,400	1,600	-	8,000	-
Powerhouse Hardstandings		9,600	2,400	-	12,000	-
Powerhouse area reinstatement fill		24,000	6,000	-	30,000	-
Dam Fill		-	-	-	-	-
Shuas Dam Fill		1,148,616	287,154	-	1,435,770	-
Shios Dam Fill		573,293	143,323	-	716,616	-
Promontories		-	-	-	-	-
Fill to promontories between Earba lochs using tunnel and other spoil		86,400	9,600	400,000	96,000	400,000
Filters and armouring stone to Promontories		40,000	10,000	-	50,000	-
Concrete Aggregates lower Area		-	-	-	-	-
Coarse Aggregate 4 - 25mm (Gravel)		252,413	-	-	252,413	-
Fine Aggregate 0 - 4mm (Sand)		-	122,701	-	122,701	-
Total Fill Required in Lower Area (m3)		**2,222,962**	**603,338**	**400,000**	**2,826,300**	**400,000**
Gravel and Rock (m3)	**2,222,962**	**2,222,962**	**-**	**-**		
Sand (m3)	**603,338**	**-**	**603,338**	**-**		
Total Useable required (m3)	**2,826,300**	**-**	**-**	**-**	**2,826,300**	
Spoil used in Promontories (m3)	**400,000**	**-**	**-**	**400,000**		
Balance to Borrow Pit 3 & 4 (m3)	**117,700**	**-**	**-**	**-**		
TOTAL Material re-used in Lower Area (m3)	**3,344,000**					

3.3 Summary of Earthworks Mass Balance in Lower Earba Area

3.3.1 In summary the lower Earba area requires a total of 2.8Mm3 of selected fill and aggregates plus an assumed 0.5Mm3 of spoil used as general fill materials, giving an overall volume of 3.3Mm3 of bulk earthworks materials which equates with the sources estimated in Section 3.1 above.

3.3.2 These estimated volumes indicate that an overall balance of materials in the lower Earba area is feasible and workable, with the relatively small borrow pits BP3 in the Earba middle reservoir area and BP4 at Shios Dam having some flexibility to provide a balance of supplementary sand and gravel fill for the dams and aggregates, with BP3 and BP4 also being able to accept unsuitable spoil as part of their reinstatement works.

3.3.3 This assessment does not include the re-used topsoil and peat, which would be re-used as described in track, site compound and peatland reinstatement as well as finishing and landscaping of the dam faces and promontories.

3.4 Description of the Main Earthworks Elements in Lower Area

Earba Reservoir Dams

3.4.1 The Shuas and Shios dams would be constructed as embankment dams with relatively gentle sloping faces at around 1 vertical in 3 horizontal gradient. This would allow a relatively wide range of suitable fill materials of various gradings, including some finer sands. Thus, there would be flexibility in the use of either rock-fill sourced from the underground works, or locally sourced sands and gravels from the powerhouse or borrow pit areas with a proportion of up to 10-15% fines content in the sands and gravels generally being acceptable in these types of embankment dams.

3.4.2 This proportional use of some fines would reduce the volume of unsuitable materials to just the very finest silts which would be screened out within the earthworks processing, with the spoil used on site for landscaping bulk fill and general reinstatement of borrow pits.

Borrow Pits and Site Compounds - General

3.4.1 It is envisaged that an early borrow pit BP1 at the Moy site entrance would be required to provide stone to improve and extend existing tracks, to construct new tracks and to provide some sand and gravel aggregates for the manufacture of concrete.

3.4.2 In addition to the powerhouse excavations and underground works, further additional materials for stone and sands for construction of the dams would be excavated from borrow pits BP3, BP4, BP5A and BP5B, all of which would be located below the final operating water level range of the reservoirs. BP2 has been omitted as described above.

3.4.3 These borrow pits would also be used for the permanent storage of any unsuitable spoil materials removed from the footprints of the dams and the powerhouse as well as unsuitable rock spoil from the underground works.

3.4.4 The proposed locations of the borrow pits have been assessed as part of the EIA and this mass balance strategy with respect to availability of suitable material and proximity to where it is required, as well as any ecological sensitivities and the initial geotechnical review and investigations.

3.4.5 The Borrow Pits BP1, BP3, BP4 in the lower area and BP5A and 5B in the upper Leamhain area, as well as SC3 at the powerhouse excavation area, would have

sufficient space for screening, selecting and stockpiling stone and sand for construction purposes.

3.4.6 In addition, Site Compounds SC1, SC5 and SC8 would be fairly large temporary works areas, also with sufficient space for stockpiling and processing sands, gravels and rock prior to selected materials being carted and placed in the dam construction and other landscape areas.

3.4.7 The arrangements for material handling, drainage and construction methods for all areas including Site Compounds, borrow pits and permanent plus temporary excavations at the powerhouse and dams would be subject to rigorous planning and execution in accordance with the SEPA issued Construction Site Licence which deals with water run-off from large construction sites.

3.4.8 Suitable backfalls in the ground surfaces and terraces of all works areas and site compounds would be provided to direct surface water run off away from any watercourses, with drainage measures on each level feeding settling ponds which would treat run off prior to soakaway style drainage lagoons in accordance with the site wide CEMD and the Construction Site Water Licence issued by SEPA. This would control silty water and prevent un- controlled discharges to the local watercourses and, in turn, Loch Earba.

3.4.9 The details of the proposed borrow bits and excavations would also be subject to detailed design and planning within the CEMD and detailed Borrow Pit Management Plans. A typical arrangement is shown in **Plate 1 – Typical Borrow Pit Arrangement** below.

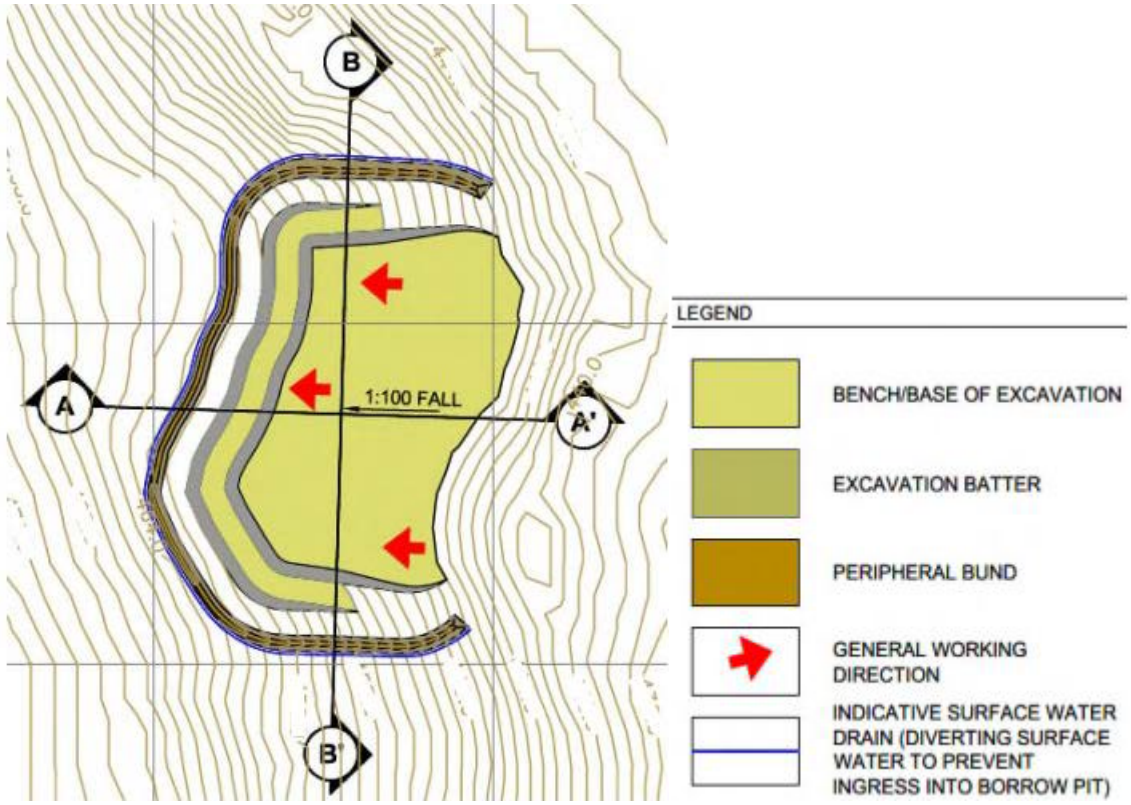


Plate 1a – Typical Borrow Pit Arrangement

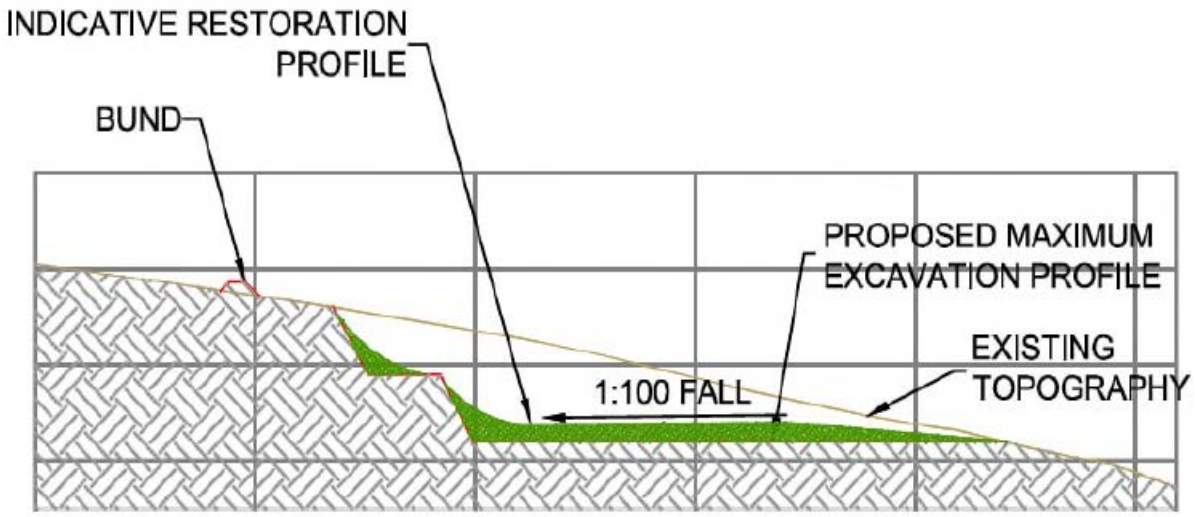


Plate 1b – Typical Section A-A through Borrow Pit

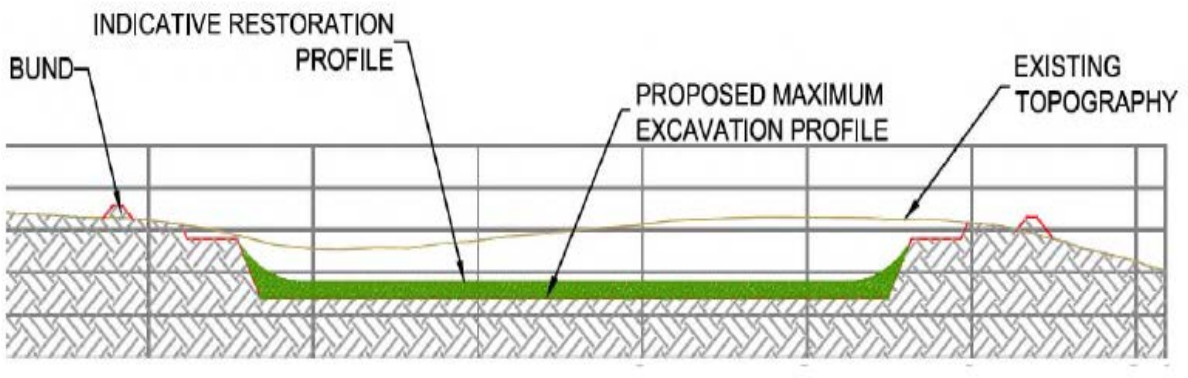


Plate 1c – Typical Section B-B through Borrow Pit

Borrow Pit 1 (BP1) and Site Compound 1 (SC1)

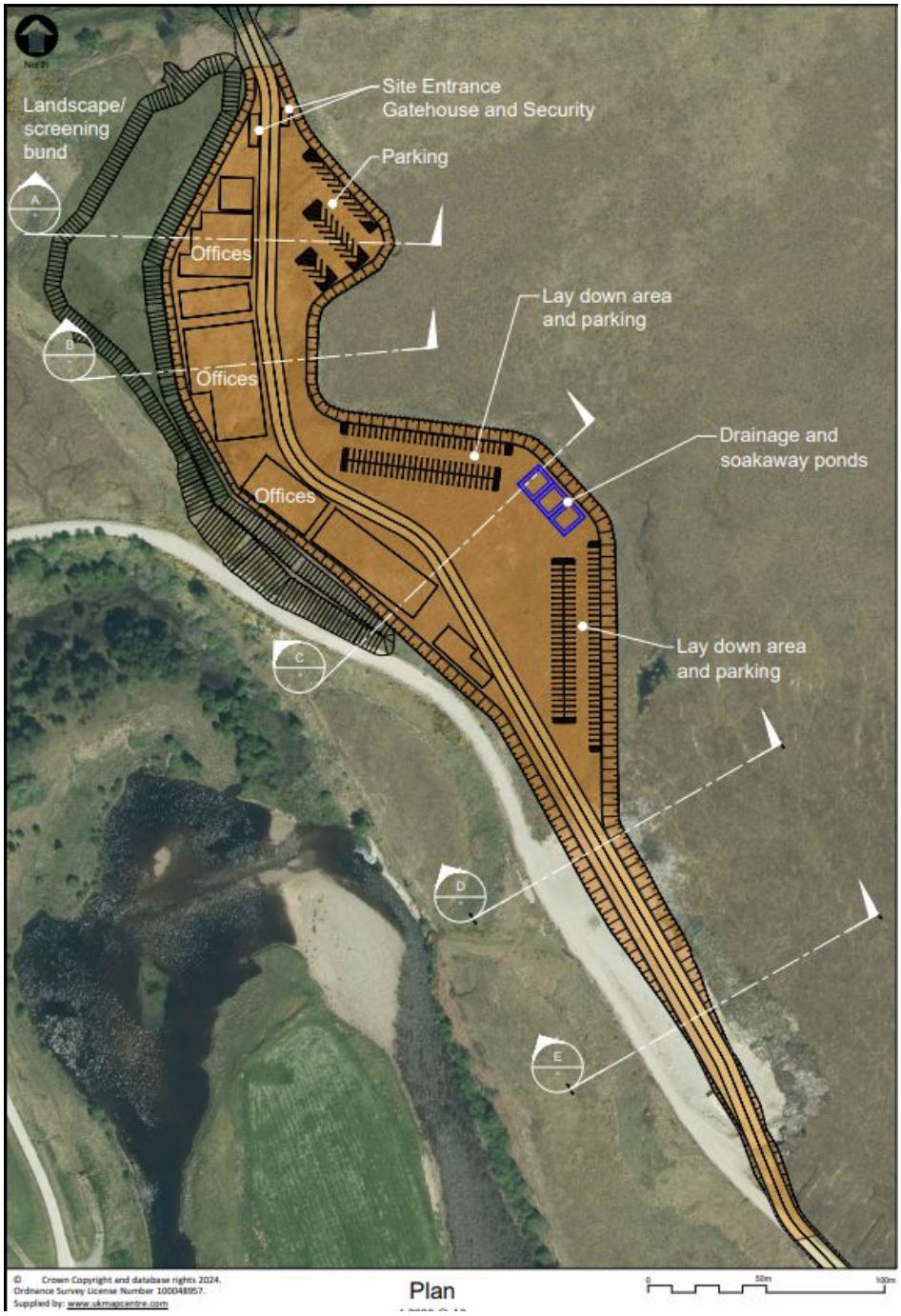


Plate 2 - Plan of Site Compound SC1 and Borrow Pit BP1 at Moy

3.4.10 The works would commence with opening of **Borrow Pit BP1** near the Moy Bridge site entrance as shown in plan in **Plate 2** above with cross sections shown in **Plate 3** below and in **Figure 2.2.1 - Site Compound SC1 / Borrow Pit BP1 - Plan and Sections.**

3.4.11 This borrow pit would be approx. 300m long by up to 50m wide by up to 4m deep, up to 60,000m3 in volume and would be on the same footprint as the proposed

site entrance compound SC1. It would be opened early as an extension of the existing gravel borrow pit at this location.

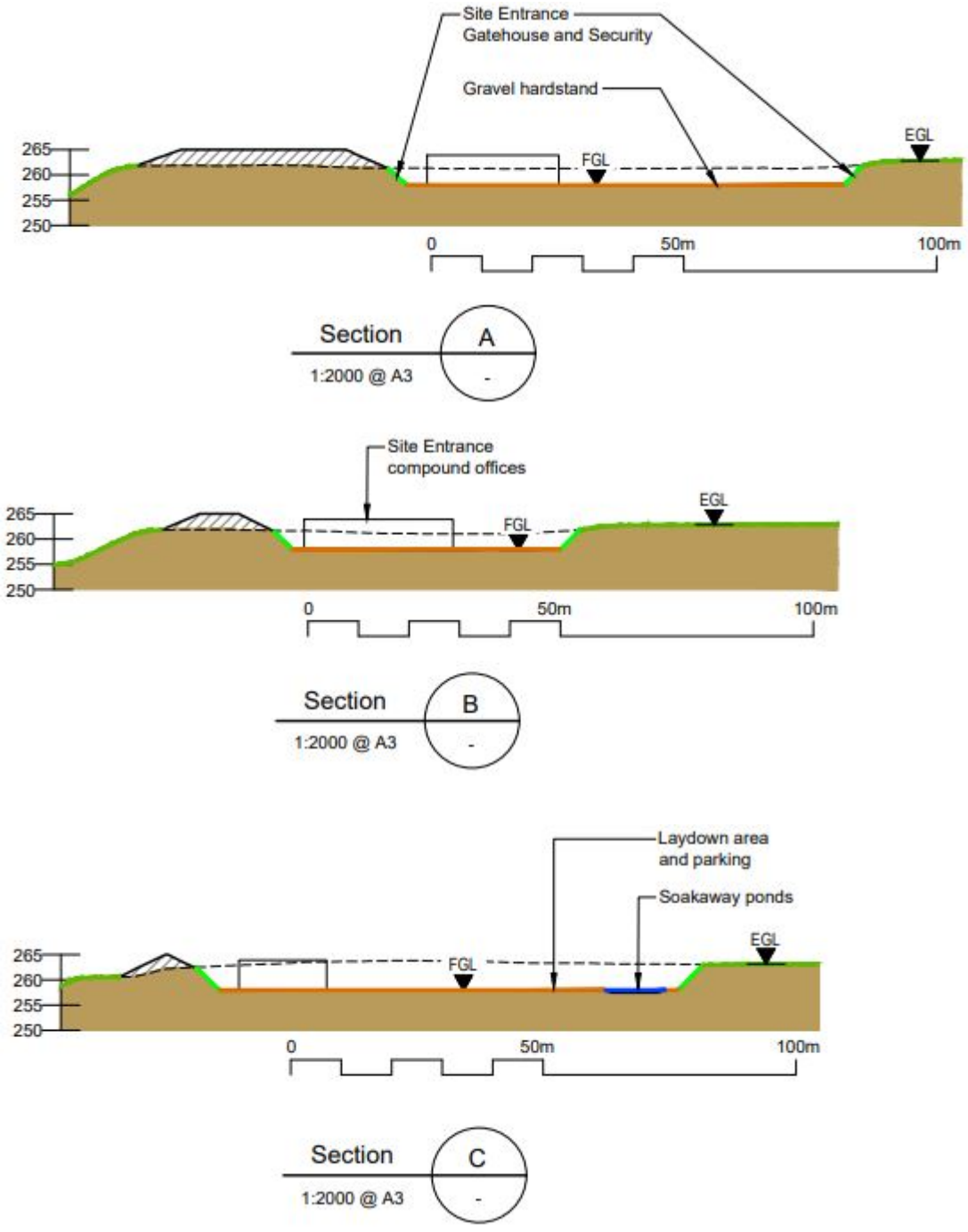


Plate 3 - Sections through Site Compound 1 and Borrow Pit 1 at Moy

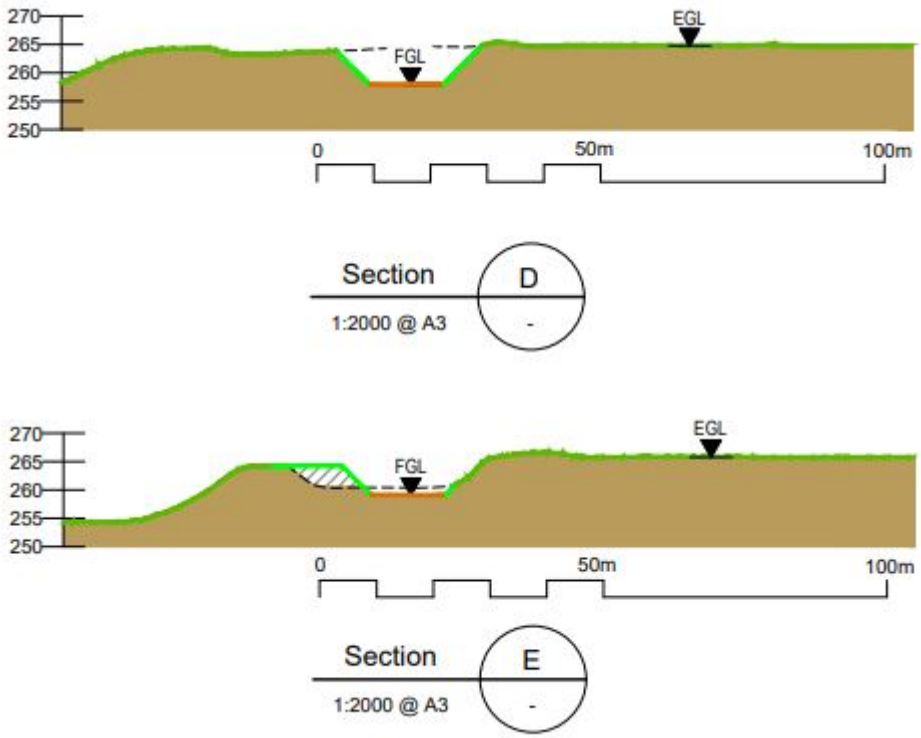


Plate 3 - Sections through Site Compound 1 and Borrow Pit 1 at Moy (continued)

3.4.12 Approximately 7,000m3 of topsoil would be stripped and re-used for dressing/ landscaping the bunds around the compound. A further volume of approx. 7,000m3 of unsuitable material from BP1 would be screened out from the sand and gravel and used to form the bunds around the west side of compound SC1.

3.4.13 The sand and gravel material from BP1 would be used to form the main construction access road from SC1 to the main works compound SC2 at Shuas Dam and the access road to Site compounds SC3 and SC4 and the powerhouse and BP3. Screened sand from BP1 would be stockpiled for use in the works, for concrete.

3.4.14 The site entrance compound, **SC1,** including security, some site offices, parking, laydown and works areas would be located within this borrow area BP1, with the bunds on the west side providing visual screening of the compound and noise reduction for neighbouring properties.

Main Site Compound SC2

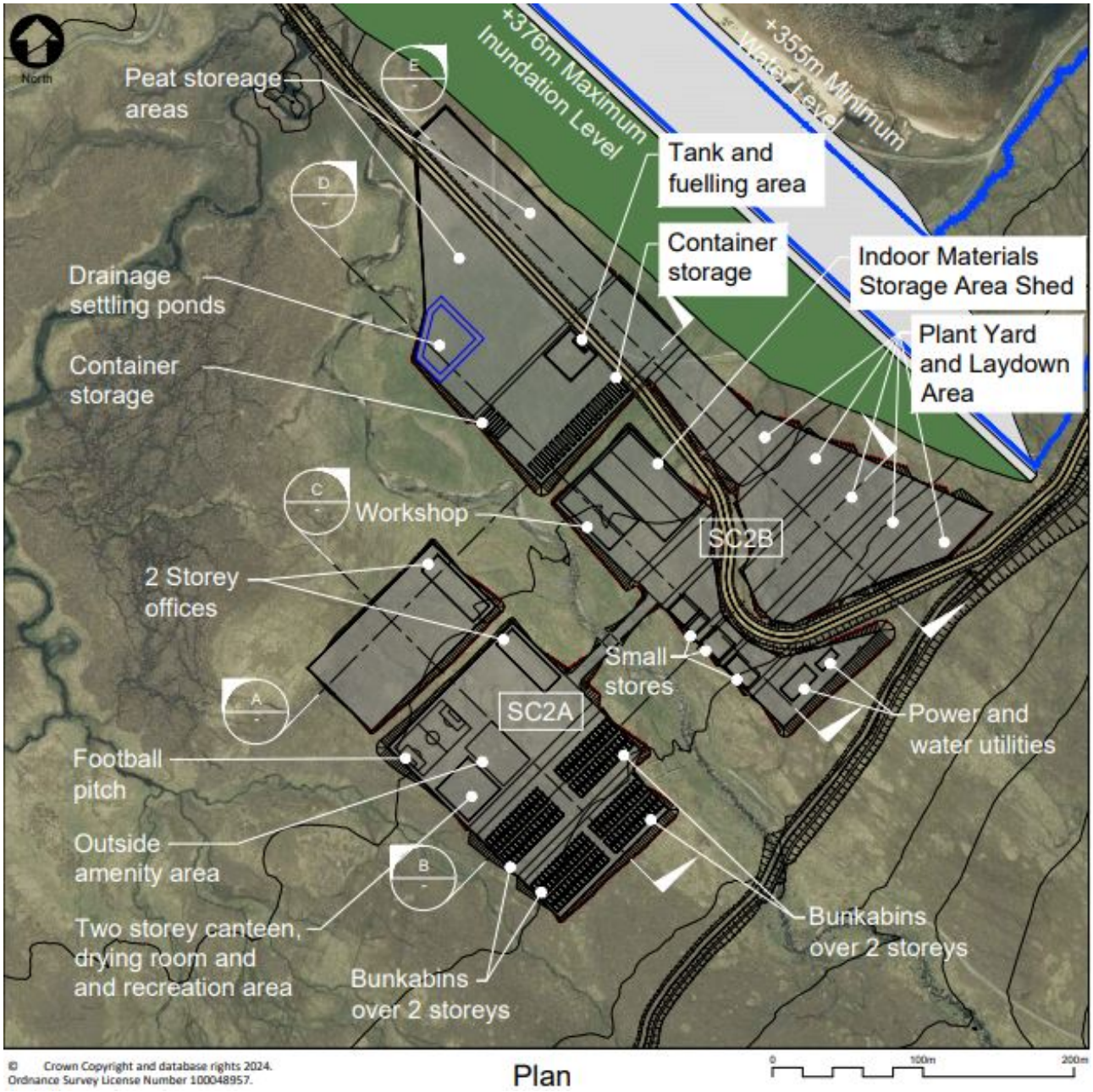
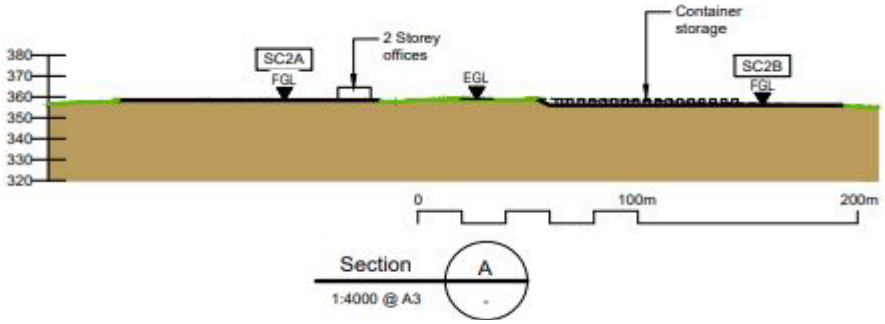


Plate 4 - Plan of Main Site Compound 2 at Shuas Dam



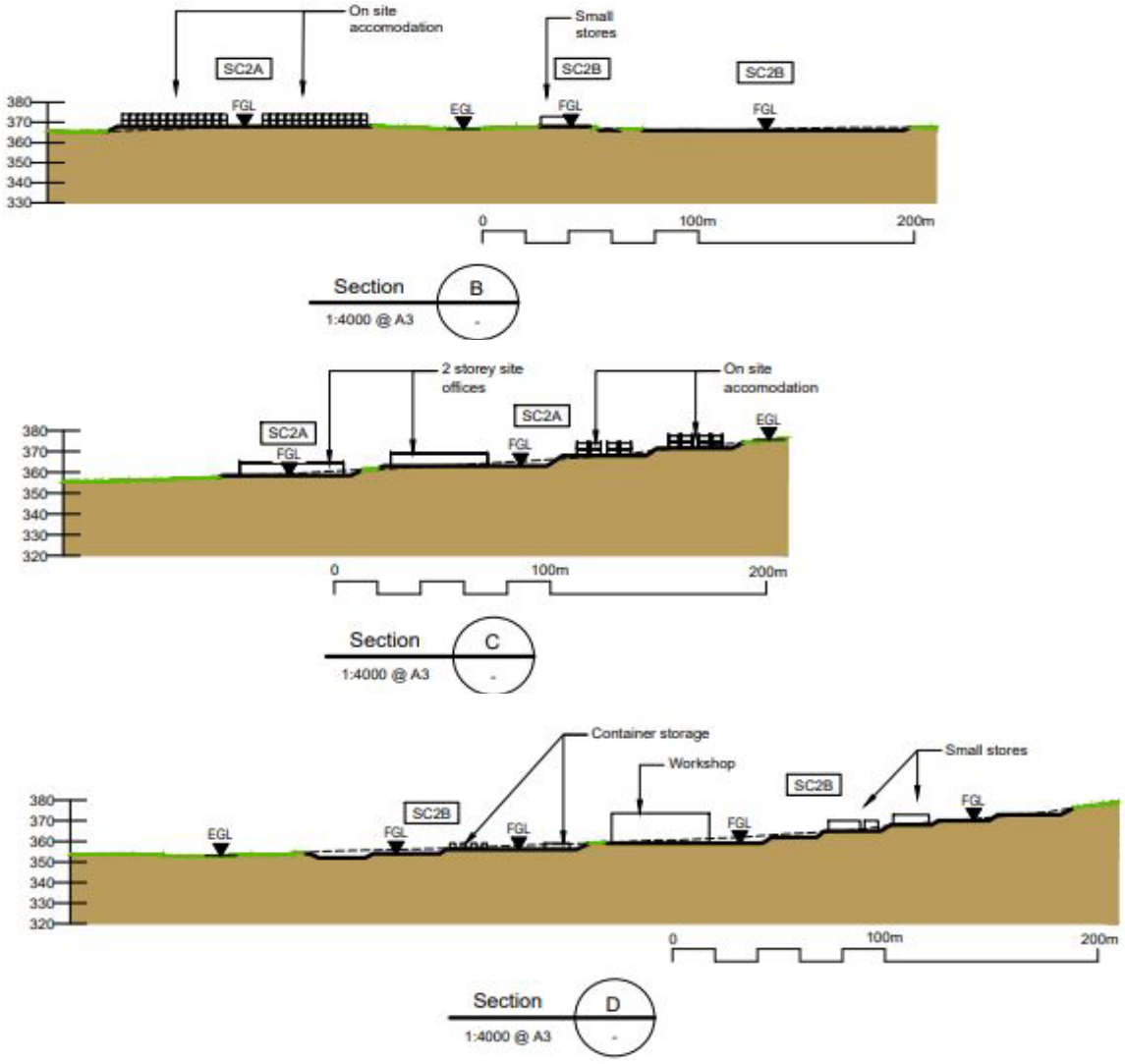


Plate 5 - Sections through Main Site Compound 2 at Shuas Dam

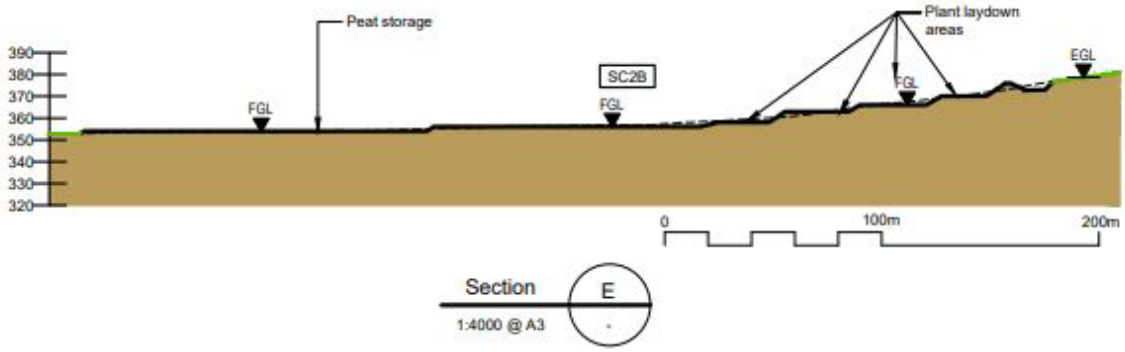


Plate 5 - Sections through Main Site Compound 2 at Shuas Dam (continued)

3.4.15 The **Main Site Compound - SC2** would include the main site accommodation camp, main site offices, parking, site utilities and laydown for plant and materials. It would be split into two terraced areas, with a suitable buffer to either side of the existing small Allt Coire Pitridh burn.

3.4.16 **SC2A** would be used mainly for worker accommodation, site offices, amenity areas and car parking, with **SC2B** providing workshops, container storage, site utilities as well as plant and material laydown areas.

3.4.17 **SC2B** would also include a large peat storage area to handle around 25-30,000m3 of peat extracted from the Shuas Dam foundation, prior to it being used across the site for peatland restoration and reinstatement.

3.4.18 The earthworks for the site compounds **SC2A** and **SC2B** would be terraced into the gentle slope as shown in **Plates 4 and 5** above and on **Figure 2.31 - Site Compound SC2 - Shuas Dam - Plan and Sections**. Suitable backfall would be provided with drainage on each terrace feeding settling ponds which would treat run off prior to soakaway style drainage, in order to control and prevent discharge of silty runoff to Locha Na H Earba.

3.4.19 A balance of cut and fill would be achieved with some suitable screened stone material used for capping the works area. Stripped topsoil would be used for landscaping the site compounds and local bunds, with some stored for use on the Shuas Dam. Sand would be screened out of the mixed gravel and stockpiled for use in concrete.

3.4.20 The roofs of the accommodation and offices as well as the area between SC2A and SC2B across the burn, could be used for housing a solar array to provide sustainable renewable energy for the Sote Compounds.

Site Compound SC3

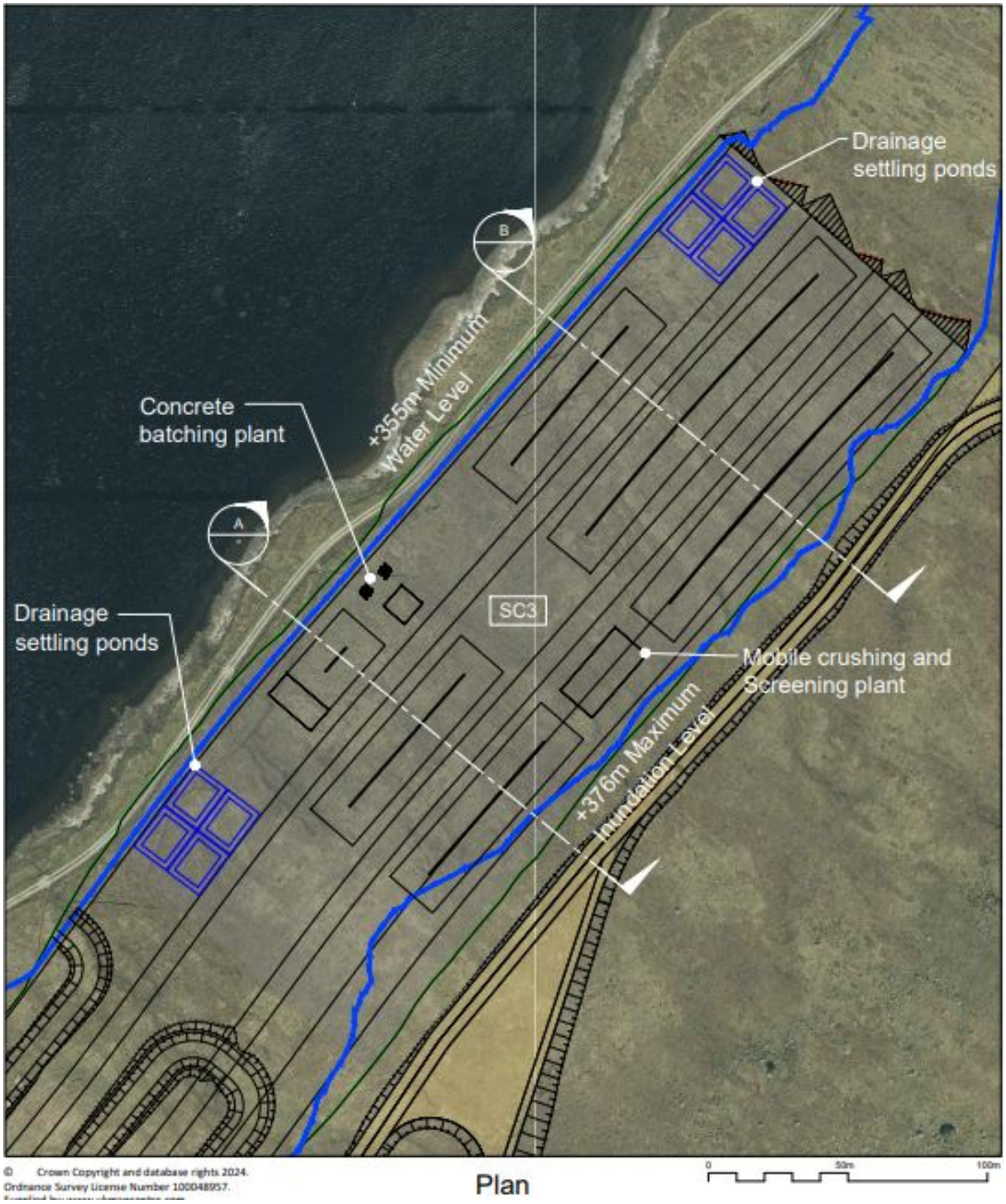


Plate 6 - Plan of Site Compound 3 at Powerhouse Area

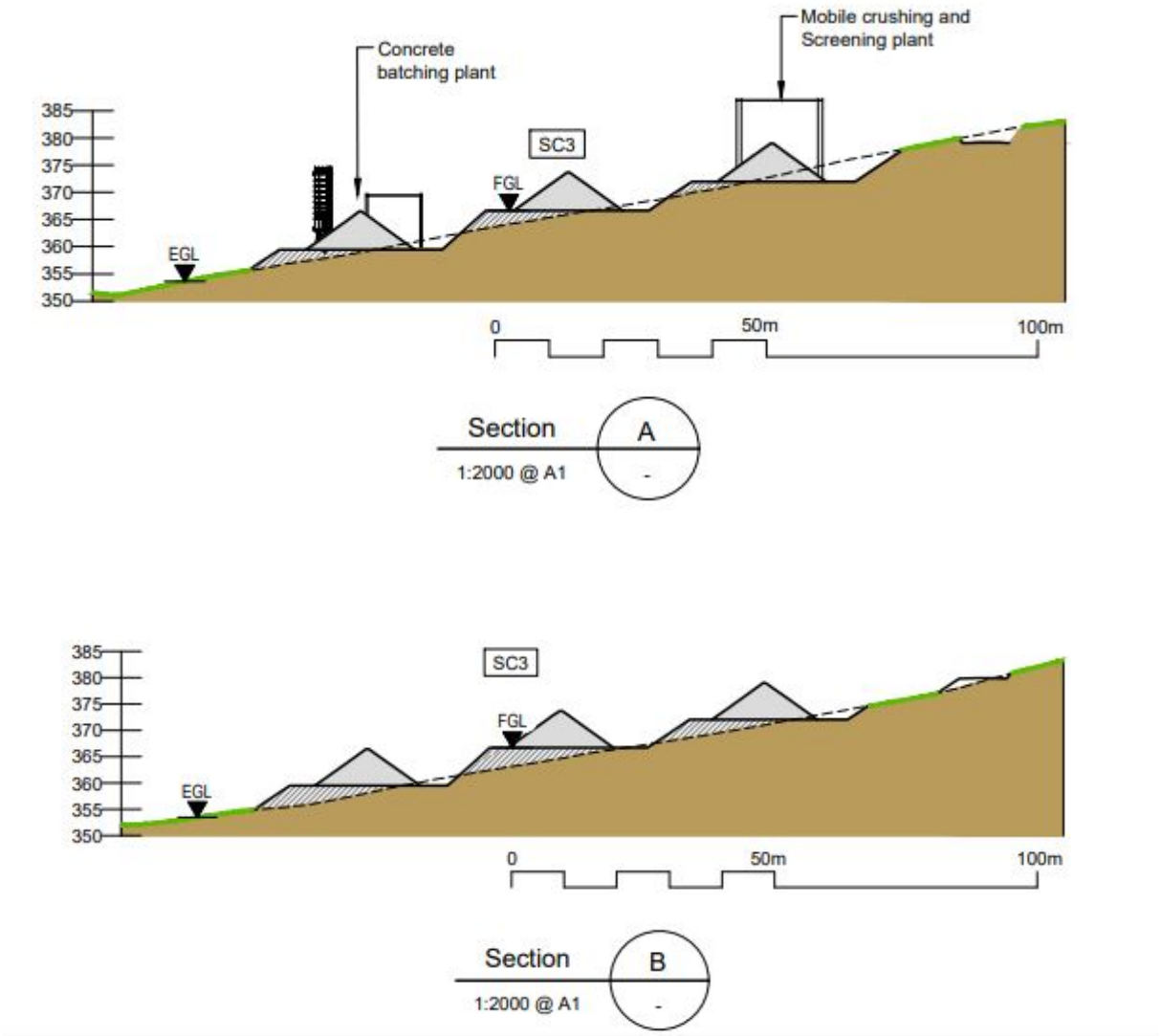


Plate 7 - Sections through Site Compound 3 at Powerhouse Area (see Figure 2.32)

3.4.21 Site compound **SC3 i**s shown in **Plates 6 and 7** above and in **Figure 2.32 - Site Compound SC3 Powerhouse Area - Plan and Sections**.

3.4.22 Site compound **SC3** would be constructed with balance of cut and fill earthworks to provide terraces located within the Earba reservoir inundation area above the existing loch. This area would be used for processing stone and rock fill material from the powerhouse area and underground works for use in the Shuas dam. Any suitable sand and gravel arisings from this area would be stockpiled for use in concrete.

3.4.23 **SC3** would also contain drainage settling lagoons for treating drainage pumped from the powerhouse area, including the main excavations and the underground shaft and tunnel works.

3.4.24 **SC3** would also contain a concrete batching plant to provide concrete for the powerhouse and underground works including tunnels and shafts.

3.4.25 Suitable backfall would be provided with drainage on each terrace feeding settling ponds which would treat run off prior to soakaway style drainage, in order to control and prevent discharge of silty runoff to Loch Earba.

3.4.26 On completion of the main civil works and prior to filling the Earba reservoir, the **SC3** area platforms would be tied into the Pitridh Aqueduct and could be developed into shallow ponds within the reservoir shoreline which would provide aquatic habitat enhancement in the Earba reservoir.

3.4.27 **Site compound 4 (SC4)** was originally separate from SC3, but these have been combined and now both form SC3.

Borrow Pit 2 (Now Omitted)

3.4.28 **Borrow Pit 2** (approx. 300m x 80m x average 6m deep, 150,000m3,) was proposed as a rock borrow pit in the lower area, approximately 1km north-east of the powerhouse. But because of relatively high levels of peat in the area and additional rock arisings expected from the powerhouse cutting, BP2 has been omitted from the proposals.

Borrow Pit 3 (BP3) and Site Compound 5 (SC5)

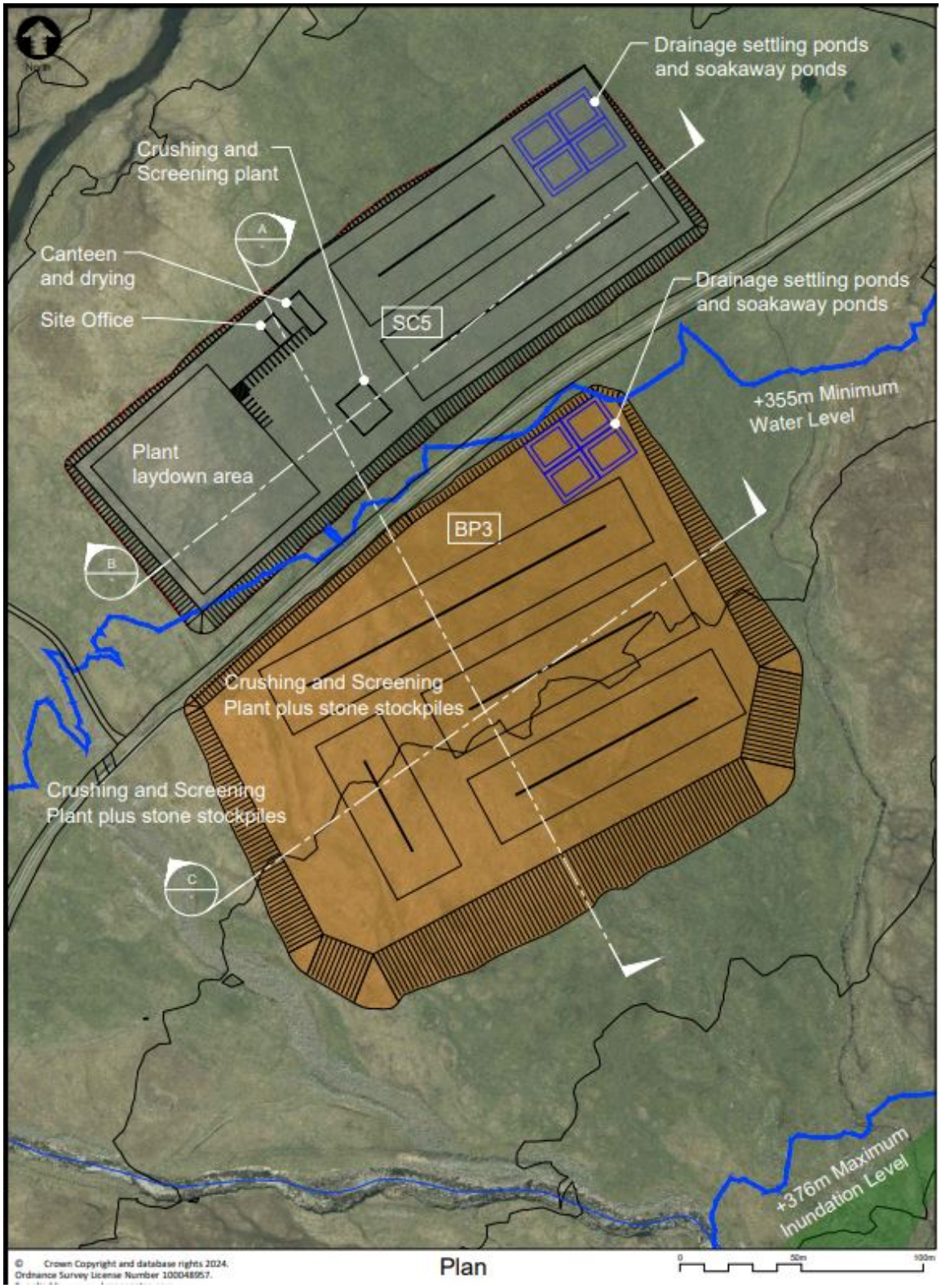


Plate 8 - Plan of BP3 and SC5 at Earba Middle Area

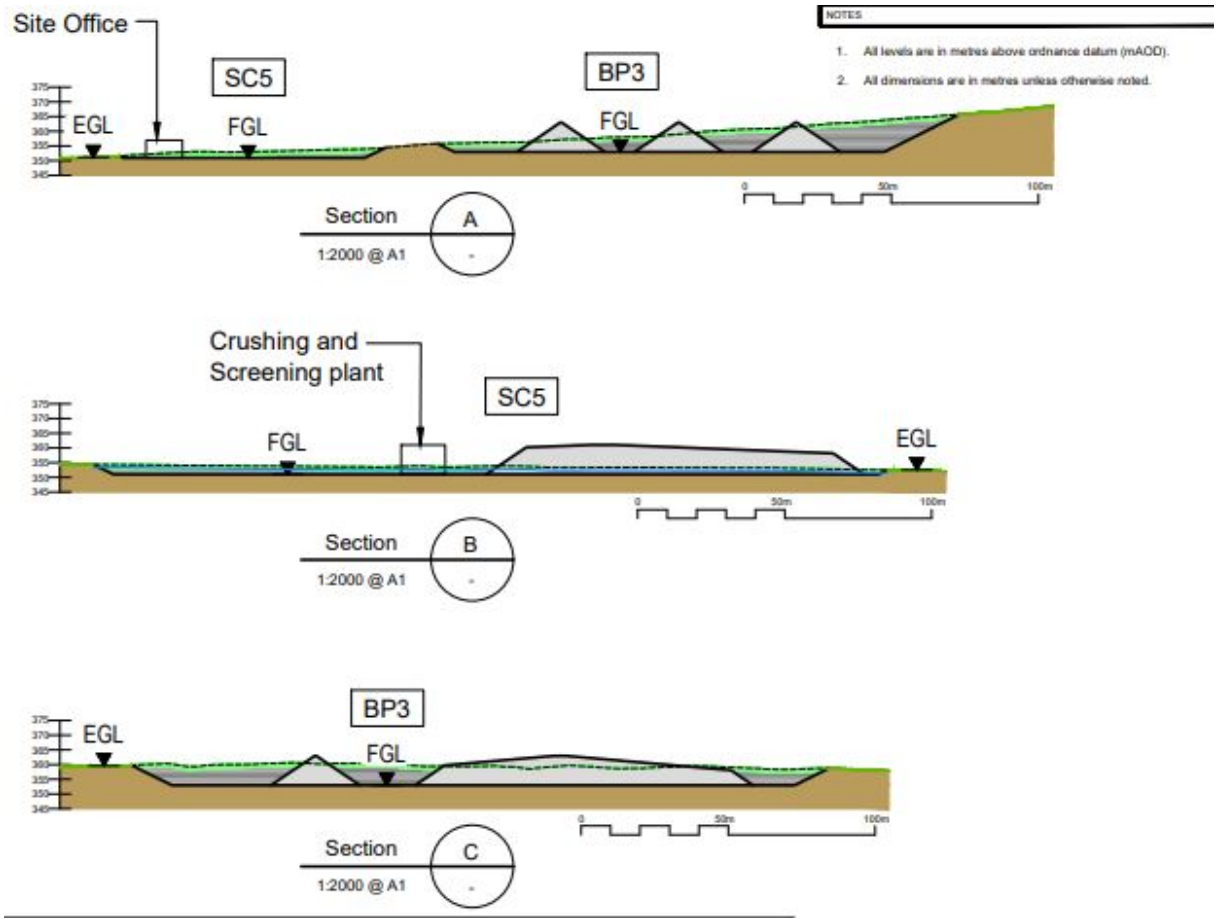


Plate 9 - Sections through BP3 and SC5

3.4.29 Borrow Pit **BP3** and site compound **SC3** are shown in **Plates 8 and 9** above and in **Figure 2.33 - Site Compound SC5/BP3 - Earba Mid Area - Plan and Sections**.

3.4.30 **Borrow Pit 3 (BP3)** (approx. 200m x 150m x 5m deep, 120,000m3,) is a sand and gravel borrow pit in the middle area between the existing Earba lochans, approximately 1.5km northeast of the powerhouse.

3.4.31 **BP 3** would be excavated to an average depth of 5m below existing ground level of 358-365 and would also be used as a source of sand and gravel for tracks and for concrete aggregates for early concrete operations, in advance of utilisation of tunnel and shaft rock arisings.

3.4.32 The existing Allt a Mhaigh / Moy Burn runs east-west well clear to the south of the borrow pit area, providing some 50m minimum clearance from the borrow pit workings.

3.4.33 **Site Compound 5 (SC5)** would be an area of approximately 250m long x 100m wide, which would contain some site offices, welfare, and plant laydown. It would also provide space for stone processing and stockpiling prior to use in the Shios dam.

3.4.34 **Both BP3 and SC5** would contain suitable local drainage measures as well as local settling and soakaway ponds to avoid direct discharge of run off to the Loch Earba.

3.4.35 **Plate 10** below describes the construction stages of works on **BP3** and **SC5**.

BP3

Stage 1
- Strip existing topsoil and superficial materials to expose clean sands and gravels, assume 0.5m thick.
- Then remove sands and gravels to depth shown on drawing

Stage 2
- Use the borrow pit to select, crush and screen the sands and gravels and stockpile for use in dams and tracks and rip rap.

Stage 3
- Backfill borrow pit with selected unsuitable materials from the borrow pits, powerhouse, tunnels and dam works
- Cap off with topsoil and turfs to reinstate to existing ground level.

SC5

Stage 1
- Strip topsoil and turfs

Stage 2
- Use area for crushing and screening and stone stockpiles as well as site establishment area

Stage 3
- Grade off back to existing ground profile and reinstate topsil and turfs

Plate 10 – Construction Stage Notes for BP3 and SC5

Borrow Pit 4

Plate 11 - Plan of Borrow Pit BP4 at Shios Dam

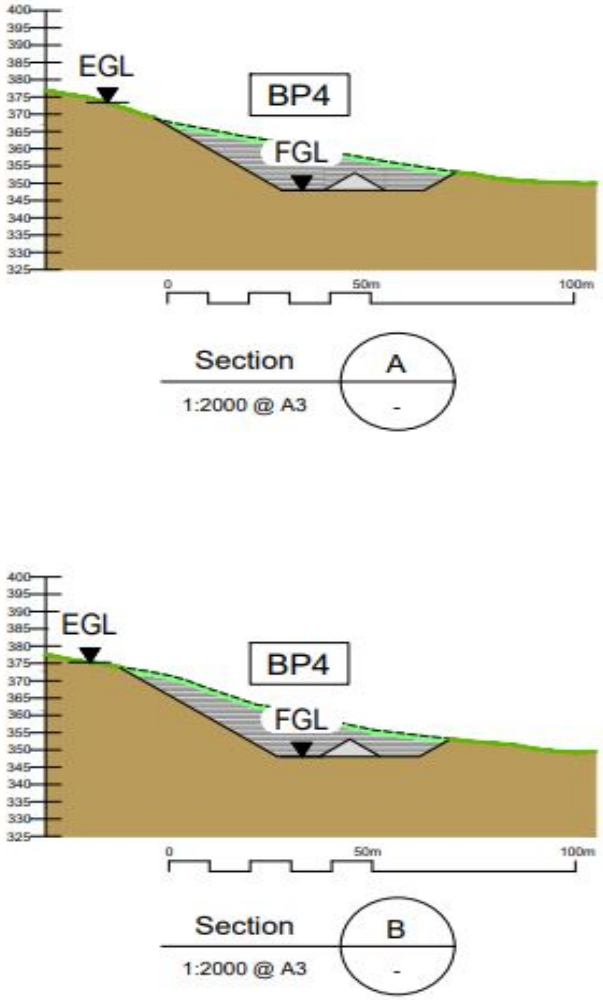


Plate 12 - Sections through Borrow Pit BP4 at Shios Dam

3.4.36 Borrow pit **BP4** is shown in **Plates 11 and 12** above and in **Figure 2.2.3 - Borrow Pit BP4 - Plan and Sections**.

3.4.37 **Borrow Pit 4** to the west of Shios dam would be an area of approximately 300m long x 75m wide, with a mixture of sands, gravel and rock, which would be used to supplement the general fill required for the Shios dam as well as providing screened sand and gravel for concrete.

3.4.38 It would also provide space for stone processing and stockpiling for use in the Shios dam and it would contain suitable local drainage measures as well as local settling and soakaway ponds to avoid direct discharge of run off to Loch Earba.

Reinstatement of Borrow Pits 3 and 4

3.4.39 Borrow pits **BP3 and BP4** would also be used in addition to the landscaping promontories halfway along the Earba reservoir for the disposal of up to 200,000m3 of unsuitable earthworks arisings within the reservoir footprint, bringing the finished levels back up close to existing ground levels in these borrow pits.

Powerhouse and Lower Control Works Cuttings and Landscaped Bund

3.4.40 The **Powerhouse** and Substation cutting shown on **Plates 13 and 14** and in **Figure 2.18 - Powerhouse Plan** and **Figure 2.19 - Powerhouse Typical Cross Section** will be some 700m long and 75-100m wide, with depth varying between 10-25m.

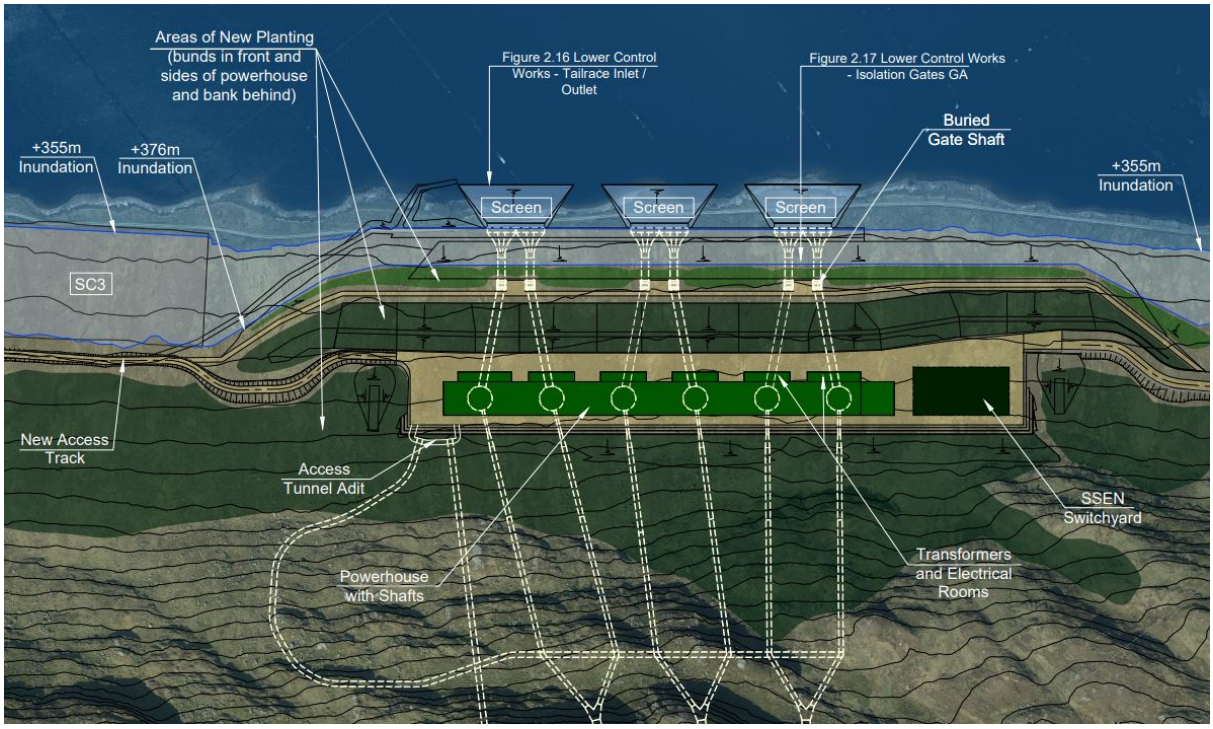


Plate 13 – Plan on Powerhouse

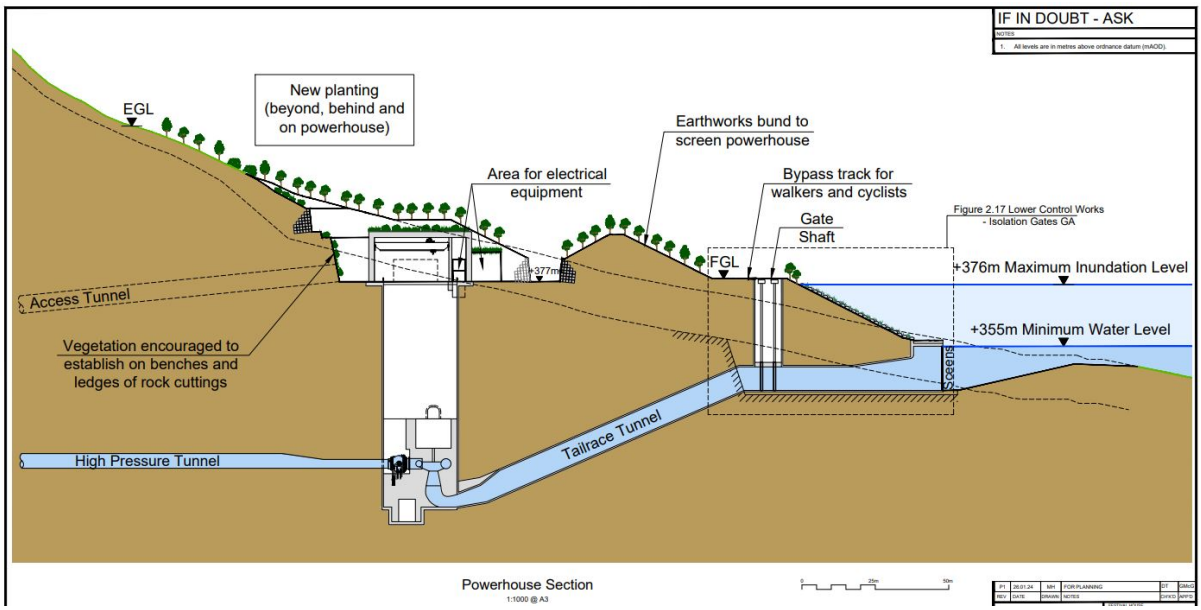


Plate 14 - Typical Section through Powerhouse

3.4.41 Based on preliminary site investigations, rockhead is estimated to be between 5-15m depth below ground level. This means that the powerhouse excavations

would yield approximately 700,000m3 of superficial sands and gravel, and 300,000m3 of rock.

3.4.42 From the initial borehole investigations, on site geophysics and existing geological maps, the rock types at the powerhouse are micaceous psammites of the Loch Laggan Psammite Formation (LLGN), with zones of interbedded pegmatitic granite. The depth to interpreted psammite bedrock, as encountered in borehole BH02, varies from 2.8 to > 22 m bgl and is of good quality. Variations in the seismic velocities and the resistivity values indicate the bedrock varies from moderately weathered/fractured to moderately to slightly weathered/fractured to slightly weathered to fresh rock.

3.4.43 This material would be excavated early in the programme and would be carted to works areas **SC3** and **SC5** for screening. Rock, gravel and sand would be utilised in the construction of the Shuas and Shios Dams and for concrete aggregates, with screened fines used for filling in the peninsulas and the borrow pits.

3.4.44 Preliminary particle size sampling of the superficial materials indicates that approximately 23% of the volume is made up of fines, amounting to around 150,000m3. These would be screened out and used to create the promontories and in the restoration of **BP3** within the lower reservoir, which would be below minimum reservoir level.

3.4.45 Sand makes up around 52% and gravel around 25% of the remaining superficial materials, around 550,000m3. These would be used for dam fill with selected materials used for concrete aggregates. The powerhouse rock arisings would be used similarly, with fines screened out likewise.

3.4.46 The permanent **lower control works** excavations approximately 250m long x 50m wide x 15m deep, would yield around 150,000m3 of similar materials to the powerhouse. The majority of these excavated materials would be stockpiled adjacent to the tailrace excavations and used for backfilling around the tailrace boxes and for the landscape bund around the powerhouse.

3.4.47 A cofferdam would be built along the Earba loch side of the lower control works and would provide sealing from water ingress from the loch during the works.

3.4.48 Drainage settling and tailings ponds would be employed in the lower control works areas to treat ground water and surface run off prior to being pumped to soakaway lagoons in the **SC3** area.

Access Tunnels

3.4.49 The three **access tunnels** shown on the tunnel layout on **Plates 15 and 16** and in **Figure 2.10 - Tunnel Layout Plan** and **Figure 2.11 - Tunnel Section** would be approximately 2100m long and 7m in excavated diameter, with an overall volume of approximately 127,000m3. Of this a around 115,000m3 would be screened in works areas **SC3** and **SC5** and selected rock used for aggregates and stone fill for the dams. The remaining 10% of the arisings (13,000m3) would used in the restoration of the borrow pit **BP3** and as landscaping fill in the promontories within the lower reservoir.

3.4.50 Drainage from the tunnels and shafts discussed below would be treated to remove fines in Silt-buster type settling tanks prior to being directed towards settling lagoons and soakaway ponds in the **SC3** area.

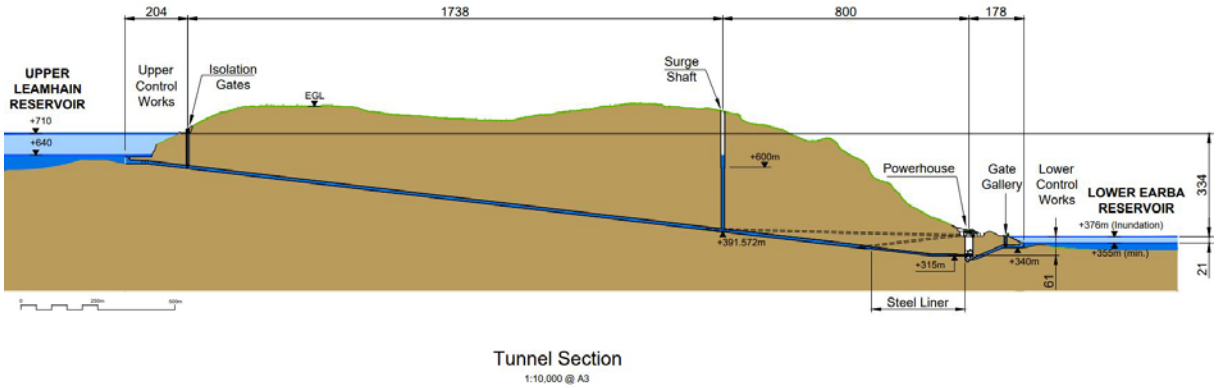
Powerhouse Shafts and Tailrace Tunnels

3.4.51 The six proposed **powerhouse shafts** would be in the order of 25m diameter and 70m deep, with an overall bulked and re-compacted volume of approx. 300,000m3. approximately 270,000m3 would be screened in works areas **SC3** and **SC5** and selected rock used for aggregates and stone fill for the dams. The remaining 10% (30,000m3) of the arisings would be fines and would be sent to the promontories and borrow pit **BP3**.

3.4.52 The six **tailrace tunnels** would be approximately 100m long and 9m in diameter yielding around 96,000m3 of rock arisings. The proportions of useable rock for the dams (86,000m3) and fines sent to fill in borrow pits (10,000m3) are estimated to be similar to the powerhouse shafts.

Headrace Tunnels, Surge Shafts and Gate Shafts

Plate 15 - Tunnel Layout Plan



Tunnel Section
1:10,000 @ A3

Plate 16 - Tunnel Section

3.4.53 The three **headrace tunnels** shown on **Plates 15 and 16** would be approximately 2350m long and 10-11m in excavated diameter and each tunnel would bifurcate into two smaller steel lined tunnels approximately 300m upstream of the powerhouse. The tunnel system would have an overall bulked and re-compacted volume of approximately 1,000,000m3. 10% of the arisings (100,000m3) would likely be unsuitable and sent to the borrow pit and landscaping fill in the promontories within the lower reservoir. The remaining 900,000m3 would be screened in works areas **SC3** and **SC5** and selected rock used for aggregates and stone fill for the dams.

3.4.54 The three proposed **surge shafts** would be in the order of 10-12m diameter and 350m deep, yielding around 192,000m3 of rock arisings. The proportions of fines are estimated to be higher than for the headrace tunnels due to the raise boring techniques likely used for part of the shaft works. The useable rock for the dams would be a slightly lower proportion at around 70% (134,000m3) with around 30% (57,000m3) of unsuitable material sent to fill in borrow pits and the promontories.

Landscaped Promontories within Earba Reservoir

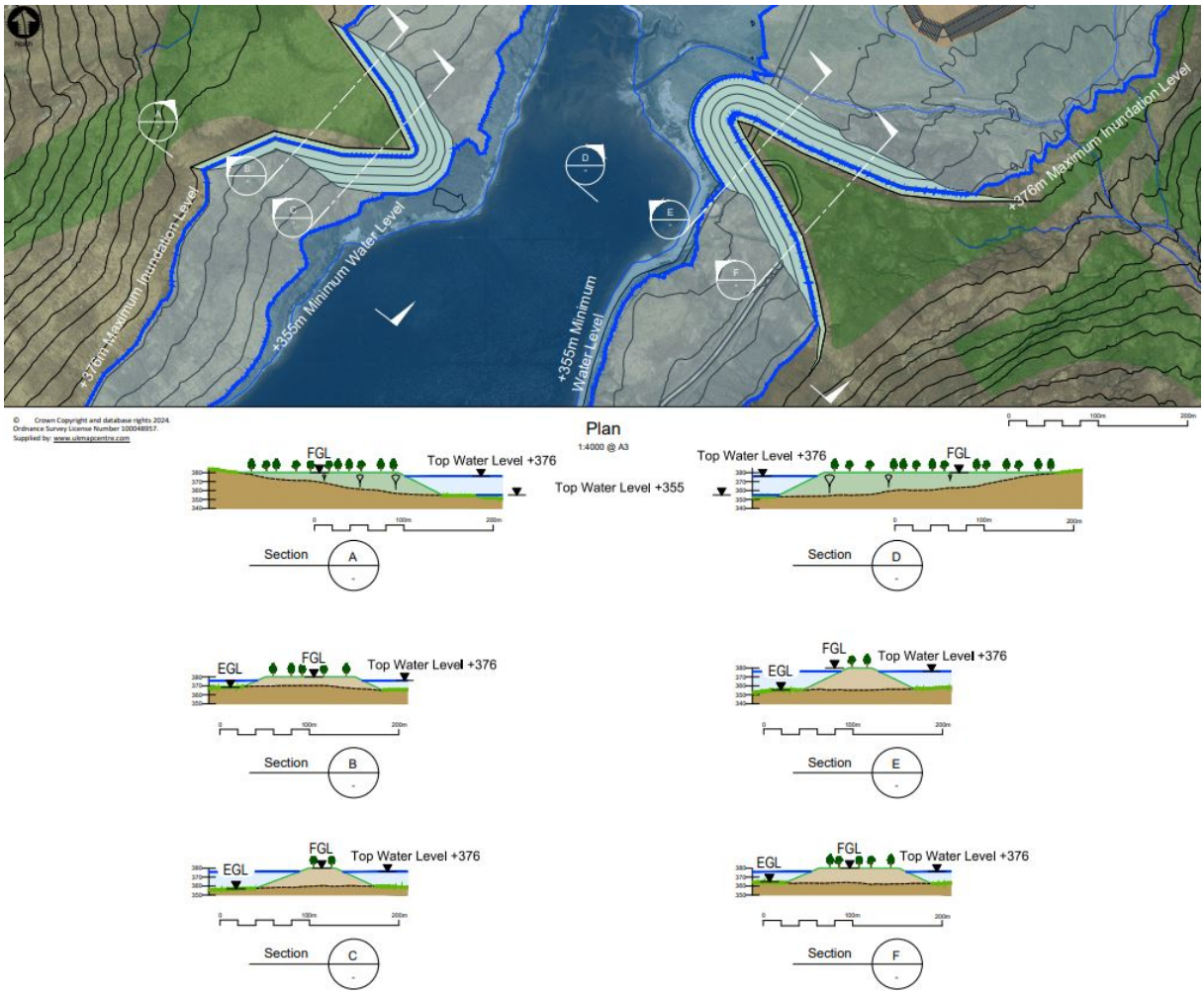


Plate 17 - Plan and Sections of the Earba Promontories

3.4.55 The existing twin lochs of Loch Earba have an isthmus between them which forms an attractive feature of the existing landscape. It is proposed to re-create this feature to some extent by introducing landscaped promontories between the existing lochs which would be raised to around 385m AOD and planted with native trees to maintain the appearance of the loch. The promontories would therefore rise up to 10m above the proposed full inundation water level of 375m AOD.

3.4.56 The promontories are shown in Plate 17 above and in **Figure 2.9 – GA of Promontories.**

3.4.57 Each of these promontories would be approximately 2-3 ha and between 10-20m deep, with an overall volume of up to around 500,000 m3.

3.4.58 The main perimeter of the promontories would be formed with 150,000m3 of engineered fill using rock, gravel and sand. Other earthworks arisings which are unsuitable for the dam construction would be used as general fill for the body of the promontories with up to 400,000m3 of volume, with further unsuitable material sent for restoration of borrow pits **BP3** and **BP4**.

Concrete Aggregates

3.4.59 Approximately 250,000m3 of gravels and 125,000m3 of sand would be screened and selected from the sands and gravels and / or the rock excavations in the lower area, for use as concrete aggregates, with appropriate testing carried out to confirm suitability of the materials as aggregates.

4. Overall Balance of Material in Upper Area

4.1 Material Required in Upper Leamhain Reservoir Area

4.1.1 The Layout of the Leamhain Reservoir is shown in **Plate 18** below and in **Figure 2.4 - Upper Leamhain Reservoir – Plan**.

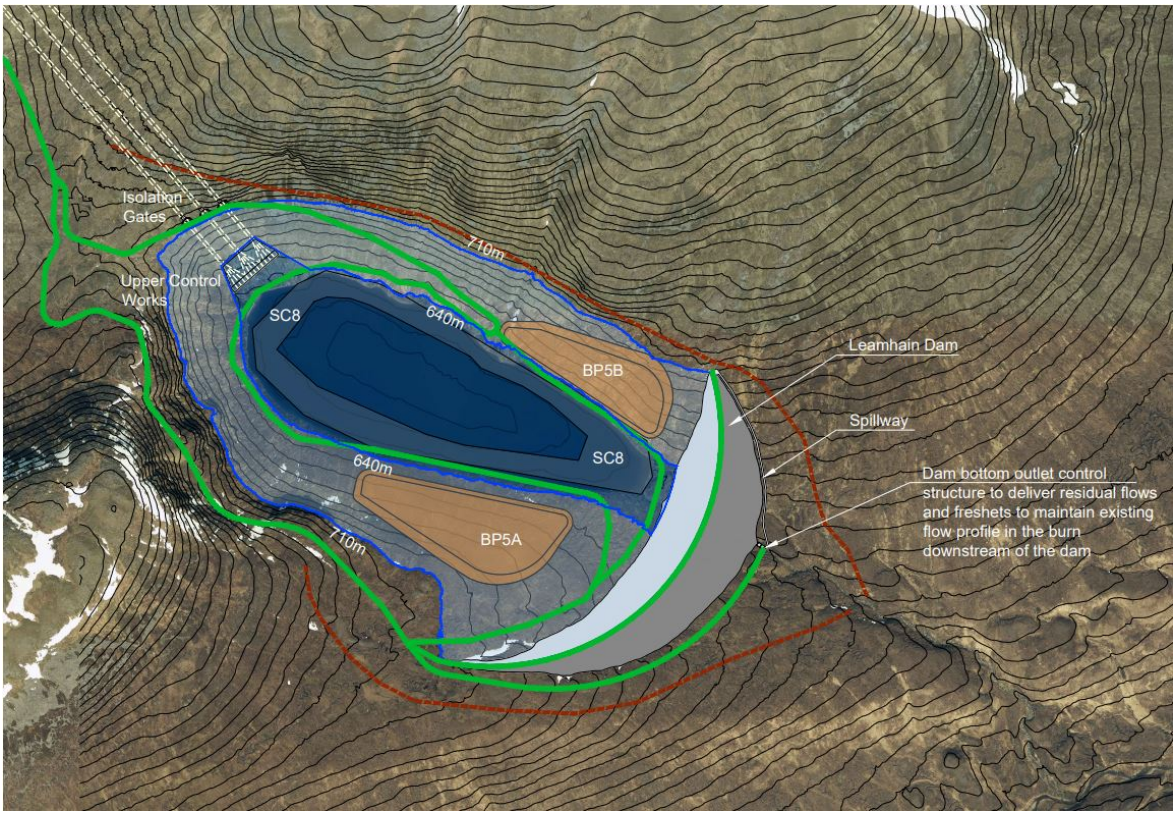


Plate 18 - Plan of the Leamhain Reservoir

4.1.2 The key issue in the upper Leamhain Reservoir area is sourcing material in order to build the Leamhain rockfill dam.

4.1.3 Rockfill would be sourced from Borrow Pits **BP5A** and **BP5B**.

4.1.4 The bedrock geology beneath the footprint of the proposed dam and the proposed borrow pits **BP5A** and **BP5B** is predominantly within metamorphic psammites, quartzites, semipelites and schistose semipelites of the Inverlair Psammite Formation.

4.1.5 It would be necessary to create sufficient working space for the dam foundations, borrow pits and materials processing close to the dam works. This would require that a large site compound, **SC8**, would need to be constructed in advance of working the borrow pits in order to provide handling areas for the various materials involved in the excavations for the dam and the borrow pits providing the rockfill. Site compound SC8 is shown in **Plates 19 to 21** below and in **Figure 2.36 - Site Compound SC8 - Leamhain Dam – Plan** and **Figure 2.37 - Site Compound SC8 - Leamhain Dam - Sections**.

4.1.6 In order to provide this space, the intention would be to draw down Loch Leamhain by 23m from 635m AOD to 612m AOD and create working areas within the footprint of the existing lochan. This is described in more detail in **Appendix 2.1 - Leamhain Dam Construction – Draft Pollution Prevention Plan**, which addresses the drainage management in order to ensure that the working area **SC8**, the Borrow Pits **BP5A** and **BP5B** and the dam and upper control works construction areas are managed in accordance with the Construction licence issued by SEPA for the works including run-off and silt control.

4.1.7 In summary, all areas would have their own self-contained drainage settling systems and these would be either pumped or drain to the main settling ponds prior to discharge to the lowered lochan, which would have some capacity to store run off from annual rainfall events. Clear run off would then be pumped from the lochan to the downstream watercourse.

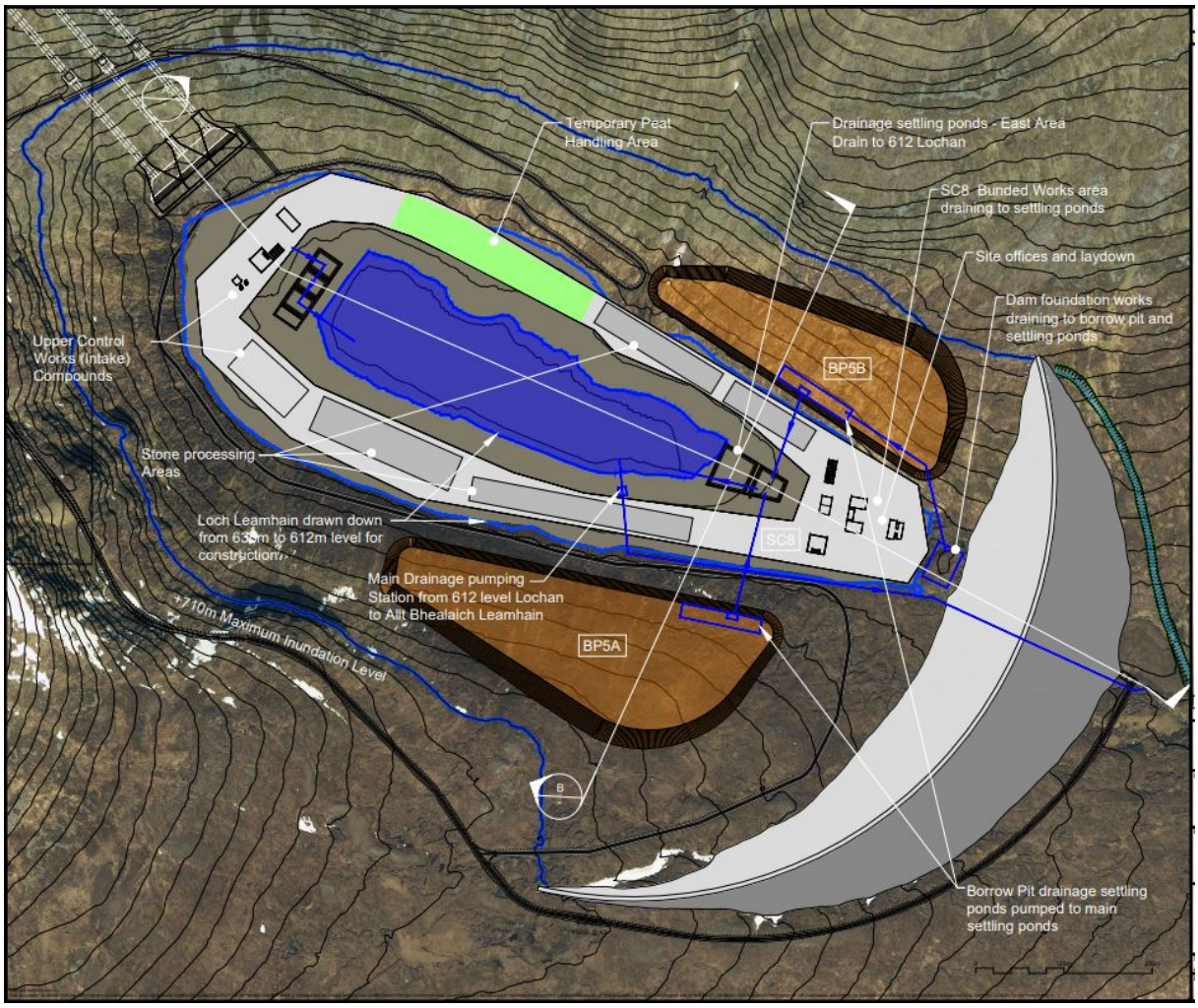


Plate 19 – Plan of SC8 and BP5A BP5B at Leamhain Reservoir

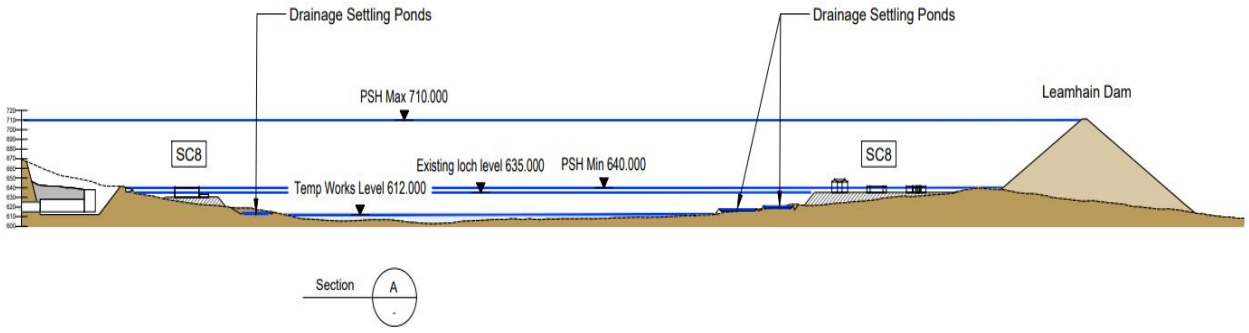


Plate 20 – Longitudinal Section of the Leamhain Reservoir

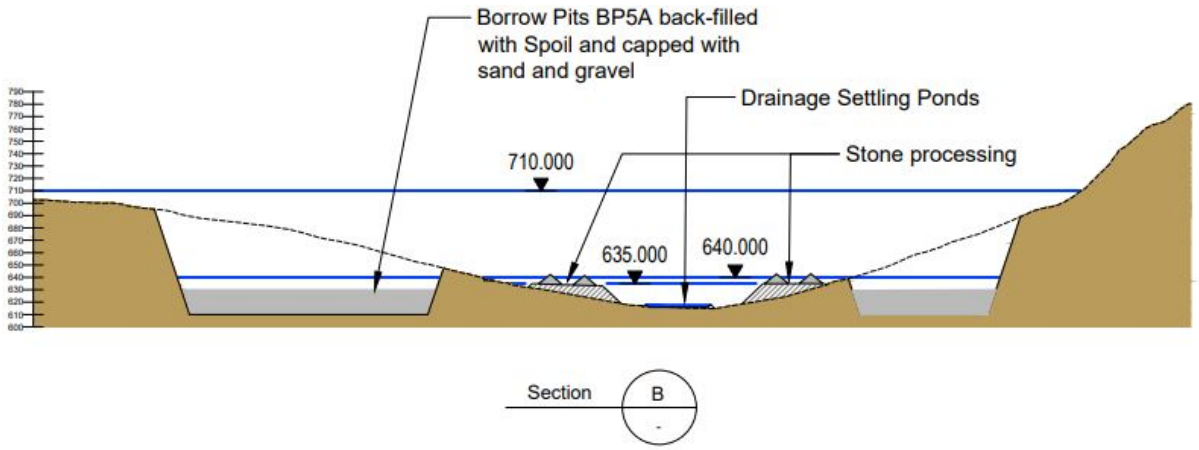


Plate 21 – Cross of SC8 and BP5A and BP5B at Leamhain Reservoir

4.1.8 The volumes of material which would require be sourced from the various elements of the works in the upper Leamhain area are summarised in **Table 4.1** below:

Required Fill for Upper Area		Volume of Cobbles and Gravel m3	Volume of Sand m3	Spoil Used Mm3	Total Selected Fill Used (m3)
Access Tracks		12,000	3,000		15,000
Temporary Hardstandings in works area SC 8		787,500	525,000		1,312,500
Filters and armouring to SC8		80,000	20,000		100,000
Leamhain Dam Fill		6,550,000	-		6,550,000
Intake Backfill		75,000	75,000		150,000
Concrete Aggregates Upper Area					
Coarse Agg 4 - 25mm (Gravel)		79,584	-		79,584
Fine Agg 0 - 4mm (Sand)		-	38,687		38,687
Total Fill Required in Upper Area m3		**7,584,084**	**661,687**	**-**	**8,245,771**
Gravel and Rock (m3)	**7,584,084**	**7,584,084**	**-**	**-**	**0**
Sand (m3)	**661,687**	**-**	**661,687**	**-**	**0**
Total Useable required (m3)	**8,245,771**	**-**	**-**	**-**	**-**
Balance to Borrow Pit 5A and 5B (m3)	**1,158,729**	**202,941**	**15,338**	**150,450**	
TOTAL Material re-used in Upper Area (m3)	**9,404,500**				
Balance for Upper Area m3		**-**	**-**	**-**	**-**
Gravel and Rock to BP 5A and 5B	**202,941**	**-**	**-**	**-**	**-**
Sand to BP 5A and 5B	**15,338**	**-**	**-**	**-**	**-**
Spoil / Fines to BP 5A and 5B	**940,450**	**-**	**-**	**-**	**-**
Total Balance of Material in Upper Area m3	**1,158,729**	**-**	**-**	**-**	**-**

Table 4.1 - Volumes of Material Required in Upper Leamhain Area (m3)

4.1.9 Superficial overburden materials including up to 1,312,000m3 of sands and gravels from the footprint of the dam and the borrow pits BP5A and BP5B would be stripped and used for the construction of the Works Area SC8 and the local access tracks.

4.1.10 Up to 6,550,000m3 of selected rock, sand and gravel fill materials would be required from **BP5A** and **BP5B** to provide the graded rockfills used for the construction of the Leamhain Dam.

4.1.11 Selected and processed aggregates for the site manufacture of concrete would include around 80,000m3 of coarse stone aggregate from 4-20mm size) and 40,000m3 of fine aggregate (sand 0-4mm). Cement would need to be imported.

4.1.12 In total the volume of spoil of around 1,000,000m3 would be used for general back filling the Borrow Pits **5A** and **5B**, with some 100,000m3 of the selected engineered fill materials engineered fill used to contain and cap the general fill.

4.1.13 In summary the upper Earba area requires a total of 8.3Mm3 of selected fill and aggregates plus an assumed 1.1Mm3 of spoil plus capping used to backfill the borrow pits, giving an overall volume of 9.4Mm3 of bulk earthworks materials.

4.1.14 This does not include the re-used topsoil and peat which are discussed in the Peat Management Plan.

4.2 Material Sources in Upper Leamhain Reservoir Area

4.2.1 The following approximate volumes of bulk earthworks materials would be won from within the Leamhain Reservoir Area site:

		Superficial Materials			Rock	(Bulking & re compaction Factor = 1.6/1.2)			
Material Sources in Upper Leamhain Area (Excavation)		**Volume of Cobbles and Gravel m3**	**Volume of Sand m3**	**Volume of Spoil m3**	**In situ Volume m3**	**Re-compacted Volume**	**Useable factor**	**Useable**	**Rock Spoil**
Leamhain South borrow pit 5A		356,400	356,400	79,200	3,230,000	4,306,667	90%	3,876,000	430,667
Leamhain North borrow Pit 5B		91,125	91,125	20,250	2,470,000	3,293,333	90%	2,964,000	329,333
Intake / Upper Control Works		13,500	13,500	3,000	225,000	300,000	90%	270,000	30,000
Leamhain Dam strip		216,000	216,000	48,000	-	-	90%	-	-
Total Dig for Upper Area m3		**677,025**	**677,025**	**150,450**	**5,925,000**	**7,900,000**	**-**	**7,110,000**	**790,000**
Gravel and Rock	**7,787,025**	**677,025**	**-**	**-**	**-**	**-**	**-**	**7,110,000**	**-**
Sand	**677,025**	**-**	**677,025**	**-**	**-**	**-**	**-**	**-**	**-**
Total re-useable in Upper Area (m3)	**8,464,050**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Total Spoil in Upper Area (m3)	**940,450**	**-**	**-**	**150,450**	**-**	**-**	**-**	**-**	**790,000**
TOTAL Material Produced in Upper Area (m3)	**9,404,500**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

Table 4.2 - Volumes of Material Sources in Upper Leamhain Area (m3)

4.2.2 Rock, sand and gravel aggregates would be sourced from borrow pits **BP5A** and **BP5B** in the upper Leamhain reservoir area (7,000,000m3 suitable, 800,000m3 unsuitable).

4.2.3 Some gravel, sand and rock fill materials in the order of 1,300,000m3 suitable and 200,000m3 spoil would also be sourced from the excavation of superficial materials from the borrow pit areas and from the footprint of the dam. These would be used to form the working area **SC8**.

4.2.4 Concrete aggregates up to approximately 120,000m3 would be screened from excavated rock or from on-site sources of sand and gravel at **BP5A** and **BP5B** and **SC8**.

4.2.5 The balance of spoil / bulk fill material produced, once the materials suitable for engineering purposes have been extracted, would be used for local land-forming and reinstatement of the construction compound **SC8** within the reservoir, with the remaining spoil being used to backfill the borrow pits **BP5A** and **BP5B**. In total the volume of spoil used would be = 1,100,000m3.

4.2.6 Topsoil and peat would be re-used for landscaping and finishing of the track edges and working areas, used for drainage ditches and sealing purposes during construction, as well as the construction compound **SC8** together with its settling lagoons for drainage management. This is described further in **Appendix 12.2 – Peat Management Plan (PMP)**.

4.3 Summary of Earthworks Mass Balance Upper Leamhain Area

4.3.1 In summary the upper Leamhain area requires a total of 8,300,000m3 of selected fill and aggregates plus an assumed 1,100,000m3 of spoil used to backfill the borrow pits, giving an overall balanced volume of 9,400,000m3 between the bulk earthworks used and materials required. This does not include the re-used topsoil and peat.