Technical Appendix 4.4: Borrow Pit Assessment

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Pell Frischmann

Appin Wind Farm

Borrow Pit Assessment

May 2025

Contents

Figures

Tables

Drawings and Appendices

1 Introduction

1.1 Purpose of the Report

Pell Frischmann (PF) has been commissioned by Appin Wind Farm Limited (the 'Applicant') to undertake a Borrow Pit Assessment associated with the construction of Appin Wind Farm (hereafter referred to as 'the Proposed Development'), located in the Dumfries and Galloway Council (DGC) administrative area, approximately 6.2 kilometres (km) north of Moniaive.

This Borrow Pit Assessment forms an appendix to the Environmental Impact Assessment (EIA) Report for the Proposed Development. The report is intended to identify potential areas of material extraction and summarise the good practice measures that will be implemented during the extraction of materials from the Site.

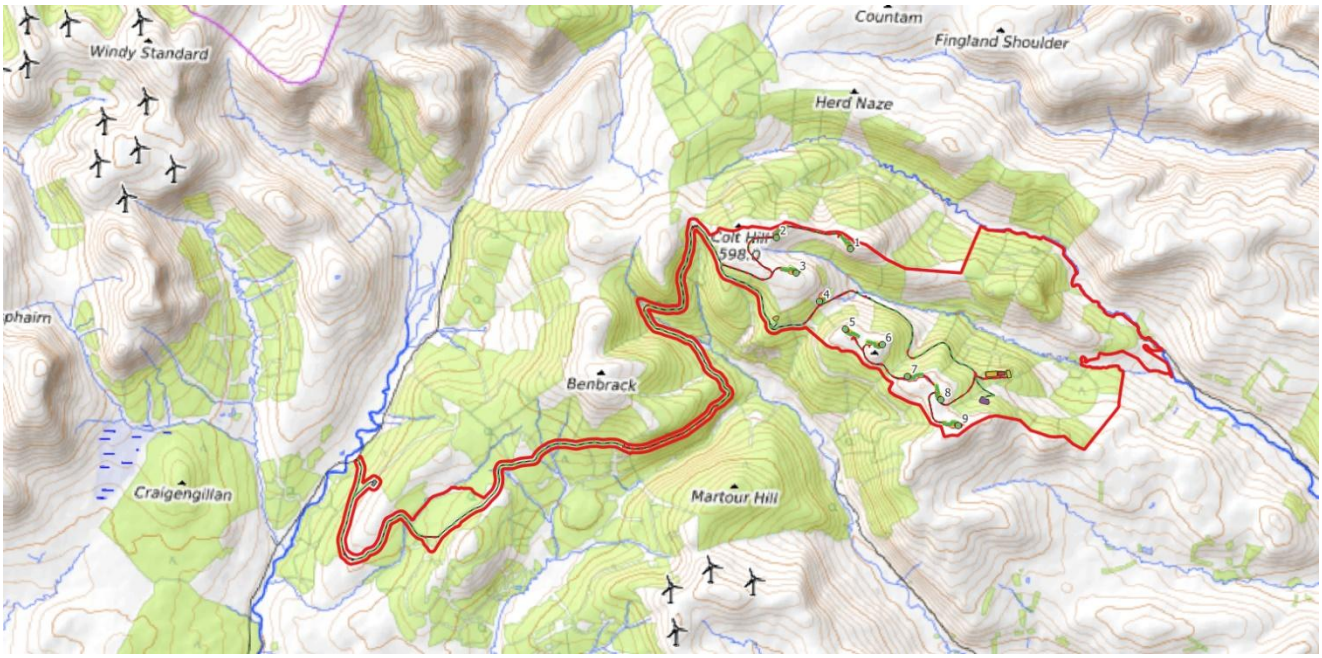
Detailed proposals for such measures will be documented prior to construction and will provide the same or greater provision in terms of protecting the water environment as those described in this document. The measures are proportionate to the risk and, where greater risk is highlighted at specific locations prior to construction, specific measures would be agreed at that time.

It should be noted that no intrusive geotechnical investigation or testing has been carried out at this stage.

2 Site Location and Overview

This report addresses the borrow pit requirement for construction of the Proposed Development. A full description of the Site components is provided in Chapter 4: Description of the Proposed Development of the EIA Report and the Site layout is presented in image 1 below.

Image 1: Site Layout



The topography is variable with most of the proposed turbines occupying hill tops, surrounded by steep slopes from all directions and proposed tracks following the ridgelines where possible.

Ordnance Survey mapping indicates the levels increase across the site from 220 m above ordnance datum (AOD) at the site entrance to a high of 598 m AOD at Colt Hill.

The Proposed Development comprises nine wind turbines, a substation, two temporary construction compounds, approximately 13 km of proposed new site tracks, 14.8 km of existing track resurfacing and other ancillary infrastructure.

The proposed infrastructure requires a large quantity of graded crushed rock fill material that will be sourced from borrow pits on the Site rather than being imported, thus reducing HGV movements on the public road network. All proposed borrow pits are extensions of existing quarries or excavation.

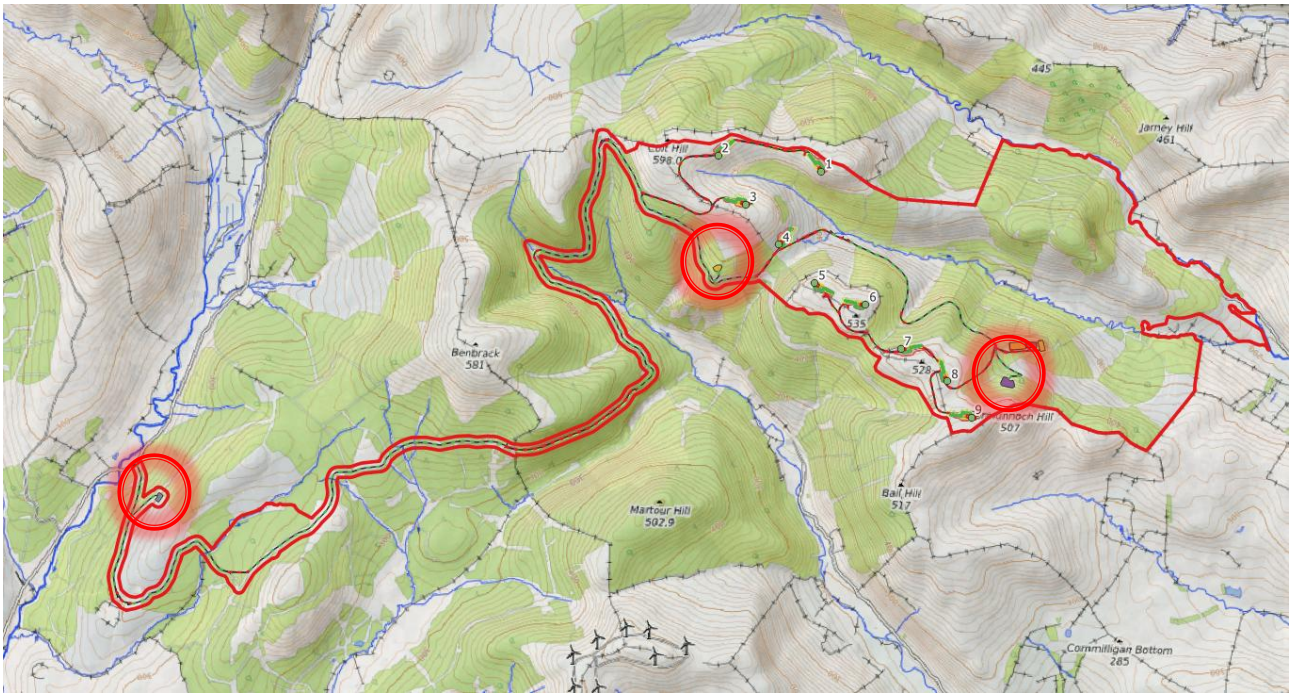
This borrow pit assessment is based on Superficial and Bedrock 1:50 k mapping available from the British Geological Survey (BGS).

3 Borrow Pit Design

3.1 Borrow Pit Siting

Three borrow pits are proposed for the Proposed Development. Their locations are shown in Image 2 below.

Image 2: Proposed Borrow Pit Location



Existing borrow pits and quarries around the Site have been selected as the proposed borrow pit locations for the Proposed Development. This has also been informed by consideration of the known environmental constraints within the Site.

The proposed borrow pit general arrangement and cross sections for the three borrow pits can be found in Appendix A.

3.2 Material Requirement Calculations

As indicated by the previous use of the proposed borrow pit locations and by the geological desktop assessment in Section 4, the geology of the Site indicates that the material extracted should be suitable for use in construction of the infrastructure required.

The estimated calculations, summarised in Table 1 below take into account the proposed access tracks, turbine hardstandings, substation and construction compounds.

Table 1 Estimated Material Requirements

Design Element	Depth (m)	Length (m)	Area (m^2)	Volume (m^3)
New Track	0.5	13,000	78,120	39,060
Upgraded Track	0.3	14,800	88,770	26,631
Turbine hardstanding	0.65	-	38,146	24,795
Substation	0.5	-	8,400	4,200
Construction compounds (x2)	0.5	-	10,000	5,000
Concrete aggregate	-	-	-	6,073
TOTAL				**105,758**

3.3 Borrow Pit Calculations

An estimate of the material generation from each of the borrow pits is presented in Table 2 below.

Table 2 Borrow Pit Material Generation

Borrow Pit	Borrow Pit 1	Borrow Pit 2	Borrow Pit 3	Total
Approximate coordinates	*264995 , 595617*	*270338, 597808*	*273112, 596712*	-
Footprint (m^2)	3,666	3,960	9,262	16,888
Cut volume (from Civil3D) (m^3)	16,302	28,000	82,500	**126,802**
After volume reduction coefficient	**13,042**	**26,600**	**78,375**	**118,017**

The calculated material volume extracted from each borrow pit has been reduced by a factor of 0.8 for small borrow pits (BP1) and 0.95 for well-established quarries (BP2 and BP3) to account for poor recovery, dilution, increased superficial cover and areas of unsuitable/poor strata as well as cut/fill inaccuracies and the conceptual status of design.

Further detailed design will allow track and hardstanding level variations to be designed for and the true cut & fill quantities to be calculated.

The high-level calculations in Table 2 indicate that the proposed borrow pits will provide the volume of material required to construct the on-site infrastructure (as per Table 1). A summary of the calculations is included in Appendix A.

4 Geology and Hydrogeology

This section summarises the geological and hydrogeological conditions on the Site and should be read in conjunction with **Chapter 6: Geology, Hydrology and Peat** of the EIA Report.

The specific ground conditions at the proposed borrow pit locations are highlighted throughout. All borrow pits are extensions of existing quarries or excavation works of some form.

4.1 Superficial

Review of the 1:50,000 scale British Geological Survey (BGS) map indicates that approximately 50 % of the Proposed Development Area is covered by superficial deposits; predominantly Devensian to Diamicton Glacial Till deposits. Quaternary Alluvium deposits (described as silt, sand and gravel) are also locally present above the Glacial Till within valleys to the eastern portion of the scheme extents, and to the west where the track terminates. There are also sporadic localised deposits of Quaternary Peat along the track and in the north of the Proposed Development; and hummocky (moundy) glacial deposits of Diamicton Sand and Gravel along the track. Superficial deposits are generally concentrated at lower level within tributary valleys, although Peat deposits are also shown locally on the hilltop plateaus.

No boreholes are shown to be available within the BGS GeoIndex website for the Proposed Development area.

Borrow Pit 1 is located on the periphery of Glacial Till deposits. The extent of these deposits will require delineation to determine their presence above the pits although based on the topography it is considered likely that excavation will be predominantly at higher elevation than the boundary of superficial deposits.

Borrow Pit 2 is not located within an area underlain by superficial deposits according to the BGS map.

Borrow Pit 3 is located on the periphery of Glacial Till deposits as shown on the BGS map. The extent of these deposits will require delineation to determine their presence within the pits. The thickness and composition of these deposits is unconfirmed although, based on the relatively elevated location towards the summit of Cormunnoch Hill (where bedrock is shown to be present from surface) and likely greater exposure to erosional rather than depositional processes, substantial thicknesses of superficial deposits are not anticipated if at all.

4.2 Bedrock

A review of the 1:50,000 scale British Geological Survey (BGS) map indicates the superficial deposits to be underlain by a series of bedrock units exposed in a thrust fault zone. The thrust faults are roughly parallel and the hanging wall side is to the northwest. The lowermost exposed unit is the Moffat Shale Group, occurring for limited extents directly adjacent to fault lines and described by the BGS as:

> *'Black shale, grey shale, bentonite, tuff.'*

Overlying the Moffat Shale Group is the Scaur Group (a turbidite sequence) of which a succession of three formations outcrop. Southeast of the thrust fault belt is the Shinnel Formation. Northwest of the thrust fault belt is the Portpatrick Formation, which occasionally interfingers with the Glenwhargen Formation. The Scaur Group 's BGS lithological descriptions are as follows:

> Shinnel Formation: *'Wacke, sandstone and siltstone turbidite succession.'*
> Portpatrick Formation: *'Wacke and siltstone turbidite succession.'*
> Glenwhargen Formation: *'Quartzose wacke and conglomerate turbidite unit.'*

Several dyke suites also penetrate the sequence.

Borrow Pit 1 and Borrow Pit 2 are situated upon wacke of the Portpatrick Formation. Borrow Pit 3 is situated upon wacke of the Shinnel Formation. No dykes are shown on the BGS map at these pit locations.

4.3 Suitability of Bedrock as Aggregate

The primary use of the aggregate extracted from borrow pits will be for the construction of tracks using unbound aggregate, with further aggregate required for construction of hardstandings, crane pads, substation and construction compounds.

The presence, thickness and composition of superficial Glacial Till deposits are not known although, as discussed in the Section 3.1, extensive thicknesses are not anticipated due to aspect and spatial trends. Glacial Tills are commonly suitable for reuse as general earthwork material and, if granular and subject to processing, potentially also suitable as capping material.

It is considered that any underlying solid deposits of sandstone may be suitable for processing to an aggregate for hardstanding subject to testing.

It is also considered that any underlying deposits of siltstone and wacke may also be suitable for reuse, although because of a greater potential for the material to be argillaceous, the material may potentially be considered suitable as general earthwork fill but not capping material.

Geotechnical investigation and testing will be required to establish that material won from the proposed borrow pits would be suitable for its intended purpose as an aggregate to form areas of unbound pavement.

4.4 Hydrogeology

The Portpatrick Formation and Glenwhargen Formation (undifferentiated) are regarded as low productivity aquifers whereby highly indurated greywackes hold limited groundwater within a near surface weathered zone and secondary fractures.

The Shinnel Formation is regarded as a low productivity aquifer whereby highly indurated rocks hold limited groundwater within a near surface weathered zone and secondary fractures.

The Moffat Shale Group is regarded as a low productivity aquifer with very limited groundwater from fractures and a very limited outcrop area.

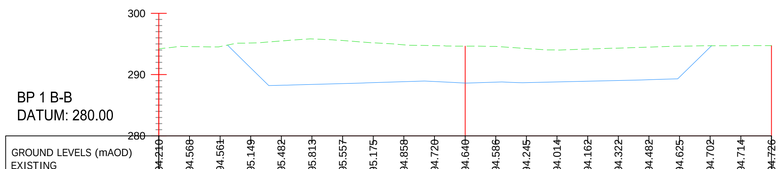
5 Conclusion

The borrow pits identified have been sited with due considerations of environmental constraints and designations. Approximate borrow pit dimensions and potential material extraction volumes have been estimated alongside material requirements for construction of infrastructure. It is estimated that a total material volume of approximately 118,000 m^3 could be extracted, with an estimated 105,500 m^3 required for construction, meaning it is likely that no material import will be required to construct the Proposed Development.

Detailed ground investigations, slope stability assessments and geotechnical testing will be required to inform the detailed design of the borrow pits.

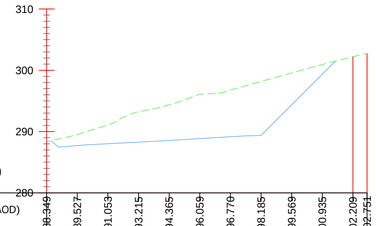
A detailed Borrow Pit Assessment will then be prepared post consent, this document will provide further detail on working methods and environmental management measures.

Appendix A : Borrow Pit Cross Sections



BP 1 B-B
DATUM: 280.00

GROUND LEVELS (mAOD) EXISTING	294.210	294.568	294.561	295.149	295.482	295.813	295.557	295.175	294.858	294.720	294.640	294.586	294.245	294.014	294.162	294.322	294.482	294.625	294.702	294.714	294.726		
PROPOSED LEVELS				291.085	288.250	288.388	288.532	288.678	288.843	288.870	288.613	288.761	288.676	288.794	288.913	289.031	289.161	289.595	294.485				
LEVEL DIFFERENCE				4.064	7.232	7.425	7.024	6.497	6.015	5.851	6.027	5.824	5.569	5.220	5.249	5.290	5.321	5.029	0.217				



BP 1 A-A
DATUM: 280.00

GROUND LEVELS (mAOD) EXISTING	288.349	289.527	291.053	293.215	294.365	296.059	296.770	298.185	299.569	300.935	302.209	302.751											
PROPOSED LEVELS		287.717	288.019	288.283	288.553	288.854	289.156	289.375	294.376	299.378													
LEVEL DIFFERENCE		1.810	3.033	4.931	5.812	7.205	7.614	8.811	5.192	1.557													

NOTE:

1. ALL DRAWINGS ARE TO BE READ IN CONJUNCTION WITH THE SPECIFICATION FOR HIGHWAY WORKS AND THE TURBINE MANUFACTURERS STANDARDS AND ALL RELEVANT DRAWINGS WITHIN THE PROJECT DESIGN PACKAGE.
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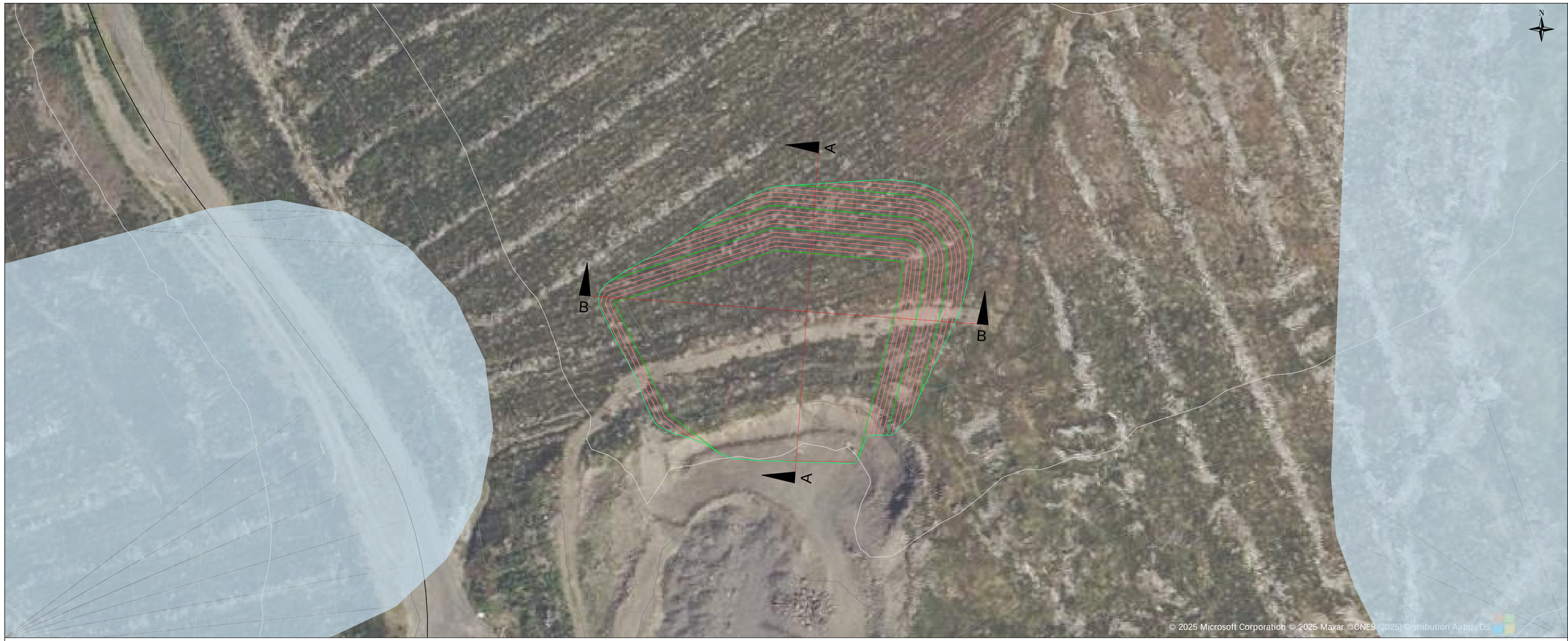
Client
Statkraft

Project
Appin Wind Farm

Drawing Title
Borrow Pit 1
Cross Section

	Name	Date	
Designed	CN	18.04.2025	Scale 1:500 @ A1
Checked	JS	02.05.2025	File Appin Site Master
			Drawing Status DRAFT

Drawing No. SK01
Revision P1



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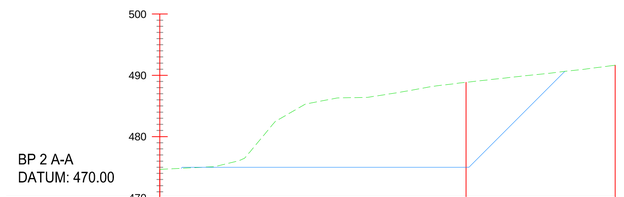
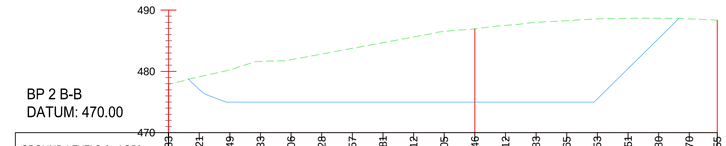


BP 2 A-A
DATUM: 470.00

GROUND LEVELS (mAOD) EXISTING	474.651	474.904	475.364	477.856	483.137	485.553	486.338	486.582	487.377	488.252	488.864	489.415	489.966	490.509	491.091	491.646	
PROPOSED LEVELS	439.684	440.911	442.562	444.566	447.610	450.168	452.446	454.505	456.283	457.849	459.552	461.301	463.044	464.843	466.739	468.422	469.870
LEVEL DIFFERENCE	34.967	33.993	32.801	33.290	35.528	35.385	33.892	32.077	31.094	30.403	29.312	28.115	26.922	25.667	24.352	23.224	



BP 2 B-B
DATUM: 470.00

GROUND LEVELS (mAOD) EXISTING	477.863	479.121	480.249	481.633	481.906	482.828	483.757	484.681	485.612	486.505	486.946	487.512	487.983	488.265	488.553	488.651	488.680	488.570	488.355
PROPOSED LEVELS		477.065	474.990	474.990	474.990	474.990	474.990	474.990	474.990	474.990	474.990	474.990	474.990	474.990	475.519	480.444	485.370		
LEVEL DIFFERENCE		2.055	5.259	6.643	6.916	7.838	8.768	9.691	10.622	11.515	11.956	12.522	12.993	13.275	13.034	8.207	3.310		

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Client
Statkraft

Project
Appin Wind Farm

Drawing Title
Borrow Pit 2
Cross Section

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Checked	JS	02.05.2025	Drawing Status	DRAFT

Drawing No. SK02
Revision P1

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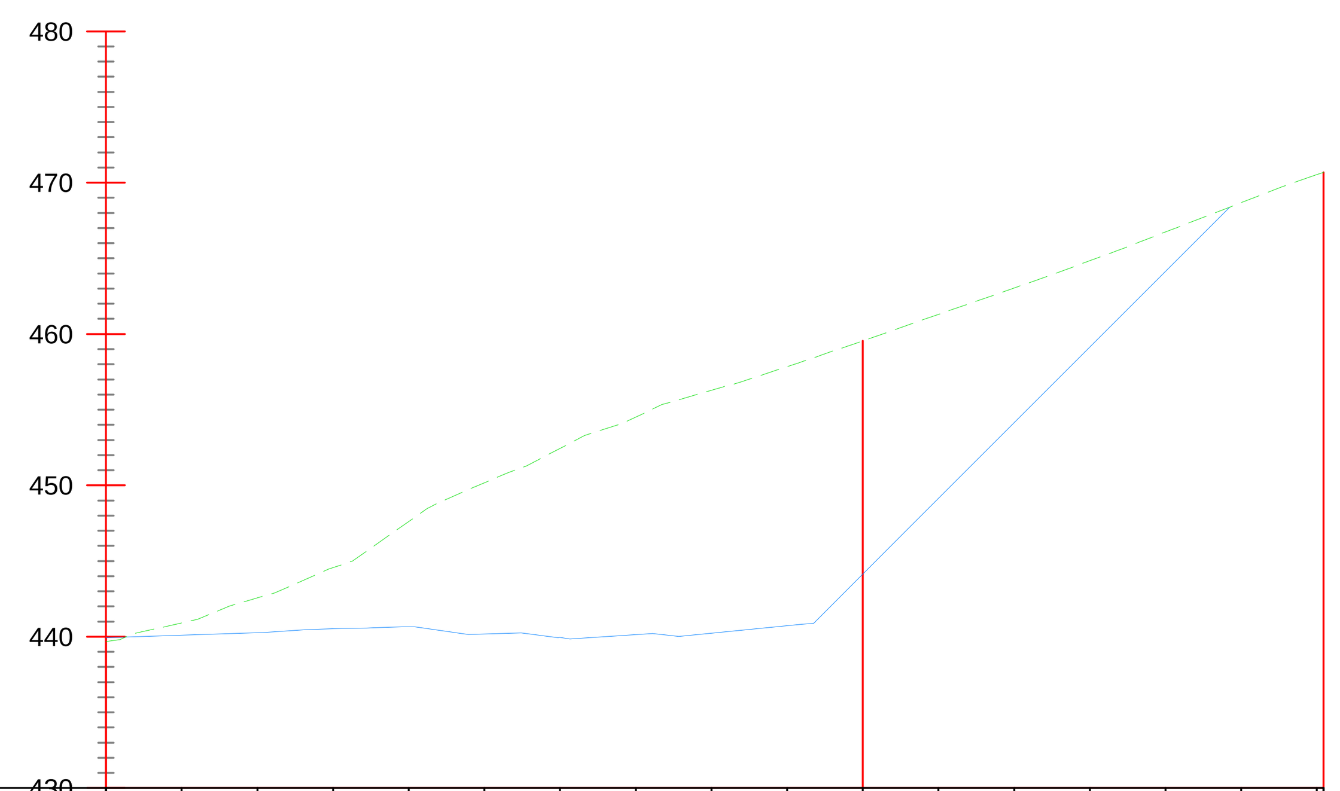
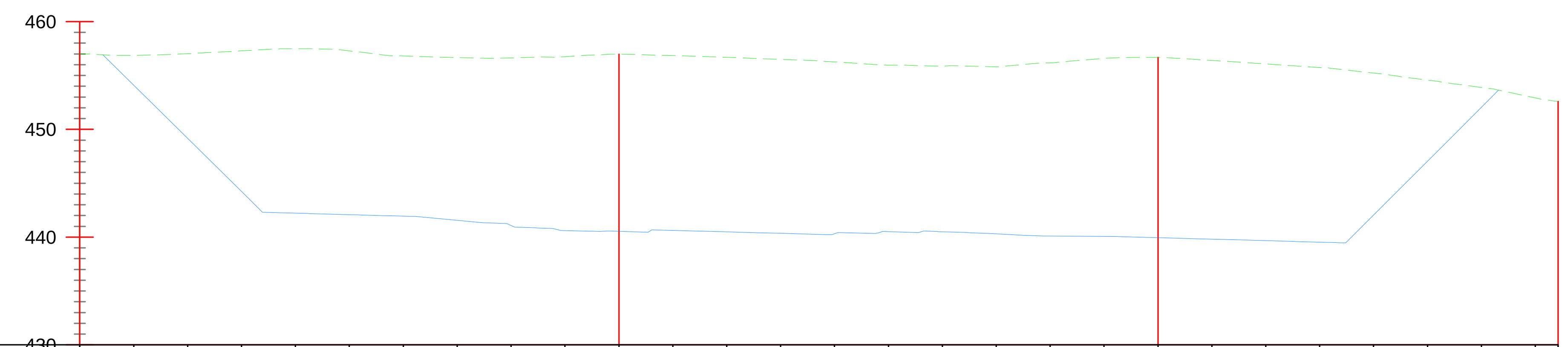


BP 3 A-A
DATUM: 430.00

GROUND LEVELS (mAOD) EXISTING	PROPOSED LEVELS	LEVEL DIFFERENCE
439.684	439.942	-0.259
440.911	440.104	0.807
442.562	440.259	2.303
444.566	440.535	4.031
447.610	440.655	6.955
450.168	440.181	9.986
452.446	439.940	12.506
454.505	440.137	14.368
456.283	440.236	16.047
457.849	440.723	17.126
459.552	444.143	15.409
461.301	449.144	12.156
463.044	454.145	8.899
464.843	459.147	5.696
466.739	464.148	2.591
468.680		
470.585		



BP 3 B-B
DATUM: 430.00

GROUND LEVELS (mAOD) EXISTING	PROPOSED LEVELS	LEVEL DIFFERENCE
456.997		
456.865	454.092	2.773
457.018	449.160	7.858
457.282	444.228	13.054
457.473	442.225	15.247
457.278	442.085	15.193
456.809	441.945	14.864
456.659	441.559	15.100
456.629	441.077	15.552
456.741	440.607	16.134
456.961	440.535	16.426
456.840	440.625	16.216
456.688	440.489	16.199
456.492	440.354	16.139
456.259	440.311	15.948
455.949	440.501	15.448
455.849	440.503	15.345
455.803	440.306	15.498
456.170	440.112	16.058
456.586	440.070	16.516
456.677	439.952	16.726
456.396	439.812	16.584
456.069	439.672	16.397
455.729	439.532	16.197
455.225	442.053	13.172
454.572	447.052	7.521
453.891	452.050	1.841
452.917		
452.596		

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Client: Statkraft

Project: Appin Wind Farm

Drawing Title: Borrow Pit 3 Cross Section

	Name	Date
Designed	CN	18.04.2025
Checked	JS	02.05.2025

Scale: 1:500 @ A1
File: Appin Site Master
Drawing Status: DRAFT
Drawing No.: SK03
Revision: P1

Appendix B : Borrow Pit Volume Calculations Sheet

Calculation sheet

Subject / Project : Appin Wind Farm
Job No. / Project No : 10109669 Ref : Material Requirements Date : 09/05/2025
Prepared by : CN Checked : SCM

Material Requirements

General Parameters

Typical Track width =	6	m	
Cut track thickness =	0.50	m	
Upgraded track thickness =	0.30	m	
Hardstand thickness =	0.65	m	
Substation thickness =	0.50	m	
Construction compound thickness =	0.50	m	

New Track Length =	13,020		
New Track Volume =	**39,060**		
Uprgaded track Length =	14,795		
Upgraded track volume =	**26,631**		
Turbine hardstand nr. =	9		
Turbine hardstand area =	4,238	m^2	(per hardstand)
Total turbine hardstand area =	38,146	m^2	
Total turbine hardstand volume =	**24,795**	**m^3**	
Substation area =	8,400	m^2	
Substation volume =	**4,200**	**m^3**	
Construction compound 1 area =	5,000	m^2	
Construction compound 1 volume =	**2,500**	**m^3**	
Construction compound 2 area =	5,000	m^2	
Construction compound 2 volume =	**2,500**	**m^3**	
Concrete aggregate volume =	**6,073**	**m^3**	
TOTAL =	**105,758**	**m^3**	

Borrow Pit - Initial Volume Calculations

Borrow Pit 1

Total Footprint (exc tie-in) =	2,324	m^2	
Total Footprint (inc tie-in) =	3,666	m^2	
Cut volume (from Civil3D) =	16,302	m^3	
Volume reduction coefficient =	0.8		(to account for overburden and any losses during processing)
Total volume =	**13,042**	**m^3**	

Borrow Pit 2

Total Footprint (exc tie-in) =	2,252	m^2	
Total Footprint (inc tie-in) =	3,960	m^2	
Cut volume (from Civil3D) =	28,000	m^3	
Volume reduction coefficient =	0.95		Large Quarry
Total volume =	**26,600**	**m^3**	

Borrow Pit 3 (SITE)

Total Footprint (exc tie-in) =	4,637	m^2	
Total Footprint (inc tie-in) =	9,262	m^2	
Cut volume (from Civil3D) =	82,500	m^3	
Volume reduction coefficient =	0.95		Large Quarry
Total volume =	**78,375**	**m^3**	

Overall Balance

Material required =	105,758	m^3	
Material generated =	118,017	m^3	
OVERALL BALANCE =	**12,258**	**m^3**	(-ve is shortfall)