NORTHCONNECT
CONNECTING RENEWABLES

NorthConnect Interconnector Converter Station and High Voltage Alternating Current Cable Route

Environmental Statement
Volume 3
Appendixes
April 2015

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VATTENFALL

Contents

Appendix A.1: Construction Noise Sources

Appendix A.2: Operational Noise Sources

Appendix A.3: Noise Monitoring Result Logs

Appendix A.4: Assessment of Blasting

Appendix B.1: Extended Phase 1 Habitat Survey Target Notes

Appendix B.2: Otter, Water vole & Badger Survey

Appendix C: Viewpoint Assessment

Appendix D: Trial Pit and Borehole Logs

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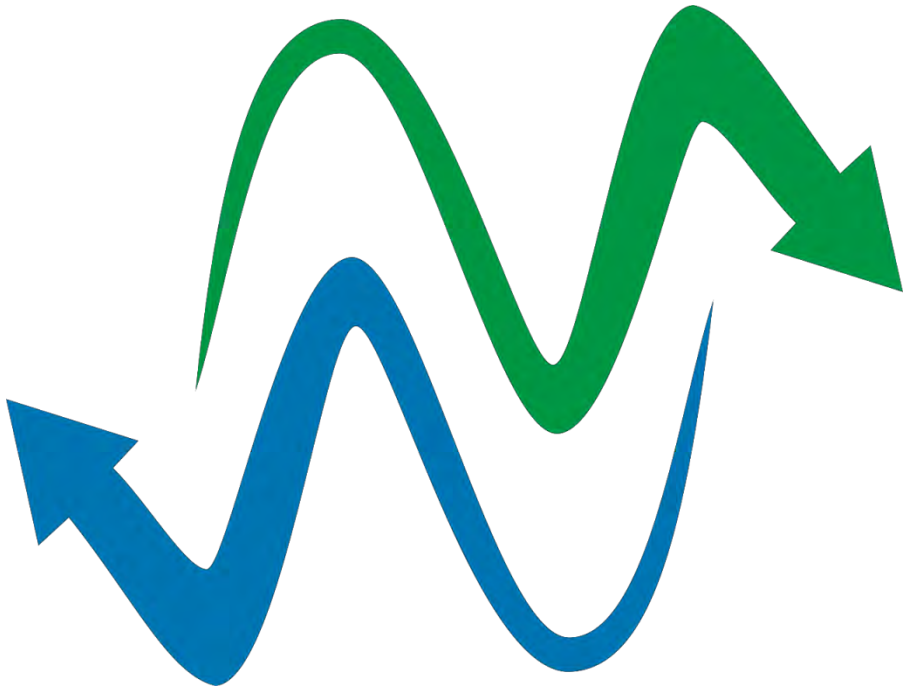

Appendix A.1: Construction Noise Sources

Appendix A.1

Indicative construction source noise terms and schedule of works.

Table A.1.1: Source Noise Terms from BS 5228-1:2009

Plant	BS 5228-1:2009 Reference	Description	SPL @ 10 m dB(A)
Large Tracked Excavator	TABLE C2 #14	Tracked excavator 226 kW, 40 t	79
Articulated Dump Truck	TABLE C4 #1	Articulated dump truck ж 194 kW, 25 t	81
Compactor	TABLE C2 #41	Vibratory plate (petrol) 3 kW, 62 kg	80
Scraper	TABLE C6 #31	Grader ж 205 kW, 25 t	86
Crusher	TABLE C9 #15	Tracked semi-mobile crusher 250 kW, 38 t	96
Hammer Attachment	TABLE C9 #13	Excavator mounted rock breaker 100 kW, 22 t	95
Medium Tracked	TABLE C2 #3	Tracked excavator 102 kW, 22 t	78
Dump Truck	TABLE C9 #21	Rigid dump truck ж 362 kW, 41 t	90
Vibratory Roller	TABLE C2 #39	Vibratory roller ж 29 kW, 4 t	74
Crane - Lorry Mounted	TABLE C4 #45	Mobile telescopic crane 260 kW, 55 t	82
Wheeled Excavator	TABLE C4 #12	Wheeled excavator ж 63 kW, 14 t	77
Concrete Pump - Lorry	TABLE C4 #29	Truck mounted concrete pump + boom arm 26 t	80
Poker Vibrator	TABLE C4 #33	Poker vibrator	78
MEWP	TABLE C4 #59	Diesel scissor lift 24 kW, 6 t	78
Road Roller	TABLE C5 #19	Road roller ж 95 kW, 22 t	80
Paving Machine	TABLE C5 #32	Asphalt paver (+ tipper lorry) ж 94 kW, 18 t	84
Diesel Combined Rig	TABLE C3 #15	Tracked drilling rig with hydraulic drifter 104 kW, 12.5 t	82
Concrete Mixer	TABLE C4 #22	Large concrete mixer 167 kW, 26 t	76
Dozer	TABLE C2 #1	Dozer ж 142 kW, 20 t	75
HGV	TABLE C11 #11	Lorry ж 306 kW, 44 t	86

Table A.1.2: Source Noise Terms supplied by Allen Gordon Associates

Plant	SPL @ 10 m dB(A)
Track Type Tractor	90
Power Float	60
Tipper Lorry Waiting	80

- Phase 1 – Preliminary works (including access road improvements) ;
- Phase 2 – Site preparation, soil strip, earthworks, stage 1 landscaping and platform;
- Phase 3 – Converter build and HVAC cable installation ; and
- Phase 4 – Stage 2 landscaping and reinstatement.

Table A.1.3: Indicative plant in operation in each phase

	Phase			
Plant	1	2	3	4
Large Tracked Excavator	-	4	2	2
Articulated Dump Truck	-	5	-	2
Compactor	-	2	1	1
Track Type Tractor	-	-	1	-
Scraper	-	-	-	-
Crusher	-	1	-	-
Hammer Attachment	1	2	-	-
Medium Tracked	-	-	2	-
Dump Truck	1	-	1	-
Vibratory Roller	1	2	1	-
Crane - Lorry Mounted	-	-	1	-
Wheeled Excavator	1	-	1	1
Concrete Pump - Lorry	-	-	1	-
Poker Vibrator	-	-	1	-
MEWP	-	-	1	-
Power Float	-	-	1	-
Road Roller	1	-	1	1
Paving Machine	1	-	1	1
Diesel Combined Rig	-	-	1	-
Concrete Mixer	1	-	1	1
Dozer	-	2	-	-
Tipper Lorry Waiting	1	-	1	1

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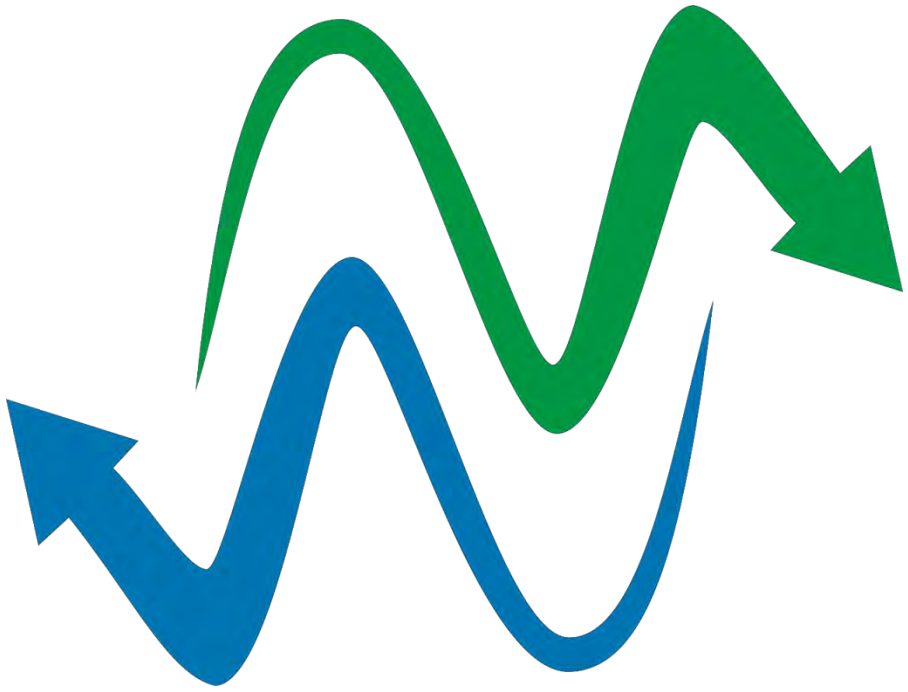

Appendix A.2: Operational Noise Sources

Appendix A.2

Table A.2.1: Indicative operational sound power level data, dBLwA

	Sound Power Level										
Item	**Frequency (Hz)**									**Sum**	
	31.5	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**	**A-weighted**	**Design Mitigation**
Transformer (Enclosed)	31.6	58.8	77.9	90	90.8	73	72.2	62	54.9	93.6	10m barrier surrounding SGTs and 10m blast walls between
Auxiliary Transformer	-17.4	12.8	28.9	45.4	53.8	52	42.2	31	23.9	56.6	None
Flat Type Coolers with limit on Fan Speed (Quieter)	0.6	24.6	56.7	70.2	76.6	81.8	84	79.8	68.7	87.5	6m barrier 3m away
Air Handling Units	-39.4	23.8	63.9	76.2	79.8	75	1.2	1	-1.1	82.3	None
L1 Reactor	-55.4	-31.2	23.9	36.4	75.8	78	72.2	53	8.9	80.7	Additional Reactor Mitigation included
C1 Cap with mitigation	-44.4	-31.2	43.9	61.4	77.8	83	56.2	46	-6.1	84.2	5 dB attenuation included
C2/C3 Cap with Mitigation	-39.4	52.8	40.9	48.4	22.8	0	1.2	1	-1.1	54.3	None

Table A.2.2: Height of equipment above ground level (AGL)

Item	Height AGL (m)
Transformer	4
Auxiliary Transformer	2
Flat Type Coolers	2.5
Air Handling Units	5
L1 Reactor	2
C1 Capacitor	10
C2 C3 Capacitor	2

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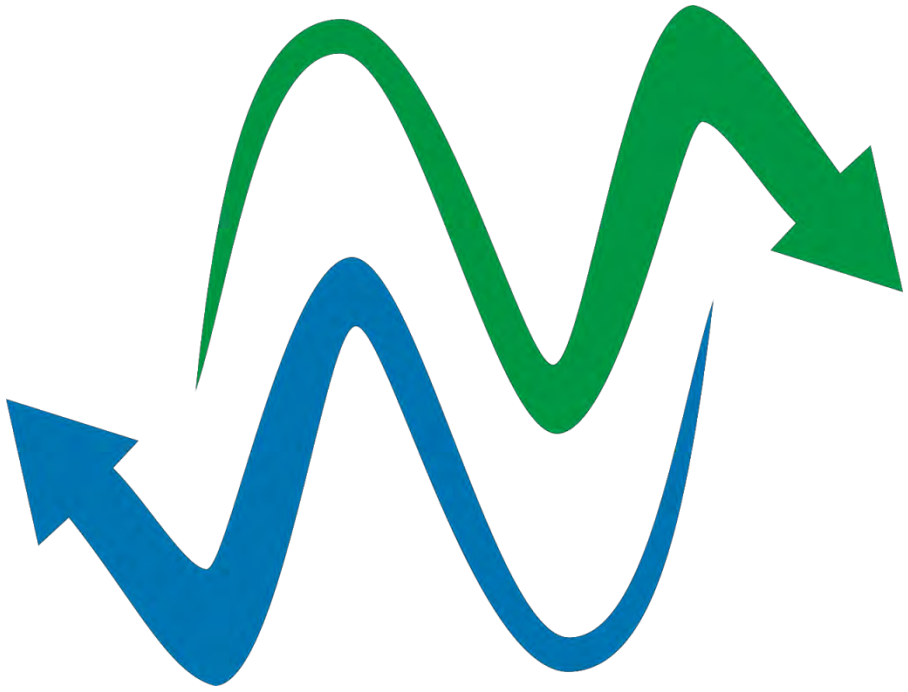

Appendix A.3: Noise Monitoring Result Logs

Appendix A.3

Table A.3.1: NMP 1 Converter Site

Start time	Duration (mm:ss)	L_{Aeq} (dB)	L_{Amax} (dB)	L_{A10} (dB)	L_{A90} (dB)
Daytime - 25/11/2014					
12:05	05:00	47.4	57.6	51.0	40.9
12:10	05:00	44.1	49.3	45.8	41.8
12:15	05:00	54.3	66.5	59.9	41.2
12:20	05:00	59.0	72.6	62.6	40.5
12:25	05:00	45.0	54.8	46.5	42.0
12:30	05:00	47.4	64.8	48.7	42.4
12:35	05:00	44.2	49.3	45.5	42.6
12:40	05:00	58.1	72.3	61.3	43.3
12:45	05:00	54.0	70.6	54.7	43.5
12:50	05:00	44.8	52.0	47.0	42.1
12:55	05:00	47.5	57.7	52.1	39.6
13:00	05:00	44.0	63.3	45.6	40.0
Night-time - 25/11/2014					
23:48	05:00	29.9	48.5	32.2	24.2
23:53	05:00	32.3	48.2	35.9	26.2
23:58	05:00	34.7	46.1	38.7	25.9

Comments:

This NSR is a rural location in the middle of a field, away from any housing. During the daytime, constant traffic noise from the A90 was the dominant noise source. There were occasional helicopters flying overhead. Other noise sources included bird calls and distant engine and machinery noise from the nearby quarry. During the night-time, there was noise from occasional vehicles on the A90, which was the dominant source of noise. A low level whine was audible from the nearby remote RADAR head. Distant noise from the sea and ships out at sea were audible, as well as calls from birds.

Table A.3.2: NMP 2 Highfield

Start time	Duration (mm:ss)	L_{Aeq} (dB)	L_{Amax} (dB)	L_{A10} (dB)	L_{A90} (dB)
Daytime - 25/11/2014					
13:50	05:00	44.9	58.5	47.3	41.1
13:55	05:00	41.4	47.9	42.9	39.7
14:00	05:00	43.6	50.1	45.3	41.1
14:05	05:00	44.2	49.6	46.2	41.4
14:10	05:00	46.7	56.1	49.7	42.0
14:15	05:00	42.0	50.7	43.8	39.6
14:20	05:00	41.3	50.3	43.2	38.2
14:25	05:00	41.9	48.5	44.7	37.0
14:30	05:00	42.0	48.8	44.4	38.8
14:35	05:00	42.6	67.9	41.6	36.6
14:40	05:00	41.0	48.2	42.6	39.2
14:45	05:00	44.5	56.2	47.8	38.7
Night-time - 25/11/2014					
23:30	05:00	40.5	59.9	36.4	23.4
23:35	05:00	32.7	59.2	34.5	23.3
23:40	05:00	27.9	48.1	29.6	21.8

Comments:

This NSR is dwelling in a rural setting away from other housing, accessed by a short track. The noise monitoring was undertaken on the access track to the west of the dwelling. This location is shielded from the A90 road and would have direct line of sight to the proposed converter station location. During the daytime, constant traffic noise from the A90 was the dominant noise source. There were occasional helicopters flying overhead. Other noise sources included occasional bird calls. During the night-time, there was noise from occasional vehicles on the A90, which was the dominant source of noise. A distant low level, low frequency rumble was audible, most likely from ships out at sea.

Table A.3.3: NMP 3 Lendrum Terrace

Start time	Duration (mm:ss)	L_{Aeq} (dB)	L_{Amax} (dB)	L_{A10} (dB)	L_{A90} (dB)
Daytime - 25/11/2014					
10:55	05:00	48.6	62.8	50.3	42.9
11:00	05:00	46.8	56.2	49.3	43.3
11:05	05:00	46.4	53.5	49	42.1
11:10	05:00	44.7	53.6	47.3	40.8
11:15	05:00	57.0	79.1	54.3	41.9
11:20	05:00	55.2	68.4	59.7	43.2
11:25	05:00	47.2	62.2	50.1	40.5
11:30	05:00	45.0	52.8	47.5	41.4
11:35	05:00	54.2	74.8	51.3	42.4
11:40	05:00	49.1	68.2	51	42.5
11:45	05:00	62.3	73.4	67.1	43.6
11:50	05:00	46.0	54.0	48.2	42.1
Night-time - 25/11/2014					
23:00	05:00	38.3	66.6	40.6	26.8
23:05	05:00	48.4	68.5	52.5	27.2
23:15	05:00	31.7	53.0	32.5	27.1

Comments:

This NSR is a row of houses set along a rural road. The road is mainly used for access rather than a through route. The monitoring was undertaken adjacent to the most eastern dwelling of the row, as this dwelling is furthest from A90. During the daytime, constant traffic noise from the A90 was the dominant noise source. There were occasional helicopters flying overhead. Other noise sources included bird calls, water running in a ditch (low level), public address system and alarms from the power station and the engines of ships at sea. During the night-time, there was noise from occasional vehicles on the A90, which was the dominant source of noise. A distant low level, low frequency rumble was audible, most likely from ships out at sea. The running water in the ditch was more noticeable due to the reduction in A90 traffic and overall noise levels.

Table A.3.4: NMP 4 Hill of Boddam Viewpoint

Start time	Duration (mm:ss)	L_{Aeq} (dB)	L_{Amax} (dB)	L_{A10} (dB)	L_{A90} (dB)
Daytime - 25/11/2014					
10:55	05:00	45.0	58.0	48.1	40.6
11:00	05:00	46.5	61.5	49.9	39.3
11:05	05:00	44.9	56.2	47.9	39.4
11:10	05:00	45.9	59.0	48.9	41.1
11:15	05:00	51.2	61.8	56.2	40.8
11:20	05:00	52.6	63.8	57.7	42.2
11:25	05:00	44.0	58.9	45.7	38.8
11:30	05:00	41.6	61.9	43.2	38.1
11:35	05:00	42.2	50.7	44.4	39.2
11:40	05:00	45.3	56.2	48.2	40.7
11:45	05:00	63.9	76.0	67.4	46.5
11:50	05:00	44.3	61.4	46.4	40.9
Night-time - 26/11/2014					
00:31	05:00	37.6	56.2	37.8	30.1
00:36	05:00	32.1	47.0	33.2	30.4
00:41	05:00	42.9	58.4	47.2	32.0

Comments:

This NSR is a rural location at the top of a hill, away from any housing. The monitoring was undertaken at the viewpoint. During the daytime, constant traffic noise from the A90 was the dominant noise source. There were occasional helicopters flying overhead. Other noise sources included bird calls, occasional engine and machinery noise from the nearby quarry and distant engines of ships at sea.

During the night-time, there was noise from occasional vehicles on the A90 and the sea and waves breaking. These were the most significant noise sources. A low level whine was audible from the nearby remote RADAR head. Distant noise from the engines of ships out at sea could was audible, a low level, low frequency rumble.

Table A.3.5: NMP 5 Gateside Access Road

Start time	Duration (mm:ss)	L_{Aeq} (dB)	L_{Amax} (dB)	L_{A10} (dB)	L_{A90} (dB)
Daytime - 25/11/2014					
12:15	05:00	54.5	65.8	59.5	42.6
12:20	05:00	61.1	74.6	65.0	43.3
12:25	05:00	46.0	57.6	47.7	43.4
12:30	05:00	44.9	57.0	46.0	43.6
12:35	05:00	46.0	54.4	47.1	44.2
12:40	05:00	53.2	65.1	59.0	45.2
12:45	05:00	58.0	71.9	59.7	44.6
12:50	05:00	50.7	69.9	50.0	44.9
12:55	05:00	48.9	55.5	52.1	44.8
13:00	05:00	54.5	76.5	51.1	45.5
13:05	05:00	48.1	54.7	50.1	46.0
13:10	05:00	49.9	60.6	53.8	44.6
Night-time - 25/11/2014					
23:06	05:00	33.7	57.7	35.4	30.2
23:11	05:00	34.7	49.1	37.3	30.4
23:16	05:00	33.2	44.1	35.2	30.6

Comments:

This NSR is a dwelling in a rural setting away from other housing, but still by a road. The road is mainly used for access rather than a through route. As the road had very little traffic, monitoring was undertaken at the road side next to the property Hjaltland to be representative of the Hjaltland and Gateside properties. During the daytime, constant traffic noise from the A90 was the dominant noise source. There were occasional helicopters flying overhead. Other noise sources included bird calls, a distant unidentified industrial noise source to the north, a constant buzz from overhead power lines and the low level, low frequency rumble of the engines of ships at sea.

During the night-time, there was noise from occasional vehicles on the A90, which was the dominant source of noise. The buzz from the overhead power line was a lot more noticeable and there were occasional bird calls.

Table A.3.6: NMP 6 Longhaven Mains

Start time	Duration (mm:ss)	L_{Aeq} (dB)	L_{Amax} (dB)	L_{A10} (dB)	L_{A90} (dB)
Daytime - 25/11/2014					
13:50	05:00	47.8	61.0	51.7	40.5
13:55	05:00	42.1	53.0	43.6	39.9
14:00	05:00	40.2	47.4	42.7	36.5
14:05	05:00	39.9	52.4	42.1	35.6
14:10	05:00	46.2	58.9	49.8	39.9
14:15	05:00	39.3	47.9	41.6	35.6
14:20	05:00	38.7	53.9	41.0	34.7
14:25	05:00	38.1	45.4	40.7	34.3
14:30	05:00	42.1	49.9	45.2	37.5
14:35	05:00	39.6	47.6	42.8	35.5
14:40	05:00	42.4	48.1	45.0	38.0
14:45	05:00	52.5	66.3	56.2	41.3
Night-time - 26/11/2014					
00:35	05:00	29.0	34.2	29.7	28.2
00:40	05:00	50.7	67.8	53.7	29.1
00:45	05:00	45.9	67.3	41.2	26.6

Comments:

This NSR is a farm, set back from the A90 and accessed by a track. No other housing is close by. The monitoring was undertaken at a location in line with the front façade of the farm house. This location is shielded slightly by the farm house from the A90, however all sides of the farm are somewhat exposed to traffic noise. During the daytime, distant constant traffic noise from the A90 was the dominant noise source. There were occasional helicopters flying overhead. Other noise sources included bird calls, a distant unknown industrial noise source to the north east and an occasional buzz from the remote RADAR head. During the night-time, there was distant noise from occasional vehicles on the A90 and the sea and waves breaking. These were the most significant noise sources.

Table A.3.7: NMP 7 Stirlinghill

Start time	Duration (mm:ss)	L_{Aeq} (dB)	L_{Amax} (dB)	L_{A10} (dB)	L_{A90} (dB)
Daytime - 25/11/2014					
15:10	05:00	63.8	74.9	67.5	52.0
15:15	05:00	66.2	74.6	70.2	55.2
15:20	05:00	66.6	82.0	69.9	53.8
15:25	05:00	66.3	73.5	69.6	54.2
15:30	05:00	64.5	74.0	68.9	44.8
15:35	05:00	67.9	85.0	71.4	52.2
15:40	05:00	66.6	73.5	69.6	57.2
15:45	05:00	65.0	72.5	69.0	49.3
15:50	05:00	64.1	72.4	68.2	49.0
15:55	05:00	65.8	73.3	69.6	51.3
16:00	05:00	65.4	73.5	68.7	54.9
16:05	05:00	65.7	72.5	69.4	53.1
Night-time - 26/11/2014					
00:57	05:00	33.0	48.6	34.5	30.1
01:02	05:00	34.7	57.9	35.7	32.4
01:09	05:00	57.5	78.1	52.7	29.6

Comments:

This NSR is a row of houses set along a busy main A road, the A90. To be representative of the free-field noise level at the distance of the houses from the road, a monitoring location in a layby further north was used. This allowed a similar setback from the road to be achieved without any reflections from the façades interfering with the measurement. During the daytime, constant traffic noise from the A90 was the dominant noise source. Other noise sources included bird calls, helicopters passing overhead and a distant unknown industrial noise source to the north east. During the night-time, there was noise from occasional vehicles passing on the A90 and a constant noise from the sea and waves breaking. Other noise sources included bird calls.

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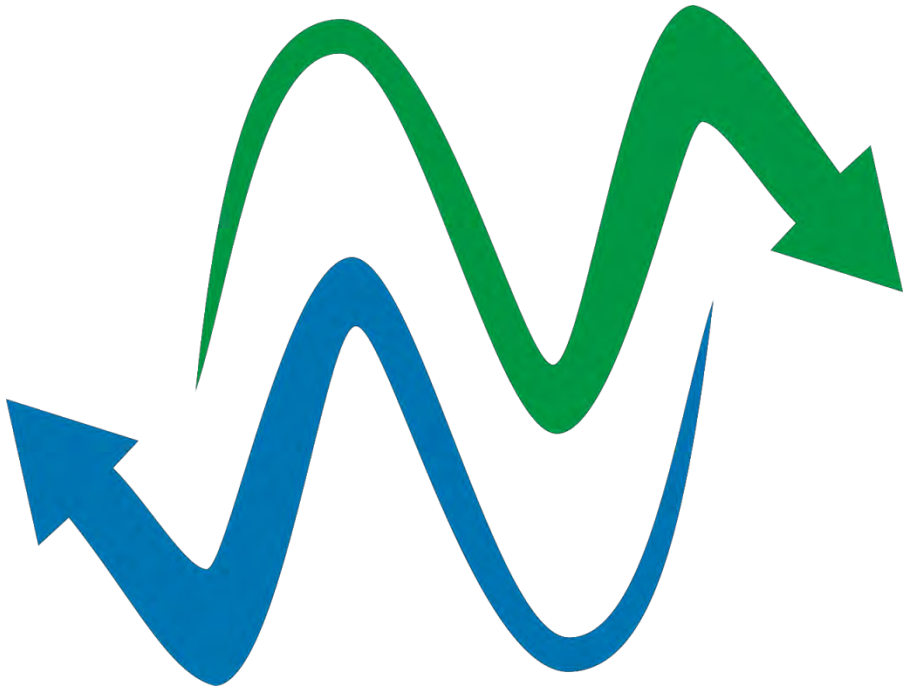

Appendix A.4: Assessment of Blasting

Assessment of Environmental Impact of Blasting at Fourfields Interconnector Converter Station Site, Aberdeenshire

NORTHCONNECT

R15.8589/2/AF
Date of Report: 11 March 2015

QUALITY MANAGEMENT

Report Title:	Assessment of Environmental Impact of Blasting at Fourfields Interconnector Converter Station Site, Aberdeenshire
Client:	NorthConnect
Report Number:	R15.8589/2/AF
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CONTENTS

1.0	Introduction	1
2.0	Site Description	3
3.0	Effects of Blasting	4
4.0	Blast Vibration Terminology	5
5.0	Vibration Criteria	8
6.0	Prediction and Control of Vibration Levels	13
7.0	Blast Vibration Data	17
8.0	Discussion	18
9.0	Conclusions	21
10.0	Recommendations	22
11.0	References	24

TABLES

1	BS 7385 Vibration Criterion
2	USBM recommendations for Measurement of Air Overpressure
3	BS 6472-2 Human Response to Vibration
4	Allowable Maximum Instantaneous Explosive Charge Weights – Inhabited Property at Fourfields Interconnector Converter Station Site
5	Predicted Vibration Levels – Vibration Receptors at Fourfields Interconnector Converter Station Site
6	Rock Depths and Explosive Charge Weights
7	Significance of Vibration Impact

FIGURES

1	Blast Areas
2	Vibration Receptors

1.0 INTRODUCTION

1.1 NorthConnect is a commercial joint venture proposing to operate a high voltage direct current electricity transmission link between Scotland and Norway. The proposed Interconnector Converter Station (ICS) in Scotland is to be located at Fourfields, Boddam, Aberdeenshire.

1.2 The Fourfields ICS will be formed, generally, on land to the south of Lendrum Terrace and west of Stirlinghill Quarry. The design of the ICS is such that there will be some major excavation to establish the proposed floor level, work which will involve rock extraction. Some of the rock deposit will be excavated without any pre-treatment, some will be ripped in advance of excavation but there will be areas where blasting is required to fragment the rock before it is removed.

1.3 A Planning Application for the development will be submitted to Aberdeenshire Council, accompanied by an Environmental Statement.

1.4 Rock blasting can, if not properly controlled, lead to adverse environmental impacts associated primarily with vibration, both ground and airborne. Accordingly it has been considered prudent to undertake an assessment regarding the implications of these proposals with respect to blast induced vibration.

1.5 Vibrock Limited, a national, independent firm of environmental consultants, has been engaged by NorthConnect to undertake this study.

1.6 As noted above, even the most well designed and executed of blasts must generate a certain amount of energy in the form of both ground vibration and airborne vibration.

1.7 As such, it is not unusual for the operators of such sites to be required to comply with a condition that limits ground vibration at the nearest sensitive locations. Airborne vibration limits are not usual for reasons detailed within this report.

1.8 The assessment of the implications of blasting operations within the Fourfields ICS considered: -

1. The potential effect of blast induced vibration upon the occupants of residential property and other sensitive structures.

2. Production of allowable instantaneous explosive charge weights for given separation distances.

3. Recommendations for any mitigation / minimisation measures that should be adopted.

1.9 Vibration predictions within this report have been based upon the likely blast designs at the site and data from monitoring typical production blasts at sites working strata similar to that which will be encountered, including at Stirlinghill Quarry.

2.0 SITE DESCRIPTION

2.1 The ICS is located some 4 km south of Peterhead town centre and 1.3 km south west of the centre of Boddam. Lendrum Terrace is some 300 metres north north east of the site. South of the site there are radar and telecommunication facilities.

2.2 The north east and central parts of the area to be excavated will not require blasting. This activity will only be necessary in around ⅓ of the site, all to the south west corner.

2.3 The land forming the site is currently in arable agricultural use.

2.4 The anticipated rock face height in the area to be blasted is some 14 metres. The maximum instantaneous explosive charge for this depth of face would, in the absence of any constraint, be around 145 kg.

2.5 However, the optimum blast design may vary from blast to blast and will necessarily be decided by the developer with reference to the site specific conditions and in order to comply with the recommended vibration criteria.

3.0 EFFECTS OF BLASTING

3.1 When an explosive detonates within a borehole stress waves are generated causing very localised distortion and cracking. Outside of this immediate vicinity, however, permanent deformation does not occur. Instead, the rapidly decaying stress waves cause the ground to exhibit elastic properties whereby the rock particles are returned to their original position following the passage of the stress waves. Such vibration is always generated even by the most well designed and executed of blasts and will radiate away from the blast site attenuating as distance increases.

3.2 With experience and knowledge of the factors which influence ground vibration, such as blast type and design, site geology and receiving structure, the magnitude and significance of these waves can be accurately predicted at any location.

3.3 Vibration is also generated within the atmosphere where the term air overpressure is used to encompass both its audible and sub-audible frequency components. Again, experience and knowledge of blast type and design enables prediction of levels and an assessment of their significance. In this instance, predictions can be made less certain by the fact that air overpressure levels may be significantly influenced by atmospheric conditions. Hence the most effective method of control is its minimisation at source.

3.4 It is important to realise that for any given blast it is very much in the operator's interest to always reduce vibration, both ground and airborne to the minimum possible in that this substantially increases the efficiency and hence economy of blasting operations.

4.0 BLAST VIBRATION TERMINOLOGY

4.1 Ground Vibration

4.1.1 Vibration can be generated within the ground by a dynamic source of sufficient energy. It will be composed of various wave types of differing characteristics and significance collectively known as seismic waves.

4.1.2 These seismic waves will spread radially from the vibration source decaying rapidly as distance increases.

4.1.3 There are four interrelated parameters that may be used in order to define ground vibration magnitude at any location. These are:-

Displacement - the distance that a particle moves before returning to its original position, measured in millimetres (mm).

Velocity - the rate at which particle displacement changes, measured in millimetres per second (mms^{-1}).

Acceleration - the rate at which the particle velocity changes, measured in millimetres per second squared (mms^{-2}) or in terms of the acceleration due to the earth's gravity (g).

Frequency - the number of oscillations per second that a particle undergoes measured in Hertz (Hz).

4.1.4 Much investigation has been undertaken, both practical and theoretical, into the damage potential of blast induced ground vibration. Among the most eminent of such research authorities are the United States Bureau of Mines (USBM), Langefors and Kihlström, and Edwards and Northwood. All have concluded that the vibration parameter best suited as a damage index is particle velocity.

4.1.5 Studies by the USBM have clearly shown the importance of adopting a monitoring approach that also includes frequency.

4.1.6 Thus the parameters most commonly used in assessing the significance of an impulsive vibration are those of particle velocity and frequency which are related for sinusoidal motion as follows:-

$$PV = 2 \pi f a$$

where PV = particle velocity
π = pi
f = frequency
a = amplitude

4.1.7 It is the maximum value of particle velocity in a vibration event, termed the peak particle velocity, that is of most significance and this will usually be measured in three independent, mutually perpendicular directions at any one location in order to ensure that the true peak value is captured. These directions are longitudinal (or radial), vertical and transverse.

4.1.8 Such maximum of any one plane measurements is the accepted standard worldwide and as recommended by the British Standards Institution and the International Standards Institute amongst others. It is also the basis for all the recognised investigations into satisfactory vibration levels with respect to damage of structures and human perception.

4.1.9 British Standard 7385 states that there is little probability of fatigue damage occurring in residential building structures due to blasting. The increase of the component stress levels due to imposed vibration is relatively nominal and the number of cycles applied at a repeated high level of vibration is relatively low. Non-structural components (such as plaster) should incur dynamic stresses which are typically well below, i.e. only 5% of, component yield and ultimate strengths.

4.1.10 All research and previous work undertaken has indicated that any vibration induced damage will occur immediately if the damage threshold has been exceeded and that there is no evidence of long term effects.

4.2 Airborne Vibration

4.2.1 Whenever an explosive is detonated transient airborne pressure waves are generated.

4.2.2 As these waves pass a given position, the pressure of the air rises very rapidly to a value above the atmospheric or ambient pressure. It then falls more slowly to a value below atmospheric before returning to the ambient value after a series of oscillations. The maximum pressure above atmospheric is known as the peak air overpressure.

4.2.3 These pressure waves will comprise of energy over a wide frequency range. Energy above 20 Hz is perceptible to the human ear as sound, whilst that below 20 Hz is inaudible, however, it can be sensed in the form of concussion. The sound and concussion together is known as air overpressure which is measured in terms of decibels (dB) or pounds per square inch (p.s.i.) over the required frequency range.

4.2.4 The decibel scale expresses the logarithm of the ratio of a level (greater or less) relative to a given base value. In acoustics, this reference value is taken as 20×10^{-6} Pascals, which is accepted as the threshold of human hearing.

4.2.5 Air overpressure (AOP) is therefore defined as:-

$$\text{AOP, dB} = 20 \log \frac{\text{(Measured pressure)}}{\text{(Reference pressure)}}$$

4.2.6 Since both high and low frequencies are of importance no frequency weighting network is applied, unlike in the case of noise measurement when an A - weighted filter is employed.

4.2.7 All frequency components, both audible and inaudible, can cause a structure to vibrate in a way which can be confused with the effects of ground vibrations.

4.2.8 The lower, inaudible, frequencies are much less attenuated by distance, buildings and natural barriers. Consequently, air overpressure effects at these frequencies can be significant over greater distances, and more readily excite a response within structures.

4.2.9 Should there be perceptible effects they are commonly due to the air overpressure inducing vibrations of a higher, audible frequency within a property and it is these secondary rattles of windows or crockery that can give rise to comment.

4.2.10 In a blast, airborne pressure waves are produced from five main sources:-

(i) Rock displacement from the face.
(ii) Ground induced airborne vibration.
(iii) Release of gases through natural fissures.
(iv) Release of gases through stemming.
(v) Insufficiently confined explosive charges.

4.2.11 Meteorological factors over which an operator has no control can influence the intensity of air overpressure levels at any given location. Thus, wind speed and direction, temperature and humidity at various altitudes can have an effect upon air overpressure.

5.0 VIBRATION CRITERIA

5.1 Introduction

5.1.1 When defining damage to residential type structures the following classifications are used:-

Cosmetic or threshold	-	the formation of hairline cracks or the growth of existing cracks in plaster, drywall surfaces or mortar joints.
Minor	-	the formation of large cracks or loosening and falling of plaster on drywall surfaces, or cracks through bricks/concrete blocks.
Major or structural	-	damage to structural elements of a building.

5.1.2 Published damage criteria will not necessarily differentiate between these damage types but rather give levels to preclude cosmetic damage and therefore automatically prevent any more severe damage.

5.2 United States Bureau of Mines

5.2.1 The comprehensive research programme undertaken by the United States Bureau of Mines (USBM) (R.I. 8507, 1980) determined that vibration values well in excess of 50 mms^{-1} are necessary to produce structural damage to residential type structures. The onset of cosmetic damage can be associated with lower vibration levels, especially at very low vibration frequencies, and a limit of 12.7 mms^{-1} is therefore recommended for such relatively unusual vibration. For the type of vibration associated with open pit blasting in this country, the safe vibration levels are seen to be from 19 - 50 mms^{-1}.

5.2.2 A further USBM publication (Bureau of Mines Technology Transfer Seminar, 1987) states that these safe vibration levels are "….for the worst case of structure conditions….", and that they are "….independent of the number of blasting events and their durations", and that no damage has occurred in any of the published data at vibration levels less than 12.7 mms^{-1}.

5.2.3 Any doubt that such low levels of vibration are perfectly safe should be dispelled by considering the strain induced within a residential type property from daily environmental changes and domestic activities. This is confirmed within the 1987 USBM publication which quotes that daily changes in humidity and temperature can readily induce strain of the order that is equivalent to blast induced vibration of from 30 - 75 mms^{-1}. Typical domestic activities will produce strain levels corresponding to vibration of up to 20 mms^{-1} and greater.

5.2.4 It is for this reason that many domestic properties will exhibit cracks that may be wrongly attributed to blasting activities. There are many additional reasons why properties will develop cracks, for example:-

a) Fatigue and ageing of wall coverings;
b) Drying out of plaster finishes;
c) Shrinkage and swelling of wood;
d) Chemical changes in mortar, bricks, plaster and stucco;
e) Structural overloading;
f) Differential foundation settlement - particularly after times of prolonged dry spells.

5.3 British Standard 7385-2: 1993 - Evaluation and Measurement for Vibration in Buildings: Guide to Damage Levels from Groundborne Vibration

5.3.1 The British Standards Institution's structural damage committee have investigated impulsive vibration with respect to its damage potential. They contacted some 224 organisations, mainly British, and found no evidence of any damage at levels less than those recommended by the USBM. The investigation culminated in British Standard 7385: Part 2: 1993.

5.3.2 British Standard 7385 gives guide values to prevent cosmetic damage to property. Between 4 Hz and 15 Hz, a guide value of 15 - 20 mms^{-1} is recommended, whilst above 40 Hz the guide value is 50 mms^{-1}. These vibration criteria reconfirm those of the USBM and are shown in Table 1.

5.3.3 All research and previous work undertaken has indicated that any vibration induced damage will occur immediately if the damage threshold has been exceeded and that there is no evidence of long term effects.

5.3.4 Whilst cosmetic damage levels range from 15 to 50 mms^{-1}, according to BS 7385: Part 2, “Minor damage is possible at vibration magnitudes which are greater than twice those given for cosmetic damage, and major damage to a building structure may occur at values greater than four times the tabulated values”. Hence vibration levels necessary for structural damage within property are accepted to be around 200 mms^{-1} and above.

5.4 BS 5228-2: 2009, Code of practice for noise and vibration control on construction and open sites – Part 2: Vibration

5.4.1 Damage threshold criteria for transient vibration within British Standard 5228-2: 2009 is guided by the tabulated levels contained within BS 7385-2: 1993.

5.4.2 Guidance values are provided for frequencies of 4 Hz and above. Below a frequency of 4 Hz where a high displacement is coupled with a low particle velocity a maximum displacement of 0.6 mm (zero to peak) should be used. Although extremely rare, the allowable peak particle velocity at a frequency of 2 Hz relates to 7.5 mms^{-1}.

5.5 The Environmental Effects of Production Blasting from Surface Mineral Workings, DETR (Vibrock Limited)

5.5.1 The object of this report was to provide guidance to the Department of the Environment, local authorities and the minerals industry on how best to minimise the adverse effects which may arise during production blasting from surface mineral workings whilst still maintaining viable and economic production.

5.5.2 In relation to allowable vibration levels the report recommended ground vibration limits of 6 to 10 mms^{-1} in 95% of all blasts over a specified period, with none greater than 12 mms^{-1}.

5.5.3 This same DETR publication also notes that "It would appear that over the years conditions have become progressively more stringent. No doubt this is as a result of MPAs seeking to reduce the number of complaints and by operators seeking to resolve issues more quickly. However, a reduction in complaints will not necessarily follow".

5.5.4 Indeed, one of the principal findings of the study which led to this publication is "Once the threshold of perception had been crossed the magnitude of vibration seemed to bear little relation to the level of resulting complaint".

5.5.5 An explanation of the necessity to use explosives and the likely effects as perceived by a site's neighbours can allay the concern of a significant proportion of those inhabitants of neighbouring property. It is invariably the case that an operator will consider the perception threshold level prior to the design of each and every blast at a particular site.

5.6 Planning Advice Note 50, Annex D

5.6.1 Planning Advice Note (PAN) 50 Annex D entitled “The Control of Blasting at Surface Mineral Workings” issued by the Scottish Executive Development Department in February 2000, is based on the DETR commissioned research by Vibrock Limited. This document provides the most recent guidance on the subject of surface mineral blasting for developments in Scotland.

5.6.2 In terms of ground vibration, PAN 50 Annex D confirms that limits for peak particle velocity in the range 6 – 10 mms^{-1} in 95% of all blasts measured over any reference period, with no individual blast exceeding a higher peak particle velocity, 12 mms^{-1} being suggested as a limit, will provide suitable and adequate control of operations.

5.7 Air Overpressure

5.7.1 Comprehensive investigations into the nature and effects of air overpressure with particular reference to its damage potential have been undertaken by the United States Bureau of Mines (R.I. 8485, 1980).

5.7.2 The weakest parts of most structures that are exposed to air overpressure are windows. Poorly mounted, and hence pre-stressed windows might crack at around 150 dB (0.1 p.s.i.) with most cracking at 170 dB (1.0 p.s.i.). Structural damage can be expected at 180 dB (3.0 p.s.i.).

5.7.3 The recommendations by the United States Bureau of Mines for measuring air overpressure are shown on Table 2.

5.7.4 The criteria in Table 2 is based on minimal probability of the most superficial type of damage in residential-type structures, the single best descriptor being recommended as the 2 Hz high pass system (R.I. 8485, 1980).

5.7.5 Satisfactory air overpressure levels are contained within BS 6472-2: 2008, which states the previously discussed research by USBM. According to BS 6472-2: 2008, "air overpressure levels measured at properties near quarries in the United Kingdom are generally around 120 dB(lin), which is 30 dB(lin) below, or only 3% of, the limit for cracking pre-stressed poorly mounted windows".

5.7.6 Current guidance contained within PAN 50 Annex D does not recommend an air overpressure limit, rather the operator should submit methods to minimise air overpressure to the Planning Authority.

5.7.7 With a sensible ground vibration limitation the economics of safe and efficient blasting will automatically ensure that air overpressures are kept to reasonable levels.

5.8 Perception Levels

5.8.1 The fact that the human body is very sensitive to vibration can result in subjective concern being expressed at energy levels well below the threshold of damage.

5.8.2 A person will generally become aware of blast induced vibration at levels of around 1.5 mms^{-1}, although under some circumstances this can be as low as 0.5 mms^{-1}. Even though such vibration is routinely generated within any property and is also entirely safe, when it is induced by blasting activities it is not unusual for such a level to give rise to subjective concern. Such concern is also frequently the result of the recent discovery of cracked plaster or brickwork that in fact has either been present for some time or has occurred due to natural processes.

5.8.3 It is our experience that virtually all complaints regarding blasting arise because of the concern over the possibility of damage to owner-occupied properties. Such complaints are largely independent of the vibration level. In fact, once an individual's perception threshold is attained, complaints can result from 3% to 4% of the total number of blasts, irrespective of their magnitude.

5.9 British Standard 6472–2: 2008 - Guide to evaluation of human exposure to vibration in buildings: Part 2: Blast-induced vibration

5.9.1 This document discusses how and where to measure blast-induced vibration and gives maximum satisfactory magnitudes of vibration with respect to human response. Satisfactory magnitudes are given as 6 to 10 mms^{-1} at a 90% confidence level as measured outside of a building on a well-founded hard surface as close to the building as possible.

5.9.2 Maximum satisfactory magnitudes of vibration with respect to human response for up to three blast vibration events per day are detailed within Table 1 of BS 6472-2: 2008 and are reproduced in Table 3.

6.0 PREDICTION AND CONTROL OF VIBRATION LEVELS

6.1 Ground Vibration

6.1.1 The accepted method of predicting peak particle velocity for any given situation is to use a scaling approach utilising separation distances and instantaneous charge weights. This method allows the derivation of the site specific relationship between ground vibration level and separation distance from a blast.

6.1.2 A scaled distance value for any location may be calculated as follows:-

Scaled Distance, SD = $DW^{-½}$ in $mkg^{-½}$

where D = Separation distance (blast to receiver) in metres
W = Maximum Instantaneous Charge (MIC) in kg
i.e. maximum weight of explosive per delay interval in kg

6.1.3 For each measurement location the maximum peak particle velocity from either the longitudinal, vertical or transverse axis is plotted against its respective scaled distance value on logarithmic graph paper.

6.1.4 An empirical relationship derived by the USBM relates ground vibration level to scaled distance as follows:-

$$PV = a\,(SD)^{b}$$

where PV = Maximum Peak Particle Velocity in mms^{-1}
SD = Scaled Distance in $mkg^{-½}$
a,b = Dimensionless Site Factors

6.1.5 The site factors a and b allow for the influence of local geology upon vibration attenuation as well as geometrical spreading. The values of a and b are derived for a specific site from least squares regression analysis of the logarithmic plot of peak particle velocity against scaled distance which results in the mathematical best fit straight line where

a is the peak particle velocity intercept at unity scaled distance
and b is the slope of the regression line

6.1.6 In almost all cases, a certain amount of data scatter will be evident, and as such statistical confidence levels are also calculated and plotted.

6.1.7 The statistical method adopted in assessing the vibration data is that used by Lucole and Dowding. The data is presented in the form of a graph showing the attenuation of ground vibration with scaled distance and results from log - normal modelling of the velocity distribution at any given scaled distance. The best fit or mean (50%) line as well as the upper 95% confidence level are plotted.

6.1.8 The process for calculating the best fit line is the least squares analysis method. The upper 95% confidence level is found by multiplying the mean line value by 1.645 times 10 raised to the power of the standard deviation of the data above the mean line. A log - normal distribution of vibration data will mean that the peak particle velocity at any scaled distance tends to group at lower values.

6.1.9 From the logarithmic plot of peak particle velocity against scaled distance, for any required vibration level it is possible to relate the maximum instantaneous charge and separation distance as follows:-

Maximum Instantaneous Charge (MIC) = $(D/SD)^2$

Where D = Separation distance (blast to receiver) in metres
SD = Scaled Distance in $mkg^{-½}$ corresponding to the vibration level required

6.1.10 The scaled distance approach assumes that blast design remains similar between those shots used to determine the scaling relationship between vibration level and separation distance and those for which prediction is required. For prediction purposes, the scaling relationship will be most accurate when calculations are derived from similar charge weight and distance values.

6.1.11 The main factors in blast design that can affect the scaling relationship are the maximum instantaneous charge weight, blast ratio, free face reflection, delay interval, initiation direction and blast geometry associated with burden, spacing, stemming and subdrill.

6.1.12 Although the instantaneous explosive charge weight has perhaps the greatest effect upon vibration level, it cannot be considered alone, and is connected to most aspects of blast design through the parameter blast ratio.

6.1.13 The blast ratio is a measure of the amount of work expected per unit of explosive, measured for example in tonnes of rock per kilogramme of explosive detonated (tonnes/kg), and results from virtually all aspects of a blast design i.e. hole diameter, depth, burden, spacing, loading density and initiation technique.

6.1.14 The scaled distance approach is also strictly valid only for the specific geology in the direction monitored. This is evident when considering the main mechanisms which contribute to ground motion dissipation:-

(i) Damping of ground vibrations, causing lower ground vibration frequencies with increasing distance.
(ii) Discontinuities causing reflection, refraction and diffraction.
(iii) Internal friction causing frequency dependent attenuation, which is greater for coarser grained rocks.
(iv) Geometrical spreading.

6.1.15 In practice similar rates of vibration attenuation may occur in different directions, however, where necessary these factors should be routinely checked by monitoring, especially on sites where geology is known to alter.

6.1.16 Where it is predicted that the received levels of vibration will exceed the relevant criteria the operator will have to reduce the maximum instantaneous explosive charge weight. One method of achieving such a reduction is to deck the explosives within the borehole. This technique splits the column of explosives in two, separated by inert material. If blasting is required at closer distances than that where double decking would be a successful strategy, other charge reduction methods would have to be employed. These could be more complex decking strategies or changes to the blast geometry and / or the use of smaller diameter boreholes.

6.2 Airborne Vibration

6.2.1 Airborne vibration waves can be considered as sound waves of a higher intensity and will, therefore, be transmitted through the atmosphere in a similar manner. Thus meteorological conditions such as wind speed, wind direction, temperature, humidity and cloud cover and how these vary with altitude, can affect the level of the air overpressure value experienced at a distance from any blast.

6.2.2 If a blast is fired in a motionless atmosphere in which the temperature remains constant with altitude then the air overpressure intensity will decrease purely as a function of distance. In fact, each time the distance doubles the air overpressure level will decrease by 6dB. However, such conditions are very rare and it is more likely that a combination of the factors mentioned above will increase the expected intensity in some areas and decrease it in others.

6.2.3 Given sufficient meteorological data it is possible to predict these increases or decreases. However, to be of use this data must be both site specific and of relevance to the proposed blasting time. In practice this is not possible because the data is obtained from meteorological stations at some distance from the blast site and necessarily at some time before the blast is to be detonated. The ever changing British weather therefore causes such data to be rather limited in value and its use clearly counter productive if it is not relevant to the blast site at the detonation time. In addition, it would not normally be safe practice to leave charged holes standing for an unknown period of time.

6.2.4 It is because of the variability of British weather that it is standard good practice to control air overpressure at source and hence minimise its magnitude at distance, even under relatively unfavourable conditions.

6.2.5 Such a procedure is recommended by the UK Government in their publications on this subject, Mineral Planning Guidance (MPG) 9 of 1992 and MPG 14 of 1995, where it is suggested that no air overpressure limit be defined but rather that methods to be employed to minimise air overpressure are submitted for approval. This approach is also recommended within the previously mentioned 1998 DETR publication and PAN 50 Annex D.

6.2.6 Such control is achieved in a well designed and executed blast in which all explosive material is adequately confined. Thus particular attention must be given to accurate face profiling and the subsequent drilling and correct placement of explosive within any borehole, having due regard to any localised weaknesses in the strata including overbreak from a previous shot, clay joints and fissured ground.

6.2.7 Stemming material should be of sufficient quantity and quality to adequately confine the explosives, and care should be taken in deciding upon the optimum detonation technique for the specific site circumstances.

6.2.8 Although there will always be a significant variation in observed air overpressure levels at a particular site it is possible to predict a range of likely values given sufficient background information and/or experience. In this respect, past recordings may be analysed according to the cube root scaled distance approach to provide a useful indication of future levels.

7.0 BLAST VIBRATION DATA

7.1 As noted in the introduction, blast vibration data monitored at sites where the strata encountered is similar to that at the Fourfields ICS has been accessed from the Vibrock database.

7.2 The data has been used together with the USBM formula to predict vibration levels. This calls for the maximum peak particle velocity (PPV) to be plotted against scaled distance (SD) in a logarithmic manner. The latter is defined as:-

$$\text{Scaled Distance } (mkg^{-½}) = \frac{\text{blast/receiver separation distance (m)}}{(MIC)^{0.5}}$$

where MIC is the maximum instantaneous charge weight in kg.

8.0 DISCUSSION

8.1 Introduction

8.1.1 Whilst the blasting to be undertaken at Fourfields is on an earthmoving / excavation site, because of the rock face heights and the techniques that will be employed, it is considered appropriate to apply the vibration criteria that would apply to surface mineral sites. The volume of rock to be blasted would be similar to that produced, annually, by a medium sized hard rock quarry.

8.1.2 As described in Section 5 above, PAN 50 Annex D recommends that for the control of vibration effects from surface mineral workings a peak particle velocity criterion in the range 6 – 10 mms^{-1}, at a 95% confidence level, is suitable. For this development we consider that the lowest level given in the guidance, 6 mms^{-1} at a 95% confidence level, would be suitable for vibration sensitive residential receptors. The radar and telecommunication facilities are less sensitive to vibration and higher criteria, as discussed below, are recommended for these receptors.

8.1.3 Table 4 gives the allowable instantaneous charge weights in order to comply with a criterion of 6 mms^{-1} at a 95% confidence level.

8.1.4 It indicates that a blast design utilising 145 kg, the anticipated maximum explosive charge that would be employed at the site, can be undertaken up to a separation distance of approximately 442 metres from any vibration sensitive residential premises whilst complying with the recommended criterion.

8.1.5 Figure 1 shows the area where it is anticipated that blasting will be required, together with the Stirlinghill Quarry access road. The full face height of 14 metres will be encountered in the south west of the area. The depth of rock to be blasted along the south east to north west limit will be from 2.5 - 6 metres, the shallower deposit being in the south east corner.

8.1.6 The minimum depth of borehole to give adequate stemming and thus control air overpressure is some 3 metres. In holes of that depth it is considered packaged explosives would be used, the instantaneous charge weight being some 5 kg. In the 6 metre depth of hole pumped explosives would be possible and this would allow a charge weight of some 35 kg. As the borehole depth increases to between 6 – 14 metres the explosive charge weight would increase correspondingly.

8.1.7 Table 5 details the predicted vibration levels from blasting in the area outlined in Figure 1. The instantaneous explosive charge weights used in the predictions are shown in Table 6 for blasts in the three corners and at a central point of the area. This gives an indication of how the received vibration levels will change as work progresses across the site.

8.1.8 In Table 5 the levels shown as the "mean" relates to the value the regression analysis evaluates as being the most likely vibration effect whilst the "maximum" is the predicted upper 95% confidence level. The receptors considered, and discussed below, are shown on Figure 2.

8.1.9 Shown in Table 7 is the impact significance criteria based on the predicted peak particle velocity vibration level received at residential properties. It should be noted that as the limit of human perception of ground vibration is around a peak particle velocity of 1.5mms^{-1}, therefore vibration below this level is considered to be negligible.

8.2 Highfield

8.2.1 This receptor is the closest to the Fourfields ICS, and sits to the north west of the development site. The closest blasting works to the receptor would be those occurring in the north west corner.

8.2.2 Referring to Table 5, at three of the four blast positions considered the instantaneous explosive charge weight used would require to be reduced from that shown in Table 6 to ensure the recommended vibration criterion were not exceeded. The most common method of achieving a charge weight reduction is to deck the explosives, as described in 6.1.16 above.

8.2.3 By adopting this technique the instantaneous charge in the north west corner would be around 12 kg and the vibration levels would be in the range 1.7 – 3.3 mms^{-1}, effects which would be perceptible but would meet the recommended criterion that is the most stringent given in PAN 50 Annex D. The significance of the impact would be considered moderate adverse.

8.3 Lendrum Terrace

8.3.1 Lendrum Terrace is a small residential area to the north of the development site. A representative receptor at the west end of the area has been used in the assessment. It is blasting at the north west corner that will be closest to the dwellings.

8.3.2 As shown in Table 5, all of the predicted levels meet the recommended criterion, the range being 0.2 – 3.7 mms^{-1}. Where charge weights have to be reduced to ensure the vibration effects at Highfield meet the recommended criterion there would be a corresponding reduction in levels here too. The significance of impact, in the worst case as one of the predicted levels is greater than 3 mms^{-1} at a 95% confidence level, would again be moderate adverse.

8.4 Radar Station

8.4.1 To the south west of the development site there is a radio and radar station complex. The commercial / industrial buildings and structures located there are less sensitive to vibration effects and we would recommend a vibration criterion of 50 mms^{-1} at a 95% confidence level as being appropriate for such receptors.

8.4.2 Inspection of Table 2 shows that the range of predicted levels at this location from blasting on the Fourfields ICS is 0.2 – 5.7 mms^{-1} all of which are significantly below the recommended level.

8.5 Telecommunication Mast

8.5.1 A telecommunications mast is located east of the ICS site and south of Stirlinghill Quarry. Being a similar facility to that previously discussed, we recommend the same vibration criterion for this receptor; 50 mms^{-1} at a 95% confidence level.

8.5.2 The range of vibration levels from blasting on the Fourfields ICS site, where various explosive charge weights would be used depending on the rock depth, is 0.3 – 4.3 mms^{-1}. All of these levels are significantly below the 50 mms^{-1} at a 95% confidence level, the criterion recommended for such facilities.

8.6 Cumulative Impacts

8.6.1 The Fourfields site is located immediately to the west of Stirlinghill Quarry, where blasting is regularly carried out.

8.6.2 Due to the time taken for vibration effects to reach a particular receptor from the instant a blast is initiated and the particles then to return to rest conditions, a few seconds, all impacts are very short term in duration.

8.6.3 There are receptors considered in this assessment which could also be impacted by blasting from Stirlinghill Quarry. The explosive charge weights used in the south western part of this site would be similar to that used in the quarry.

8.6.4 As described above, the effects of vibration are of extremely short duration, a matter of a few seconds following the initiation of the explosives, after which time the ground particles return to their previous rest state. Given the various separation distances involved, even if a blast on Stirlinghill Quarry was initiated at precisely the same time as one on the Fourfields development, the likelihood of the two effects arriving and creating an enhanced vibration effect is very remote.

8.6.5 However, to preclude this from occurring altogether we recommend that the Fourfields liaises with the quarry operator to make sure no two blasts are fired at the same time.

8.6.6 It is likely, for safety reasons, there will have to be some dialogue between the two operators in any case as prior to a blast on the Fourfields site traffic on the quarry access road may have to be stopped.

9.0 CONCLUSIONS

9.1 A criterion for restricting vibration levels from blasting has been recommended in order to address the need to minimise annoyance to nearby residents in vibration sensitive dwellings. Accordingly, we have recommended a criterion of 6 mms^{-1} for 95% of events, from PAN 50 Annex D, as a satisfactory magnitude for vibration from blasting at the Fourfields Interconnector Converter Station site.

9.2 To ensure this is complied with, the instantaneous explosive charge weights against distance set out in Table 4 should not be exceeded unless subsequent monitoring data indicates this will not result in a breach of the recommended criterion.

9.3 For receptors of a commercial / industrial nature, a higher vibration criterion has been recommended, as discussed in the previous section.

9.4 In relation to occupied residential properties, all blasts shall be designed in order to comply with a vibration criteria of 6 mms^{-1} peak particle velocity at a 95% confidence level as measured in any of the three planes of measurement.

9.5 For occupied residential properties all vibration will be of a low order of magnitude and would be entirely safe with respect to the possibility of the most cosmetic of plaster cracks.

9.6 All vibration will also be well below those levels recommended for blast induced vibration as being satisfactory within the previously discussed British Standard Guide BS 6472-2: 2008.

9.7 All vibration, as measured at residential properties, will conform to PAN 50 Annex D where illustrative figures of 6 to 10 mms^{-1} at 95% confidence are given.

9.8 With such low ground vibration levels, accompanying air overpressure would also be of a very low and hence safe level, although possibly perceptible on occasions at the closest of properties.

9.9 If the site developer, NorthConnect, follows the recommendations given, there is no reason why blasting operations within the Fourfields Interconnector Converter Station site will give rise to adverse comment due to induced vibration at any of the dwellings in the vicinity.

10.0 RECOMMENDATIONS

10.1 The following recommendations are presented in order to minimise the vibration impact of blasting operations from the Fourfields Interconnector Converter Station site to nearby residents.

Ground Vibration - Inhabited Property

10.2 We recommend that a ground vibration limit is chosen that not only is perfectly safe for the integrity of structures, but also takes into account the physiological effects on adjacent neighbours. As such we recommend a vibration limit of 6 mms^{-1} peak particle velocity. The limit of 6 mms^{-1} is successful current practice at numerous open pit workings within the United Kingdom, where blasting similar to that proposed is regularly undertaken, and also agrees with the relevant British Standard 6472-2: 2008.

Ground Vibration – Industrial Buildings and Structures

10.3 These receptor locations are less sensitive to vibration and as such we recommend a vibration limit of 50 mms^{-1} at a 95% confidence level, as described in BS 7385, as being appropriate to safeguard the integrity of the buildings and structures.

Air Overpressure

10.4 Our considerable past experience of air overpressure measurement and control leads us to the firm conclusion that it is totally impracticable to set a maximum air overpressure limit, with or without an appropriate percentile of exceedances being allowed, simply because of the significant and unpredictable effect of variable weather conditions.

10.5 This point is clearly recognised in the latest guidelines issued by the Scottish Executive, PAN 50 Annex D, which recommends that the operator should submit methods to minimise air overpressure to the Planning Authority. They do not recommend an air overpressure limit.

10.6 With a sensible ground vibration limitation the economics of safe and efficient blasting will automatically ensure that air overpressures are kept to reasonable levels.

10.7 We therefore recommend that in line with the current best accepted modern practice in the extraction industries that safe and practical measures are adopted that ensure the minimisation of air overpressure generated by blasting at source, considering such factors as initiation technique.

Monitoring and Control

10.8 NorthConnect should design blasting operations taking into account the findings of this report.

10.9 A programme of blast monitoring should be implemented. The results of such monitoring will indicate whether or not there is compliance with the vibration criteria and they can also be used to create and continually update a regression analysis and thus provide valuable input to the design of future blasts.

10.10 Prior to each blast, the person in charge must decide on an appropriate "danger zone". All people; employees on site, employees at Stirlinghill Quarry and users of nearby footpaths, must be evacuated from the danger zone before the shot is fired and remain outside the danger zone until the blast has been fired, inspected and the all-clear signal given. Sentries will have to be employed to make sure transient users of the footpaths around the area do not inadvertently enter the area during firing.

10.11 With the above control recommendations implemented and the exercise of reasonable engineering control over blasting operations, it is envisaged that the Fourfields development will work within the vibration criteria and without undue annoyance to local residents.

11.0 REFERENCES

1. BS ISO 4866: 2010. Mechanical vibration and shock – Vibration of fixed structures – Guidelines for the measurement of vibrations and evaluation of their effects on structures. British Standards Institution.

2. BS 6472-2: 2008. Guide to evaluation of human exposure to vibration in buildings, Part 2: Blast-induced vibration. British Standards Institution.

3. BS 7385: 1993 Evaluation and measurement for vibration in buildings: Part 2. Guide to damage levels from groundborne vibration. British Standards Institution.

4. BS 5228-2: 2009, Code of practice for noise and vibration control on construction and open sites – Part 2: Vibration.

5. Minerals Planning Guidance Note No. 9, 1992 Planning and Compensation Act 1991: Interim Development Order Permissions (IDOS) - Conditions. Department of the Environment, Welsh Office.

6. Minerals Planning Guidance Note No. 14, 1995 Environment Act 1995: Review of Mineral Planning Permissions. Department of the Environment, Welsh Office.

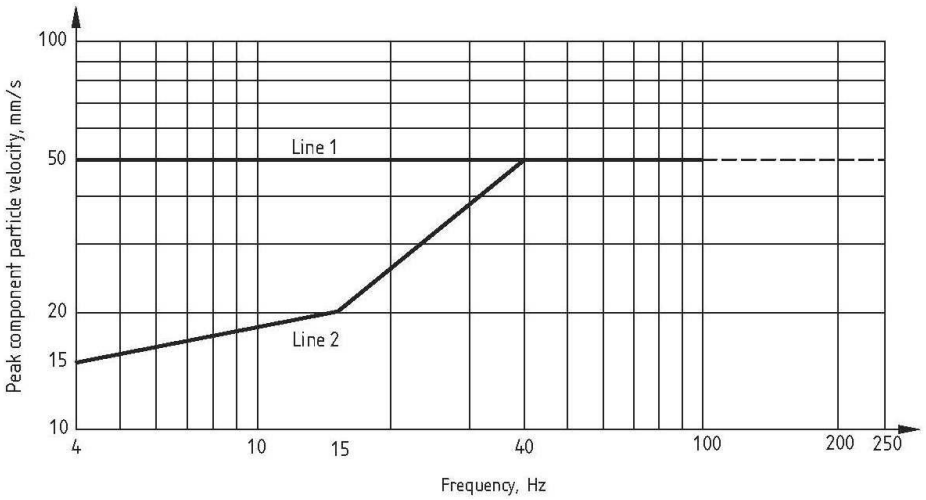
7. The Environmental Effects of Production Blasting from Surface Mineral Workings, Vibrock Report on behalf of the DETR, 1998.

8. Planning Advice Note 50, Annex D: The Control of Blasting at Surface Mineral Workings, Scottish Executive Development Department, February 2000.

TABLE 1

BS 7385 VIBRATION CRITERIA

Line	Type of Building	Peak component particle velocity in frequency range of predominant pulse	
		4 Hz to 15 Hz	15 Hz and above
1	Reinforced or framed structures	50 mms^{-1} at 4 Hz and above	50 mms^{-1} at 4 Hz and above
	Industrial and heavy commercial buildings		
2	Unreinforced or light framed structures	15 mms^{-1} at 4 Hz increasing to 20 mms^{-1} at 15 Hz	20 mms^{-1} at 15 Hz increasing to 50 mms^{-1} at 40 Hz and above
	Residential or light commercial buildings		
Note 1 – values referred to are at the base of the building Note 2 – for line 2, at frequencies below 4 Hz, a maximum displacement of 0.6 mm (zero to peak) is not to be exceeded			



Transient vibration guide values for cosmetic damage (BS 7385-2: 1993, pg 6)

TABLE 2

USBM RECOMMENDATIONS FOR MEASUREMENT OF AIR OVERPRESSURE

Instrument Response	Maximum Recommended Level (dB)
0.1 Hz high pass	134
2.0 Hz high pass	133
5.0 or 6.0 Hz high pass	129
C- Slow	105 dB (C)

TABLE 3

BS 6472-2 HUMAN RESPONSE TO VIBRATION

Place	Time	Satisfactory magnitude[A)] (ppv mms^{-1})
Residential	Day [D)]	6.0 to 10.0 [C)]
	Night [D)]	2.0
	Other times [D)]	4.5
Offices [B)]	Any time	14.0
Workshops [B)]	Any time	14.0

A) The satisfactory magnitudes are the same for the working day and the rest day unless otherwise stated;
B) Critical working areas where delicate tasks impose more stringent criteria than human comfort are outside the scope of this standard;
C) With residential properties people exhibit a wide variation of tolerance to vibration. Specific values are dependent upon social and cultural factors, psychological attitudes and the expected degree of intrusion. In practice the lower satisfactory magnitude should be used with the higher magnitude being justified on a case-by-case basis;
D) For the purpose of blasting, daytime is considered to be 08h00 to 18h00 Monday to Friday and 08h00 to 13h00 Saturday. Routine blasting would not normally be considered on Sundays or Public Holidays. Other times cover the period outside of the working day but exclude night-time, which is defined as 23h00 to 07h00.

TABLE 4

ALLOWABLE MAXIMUM INSTANTANEOUS EXPLOSIVE CHARGE WEIGHTS – INHABITED PROPERTY AT FOURFIELDS INTERCONNECTER CONVERTER STATION SITE

The following allowable maximum instantaneous charge weights at the given blast/receiver separation distances have been generated from recordings undertaken at sites working similar strata to that at the proposed development:-

Blast/Receiver Separation Distance (metres)	Allowable Maximum Instantaneous Charge Weight, kg to comply with 6 mms^{-1} at 95% confidence level
150	17
175	23
200	30
225	37
250	46
275	56
300	67
325	78
350	90
375	104
400	118
425	134
450	150
475	167
500	185

TABLE 5

PREDICTED VIBRATION LEVELS - VIBRATION RECEPTORS AT FOURFIELDS INTERCONNECTER CONVERTER STATION SITE

Considering instantaneous explosive charges shown in paragraph 8.1.7 above, the following vibration levels are predicted for blasting operations at the proposed development.

Location	Vibration Level Peak Particle Velocity (mms^{-1})							
	NE Corner		SE Corner		Centre		SW Corner	
	Mean	Max'm	Mean	Max'm	Mean	Max'm	Mean	Max'm
Highfield	3.0*	6.0*	0.2	0.4	3.0*	6.0*	3.0*	6.0*
Lendrum Terrace	1.1	2.1	0.2	0.3	1.4	2.9	1.8	3.7
Radar Station	0.7	1.3	0.1	0.2	1.4	2.9	2.8	5.7
Telecomm's Mast	0.6	1.2	0.3	0.6	1.5	3.0	2.1	4.3

* Charge weights reduced to ensure vibration criterion complied with

TABLE 6

ROCK DEPTHS AND EXPLOSIVE CHARGE WEIGHTS

Position	Borehole Depth (m)	Explosive Charge Weight (kg)
South east corner	3	5
North west corner	6	35
South west corner	14	145
Centre	9.5	80

TABLE 7

SIGNIFICANCE OF VIBRATION IMPACT

Magnitude of Impact	Predicted Peak Particle Velocity Vibration Levels (mms^{-1})	
	Blasting Operations	Significance of Impact
Major Adverse	>6.0 at a 95% confidence level	Significant
Moderate Adverse	>3.0 to ≤6.0 at a 95% confidence level	Moderate
Minor/Slight Adverse	>1.5 to ≤3.0 at a 95% confidence level	Minor
Negligible	≤1.5 at a 95% confidence level	Insignificant

FIGURE 1

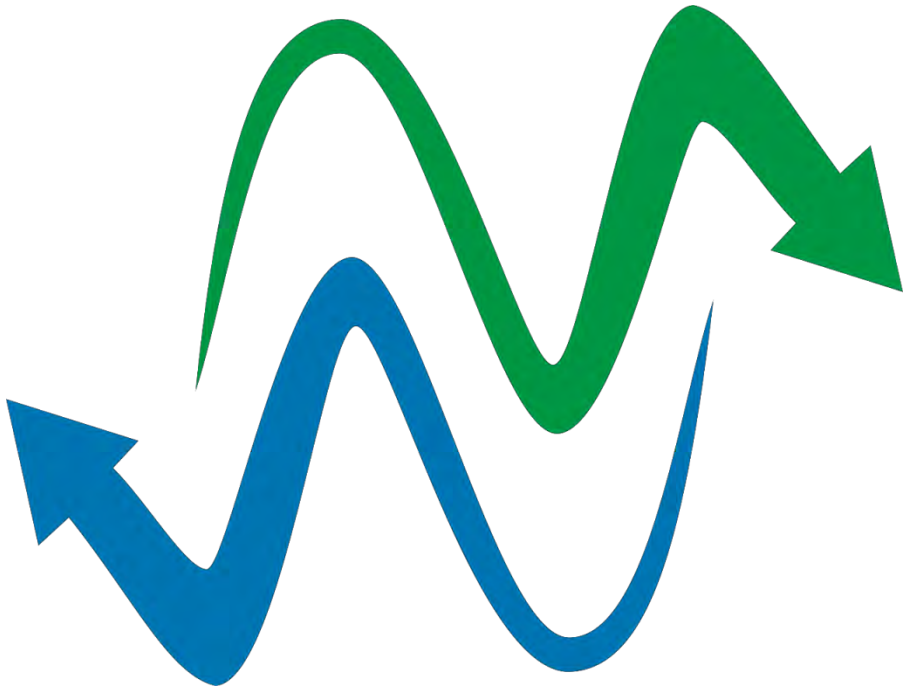
ANTICIPATED BLAST AREA

FIGURE 2

VIBRATION RECEPTORS

● Vibration Receptors

NORTHCONNECT
CONNECTING RENEWABLES



Appendix B.1: Extended Phase 1 Habitat Survey Target Notes

Appendix B.1: Extended Phase 1 Habitat Survey Target Notes

Target Note	Grid reference	Notes
1	NK 11624 42068	Small copse of woodland adjacent to Denend house dominated by Sitka spruce with sycamore also present. Copse is situated on steep bank approximately 4m high which appears to comprise of rubble and other agricultural refuse. Signs of rabbit burrows and mammal foraging, potentially including badger were present but no conclusive evidence of the species was identified.
2	NK 11722 42046	Stream 0.5 – 1m wide at the bottom, 3-4m wide at the top, banks 80-90° and 2-3m high. Bottom of pebbles and gravel, water depth about 10cm, very slow flow. Overgrown with gorse, broom, meadowsweet, cocksfoot, creeping thistle, raspberry *Rubus idaeus*, common nettle, Yorkshire fog, hogweed, eared willow *Salix aurita*.
3	NK 11630 41966	Tall ruderal vegetation along the edge of the arable field with red dead nettle *Lamium purpureum*, smooth sow thistle, tufted vetch, oxeye daisy, cleavers, common chickweed, common bistort *Persicaria bistorta*, alder and rowan saplings and the grasses Yorkshire fog and Timothy *Phleum pratense*..
4	NK 11591 41937	Mammal pathway going from arable field under fence to stream. No definitive evidence such as prints or hair suggesting which mammal.
5	NK 11581 41925	Dry ditch draining field, only about 10m long, 0.5m wide at bottom, 2m wide at top, banks up steep to 1m, 70 – 90°. Overgrown with soft rush.
6	NK 11552 41879	Wet ditch along fence line with 10cm water but not flowing, ditch becomes dry further to the north west. 1m wide at bottom, 2-3m wide at top, banks 70-90°, 2m high. Overgrown with soft rush, Yorkshire fog, gorse, cocksfoot, common nettle, creeping thistle.
7	NK 11543 41872	Pond in valley with outflow into stream, dammed at eastern end. Roughly rectangle shaped (20x15m wide at eastern end and by 10m wide at western end), banks up to 1m high and 45-60°. Surrounded by unimproved/marshy grassland. Pond is completely overgrown broad-leaved pondweed and soft rush and water horsetail *Equisetum fluviatile* present on margins.
8	NK 11377 42035	Mammal pathway into arable field from ditch. Some burrows in banking of ditch likely to be rabbit, no other signs, burrows do not go very deep.
9	NK 11406 42061	Mammal pathway into arable field from road and semi-improved field. Double fence line along track planted with alder and hawthorn.
10	NK 11677 42077	Mound of large stones potentially from a former building. These may offer some sheltering opportunities for badgers, small mammals and potentially reptiles.
11	NK 11623 41935	Three mammal pathways from arable field into area of gorse, a single scat was identified which was green/brown in colour and soft with grass and insect remains in. This is most consistent with badger.
12	NK 11536 42228	Fence lines surrounding arable field were mostly comprised of a double post and wire fence with some hedgerow planting including hazel, hawthorn and blackthorn. Planted specimens were heavily grazed and not well established with no effective hedgerow present. Ground flora between fences was dominated by common nettle, creeping thistle, cocksfoot, false oat grass *Arrhenatherum elatius*, bramble, cow parsley, rosebay willowherb, common ragwort, ribwort plantain, creeping buttercup tufted vetch and spear thistle.
13	NK 11522	Low density planting of broadleaved trees associated with edge of

Target Note	Grid reference	Notes
	42285	plantation habitat including hazel, sycamore and crack willow.
14	NK 11689 42430	Small area of marshy grassland dominated by soft rush, Yorkshire fog and creeping buttercup.
15	NK 11694 42408	Ditch with only very small amounts of stationary water present (<10cm), approximately 1m deep with 45° slopes. Banks were densely vegetated with marshy grassland vegetation with bed of ditch also supporting soft rush colonisation.
16	NK 11759 42049	Burn supporting flowing water up to 20cm deep in places. Banks up to 1.5m high with extensive colonisation on northern bank by European gorse. Southern bank dominated by tall herb communities with extensive rosebay willowherb along with rank grasses dominated by cocksfoot, soft rush, creeping thistle, foxglove, common nettle and meadow vetchling *Lathyrus pratensis*.
17	NK 11802 42051	A band of marshy grassland to the north of the ditch supported soft rush, compact rush, crested dog's tail, rough meadow grass *Poa trivialis*, marsh thistle *Cirsium palustre*, Yorkshire fog and broad-leaved dock along with occasional meadowsweet and wild angelica *Angelica sylvestris*.
18	NK 11851 42084	Heavily grazed improved grassland field with steep bank to marshy grassland and ditch. Grasses present included perennial rye grass, white clover, crested dog's tail, and Yorkshire fog.
19	NK 12046 48813	Wet ditch, bottom 0.5m wide, 3-4m wide at the top, banks 70-80° covered in brambles, rosebay willow herb and gorse. Water 10-20cm deep, moderate flow, bottom gravel, pebbles.
20	NK 12080 41614	Series of four settling ponds all of indeterminate depth. Pond 1 5x5m, banks 1-1.5m high, 70-80°. Pond 2 6x5m, banks 1m high, 70-80°. Pond 3 6x8m, banks 1-1.5m, 70-80°. Pond 4 4x10m, banks 1m high, 70-80°. Ponds surrounded by semi-improved grassland with soft rush, cocksfoot, broad leaved dock, common ragwort, European gorse. Fifth smaller pond, 4x3m overgrown with curly waterweed. Across the track on Highfield land was an artificial pond which is used for fishing. Approx. 60x120m. Island in the middle with deciduous trees, possibly willow. Soil banks about 1m high surrounded by semi-improved grassland.
21	NK 12085 41482	Ditch 0.5m at bottom, 3-4m at top, banks 80-90°, bottom gravel, silt, pebbles. Banks up to 3m with rosebay willowherb, common sorrel, cocksfoot, ribwort plantain, soft rush, spear thistle, hogweed, hard fern.
22	NK 12090 41411	Wind break of young 3-5m planted deciduous trees including ash, alder, hawthorn, rowan, elder and willow. Very open semi-improved grass underneath.
23	NK 12117 41193	Pond 30x5m. Earth banks vary 1m on east side, 2-3m on west side, 60-80°. Surrounded by marshy grassland. Young willows 4m on east bank. Indeterminate depth.
24	NK 12206 41048	Old barn, stone walls with slate roof, some of roof had collapsed exposing roof trusses. Two outbuildings with stone walls, one with pan tile roof and the other corrugated.
25	NK 12077 40964	Dry heath dominated by heather with some crowberry, scarce cross-leaved heath. Heather uniform and short 0.5m. Underneath heather hard rush, *Pleurozium schreberi* and red fescue.
26	NK 12026 40956	Bog pool formed where ditch had been blocked, unknown depth, mostly covered in *Sphagnum cuspidatum*, surrounded by soft rush. Froglet.
27	NK 12022 40953	Otter spraint on grass hummock, black with remains of bones, slide into bog pool.

Target Note	Grid reference	Notes
28	NK 11858 40939	Quarry disused, cliff face about 10m high, small pool in bottom with reed canary grass and surrounded by European gorse. Hillside with remains of workings
29	NK 11863 40929	Badger latrine with three pits, two with dung located beneath large boulders. Mammal pathways leading from boulders to grassland, no other signs of badger but potential for sett in the boulders or in the gorse.

NORTHCONNECT
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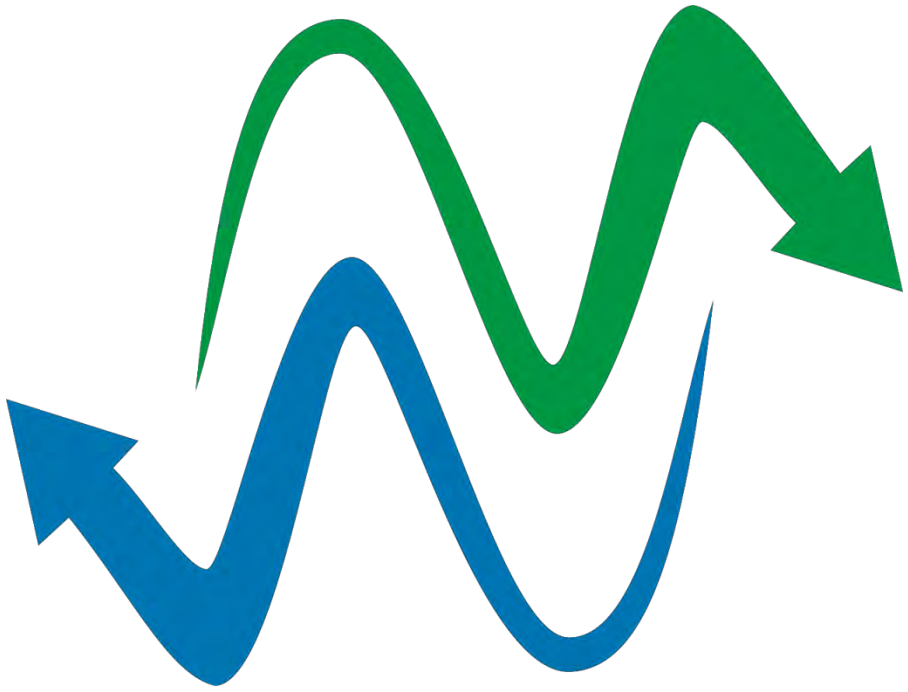

Appendix B.2: Otter, Water vole & Badger Survey

VERSION 1.2

OCTOBER 31, 2014

TECHNICAL REPORT

NORTH CONNECT ECOLOGICAL SURVEYS

OTTER, WATER VOLE & BADGER SURVEY

REPORT REF: 14/021/AFF/R01

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CONTENTS

1 Introduction 3
1.1 Terms of Reference 3
1.2 Objectives of Study 3
1.3 Site Description 3
2 Legislative Context 3
2.1 Otter 3
2.2 Water Vole 4
2.3 Badger 4
3 Methodology 5
3.1 Otter 5
3.2 Water Vole 5
3.3 Badger 6
3.4 Limitations 6
4 Results 6
4.1 Existing Information 6
4.2 Habitat Assessment 6
4.2.1 Otter 6
4.2.2 Water Vole 7
4.2.3 Badger 8
4.3 Surveys 9
4.3.1 Otter 9
4.3.2 Water Vole 9
4.3.3 Badger 9
5 Discussion 9
5.1 Otter 9
5.2 Water Vole 10
5.3 Badger 10
6 References 11
Appendix A – Figures 12
Appendix B – Photographs 16

1 INTRODUCTION

1.1 TERMS OF REFERENCE

Tracks Ecology was commissioned by Affric Limited to undertake an ecological survey focusing on otter, water vole and badger at the site of the North Connect scheme; a joint venture project involving the construction of a HVDC power interconnector between Norway and the United Kingdom. The 'Site' consists of the locations of the converter station at Fourfields and the underground high voltage alternating current (HVAC) cable route.

The survey is required to support a planning application and Environmental Impact Assessment (EIA) of the onshore works and was identified as necessary through an initial extended Phase 1 survey and subsequent Scoping Report.

For the purposes of this survey the 'Survey Area' for otter and water vole includes all watercourses and waterbodies within a buffer of 200m to infrastructure and for badger all land within a buffer of 100m to infrastructure. Figure 1 outlines the Survey Areas and proposed infrastructure.

1.2 OBJECTIVES OF STUDY

This report seeks to document the likely presence or absence of otter *Lutra lutra,* water vole *Arvicola amphibious* and badger *Meles meles* from within the respective Survey Areas. Otter, water vole and badger are all afforded some level of protection under UK law.

The report details the results of the surveys with the following details:

- legislative context;
- field survey methodology;
- field survey results; and
- discussion.

1.3 SITE DESCRIPTION

The Site is located approximately 2km south of Peterhead, Aberdeenshire with the HVAC cable route running from the existing sub-station at Millbank (NK 121426) to the Converter Station at Fourfields (NK 120414). The HVAC cable route follows the public road for the majority of its route which is bordered by mixed agricultural land. The Fourfields location is within a number of large agricultural fields with simple post and wire or stone wall boundaries. The wider area supports intensive agricultural, minor roads, scattered dwellings and farm complexes.

The Survey Areas include farmland dominated by arable and improved grassland habitats along with active and former quarries, scrub, small coniferous plantations and a number of small watercourses, drains and small waterbodies Figure 1. Further information on the habitats present is detailed within the extended Phase 1 report (Atmos Consulting Ltd 2014).

2 LEGISLATIVE CONTEXT

2.1 OTTER

The otter is a European Protected Species (EPS) and is protected by the Conservation (Natural Habitats &c.) Regulations 1994 as amended in Scotland which transpose into Scottish law the European Community's Habitats Directive (92/43/EEC). This means that it is an offence to:

- deliberately or recklessly capture, injure or kill, harness, damage or destroy a breeding site or resting place of an EPS or a group of EPS;
- disturb an EPS while it is occupying a structure or place which it uses for shelter or protection;
- disturb an EPS while it is rearing or otherwise caring for its young;
- obstruct access by an EPS to a breeding or resting place;
- disturb an EPS in a manner that is, or circumstances which are, likely to significantly affect the local distribution or abundance of that particular species; and,
- to disturb an EPS in a manner that is, or in circumstances which are likely to impair its ability to survive, breed or reproduce, or rear or otherwise care for its young.

In addition to the above, otter is listed in the Scottish Biodiversity List, the UK Biodiversity Action Plan (BAP) and although the new North East Scotland LBAP is not individual species focused they feature within the ecosystem groups.

2.2 WATER VOLE

Water vole is afforded protection in Scotland under section 9(4) of the Wildlife and Countryside Act 1981, as amended by the Nature Conservation (Scotland) Act 2004 and the Wildlife and Natural Environment (Scotland) Act 2011, with the protection extended to include 'reckless' acts (continuing with an action in the knowledge of the consequences of that action) and acts of 'interference', as an addition to destructive acts cited in the 1981 Act.

Under the terms of section 9(4) it is an offence to "intentionally or recklessly":

- Damage, destroy or obstruct access to any structure or place which a water vole uses for shelter or protection; and
- Disturbance while in a place of shelter.

However, it should be noted that under present legislation the animals themselves are not otherwise protected in Scotland although recent proposals to extend the protection to the animals is proposed.

In addition to the above, water vole are also listed in the Scottish Biodiversity List, the UK BAP and feature within the ecosystem approach of the North East Scotland LBAP.

2.3 BADGER

Eurasian badgers and their setts are protected under the Protection of Badgers Act 1992 and by Section 11 (Schedule 6) of the Wildlife and Countryside Act 1981 (as amended in Scotland). It is illegal to kill, injure, take, possess or cruelly ill-treat a badger, or attempt to. Badger setts are protected from interference and it is an offence to obstruct access to, or any entrance of, a badger sett. In addition it is illegal to disturb a badger when it is occupying a sett.

The Protection of Badgers Act 1992 was amended by the Nature Conservation (Scotland) Act 2004 to make it illegal to knowingly cause or permit an act which would interfere with a badger sett, and included recklessly killing, injuring or taking a badger.

In addition to the above, the badger is listed in the Scottish Biodiversity List.

3 METHODOLOGY

3.1 OTTER

The otter survey was undertaken in broad accordance with the approach detailed by Scottish Natural Heritage "Otters and Development" guidance document (Scottish Natural Heritage 2010) and Chanin (2003). The survey concentrated on watercourses present within the Survey Area and included a thorough check for otter resting places including holts and couches and was undertaken by an ecologist experienced in otter survey.

Due to the often elusive nature of otter surveys predominantly rely on the interpretation of field signs rather than direct observation of the animals themselves. However, in remote locations where human disturbance is low direct observations may be possible. During the survey the following field signs were sought, with those which can be regarded as definitive, i.e. they provide certain confirmation of the presence of this species, marked with an asterisk:

- otter spraint (faeces)*;
- otter holt (den);
- footprint*;
- couch (resting place above ground); and
- pathways and slides into water.

All evidence identified during the surveys was recorded using a Garmin GPS Map62 with the feature of interest target noted and photographed.

The otter survey was undertaken on a 29th September 2014 by a suitably qualified and experienced ecologist. All accessible areas within the Survey Area which extended to 200m from Site infrastructure were surveyed with watercourses and ditches examined from banks or within the channel where access was possible and safe.

3.2 WATER VOLE

The methodology employed during the survey follows that of an adapted version of the "Water vole Conservation Handbook" (Strachan and Moorhouse, 2011) with additional reference to other publications (e.g. Ryland & Kemp 2009). Further field sign guidance was also used (Corbet & Southern 1977; Macdonald & Barrett 1993).

Active searches were conducted for water vole sign, including:

- droppings;
- burrows;
- latrines;
- feeding stations;
- lawns; and
- footprints and pathways.

The water vole survey was undertaken concurrently with the otter survey on 29th September 2014 by James Bunyan MCIEEM, a suitably qualified and experienced ecologist. All relevant areas within the Survey Area which extended to 200m from Site infrastructure were surveyed with watercourses examined from both bank or from within the channel where possible and safe to do so.

Evidence of water vole sign/activity recorded during the survey was geo-referenced using a handheld GPS with the feature of interest, target noted and photographed.

3.3 BADGER

The survey for badger was undertaken concurrently with the otter and water vole survey and covered all accessible areas of the Survey Area which extended to 100m from Site infrastructure. The badger survey comprised a search for setts and other signs of badger activity, e.g. latrines, dung pits, pathways, snagged hair and signs of foraging.

3.4 LIMITATIONS

Otter surveys can be undertaken at any time of year and as such September was a suitable time for the survey. Water vole surveys are best surveyed for between April and September inclusive, outside of which time, activity levels and territory marking varies considerably. Badger surveys are generally best undertaken when vegetation is at a minimum during winter months to maximise chances of identifying sett structures, however across agricultural habitats with the majority of cover vegetation from European gorse *Ulex europaeus* an evergreen species it is not considered a significant constraint. As a result there is no significant limitation with respect to timing of the surveys although the water vole survey was at the very end of the recognised survey window.

Surveys were undertaken with five significant rain free days resulting in no significant limitation.

A number of sections of the Survey Area supported dense gorse scrub (Appendix B, Plate 19) preventing comprehensive access. Surveys including a thorough search of the perimeter of these areas for evidence of use by the focal species. However, a minor limitation was experienced due to the lack of access with areas of restricted access identified on Figure 2.

Three further areas were inaccessible to survey due to access restrictions. These included the Ministry of Defence base in the south west of the Survey Area, the operational quarry in the east of the Survey Area and the Highfields property located centrally.

4 RESULTS

4.1 EXISTING INFORMATION

A number of ecological surveys have been undertaken during 2013 and 2014 to inform the site selection process for the HVAC route and converter building location. The latest surveys undertaken in May 2014 included an extended Phase 1 survey of the Fourfields location with the majority of the HVAC cable route subject to an extended Phase 1 survey during September 2013 (Atmos Consulting 2014). The report reviews existing records held by the North East Scotland Biological Records Centre (NESBReC) and findings of all surveys to date across the Survey Area. No records for otter, water vole or badger were reported although the habitat was identified as being suitable for all three species.

4.2 HABITAT ASSESSMENT

4.2.1 OTTER

The Survey Area supports a number of watercourses including a small burn and several agricultural drains. Furthermore four waterbodies are present within or immediately adjacent to the 200m buffer Survey Area with an additional group of settlement lagoons associated with the quarry. The Survey Area is located less than 350m inland from the coast at its closest point and as such is likely to be within range of coastal otter territories.

Waterbody 1 (Appendix B, Plate 1) was a large man made fishing or waterfowl pond within the grounds of the Highfield property. The pond was approximately 175m long and 75m wide with a small island present. As a result of restricted access the pond was not subject to a detailed survey but it was assessed that the pond is likely to offer some suitability for otter in terms of foraging and above ground shelter opportunities.

The quarry area supported a series of settlement lagoons (Waterbody 2) (Appendix B, Plates 2, 3 and 4) which were presently in used for water treatment from the operational quarry. All of the lagoons were steep sided and appeared to be lined with coarse rock armour which has subsequently been colonised by vegetation. The southernmost three lagoons were heavily clouded with silt and unsuitable for use by otter, the remaining two lagoons although supporting clearer water offer very little in the way of shelter or foraging resource other than the potential for supporting congregations of amphibians during the spring.

Waterbody 3 (Appendix B, Plate 5) was an inline pond associated with agricultural drainage and was approximately 20m long by 8m wide with a drain entering the pond in the southeastern corner. Extensive tall herb with grassland habitat dominated the immediate vicinity along with a number of sycamore *Acer pseudoplatanus* tress along the eastern banks which had been pollarded in the past. The pond and surrounding habitat may offer suitable locations for an otter couch as vegetation cover was good along with limited foraging potential.

Waterbodies 4 and 5 were former quarry ponds both with very steep sides and rocky banks. Waterbody 4 (Appendix B, Plate 6) was just outwith the 200m buffer within an area of heathland to the south east of the Survey Area and Waterbody 5 (Appendix B, Plate 7) was located on the western side of the Survey Area within dense gorse scrub. Both ponds offered very limited opportunities for use by otter although periodic use by local otters is possible. No close inspection of Waterbody 5 was possible due to health and safety concerns as dense gorse scrub continued to the steep sided waterbody. The dense gorse surrounding Waterbody 5 could offer some potential for couches.

A single permanent watercourse runs through the HVAC section of the Survey Area (Watercourse C and D). The section of the watercourse to the west of the public road (Watercourse C) is heavily encroached by gorse scrub with the channel often inaccessible for comprehensive survey. The water level was low, typically less than 0.2m and narrow (approximately 1m) and is unlikely to support extensive fish populations. Watercourse D was a straight channel formed by steep banks dominated by rank grassland, tall herb and ruderal species. The water was rarely deeper than 20cm with exposed rocks and occasional pools.

The other watercourses within the Survey Area (Watercourses A, B, E, F, G &H) were best described as agricultural drains and often supported very low water levels. The majority of these were heavily choked with vegetation and unlikely to offer significant resource for otter other than commuting routes or seasonal foraging for amphibians.

4.2.2 WATER VOLE

The majority of the watercourses are agricultural drains supporting often low levels of water. Watercourse A (Appendix B, Plate 10) flows alongside the plantation woodland to the north and arable fields to the south with a narrow rank grassland buffer strip. The drain channel was approximately 2m wide and 1m deep and heavily choked with vegetation (predominantly grasses). No open water was present although the ditch is still suitable to support water vole as adjacent vegetation cover was thick offering good shelter. Winter food was also available in the form of a strip of deciduous trees including willows.

As Watercourse A passes under the public road through a culvert it enters a pasture field of improved grassland (Watercourse B) (Appendix B, Plate 11). This watercourse is ill defined and heavily poached by cattle and completely unsuitable for use by water voles for shelter, although it is may to provide a sub-optimal commuting link.

Watercourse C (Appendix B, Plate 12) is a larger flowing burn approximately 1m wide and 20cm deep at the time of survey. Upstream of the public road the watercourse is dominated by extensive gorse scrub and therefore only restricted ground cover from grasses, rushes and ephemeral species offering limited suitability for water vole. The burn substrate was generally rocky with areas of gravel although siltation of areas of slower flow were apparent, banks comprised of earth and gravel.

As this watercourse passes through the culvert to the east of the public road (Watercourse D) the banks become steep and dominated by Yorkshire fog *Holcus lanatus,* rosebay willowherb *Chamerion angustifolium*, cock's-foot *Dactylis glomerata* hogweed *Heracleum sphondylium*, soft rush *Juncus effuses* and common nettle *Urtica dioica* (Appendix B, Plate 13). The water was consistently shallow at 20cm with frequent exposed rocks and only the occasional pool. The banks were steep at 45° and extended up to 2m in a number of places. The burn continued before reaching a confluence with the remnant water from the ill-defined Watercourse B.

Watercourse E (Appendix B, Plate 14) and F (Appendix B, Plate 15) passed along the northern and eastern edge of the Fourfield site before heading north along the Highfields property and to Lendrum Terrace outwith the Survey Area. Water depth was very low, generally less than 10cm with steep sides at 45° and banks extending to 2.5m in places. They were typically overgrown with rosebay willowherb, scrub and ephemeral species from adjacent field boundaries encroaching. The banks were subject to disturbance from past ditch clearance and offered sub-optimal habitat for water voles.

Watercourse G (Appendix B, Plate 16) was dry at the time of survey and banks were formed by thinly vegetated gravel substrates which were becoming increasingly colonised by ephemeral and perennial species where substrate stability allowed. As a result the watercourse is again suboptimal for water voles as a place of shelter as cover is very limited with little or no water.

Watercourse H (Appendix B, Plate 17) is a short section of agricultural drain extending south out of the Survey Area. The ditch is relatively deep at 1m and approximately 1m wide although the entire length of the ditch is choked with grass dominated vegetation resulting in no visible open water although the ditch offers suitable habitat for water voles with extensive foraging opportunities, although suitable banks for burrow construction may be limited.

A number of the waterbodies also offered some suitability for water voles with Waterbody 1 offering the highest potential but access restrictions prevented a detailed survey of the area. Waterbody 3 was also suitable for use by water voles but no evidence to their presence was identified during the surveys and the connecting ditches are sub-optimal. The northernmost settlement lagoon which appears more like a naturalized pond may also offer some potential but the pond was not large and bank substrate was stoney and generally unsuitable for burrowing.

4.2.3 BADGER

The agricultural landscape with extensive improved and semi-improved grassland along with arable fields offers highly suitable habitat for foraging badgers. In addition the dense areas

of gorse scrub offer suitability for sheltered commuting routes and potential sett building locations.

4.3 SURVEYS

4.3.1 OTTER

A potential holt location was identified within Watercourse B approximately 50m upstream of the road culvert Appendix B, Plate 9). The burrow was on the edge of the stream (potentially being submerged in high flows) and covered with gorse scrub with an entrance of approximately 20cm in diameter and roughly circular. No field signs to categorically confirm use by otter or any other animal were present but the structure and location of the burrow was most consistent with otter. In addition a single weathered spraint was located along the western bank of Waterbody 4 on a rock (outside the survey area) see Plate 8 (Appendix B). No other signs of use by otter were identified although the dense scrub and areas of restricted access may support such signs.

4.3.2 WATER VOLE

Watercourse D supported extensive evidence of use by water vole with numerous latrines identified along its reach (Appendix B, Plate 18). The water vole colony did not extend west to the other side of the road (Watercourse C) where the habitat is far less suitable due to extent of gorse scrub. Despite over ten latrines being identified along the 250m stretch of river no burrows were identified. This is probably due to the dense vegetation and steep sided banks making searches difficult. All other watercourses did not support evidence of water vole being present at the time of survey.

4.3.3 BADGER

Limited evidence to suggest that badger are present within the Survey Area was identified at the time of survey. Only a single field sign confirming the presence was recorded in the form of snagged hair on barbed wire fence in the west of the Survey Area. No evidence of setts or latrines were identified from within the Survey Area although the dense scrub and areas of restricted access may support such signs.

5 DISCUSSION

5.1 OTTER

The surveys identified the presence of a burrow consistent with that of an otter holt although this could not be categorically confirmed from the single visit survey. The location of the potential holt will not be directly affected by the proposed works although the cable route is approximately 50m downstream of its location. As a result it is recommended that prior to works commencing further surveys are undertaken to identify current use of the Site. Further surveys of potential holt locations (should they still be present) would be required and these may be best undertaken with the aid of remotely triggered camera trap deployment for a period of approximately three months (a reasonable duration to expect evidence of use) in a location which will not result in disturbance itself, but enable the use of the burrow to be monitored.

The pre-construction surveys and focused holt surveys, should they be present, will dictate the need for further surveys and/or design of an appropriate mitigation strategy to ensure that the otter holt is not disturbed during the works. If disturbance cannot be ruled out then

it may be necessary to apply for a derogation licence under the Conservation (Natural Habitats &c.) Regulations 1994 as amended in Scotland for the works to proceed lawfully.

5.2 WATER VOLE

Due to the current design of the cable route no damage, destruction or obstruction of water vole structures or places of shelter, or disturbance of water voles while in a place of shelter will occur as part of the proposed works. All water vole signs were identified east of the public road on the distal side from the proposed HVAC cable route.

Although the precise details of the works are unknown at this stage it is possible that the construction techniques used can be undertaken without significant disturbance to the downstream water vole colony. However, to ensure that impacts to water vole populations are minimised and places of shelter are protected from disturbance an appropriate mitigation strategy will be required.

No significant increase in habitat fragmentation will occur as works are linear in nature and cross perpendicular to the watercourse resulting in a very small footprint across potential water vole habitat.

As a result it is recommended that based on the survey results to date, it is recommended that a mitigation plan is developed, suggested inclusions with respect to the presence of water vole are:

- Pre-construction checks of all areas to be directly disturbed (plus 200m buffer) prior to works commencing. Immediately prior to works this should include a destructive search of vegetation along the banks of watercourse C to a distance of 10m either side of proposed disturbance. Once scrub is cleared the vegetation should be maintained as short as possible
- exposing the earth to discourage colonization from water voles. **Note** – it is not recommended that gorse scrub clearance is undertaken prior to works as this is likely to encourage water voles to expand their range to the western side of the public road and result in increased conflict.
- Best practice methodology with respect to preventing any pollution of watercourses (including sediment) should be maintained through a Construction Environmental Management Plan.
- Duration and footprint of works within proximity to the watercourse should be minimised.

If at any point the potential for significant disturbance to water voles cannot be ruled out then a licence may be required.

5.3 BADGER

No evidence to suggest badger are using the Survey Area as a place of shelter (sett) was identified during the survey and as such no recommendations with respect to this species are made. However, as the habitats are suitable for use by badger and evidence of badger passing through the Survey Area were recorded, it is recommended that as well as pre-construction surveys, all scrub clearance is undertaken with caution and with hand tools. If any large mammal burrows are identified then works should cease and a suitably experienced ecologist contacted.

6 REFERENCES

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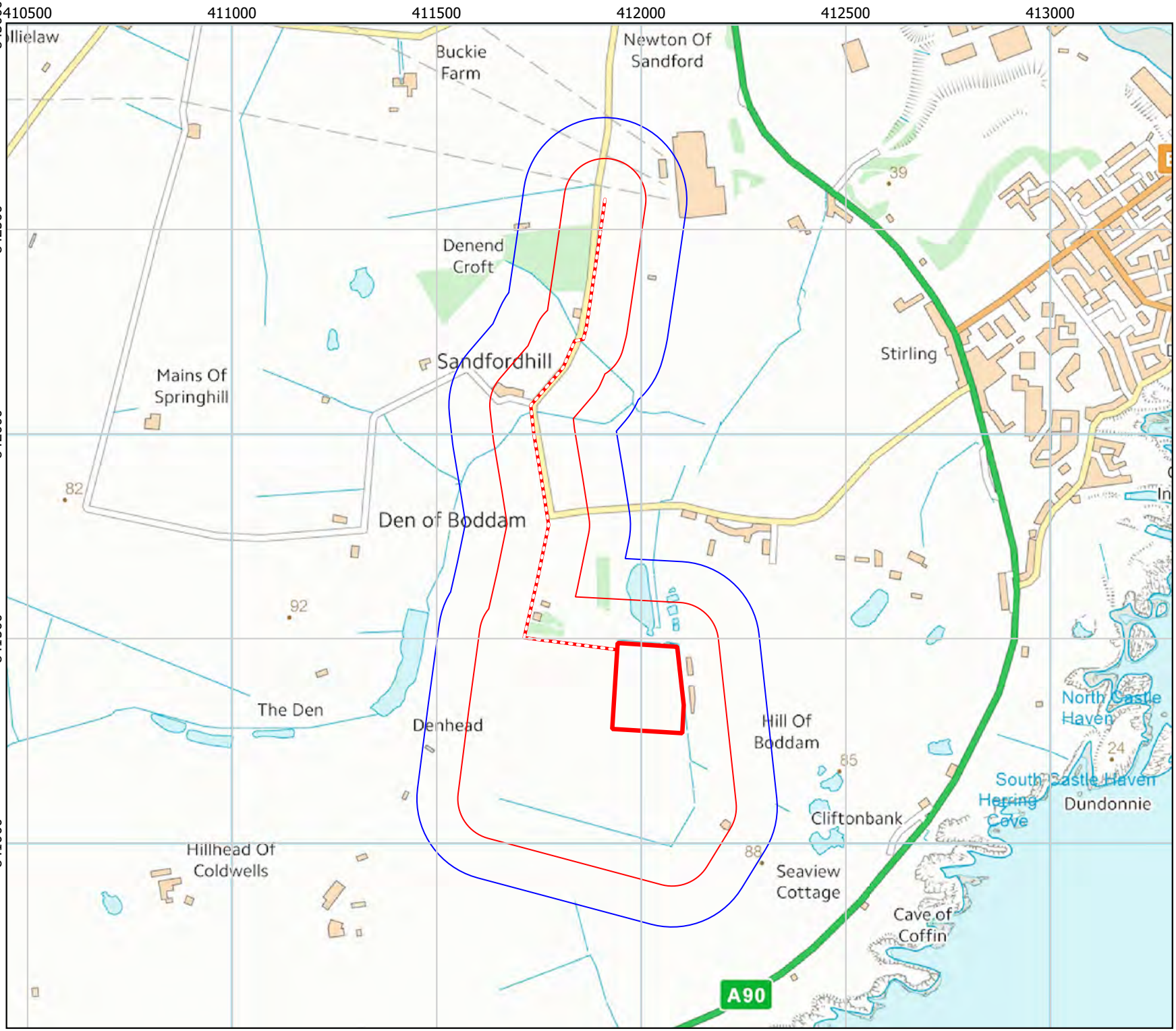
APPENDIX A – FIGURES



NorthConnect,
Peterhead, Aberdeenshire

Figure 1: Infrastructure and Survey Areas

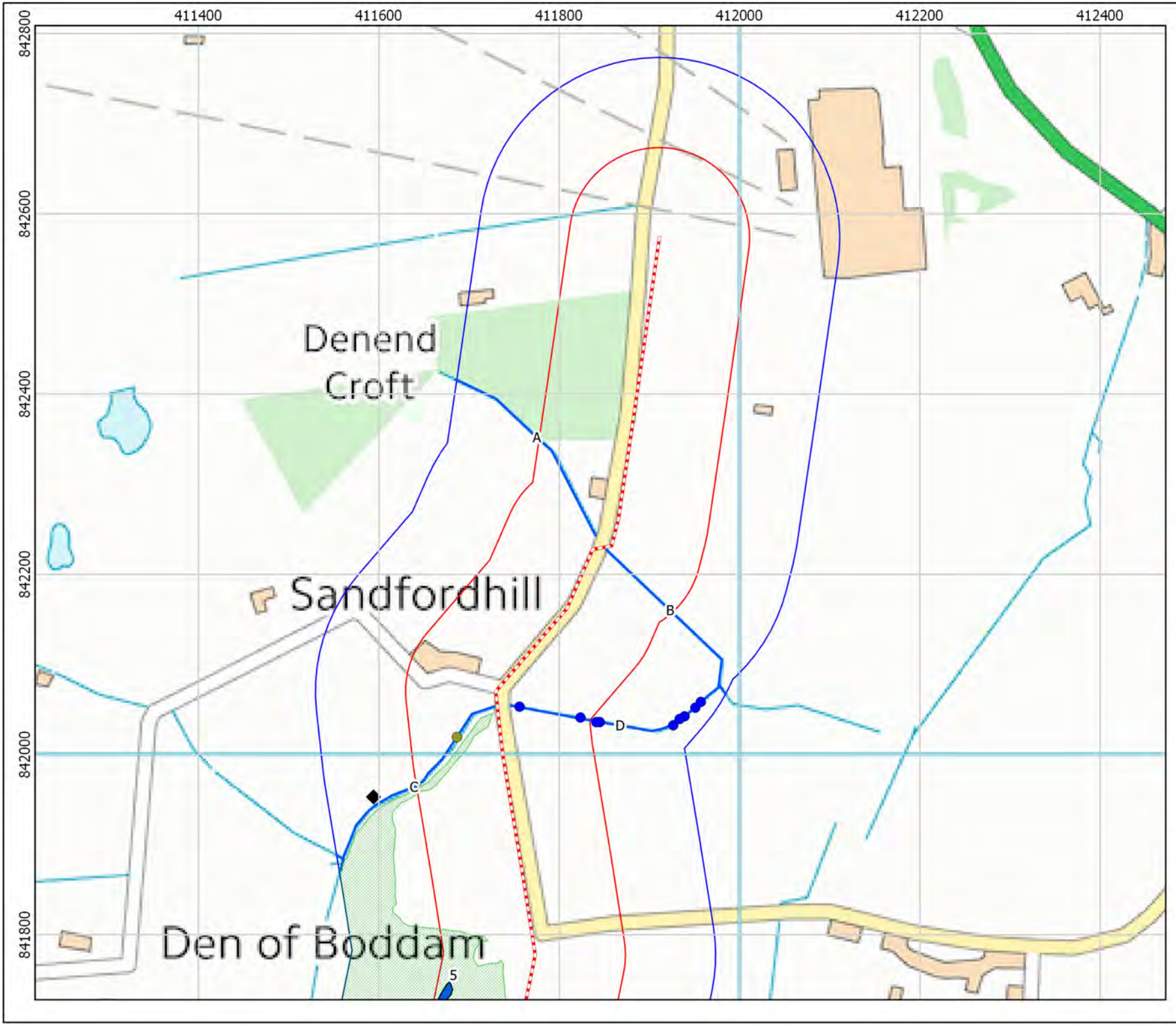
Legend

- HVAC Cable Route
- Converter Station
- 100m Buffer (Badger)
- 200m Buffer (Otter/WV)

0 100 200 300 m

N

Project Number: 14 021 AFF
Drawing Number: 001
Date of Production: 10/10/2014



NorthConnect,
Peterhead, Aberdeenshire

Figure 2a: Survey Results

Legend

Survey Results

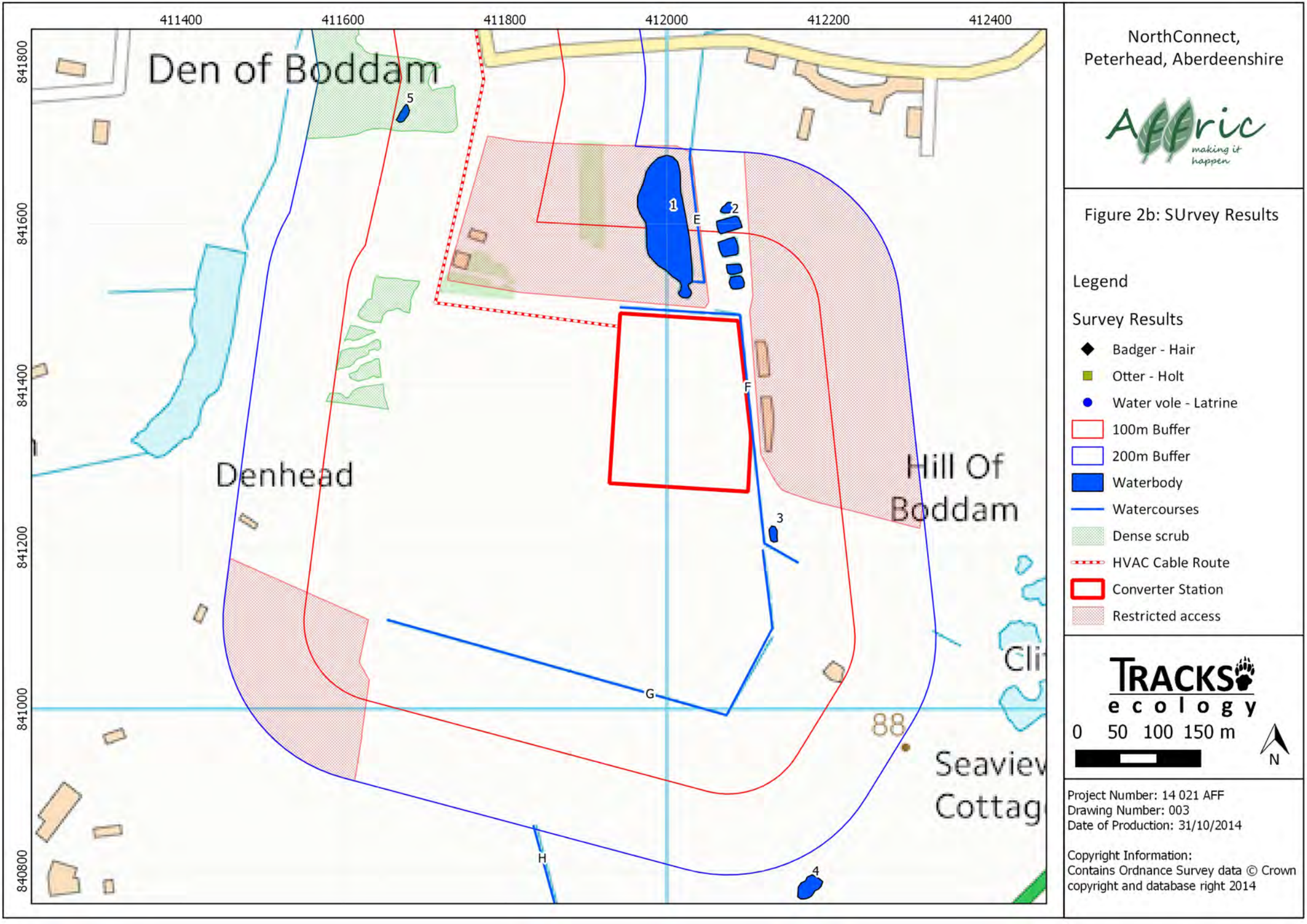
- Badger - Hair
- Otter - Holt
- Water vole - Latrine
- 100m Buffer
- 200m Buffer
- Waterbody
- Watercourses
- Dense scrub
- HVAC Cable Route

TRACKS ecology

0 50 100 150 m

N

Project Number: 14 021 AFF
Drawing Number: 002
Date of Production: 10/10/2014



NorthConnect,
Peterhead, Aberdeenshire

Figure 2b: SUrvey Results

Legend

Survey Results

- Badger - Hair
- Otter - Holt
- Water vole - Latrine
- 100m Buffer
- 200m Buffer
- Waterbody
- Watercourses
- Dense scrub
- HVAC Cable Route
- Converter Station
- Restricted access

TRACKS ecology

0 50 100 150 m

N

Project Number: 14 021 AFF
Drawing Number: 003
Date of Production: 31/10/2014

APPENDIX B – PHOTOGRAPHS

Plate 1: Waterbody 1

Plate 2: Northernmost settlement lagoon, Waterbody 2

Plate 3: Clearer northern settlement lagoon with rock banks visible, Waterbody 2

Plate 4: Silt ladened settlement lagoon, Waterbody 2

Plate 5: Waterbody 3

Plate 6: Waterbody 4

Plate 7: Waterbody 5

Plate 8: Otter spraint adjacent to Waterbody 4

Plate 9: Potential otter holt

Plate 10: Watercourse A

Plate 11: Watercourse B

Plate 12: Watercourse C

Plate 13: Watercourse D

Plate 14: Watercourse E

Plate 15: Watercourse F

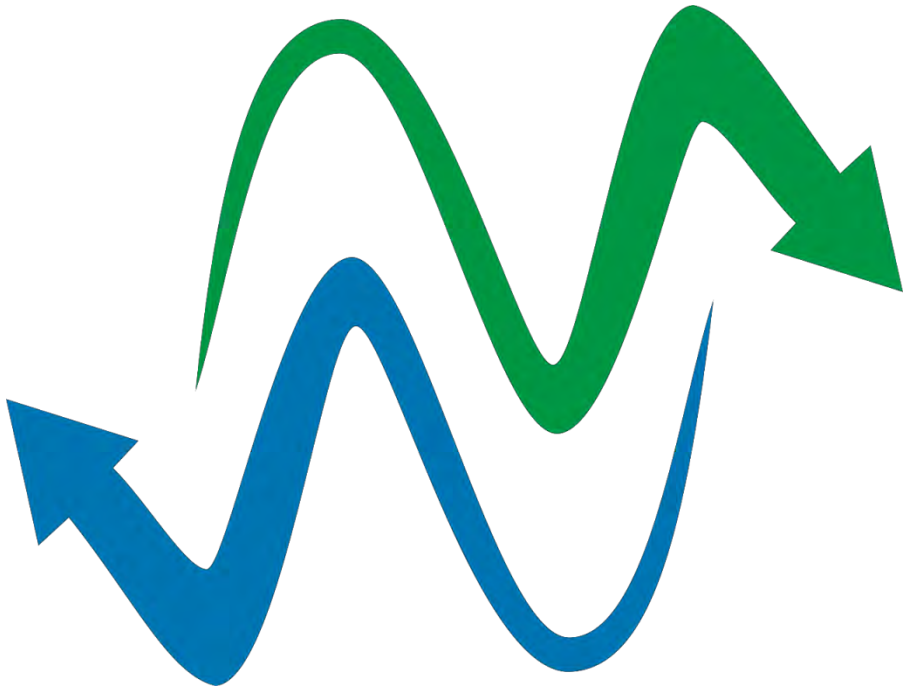
Plate 16: Watercourse G

Plate 17: Watercourse H

Plate 18: Example water vole latrine on Watercourse D

Plate 19: Area of dense scrub

NORTHCONNECT
CONNECTING RENEWABLES



Appendix C: Viewpoint Assessment

Viewpoint: 1	
Baseline conditions	
Viewpoint location: Hill of Boddam Viewpoint	
Grid reference: NK1227 4093	**Drawing Numbers:** 3110 & 3111
Distance to building: 0.38 km	**View direction:** 325°
Landscape character type: BB1	**Landscape designation:** none

Context:

This elevated viewpoint lies to the southeast of the Converter Station, beside a granite cairn, bench and view indicator. It provides panoramic views in all directions and is used by walkers, joggers and some walking groups.

Current view:

The view northwest is across rough grassland towards a stone byre in the corner of improved grass field enclosed by post and wire fencing. The ground falls away towards the Fourfields site, which is in arable cultivation and divided by stone dykes. Tree belts around Highfield and Braeside Trout Fishery can be seen to the north, beyond which the ground rises slightly towards a low ridge. A line of pylons crosses the view, with several large industrial buildings and some scattered dwellings, most with adjacent tree belts for shelter. Mormond Hill forms a slight focus in the otherwise flat coastal plain, with several clusters of wind turbines, masts and flare stacks visible in the distance.

The view northwest forms part of a wide panorama. Peterhead and the Reform Tower are visible to the north beyond Upperton Industrial Estate. The coast can be seen through 180 degrees from north, through east to south. To the northeast, beyond Stirling Hill quarry, Peterhead Power Station chimneys tend to draw the eye and there are views of dramatic cliffs further south. The longest views are to the southwest towards Bennachie; views to the west are curtailed by rising ground with the nearby radome and masts at RAF Buchan Ness prominent on the skyline.

Landscape sensitivity

Susceptibility to change:

Although lying within the coastal LCT, this landscape is heavily influenced by the agricultural plain to the west. The large scale, open, undulating landscape is moderately varied. Frequent settlement and infrastructure, traffic noise and the sound of nearby industry reduce susceptibility, although the area forms a backdrop in some views and has a regular field pattern, which increases susceptibility. Overall it is assessed as **medium**.

Landscape value:

Panoramic coastal views, varied land use, heathland vegetation and coastal landform contribute to the landscape quality, although the nearby, MOD facilities, quarry, masts, pylons, industrial buildings, eroded field boundaries and traffic noise detract. The transition between landscape types is unusual; the area is valued by local residents and others who use it and the nearby quarry and flint mines add to the cultural heritage value. Landscape value is assessed as **med-high**.

Visual receptors, receptor susceptibility to change and value of view

path users:

- most path users come to enjoy the view – **high** susceptibility
- well promoted viewpoint but small-med number of receptors – **med-high** value

Assessment of predicted effects

Description of changes:

The converter building and would be the most obvious new element, with the attached transformer building visible to the right and part of the GIS building visible below, further to the right. The proposed earth mounds would screen the SGT building and other components

Viewpoint: 1	
from view. The converter building would occupy some 15 degrees of the view, but the proposed mounds would extend further. The site access would be screened by the mounds. The planted roof of the converter building would follow the line of the adjacent mound with a curving section of translucent cladding visible below. Granite cladding would be visible on the lower parts of the buildings. The built elements would be predominantly front-lit by the sun.	
Landscape effects: The Converter Station would introduce large-scale industrial built elements into a landscape predominantly of agricultural character, although one heavily influenced by mineral extraction and processing, MOD use, masts, pylons and other built elements. It would disrupt the field pattern and the sense of openness. The scale of the converter building would be much larger than the traditional buildings visible in the foreground, although the earth mounds, planted roof and use of granite cladding would help to limit the landscape effects of this. Although the changes to the landform would be obvious, the proposed mounds would reflect the undulating character of the surrounding topography. The quarry and other infrastructure detract from the rural character at present, but the changes due to the Converter Station would be more evident, affecting several of the landscape characteristics. The magnitude of landscape effect is predicted to be **med-large.**	
Visual effects: The Converter Station would introduce an obvious new element in the view, forming a new focus. Although existing industrial buildings are visible in the middle distance to the north, the Converter Station would bring about a noticeable change. Together with the earth mounds, it would affect a moderate proportion of the extensive view, concealing the view of Mormond Hill. The low profile and curving form of the converter building against the sky and its integration with the adjacent mounds would help to minimise the visual effects, whilst the planted roof and granite cladding would help to reduce the contrast with nearby landscape elements. Taking these points into account, the magnitude of visual effect is predicted to be **med-large**.	
Significance of predicted operational visual effect:	**path users: mod-major** (significant)
Construction effects: Ground-based construction activity would be visible from this viewpoint, across the Converter Station platform and the construction compound and laydown area. Construction traffic entering the site would also be visible. Earth mounds to the north of the site access would be formed during the enabling works and would screen ground-based activity within this part of the site, although construction of the upper parts of the buildings would be visible.	
Effects of Proposed Planting: Woodland planting on the north mound would be visible, on either side of the proposed site access. Only that to the north of the access would be planted as part of the enabling works. The effect of tree and shrub growth would be to screen the lower parts of the proposed buildings. By year 10 the lower parts of the converter building and much of the GIS building would be hidden from view, as shown in Drawing 3111. By year 15 this planting is likely to screen the GIS building and much of the granite cladding of the converter building.	

Viewpoint: 2	
Baseline conditions	
Viewpoint location: Lendrum Terrace	
Grid reference: NK1209 4181	**Drawing Numbers:** 3113 & 3114
Distance to building: 0.39 km	**View direction:** 195°
Landscape character type: BB1 and BB7	**Landscape designation:** none

Context:

This viewpoint lies on the bridge over the remains of the 19th century railway (described in Chapter 9), between Lendrum Terrace and the Stirling Hill Access Network. It provides similar but slightly more open views to those from the adjacent footpath and also represents the intermittent oblique views that road users would have travelling east and west along this minor road. Some nearby dwellings may have similar views from upper floors towards the site, above the adjacent conifer tree belts and earth bunds that currently screen the quarry from view.

Current view:

Looking south the view follows a drainage channel bordered by a drying green on the left and gorse scrub to the right. The ground level rises towards the site, which is framed by a grass covered earth bund to the left and a conifer belt around Braeside Trout Fishery to the right. A low ridge forms the skyline on the far side of the arable fields of the Fourfields site. An overhead electric line on timber poles crosses the view and a mast is visible on the skyline to the right.

The view south forms part of a wider view of varied length. To the west, a low ridge forms the skyline beyond undulating farmland with forest plantations, pylons and occasional dwellings. There are longer views to the north towards Peterhead and the Reform Tower, with the substation and pylons in the middle distance and Upperton Industrial Estate beyond. The coast is visible to the northeast beyond Peterhead Power Station and parts of Boddam. Undulating grass fields and the dwellings of Lendrum Terrace curtail views to the east and southeast.

Landscape sensitivity

Susceptibility to change:

This medium scale, moderately enclosed and varied, undulating landscape has some settlement, infrastructure and land use change. The regular field pattern is evident, but the landscape is relatively low-lying and the noise of traffic and industry reduce susceptibility, which is assessed as **medium** overall.

Landscape value:

Varied land use, coastal views and the rural character contribute to the landscape quality, but quarry buildings and disturbed land, masts, pylons, overhead power lines, industrial buildings, eroded field boundaries, roadside clutter and traffic noise detract. The area is valued by local residents and others who use the footpath system and the nearby quarry, remains of the 19th century railway and flint mines add to the cultural heritage value. Landscape value is assessed as **medium** overall.

Visual receptors, receptor susceptibility to change and value of view

residents:

- views from dwellings - **high** susceptibility
- not widely promoted view, small number of receptors– **medium** value

path users:

- some path users come to enjoy the view – **med-high** susceptibility
- well promoted route but small-med number of receptors – **med-high** value

road users:

Viewpoint: 2

- most road users likely to be travelling for other purposes than the view - **medium** susceptibility
- view not widely promoted, medium number of receptors – **medium** value

Assessment of predicted effects

Description of changes:

The gable of the converter building and attached control building would be visible directly behind the existing timber hut next to the fishing loch, the curving roofline visible against the sky. The upper part of the GIS building would also be visible to the left, partly concealed by the earth mounds. The SGT building would be screened from view. The converter building would occupy approximately 15 degrees of the view and would be predominantly back-lit, although the translucent cladding would allow some light penetration. Part of the granite cladding would be visible at lower levels, with the planted roof above. Small sections of crib walling on the inner faces of the earth mounds would be visible on either side of the building. The gently sloping mounds would occupy most of the 39.6 degree view.

Landscape effects:

The Converter Station would introduce a large-scale industrial building into a landscape predominantly of agricultural character, although one heavily influenced by mineral extraction and processing, MOD use, masts, pylons and other built elements. It would disrupt the sense of openness and detract from the rural character and its large scale would adversely affect that of nearby tree groups and buildings. Changes to the landform would be clearly apparent, but the landscape pattern would be less affected.

The curving form and planted roof of the converter building would reduce its landscape effect, whilst the proposed mounds would assist the integration of the building into the existing landform. The screening of ancillary structures would also reduce the landscape effect.

The changes would be obvious, affecting several of the key landscape characteristics but, taking into account the detractors already present, and the embedded mitigation measures proposed, the magnitude of landscape effect is predicted to be **med-large.**

Visual effects:

The Converter Station would form an obvious new focus but would not detract from the longer views of Peterhead and the coast. It would affect a moderate part of this wide view and would sit relatively low on the skyline, well integrated with the adjacent mounds and the skyline beyond. The translucent cladding and planted roof would help to reduce the visual contrast of the building but, together with the proposed mounds, it would obscure views of the agricultural landscape beyond to the south.

The magnitude of visual effect is predicted to be **med-large** for walkers and residents who would have direct views and **medium** for road users who would have oblique views along a short section of road.

Significance of predicted operational visual effect:	**residents: mod-major** (significant) **walkers: mod-major** (significant) **road users: moderate** (not significant)

Construction effects:

Once the earth mounds have been constructed as part of the enabling works, much of the ground-based construction activity would be screened from view. Construction of the upper parts of the converter building would be visible from this viewpoint.

Effects of Proposed Planting:

Woodland planting on the north and east mounds would be visible either side of the existing quarry bund. These would be planted as part of the enabling works. The proposed woodland planting would extend the existing tree belts, helping to integrate the building within this undulating landscape.

Viewpoint: 2
The effect of tree and shrub growth would be to screen the lower parts of the proposed buildings. By year 10 the lower parts of the converter building and much of the GIS building would be hidden from view, as shown in Drawing 3114. By year 15 much of the granite cladding of the converter building would be concealed and only the translucent cladding and planted roof visible. Climbers planted on the crib walling would reduce the visual contrast of the light coloured concrete over time and could be expected to cover this completely by year 15.

Viewpoint: 3	
Baseline conditions	
Viewpoint location: Footpath west of Sandfordhill Reservoir	
Grid reference: NK1131 4150	**Drawing Numbers:** 3116 & 3117
Distance to building: 0.62 km	**View direction:** 105°
Landscape character type: BB7	**Landscape designation:** none

Context:

The viewpoint lies to the west of Boddam Den as the existing footpath meets a track leading to an isolated dwelling. This walk forms part of the Stirling Hill Access Network but visitors are more likely to approach the flint mines from Highfield, as directed by brown tourist signs. A new car park and picnic tables have been installed beside the nearby reservoir, which is also used for fishing, but there would be no views of the Converter Station from here. The viewpoint represents views enjoyed by walkers. Similar views would be possible from the adjacent dwelling.

Current view:

The view east is across regular grass fields bounded by post and wire fences. Boddam Den cuts across the view, beyond which a mix of rough grass, heather and improved grass fields rises towards a line of gorse scrub that forms the skyline. Several masts are visible and a power line passes overhead.

This view forms part of a wider view that includes pylon lines, masts and flare stacks to the north, Upperton Industrial Estate, Peterhead and its harbour, Peterhead Power Station and the substation to the northeast. The coast is visible from north to just north of east. Rising ground curtails views in other directions, although the radome and masts at RAF Buchan Ness are evident above the skyline to the south.

Landscape sensitivity

Susceptibility to change:

This is a medium scale, partly open, undulating, moderately varied landscape with some settlement, infrastructure and land use change. The regular field pattern is evident and the landscape forms a minor skyline, but the noise of traffic and industry reduce susceptibility, which is assessed as **medium** overall.

Landscape value:

Varied land use, heathland vegetation, the more rugged landform of the Den, some coastal views and the stronger rural character contribute to the landscape quality, but nearby masts and overhead power lines, views of pylons, industrial buildings, eroded field boundaries and traffic noise detract. The area is valued by local residents and others who use the footpath system and reservoir, and the adjacent flint mines add to the cultural heritage value. Landscape value is assessed as **med-high** overall.

Visual receptors, receptor susceptibility to change and value of view

residents:

- views from dwellings – **high** susceptibility
- not widely promoted view, small number of receptors – **medium** value

path users:

- most path users come to enjoy the view – **high** susceptibility
- well promoted viewpoint but small-med number of receptors – **med-high** value

Assessment of predicted effects

Description of changes:

The planted roof of the converter building would be visible above the gorse scrub that forms the skyline at this point, between the proposed earth mounds. No other parts of the

Viewpoint: 3	
Converter Station would be seen from this viewpoint.	
Landscape effects: Although the Converter Station would introduce a large scale industrial building into a rural landscape, this would be hard to appreciate from this viewpoint, as only part of the planted roof would be visible. It would not affect the landscape pattern, the landform or the scale of any landscape elements. Existing infrastructure detracts from the rural character at present and the Converter Station would not affect this further. The change to the landform would be apparent but the proposed mounds would reflect the existing undulating landform in the vicinity, helping to limit any landscape effects. Few characteristics would be affected and the changes would be minor, affecting the experience of the landscape slightly. The magnitude of landscape effect is predicted to be **small**.	
Visual effects: The Converter Station would not form an obvious new focus or affect the longer views to Peterhead and the coast. It would sit very low on the skyline, and would not contrast noticeably with the adjacent landscape elements. The visible part of the converter building roof would occupy a small proportion of the wider view but the earth mounds would be more extensive. Overall the changes would be apparent but not conspicuous. The magnitude of visual effect is predicted to be **small**.	
Significance of predicted operational visual effect:	**residents: moderate** (not significant) **walkers: moderate** (not significant)
Construction effects: Once the earth mounds have been constructed during the enabling works, much of the construction activity would be hidden from view. Although the southernmost mound would be formed during the last phase of the construction period, the existing ridge that lies along the western boundary of the Fourfields site is likely to screen the laydown area from view. Construction of some of the upper parts of the converter building would be visible.	
Effects of proposed planting: Woodland planting on the north and east mounds would not be visible from this viewpoint.	

Viewpoint: 4	
Baseline conditions	
Viewpoint location: Elevated Sculpture at the Entrance to the Power Station	
Grid reference: NK1260 4261	**Drawing Numbers:** 3119 & 3120
Distance to building: 1.32 km	**View direction:** 210°
Landscape character type: BB1	**Landscape designation:** none

Context:

This viewpoint lies beside the triangular concrete artwork at the top of a mound, created as part of the environmental improvements associated with Peterhead Power Station. A grass path leads to the artwork from a dedicated car park and a brown tourist sign directs visitors from the adjacent A90. The view is representative of those experienced by visitors.

Current view:

The ground slopes steeply away across rough grass with a mown path leading to the car park below. A mixed tree belt surrounds the car park; this belt is thicker to the left of the view but is sufficiently narrow towards the centre to allow views of traffic moving along the A90. Beyond this, a walled enclosure at Millbank contains numerous caravans and the roof of a dwelling is just visible to the right. A power line on timber poles beside a stone dyke leads the eye uphill through grass fields enclosed by post and wire fences with some hedges. The landform becomes more obviously undulating higher up, emphasised by a small burn. Dwellings amongst trees at Lendrum Terrace are visible on the skyline, with some areas of gorse scrub to the left and tree belts around Braeside Trout Fishery and Highfield to the right. Arable fields at Fourfields are visible behind Lendrum Terrace, backed by several masts on the skyline.

The view southwest forms part of a much wider view from south almost to north towards the enclosing ridge of land with a scatter of masts, tree belts and pylons evident. To the north, views towards Upperton Industrial Estate and Peterhead are interrupted by the nearby substation. To the northeast, coastal views are framed by Peterhead Power Station. Rising ground curtails views to the east, but Boddam, the lighthouse and some industrial buildings next to the A90 are visible to the southeast. To the south the quarry is screened from view by the ridge.

Landscape sensitivity

Susceptibility to change:

Although lying within the coastal LCT, this landscape is heavily influenced by the adjacent power station, A90 corridor, substation and nearby pylons. It is a medium to large scale, open, undulating landscape and is moderately varied. Frequent settlement and infrastructure, traffic noise and the sound of the power station reduce susceptibility, but it forms a backdrop in some views, which increases it slightly. Overall it is assessed as **low-med**.

Landscape value:

Coastal views and some varied landform contribute to the landscape quality and the viewpoint and adjacent North Sea Trail add recreational value, although the nearby road corridor, industrial buildings, pylons, masts, eroded field boundaries and traffic noise detract. Landscape value is assessed as **medium**.

Visual receptors, receptor susceptibility to change and value of view

visitors:

- most come to appreciate the view – **high** susceptibility
- promoted view but small-med number of receptors – **med-high** value

Assessment of predicted effects

Description of changes:

Viewpoint: 4	
The gable of the converter building and attached control building would be visible directly behind dwellings along Lendrum Terrace, the curving roofline visible against the sky. The upper part of the GIS building would also be visible to the left, partly concealed by dwellings and trees. The SGT building would be screened from view. The converter building would occupy approximately six degrees of the view and would be predominantly back-lit, although the translucent cladding would allow some light penetration. Part of the granite cladding would be visible at lower levels, with the planted roof above. Small sections of crib walling on the inner faces of the earth mounds would be visible on either side of the building, partly screened by existing trees. The gently sloping mounds would extend either side of the converter building, reflecting the curving profile if its roof.	
Landscape effects: The scale of the Converter Station would affect that of adjacent tree groups and buildings, but its effect on the scale of the undulating topography would be less noticeable. Although the converter building and proposed mounds would obscure the pattern of fields to the south, the curving profile of the roofline and mounds would relate well to the pattern of undulating fields, visible in the foreground. It would detract slightly from the rural character of the backdrop, although the planted roof and curving form of the building would limit this effect, whilst masts on the skyline and nearby buildings and other infrastructure already affect the landscape experience. Changes would be noticeable, affecting some characteristics to a degree. The magnitude of landscape effect is assessed as **small-med**.	
Visual effects: The Converter Station would introduce a new focus, but not within the most diverse part of the view, which is towards the coast. Although larger in scale than other built elements nearby in the view, the curving profile and translucent cladding of the converter building would help to reduce its visual effect. The Converter Station would bring about a noticeable change, but would sit low on the skyline and occupy a small part of this wide view, limiting the visual effect. Overall, the magnitude of visual effect is predicted to be **small-med.**	
Significance of predicted operational visual effect:	**visitors: moderate** (not significant)
Construction effects: The formation of earth mounds during the enabling works and subsequent construction of the upper parts of the converter building would be visible. Once enabling works have been completed, the proposed mounds would screen much of the ground-based construction activity. Although mounds to the north of the access road would be formed towards the end of the construction period, dwellings and existing trees along Lendrum Terrace are likely to screen activity from this viewpoint.	
Effects of proposed planting: Proposed woodland planting on the north and east mounds would be visible below the buildings, appearing to extend the existing tree belts and helping to integrate the Converter Station. All would be planted as part of the enabling works. The effect of tree and shrub growth would be to screen the lower parts of the proposed buildings. By year 10 the lower parts of the converter building and much of the GIS building would be hidden from view, as shown in Drawing 3120. By year 15 the GIS building and much of the granite cladding of the converter building would be concealed, with only the translucent cladding and planted roof visible. Climbers planted on the crib walling would reduce the visual contrast of the wall over time and could be expected to cover this completely by year 15.	

Viewpoint: 5	
Baseline conditions	
Viewpoint location: A90 Substation Entrance	
Grid reference: NK1236 4267	**Drawing Numbers:** 3122 & 3123
Distance to building: 1.28 km	**View direction:** 200°
Landscape character type: BB1	**Landscape designation:** none

Context:

The viewpoint lies beside planted embankments that surround the substation. It represents views experienced by road users for approximately 350 m as they head south. Users of the North Sea Trail, on the opposite side of the road would have similar views. Views from the adjacent dwelling at Millbank would be screened by outbuildings but a house nearby to the west would have similar open views of the Converter Station.

Current view:

Beyond the grass verge of the substation entrance the view southwest is across grass fields enclosed by post and wire fences. Beyond this, a hedge on more undulating fields to the left of the view leads the eye towards the skyline, with the dwellings at Lendrum Terrace set amongst trees. To the right, the skyline is formed by the grass embankments of the remains of the 19th century railway, with the masts at RAF Buchan Ness visible on the skyline. A power line on timber poles crosses the view, which otherwise has no strong focus.

The view southwest is framed on the left by nearby farm buildings and by planting around the substation to the right. Apart from a restricted view southeast to Boddam, views in other directions are short, curtailed by earth mounds, tree planting and by the substation and power station.

Landscape sensitivity

Susceptibility to change:

This medium scale, undulating and moderately varied landscape is neither enclosed nor open. Although lying within the coastal LCT, it is heavily influenced by the adjacent power station, A90 corridor, substation, traffic noise and the sound of the power station. Overall it is assessed as **low-med**.

Landscape value:

The adjacent North Sea Trail adds recreational value and the rural backdrop to the southwest contributes to landscape quality, although the nearby road corridor, industrial buildings, masts, eroded field boundaries and traffic noise detract. Landscape value is assessed as **low-med**.

Visual receptors, receptor susceptibility to change and value of view

residents:

- views from dwellings – **high** susceptibility
- not widely promoted view, small number of receptors – **medium** value

path users:

- most path users come to enjoy the view – **high** susceptibility
- path well promoted, small-med number of receptors – **med-high** value

road users:

- main tourist route - some users likely to be focussed on the view – **med-high** susceptibility
- view not widely promoted, large number of receptors – **med-high** value

Assessment of predicted effects

Description of changes:

The gable of the converter building and attached control building would be visible above the

Viewpoint: 5	
railway embankment, behind the power line on timber poles and to the right of the dwellings along Lendrum Terrace, its curving roofline visible against the sky. Intervening landform would screen much of the lower part of the converter building and the GIS and SGT buildings from view. The converter building would occupy approximately five degrees of the view and would be predominantly back-lit, although the translucent cladding would allow some light penetration. Sections of crib walling on the inner faces of the earth mounds would be visible on both sides of the building. The gently sloping mounds would extend either side of the converter building, reflecting the curving profile if its roof.	
Landscape effects: The converter building would appear similar in scale to the barns to the left of the view, but would detract slightly from the scale of dwellings and tree groups along the skyline. The landform and landscape pattern are indistinct and would not be noticeably affected. The main effect would be on the rural character of the backdrop, although the buildings and masts along the skyline and the adjacent substation already affect this and the planted roof and curving form of the converter building would limit the effect. The changes would be apparent, but affecting few of the characteristics and only to a degree. The magnitude of landscape effect is predicted to be **small-med**.	
Visual effects: Although the Converter Station would occupy a small proportion of the view and similar elements are visible nearby in other directions, it would occupy the longest part of the view. Translucent cladding would reduce the contrast with light skies, whilst the low curving profile of the building against the skyline and integration with the undulating mounds would also limit the visual effect. The changes would be noticeable and the magnitude of visual effect is predicted to be **small-med** for residents and path users, but **small** for road users, who would see the Converter Station from a relatively short section of road.	
Significance of predicted operational visual effect:	**residents: moderate** (not significant) **path users: moderate** (not significant) **road users: mod-minor** (not significant)
Construction effects: The formation of earth mounds during the enabling works and subsequent construction of the upper parts of the converter building would be visible, but all other construction activity is likely to be screened from this viewpoint.	
Effects of proposed planting: Proposed woodland planting on the north and east mounds would be visible either side of the converter building, appearing to extend the existing tree belts and helping to integrate the Converter Station. All would be planted as part of the enabling works. The effect of tree and shrub growth would be to screen parts of the crib walling. By year 10 the section of crib walling to the right of the converter building would be hidden from view, as shown in Drawing 3123. Climbers planted on the crib walling would reduce the visual contrast of the crib wall over time and could be expected to cover this completely by year 15.	

Viewpoint: 6	
Baseline conditions	
Viewpoint location: Minor Road south of Newton	
Grid reference: NK1195 4310	**Drawing Numbers:** 3125 & 3126
Distance to building: 1.56 km	**View direction:** 180°
Landscape character type: BB7	**Landscape designation:** none

Context:

The viewpoint lies on a minor road just to the west of the A90. It is representative of the views experiences by road users and residents of one dwelling. Similar views would be possible for road users heading south along a section of road approximately 1 km long.

Current view:

The view south is along the minor road, which is bounded by stone dyke and post and wire fences with medium sized grass fields on either side. The road leads the eye upwards towards the arable fields that form the skyline. The dwellings of Lendrum Terrace lie below the skyline to the left of the view, with parts of the quarry and moving vehicles visible to the right. Further to the right a conifer belt around Denend is quite prominent, with the radome and masts at RAF Buchan Ness visible on the skyline above. A nearby pylon line crosses the middle of the view and a phone line passes overhead.

The view south forms part of a wide view of varied length. To the west, some large buildings in Upperton Industrial Estate occupy the skyline amongst pylon lines. Arable fields on rising ground curtail views to the northwest but some more distant masts are visible. To the north there are slightly longer views towards the Towerhill area of Peterhead and the Reform Tower. Views to the northeast are screened by the nearby house and tree belts, beyond which Peterhead Power Station and the nearby substation are partly screened by tree planting. A small section of coast can be seen beyond some buildings in Boddam, visible to the southeast.

Landscape sensitivity

Susceptibility to change:

This is a medium to large scale, open, undulating, fairly simple, relatively low-lying landscape with some settlement, infrastructure and land use change. The regular field pattern is evident, but the noise of nearby industry reduces susceptibility, which is assessed as **medium** overall.

Landscape value:

Some coastal views and the rural character contribute to the landscape quality, but nearby pylon lines, industrial buildings, masts, eroded field boundaries and the noise of industry and traffic on the A90 detract. The area has some recreational value and the landscape value is assessed as **medium** overall.

Visual receptors, receptor susceptibility to change and value of view

residents:

- views from dwellings – **high** susceptibility
- view not promoted, small number of receptors – **medium** value

road users:

- minor road used for access - most users unlikely to be focussed on the view – **medium** susceptibility
- view not promoted, medium number of receptors – **medium** value

Assessment of predicted effects

Description of changes:

The gable of the converter building and attached control building and the upper part of the

Viewpoint: 6	
GIS building would appear behind existing tree belts at Braeside Trout Fishery but the STG building would be screened from view by the proposed earth mounds. The planted roof and translucent cladding of the converter building would be visible, but much of the granite cladding would be concealed from view. The converter building would occupy approximately four degrees of the view and would be predominantly back-lit, although the translucent cladding would allow some light penetration. Crib walling on the inner faces of the earth mounds would be visible to the left of the building, with a small section to the right. The gently sloping mounds would extend either side of the converter building, reflecting the curving profile of its roof.	
Landscape effects: The Converter Station would introduce a large-scale industrial building into a landscape predominantly of agricultural character, but currently heavily influenced by pylons, masts and other infrastructure. The converter building would appear similar in scale to the nearby substation, but larger than that of other nearby elements such as dwellings and tree belts. It would disrupt the sense of openness slightly and changes to the landform would also be apparent, but the landscape pattern would be less affected. The screening of ancillary structures and the curving form and planted roof of the converter building would help to reduce its landscape effect, whilst the proposed mounds would help to integrate the building into the existing landform. The changes would be noticeable, affecting some of the characteristics to a degree. The magnitude of landscape effect is predicted to be **small-med**.	
Visual effects: The Converter Station would draw the eye and form a new focus, but would not affect the longer views towards Peterhead and the coast. Translucent cladding would reduce the contrast with light skies, whilst the low curving profile against the skyline and integration with the undulating mounds would also limit the visual effect. It would occupy a small proportion of the wider view but the changes would be noticeable. Residents and road users heading south would have direct views and the magnitude of visual effect is predicted to be **small-med**.	
Significance of predicted operational visual effect:	**residents: moderate** (not significant) **road users: moderate** (not significant)
Construction effects: The formation of earth mounds during the enabling works and subsequent construction of the upper parts of the converter building would be visible, but all other construction activity is likely to be screened from this viewpoint.	
Effects of proposed planting: Proposed woodland planting on the north and east mounds would be visible below and to the left of the converter building, appearing to extend the existing tree belts and helping to integrate the Converter Station. All would be planted as part of the enabling works. The effect of tree and shrub growth would be to screen the GIS building and increasing amounts of the converter building from view. The GIS building and the section of crib walling to the right of the converter building would be screened by year 5. By year 10 much of the granite cladding of the converter building would be hidden from view, as shown in Drawing 3126. By year 15 much of the granite cladding of the converter building would be concealed and only the translucent cladding and planted roof visible. Woodland planting would also screen much of the crib walling to the left of the building, whilst climbers would reduce the visual contrast of the crib wall over time and by year 15 could be expected to cover any sections that remain visible.	

Viewpoint: 7	
Baseline conditions	
Viewpoint location: Minor Road south of Newfield	
Grid reference: NK1050 84275	**Drawing Number:** 3128
Distance to building: 1.94 km	**View direction:** 135°
Landscape character type: BB7	**Landscape designation:** none

Context:

The viewpoint lies on a minor road within an open landscape and similar views would be possible from a wide area. A nearby dwelling would have direct views of the Converter Station, but those for road users heading southwest would be oblique.

Current view:

The view southeast is across medium sized, regular, undulating grass fields enclosed by post and wire fences with some stone walls. The land rises gently towards the skyline, which is generally open, punctuated by several masts and the tree belt around Highfield. There is no strong focus to the view, which has a horizontal emphasis.

The view southeast forms part of a wider view towards the undulating ridge that encloses the site. Further south a small wind turbine is visible nearby at Springhill Farm where views are curtailed by rising ground and a substantial tree belt. To the southwest, west and northwest there are longer views towards a line of low undulating hills, with a scatter of woodland blocks. To the southwest, the minor road draws the eye and a pylon line is prominent to the west. Views to the north are shorter, screened by a conifer belt around the nearby dwelling and by industrial buildings and the power station further to the east.

Landscape sensitivity

Susceptibility to change:

This is a med-large scale, open, undulating, slightly varied landscape with some settlement, infrastructure and land use change. The field pattern is more evident to the west. Overall susceptibility is assessed as **medium**.

Landscape value:

The landscape has a strongly rural character, especially towards the west, and is relatively tranquil. Detractors include nearby pylons and industrial buildings, the power station, masts and radome, eroded field boundaries and some derelict buildings. There is little evidence of any recreational use or cultural heritage features and the landscape is intensively farmed. Overall landscape value is assessed as **medium**.

Visual receptors, receptor susceptibility to change and value of view

residents:

- views from dwellings - **high** susceptibility
- not widely promoted view, small number of receptors– **medium** value

road users:

- minor road used for access - most users unlikely to be focussed on the view – **medium** susceptibility
- view not promoted, medium number of receptors – **medium** value

Assessment of predicted effects

Description of changes:

The translucent cladding of the gable and a tapering section of planted roof of the converter building would be visible to the right of several masts on the skyline and directly behind the tree belt around Highfield. No other proposed buildings would be visible. The converter building would occupy approximately three degrees of the view and would be predominantly back-lit. It would appear to extend the proposed earth mounds, which would be visible to the

Viewpoint: 7	
right of the converter building, reflecting the curving profile of its roof.	
Landscape effects: The Converter Station would introduce an industrial building into a part of the landscape that is predominantly rural, although masts and the radome are visible nearby. It would have little effect on any landscape elements, or on the landscape pattern, which is indistinct. The scale of the converter building and mounds would reflect that of the topography visible nearby. It would bring about a minor change, affecting few of the key characteristics and the magnitude of landscape effect is assessed as **small**.	
Visual effects: The Converter Station would not draw the eye noticeably, or affect the longer views to the west. It would occupy a small part of the wide view and the low profile and horizontal emphasis would further reduce the visual effect. The magnitude of visual effect is assessed as **small** for residents who would have direct views, and **small-neg** for road users, who would have oblique views.	
Construction effects: The formation of earth mounds during the enabling works and subsequent construction of the upper parts of the converter building would be visible, but all other construction activity is likely to be screened from this viewpoint.	
Significance of predicted operational visual effect:	**residents: mod-minor** (not significant) **road users: minor** (not significant)
Effects of proposed planting: Proposed woodland planting is unlikely to be visible from this viewpoint.	

Viewpoint: 8	
Baseline conditions	
Viewpoint location: A982 north of Invernettie Roundabout	
Grid reference: NK1192 4412	**Drawing Numbers:** 3131& 3123
Distance to building: 2.67 km	**View direction:** 180°
Landscape character type: Urban	**Landscape designation:** none

Context:

The viewpoint lies on the North Sea Trail on the edge of the urbanised outskirts of Peterhead. Road users heading south and those on the North Sea Trail would have direct views for approximately 350 m north of the viewpoint. South of the roundabout the view would be screened by the embankment of the convict railway, but more open views would be possible from a 180 m long section of the A90 further south.

Current view:

The foreground is dominated by roadside clutter and moving vehicles. Beyond the roundabout the view south is across medium sized undulating grass fields enclosed by post and wire fences. A stone abutment of the remains of the 19th century railway can be seen to the left and a section of stone wall and embankment to the right of the A90. The A90 leads the eye south towards a tree belt around Newton on the skyline. To the right of the road, some disturbed land, power lines on timber poles and occasional buildings add to the clutter. The undulating skyline is interrupted by numerous masts, a barn at Newton farm, pylons, electric lines and the radome at RAF Buchan Ness. The tree belt around Highfield is visible to the left of the pylons, beside the arable fields of the Fourfields site.

The view south forms part of a wider view towards the ridge that encloses the site, which is framed by nearby buildings. Industrial buildings screen views to the southwest and northwest; and mature broadleaved woods around a walled garden curtail views to the north and northeast, although the Reform Tower is partly visible. Other industrial buildings screen views to the east but there is a narrow view of the coast between these and Peterhead Power Station, which lies to the southeast.

Landscape sensitivity

Susceptibility to change:

This medium to large scale, undulating, moderately varied landscape is highly urbanised, busy and noisy. Landscape susceptibility is assessed as **low**.

Landscape value:

The glimpse of the coast and views of the walled garden and broadleaved trees to the north add to the landscape value but heavy traffic, industrial buildings, roadside clutter, the Power Station, pylons, masts, radome, eroded field boundaries, litter, disturbed land and some derelict buildings detract. The North Sea Trail provides some recreational value and the remains of the 19th century railway add cultural heritage interest. Overall landscape value is assessed as **low-med**.

Visual receptors, receptor susceptibility to change and value of view

path users:

- most likely to be focussed on the view – **high** susceptibility
- route well promoted, small-med number of receptors – **med-high** value

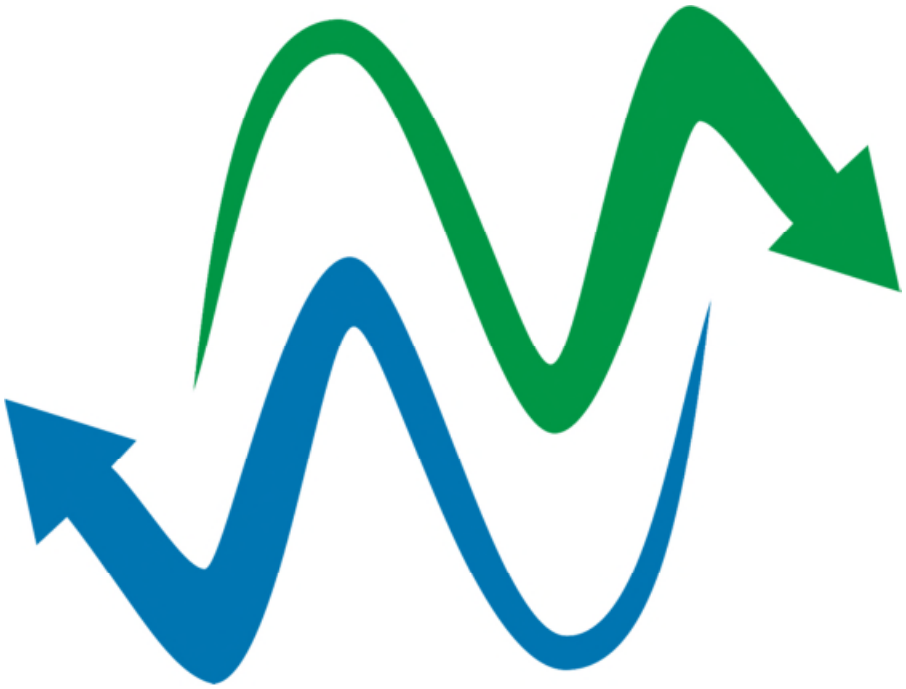
road users:

- main tourist route – some users may be focussed on the view – **med-high** susceptibility
- view not promoted, large number of receptors – **med-high** value

Assessment of predicted effects

Viewpoint: 8	
Description of changes: The translucent cladding of the converter building gable would appear on the skyline to the right of the barn at Newton farm and directly behind a garage building. It would occupy approximately two degrees of the view and would be predominantly back-lit, although the translucent cladding would allow some light penetration. The gently sloping mounds would extend either side of the converter building, reflecting the curving profile if its roof. A small section of crib walling would be visible between the converter building and the existing barn	
Landscape effects: The Converter Station would introduce a building of similar apparent scale to those visible nearby. It would have little effect on nearby landscape elements or on the landscape pattern, which is indistinct. The rural character of the backdrop is already affected by the industrial buildings and infrastructure; the Converter Station would add to this slightly but nearby detractors would remain more evident. It would bring about a minor change, affecting some characteristics to an extent and the magnitude of landscape effect is assessed as **small-neg**.	
Visual effects: The Converter Station would not form a strong focus, it would occupy a small proportion of the view and would appear similar in scale to elements already present in the view. It would add slightly to the sense of clutter, but the translucent cladding would reduce the contrast against light skies, reducing the effect. It would bring about a minor change and the magnitude of visual effect is assessed as **small**.	
Significance of predicted operational visual effect:	**path users: moderate** (not significant) **road users: mod-minor** (not significant)
Construction effects: The formation of earth mounds during the enabling works and subsequent construction of the upper parts of the converter building would be visible, but all other construction activity is likely to be screened from this viewpoint.	
Effects of proposed planting: A small section of proposed woodland planting would be visible to the left of the converter building, partly obscured by the barn at Newton farm, with a smaller section to the right of the converter building, as shown on Drawing 3132. Climbers would reduce the visual contrast of the crib walling over time and by year 15 could be expected to cover the section that is visible.	

NORTHCONNECT
CONNECTING RENEWABLES



Appendix D: Trial Pit and Borehole Logs

Trial Pit and Borehole Logs

SYNERGIST PROJECTS
Trial Pit Log

TP No.: **TP1**
Sheet 1 of 1

Level (mAOD): **61.92**
Coordinates: **E: 412053.726**
N: 841467.833
Date: **12-Mar-14**
Plant: **JCB-3CX**

Location: **Four Fields**
Client: **NorthConnect KS**
Engineer: **R.Blanchfield**

Depth (mbgl)	Level (mAOD)	Legend	DESCRIPTION OF STRATA	Samples Tests	Depth (mbgl)
			Loose soft dark brown slightly silty slightly gravelly sandy TOPSOIL with rootlets noted. Gravel is fine rounded to sub-rounded of mixed lithologies.	D (S1)	0.00
0.35	61.57		Medium dense orangey brown gravelly SAND. Gravel is medium to coarse angular to sub-rounded of mixed lithologies.	D/B (S2)	0.40
0.50	61.42		Medium dense firm to stiff orangey red sandy slightly gravelly CLAY. Gravel is fine to medium sub-rounded of mixed lithologies.	D/B (S3)	1.00
				▼	1.35
1.65	60.27		Loose red clayey slightly gravelly SAND. Gravel is fine to coarse sub-rounded to angular of mixed lithologies.	▽ D (S4)	1.70
1.75	60.17		Trial Pit complete (Could not proceed further due to risk on side/base stability and also the deposition of wet clayey sand onto recently ploughed field)		

ANNOTATED SKETCH DRAWING (Not to Scale)

SAMPLES / TESTS

T	Environmental sample
D	Disturbed
B	Bulk
W	Water
HV	Hand Vane
▽	Water strike
▼	Water level

OTHER INFORMATION

Side stability: Vertical faces stable. Groundwater flow area at base looser.
Other details:
1. TP location recently ploughed. Topsoil consisted grass onto clay at field boundaries.
2. Groundwater flow observed in below 1.65 mbgl layer
3. 3" Pump (1.4 l/sec) marginally overcame inflow rate in 1.5m x 1.5m base of excavation

Logged by:	R.Blanchfield	Project No.:
Checked by:	-	NCK-GEO01

SYNERGIST PROJECTS
Trial Pit Log

TP No.: TP2
Sheet 1 of 1

Level (mAOD): 74.24
Coordinates: E: 411924.425
N: 841273.086
Date: 12-Mar-14
Plant: JCB-3CX

Location: Four Fields
Client: NorthConnect KS
Engineer: R.Blanchfield

Depth (mbgl)	Level (mAOD)	Legend	DESCRIPTION OF STRATA	Samples Tests	Depth (mbgl)
			Loose soft dark brown slightly silty slightly gravelly sandy TOPSOIL with rootlets noted. Gravel is fine rounded to sub-rounded of mixed lithologies.		
0.30	73.94		Medium dense orangey brown slightly clayey gravelly SAND. Gravel is angular to rounded of mixed lithologies.	D (S1)	0.45
				B (S2)	0.70
1.20	73.04		Clayey sandy COBBLES consisting weathered rock head onto bedrock.		
1.30	72.94		Proved bedrock. Strong to very strong red GRANITE (probably Red Peterhead Pluton Granite)		
			Trial Pit complete		

ANNOTATED SKETCH DRAWING (Not to Scale)

SAMPLES / TESTS
T Environmental sample
D Disturbed
B Bulk
W Water
HV Hand Vane
▽ Water strike
▼ Water level

OTHER INFORMATION
Side stability: Vertical faces stable.
Other details: 1. TP location recently ploughed. Topsoil consisted grass onto clay at field boundaries.
2.
3.

Logged by:	R.Blanchfield	Project No.:
Checked by:	-	NCK-GEO01

SYNERGIST PROJECTS
Trial Pit Log

TP No.: TP3
Sheet 1 of 1

SYNERGIST Projects

Level (mAOD): 76.40
Coordinates: E: 411800.148
N: 841485.033
Date: 12-Mar-14
Plant: JCB-3CX
Location: Four Fields
Client: NorthConnect KS
Engineer: R.Blanchfield

Depth (mbgl)	Level (mAOD)	Legend	DESCRIPTION OF STRATA	Samples Tests	Depth (mbgl)
			Loose soft dark brown slightly silty slightly gravelly sandy TOPSOIL with rootlets noted. Gravel is fine rounded to sub-rounded of mixed lithologies.		
0.30	76.10		Medium dense orangey brown slightly clayey gravelly SAND. Gravel is angular to sub-rounded of mixed lithologies.	D/B (S1)	0.50
1.25	75.15		Clayey sandy COBBLES consisting weathered rock head onto bedrock.		
1.35	75.05		Proved bedrock. Strong to very strong red GRANITE (probably Red Peterhead Pluton Granite)		
			Trial Pit complete		

ANNOTATED SKETCH DRAWING (Not to Scale)

Intrusion of a medium dense grey brown clayey slightly gravelly SAND observed across corner of trial pit between the TOPSOIL and underlying orangey brown layers:

SAMPLES / TESTS

T	Environmental sample
D	Disturbed
B	Bulk
W	Water
HV	Hand Vane
▽	Water strike
▼	Water level

OTHER INFORMATION

Side stability: Vertical faces stable.
Other details:
1. TP location recently ploughed. Topsoil consisted grass onto clay at field boundaries.
2. Cobble (100mm) piece of black friable rock observed in face at 0.70 mbgl (possibly flint)
3.

Logged by:	R.Blanchfield	Project No.:
Checked by:	-	NCK-GEO01

ers

Site Name	Fourfields, Boddam, Peterhead
Client	North Connect
Consultant	North Connect
Contractor	ERS

Contract No: 955001

Trial Pit No: TP04

Location:	North: 841684.8084	East: 411752.0133	Ground Level: 74.09	Inclination:	Scale: 1:50
Dates: 07/10/2014 - 07/10/2014		Logged By: BP	Data Input: BP	Checked By:	Status: Draft

Samples		Tests			STRATA DETAILS			Level	Water	Backfill	
Depth	Type	Depth	Type	Results	Depth	Description	Legend	mAOD	Level	Depth	Legend
0.20	E				0.35	Dark brown clayey TOPSOIL		73.74			
0.60	B					Firm orange brown sandy gravelly CLAY with cobbles, boulders and pockets of clayey sand. Gravel is angular to rounded fine to coarse predominantly of granite.					
0.60	T				1.30			72.79			
1.40	B					Weathered GRANITE recovered as pink and orange angular fine to coarse gravel. Excavator able to dig material with moderate ease. At 1.90m rock becomes competent and is very difficult to extract.					
1.40	T				1.90			72.19		1.90	

(End of Trial Pit)

Remarks:

Hole Type			Plant(s) Used	Dimensions	Water Levels		Waterstrike				Figure No
From	To	Type		0.8m x 3.6m	Morning	Evening	Struck	Rose To	Time (min)		05
0.00	1.90	TP	JCB 3CX								Sheet 1 of 1

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Site Name	Fourfields, Boddam, Peterhead
Client	North Connect
Consultant	North Connect
Contractor	ERS

Contract No: 955001

Trial Pit No: TP05

Location:	North: 841908.2441	East: 411747.8323	Ground Level: 60.94	Inclination:	Scale: 1:50
Dates: 07/10/2014 - 07/10/2014		Logged By: BP	Data Input: BP	Checked By:	Status: Draft

Samples		Tests			STRATA DETAILS			Level	Water	Backfill	
Depth	Type	Depth	Type	Results	Depth	Description	Legend	mAOD	Level	Depth	Legend
						Dark brown clayey TOPSOIL					
					0.30	Firm orange brown sandy gravelly CLAY with cobbles, boulders and pockets of clayey sand. Gravel is angular to rounded fine to coarse of mixed lithology including flint.		60.64			
0.50	B										
0.50	T										
0.80	B										
0.80	T										
1.50	VPP(45 kPa, 66kPa)										
					1.80	Soft to firm orange brown sandy gravelly CLAY with cobbles, boulders and pockets of clayey sand. Gravel is angular to rounded fine to coarse of mixed lithology.		59.14			
2.00	B										
2.00	T										
					2.90			58.04		2.90	

(End of Trial Pit)

Remarks

Hole Type			Plant(s) Used	Dimensions	Water Levels		Waterstrike				Figure No
From	To	Type		0.8m x 3.5m	Morning	Evening	Struck	Rose To	Time (min)		06
0.00	2.90	TP	JCB 3CX								Sheet
											1 of 1

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Site Name	Fourfields, Boddam, Peterhead
Client	North Connect
Consultant	North Connect
Contractor	ERS

Contract No: 955001

Trial Pit No: TP06

Location:	North: 842219.115	East: 411823.4068	Ground Level: 50.63	Inclination:	Scale: 1:50
Dates: 07/10/2014 - 07/10/2014		Logged By: BP	Data Input: BP	Checked By:	Status: Draft

Samples		Tests			STRATA DETAILS			Level	Water	Backfill	
Depth	Type	Depth	Type	Results	Depth	Description	Legend	mAOD	Level	Depth	Legend
0.40	E				0.60	Dark brown clayey TOPSOIL.		50.03			
1.00	B					Firm brown sandy gravelly CLAY with cobbles, boulders and pockets of clayey sand. Gravel is angular to rounded fine to coarse of mixed lithology.					
1.00	T										
2.00	VPP(66kPa)				2.00			48.63			
2.20	B					Stiff brown sandy gravelly CLAY with cobbles, boulders and pockets of clayey sand. Gravel is angular to rounded fine to coarse of mixed lithology.					
2.20	T				2.50			48.13		2.50	

(End of Trial Pit)

Remarks:

Hole Type			Plant(s) Used	Dimensions	Water Levels		Waterstrike				Figure No
From	To	Type		0.8m x 3.1m	Morning	Evening	Struck	Rose To	Time (min)		07
0.00	2.50	TP	JCB 3CX								Sheet
											1 of 1

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Site Name	Fourfields, Boddam, Peterhead
Client	North Connect
Consultant	North Connect
Contractor	ERS

Contract No: 955001

Trial Pit No: TP07

Location:	North: 842095.2302	East: 411734.1303	Ground Level: 53.96	Inclination:	Scale: 1:50
Dates: 07/10/2014 - 07/10/2014		Logged By: BP	Data Input: BP	Checked By:	Status: Draft

Samples		Tests			STRATA DETAILS			Level	Water	Backfill	
Depth	Type	Depth	Type	Results	Depth	Description	Legend	mAOD	Level	Depth	Legend
0.10	E				0.20	Dark brown clayey TOPSOIL		53.76			
0.40	B					Firm brown sandy gravelly CLAY with cobbles, boulders and pockets of clayey sand. Gravel is angular to rounded fine to coarse of mixed lithology.					
0.40	T										
1.20	VPP(32 kPa)				1.10	Firm brown mottled grey sandy gravelly CLAY with cobbles, boulders and pockets of clayey sand. Gravel is angular to rounded fine to coarse of mixed lithology.		52.86			
1.50	B										
1.50	T										
					2.10	Light brown slightly gravelly fine to coarse SAND. Gravel is angular to rounded fine to coarse of mixed lithology.		51.86			
2.50	B										
2.50	T				2.70			51.26		2.70	

(End of Trial Pit)

Remarks:

Hole Type			Plant(s) Used	Dimensions	Water Levels		Waterstrike				Figure No
From	To	Type		0.8m x 2.8m	Morning	Evening	Struck	Rose To	Time (min)		08
0.00	2.70	TP	JCB 3CX								Sheet
											1 of 1

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Site Name	Fourfields, Boddam, Peterhead
Client	North Connect
Consultant	North Connect
Contractor	ERS

Contract No: 955001

Borehole No: BH01

Location: North: 841457.9632 East: 412060.6554 Ground Level: 62.18 Inclination: -90 Scale: 1:50

Dates: 08/10/2014 - 08/10/2014 Driller(s): JL CT Logged By: BP Data Input: BP Checked By: Status: Draft

Samples & Test							STRATA DETAILS		Level	Water		Backfill	
Depth	Sample Type		In-situ Tests				Depth	Description	Legend	mOD	Level	Depth	Legend
0.30	B						0.30	Dark brown clayey TOPSOIL		61.88		0.50	
			Pen.	N	Cas.	Wat.		Soft orange brown slightly mottled grey sandy slightly gravelly CLAY with cobbles. Gravel is subangular to subrounded fine to coarse of mixed lithology.					
1.00-2	U	1.00 S	300	6	1.00						1	1.00	
			Pen.	N	Cas.	Wat.	1.80						
2.00-3	U	2.00 S	300	5	2.00			Soft grey slightly sandy gravelly CLAY with cobbles. Gravel is subangular to subrounded fine to coarse of mixed lithology.		60.38			
			Pen.	N	Cas.	Wat.					1	3.00	
		3.00 S	0	>50	2.00		3.10	Weathered GRANITE recovered as pink and orange angular fine to coarse gravel.		59.08			
From	To	TCR	SCR	RQD	FI		4.00	Moderatley strong pink and grey GRANITE. Weathering between 4.70m and 5.00m has reduced strength to weak and rock is recovered as angular coarse gravel. Fractures: close to medium spaced subhorizontal dipping approximatley 45°, rough stepped.		58.18			
4.00	5.00	100	65	61	7								
5.00	6.00	96	59	29	9								
							6.00			56.18		6.00	

(End of Borehole)

Soil Boring Casing			Water Added			Chiselling			Rotary Casing			Flush Details			
From	To	Diameter (mm)	From	To	Amount	From	To	Time (hrs)	From	To	Diameter (mm)	From	To	Type	Returns (%)
0.00	3.50	140							0.00	3.50	140	0.00	6.00	Air Mist	100
3.50	6.00	110													

Hole Type			Drill Rig Type	Boring / Drilling Progress			Water Levels		Waterstrike				Figure No
From	To	Type		Date	Hole Depth	Casing Depth	Morning	Evening	Struck	Rose To	Time (min)	Cut Off	01
0.00	1.60	WLS	Dando Terrier 2002	08-10-14	6.00	3.50	1.00		3.00	1.00	20.00		Sheet
1.60	4.00	RO											1 of 1
4.00	6.00	RC											

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Site Name	Fourfields, Boddam, Peterhead
Client	North Connect
Consultant	North Connect
Contractor	ERS

Contract No: 955001

Borehole No: BH02

Location:	North: 841482.9289	East: 411969.2194	Ground Level: 64.72	Inclination:	Scale: 1:50
Dates: 07/10/2014 - 09/10/2014	Driller(s): JL CT	Logged By: BP	Data Input: BP	Checked By:	Status: Draft

Samples & Test				STRATA DETAILS		Level	Water	Backfill	
Depth	Sample Type		In-situ Tests	Depth	Description	Legend	mOD	Level	Depth	Legend
0.30	B			0.30	Dark brown clayey TOPSOIL		64.42		0.50	
			Pen. N Cas. Wat.		Soft to firm orange brown sandy slightly gravelly CLAY with cobbles and boulders. Gravel is subangular to subrounded fine to coarse of mixed lithology.					
1.00-2	U	1.00 S	300 9 1.00						1.00	
			Pen. N Cas. Wat.							
		2.00 S	300 33 2.00	2.00	Stiff to very stiff orange brown sandy slightly gravelly CLAY with cobbles and boulders. Gravel is subangular to subrounded fine to coarse of mixed lithology.		62.72			
			Pen. N Cas. Wat.							
		2.55 S	0 >50 2.00	2.55	Weathered GRANITE recovered as pink and orange angular fine to coarse gravel.		62.17			
			Pen. N Cas. Wat.						3.30	
		3.50 S	275 >50 2.50							
				5.00			59.72		5.00	

(End of Borehole)

Remarks:
Borehole drilled to 5.00m, but caved in to 3.30m

Soil Boring Casing			Water Added			Chiselling			Rotary Casing			Flush Details			
From	To	Diameter (mm)	From	To	Amount	From	To	Time (hrs)	From	To	Diameter (mm)	From	To	Type	Returns (%)
0.00	2.00	140							0.00	2.00	140	0.00	5.00	Air Mist	100
2.00	5.00	110													

Hole Type			Drill Rig Type	Boring / Drilling Progress			Water Levels		Waterstrike				Figure No
From	To	Type		Date	Hole Depth	Casing Depth	Morning	Evening	Struck	Rose To	Time (min)	Cut Off	02
0.00	2.55	WLS	Dando Terrier 2002	07-10-14	2.55	2.50							Sheet
2.55	3.50	RC		09-10-14	5.00								1 of 1
3.50	5.00	RO											

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Site Name	Fourfields, Boddam, Peterhead
Client	North Connect
Consultant	North Connect
Contractor	ERS

Contract No: 955001

Borehole No: BH03

Location:	North: 841338.3876	East: 412094.0351	Ground Level: 65.54	Inclination:	Scale: 1:50
Dates: 07/10/2014 - 09/10/2014	Driller(s): JL CT	Logged By: BP	Data Input: BP	Checked By:	Status: Draft

Samples & Test

Depth	Sample Type		In-situ Tests
0.30	B		
			Pen. N Cas. Wat.
1.00-1.6	U	1.00 S	300 6 1.00
			Pen. N Cas. Wat.
		1.60	300 >50 1.60

STRATA DETAILS

Depth	Description	Legend	Level mOD
0.30	Dark brown clayey TOPSOIL.		65.24
1.30	Soft grey brown slightly sandy gravelly CLAY with cobbles. Gravel is subangular to subrounded fine to coarse of mixed lithology.		64.24
5.40	Weathered GRANITE recovered as pink and orange angular fine to coarse gravel.		60.14
5.70	Strong pale grey and pink GRANITE.		59.84
	Weak pink and grey GRANITE. Highly weathered throughout reducing strength to very weak and in places recovered as coarse angular gravel. Fractures: non intact to very closely spaced rough.		

From	To	TCR	SCR	RQD	FI
5.40	6.90	47	15	0	NI
9.50	11.00	48	23	0	NI

Water

Level	Depth
	0.50
	1.00
	1.30
	6.00

Backfill

Legend

Remarks:

Soil Boring Casing			Water Added			Chiselling			Rotary Casing			Flush Details			
From	To	Diameter (mm)	From	To	Amount	From	To	Time (hrs)	From	To	Diameter (mm)	From	To	Type	Returns (%)
0.00	2.50	140							0.00	2.50	140	0.00	12.50	Air Mist	100
2.00	12.50	110													

Hole Type			Drill Rig Type	Boring / Drilling Progress			Water Levels		Waterstrike				Figure No
From	To	Type		Date	Hole Depth	Casing Depth	Morning	Evening	Struck	Rose To	Time (min)	Cut Off	03
0.00	2.05	WLS	Dando Terrier 2002	07-10-14	1.60	3.00	1.30						Sheet
2.05	5.40	RO											1 of 2
5.40	6.90	RC											
6.90	9.50	RO											

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Site Name	Fourfields, Boddam, Peterhead
Client	North Connect
Consultant	North Connect
Contractor	ERS

Contract No: 955001

Borehole No: BH03

Location:	North: 841338.3876	East: 412094.0351	Ground Level: 65.54	Inclination:	Scale: 1:50
Dates: 07/10/2014 - 09/10/2014	Driller(s): JL CT	Logged By: BP	Data Input: BP	Checked By:	Status: Draft

Rock Coring						STRATA DETAILS			Level	Water		Backfill
From	To	TCR	SCR	RQD	FI	Depth	Description	Legend	mOD	Level	Depth	Legend
9.50	11.00	48	23	0	NI		Weak pink and grey GRANITE. Highly weathered throughout reducing strength to very weak and in places recovered as coarse angular gravel. Fractures: non intact to very closely spaced rough. *(continued)*					
11.00	12.50	61	33	33	5	12.50			53.04		12.50	

(End of Borehole)

Remarks:

Soil Boring Casing			Water Added						Rotary Casing			Flush Details			
From	To	Diameter (mm)	From	To	Amount	From	To	Time (hrs)	From	To	Diameter (mm)	From	To	Type	Returns (%)

Hole Type			Drill Rig Type	Boring / Drilling Progress			Water Levels		Waterstrike				Figure No
From	To	Type		Date	Hole Depth	Casing Depth	Morning	Evening	Struck	Rose To	Time (min)	Cut Off	03
			Dando Terrier 2002	08-10-14	12.50	2.50							Sheet 2 of 2

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Site Name	Fourfields, Boddam, Peterhead
Client	North Connect
Consultant	North Connect
Contractor	ERS

Contract No: 955001

Borehole No: BH04

Location:	North: 842128.1995	East: 411765.6687	Ground Level: 55.35	Inclination:	Scale: 1:50
Dates: 08/10/2014 - 08/10/2014	Driller(s): JL CT	Logged By: BP	Data Input: BP	Checked By:	Status: Draft

Samples & Test			STRATA DETAILS			Level	Water	Backfill	
Depth	Sample Type	In-situ Tests	Depth	Description	Legend	mOD	Level	Depth	Legend
0.30-1	U		0.30	Dark brown clayey TOPSOIL		55.05			
1.00-2	U			Orange brown sandy gravelly CLAY with occasional pockets of sand and gravel. Gravel is angular to rounded fine to coarse of mixed lithology.					
2.00-3	U		3.00			52.35		3.00	
				(End of Borehole)					

Remarks

Soil Boring Casing			Water Added			Chiselling			Rotary Casing			Flush Details			
From	To	Diameter (mm)	From	To	Amount	From	To	Time (hrs)	From	To	Diameter (mm)	From	To	Type	Returns (%)
0.00	3.00	128													

Hole Type			Drill Rig Type	Boring / Drilling Progress			Water Levels		Waterstrike				Figure No
From	To	Type		Date	Hole Depth	Casing Depth	Morning	Evening	Struck	Rose To	Time (min)	Cut Off	04
			Dando Terrier 2002	08-10-14	3.00	3.00							Sheet: 1 of 1