	Species Total	15
NVC Code U4a *Festuca ovina-Agrostis capillaris-Galium saxatile* grassland; typical sub-community	Site & Vegetation Description Short sward with succession to wet heath impeded by moderate to high levels of grazing, which maintains *Calluna* at low height and abundance; otherwise it would develop into wet heath. Peaty soil permits the growth of low *S. capillifolium* and *P. commune* carpets	

Photo of Quadrat 58

Quadrat no.	Date	Estimated Slope (°)
59	20th June 2016	10
Quadrat size: 2m X 2m	Grid Ref: IC 74743 25154	

Surveyor	Altitude (m asl)	Site
KH	317	Dunbeg South

Species	DOMIN	Species	DOMIN
Potentilla erecta	4		
Polygala serpyliifolia	1		
Nardus stricta	3		
Erica tetralix	3		
Juncus squarrosus	2		
Festuca ovina	8		
Calluna vulgaris	1		
Eriophorum vaginatum	2		
Molinia caerulea	4		
Juncus acutiflorus	3		
Rhytidiadelphis loreus	3		
Sphagnum capillifolium	5		
Polytrichum commune	2		
Sphagnum papillosum	2		

		Species Total	14
NVC Code U4a *Festuca ovina-Agrostis capillaris-Galium saxatile* grassland; typical sub-community	Site & Vegetation Description Open sward with low *Sphagnum capillifolium* hummocks and *Festuca ovina* tussocks dominating. High grazing levels preventing succession to wet heath. Active peat formation due to presence of *Eriophorum* and Sphagna. Peaty soil permits the growth of Sphagna and *P. commune*		

Photo of Quadrat 59

Quadrat no. 60	Date 27th June 2016	Estimated Slope (°) 13
Quadrat size 2m X 2m	Grid Ref IC 72943 25004	
Surveyor KH	Altitude (m asl) 235	Site Dunbeg South

Species	DOMIN	Species	DOMIN
Calluna vulgaris	6		
Potentilla erecta	2		
Deschampsia flexuosa	3		
Anthoxanthum odoratum	5		
Nardus stricta	6		
Deschampsia caespitosa	5		
Galium saxatile	2		
Carex panicea	3		
Festuca vivipara	2		
Carex flacca	2		
Holcus lanatus	2		
Hylocomium splendens	3		
Rhytidiadelphis squarrosus	7		
Calliergonella cuspidatum	4		
Thuidium tamariscinum	4		
Pseudoscleropodium purum	2		
Hypnum jutlandicum	3		

		Species Total	17
NVC Code H9d *Calluna vulgaris-Deschampsia flexuosa* heath; *Galium saxatile* sub-community	Site & Vegetation Description Past heavy grazing evident which has created low hummocks of *Calluna* with tussocks of unpalatable *Nardus* and *Deschampsia caespitosa.*Also present is patchily grazed sward of *D. flexuosa* and *A. odoratum.*		

Photo of Quadrat 60

Quadrat no.	Date	Estimated Slope (°)
61	27th June 2016	11

Quadrat size	Grid Ref
2m X 2m	IC 73093 25004

Surveyor	Altitude (m asl)	Site
KH	254	Dunbeg South

Species	DOMIN	Species	DOMIN
Juncus squarrosus	1		
Carex echinata	6		
Calluna vulgaris	7		
Nardus stricta	8		
Potentilla erecta	4		
Erica tetralix	2		
Carex panicea	2		
Holcus lanatus	2		
Trichophorum germanicum	1		
Deschampsia caespitosa	4		
Deschampsia flexuosa	5		
Hylocomium splendens	2		
Sphagnum capillifolium	5		
Rhytidiadelphis loreus	4		
Polytrichum juniperinum	1		
Thuidium tamariscinum	2		
Polytrichum commune	2		
Pseudoscleropodium purum	3		
Dicranum scoparium	2		

		Species Total	19

NVC Code	Site & Vegetation Description
H9d *Calluna vulgaris-Deschampsia flexuosa* heath; *Galium saxatile* sub-community	Heath being maintained at closely-cropped height via periodic heavy grazing pressure - sheep most likely prefer lower slopes for grazing and shelter with *Calluna* dominant with occasional visits to higher ground to graze on heath

Photo of Quadrat 61

Quadrat no. 62	Date 27th June 2016	Estimated Slope (°) 4
Quadrat size 2m X 2m	Grid Ref IC 73243 25004	
Surveyor KH	Altitude (m asl) 261	Site Dunbeg South

Species	DOMIN	Species	DOMIN
Anthoxanthum odoratum	4		
Carex panicea	4		
Carex echinata	6		
Calluna vulgaris	6		
Deschampsia caespitosa	5		
Galium saxatile	3		
Deschampsia flexuosa	4		
Potentilla erecta	2		
Juncus bulbosus	1		
Holcus lanatus	1		
Juncus squarrosus	1		
Nardus stricta	2		
Luzula campestris	2		
Thuidium tamariscinum	5		
Rhytidiadelphis squarrosus	6		
Rhytidiadelphis loreus	6		
Hypnum jutlandicum	6		
Pseudoscleropodium purum	2		
Hylocomium splendens	2		

		Species Total	19

NVC Code	Site & Vegetation Description
H9d *Calluna vulgaris-Deschampsia flexuosa* heath; *Galium saxatile* sub-community	Heath maintained at low height due to grazing pressure

Photo of Quadrat 62

Quadrat no. 63	Date 27th June 2016	Estimated Slope (°) 6
Quadrat size 2m X 2m	Grid Ref IC 73393 25004	
Surveyor KH	Altitude (m asl) 260	Site Dunbeg South

Species	DOMIN	Species	DOMIN
Calluna vulgaris	8		
Galium saxatile	3		
Nardus stricta	4		
Potentilla erecta	3		
Juncus acutiflorus	1		
Carex echinata	2		
Molinia caerulea	5		
Cynosurus cristatus	1		
Erica tetralix	1		
Deschampsia caespitosa	3		
Rhytidiadelphis squarrosus	4		
Pseudoscleropdium purum	4		
Polytrichum commune	2		
Sphagnum capillifolium	4		
Rhytidiadelphis loreus	6		
Thuidium tamariscinum	5		
Hylocomium splendens	3		
Pleurozium schreberi	3		

		Species Total	18
NVC Code H9e *Calluna vulgaris-Deschampsia flexuosa* heath; *Molinia caerulea* sub-community	Site & Vegetation Description Heath with evidence of moderate grazing pressure which is preventing *Calluna* developing into taller and more continuous blanket		

Photo of Quadrat 63

Quadrat no.	Date	Estimated Slope (^{o})
64	27th June 2016	5

Quadrat size	Grid Ref
2m X 2m	IC 73543 25004

Surveyor	Altitude (m asl)	Site
KH	261	Dunbeg South

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	9		
Potentilla erecta	5		
Carex panicea	4		
Carex pulicaris	3		
Taraxacum officinalis agg.	3		
Carex echinata	3		
Ranunculus acris	4		
Juncus effusus	3		
Anthoxanthum odoratum	2		
Festuca ovina	3		
Cirsium palustre	2		
Holcus lanatus	2		
Trifolium repens	3		
Cardamine pratensis	1		
Carex flacca	2		
Rhytidiadelphis squarrosus	7		
Pseudoscleropdium purum	5		
Thuidium tamariscinum	6		

		Species Total	18

NVC Code	Site & Vegetation Description
M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community	Rush pasture with scattered sedges; patchy grazing

Photo of Quadrat 64

Quadrat no.	Date	Estimated Slope (°)
65	15th June 2016	5

Quadrat size	Grid Ref
2m X 2m	IC 73693 25004

Surveyor	Altitude (m asl)	Site
CL	265	Dunbeg South

Species	DOMIN	Species	DOMIN
Luzula multiflora	3		
Juncus acutiflorus	8		
Anthoxanthum odoratum	7		
Lolium perenne	4		
Potentilla erecta	3		
Holcus lanatus	3		
Festuca ovina	2		
Ranunuculus acris	1		
Pedicularis sylvatica	1		
Carex panicea	4		
Carex echinata	1		
Rhytidiadelphis squarrosus	8		
Hylocomium splendens	4		
		Species Total	13

NVC Code	Site & Vegetation Description

M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community	Marshy grassland with evidence of patchy grazing

Photo of Quadrat 65

Quadrat no. 66	Date 27th June 2016	Estimated Slope (^{o}) 6
Quadrat size 2m X 2m	Grid Ref IC 73843 25004	

Surveyor KH	Altitude (m asl) 265	Site Dunbeg South

Species	DOMIN	Species	DOMIN
Luzula campestre	3		
Juncus acutiflorus	8		
Anthoxanthum odoratum	7		
Carex nigra	3		
Deschampsia caespitosa	4		
Potentilla erecta	3		
Holcus lanatus	3		
Festuca vivipara	1		
Festuca ovina	2		
Nardus stricta	5		
Carex flacca	4		
Carex panicea	4		
Rhytidiadelphis squarrosus	8		
Thuidium tamariscinum	4		

		Species Total	14
NVC Code M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community	Site & Vegetation Description Rush pasture with evidence of patchy grazing		

Photo of Quadrat 66

Quadrat no. 67	Date 23th June 2016	Estimated Slope (°) 5
Quadrat size 2m X 2m	Grid Ref IC 73993 25004	
Surveyor KH	Altitude (m asl) 273	Site Dunbeg South

Species	DOMIN	Species	DOMIN
Juncus acutifloris	7		
Anthoxanthum odoratum	4		
Festuca rubra	2		
Ranunculus acris	4		
Equisetum palustre	4		
Cardamine pratense	1		
Potentilla erecta	4		
Pleurozium schreberi	5		
		Species Total	8
NVC Code	Site & Vegetation Description		

Photo of Quadrat 67

Quadrat no. 68	Date 27th June 2016	Estimated Slope (^{o}) 5
Quadrat size 2m X 2m	Grid Ref IC 74143 25004	
Surveyor KH	Altitude (m asl) 273	Site Dunbeg South

Species	DOMIN	Species	DOMIN
Holcus lanatus	4		
Juncus effusus	6		
Anthoxanthum odoratum	3		
Festuca ovina	4		
Juncus squarrosus	2		
Rumex acetosa	3		
Nardus stricta	2		
Cynosurus cristatus	1		
Festuca vivipara	2		
Potentilla erecta	2		
Carex flacca	2		
Poa pratensis	3		
Cerastium fontanum	1		
Trifolium repens	2		
Rhytidiadelphis squarrosus	8		
Kindbergia praelonga	2		

		Species Total	16
NVC Code M23b *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus effusus* sub-community	Site & Vegetation Description Short sward with evidence of heavy grazing. Several mesophytic species present indicative of localised enrichment of soil e.g. *Cerastium fontanum, Trifolium repens*		

Photo of Quadrat 68

Quadrat no.		Date	Estimated Slope (^{o})
69		27th June 2016	3
Quadrat size 2m X 2m		Grid Ref IC 74293 25004	
Surveyor KH	Altitude (m asl) 279	Site Dunbeg South	

Species	DOMIN	Species	DOMIN
Anthoxanthum odoratum	5		
Holcus lanatus	4		
Festuca ovina	5		
Luzula campestre	2		
Juncus acutiflorus	8		
Potentilla erecta	4		
Carex panicea	2		
Carex flacca	2		
Carex echinata	2		
Deschampsia caespitosa	1		
Rhytidiadelphis squarrosus	8		
Thuidium tamariscinum	2		

		Species Total	12
NVC Code M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community	Site & Vegetation Description Moderate grazing pressure evident. Poor species diversity compared to other areas of rush pasture		

Photo of Quadrat 69

Quadrat no.	Date	Estimated Slope (^{o})
70	27th June 2016	2

Quadrat size	Grid Ref
2m X 2m	IC 74443 25004

Surveyor	Altitude (m asl)	Site
KH	297	Dunbeg South

Species	DOMIN	Species	DOMIN
Anthoxanthum odoratum	5		
Juncus acutiflorus	9		
Cirsium palustre	2		
Holcus lanatus	3		
Ranunculus acris	3		
Viola palustris	2		
Carex echinata	2		
Luzula campestre	1		
Rhytidiadelphis squarrosus	6		
Pseudoscleropodium purum	4		

		Species Total	10

NVC Code	Site & Veg Description
M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community	Relatively species-poor rush pasture with evidence of moderate levels of grazing

Photo of Quadrat 70

Quadrat no. 71	Date 27th June 2016	Estimated Slope (°) 10
Quadrat size 2m X 2m	Grid Ref IC 74593 25004	

Surveyor KH	Altitude (m asl) 313	Site Dunbeg South

Species	DOMIN	Species	DOMIN
Juncus effusus	5		
Potentilla erecta	4		
Juncus squarrosus	5		
Calluna vulgaris	4		
Eriophorum vaginatum	2		
Carex nigra	2		
Juncus acutiflorus	6		
Deschampsia caespitosa	2		
Anthoxanthum odoratum	2		
Galium saxatile	3		
Deschampsia flexuosa	2		
Rhytidiadelphis squarrosus	5		
Rhytidiadelphis loreus	6		
Sphagnum papillosum	5		
Sphagnum fallax	4		
Thuidium tamariscinum	2		
Plagiothecium undulatum	1		
Polytrichum commune	2		
Hypnum jutlandicum	2		

		Species Total	19
NVC Code M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community	Site & Vegetation Description Sward wet, open and short with evidence of heavy grazing e.g. *Calluna* very short and patchy. Active peat formation due to presence of *Eriophorum* and Sphagna		

Photo of Quadrat 71

Quadrat no.	Date	Estimated Slope (°)
72	27th June 2016	4
Quadrat size 2m X 2m	Grid Ref IC 74743 25004	
Surveyor KH	Altitude (m asl) 327	Site Dunbeg South

Species	DOMIN	Species	DOMIN
Eriophorum angustifolium	7		
Trichophorum germanicum	6		
Carex echinata	3		
Potentilla erecta	2		
Calluna vulgaris	4		
Festuca ovina	1		
Erica cinerea	1		
Narthecium ossifragum	2		
Drosera rotundifolia	2		
Juncus bulbosus	2		
Eleocharis multicaulis	2		
Molinia caerulea	2		
Carex panicea	2		
Rhytidiadelphis squarrosus	4		
Sphagnum papillosum	6		
Sphagnum capillifolium	5		
Bare soil	6		

		Species Total	16

NVC Code	Site & Vegetation Description
M17a *Trichophorum caespitosum-Eriophorum vaginatum* blanket mire; *Drosera rotundifolia-Sphagnum* species sub-community	Wet mire with *Narthecium, Drosera, Juncus bulbosus* and *Eleocharis*; higher ground either side with *Eriophorum, Calluna,* Sphagna, *Erica* and *Trichophorum*

Photo of Quadrat 72

Quadrat no. 73	Date 27th June 2016	Estimated Slope (°) 4
Quadrat size 2m X 2m	Grid Ref IC 73093 24854	
Surveyor KH	Altitude (m asl) 280	Site Dunbeg South

Species	DOMIN	Species	DOMIN
Calluna vulgaris	8		
Molinia caerulea	5		
Nardus stricta	1		
Carex echinata	3		
Anthoxanthum odoratum	2		
Deschampsia caespitosa	3		
Erica tetralix	2		
Rhytdiadelphis loreus	8		
Pseudoscleropodium purum	6		
Rhytidiadelphis squarrosus	5		
Hylocomium splendens	4		
Polytrichum commune	3		
Sphagnum subnitens	1		
Hypnum jutlandicum	3		

		Species Total	14

NVC Code	Site & Vegetation Description
M15b *Trichophorum caespitosum-Erica tetralix* wet heath; typical sub-community	Wet heath / acid grassland mosaic with low grazing pressure

Photo of Quadrat 73

Quadrat no. 74	Date 27th June 2016	Estimated Slope (°) 5
Quadrat size 2m X 2m	Grid Ref IC 73243 24854	
Surveyor KH	Altitude (m asl) 280	Site Dunbeg South

Species	DOMIN	Species	DOMIN
Carex panicea	3		
Carex echinata	3		
Deschampsia caespitosa	5		
Anthoxanthum odoratum	8		
Festuca ovina	5		
Luzula campestre	2		
Calluna vulgaris	2		
Carex flacca	2		
Holcus lanatus	2		
Galium saxatile	1		
Carex pilulifera	1		
Pseudoscleropodium purum	6		
Rhytidiadelphis squarrosus	7		
Thuidium tamariscinum	4		
Hypnum jutlandicum	3		

		Species Total	15
NVC Code U4a *Festuca ovina-Agrostis capillaris-Galium saxatile* grassland; typical sub-community	Site & Vegetation Description Acid grassland with evidence of heavy grazing which has maintained succeeding *Calluna* in a short and subordinate state; some evidence of base-rich flushing as *Carex flacca* and *C. panicea* are present		

Photo of Quadrat 74

Quadrat no.		Date	Estimated Slope (^{o})
75		27th June 2016	7
Quadrat size 2m X 2m		Grid Ref IC 73393 24893	
Surveyor KH	Altitude (m asl) 280	Site Dunbeg South	

Species	DOMIN	Species	DOMIN
Calluna vulgaris	8		
Potentilla erecta	5		
Deschampsia flexuosa	4		
Anthoxanthum odoratum	2		
Carex nigra	7		
Carex echinata	1		
Hypnum jutlandicum	2		
Rhytidiadelphis squarrosus	5		
Rhytidiadelpihs loreus	6		
Pseudoscleropodium purum	6		
Polytrichum commune	7		
Hylocomium splendens	5		
Sphagnum fallax	1		

		Species Total	13

NVC Code	Site & Vegetation Description
H9d *Calluna vulgaris-Deschampsia flexuosa* heath; *Galium saxatile* sub-community	Wet heath with heavy grazing maintaining *Calluna* in short growth habit

Photo of Quadrat 75

Quadrat no. 76	Date 27th June 2016	Estimated Slope (°) 8
Quadrat size 2m X 2m	Grid Ref IC 73543 24854	
Surveyor KH	Altitude (m asl) 282	Site Dunbeg South

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	9		
Ranunculus acris	4		
Luzula campestre	2		
Holcus lanatus	2		
Anthoxanthum odoratum	2		
Viola palustris	3		
Ranunculus flammula	3		
Carex echinata	2		
Carex pulicaris	1		
Festuca ovina	2		
Galium palustre	1		
Thuidium tamariscinum	4		
Rhytidiadelphis squarrosus	6		
Sphagnum papillosum	1		

		Species Total	14

NVC Code	Site & Vegetation Description
M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community	Rush pasture with patchy and mderate levels of grazing. Moss cover much reduced compared to neighbouring quadrats

Photo of Quadrat 76

Quadrat no.	Date	Estimated Slope (^{o})
77	23rd June 2016	

Quadrat size	Grid Ref
2m X 2m	IC 73693 24854

Surveyor	Altitude (m asl)	Site
CL	286	Dunbeg South

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	7		
Ranunculus acris	4		
Potentilla erecta	4		
Holcus lanatus	4		
Anthoxanthum odoratum	2		
Cardamine pratense			
Festuca rubra	4		
Cirsium palustre	1		
Hylocomium splendens	5		
Rhytidiadelphis squarrosus	4		
Pseudoscleropodium purum	6		
Litter	5		
		Species Total	11

NVC Code	Site & Vegetation Description

M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community	Rush pasture with patchy and mderate levels of grazing. Moss cover much reduced compared to neighbouring quadrats

Photo of Quadrat 77

Quadrat no. 78	Date 27th June 2016		Estimated Slope (^{o}) 8
Quadrat size 2m X 2m	Grid Ref IC 73843 24854		
Surveyor KH	Altitude (m asl) 280	Site Dunbeg South	
Species	DOMIN	Species	DOMIN
Juncus acutiflorus	8		
Potentilla erecta	3	*Juncus acutiflorus* thatch	5
Pedicularis sylvatica	3		
Carex panicea	2		
Luzula campestre	1		
Eriophorum angustifolium	2		
Anthoxanthum odoratum	2		
Viola palustris	1		
Galium saxatilis	2		
Carex echinata	1		
Leontodon autumnalis	1		
Festuca ovina	1		
Deschampsia caespitosa	1		
Aulacomnium palustre	7		
Dicranum scoparium	3		
Sphagnum papillosum	6		
Pleurozium schreberi	5		
Polytrichum commune	4		
Rhytidiadelphis squarrosus	3		
Thuidium tamariscinum	3		

		Species Total	20
NVC Code M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community		Site & Vegetation Description Rush pasture with hummocks and carpets of mosses. Moderate levels of grazing resulting in low quantity of rush thatch. Species-rich sward	

Photo of Quadrat 78

Quadrat no.	Date	Estimated Slope (^{o})
79	27th June 2016	10

Quadrat size	Grid Ref
2m X 2m	IC 73993 24854

Surveyor	Altitude (m asl)	Site
KH	271	Dunbeg South

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	9		
Ranunculus acris	4		
Holcus lanatus	2		
Anthoxanthum odoratum	3		
Rumex acetosa	3		
Ranunculus flammula	2		
Cirsium dissectum	1		
Cardamine pratensis	1		
Luzula campestris	1		
Equisetum fluviatile	1		
Carex echinata	1		
Galium palustre	1		
Rhytidiadelphis squarrosus	6		
Kindbergia praelonga	4		

		Species Total	14
NVC Code M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community	Site & Vegetation Description Tall rush pasture with species indicative of marshy soil conditions. Grazing moderate and patchy - hence low quantity of rush thatch		

Photo of Quadrat 79

Quadrat no. 80	Date 27th June 2016	Estimated Slope (^{o}) 6
Quadrat size 2m X 2m	Grid Ref IC 74143 24854	

Surveyor KH	Altitude (m asl) 278	Site Dunbeg South

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	9		
Potentilla erecta	3		
Erica tetralix	3		
Galium saxatile	3		
Deschampsia flexuosa	3		
Anthoxanthum odoratum	2		
Holcus lanatus	1		
Polytrichum commune	5		
Sphagnum papillosum	5		
Rhytidiadelphis squarrosus	4		
	6		

		Species Total	10

NVC Code	Site & Vegetation Description
M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community	Rush pasture with low hummocks of *Sphagnum papillosum*. Moderate grazing levels

Photo of Quadrat 80

Quadrat no.	Date	Estimated Slope (^{o})
81	27th June 2016	15

Quadrat size	Grid Ref
2m X 2m	IC 74293 24854

Surveyor	Altitude (m asl)	Site
KH	284	Dunbeg South

Species	DOMIN	Species	DOMIN
Cirsium palustre	4		
Cynosurus cristatus	4		
Holcus lanatus	5		
Euphrasia sp.	3		
Trifolium repens	3		
Rumex acetosa	4		
Plantago lanceolata	2		
Cerastium fontanum	2		
Luzula campestre	2		
Ranunculus acris	2		
Cirsium dissectum	1		
Bellis perennis	4		
Poa trivialis	6		
Poa annua	5		
Raununculus repens	2		
Festuca ovina	4		
Rhytidiadelphis squarrosus	5		

		Species Total	16

NVC Code *MG1 - Festuca rubra-Holcus lanatus-* *Anthoxanthum odoratum* provisional grassland community (Rodwell et al. 2000)	Site & Vegetation Description Closely-grazed sward. *Cirsium palustre* only species exceeding ~10cm in height due to unpalatability

Photo of Quadrat 81

Quadrat no.		Date		Estimated Slope (^{o})	
82		27th June 2016		12	
Quadrat size		Grid Ref			
2m X 2m		IC 74443 24854			
Surveyor	Altitude (m asl)		Site		
KH	301		Dunbeg South		

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	10		
Ranunculus acris	2		
Dactylorhiza maculatum	1		
Potentilla erecta	2		
Anthoxanthum odoratum	2		
Luzula campestris	2		
Festuca ovina	2		
Holcus lanatus	2		
Poa pratensis	1		
Carex panicea	1		
Rhytidiadelphis squarrosus	5		

		Species Total	11

NVC Code	Site & Vegetation Description
M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community	Moderately grazed rush pasture

Photo of Quadrat 82

Quadrat no.	Date	Estimated Slope (^{o})
83	28th June 2016	10
Quadrat size: 2m X 2m	Grid Ref: IC 74593 24854	

Surveyor	Altitude (m asl)	Site
KH	321	Dunbeg South

Species	DOMIN	Species	DOMIN
Trichophorum germanicum	8		
Eriophorum vaginatum	5		
Eriophorum angustifolium	5		
Drosera rotundifolia	3		
Carex echinata	2		
Carex panicea	3		
Juncus squarrosus	4		
Potentilla erecta	2		
Calluna vulgaris	3		
Sphagnum cuspidatum	4		
Sphagnum papillosum	3		

		Species Total	11

NVC Code	Site & Vegetation Description
M17a *Trichophorum caespitosum-Eriophorum vaginatum* blanket mire; *Drosera rotundifolia-Sphagnum* species sub-community OR M15a *Trichophorum caespitosum* mire	Blanket mire with open, short sward. *Calluna* sparse and short, indicating periodic heavy grazing pressure

Photo of Quadrat 83

Quadrat no.	Date	Estimated Slope (°)
84	28th June 2016	1
Quadrat size: 2m X 2m	Grid Ref: IC 74743 24854	

Surveyor	Altitude (m asl)	Site
KH	329	Dunbeg South

Species	DOMIN	Species	DOMIN
Calluna vulgaris	6		
Eriophorum vaginatum	6		
Eriophorum angustifolium	6		
Erica tetralix	3		
Trichophorum germanicum	8		
Sphagnum capillifolium	5		
Cladonia portentosa	3		
Dicranum scoparium	2		

		Species Total	8
NVC Code M15a *Trichophorum caespitosum-Erica tetralix* wet heath; typical sub-community	Site & Vegetation Description Species-poor wet heath; grazing keeps *Calluna* short. Small, scattered pools adjacent to quadrat remnant of original pool-and-hummock mire system. Relative abundance of *Eriophorum vaginatum may* suggest gradation of M15 into blanket mire. Evidence of cut-over bog higher up slope; blanket mire is most likely prevalent where peat is sufficienty deep but on cut-over areas, wet heath such as M15 has developed		

Photo of Quadrat 84

Quadrat no. 85	Date 28th June 2016	Estimated Slope (°) 2
Quadrat size 2m X 2m	Grid Ref IC 74893 24854	
Surveyor KH	Altitude (m asl) 327	Site Dunbeg South

Species	DOMIN	Species	DOMIN
Eriophorum vaginatum	8		
Molinia caerulea	7		
Erica cinerea	3		
Potentilla erecta	4		
Sphagnum capillifolium	6		
Sphagnum fallax	4		
Sphagnum papillosum	3		

		Species Total	7

NVC Code	Site & Vegetation Description
M20 *Eriophorum vaginatum* blanket mire	Species-poor mire. Sward dominated by tussocks of *Molinia* with scattered *Eriophorum vaginatum* and low hummocks of Sphagna

Photo of Quadrat 85

Quadrat no. 86	Date 15th June 2016	Estimated Slope (^{o}) 7
Quadrat size 2m X 2m	Grid Ref IC 73243 24704	
Surveyor CL	Altitude (m asl) 295	Site Dunbeg South

Species	DOMIN	Species	DOMIN
Calluna vulgaris	6		
Luzula multiflora			
Deschampsia flexuosa	7		
Galium saxatile	6		
Carex echinata	4		
Anthoxanthum odoratum	2		
Potentilla erecta	2		
Eriophorum vaginatum	2		
Holcus lanatus			
Nardus stricta			
Rhytidiadelphis squarrosus	6		
Rhytidiadelphis loreus			
Hylocomium splendens	2		
Polytrichum commune	5		
Pseudoscleropodium purum			
Hypnum jutlandicum			
		Species Total	16

NVC Code	Site & Vegetation Description

H9d *Calluna vulgaris-Deschampsia flexuosa* heath; *Galium saxatile* sub-community	Wet heath / acid grassland mosaic with hummocks of *Polytrichum commune* and *Galium saxatile.Calluna* cover and height both poor, indicating at least periodic heavy grazing pressure

Photo of Quadrat 86

Quadrat no. 87	Date 28th June 2016	Estimated Slope (^{o}) 7
Quadrat size 2m X 2m	Grid Ref IC 73393 24704	

Surveyor KH	Altitude (m asl) 297	Site Dunbeg South

Species	DOMIN	Species	DOMIN
Calluna vulgaris	6		
Deschampsia flexuosa	7		
Galium saxatile	6		
Carex echinata	4		
Anthoxanthum odoratum	2		
Potentilla erecta	2		
Eriophorum vaginatum	2		
Juncus squarrosus	2		
Deschampsia caespitosa	3		
Carex nigra	6		
Sphagnum capillifolium	1		
Rhytidiadelphis loreus	6		
Plagiothecium undulatum	1		
Thuidium tamariscinum	2		
Sphagnum fallax	4		
Polytrichum commune	5		

		Species Total	16

NVC Code	Site & Vegetation Description
H9d *Calluna vulgaris-Deschampsia flexuosa* heath; *Galium saxatile* sub-community	Wet heath / acid grassland mosaic with hummocks of *Polytrichum commune* and *Galium saxatile.Calluna* cover and height both poor, indicating at least periodic heavy grazing pressure

Photo of Quadrat 87

Quadrat no.	Date	Estimated Slope (^{o})
88	28th June 2016	3
Quadrat size: 2m X 2m	Grid Ref: IC 73543 24704	

Surveyor	Altitude (m asl)	Site
KH	296	Dunbeg South

Species	DOMIN	Species	DOMIN
Viola palustris	3		
Ranunculus flammula	4		
Taraxacum officinale agg.	1		
Anthoxanthum odoratum	4		
Luzula campestris	1		
Ranunculus acris	2		
Cerastium fontanum	1		
Nardus stricta	1		
Juncus acutiflorus	7		
Potentilla erecta	3		
Carex panicea	3		
Leontodon autumnalis	1		
Cirsium dissectum	2		
Cardamine pratensis	1		
Carex echinata	1		
Cirsium palustre	1		
Rhytidiadelphis squarrosus	8		
Kindbergia praelonga	2		
Calliergonella cuspidatum	2		

		Species Total	19

NVC Code	Site & Vegetation Description
M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community	Marshy grassland with low grazing pressure

Photo of Quadrat 88

Quadrat no. 89	Date 28th June 2016	Estimated Slope (^{o}) 4
Quadrat size 2m X 2m	Grid Ref IC 73693 24704	
Surveyor KH	Altitude (m asl) 295	Site Dunbeg South

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	9		
Anthoxanthum odoratum	4		
Deschampsia caespitosa	3		
Potentilla erecta	3		
Galium saxatile	2		
Juncus squarrosus	1		
Luzula campestris	1		
Polytrichum commune	5		
Rhytidiadelphis squarrosus	5		
Pseudopscleropodium purum	3		
Sphagnum fallax	2		
Thuidium tamariscinum	2		

		Species Total	12

NVC Code	Site & Vegetation Description
M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community	Rush pasture - ungrazed this year and thick thatch indicates previous low grazing pressure. Sward tall and dense

Photo of Quadrat 89

Quadrat no.	Date	Estimated Slope (^{o})
90	23th June 2016	2
Quadrat size 2m X 2m	Grid Ref IC 73843 24704	

Surveyor	Altitude (m asl)	Site
CL	292	Dunbeg South

Species	DOMIN	Species	DOMIN
Potentilla erecta	4	*Carex nigra*	
Calluna vulgaris	5		
Eriophorum angustifolium	5		
Juncus squarrosus	5		
Molinia caerulea	5		
Nardus stricta	4		
Rhytidiadelphis squarrosus	4		
Sphagnum capillifolium	4		
Spahgnum palustre	5		
Sphagnum papillosum	5		
Sphagnum denticulatum	2		
Dicranum scoparium	1		
		Species Total	13

NVC Code	Site & Vegetation Description
M17 *Trichophorum caespitosum-Eriophorum vaginatum* blanket mire	

Photo of Quadrat 90

Quadrat no.	Date	Estimated Slope (^{o})
91	28th June 2016	2
Quadrat size: 2m X 2m	Grid Ref: IC 73993 24704	
Surveyor: KH	Altitude (m asl): 288	Site: Dunbeg South

Species	DOMIN	Species	DOMIN
Dechampsia flexuosa	5		
Galium saxatile	2		
Potentilla erecta	3		
Calluna vulgaris	3		
Luzula campestris	2		
Vaccinium myrtillus	2		
Eriophorum vaginatum	2		
Juncus acutiflorus	7		
Molinia caerulea	4		
Rhytidiadelphis loreus	9		
Hypnum jutlandicum	3		
Sphagnum capillifolium	3		
Plagiothecium undulatum	1		
Thuidium tamariscinum	2		
Pleurozium schreberi	2		
Rhytidiadelphis squarrosus	2		

		Species Total	16

NVC Code	Site & Vegetation Description
M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community	Acid grassland dominated by *Deschampsia flexuosa*. *Calluna* very short and indicative of previous heavy grazing. No recent grazing as *Deschampsia* sward tall with abundant flowering spikes

Photo of Quadrat 91

Quadrat no.	Date	Estimated Slope (^{o})
92	28th June 2016	5
Quadrat size: 2m X 2m	Grid Ref: IC 74143 24704	

Surveyor	Altitude (m asl)	Site
KH	292	Dunbeg South

Species	DOMIN	Species	DOMIN
Trichophorum germanicum	8		
Calluna vulgaris	5		
Potentilla erecta	2		
Eriophorum vaginatum	2		
Molinia caerulea	5		
Carex nigra	3		
Juncus squarrosus	3		
Polygala serpyllifolia	2		
Galium saxatile	2		
Eriophorum angustifolium	4		
Rhytidiadelphis squarrosus	4		
Rhytidiadelphis loreus	7		
Sphagnum capillifolium	3		
Dicranum scoparium	1		
Lophozia ventricosa	1		
Cladonia portentosa	1		

		Species Total	16
NVC Code M15a *Trichophorum caespitosum-Erica tetralix* wet heath; typical sub-community		Site & Vegetation Description Mire dominated by *Trichophorum. Calluna* patchy and of moderate height (~20cm) indicating periodic moderate grazing. Surrounding habitat acid grassland dominated by *Deschampsia flexuosa*	

Photo of Quadrat 92

Quadrat no.		Date		Estimated Slope (^{o})
93		28th June 2016		2
Quadrat size 2m X 2m		Grid Ref IC 74293 24704		
Surveyor KH	Altitude (m asl) 292		Site Dunbeg South	

Species	DOMIN	Species	DOMIN
Eriophorum angustifolium	5		
Carex rostrata	8		
Equisetum fluviatile	3		
Potentilla erecta	3		
Drosera rotundifolia	2		
Molinia caerulea	5		
Juncus acutiflorus	4		
Carex nigra	4		
Anthoxanthum odoratum	2		
Sphagnum papillosum	8		
Sphagnum fallax	5		

		Species Total	11

NVC Code	Site & Vegetation Description
S9b *Carex rostrata* swamp; *Menyanthes trifoliata-Equisetum fluviatile* sub-community	Wet acidic hollow with waterlogged *Sphagnum* carpet

Photo of Quadrat 93

Quadrat no.		Date	Estimated Slope (°)
94		28th June 2016	8
Quadrat size 2m X 2m		Grid Ref IC 74443 24704	
Surveyor KH	Altitude (m asl) 301	Site Dunbeg South	

Species	DOMIN	Species	DOMIN
Carex panicea	3		
Potentilla erecta	3		
Erica tetralix	4		
Deschampsia flexuosa	3		
Calluna vulgaris	4		
Molinia caerulea	8		
Nardus stricta	2		
Eriophorum angustifolium	7		
Polygala serpyllifolia	1		
Galium saxatile	1		
Trichophorum germanicum	2		
Juncus squarrosus	2		
Juncus acutiflorus	2		
Sphagnum capillifolium	8		
Dicranum scoparium	1		
Racomitrium languinosum	1		
Sphagnum papillosum	2		
Rhyidiadelphis loreus	4		

		Species Total	18

NVC Code	Site & Vegetation Description
M25a *Molinia caerulea-Potentilla erecta* mire; *Erica tetralix* sub-community	*Molinia* grassland with stunted succeeding wet heath due to periodic moderate grazing pressure

Photo of Quadrat 94

Quadrat no. 95	Date 28th June 2016	Estimated Slope (°) 10
Quadrat size 2m X 2m	Grid Ref IC 74593 24704	
Surveyor KH	Altitude (m asl) 321	Site Dunbeg South

Species	DOMIN	Species	DOMIN
Deschampsia flexuosa	6		
Molinia caerulea	7		
Potentilla erecta	3		
Calluna vulgaris	4		
Polygala serpyllifolia	2		
Erica cinerea	3		
Galium saxatile	2		
Juncus squarrosus	3		
Luzula campestris	1		
Deschampsia caespitosa	1		
Trichophorum germanicum	5		
Erica tetralix	1		
Sphagnum capillifolium	7		
Pleurozium schreberi	2		
Rhytidiadelphis squarrosus	4		
Rhytididelphis loreus	5		
Plagiothecium undulatum	1		
Hypnum jutlandicum	1		
Dicranum scoparium	1		

		Species Total	19

NVC Code	Site & Vegetation Description
M25a *Molinia caerulea-Potentilla erecta* mire; *Erica tetralix* sub-community	*Molinia* grassland with periodic moderate grazing pressure preventing succession to heath. *E. cinerea* present on hummocks and *E. tetralix* in hollows. Abundance of *Deschampsia flexuosa* in sward shows gradation to U2 grassland

Photo of Quadrat 95

Quadrat no. 96	Date 28th June 2016	Estimated Slope (°) 1
Quadrat size 2m X 2m	Grid Ref IC 74743 24704	
Surveyor KH	Altitude (m asl) 331	Site Dunbeg South

Species	DOMIN	Species	DOMIN
Eriophorum vaginatum	2		
Eriophorum angustifolium	6		
Trichophorum germanicum	4		
Erica cinerea	4		
Calluna vulgaris	3		
Erica tetralix	1		
Deschampsia flexuosa	7		
Dryopteris dilatata	1		
Polytrichum juniperinum	1		
Sphagnum capillifolium	7		
Hypnum jutlandicum	2		
Cladonia portentosa	1		
Bare peat	5		

		Species Total	12
NVC Code U2a *Deschampsia flexuosa* grassland; *Festuca ovina-Agrostis capillaris* sub-community' forming mosaic with M17 *Trichophorum caespitosum-Eriophorum vaginatum* blanket mire	Site & Vegetation Description Acid grassland / mire mosaic with no evidence of recent grazing. *Calluna* cover short and low which indicates previous heavy grazing. Bare peat evidence of previous disturbance e.g. sheep poaching		

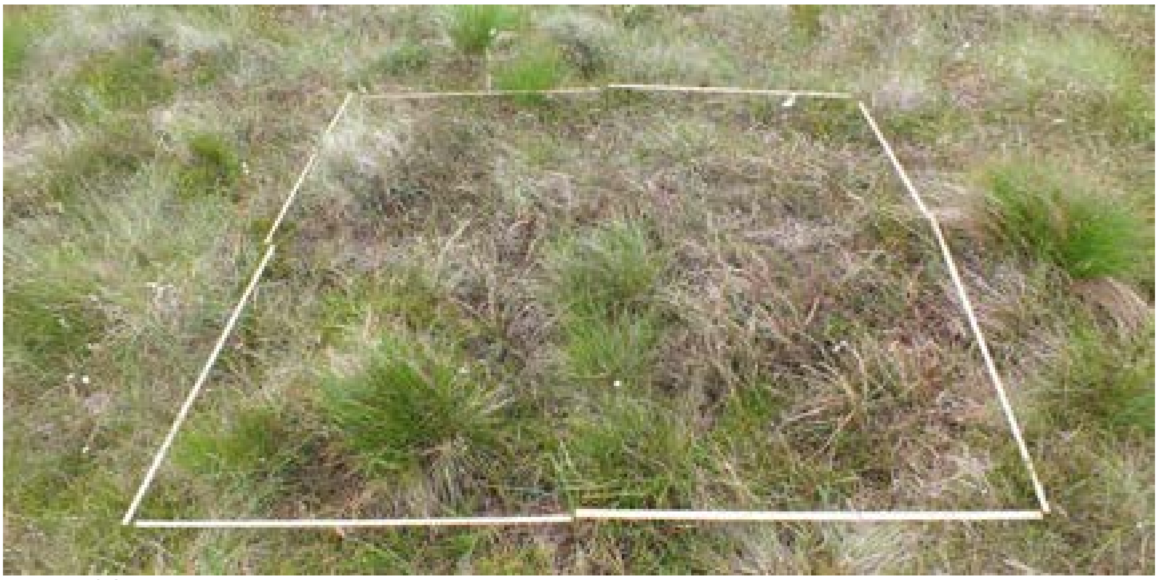

Photo of Quadrat 96

Quadrat no.		Date	Estimated Slope (°)
97		28th June 2016	1
Quadrat size: 2m X 2m		Grid Ref: IC 74893 24704	
Surveyor: KH	Altitude (m asl): 334	Site: Dunbeg South	

Species	DOMIN	Species	DOMIN
Trichophorum germanicum	8		
Erica tetralix	1		
Eriophorum vaginatum	3		
Calluna vulgaris	4		
Eriophorum angustifolium	4		
Narthecium ossifragum	1		
Erica cinerea	3		
Racomitrium languinosum	4		
Sphagnum capillifolium	6		
Hypnum jutlandicum	2		
Sphagnum papillosum	2		
Polytrichum juniperinum	1		
Campylopus introflexus	1		
Cladonia portentosa	1		
Bare peat	5		

		Species Total	14

NVC Code M17b *Trichophorum caespitosum-Eriophorum vaginatum* blanket mire; *Cladonia* species sub-community	Site & Vegetation Description Mire with evidence of previous heavy grazing (*Calluna* short and not abundant) and disturbance (bare peat due to sheep poaching)

Photo of Quadrat 97

Quadrat no. 98	Date 15th July 2016	Estimated Slope (°) 2
Quadrat size 2m x 2m	Grid Ref IC 7324324554	

Surveyor KH	Altitude (m asl) 316	Site Dunbeg South

Species	DOMIN	Species	DOMIN
Calluna vulgaris	7		
Erica tetralix	2		
Potentilla erecta	3		
Molinia caerulea	6		
Juncus acutiflorus	5		
Sphagnum capillifolium	5		
Rhytidiadelphis loreus	5		
Cladonia portentosa	2		

		Species Total	8

NVC Code	Site & Vegetation Description
M15 *Trichophorum caespitosum-Erica tetralix* wet heath	Wet heath / *Molinia* grassland mosaic. *Calluna* ~35cm tall and mature. Low grazing pressure due to extensive grazing regime

Photo of Quadrat 98

Quadrat no. 99	Date 15th July 2016	Estimated Slope (^{o}) 5
Quadrat size 2m x 2m	Grid Ref IC 7339324554	
Surveyor KH	Altitude (m asl) 310	Site Dunbeg South

Species	DOMIN	Species	DOMIN
Calluna vulgaris	6		
Deschampsia flexuosa	5		
Potentilla erecta	3		
Molinia caerulea	4		
Luzula campestre	1		
Eriophorum vaginatum	2		
Deschampsia caespitosa	5		
Galium saxatile	1		
Rhytidiadelphis loreus	6		
Sphagnum capillifolium	6		
Polytrichum commune	4		
Thuidium tamariscinum	7		
Hylocomium splendens	5		

		Species Total	13

NVC Code	Site & Vegetation Description
M15 *Trichophorum caespitosum-Erica tetralix* wet heath	*Calluna* in hummocks with scattered grassy tussocks. Low grazing pressure

Photo of Quadrat 99

Quadrat no. 100	Date 15th July 2016	Estimated Slope (°) 3
Quadrat size 2m x 2m	Grid Ref IC 7354324554	

Surveyor KH	Altitude (m asl) 307	Site Dunbeg South

Species	DOMIN	Species	DOMIN
Calluna vulgaris	8		
Potentilla erecta	3		
Deschampsia flexuosa	5		
Carex echinata	2		
Carex nigra	5		
Molinia caerulea	3		
Sphagnum cuspidatum	4		
Polytrichum commune	3		
Sphagnum capillifolium	5		
Rhytidiadelphis loreus	5		
Scapania umbrosa	2		
Pleurozium schreberi	3		
Thuidium tamariscinum	3		

		Species Total	13

NVC Code	Site & Vegetation Description
M15 *Trichophorum caespitosum-Erica tetralix* wet heath	Wet heath. *Calluna* ~40cm tall and mature, some degenerating. *Calluna* in hummocks with *Sphagnum capillifolium*, pleurocarpous mosses and *Scapania*. Hollows with *Sphagnum cuspidatum* and *Carex nigra*. Low grazing pressure

Photo of Quadrat 100

Quadrat no. 101	Date 15th July 2016	Estimated Slope (°) 5
Quadrat size 2m x 2m	Grid Ref IC 7369324554	

Surveyor KH	Altitude (m asl) 306	Site Dunbeg South

Species	DOMIN	Species	DOMIN
Calluna vulgaris	7		
Potentilla erecta	4		
Juncus squarrosus	4		
Molinia caerulea	5		
Deschampsia flexuosa	2		
Juncus acutiflorus	2		
Eriophorum angustifolium	5		
Galium saxatile	1		
Rhytidiadelphis squarrosus	6		
Thuidium tamariscinum	5		
Sphagnum capillifolium	5		
Rhytidiadelphis loreus	4		
Sphagnum papillosum	5		

		Species Total	13

NVC Code	Site & Vegetation Description
NVC Code M15 *Trichophorum caespitosum-Erica tetralix* wet heath	Site & Vegetation Description Wet heath with many *Molinia* tussocks and scattered *E. angustifolium. Calluna* ~10cm tall and patchy. Sward open in places where mosses dominate

Photo of Quadrat 101

Quadrat no.	Date	Estimated Slope (°)
102	15th July 2016	1

Quadrat size	Grid Ref
2m x 2m	IC 7384324554

Surveyor	Altitude (m asl)	Site
KH	305	Dunbeg South

Species	DOMIN	Species	DOMIN
Molinia caerulea	6		
Erica tetralix	4		
Calluna vulgaris	6		
Trichophorum germanicum	5		
Juncus squarrosus	4		
Potentilla erecta	3		
Erica cinerea	1		
Eriophorum angustifolium	3		
Cladonia portentosa	1		
Racomitrium languinosum	4		

		Species Total	10

NVC Code	Site & Vegetation Description
M15 *Trichophorum caespitosum-Erica tetralix* wet heath	Wet heath / *Molinia* grassland mosaic. Relatively flat with scattered *Racomtrium* hummocks. Grazing pressure low

Photo of Quadrat 102

Quadrat no. 103	Date 15th July 2016	Estimated Slope (°) 2
Quadrat size 2m x 2m	Grid Ref IC 7399324554	

Surveyor KH	Altitude (m asl) 301	Site Dunbeg South

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	8		
Dactylorrhiza maculata	1		
Succisia pratensis	3		
Potentilla erecta	3		
Carex panicea	2		
Calluna vulgaris	2		
Trichophorum germanicum	5		
Nardus stricta	2		
Molinia caerulea	3		
Carex echinata	2		
Anthoxanthum odoratum	1		
Breutelia chrysocoma	2		
Rhytidiadelphis loreus	3		
Sphagnum papillosum	6		
Sphagnum cuspidatum	4		

Polytrichum commune	2		
Open water	4		
		Species Total	16

NVC Code	Site & Vegetation Description
M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community	Rush pasture - very wet underfoot. Sward patchy and open. Wet hollow between two rocky outcrops

Photo of Quadrat 103

Quadrat no. 104	Date 15th July 2016	Estimated Slope (°) 2
Quadrat size 2m x 2m	Grid Ref IC 7414324554	

Surveyor KH	Altitude (m asl) 304	Site Dunbeg South

Species	DOMIN	Species	DOMIN
Molinia caerulea	5		
Anthoxanthum odoratum	2		
Potentilla erecta	3		
Galium saxatile	3		
Juncus acutiflorus	8		
Luzula campestre	3		
Carex pilulifera	1		
Pedicularis sylvatica	3		
Deschampsia caespitosa	4		
Carex echinata	2		
Erica tetralix	3		
Erica cinerea	1		
Thuidium tamariscinum	5		
Rhytidiadelphis squarrosus	6		
Hypnum jutlandicum	6		
Sphagnum fallax	5		

		Species Total	16

NVC Code	Site & Vegetation Description
M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community	Rush pasture with tussocks of *Molinia*. Very wet underfoot. Sward patchy with low levels of grazing

Photo of Quadrat 104

Quadrat no. 105	Date 15th June 2016	Estimated Slope (°) 4
Quadrat size 2m X 2m	Grid Ref IC 74293 24554	
Surveyor CL	Altitude (m asl) 317	Site Dunbeg South

Species	DOMIN	Species	DOMIN
Anthaxanthum odoratum	4	*Carex binervous*	4
Deschampsia flexuosa	5	*Carex panacea*	2
Potentilla erecta	4	*Carex nigra*	1
Luzula multiflora	2	*Carex echinata*	1
Lolium perenne	4		
Eriophorum angustifolium	1	*Sphagnum papillosum*	2
Nardus stricta	5	*Sphagnum subnitens*	1
Ranunculus acris	2	*Rhytidiadelphis squarrosus*	1
Vaccinium myrtillus	4	*Sphagnum capillifolium*	4
Festuca ovina	4	*Polytrichum commune*	1
Agrostis canina	1	*Hylocomium splendens*	3
Galium saxatile	3	*Pleurozium schreberi*	1
Juncus squarrosus	4	*Pseudoscleropodium purum*	2
Polygala serpyllifolia	1		
Poa pratensis	2		
Holcus lanatus	4		
Pedicularis sylvatica	1		

	Species Total	29

NVC Code	Site & Vegetation Description
M23a Juncus effusus/acutiflorus-Galium palustre rush pasture; Juncus acutiflorus sub-community	

Photo of Quadrat 105

Quadrat no.	Date	Estimated Slope (^{o})
106	15th July 2016	5
Quadrat size 2m x 2m	Grid Ref IC 7444324554	
Surveyor KH	Altitude (m asl) 312	Site Dunbeg South

Species	DOMIN	Species	DOMIN
Deschampsia flexuosa	5		
Anthoxanthum odoratum	2		
Molinia caerulea	7		
Galium saxatile	3		
Calluna vulgaris	4		
Juncus squarrosus	3		
Potentilla erecta	3		
Luzula campestre	1		
Erica cinerea	3		
Trichophorum germanicum	5		
Carex flacca	3		
Rhytidiadelphis squarrosus	6		
Polytrichum commune	3		
Pleurozium schreberi	2		

Bare soil	4		
		Species Total	14

NVC Code	Site & Vegetation Description
M25a *Molinia caerulea-Potentilla erecta* mire; *Erica tetralix* sub-community	*Molinia* grassland with scattered *Deschampsia flexuosa* and *Trichophorum germanicum* tussocks. Scattered areas of bare soil. Low grazing pressure

Photo of Quadrat 106

Quadrat no. 107	Date 28th June 2016	Estimated Slope (°) 2
Quadrat size 2m X 2m	Grid Ref IC 74593 24554	
Surveyor KH	Altitude (m asl) 317	Site Dunbeg South

Species	DOMIN	Species	DOMIN
Eriophorum vaginatum	3		
Deschampsia flexuosa	6		
Potentilla erecta	3		
Eriophorum angustifolium	3		
Deschampsia caespitosa	4		
Galium saxatile	3		
Juncus effusus	4		
Sphagnum fallax	6		
Rhytidiadelphis loreus	5		
Sphagnum capillifolium	2		
Polytrichum commune	3		
Polytrichum juniperinum	2		
Aulacomnium palustre	3		
Sphagnum papillosum	3		
Thuidium tamariscinum	2		

		Species Total	15

NVC Code	Site & Vegetation Description
U2a *Deschampsia flexuosa* grassland; *Festuca ovina-Agrostis capillaris* sub-community	Acid grassland with fringe of *Juncus effusus*. No *Calluna* indicates previous heavy grazing pressure

Photo of Quadrat 107

Quadrat no. 108	Date 28th June 2016	Estimated Slope (^{o}) 3
Quadrat size 2m X 2m	Grid Ref IC 74743 24554	
Surveyor KH	Altitude (m asl) 327	Site Dunbeg South

Species	DOMIN	Species	DOMIN
Molinia caerulea	5		
Deschampsia flexuosa	7		
Eriophorum vaginatum	4		
Deschampsia caespitosa	6		
Galium saxatile	3		
Drosera rotundifolia	1		
Potentilla erecta	2		
Polytrichum commune	6		
Sphagnum papillosum	6		
Sphagnum fallax	4		

		Species Total	10

NVC Code	Site & Vegetation Description
U2a *Deschampsia flexuosa* grassland; *Festuca ovina-Agrostis capillaris* sub-community	Acid grassland with no *Calluna* present, indicating previous heavy grazing pressure

Photo of Quadrat 108

Quadrat no. 109	Date 28th June 2016	Estimated Slope (^{o}) 2
Quadrat size 2m X 2m	Grid Ref IC 74893 24554	
Surveyor KH	Altitude (m asl) 332	Site Dunbeg South

Species	DOMIN	Species	DOMIN
Potentilla erecta	4		
Eriophorum vaginatum	5		
Calluna vulgaris	2		
Galium saxatile	2		
Deschampsia caespitosa	9		
Carex panicea	2		
Molinia caerulea	2		
Sphagnum capillifolium	7		
Sphagnum papillosum	3		
Rhytidiadelphis loreus	5		
Sphagnum fallax	2		
Polytrichum commune	5		
Hypnum jutlandicum	3		

		Species Total	13

NVC Code	Site & Vegetation Description
U13 Deschampsia caespitosa-Galium saxatile grassland (for acid grassland part of mosaic)	Acid grassland / mire mosaic

Photo of Quadrat 109

Quadrat no.	Date	Estimated Slope (^{o})
110	14th July 2016	5
Quadrat size 2m x 2m	Grid Ref IC 7324324404	

Surveyor	Altitude (m asl)	Site
KH	328	Dunbeg South

Species	DOMIN	Species	DOMIN
Calluna vulgaris	7		
Erica tetralix	2		
Eriophorum vaginatum	5		
Galium saxatile	3		
Hypnum jutlandicum	7		
Cladonia portentosa	1		
Polytrichum commune	2		
Sphagnum capillifolium	5		
Rhytidiadelphis loreus	5		
Sphagnum fallax	6		
Pseudoscleropodium purum	3		

		Species Total	11

NVC Code	Site & Vegetation Description
M15 *Trichophorum caespitosum-Erica tetralix* wet heath	Wet heath with *Calluna* ~20cm tall; patchy in low hummocks with pleurocarpous mosses and *Sphagnum capillifolium*

Photo of Quadrat 110

Quadrat no.		Date		Estimated Slope (°)
111		14th July 2016		2
Quadrat size		Grid Ref		
2m x 2m		IC 739324404		
Surveyor	Altitude (m asl)		Site	
KH	320		Dunbeg South	

Species	DOMIN	Species	DOMIN
Calluna vulgaris	8		
Galium saxatile	3		
Deschampsia flexuosa	5		
Erica cinerea	4		
Deschampsia caespitosa	3		
Eriophorum angustifolium	3		
Molinia caerulea	2		
Hypnum jutlandicum	7		
Pseudoscleropodium purum	3		
Thuidium tamariscinum	3		
Rhytidiadelphis squarrosus	3		
Hylocomium splendens	2		
Polytrichum juniperinum	1		

		Species Total	13

NVC Code	Site & Vegetation Description
M15 *Trichophorum caespitosum-Erica tetralix* wet heath	Dry heath with *Calluna* ~15cm tall. Abundant ground layer of pleurocarpous mosses

Photo of Quadrat 111

Quadrat no.	Date	Estimated Slope (°)
112	14th July 2016	2

Quadrat size	Grid Ref
2m x 2m	IC 7354324404

Surveyor	Altitude (m asl)	Site
KH	318	Dunbeg South

Species	DOMIN	Species	DOMIN
Calluna vulgaris	8		
Erica tetralix	3		
Eriophorum vaginatum	5		
Molinia caerulea	5		
Potentilla erecta	3		
Racomitrium languinosum	3		
Cladonia portentosa	2		
Sphagnum capillifolium	4		
Rhytidiadelphis loreus	5		
Brachythecium rutabulum	3		
Hypnum jutlandicum	6		

		Species Total	11

NVC Code	Site & Vegetation Description
M15 *Trichophorum caespitosum-Erica tetralix* wet heath	Wet heath with *Calluna* ~20cm tall. Very low grazing pressure

Photo of Quadrat 112

Quadrat no. 113	Date 14th July 2016	Estimated Slope (°) 3
Quadrat size 2m x 2m	Grid Ref IC 7369324404	

Surveyor KH	Altitude (m asl) 315	Site Dunbeg South

Species	DOMIN	Species	DOMIN
Calluna vulgaris	4		
Erica tetralix	3		
Eriophorum vaginatum	8		
Potentilla erecta	3		
Polygala vulgaris	1		
Deschampsia flexuosa	1		
Molinia caerulea	5		
Sphagnum fallax	2		
Sphagnum capillifolium	5		
Thuidium tamariscinum	2		
Hypnum jutlandicum	4		

		Species Total	11

NVC Code	Site & Vegetation Description
M20 *Eriophorum vaginatum* blanket mire	*Eriophorum vaginatum* mire with sward dense and relatively ungrazed. *Calluna* very patchy and ~25cm tall. Very wet underfoot due to recent heavy rain

Photo of Quadrat 113

Quadrat no. 114	Date 14th July 2016	Estimated Slope (°) 5
Quadrat size 2m x 2m	Grid Ref IC 7384324404	

Surveyor KH	Altitude (m asl) 313	Site Dunbeg South

Species	DOMIN	Species	DOMIN
Trichophorum germanicum	8		
Potentilla erecta	3		
Eriophorum angustifolium	3		
Calluna vulgaris	4		
Carex panicea	2		
Succisia pratensis	1		
Molinia caerulea	4		
Juncus squarrosus	3		
Erica cinerea	3		
Dactylorrhiza maculata	1		
Sphagnum papillosum	2		
Hypnum jutlandicum	3		
Rhytidiadelphis loreus	3		

Bare peat	4		
		Species Total	13

NVC Code	Site & Vegetation Description
M17 *Trichophorum caespitosum-Eriophorum vaginatum* blanket mire	*Trichophorum* mire with hummocks of *Calluna* and *E. cinerea*. Small patches of wet, bare peat with evidence of moderate sheep grazing i.e. rounded *Calluna* plants

Photo of Quadrat 114

Quadrat no.		Date	Estimated Slope (^{o})
115		15th June 2016	3
Quadrat size		Grid Ref	
2m X 2m		IC 73993 24404	
Surveyor	Altitude (m asl)		Site
CL	335		Dunbeg South

Species	DOMIN	Species	DOMIN
Eriophoum angustifolium	4		
Potentilla erecta	3		
Calluna vulgaris	8		
Trichophorum germanicum	3		
Juncus squarrosus	6		
Polygala serpyllifolia	1		
Anthoxanthum odoratum	3		
Sphagnum capillifolium	7		
Rhytidiadelphis loreus	2		
Dicranum scoparium	1		
Litter	5		

		Species Total	10

NVC Code	Site & Vegetation Description
M17 *Trichophorum caespitosum-Eriophorum vaginatum* blanket mire	Blanket mire

Photo of Quadrat 115

Quadrat no. 116	Date 14th July 2016	Estimated Slope (^{o}) 5
Quadrat size 2m x 2m	Grid Ref IC 7414324404	

Surveyor KH	Altitude (m asl) 312	Site Dunbeg South

Species	DOMIN	Species	DOMIN
Vaccinium myrtillus	3		
Potentilla erecta	3		
Erica tetralix	5		
Erica cinerea	2		
Molinia caerulea	8		
Calluna vulgaris	4		
Juncus squarrosus	4		
Galium saxatile	1		
Deschampsia caespitosa	4		
Eriophorum vaginatum	5		
Thuidium tamariscinum	3		
Rhytidiadelphis loreus	3		
Sphagnum papillosum	4		
Sphagnum capillifolium	4		

Bare peat	4		
		Species Total	14

NVC Code	Site & Vegetation Description
M25a *Molinia caerulea-Potentilla erecta* mire; *Erica tetralix* sub-community	*Molinia* grassland with scattered tussocks of *Eriophorum vaginatum* and *Erica tetralix*. Grazing pressure low

Photo of Quadrat 116

Quadrat no.	Date	Estimated Slope (^{o})
117	14th July 2016	2

Quadrat size	Grid Ref
2m x 2m	IC 7429324404

Surveyor	Altitude (m asl)	Site
KH	316	Dunbeg South

Species	DOMIN	Species	DOMIN
Dactylorrhiza maculata	1		
Molinia caerulea	4		
Calluna vulgaris	4		
Carex panicea	3		
Carex echinata	2		
Juncus squarrosus	4		
Trichophorum germanicum	6		
Drosera rotundifolia	2		
Succisia pratensis	2		
Potentilla erecta	1		
Polygala vulgaris	2		
Eriophorum angustifolium	1		
Rhytidiadelphis loreus	2		
Sphagnum capillifolium	3		

Bare peat	7		
		Species Total	14

NVC Code M17 *Trichophorum caespitosum-Eriophorum vaginatum* blanket mire	Site & Vegetation Description Wet hollow with ~30% wet, bare peat

Photo of Quadrat 117

Quadrat no. 118	Date 14th July 2016	Estimated Slope (^{o}) 3
Quadrat size 2m x 2m	Grid Ref IC 7444324404	

Surveyor KH	Altitude (m asl) 314	Site Dunbeg South

Species	DOMIN	Species	DOMIN
Erica tetralix	4		
Potentilla erecta	2		
Deschampsia flexuosa	2		
Carex panicea	3		
Molinia caerulea	7		
Calluna vulgaris	2		
Carex flacca	1		
Eriophorum vaginatum	2		
Luzula campestre	1		
Blechnum spicant	2		
Deschampsia caespitosa	4		
Sphagnum papillosum	5		
Cladonia portentosa	4		
Sphagnum capillifolium	3		

Dicranum scoparium	1		
Bare peat	4		
		Species Total	15
NVC Code M25a *Molinia caerulea-Potentilla erecta* mire; *Erica tetralix* sub-community		Site & Vegetation Description Short, open sward, in very wet hollow	

Photo of Quadrat 118

Quadrat no.	Date	Estimated Slope (°)
119	14th July 2016	2

Quadrat size	Grid Ref
2m x 2m	IC 7459324404

Surveyor	Altitude (m asl)	Site
KH	323	Dunbeg South

Species	DOMIN	Species	DOMIN
Potentilla erecta	4		
Eriophorum angustifolium	2		
Eriophorum vaginatum	7		
Deschampsia caespitosa	4		
Erica tetralix	3		
Molinia caerulea	4		
Drosera rotundifolia	1		
Luzula campestre	1		
Sphagnum capillifolium	4		
Sphagnum papillosum	6		
Hypnum jutlandicum	3		
Rhytidiadelphis loreus	3		

		Species Total	12

NVC Code	Site & Vegetation Description
M20 *Eriophorum vaginatum* blanket mire	Cutover bog; very wet underfoot with thick rafts of floating vegetation - unstable! Relatively flat, peat-forming mire. Ungrazed due to unstable ground layer

Photo of Quadrat 119

Quadrat no. 120	Date 14th July 2016	Estimated Slope (^{o}) 5
Quadrat size 2m x 2m	Grid Ref IC 7474324404	

Surveyor KH	Altitude (m asl) 333	Site Dunbeg South

Species	DOMIN	Species	DOMIN
Deschampsia flexuosa	7		
Potentilla erecta	3		
Deschampsia caespitosa	3		
Galium saxatile	3		
Calluna vulgaris	4		
Sphagnum papillosum	7		
Polytrichum commune	4		
Sphagnum capillifolium	4		
Breutelia chrysocoma	2		
Rhytidiadelphis loreus	3		

		Species Total	10

NVC Code	Site & Vegetation Description
U2 *Deschampsia flexuosa* grassland	*Deschampsia flexuosa* grassland on cutover bog. Grazing pressure low

Photo of Quadrat 120

Quadrat no. 121	Date 14th July 2016	Estimated Slope (°) 2
Quadrat size 2m x 2m	Grid Ref IC 7489324404	
Surveyor KH	Altitude (m asl) 338	Site Dunbeg South

Species	DOMIN	Species	DOMIN
Potentilla erecta	3		
Deschampsia flexuosa	6		
Eriophorum vaginatum	5		
Erica tetralix	3		
Deschampsia caespitosa	4		
Molinia caerulea	4		
Luzula campestre	2		
Trichophorum germanicum	2		
Calluna vulgaris	1		
Sphagnum papillosum	5		
Rhytidiadelphis loreus	3		
Sphagnum capillifolium	2		

		Species Total	12

NVC Code	Site & Vegetation Description
U2 *Deschampsia flexuosa* grassland	*Deschampsia flexuosa* grassland in hollow; very wet underfoot

Photo of Quadrat 121

Quadrat no.		Date	Estimated Slope (^{o})
122		14th July 2016	2
Quadrat size 2m x 2m		Grid Ref IC 7504324404	
Surveyor KH	Altitude (m asl) 345	Site Dunbeg South	

Species	DOMIN	Species	DOMIN
Molinia caerulea	8		
Erica cinerea	5		
Carex panicea	2		
Erica tetralix	3		
Potentilla erecta	3		
Trichophorum germanicum	5		
Vaccinium oxycoccos	1		
Sphagnum capillifolium	6		
Hypnum jutlandicum	2		
Racomitrium languinosum	2		

		Species Total	10

NVC Code	Site & Vegetation Description
M25a *Molinia caerulea-Potentilla erecta* mire; *Erica tetralix* sub-community	*Molinia* grassland on mound with much *E. cinerea*; adjacent hollow wetter with *E. tetralix*. Surrounding vegetation similar network of low hummocks and hollows

Photo of Quadrat 122

Quadrat no.	Date	Estimated Slope (°)
123	14th July 2016	3

Quadrat size	Grid Ref
2m x 2m	IC 7324324254

Surveyor	Altitude (m asl)	Site
KH	331	Dunbeg South

Species	DOMIN	Species	DOMIN
Calluna vulgaris	7		
Deschampsia flexuosa	4		
Potentilla erecta	3		
Galium saxatile	2		
Eriophorum vaginatum	4		
Deschampsia flexuosa	5		
Molinia caerulea	7		
Polytrichum commune	4		
Hypnum jutlandicum	5		
Rhytidiadelphis squarrosus	6		
Thuidium tamariscinum	5		
Sphagnum capillifolium	4		
Sphagnum fallax	3		

		Species Total	13

NVC Code	Site & Vegetation Description
M15 *Trichophorum caespitosum-Erica tetralix* wet heath	Wet heath / *Molinia* grassland mosaic with *Calluna* ~30cm tall. Grazing pressure low

Photo of Quadrat 123

Quadrat no. 124	Date 14th July 2016	Estimated Slope (°) 3
Quadrat size 2m x 2m	Grid Ref IC 7339324254	

Surveyor KH	Altitude (m asl) 328	Site Dunbeg South

Species	DOMIN	Species	DOMIN
Calluna vulgaris	8		
Eriophorum vaginatum	5		
Molinia caerulea	5		
Erica tetralix	3		
Galium saxatile	2		
Sphagnum fallax	4		
Rhytidiadelphis loreus	3		
Thuidium tamariscinum	3		
Sphagnum papillosum	1		
Hylocomium splendens	5		
Plagiothecium undulatum	1		

		Species Total	11

NVC Code	Site & Vegetation Description
M15 *Trichophorum caespitosum-Erica tetralix* wet heath	Wet heath with mature, gappy *Calluna* ~35cm tall. Sphagna and mosses in shaded layer beneath *Calluna.* Grazing pressure low

Photo of Quadrat 124

Quadrat no. 125	Date 14th July 2016	Estimated Slope (°) 3
Quadrat size 2m x 2m	Grid Ref IC 7354324254	
Surveyor KH	Altitude (m asl) 329	Site Dunbeg South

Species	DOMIN	Species	DOMIN
Calluna vulgaris	6		
Erica cinerea	2		
Potentilla erecta	3		
Anthoxanthum odoratum	3		
Molinia caerulea	8		
Carex echinata	4		
Deschampsia caespitosa	4		
Carex flacca	1		
Luzula campestre	1		
Juncus acutiflorus	2		
Erica tetralix	1		
Thuidium tamariscinum	5		
Rhytidiadelphis squarrosus	5		

Pseudoscleropodium purum *Hypnum jutlandicum*	4 6		
		Species Total	15
NVC Code M15 *Trichophorum caespitosum-Erica tetralix* wet heath		Site & Vegetation Description *Molinia* grassland / heath mosaic. Hummocks of *Calluna* ~20cm tall. *E. tetralix* in hollows. Most mosses beneath *Calluna* as thick *Molinia* thatch otherwise obscures light	

Photo of Quadrat 125

Quadrat no. 126		Date 14th July 2016		Estimated Slope (°) 5
Quadrat size 2m x 2m		Grid Ref IC 7369324254		
Surveyor KH	Altitude (m asl) 326		Site Dunbeg South	

Species	DOMIN	Species	DOMIN
Deschampsia flexuosa	8		
Deschampsia caespitosa	3		
Anthoxanthum odoratum	2		
Potentilla erecta	3		
Eriophorum vaginatum	3		
Calluna vulgaris	6		
Juncus acutiflorus	3		
Carex echinata	3		
Nardus stricta	2		
Juncus squarrosus	4		
Luzula campestre	1		
Sphagnum capillifolium	3		
Rhytidiadelphis squarrosus	3		

Hypnum jutlandicum *Rhytidiadelphis loreus* *Brachythecium rutabulum* *Plagiothecium undulatum*	4 4 1 1		
		Species Total	17
NVC Code M15 *Trichophorum caespitosum-Erica tetralix* wet heath	Site & Vegetation Description Scattered *Calluna* 5cm tall. Grazing heavier here than previous quadrats further west (separated by fence). Sward open with low *S. capillifolium* hummocks		

Photo of Quadrat 126

Quadrat no. 127	Date 14th July 2016	Estimated Slope (^{o}) 1
Quadrat size 2m x 2m	Grid Ref IC 7384324254	
Surveyor KH	Altitude (m asl) 319	Site Dunbeg South

Species	DOMIN	Species	DOMIN
Calluna vulgaris *Luzula campestre* *Eriophorum vaginatum* *Molinia caerulea* *Erica tetralix* *Polygala vulgaris* *Eriophorum angustifolium* *Deschampsia caespitosa* *Drosera rotundifolia* *Potentilla erecta* *Sphagnum papillosum* *Sphagnum capillifolium* *Sphagnum fallax*	4 1 7 2 2 1 2 3 2 2 5 4 3		

Rhytidiadelphis loreus *Brachythecium rutabulum* *Polytrichum commune* *Plagiothecium undulatum* *Hypnum jutlandicum* *Aulacomnium palustre*	4 2 1 1 4 1		
		Species Total	19
NVC Code M17 *Trichophorum caespitosum-Eriophorum vaginatum* blanket mire	Site & Vegetation Description *Eriophorum vaginatum* mire with scattered *Calluna* hummocks ~15cm tall. Grazing moderate and patchy. Sward patchy, open and short. Would revert to wet heath with reduced grazing pressure		

Photo of Quadrat 127

Quadrat no. 128	Date 14th July 2016	Estimated Slope (^{o}) 1
Quadrat size 2m x 2m	Grid Ref IC 7399324254	
Surveyor KH	Altitude (m asl) 323	Site Dunbeg South

Species	DOMIN	Species	DOMIN
Calluna vulgaris	4		
Erica tetralix	3		
Potentilla erecta	3		
Eriophorum vaginatum	5		
Juncus acutiflorus	7		
Eriophorum angustifolium	4		
Polygala vulgaris	1		
Molinia caerulea	4		
Sphagnum papillosum	3		
Sphagnum capillifolium	7		
Rhytidiadelphis loreus	5		
Cladonia portentosa	2		
Hypnum jutlandicum	4		

		Species Total	13

NVC Code	Site & Vegetation Description
M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community	Rush pasture with low patches of *Calluna* ~10cm tall. Moderate grazing; sward quite open with low hummocks of Sphagna

Photo of Quadrat 128

Quadrat no. 129	Date 14th July 2016	Estimated Slope (^{o}) 1
Quadrat size 2m x 2m	Grid Ref IC 7414324254	

Surveyor KH	Altitude (m asl) 319	Site Dunbeg South

Species	DOMIN	Species	DOMIN
Eriophorum vaginatum	5		
Narthecium ossifragum	5		
Erica tetralix	3		
Juncus acutiflorus	8		
Trichophorum germanicum	5		
Drosera rotundifolia	1		
Eriophorum angustifolium	3		
Molinia caerulea	2		
Juncus squarrosus	1		
Sphagnum capillifolium	6		
Sphagnum papillosum	6		

		Species Total	11

NVC Code	Site & Vegetation Description
M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community	Rush pasture with very wet ground; low carpets of Sphagna. In hollow. Sward quite open with scattered low *Calluna* plants in adjacent habitat

Photo of Quadrat 129

Quadrat no. 130	Date 14th July 2016	Estimated Slope (^{o}) 3
Quadrat size 2m x 2m	Grid Ref IC 7429324254	
Surveyor KH	Altitude (m asl) 320	Site Dunbeg South

Species	DOMIN	Species	DOMIN
Molinia caerulea	7		
Erica tetralix	4		
Polygala vulgaris	1		
Juncus squarrosus	2		
Calluna vulgaris	4		
Potentilla erecta	2		
Eriophorum angustifolium	5		
Carex echinata	2		
Carex panicea	1		
Drosera rotundifolia	2		
Trichophorum germanicum	4		
Cladonia portentosa	2		
Sphagnum papillosum	5		

Hypnum jutlandicum *Racomitrium languinosum* Bare peat	4 4 4		
		Species Total	15
NVC Code M25a *Molinia caerulea-Potentilla erecta* mire; *Erica tetralix* sub-community	Site & Vegetation Description *Molinia* grassland, very wet underfoot. *Calluna* low and scattered due to moderate grazing pressure. Sward qute open between *Molinia* tussocks		

Photo of Quadrat 130

Appendix 6.3 – NVC Quadrat Data & Photos (2017)

Note; that the NVC categories assigned to each individual quadrat (or plot) may not necessarily match the overall NVC map on Figure 6.2. This is due to the fact that plots are analysed together in groups of 5 or more plots when assigning categories (for statistical purposes) to larger blocks of habitat. Therefore, there is no contradiction between plots (2m x 2m) and groups (field scale), as the two are for differing purposes.

Quadrat no. 1	Date 4th July 2017	Estimated Slope (°) 0
Quadrat size 2m x 2m	Grid Ref IC 73470 25709	
Surveyor KH	Altitude (m asl) 169	Site Dunbeg South

Species	DOMIN	Species	DOMIN
Holcus lanatus	80		
Ranunculus repens	5		
Cirsium arvense	10		
Cynosurus cristatus	2		
Lolium perenne	5		
Urtica dioica	2		
Juncus effusus	3		
Bellis perennis	1		
Rumex acetosa	2		
Anthoxanthum odoratum	1		
Trifolium repens	1		
Festuca rubra	1		
		Species Total	12

NVC (Surveyor) code	Site & Vegetation Description
Festuca rubra/Holcus lanatus/ Anthoxanthum odoratum provisional grassland community (Rodwell et al. 2000)	Path-side mesotrophic grassland. Ungrazed & undisturbed. Sward patchy & species-rich

MAVIS Plot Result	'Goodness of Fit'
MG6b	52.96
MG6	52.31
MG6a	50.08

Quadrat no.	Date	Estimated Slope (^{o})
2	4th July 2017	3

Quadrat size	Grid Ref
2m x 2m	IC 73484 25702

Surveyor	Altitude (m asl)	Site
KH	174	Dunbeg South

Species	DOMIN	Species	DOMIN
Holcus lanatus	45		
Cynosurus cristatus	30		
Ranunculus flammula	10		
Cirsium palustre	5		
Festuca rubra	1		
Ranunculus repens	5		
Carex nigra	1		
Juncus effusus	10		
Galium palustre	1		
Juncus acutiflorus	2		
Anthoxanthum odoratum	1		
Carex ovalis	1		
Prunella vulgaris	1		
Cirsium dissectum	1		
Rhytidiadelphis squarrosus	45		
Pseudoscleropodium purum	10		
		Species Total	16

NVC Surveyor Code	Site & Vegetation Description
Festuca rubra/Holcus lanatus/Anthoxanthum odoratum provisional grassland community (Rodwell et al. 2000)	*Juncus effusus* pasture on gently sloping ground. Ungrazed, patchy sward

MAVIS Plot Result	'Goodness of Fit'
M23a	42.40
MG8c	41.46
M23	40.03

Quadrat no.	Date	Estimated Slope (^{o})
3	4th July 2017	4
Quadrat size	**Grid Ref**	
2m x 2m	IC 73501 25634	

Surveyor	Altitude (m asl)	Site
KH	181	Dunbeg South

Species	DOMIN	Species	DOMIN
Ranunculus repens	20		
Cynosurus cristatus	20		
Holcus lanatus	25		
Cirsium palustre	15		
Juncus acutiflorus	10		
Juncus effusus	5		
Cirsium dissectum	2		
Taraxacum officinale	2		
Luzula multiflora	1		
Carex pulicaris	1		
Leontodon autumnalis	2		
Trifolium repens	10		
Bellis perennis	1		
Rhytidiadelphis squarrosus	35		
Calliergonella cuspidatum	10		
		Species Total	15

NVC Surveyor Code	Site & Vegetation Description
Festuca rubra/Holcus lanatus/ Anthoxanthum odoratum provisional grassland community (Rodwell et al. 2000)	Grazed *Juncus effusus* pasture. Sward patchy, situated at edge of tightly grazed area. Mesotrophic grassland

MAVIS Plot Result	'Goodness of Fit'
MG8d	35.86
MG8	35.65
MG6a	33.40

Quadrat no. 4	Date 4th July 2017	Estimated Slope (^{o}) 3
Quadrat size 2m x 2m	Grid Ref IC 73515 25594	

Surveyor	Altitude (m asl)	Site
KH	186	Dunbeg South

Species	DOMIN	Species	DOMIN
Holcus lanatus	55		
Anthoxanthum odoratum	2		
Nardus stricta	15		
Ranunculus repens	5		
Cirsium palustre	2		
Cirsium dissectum	2		
Ranunculus flammula	2		
Trifolium repens	2		
Taraxacum officinale	2		
Cynosurus cristatus	10		
Leontodon autumnalis	1		
Prunella vulgaris	1		
Festuca rubra	2		
Luzula multiflora	1		
Juncus effusus	5		
Rhytidiadelphis squarrosus	40		
Pseudoscleropodium purum	3		
		Species Total	17

NVC Surveyor Code	Site & Vegetation Description
Festuca rubra/Holcus lanatus/Anthoxanthum odoratum provisional grassland community (Rodwell et al. 2000)	Grazed in patches with +/- open sward. Mesotrophic with occasional *Nardus stricta* in sward. Adjacent habitat is *Juncus effusus* pasture

Mavis Plot Result	'Goodness of Fit'
MG6d	40.23
MG8d	39.96
MG8	39.24

Quadrat no.	Date	Estimated Slope (^{o})
5	4th July 2017	3
Quadrat size: 2m x 2m	Grid Ref: IC 73525 25555	

Surveyor	Altitude (m asl)	Site
KH	187	Dunbeg South

Species	DOMIN	Species	DOMIN
Holcus lanatus	25	*Rhytidiadelphis squarrosus*	40
Ranunculus flammula	15	*Pseudoscleropodium purum*	10
Festuca ovina	3	*Calliergonella cuspidatum*	2
Anthoxanthum odoratum	2	*Hylocomium splendens*	5
Cynosurus cristatus	10		
Juncus conglomeratus	5		
Galium palustre	1		
Prunella vulgaris	2		
Trifolium repens	1		
Ranunculus repens	2		
Juncus acutiflorus	5		
Cirsium palustre	3		
Potentilla erecta	2		
Cirsium dissectum	1		
Ranunculus acris	1		
Cardamine pratense	1		
Carex echinata	1		
Taraxacum officinale	1		
Agrostis canina	1		
Agrostis capillaris	1		
		Species Total	24

NVC Surveyor Code

Festuca rubra/Holcus lanatus/Anthoxanthum odoratum provisional grassland community (Rodwell et al. 2000)

MAVIS Plot Results	'Goodness of Fit'
MG8c	43.19
M23a	42.35
MG6d	41.61

Site & Vegetation Description

Acid / mesotrophic grassland mosaic with wet element. Adjacent vegetation *Juncus effusus* pasture. Very low intensity grazing (or ungrazed). Sward tall but open

Quadrat no.	Date	Estimated Slope (°)
6	4th July 2017	5

Quadrat size	Grid Ref
2m x 2m	IC 73534 25502

Surveyor	Altitude (m asl)	Site
KH	189	Dunbeg South

Species	DOMIN	Species	DOMIN
Cynosurus cristatus	5	*Calliergonella cuspidatum*	10
Anthoxanthum odoratum	2	*Thuidium tamariscinum*	2
Holcus lanatus	30	*Rhytidiadelphis squarrosus*	45
Ranunculus flammula	5		
Ranunculus repens	2		
Juncus acutiflorus	20		
Trifolium repens	2		
Cirsium dissectum	1		
Juncus effusus	2		
Cirsium palustre	2		
Potentilla erecta	1		
Ranunculus acris	1		
Juncus conglomeratus	1		
Cardamine pratense	1		
Rumex acetosa	1		
Leontodon autumnalis	1		
Agrostis capillaris	1		
		Species Total	20

NVC Code

Festuca rubra/Holcus lanatus/Anthoxanthum odoratum provisional grassland community (Rodwell et al. 2000)

MAVIS Plot Results	'Goodness of Fit'
MG14b	46.05
MG8d	44.86
M23a	44.30

Site & Vegetation Description

Acid / mesotrophic grassland mosaic with wet element. Adjacent vegetation *Juncus effusus* pasture. Very low intensity grazing (or ungrazed). Sward tall but open

Quadrat no. 7	Date 4th July 2017	Estimated Slope (^{o}) 3
Quadrat size 2m x 2m	Grid Ref IC 73545 25451	

Surveyor KH	Altitude (m asl) 198	Site Dunbeg South

Species	DOMIN	Species	DOMIN
Juncus effusus	5		
Anthoxanthum odoratum	2		
Holcus lanatus	30		
Cynosurus cristatus	5		
Cirsium palustre	3		
Ranunculus acris	2		
Potentilla erecta	3		
Luzula multiflora	1		
Carex pulicaris	1		
Ranunculus flammula	2		
Juncus acutiflorus	40		
Leontodon autumnalis	1		
Trifolium repens	2		
Taraxacum officinale	2		
Deschampsia caespitosa	2		
Rhytidiadelphis squarrosus	55		
Pseudoscleropodium purum	15		
Plagiomnium undulatum	1		
		Species Total	18

NVC Code	Site & Vegetation Description
M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community	*Juncus acutiflorus* pasture with very low / no grazing pressure. Sward tall but open; acid grassland element within sward

MAVIS Plot Results	'Goodness of Fit'
M23a	38.64
MG5c	36.51
MG6b	35.92

Quadrat no.	Date	Estimated Slope (°)
8	4th July 2017	5

Quadrat size	Grid Ref
2m x 2m	IC 73422 25388

Surveyor	Altitude (m asl)	Site
KH	205	Dunbeg South

Species	DOMIN	Species	DOMIN
Holcus lanatus	60		
Cynosurus cristatus	3		
Juncus acutiflorus	20		
Anthoxanthum odoratum	2		
Trifolium repens	2		
Ranunculus repens	3		
Nardus stricta	5		
Potentilla erecta	1		
Ranunculus flammula	2		
Rumex acetosa	1		
Festuca ovina	1		
Luzula multiflora	1		
Rhytidiadelphis squarrosus	30		
		Species Total	13

NVC Code	Site & Vegetation Description
Festuca rubra/Holcus lanatus/ Anthoxanthum odoratum provisional grassland community (Rodwell et al. 2000)	Greater mesotrophic influence than in Q7. Patchy, low intensity grazing. Sward patchy & open

MAVIS Plot Results	'Goodness of Fit'
U4b	39.57
U4d	39.00
U20a	38.77

Quadrat no.	Date	Estimated Slope (^{o})
9	4th July 2017	5
Quadrat size: 2m x 2m	Grid Ref: IC 73363 25367	
Surveyor: KH	Altitude (m asl): 208	Site: Dunbeg South

Species	DOMIN	Species	DOMIN
Anthoxanthum odoratum	2	*Rhytidiadelphis squarrosus*	15
Ranunculus acris	5	*Thuidium tamariscinum*	10
Holcus lanatus	40	*Pseudoscleropodium purum*	5
Deschampsia caespitosa	2		
Cynosurus cristatus	3		
Ranunculus flammula	5		
Potentilla erecta	2		
Cardamine pratense	1		
Trifolium repens	2		
Cirsium dissectum	3		
Juncus acutiflorus	30		
Cirsium palustre	5		
Agrostis canina	1		
Carex nigra	1		
Luzula multiflora	1		
Carex viridula	1		
Carex echinata	1		
Juncus conglomeratus	1		
		Species Total	21

NVC Code	Site & Vegetation Description
Festuca rubra/Holcus lanatus/ Anthoxanthum odoratum provisional grassland community (Rodwell et al. 2000)	Very low intensity grazing in general area. Sward tall but open

MAVIS Plot Results	'Goodness of Fit'
MG8c	38.86
M26b	37.71
M23a	37.34

Quadrat no.	Date	Estimated Slope (^{o})
10	4th July 2017	5
Quadrat size: 2m x 2m	Grid Ref: IC 73306 25338	
Surveyor: KH	Altitude (m asl): 216	Site: Dunbeg South

Species	DOMIN	Species	DOMIN
Deschampsia caespitosa	20	*Rhytidiadelphis squarrosus*	40
Holcus lanatus	15	*Thuidium tamariscinum*	5
Potentilla erecta	2	*Pseudoscleropodium purum*	5
Luzula multiflora	1	*Plagiomnium undulatum*	1
Anthoxanthum odoratum	3		
Rumex acetosa	2		
Ranunculus acris	5		
Juncus acutiflorus	35		
Cynosurus cristatus	5		
Ranunculus repens	3		
Galium palustre	1		
Trifolium repens	2		
Festuca rubra	1		
Carex panicea	1		
Nardus stricta	2		
Carex viridula	1		
		Species Total	20

NVC Code

M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community

MAVIS Plot Results	'Goodness of Fit'
U4d	43.19
MG8	40.54
U4b	40.31

Site & Vegetation Description

Patchy sward with very low intensity grazing. Sward rather open with tussocks of *Deschampsia caespitosa* between *Holcus lanatus* and *Juncus acutiflorus*

Quadrat no. 11	Date 4th July 2017	Estimated Slope (^{o}) 3
Quadrat size 2m x 2m	Grid Ref IC 73233 25303	

Surveyor KH	Altitude (m asl) 218	Site Dunbeg South

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	80		
Deschampsia flexuosa	15		
Potentilla erecta	5		
Molinia caerulea	2		
Anthoxanthum odoratum	2		
Carex nigra	1		
Deschampsia caespitosa	5		
Galium saxatile	1		
Carex flacca	1		
Pseudoscleropodium purum	2		
Rhytidiadelphis squarrosus	15		
Hylocomium splendens	5		
Rhytidiadelphis loreus	2		
Polytrichum commune	3		
		Species Total	14

NVC Code	Site & Vegetation Description
M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community	In different 'field' than Q1 - Q12. Acid grassland / Juncus acutiflorus mosaic with tall and open sward. Ungrazed & relatively species-poor

MAVIS Plot Result	'Goodness of Fit'
U5a	44.26
U4d	42.81
U16b	41.76

Quadrat no. 12	Date 4th July 2017	Estimated Slope (^{o}) 2
Quadrat size 2m x 2m	Grid Ref IC 73203 25284	

Surveyor KH	Altitude (m asl) 221	Site Dunbeg South

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	65		
Anthoxanthum odoratum	2		
Potentilla erecta	5		
Deschampsia caespitosa	2		
Carex nigra	1		
Deschampsia flexuosa	5		
Galium saxatile	2		
Carex echinata	1		
Festuca ovina	2		
Polytrichum commune	25		
Sphagnum capillifolium	15		
Rhytidiadelphis loreus	35		
		Species Total	12

NVC Code	Site & Vegetation Description
M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community	Acid grassland / Juncus acutiflorus mosaic with tall but open sward; ungrazed. *Deschampsia flexuosa* less frequent than in Q15. *Sphagnum capillifolium* notable

MAVIS Plot Result	‘Goodness of Fit’
M6d	42.63
U4d	40.69
U5a	40.66

Quadrat no. 13	Date 4th July 2017	Estimated Slope (^{o}) 5
Quadrat size 2m x 2m	Grid Ref IC 73202 25259	

Surveyor KH	Altitude (m asl) 227	Site Dunbeg South

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	45		
Potentilla erecta	5		
Galium saxatile	3		
Anthoxanthum odoratum	2		
Deschampsia caespitosa	10		
Deschampsia flexuosa	5		
Juncus squarrosus	3		
Luzula multiflora	1		
Molinia caerulea	2		
Carex nigra	1		
Carex flacca	1		
Polytrichum commune	25		
Rhytidiadelphis loreus	30		
Sphagnum capillifolium	10		
Rhytidiadelphis squarrosus	15		
Hylocomium splendens	10		
		Species Total	16

NVC Code	Site & Vegetation Description
M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community	*Juncus acutiflorus* pasture with rich bryophyte layer. Sward very open with very low grazing pressure. *Deschampsia caespitosa* abundant in general area

MAVIS Plot Result	'Goodness of Fit'
U5b	46.54
U6d	45.71
U5a	45.28

Quadrat no.	Date	Estimated Slope (°)
14	4th July 2017	5

Quadrat size	Grid Ref
2m x 2m	IC 73182 25249

Surveyor	Altitude (m asl)	Site
KH	223	Dunbeg South

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	50		
Galium saxatile	10		
Deschampsia caespitosa	5		
Molinia caerulea	5		
Potentilla erecta	2		
Anthoxanthum odoratum	5		
Juncus squarrosus	10		
Festuca ovina	2		
Holcus lanatus	10		
Polytrichum commune	30		
Pseudoscleropodium purum	10		
Rhytidiadelphis squarrosus	20		
Pleurozium schreberi	5		
		Species Total	13

NVC Code	Site & Vegetation Description
M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community	*Juncus acutiflorus* pasture with much *Anthoxanthum odoratum* & *Deschampsia caespitosa* in wider area. Sward very open with very low grazing pressure. Mounds of bryophytes present

MAVIS Plot Result	'Goodness of fit'
U5a	47.90
U4e	46.68
U5d	46.48

Quadrat no.	Date	Estimated Slope (^{o})
15	4th July 2017	8
Quadrat size: 2m x 2m	Grid Ref: IC 73174 25264	

Surveyor	Altitude (m asl)	Site
KH	221	Dunbeg South

Species	DOMIN	Species	DOMIN
Anthoxanthum odoratum	2		
Deschampsia caespitosa	10		
Potentilla erecta	10		
Galium saxatile	2		
Carex echinata	10		
Carex panicea	1		
Molinia caerulea	5		
Luzula multiflora	1		
Carex flacca	1		
Nardus stricta	35		
Polytrichum commune	20		
Rhytidiadelphis squarrosus	35		
Pleurozium schreberi	15		
Thuidium tamariscinum	5		
Pseudoscleropodium purum	5		
		Species Total	15

NVC Code		Site & Vegetation Description
U5 *Nardus stricta-Galium saxatile* grassland		Acid grassland with lack of *Juncus* spp. Sward open and patchy with little / no grazing pressure
MAVIS PLOT Result	'Goodness of fit'	
U4d	49.91	
U5a	45.18	
U5b	45.05	

Quadrat no. 16	Date 4th July 2017	Estimated Slope (^{o}) 8
Quadrat size 2m x 2m	Grid Ref IC 73157 25253	
Surveyor KH	Altitude (m asl) 222	Site Dunbeg South

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	25		
Deschampsia caespitosa	10		
Anthoxanthum odoratum	1		
Potentilla erecta	1		
Holcus lanatus	45		
Molinia caerulea	15		
Deschampsia flexuosa	5		
Galium saxatile	1		
Agrostis capillaris	15		
Rhytidiadelphis squarrosus	25		
Thuidium tamariscinum	2		
		Species Total	11

NVC Code	Site & Vegetation Description
Festuca rubra/Holcus lanatus/ Anthoxanthum odoratum provisional grassland community (Rodwell et al. 2000)	Relatively dense, grassy sward. Mesotrophic Holcus *lanatus / Juncus acutiflorus* pasture. Poor bryophyte layer. Sward tall but patchy. Grazing pressure low

MAVIS Plot Result	'Goodness of fit'
U20a	46.73
U4d	44.65
U5a	43.82

Quadrat no.	Date	Estimated Slope (^{o})
17	4th July 2017	10
Quadrat size	Grid Ref	
2m x 2m	IC 73130 25254	

Surveyor	Altitude (m asl)	Site
KH	220	Dunbeg South

Species	DOMIN	Species	DOMIN
Deschampsia flexuosa	5		
Anthoxanthum odoratum	2		
Rumex acetosa	5		
Potentilla erecta	2		
Holcus lanatus	45		
Galium saxatile	2		
Cirsium dissectum	3		
Deschampsia caespitosa	15		
Festuca ovina	5		
Nardus stricta	15		
Cirsium palustre	2		
Thuidium tamariscinum	10		
Pleurozium schreberi	10		
Rhytidiadelphis squarrosus	45		
Pseudoscleropodium purum	5		
Hylocomium splendens	5		
		Species Total	16

NVC Code	Site & Vegetation Description
Festuca rubra/Holcus lanatus/ Anthoxanthum odoratum provisional grassland community (Rodwell et al. 2000)	Low intensity grazing pressure. Sward patchy but rather dense with grasses

MAVIS Plot Result	'Goodness of fit'
U5a	53.66
U4d	51.02
U20a	49.54

Quadrat no. 18		Date 4th July 2017		Estimated Slope (°) 3
Quadrat size 2m x 2m		Grid Ref IC 73554 25411		
Surveyor KH	Altitude (m asl) 202		Site Dunbeg South	

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	80		
Holcus lanatus	10		
Festuca ovina	1		
Ranunculus acris	3		
Ranunculus flammula	2		
Luzula multiflora	1		
Potentilla erecta	2		
Trifolium repens	1		
Agrostis canina	1		
Taraxacum officinale	1		
Prunella vulgaris	1		
Carex echinata	1		
Cynosurus cristatus	1		
Molinia caerulea	10		
Dactylorhiza fuchsii	1		
Leontodon autumnalis	1		
Rhytidiadelphis squarrosus	40		
Pleurozium schreberi	5		
		Species Total	18

NVC Code		Site & Vegetation Description
M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community		*Juncus acutiflorus* pasture. Sward patchy & open; grazing pressure very light
MAVIS Plot Result	'Goodness of fit'	
M6d M25b M23a	34.88 34.05 33.92	

Quadrat no.	Date	Estimated Slope (^{o})
19	4th July 2017	3

Quadrat size	Grid Ref
2m x 2m	IC 73567 25382

Surveyor	Altitude (m asl)	Site
KH	205	Dunbeg South

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	85		
Ranunculus flammula	3		
Holcus lanatus	10		
Cirsium dissectum	1		
Potentilla erecta	2		
Anthoxanthum odoratum	2		
Luzula multiflora	1		
Carex echinata	1		
Carex pulicaris	1		
Ranunculus acris	3		
Trifolium repens	1		
Epilobium palustre	1		
Cardamine pratense	1		
Rhytidiadelphis squarrosus	50		
Plagiomnium undulatum	1		
		Species Total	15

NVC Code	Site & Vegetation Description
M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community	*Juncus acutiflorus* pasture. Sward tall but open & lightly grazed

MAVIS Plot Results	'Goodness of fit'
M23a	36.43
M6d	34.07
M23	31.06

Quadrat no. 20	Date 4th July 2017		Estimated Slope (^{o}) 3
Quadrat size 2m x 2m	Grid Ref IC 73592 25384		
Surveyor KH	Altitude (m asl) 203	Site Dunbeg South	

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	90		
Luzula multiflora	1		
Cynosurus cristatus	1		
Potentilla erecta	1		
Anthoxanthum odoratum	1		
Molinia caerulea	2		
Carex echinata	3		
Carex panicea	1		
Carex flacca	1		
Holcus lanatus	5		
Rhytidiadelphis squarrosus	25		
Hylocomium splendens	10		
Pseudoscleropodium purum	5		
		Species Total	13

NVC Code	Site & Vegetation Description
M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community	*Juncus acutiflorus* more dominant in sward than in Q24. Sward also tall but open and lightly grazed

MAVIS Plot Results	'Goodness of fit'
M25b	45.84
M6d	42.52
M25	40.29

Quadrat no.	Date	Estimated Slope (°)
21	6th July 2017	5

Quadrat size	Grid Ref
2m x 2m	IC 23596 25356

Surveyor	Altitude (m asl)	Site
KH	209	Dunbeg South

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	85		
Ranunculus acris	5		
Potentilla erecta	1		
Holcus lanatus	10		
Juncus conglomeratus	3		
Cynosurus cristatus	2		
Taraxacum officinale	2		
Deschampsia flexuosa	1		
Carex panicea	1		
Anthoxanthum odoratum	1		
Juncus bulbosus	1		
Carex flacca	1		
Luzula multiflora	1		
Epilobium palustre	1		
Leontodon autumnalis	1		
Deschampsia caespitosa	1		
Rhytidiadelphis squarrosus	60		
Pseudoscleropodium purum	15		
		Species Total	18

NVC Code	Site & Vegetation Description
M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community	*Juncus acutiflorus* more dominant in sward than in Q24. Sward also tall but open and lightly grazed

MAVIS Plot Results	'Goodness of fit'
MG8a	34.62
M26b	34.37
U4d	34.17

Quadrat no.	Date	Estimated Slope (^{o})
22	6th July 2017	4
Quadrat size: 2m x 2m	Grid Ref: IC 73578 25355	

Surveyor	Altitude (m asl)	Site
KH	206	Dunbeg South

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	80		
Ranunculus acris	2		
Luzula multiflora	1		
Potentilla erecta	3		
Holcus lanatus	5		
Carex nigra	1		
Festuca rubra	1		
Leontodon autumnalis	1		
Ranunculus flammula	1		
Trifolium repens	1		
Carex echinata	2		
Anthoxanthum odoratum	1		
Rhytidiadelphis squarrosus	35		
Thuidium tamariscinum	15		
Pleurozium schreberi	10		
		Species Total	15

NVC Code		Site & Vegetation Description
M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community		Sward tall but open and lightly grazed
MAVIS Plot Resuls	'Goodness of fit'	
MC9e	42.02	
U4d	39.26	
U5c	39.06	

Quadrat no.	Date	Estimated Slope (^{o})
23	6th July 2017	5

Quadrat size	Grid Ref
2m x 2m	IC 73585 25334

Surveyor	Altitude (m asl)	Site
KH	209	Dunbeg South

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	75		
Juncus conglomeratus	2		
Ranunculus acris	5		
Potentilla erecta	2		
Epilobium palustre	1		
Holcus lanatus	10		
Juncus effusus	1		
Cardamine pratense	1		
Ranunculus flammula	2		
Calliergonella cuspidatum	25		
Pseudoscleropodium purum	5		
Thuidium tamariscinum	15		
Rhytidiadelphis squarrosus	20		
		Species Total	13

NVC Code	Site & Vegetation Description
M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community	Wetter underfoot than previous quadrats. Grazing pressure very low. Sward tall but open

MAVIS Plot Resuls	‘Goodness of fit’
M23a	40.71
M23	38.15
M23b	35.06

Quadrat no.		Date	Estimated Slope (°)
24		6th July 2017	4
Quadrat size 2m x 2m		Grid Ref IC 73570 25306	
Surveyor KH	Altitude (m asl) 216	Site Dunbeg South	

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	85		
Anthoxanthum odoratum	1		
Ranunculus acris	2		
Holcus lanatus	5		
Potentilla erecta	2		
Juncus conglomeratus	3		
Luzula multiflora	1		
Trifolium repens	1		
Carex nigra	1		
Agrostis canina	1		
Deschampsia caespitosa	2		
Rhytidiadelphis squarrosus	55		
Kindbergia praelonga	2		
Pseudoscleropodium purum	3		
		Species Total	14

NVC Code		Site & Vegetation Description
M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community		*Juncus acutiflorus* pasture in close proximity to drainage ditch. Sward tall but open with very low grazing pressure
MAVIS Plot Resuls	'Goodness of fit'	
U4d	38.05	
M25b	37.52	
M26b	36.49	

Quadrat no. 25	Date 6th July 2017	Estimated Slope (^{o}) 6
Quadrat size 2m x 2m	Grid Ref IC 73540 25270	

Surveyor KH	Altitude (m asl) 220	Site Dunbeg South

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	80		
Holcus lanatus	10		
Potentilla erecta	3		
Cynosurus cristatus	1		
Luzula multiflora	1		
Ranunculus acris	2		
Cirsium palustre	2		
Trifolium repens	2		
Agrostis canina	1		
Anthoxanthum odoratum	1		
Carex flacca	1		
Carex panicea	1		
Thuidium tamariscinum	15		
Rhytidiadelphis squarrosus	45		
Pseudoscleropodium purum	5		
Plagiomnium undulatum	1		
		Species Total	16

NVC Code		Site & Vegetation Description
M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community		Ungrazed or with very low intensity grazing. Sward tall but open
MAVIS Plot Results	'Goodness of fit'	
U5c	39.08	
M26b	38.30	
U4d	38.16	

Quadrat no.	Date	Estimated Slope (^{o})
26	6th July 2017	8

Quadrat size	Grid Ref
2m x 2m	IC 73510 25240

Surveyor	Altitude (m asl)	Site
KH	225	Dunbeg South

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	65		
Ranunculus flammula	2		
Luzula multiflora	1		
Holcus lanatus	10		
Ranunculus acris	3		
Cynosurus cristatus	1		
Juncus effusus	2		
Potentilla erecta	5		
Molinia caerulea	1		
Agrostis canina	1		
Trifolium repens	2		
Cirsium dissectum	2		
Cirsium palustre	2		
Anthoxanthum odoratum	1		
Carex panicea	1		
Rhytidiadelphis squarrosus	65		
Pseudoscleropodium purum	10		
Calliergonella cuspidatum	3		
Hylocomium splendens	5		
		Species Total	19

NVC Code	Site & Vegetation Description
M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community	Ungrazed or with very low intensity grazing. Sward tall but open

MAVIS Plot Results	'Goodness of fit'
M23a	45.76
M25b	44.25
MG8c	41.98

Quadrat no. 27	Date 6th July 2017	Estimated Slope (°) 11
Quadrat size 2m x 2m	Grid Ref IC 73484 25207	

Surveyor KH	Altitude (m asl) 233	Site Dunbeg South

Species	DOMIN	Species	DOMIN
Festuca ovina	2	*Rhytidiadelphis squarrosus*	75
Juncus acutiflorus	75	*Pseudoscleropodium purum*	5
Ranunculus acris	2	*Calliergonella cuspidatum*	5
Holcus lanatus	5		
Potentilla erecta	5		
Cynosurus cristatus	1		
Trifolium repens	2		
Taraxacum officinale	1		
Cirsium palustre	2		
Anthoxanthum odoratum	1		
Carex pulicaris	1		
Carex flacca	1		
Luzula multiflora	1		
Cirsium dissectum	1		
Leontodon autumnalis	1		
Cardamine pratense	1		
Epilobium palustre	1		
		Species Total	20

NVC Code

M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community

MAVIS Plot Results	'Goodness of fit'
U5c	37.17
MG5c	36.38
MG8	36.19

Site & Vegetation Description

Ungrazed or with very low intensity grazing. Sward tall but open

Quadrat no.	Date	Estimated Slope (^{o})
28	6th July 2017	9
Quadrat size 2m x 2m	Grid Ref IC 73486 25156	
Surveyor KH	Altitude (m asl) 239	Site Dunbeg South

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	60	*Pseudoscleropodium purum*	10
Juncus effusus	10	*Rhytidiadelphis squarrosus*	65
Deschampsia caespitosa	2	*Plagiomnium undulatum*	1
Ranunculus acris	3		
Potentilla erecta	5		
Holcus lanatus	2		
Anthoxanthum odoratum	1		
Carex echinata	3		
Nardus stricta	5		
Carex nigra	1		
Carex pulicaris	1		
Carex panicea	1		
Cirsium dissectum	2		
Juncus bulbosus	1		
Trifolium repens	1		
Cynosurus cristatus	1		
		Species Total	19

NVC Code		Site & Vegetation Description
M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community		Ungrazed or with very low intensity grazing. Sward tall but open
MAVIS Plot Results	'Goodness of fit'	
M26b	41.54	
U5c	36.92	
M26	36.42	

Quadrat no.	Date	Estimated Slope (°)
29	6th July 2017	9
Quadrat size: 2m x 2m	Grid Ref: IC 73501 25113	

Surveyor	Altitude (m asl)	Site
KH	247	Dunbeg South

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	75		
Holcus lanatus	10		
Festuca rubra	1		
Ranunculus acris	2		
Potentilla erecta	2		
Trifolium repens	1		
Luzula multiflora	1		
Agrostis canina	1		
Anthoxanthum odoratum	1		
Cirsium dissectum	1		
Cirsium palustre	2		
Carex panicea	1		
Carex echinata	1		
Rhytidiadelphis squarrosus	75		
Pseudoscleropodium purum	15		
Thuidium tamariscinum	5		
Calliergonella cuspidatum	3		
Kindbergia praelonga	1		
		Species Total	18

NVC Code	Site & Vegetation Description
M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community	Ungrazed or with very low intensity grazing. Sward tall but open

MAVIS Plot Results	'Goodness of fit'
M25b	41.85
M26b	41.57
U5c	41.25

Quadrat no.	Date	Estimated Slope (°)
30	6th July 2017	8
Quadrat size 2m x 2m	Grid Ref IC 73511 25066	

Surveyor	Altitude (m asl)	Site
KH	253	Dunbeg South

Species	DOMIN	Species	DOMIN
Carex flacca	1		
Juncus acutiflorus	90		
Potentilla erecta	5		
Carex pulicaris	1		
Holcus lanatus	10		
Molinia caerulea	1		
Carex echinata	1		
Anthoxanthum odoratum	1		
Trifolium repens	1		
Rhytidiadelphis squarrosus	70		
Calliergonella cuspidatum	10		
Plagiomnium undulatum	1		
Thuidium tamariscinum	5		
Hylocomium splendens	3		
		Species Total	14

NVC Code	Site & Vegetation Description
M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community	Ungrazed or with very low intensity grazing. Sward tall but open. Rather species-poor compared to previous quadrats. Sward also thicker and taller than Q30 - Q34

MAVIS Plot Results	'Goodness of fit'
M26b	40.83
M6d	39.00
M26	36.78

Quadrat no. 31	Date 6th July 2017	Estimated Slope (^{o}) 7
Quadrat size 2m x 2m	Grid Ref IC 73524 25017	

Surveyor KH	Altitude (m asl) 260	Site Dunbeg South

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	85		
Agrostis canina	1		
Ranunculus acris	2		
Deschampsia caespitosa	1		
Potentilla erecta	5		
Cardamine pratense	1		
Holcus lanatus	5		
Juncus conglomeratus	10		
Luzula multiflora	1		
Cirsium dissectum	1		
Trifolium repens	2		
Carex echinata	1		
Galium palustre	1		
Anthoxanthum odoratum	1		
Rhytidiadelphis squarrosus	65		
Plagiomnium undulatum	1		
Calliergonella cuspidatum	10		
Thuidium tamariscinum	10		
		Species Total	18

NVC Code	Site & Vegetation Description
M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community	Low grazing pressure. Sward tall but relatively open

MAVIS Plot Results	'Goodness of fit'
M23a	38.64
M24c	36.99
M26b	36.77

Quadrat no.	Date	Estimated Slope (^{o})
32	6th July 2017	5
Quadrat size: 2m x 2m	Grid Ref: IC 73535 24973	

Surveyor	Altitude (m asl)	Site
KH	270	Dunbeg South

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	65	*Thuidium tamariscinum*	10
Ranunculus acris	10	*Rhytidiadelphis squarrosus*	65
Potentilla erecta	3	*Kindbergia praelonga*	2
Leontodon autumnalis	2	*Calliergonella cuspidatum*	5
Agrostis canina	1	*Pseudoscleropodium purum*	5
Taraxacum officinale	1	*Hylocomium splendens*	2
Trifolium repens	1		
Cirsium dissectum	2		
Holcus lanatus	5		
Anthoxanthum odoratum	1		
Cirsium palustre	2		
Carex pulicaris	1		
Nardus stricta	5		
Carex echinata	2		
Luzula multiflora	1		
Carex panicea	1		
		Species Total	22

NVC Code

M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community

Site & Vegetation Description

Low grazing pressure. Sward shorter, more open and more species-rich than Q36

MAVIS Plot Results	'Goodness of fit'
U5c	46.87
U4d	39.56
M26b	38.49

Quadrat no. 33	Date 6th July 2017	Estimated Slope (^{o}) 7
Quadrat size 2m x 2m	Grid Ref IC 73546 24933	
Surveyor KH	Altitude (m asl) 274	Site Dunbeg South

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	80		
Ranunculus acris	10		
Potentilla erecta	10		
Holcus lanatus	3		
Anthoxanthum odoratum	2		
Agrostis canina	2		
Dactylorhiza fuchsii	1		
Cirsium dissectum	2		
Taraxacum officinale	2		
Leontodon autumnalis	5		
Carex flacca	1		
Epilobium palustre	1		
Cirsium palustre	2		
Carex pulicaris	1		
Deschampsia caespitosa	1		
Rhytidiadelphis squarrosus	45		
Pseudoscleropodium purum	15		
Calliergonella cuspidatum	25		
Thuidium tamariscinum	10		
		Species Total	19

NVC Code		Site & Vegetation Description
M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community		Low grazing pressure. Sward shorter, more open and rather species-rich
MAVIS Plot Results	‘Goodness of fit’	
M26b	36.83	
M26	34.90	
U5c	33.85	

Quadrat no. 34	Date 6th July 2017	Estimated Slope (^{o}) 9
Quadrat size 2m x 2m	Grid Ref IC 73556 24888	

Surveyor KH	Altitude (m asl) 277	Site Dunbeg South

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	85		
Holcus lanatus	2		
Ranunculus acris	2		
Ranunculus flammula	2		
Potentilla erecta	5		
Luzula multiflora	1		
Agrostis canina	1		
Carex echinata	2		
Anthoxanthum odoratum	1		
Carex pulicaris	1		
Trifolium repens	2		
Festuca ovina	2		
Molinia caerulea	5		
Calliergonella cuspidatum	20		
Rhytidiadelphis squarrosus	65		
Plagiomnium undulatum	1		
		Species Total	16

NVC Code

M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community

Site & Vegetation Description

Low grazing pressure. Sward tall but relatively open

MAVIS Plot Results	'Goodness of fit'
M6d	44.00
M25b	41.72
M26b	39.97

Quadrat no.	Date	Estimated Slope (°)
35	6th July 2017	6
Quadrat size	**Grid Ref**	
2m x 2m	IC 73527 24836	

Surveyor	Altitude (m asl)	Site
KH	281	Dunbeg South

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	65		
Potentilla erecta	15		
Anthoxanthum odoratum	3		
Luzula multiflora	1		
Viola palustris	5		
Holcus lanatus	3		
Cirsium dissectum	1		
Ranunculus acris	1		
Molinia caerulea	2		
Agrostis canina	2		
Carex echinata	2		
Carex panicea	5		
Cirsium palustre	2		
Thuidium tamariscinum	15		
Calliergonella cuspidatum	25		
Rhytidiadelphis squarrosus	35		
		Species Total	16

NVC Code	Site & Vegetation Description
M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community	Low grazing pressure. Sward tall but relatively open

MAVIS Plot Results	'Goodness of fit'
M6d	48.89
M25b	47.68
M23a	42.87

Quadrat no. 36	Date 6th July 2017	Estimated Slope (^{o}) 7
Quadrat size 2m x 2m	Grid Ref IC 73483 24830	

Surveyor KH	Altitude (m asl) 281	Site Dunbeg South

Species	DOMIN	Species	DOMIN
Calluna vulgaris	80		
Carex echinata	1		
Molinia caerulea	2		
Potentilla erecta	5		
Carex flacca	1		
Juncus squarrosus	5		
Juncus acutiflorus	2		
Carex nigra	1		
Deschampsia flexuosa	8		
Erica tetralix	2		
Sphagnum capillifolium	10		
Rhytidiadelphis squarrosus	20		
Rhytidiadelphis loreus	10		
Pseudoscleropodium purum	5		
Thuidium tamariscinum	25		
Pleurozium schreberi	5		
		Species Total	16

NVC Code M15 *Trichophorum caespitosum-Erica tetralix* wet heath	Site & Vegetation Description Wet heath vegetation on bank of small, north-to-south flowing stream. Ungrazed. *Calluna* to c.40cm tall with scattered tussocks of *Deschampsia flexuosa*

MAVIS Plot Results	'Goodness of fit'
M15d	43.72
M17c	41.35
M15	40.33

Quadrat no.		Date	Estimated Slope (°)
37		6th July 2017	6
Quadrat size		Grid Ref	
2m x 2m		IC 73450 24849	

Surveyor	Altitude (m asl)	Site
KH	276	Dunbeg South

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	85		
Deschampsia flexuosa	5		
Potentilla erecta	5		
Galium saxatile	2		
Molinia caerulea	3		
Anthoxanthum odoratum	1		
Holcus lanatus	1		
Polytrichum commune	10		
Sphagnum capillifolium	5		
Thuidium tamariscinum	10		
Sphagnum palustre	3		
Plagiomnium undulatum	1		
Hylocomium splendens	3		
Breutelia chrysocoma	2		
Rhytidiadelphis squarrosus	15		
Sphagnum fallax	2		
		Species Total	16

NVC Code		Site & Vegetation Description
M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community		Good bryophyte layer with bryos in mounds. Ungrazed. Noticeably wet underfoot
MAVIS Plot Result	‘Goodness of fit’	
M6d	46.61	
U5a	38.18	
U20a	36.29	

Quadrat no.		Date	Estimated Slope (°)	
38		6th July 2017	10	
Quadrat size		Grid Ref		
2m x 2m		IC 73436 24873		
Surveyor	Altitude (m asl)		Site	
KH	278		Dunbeg South	

Species	DOMIN	Species	DOMIN
Deschampsia flexuosa	3		
Calluna vulgaris	70		
Eriophorum vaginatum	10		
Molinia caerulea	2		
Rhytidiadelphis loreus	35		
Polytrichum commune	15		
Sphagnum capillifolium	2		
Rhytidiadelphis squarrosus	3		
Pleurozium schreberi	45		
Hylocomium splendens	2		
		Species Total	10

NVC Code		Site & Vegetation Description
M19 *Calluna vulgaris-Eriophorum vaginatum* blanket & raised mire		Wet heath with acid grassland element. *Calluna* to c.30cm tall. Mounds of *Eriophorum vaginatum* and bryophytes. Ungrazed
MAVIS Plot Result	'Goodness of fit'	
H22a M19a W18d	52.25 47.06 47.04	

Quadrat no.	Date	Estimated Slope (°)
39	6th July 2017	7

Quadrat size	Grid Ref
2m x 2m	IC 73445 24895

Surveyor	Altitude (m asl)	Site
KH	277	Dunbeg South

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	30		
Anthoxanthum odoratum	2		
Galium saxatile	3		
Potentilla erecta	10		
Calluna vulgaris	60		
Deschampsia flexuosa	10		
Molinia caerulea	2		
Sphagnum capillifolium	2		
Polytrichum commune	10		
Pseudoscleropodium purum	2		
Rhytidiadelphis squarrosus	5		
Rhytidiadelphis loreus	15		
Pleurozium schreberi	20		
Sphagnum fallax	5		
		Species Total	14

NVC Code	Site & Vegetation Description
M15 *Trichophorum caespitosum-Erica tetralix* wet heath	Mosaic of wet heath, acid grassland and *Juncus acutiflorus* pasture vegetation. *Calluna* to c.30cm height. Ungrazed. Ground bryophyte ground layer, in distinctive mounds

MAVIS Plot Result	'Goodness of fit'
U20b	47.30
U5d	44.80
U5a	44.54

Quadrat no. 40	Date 6th July 2017	Estimated Slope (^{o}) 9
Quadrat size 2m x 2m	Grid Ref IC 73422 24895	

Surveyor KH	Altitude (m asl) 275	Site Dunbeg South

Species	DOMIN	Species	DOMIN
Calluna vulgaris	70		
Deschampsia flexuosa	3		
Molinia caerulea	15		
Potentilla erecta	5		
Eriophorum vaginatum	20		
Galium saxatile	1		
Erica tetralix	1		
Juncus squarrosus	3		
Polytrichum commune	20		
Rhytidiadelphis loreus	25		
Hylocomium splendens	2		
Pseudoscleropodium purum	1		
Pleurozium schreberi	15		
Thuidium tamariscinum	10		
		Species Total	14

NVC Code	Site & Vegetation Description
M19 *Calluna vulgaris-Eriophorum vaginatum* blanket & raised mire	Wet heath with acid grassland element. Very low grazing pressure (some sheep dung in vicinity). *Calluna* to c.40cm height. Good bryophyte layer in distinctive mounds

MAVIS Plot Result	'Goodness of fit'
H22a	49.43
M15d	47.09
M19a	45.75

Quadrat no. 41	Date 6th July 2017	Estimated Slope (^{o}) 9
Quadrat size 2m x 2m	Grid Ref IC 73408 24918	

Surveyor KH	Altitude (m asl) 273	Site Dunbeg South

Species	DOMIN	Species	DOMIN
Calluna vulgaris	45		
Juncus acutiflorus	35		
Deschampsia flexuosa	3		
Anthoxanthum odoratum	1		
Galium saxatile	1		
Potentilla erecta	1		
Molinia caerulea	5		
Sphagnum capillifolium	10		
Polytrichum commune	20		
Sphagnum fallax	15		
Plagiomnium undulatum	1		
Rhytidiadelphis loreus	5		
		Species Total	12

NVC Code	Site & Vegetation Description
M15 *Trichophorum caespitosum-Erica tetralix* wet heath	Wet heath / *Juncus acutiflorus* pasture mosaic. Very low grazing pressure. *Calluna* to c.25cm tall

MAVIS Plot Result	'Goodness of fit'
H9d	40.86
H22a	40.60
M6d	39.52

Quadrat no. 42	Date 6th July 2017	Estimated Slope (^{o}) 10
Quadrat size 2m x 2m	Grid Ref IC 73390 24967	

Surveyor KH	Altitude (m asl) 265	Site Dunbeg South

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	55		
Calluna vulgaris	30		
Potentilla erecta	5		
Galium saxatile	2		
Molinia caerulea	3		
Deschampsia caespitosa	1		
Deschampsia flexuosa	3		
Carex nigra	1		
Polytrichum commune	15		
Rhytidiadelphis squarrosus	3		
Rhytidiadelphis loreus	35		
Hypnum jutlandicum	1		
Sphagnum fallax	20		
Pleurozium schreberi	10		
		Species Total	14

NVC Code		Site & Vegetation Description
M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community		Wet heath / *Juncus acutiflorus* pasture mosaic. Very low grazing pressure. *Calluna* to c.30cm tall. Relatively less *Calluna* and more *J. acutiflorus* than in Q47. Good bryophyte ground layer
MAVIS Plot Result	'Goodness of fit'	
H12a	44.67	
M15d	43.96	
M6d	42.72	

Quadrat no.	Date	Estimated Slope (°)
43	6th July 2017	10
Quadrat size 2m x 2m	Grid Ref IC 73383 24988	
Surveyor KH	Altitude (m asl) 265	Site Dunbeg South

Species	DOMIN	Species	DOMIN
Calluna vulgaris	30		
Juncus acutiflorus	40		
Deschampsia flexuosa	2		
Potentilla erecta	3		
Erica tetralix	1		
Molinia caerulea	5		
Carex echinata	1		
Sphagnum capillifolium	15		
Rhytidiadelphis loreus	55		
Thuidium tamariscinum	10		
Sphagnum fallax	2		
Hypnum jutlandicum	10		
Rhytidiadelphis squarrosus	1		
		Species Total	13

NVC Code		Site & Vegetation Description
M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community		*J. acutiflorus* / wet heath mosaic. *Calluna* to c.30cm tall. Grazing very light. Good mounded bryophyte layer
MAVIS Plot Results	'Goodness of fit'	
M6d	46.47	
M25a	44.60	
M15d	44.09	

Quadrat no.	Date	Estimated Slope (°)
44	7th July 2017	9

Quadrat size	Grid Ref
2m x 2m	IC 73567 24835

Surveyor	Altitude (m asl)	Site
KH	284	Dunbeg South

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	95		
Holcus lanatus	10		
Anthoxanthum odoratum	3		
Agrostis canina	3		
Potentilla erecta	2		
Rhytidiadelphis squarrosus	25		
Kindbergia praelonga	5		
		Species Total	7

NVC Code

M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community

Site & Vegetation Description

Very species-poor *J. acutiflorus* rush pasture. Grazing pressure very low. Sward tall & dense hence poorly developed bryophyte ground layer

MAVIS Plot Resuls	'Goodness of fit'
M6d	41.58
M25b	37.66
M25	34.67

Quadrat no. 45		Date 7th July 2017		Estimated Slope (°) 9
Quadrat size 2m x 2m		Grid Ref IC 73572 24799		
Surveyor KH	Altitude (m asl) 288		Site Dunbeg South	

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	80		
Potentilla erecta	10		
Holcus lanatus	5		
Viola palustris	2		
Ranunculus acris	2		
Anthoxanthum odoratum	1		
Luzula multiflora	1		
Cardamine pratense	1		
Cirsium dissectum	1		
Agrostis canina	1		
Rhytidiadelphis squarrosus	55		
Calliergonella cuspidatum	20		
Kindbergia praelonga	10		
		Species Total	13

NVC Code M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community	Site & Vegetation Description Sward less dense than Q53 with slightly more well developed bryophyte ground layer. Grazing pressure very low

MAVIS Plot Resuls	'Goodness of fit'
M6d	38.96
M23a	37.99
M25b	37.68

Quadrat no. 46	Date 7th July 2017	Estimated Slope (^{o}) 10
Quadrat size 2m x 2m	Grid Ref IC 73623 24746	
Surveyor KH	Altitude (m asl) 293	Site Dunbeg South

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	85		
Ranunculus acris	5		
Holcus lanatus	5		
Anthoxanthum odoratum	1		
Festuca rubra	1		
Potentilla erecta	3		
Leontodon autumnalis	2		
Taraxacum officinale	1		
Carex panicea	1		
Cirsium dissectum	1		
Epilobium palustre	1		
Rhytidiadelphis squarrosus	70		
Pseudoscleopodium purum	55		
Plagiomnium undulatum	1		
		Species Total	14

NVC Code	Site & Vegetation Description
M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community	Very lightly grazed. Sward tall, dense in parts with bryophyte mounds in more open parts of sward

MAVIS Plot Resuls	'Goodness of fit'
MC9e	37.49
MG8a	36.25
M26b	35.62

Quadrat no. 47	Date 7th July 2017	Estimated Slope (^{o}) 10
Quadrat size 2m x 2m	Grid Ref IC 73614 24722	
Surveyor KH	Altitude (m asl) 290	Site Dunbeg South

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	85		
Potentilla erecta	7		
Ranunculus flammula	2		
Taraxacum officinale	2		
Cirsium palustre	2		
Agrostis canina	2		
Nardus stricta	5		
Leontodon autumnalis	1		
Cardamine pratense	1		
Viola palustris	1		
Epilobium palustre	1		
Carex echinata	1		
Pseudoscleopodium purum	40		
Rhytidiadelphis squarrosus	70		
		Species Total	14

NVC Code		Site & Vegetation Description
M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community		Very lightly grazed. Sward more dense than in Q57 hence bryophytes present but in carpets rather than mounds
MAVIS Plot Resuls	'Goodness of fit'	
M6d	38.73	
M6b	35.64	
M6	35.63	

Quadrat no.	Date	Estimated Slope (^{o})
48	7th July 2017	10

Quadrat size	Grid Ref
2m x 2m	IC 73607 24696

Surveyor	Altitude (m asl)	Site
KH	295	Dunbeg South

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	80		
Ranunculus acris	2		
Anthoxanthum odoratum	1		
Holcus lanatus	20		
Cerastium fontanum	1		
Epilobium palustre	1		
Cirsium palustre	1		
Carex echinata	2		
Agrostis canina	3		
Cardamine pratense	1		
Rhytidiadelphis squarrosus	75		
Pseudoscleopodium purum	55		
Calliergonella cuspidatum	15		
		Species Total	13

NVC Code

M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community

Site & Vegetation Description

Very lightly grazed. Sward more dense than in Q57 hence bryophytes present but in carpets rather than mounds

MAVIS Plot Resuls	'Goodness of fit'
M23a	39.11
M23b	36.52
M23	36.44

Quadrat no.	Date	Estimated Slope (°)
49	7th July 2017	3

Quadrat size	Grid Ref
2m x 2m	IC 74034 24841

Surveyor	Altitude (m asl)	Site
KH	272	Dunbeg South

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	85		
Holcus lanatus	2		
Agrostis canina	1		
Potentilla erecta	2		
Cirsium palustre	1		
Anthoxanthum odoratum	1		
Ranunculus acris	5		
Taraxacum officinale	2		
Cirsium dissectum	1		
Trifolium repens	2		
Luzula multiflora	1		
Festuca rubra	1		
Carex echinata	2		
Molinia caerulea	1		
Galium palustre	1		
Carex panicea	3		
Carex viridula	2		
Rhytidiadelphis squarrosus	65		
Calliergonella cuspidatum	15		
		Species Total	19

NVC Code

M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community

MAVIS Plot Results	'Goodness of fit'
M23a	45.53
M25b	43.26
M6d	41.29

Site & Vegetation Description

Sward relatively short and open. Grazing pressure very light. Situated in a hollow between hills

Quadrat no.		Date	Estimated Slope (°)
50		7th July 2017	5
Quadrat size 2m x 2m		Grid Ref IC 74056 24852	
Surveyor KH	Altitude (m asl) 277	Site Dunbeg South	

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	45		
Calluna vulgaris	25		
Erica tetralix	1		
Potentilla erecta	10		
Deschampsia flexuosa	2		
Juncus squarrosus	2		
Galium saxatile	1		
Molinia caerulea	1		
Trichophorum germanicum	2		
Carex echinata	1		
Sphagnum capillifolium	3		
Polytrichum commune	2		
Sphagnum fallax	15		
Rhytidiadelphis squarrosus	10		
Rhytidiadelphis loreus	25		
Calliergonella cuspidatum	20		
Thuidium tamariscinum	2		
		Species Total	17

NVC Code		Site & Vegetation Description
M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community		Situated on hill to immediate NE of Q61 with heath vegetation & much less *Juncus acutiflorus.* Sward very short, open and patchy with good bryophyte layer. Grazing pressure very low. *Calluna* to c.10cm height. Adjacent habitat *Juncus acutiflorus* pasture with occasional *Calluna* in sward. Soil rather thin
MAVIS Plot Resuls	'Goodness of fit'	
M15d	47.14	
M15	44.96	
M6d	44.69	

Quadrat no. 51		Date 7th July 2017		Estimated Slope (^{o}) 6	
Quadrat size 2m x 2m		Grid Ref IC 74052 24878			
Surveyor KH	Altitude (m asl) 275		Site Dunbeg South		

Species	DOMIN	Species	DOMIN
Carex nigra	3		
Trichophorum germanicum	25		
Deschampsia flexuosa	2		
Potentilla erecta	5		
Molinia caerulea	10		
Calluna vulgaris	35		
Vaccinium myrtillus	1		
Erica cinerea	2		
Nardus stricta	3		
Festuca ovina	1		
Anthoxanthum odoratum	1		
Agrostis capillaris	1		
Luzula multiflora	1		
Carex flacca	1		
Hypnum jutlandicum	10		
Sphagnum capillifolium	10		
Rhytidiadelphis loreus	35		
Hylocomium splendens	20		
Rhytidiadelphis squarrosus	5		
		Species Total	19

NVC Code		Site & Vegetation Description
M15 *Trichophorum caespitosum-Erica tetralix* wet heath		Situated on edge of hill with steep, rocky slope to immediate W of quadrat. *Calluna* to c.10cm tall. Very light grazing pressure. Soil thin
MAVIS Plot Resuls	'Goodness of fit'	
M15d	50.94	
U5a	50.18	
U5	49.68	

Quadrat no.		Date	Estimated Slope (°)
52		7th July 2017	3
Quadrat size		Grid Ref	
2m x 2m		IC 74079 24866	

Surveyor	Altitude (m asl)	Site
KH	279	Dunbeg South

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	55	*Polytrichum commune*	2
Potentilla erecta	5	*Sphagnum palustre*	10
Calluna vulgaris	20	*Pseudoscleropodium purum*	3
Anthoxanthum odoratum	1	*Hylocomium splendens*	10
Deschampsia flexuosa	2	*Rhytidiadelphis loreus*	25
Polygala serpyllifolia	1	*Pleurozium schreberi*	15
Pedicularis palustris	2	*Rhytidiadelphis squarrosus*	3
Molinia caerulea	5	*Sphagnum fallax*	10
Carex panicea	1		
Deschampsia caespitosa	2		
Juncus conglomeratus	2		
Galium saxatile	1		
		Species Total	20

NVC Code		Site & Vegetation Description
M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community		Sward open & patchy. *Calluna* to c.10cm height. Grazing pressure very low
MAVIS Plot Results	'Goodness of fit'	
U5a	43.08	
U4e	41.53	
U4d	41.19	

Quadrat no.	Date	Estimated Slope (^{o})
53	7th July 2017	4
Quadrat size	Grid Ref	
2m x 2m	IC 74077 24884	

Surveyor	Altitude (m asl)	Site
KH	275	Dunbeg South

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	40	*Cladonia portentosa*	1
Calluna vulgaris	25	*Sphagnum palustre*	20
Erica tetralix	2	*Hylocomium splendens*	20
Potentilla erecta	5	*Sphagnum fallax*	10
Polygala serpyllifolia	1	*Rhytidiadelphis loreus*	15
Pedicularis sylvatica	3	*Rhytidiadelphis squarrosus*	5
Trichophorum germanicum	3	*Sphagnum capillifolium*	2
Molinia caerulea	15		
Carex panicea	2	Bare peat	5
Carex nigra	1		
Carex echinata	2		
		Species Total	18

NVC Code	Site & Vegetation Description
M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community	Sward open & patchy. *Calluna* to c.10cm height. Grazing pressure very low. Good bryophyte layer

MAVIS Plot Results	'Goodness of fit'
M15b	48.62
M15	48.11
M15a	47.22

Quadrat no.	Date	Estimated Slope (^{o})
54	7th July 2017	15
Quadrat size: 2m x 2m	Grid Ref: IC 74071 24906	

Surveyor	Altitude (m asl)	Site
KH	273	Dunbeg South

Species	DOMIN	Species	DOMIN
Trichophorum germanicum	15		
Carex echinata	5		
Potentilla erecta	3		
Blechnum spicant	1		
Erica cinerea	3		
Calluna vulgaris	25		
Molinia caerulea	3		
Carex panicea	2		
Juncus bulbosus	1		
Drosera rotundifolia	1		
Pedicularis sylvatica	1		
Racomitrium languinosum	3		
Rhytidiadelphis loreus	3		
Sphagnum fallax	2		
Campylopus flexuosa	1		
Sphagnum capillifolium	5		
Bare peat	30		
		Species Total	16

NVC Code

M15 *Trichophorum caespitosum-Erica tetralix* wet heath

Site & Vegetation Description

On edge of hill (as for Q63). Sward very short and open with some sheep poaching & adjacent bare peat / rocks. *Calluna* to c.10cm tall. Grazing pressure high

MAVIS Plot Resuls	'Goodness of fit'
M15c	46.45
M15	42.76
M15b	42.48

Quadrat no. 55	Date 7th July 2017	Estimated Slope (^{o}) 2
Quadrat size 2m x 2m	Grid Ref IC 74086 24934	

Surveyor KH	Altitude (m asl) 271	Site Dunbeg South

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	75		
Ranunculus acris	10		
Holcus lanatus	10		
Luzula multiflora	1		
Potentilla erecta	5		
Epilobium palustre	1		
Agrostis canina	2		
Cardamine pratense	1		
Cirsium palustre	1		
Carex echinata	1		
Cirsium dissectum	1		
Molinia caerulea	2		
Festuca rubra	1		
Rhytidiadelphis squarrosus	85		
Calliergonella cuspidatum	20		
		Species Total	15

NVC Code	Site & Vegetation Description
M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community	Situated at base of rocky hill. Sward tall but patchy with dense areas. Very low grazing pressure

MAVIS Plot Resuls	'Goodness of fit'
M25c	42.96
M23a	42.96
M25	40.94

Quadrat no.		Date	Estimated Slope (°)
56		7th July 2017	5
Quadrat size		Grid Ref	
2m x 2m		IC 74118 24970	
Surveyor	Altitude (m asl)	Site	
KH	277	Dunbeg South	

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	95		
Holcus lanatus	5		
Molinia caerulea	3		
Anthoxanthum odoratum	1		
Potentilla erecta	3		
Deschampsia caespitosa	1		
Cerastium fontanum	1		
Rhytidiadelphis squarrosus	35		
Pseudoscleopodium purum	40		
Calliergonella cuspidatum	10		
		Species Total	10

NVC Code		Site & Vegetation Description
M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community		Species-poor sward which is tall and relatively dense. Light grazing pressure.
MAVIS Plot Results	‘Goodness of fit’	
M25b	42.81	
M6d	39.14	
M25	38.50	

Quadrat no.	Date	Estimated Slope (^{o})
57	7th July 2017	6
Quadrat size 2m x 2m	Grid Ref IC 74098 25017	

Surveyor	Altitude (m asl)	Site
KH	273	Dunbeg South

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	10		
Potentilla erecta	10		
Deschampsia caespitosa	5		
Nardus stricta	2		
Luzula multiflora	1		
Carex echinata	10		
Carex nigra	2		
Carex flacca	5		
Anthoxanthum odoratum	1		
Calluna vulgaris	5		
Juncus squarrosus	20		
Molinia caerulea	30		
Rhytidiadelphis squarrosus	75		
Pleurozium schreberi	5		
Hylocomium splendens	15		
Thuidium tamariscinum	10		
		Species Total	16

NVC Code

M25 *Molinia caerulea-Potentilla erecta* mire

MAVIS Plot Result	'Goodness of fit'
U5c	45.33
U4d	43.55
U6d	43.42

Site & Vegetation Description

Moderately grazed sward on N-facing slope within adjacent habitat of *Juncus acutiflorus* pasture. Sward open & patchy

Quadrat no. 58	Date 7th July 2017	Estimated Slope (^{o}) 6
Quadrat size 2m x 2m	Grid Ref IC 74071 25061	
Surveyor KH	Altitude (m asl) 264	Site Dunbeg South

Species	DOMIN	Species	DOMIN
Nardus stricta	10	*Sphagnum capillifolium*	30
Juncus squarrosus	20	*Polytrichum commune*	2
Luzula multiflora	1	*Rhytidiadelphis loreus*	35
Potentilla erecta	5	*Rhytidiadelphis squarrosus*	10
Molinia caerulea	10	*Thuidium tamariscinum*	2
Carex echinata	5	*Hylocomium splendens*	5
Carex panicea	1		
Calluna vulgaris	35		
Polygala serpyllifolia	1		
Carex flacca	1		
Carex nigra	1		
Erica tetralix	1		
Carex pilulifera	1		
		Species Total	19

NVC Code		Site & Vegetation Description
M15 *Trichophorum caespitosum-Erica tetralix* wet heath		Situated on same N-facing slope as Q70. Sward short & open with good bryophyte layer. Developing wet heath vegetation - *Calluna* to c.15cm height
MAVIS Plot Result	'Goodness of fit'	
M15d M15 M15b	46.51 45.82 42.80	

Quadrat no.	Date	Estimated Slope (^{o})
59	7th July 2017	9
Quadrat size 2m x 2m	Grid Ref IC 74042 25114	

Surveyor	Altitude (m asl)	Site
KH	256	Dunbeg South

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	55	*Aulacomnium palustre*	5
Potentilla erecta	5	*Sphagnum palustre*	10
Anthoxanthum odoratum	2	*Rhytidiadelphis squarrosus*	45
Pedicularis sylvatica	2	*Pseudoscleopodium purum*	20
Festuca rubra	1	*Rhytidiadelphis loreus*	5
Molinia caerulea	15	*Thuidium tamariscinum*	5
Polygala serpyllifolia	1	*Hypnum jutlandicum*	10
Calluna vulgaris	5	*Hylocomium splendens*	10
Carex echinata	2	*Sphagnum capillifolium*	5
Juncus squarrosus	15		
		Bare peat	3
		Species Total	19

NVC Code

M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community

MAVIS Plot Result	'Goodness of fit'
M15	39.89
M6d	39.42
M15d	39.30

Site & Vegetation Description

Sward light to moderately grazed, open & patchy with well developed bryophyte layer

Quadrat no. 60	Date 7th July 2017	Estimated Slope (°) 6
Quadrat size 2m x 2m	Grid Ref IC 74026 75150	

Surveyor KH	Altitude (m asl) 254	Site Dunbeg South

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	85		
Potentilla erecta	10		
Agrostis canina	2		
Anthoxanthum odoratum	2		
Carex nigra	5		
Molinia caerulea	10		
Luzula multiflora	1		
Holcus lanatus	3		
Deschampsia caespitosa	1		
Rhytidiadelphis squarrosus	35		
Pseudoscleopodium purum	25		
Thuidium tamariscinum	5		
		Species Total	12

NVC Code	Site & Vegetation Description
M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community	Lightly grazed, tall, patchy sward

MAVIS Plot Result	'Goodness of fit'
M25b	45.74
M6d	44.33
U4d	41.72

Quadrat no. 61	Date 7th July 2017	Estimated Slope (°) 4
Quadrat size 2m x 2m	Grid Ref IC 74012 25177	
Surveyor KH	Altitude (m asl) 255	Site Dunbeg South

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	65		
Potentilla erecta	5		
Calluna vulgaris	20		
Nardus stricta	3		
Deschampsia caespitosa	1		
Molinia caerulea	10		
Polygala serpyllifolia	1		
Carex panicea	1		
Erica tetralix	1		
Galium saxatile	1		
Anthoxanthum odoratum	1		
Pedicularis sylvatica	1		
Thuidium tamariscinum	5		
Rhytidiadelphis loreus	30		
Sphagnum capillifolium	5		
Sphagnum fallax	2		
Hylocomium splendens	15		
		Species Total	17

NVC Code	Site & Vegetation Description
M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community	Sward moderately grazed, patchy & relatively open. *Calluna* to c.10cm tall

MAVIS Plot Result	'Goodness of fit'
M15c	44.53
M15	43.74
M15b	43.40

Quadrat no. 62	Date 7th July 2017		Estimated Slope (^{o}) 3
Quadrat size 2m x 2m	Grid Ref IC 73996 25212		
Surveyor KH	Altitude (m asl) 252	Site Dunbeg South	

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	10		
Potentilla erecta	10		
Anthoxanthum odoratum	2		
Juncus squarrosus	55		
Polygala serpyllifolia	1		
Pedicularis sylvatica	3		
Carex nigra	2		
Carex flacca	2		
Deschampsia caespitosa	1		
Molinia caerulea	20		
Luzula multiflora	1		
Nardus stricta	5		
Rhytidiadelphis loreus	10		
Hylocomium splendens	10		
Rhytidiadelphis squarrosus	5		
Thuidium tamariscinum	15		
Pseudoscleropodium purum	10		
Sphagnum fallax	3		
		Species Total	18

NVC Code

U6 *Juncus squarrosus-Festuca ovina* grassland

Site & Vegetation Description

Area of heavy grazing within *Juncus acutiflorus* pasture where grasses and *Juncus squarrosus* dominant. Sward patchy & open with good bryophyte layer

MAVIS Plot Result	'Goodness of fit'
U5c	43.80
U4d	42.31
U6d	38.42

Quadrat no.	Date	Estimated Slope (^{o})
63	7th July 2017	6
Quadrat size	**Grid Ref**	
2m x 2m	IC 73977 25234	

Surveyor	Altitude (m asl)	Site
KH	252	Dunbeg South

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	60		
Potentilla erecta	2		
Juncus squarrosus	10		
Deschampsia caespitosa	1		
Carex panicea	2		
Molinia caerulea	10		
Anthoxanthum odoratum	1		
Carex nigra	2		
Hylocomium splendens	25		
Hypnum jutlandicum	10		
Rhytidiadelphis squarrosus	35		
Pseudoscleropodium purum	5		
Rhytidiadelphis loreus	10		
Campylopus introflexus	1		
		Species Total	14

NVC Code

M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community

MAVIS Plot Result	'Goodness of fit'
M6d	41.14
U4d	36.86
U5c	36.09

Site & Vegetation Description

Moderately grazed sward with some light poaching. Sward open, patchy & rather short

Quadrat no. 64	Date 10th July 2017	Estimated Slope (^{o}) 2
Quadrat size 2m x 2m	Grid Ref IC 73949 25239	

Surveyor KH	Altitude (m asl) 246	Site Dunbeg South

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	70		
Potentilla erecta	3		
Carex echinata	2		
Deschampsia caespitosa	1		
Molinia caerulea	15		
Anthoxanthum odoratum	1		
Drosera rotundifolia	1		
Sphagnum capillifolium	2		
Sphagnum fallax	15		
Sphagnum palustre	5		
Aulacomnium palustre	1		
Rhytidiadelphis loreus	15		
Polytrichum commune	1		
Thuidium tamariscinum	10		
Rhytidiadelphis squarrosus	5		
Pseudoscleropodium purum	5		
		Species Total	12

NVC Code M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community		Site & Vegetation Description Moderately grazed with open sward and well developed bryophyte layer. Flushed area - noticeably wet underfoot
MAVIS Plot Results M6d M6 M6a	'Goodness of fit' 50.98 40.52 39.59	

Quadrat no.	Date	Estimated Slope (^{o})
65	10th July 2017	0
Quadrat size 2m x 2m	Grid Ref IC 73947 25258	

Surveyor	Altitude (m asl)	Site
KH	248	Dunbeg South

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	50		
Anthoxanthum odoratum	1		
Deschampsia caespitosa	1		
Molinia caerulea	30		
Potentilla erecta	5		
Juncus squarrosus	5		
Carex flacca	8		
Nardus stricta	10		
Rhytidiadelphis squarrosus	10		
Pseudoscleropodium purum	15		
Hypnum jutlandicum	20		
Hylocomium splendens	5		
Bare soil	5		
		Species Total	12

NVC Code

M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community

MAVIS Plot Results	'Goodness of fit'
M6d	39.22
U5a	39.16
U5c	37.29

Site & Vegetation Description

Moderate / heavy grazing pressure within *Juncus acutiflorus* pasture; some poaching also evident. Sward short & open with much thatch, indicating recent increase in grazing pressure; hence poorly developed bryophyte layer. Fresh sheep dunging evident nearby

Quadrat no.	Date	Estimated Slope (^{o})
66	10th July 2017	2

Quadrat size	Grid Ref
2m x 2m	IC 73919 25253

Surveyor	Altitude (m asl)	Site
KH	247	Dunbeg South

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	70		
Potentilla erecta	5		
Anthoxanthum odoratum	2		
Deschampsia caespitosa	1		
Eriophorum angustifolium	5		
Calluna vulgaris	15		
Juncus squarrosus	10		
Erica tetralix	1		
Drosera rotundifolia	1		
Molinia caerulea	2		
Sphagnum fallax	10		
Hylocomium splendens	15		
Polytrichum commune	1		
Rhytidiadelphis loreus	20		
Sphagnum capillifolium	5		
Sphagnum palustre	5		
Sphagnum cuspidatum	1		
		Species Total	17

NVC Code

M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community

MAVIS Plot Results	'Goodness of fit'
M21b	49.90
M21	47.59
M6d	46.09

Site & Vegetation Description

Damp hollow within *Juncus acutiflorus* pasture. Sward open, patchy & relatively short with well developed bryophyte layer. Wet heath vegetation developing. Moderate / heavy grazing pressure with abundance of *Juncus squarrosus* in sward. *Calluna* to c.10cm height. Flushed area hence presence of Sphagna

Quadrat no. 67	Date 10th July 2017	Estimated Slope (°) 2
Quadrat size 2m x 2m	Grid Ref IC 73942 25283	

Surveyor KH	Altitude (m asl) 246	Site Dunbeg South

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	10	*Hylocomium splendens*	10
Anthoxanthum odoratum	3	*Rhytidiadelphis squarrosus*	20
Holcus lanatus	15	*Hypnum jutlandicum*	30
Deschampsia caespitosa	1	*Thuidium tamariscinum*	5
Nardus stricta	50		
Potentilla erecta	3		
Ranunculus acris	5		
Carex flacca	3		
Carex pulicaris	1		
Carex panicea	15		
Cirsium dissectum	2		
Juncus bulbosus	1		
Galium saxatile	1		
Juncus effusus	2		
Danthonia decumbens	1		
Ranunculus flammula	1		
		Species Total	19

NVC Code	Site & Vegetation Description
U5 *Nardus stricta-Galium saxatile* grassland	Band of *Nardus stricta* grassland within adjacent *Juncus acutiflorus* pasture. Grazing pressure in general area moderate with occasional sheep dunging. Sward patchy & open; *Nardus* little-grazed with several discarded tussocks

MAVIS Plot Results	'Goodness of fit'
U5c	43.19
U4d	39.35
U5	36.87

Quadrat no. 68	Date 10th July 2017	Estimated Slope (^{o}) 8
Quadrat size 2m x 2m	Grid Ref IC 73938 25315	
Surveyor KH	Altitude (m asl) 241	Site Dunbeg South

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	60		
Anthoxanthum odoratum	1		
Trichophorum germanicum	8		
Potentilla erecta	10		
Juncus conglomeratus	2		
Deschampsia caespitosa	1		
Carex panicea	2		
Galium saxatile	1		
Holcus lanatus	15		
Pedicularis sylvatica	2		
Nardus stricta	3		
Hypnum jutlandicum	20		
Thuidium tamariscinum	20		
Rhytidiadelphis squarrosus	15		
Hylocomium splendens	10		
Rhytidiadelphis loreus	2		
Bare soil	5		
		Species Total	16

NVC Code	Site & Vegetation Description
M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community	Moderately grazed, relatively short & patchy sward with occasional poaching

MAVIS Plot Results	'Goodness of fit'
U4d	41.90
U5c	38.73
U5a	37.59

Quadrat no.	Date	Estimated Slope (°)
69	10th July 2017	5

Quadrat size	Grid Ref
2m x 2m	IC 74050 25168

Surveyor	Altitude (m asl)	Site
KH	246	Dunbeg South

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	75	*Rhytidiadelphis squarrosus*	50
Luzula multiflora	1	*Hylocomium splendens*	35
Ranunculus flammula	1	*Thuidium tamariscinum*	5
Potentilla erecta	5	*Pseudoscleropodium purum*	1
Ranunculus acris	10		
Anthoxanthum odoratum	1		
Trifolium repens	2		
Carex nigra	1		
Leontodon autumnalis	5		
Molinia caerulea	5		
Cynosurus cristatus	2		
Holcus lanatus	5		
Prunella vulgaris	2		
Juncus effusus	5		
Carex panicea	1		
		Species Total	18

NVC Code	Site & Vegetation Description
M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community	Lightly grazed, tall & patchy sward

MAVIS Plot Results	'Goodness of fit'
U5c	42.05
M26b	40.75
MG8c	40.16

Quadrat no. 70	Date 10th July 2017	Estimated Slope (^{o}) 2
Quadrat size 2m x 2m	Grid Ref IC 74088 25184	

Surveyor KH	Altitude (m asl) 249	Site Dunbeg South

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	90		
Molinia caerulea	15		
Carex nigra	1		
Deschampsia caespitosa	1		
Holcus lanatus	2		
Potentilla erecta	5		
Festuca rubra	1		
Epilobium palustre	1		
Plagiomnium undulatum	1		
Thuidium tamariscinum	10		
Hylocomium splendens	25		
Pseudoscleropodium purum	2		
Rhytidiadelphis squarrosus	5		
Calliergonella cuspidatum	35		
Rhizomnium punctatum	1		
		Species Total	15

NVC Code

M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community

Site & Vegetation Description

Lightly grazed sward, rather dense in parts with good bryophyte layer in areas of shorter sward

MAVIS Plot Results	'Goodness of fit'
M26b	41.67
M26	37.91
M25b	33.64

Quadrat no. 71	Date 10th July 2017	Estimated Slope (^{o}) 3
Quadrat size 2m x 2m	Grid Ref IC 74141 25195	
Surveyor KH	Altitude (m asl) 251	Site Dunbeg South

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	75		
Holcus lanatus	15		
Agrostis canina	2		
Luzula multiflora	1		
Potentilla erecta	5		
Anthoxanthum odoratum	1		
Molinia caerulea	5		
Deschampsia caespitosa	1		
Carex echinata	2		
Carex panicea	1		
Cynosurus cristatus	1		
Pseudoscleropodium purum	25		
Rhytidiadelphis squarrosus	40		
Calliergonella cuspidatum	5		
		Species Total	14

NVC Code	Site & Vegetation Description
M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community	Lightly grazed, rather open sward with poorly developed bryophyte layer

MAVIS Plot Results	'Goodness of fit'
M25b	48.25
M6d	46.80
M25	43.08

Quadrat no. 72	Date 10th July 2017		Estimated Slope (°) 5
Quadrat size 2m x 2m	Grid Ref IC 74198 25187		
Surveyor KH	Altitude (m asl) 254	Site Dunbeg South	
Species	DOMIN	Species	DOMIN
Juncus acutiflorus	90	*Thuidium tamariscinum*	25
Ranunculus acris	5	*Rhytidiadelphis squarrosus*	55
Holcus lanatus	2	*Plagiomnium undulatum*	2
Cynosurus cristatus	1	*Calliergonella cuspidatum*	5
Potentilla erecta	5		
Cirsium palustre	2		
Carex nigra	1		
Festuca ovina	1		
Anthoxanthum odoratum	1		
Juncus effusus	2		
Epilobium palustre	1		
Galium saxatile	1		
Agrostis canina	2		
Carex flacca	1		
Trifolium repens	1		
Rumex acetosa	1		
Taraxacum officinale	1		
Cirsium dissectum	1		
		Species Total	22

NVC Code

M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community

MAVIS Plot Results	'Goodness of fit'
M25b	48.25
M6d	46.80
M25	43.08

Site & Vegetation Description

Sward dense and very lightly grazed

Quadrat no.	Date	Estimated Slope (^{o})
73	10th July 2017	11
Quadrat size	Grid Ref	
2m x 2m	IC 74228 25154	

Surveyor	Altitude (m asl)	Site
KH	266	Dunbeg South

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	85		
Ranunculus acris	15		
Trifolium repens	5		
Holcus lanatus	2		
Cynosurus cristatus	1		
Rumex acetosa	2		
Galium palustre	1		
Cirsium palustre	1		
Lysimachia nemorum	3		
Stellaria graminea	1		
Epilobium palustre	1		
Cardamine pratense	1		
Filipendula ulmaria	2		
Agrostis canina	1		
Cirsium dissectum	1		
Taraxacum officinale	1		
Plagiomnium undulatum	2		
Calliergonella cuspidatum	25		
Rhytidiadelphis squarrosus	5		
		Species Total	19

NVC Code

M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community

MAVIS Plot Results	'Goodness of fit'
MG6d	42.78
M23a	39.98
M23	39.05

Site & Vegetation Description

Lightly grazed (or ungrazed) sward which is tall & dense. Bryophyte layer sparse

Quadrat no.	Date	Estimated Slope (^{o})
74	10th July 2017	15
Quadrat size 2m x 2m	Grid Ref IC 74243 25102	

Surveyor	Altitude (m asl)	Site
KH	252	Dunbeg South

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	75	*Plagiomnium undulatum*	1
Ranunculus acris	10	*Rhytidiadelphis squarrosus*	25
Potentilla erecta	10	*Calliergonella cuspidatum*	30
Anthoxanthum odoratum	1	*Thuidium tamariscinum*	10
Festuca ovina	1		
Holcus lanatus	2		
Juncus conglomeratus	2		
Cynosurus cristatus	3		
Leontodon autumnalis	5		
Cirsium dissectum	1		
Trifolium repens	2		
Galium verum	1		
Galium palustre	1		
Carex nigra	1		
Taraxacum officinale	1		
Lysimachia nemorum	2		
Nardus stricta	3		
Anemone nemorosa	1		
		Species Total	22

NVC Code

M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community

Site & Vegetation Description

Sward tall but open, lightly grazed & species-rich; shading has resulted in relatively poor bryophyte layer

MAVIS Plot Results	'Goodness of fit'
MG6d	42.78
M23a	39.98
M23	39.05

Quadrat no.	Date	Estimated Slope (°)
75	10th July 2017	7
Quadrat size 2m x 2m	Grid Ref IC 74279 25077	

Surveyor	Altitude (m asl)	Site
KH	276	Dunbeg South

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	30		
Juncus effusus	50		
Holcus lanatus	5		
Luzula multiflora	1		
Deschampsia flexuosa	2		
Potentilla erecta	15		
Anthoxanthum odoratum	3		
Agrostis canina	2		
Poa pratensis	1		
Rumex acetosa	3		
Carex nigra	1		
Deschampsia caespitosa	1		
Rhytidiadelphis squarrosus	70		
Pseudoscleropodium purum	5		
		Species Total	14

NVC Code	Site & Vegetation Description
M23b *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus effusus* sub-community	Sward lightly grazed, tall & relatively open. Quadrat on interface between stand of *Juncus effusus* within wider area of *Juncus acutiflorus* pasture

MAVIS Plot Results	'Goodness of fit'
U4d	41.40
M25b	40.94
M6d	37.18

Quadrat no.	Date	Estimated Slope (^{o})
76	10th July 2017	12
Quadrat size: 2m x 2m	Grid Ref: IC 74325 25081	

Surveyor	Altitude (m asl)	Site
KH	280	Dunbeg South

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	85		
Agrostis canina	5		
Potentilla erecta	15		
Rumex acetosa	5		
Holcus lanatus	3		
Luzula multiflora	1		
Juncus effusus	5		
Cirsium dissectum	1		
Sphagnum palustre	5		
Rhytidiadelphis squarrosus	35		
Pseudoscleropodium purum	10		
Thuidium tamariscinum	5		
		Species Total	12

NVC Code

M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community

Site & Vegetation Description

Sward tall, dense and species-poor. Grazing light or lacking. Poorly developed bryophyte layer owing to shading

MAVIS Plot Results	'Goodness of fit'
M6d	36.94
M25b	35.20
U4d	33.06

Quadrat no.	Date	Estimated Slope (^{o})
77	10th July 2017	7

Quadrat size	Grid Ref
2m x 2m	IC 74354 25089

Surveyor	Altitude (m asl)	Site
KH	284	Dunbeg South

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	90		
Holcus lanatus	3		
Ranunculus flammula	2		
Potentilla erecta	8		
Anthoxanthum odoratum	1		
Juncus effusus	5		
Carex nigra	1		
Molinia caerulea	3		
Leontodon autumnalis	2		
Epilobium palustre	1		
Rhytidiadelphis squarrosus	40		
		Species Total	11

NVC Code	Site & Vegetation Description
M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community	Sward lightly grazed, tall & patchy with poorly developed bryophyte ground layer owing to heavy shading

MAVIS Plot Results	'Goodness of fit'
M6d	43.82
M25c	42.40
M23a	42.21

Quadrat no.	Date	Estimated Slope (°)
78	10th July 2017	9
Quadrat size: 2m x 2m	Grid Ref: IC 74346 25070	

Surveyor	Altitude (m asl)	Site
KH	282	Dunbeg South

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	90		
Holcus lanatus	5		
Rumex acetosa	2		
Ranunculus acris	10		
Luzula multiflora	1		
Potentilla erecta	5		
Taraxacum officinale	5		
Juncus effusus	1		
Carex nigra	3		
Agrostis canina	1		
Anthoxanthum odoratum	3		
Molinia caerulea	3		
Trifolium repens	5		
Epilobium palustre	1		
Rhytidiadelphis squarrosus	40		
Pseudoscleropodium purum	15		
		Species Total	16

NVC Code	Site & Vegetation Description
M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community	Tall, patchy, dense sward with poor bryophyte layer. Grazing pressure very light or absent

MAVIS Plot Resuls	'Goodness of fit'
M25b	44.96
M23a	43.61
M6d	41.43

Quadrat no.	Date	Estimated Slope (°)
79	10th July 2017	8
Quadrat size	Grid Ref	
2m x 2m	IC 74344 25050	

Surveyor	Altitude (m asl)	Site
KH	283	Dunbeg South

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	80		
Potentilla erecta	15		
Cynosurus cristatus	1		
Rumex acetosa	1		
Ranunculus acris	3		
Juncus effusus	5		
Cirsium dissectum	2		
Cirsium palustre	3		
Deschampsia caespitosa	2		
Carex nigra	1		
Trifolium repens	3		
Holcus lanatus	5		
Epilobium palustre	1		
Rhytidiadelphis squarrosus	45		
		Species Total	14

NVC Code

M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community

MAVIS Plot Resuls	'Goodness of fot'
M23a	39.97
M23b	39.22
M23	37.50

Site & Vegetation Description

Sward rather tall but patchy and lightly grazed. Poorly developed bryophyte ground layer

Quadrat no. 80	Date 10th July 2017	Estimated Slope (^{o}) 5
Quadrat size 2m x 2m	Grid Ref IC 74327 25053	
Surveyor KH	Altitude (m asl) 281	Site Dunbeg South

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	80		
Potentilla erecta	10		
Holcus lanatus	3		
Anthoxanthum odoratum	1		
Trifolium repens	2		
Cirsium palustre	2		
Juncus conglomeratus	1		
Luzula multiflora	1		
Molinia caerulea	3		
Carex nigra	1		
Nardus stricta	2		
Taraxacum officinale	1		
Ranunculus flammula	3		
Galium palustre	1		
Epilobium palustre	1		
Rhytidiadelphis squarrosus	60		
Thuidium tamariscinum	5		
Pleurozium schreberi	5		
Hylocomium splendens	15		
		Species Total	19

NVC Code	Site & Vegetation Description
M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community	Sward tall, open & patchy. Grazing pressure light. Rather species-rich sward

MAVIS Plot Results	'Goodness of fit'
M23a	39.78
U5c	38.97
M25c	37.64

Quadrat no.	Date	Estimated Slope (^{o})
81	10th July 2017	7

Quadrat size	Grid Ref
2m x 2m	IC 74292 25023

Surveyor	Altitude (m asl)	Site
KH	279	Dunbeg South

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	90		
Potentilla erecta	10		
Holcus lanatus	3		
Pedicularis sylvatica	2		
Anthoxanthum odoratum	1		
Molinia caerulea	5		
Deschampsia caespitosa	1		
Luzula multiflora	2		
Juncus conglomeratus	1		
Agrostis canina	1		
Rhytidiadelphis squarrosus	25		
Thuidium tamariscinum	5		
Pseudoscleropodium purum	2		
		Species Total	13

NVC Code

M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community

Site & Vegetation Description

Sward tall but open & patchy. Poorly developed bryophyte layer. Grazing pressure light

MAVIS Plot Results	'Goodness of fit'
M25b	42.78
U4d	39.43
M6d	39.25

Quadrat no. 82		Date 10th July 2017		Estimated Slope (^{o}) 7	
Quadrat size 2m x 2m		Grid Ref IC 74275 24978			
Surveyor KH	Altitude (m asl) 277		Site Dunbeg South		

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	60		
Anthoxanthum odoratum	5		
Molinia caerulea	15		
Luzula multiflora	1		
Holcus lanatus	10		
Potentilla erecta	5		
Nardus stricta	2		
Agrostis canina	2		
Deschampsia caespitosa	5		
Juncus squarrosus	5		
Rhytidiadelphis squarrosus	40		
Pseudoscleropodium purum	10		
		Species Total	12

NVC Code	Site & Vegetation Description
M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community	Heavily grazed, very patchy sward in close proximity to track and field gate. Tussocks of *Nardus stricta* distinctive around margin of *Juncus* pasture in this area

MAVIS Plot Results	'Goodness of fit'
M25b	45.74
M6d	43.66
U4d	43.23

Quadrat no.		Date		Estimated Slope (°)
83		24th July 2017		12
Quadrat size		Grid Ref		
2m x 2m		IC 74393 25185		
Surveyor	Altitude (m asl)		Site	
KH	287		Dunbeg South	

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	90		
Ranunculus acris	5		
Holcus lanatus	2		
Potentilla erecta	15		
Molinia caerulea	5		
Trifolium repens	3		
Viola palustris	1		
Cirsium palustre	3		
Anthoxanthum odoratum	1		
Cynosurus cristatus	1		
Luzula multiflora	1		
Cirsium dissectum	3		
Pseudoscleropodium purum	10		
Rhytidiadelphis squarrosus	60		
Thuidium tamariscinum	5		
		Species Total	15

NVC Code		Site & Vegetation Description
M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community		Sward open & patchy with light grazing pressure; much thatch in ground layer indicating light grazing in recent years
MAVIS Plot Resuls	'Goodness of fit'	
M25b	42.58	
M24c	37.92	
M23a	37.69	

Quadrat no. 84	Date 24th July 2017	Estimated Slope (^{o}) 8
Quadrat size 2m x 2m	Grid Ref IC 74422 25236	

Surveyor KH	Altitude (m asl) 285	Site Dunbeg South

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	90		
Holcus lanatus	5		
Luzula multiflora	1		
Ranunculus flammula	2		
Molinia caerulea	3		
Potentilla erecta	3		
Ranunculus acris	5		
Anthoxanthum odoratum	1		
Taraxacum officinale	2		
Cerastium fontanum	1		
Cirsium palustre	3		
Leontodon autumnalis	1		
Carex nigra	1		
Carex flacca	1		
Rhytidiadelphis squarrosus	55		
		Species Total	15

NVC Code

M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community

MAVIS Plot Results	'Goodness of fit'
M25b	40.39
M23a	39.98
M6d	37.29

Site & Vegetation Description

Tall, dense, ungrazed sward with poorly developed bryophyte layer. Abundant *Juncus acutiflorus* thatch in ground layer indicating light grazing pressure in recent years

Quadrat no. 85	Date 24th July 2017	Estimated Slope (^{o}) 10
Quadrat size 2m x 2m	Grid Ref IC 74451 25287	
Surveyor KH	Altitude (m asl) 287	Site Dunbeg South

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	85		
Holcus lanatus	5		
Anthoxanthum odoratum	1		
Potentilla erecta	10		
Deschampsia caespitosa	2		
Ranunculus acris	5		
Cirsium palustre	2		
Juncus effusus	2		
Molinia caerulea	2		
Cirsium dissectum	1		
Luzula multiflora	1		
Potentilla erecta	5		
Rhytidiadelphis squarrosus	40		
Pseudoscleropodium purum	3		
		Species Total	14

NVC Code		Site & Vegetation Description
M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community		Sward tall, dense & lightly grazed
MAVIS Plot Results	'Goodness of fit'	
M25b	47.04	
M25c	42.21	
M23a	41.81	

Quadrat no.	Date	Estimated Slope (^{o})
86	24th July 2017	8
Quadrat size	Grid Ref	
2m x 2m	IC 74481 25334	

Surveyor	Altitude (m asl)	Site
KH	283	Dunbeg South

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	80		
Molinia caerulea	10		
Potentilla erecta	5		
Luzula multiflora	1		
Anthoxanthum odoratum	1		
Ranunculus acris	10		
Cirsium palustre	3		
Leontodon autumnalis	2		
Juncus effusus	5		
Rhytidiadelphis squarrosus	70		
		Species Total	10

NVC Code

M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community

MAVIS Plot Results	'Goodness of fit'
M25b	41.48
M6d	41.06
M25c	39.10

Site & Vegetation Description

Sward shorter & morepatchy than in Q101. Lightly grazed & species-poor

Quadrat no. 87		Date 24th July 2017		Estimated Slope (°) 9
Quadrat size 2m x 2m		Grid Ref IC 74493 25371		
Surveyor KH	Altitude (m asl) 282		Site Dunbeg South	

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	85		
Potentilla erecta	5		
Deschampsia caespitosa	5		
Holcus lanatus	2		
Molinia caerulea	10		
Anthoxanthum odoratum	1		
Cirsium palustre	3		
Juncus effusus	3		
Taraxacum officinale	1		
Cerastium fontanum	1		
Ranunculus repens	3		
Ranunculus acris	10		
Cirsium dissectum	1		
Rhytidiadelphis squarrosus	45		
Thuidium tamariscinum	25		
Pseudoscleropodium purum	10		
Pleurozium schreberi	5		
Plagiomnium undulatum	1		
		Species Total	18

NVC Code		Site & Vegetation Description
M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community		Sward tall, dense & lightly grazed
MAVIS Plot Results	'Goodness of fit'	
M23a	40.19	
M25b	38.21	
M26b	36.70	

Quadrat no. 88	Date 24th July 2017	Estimated Slope (°) 9
Quadrat size 2m x 2m	Grid Ref IC 74523 25394	
Surveyor KH	Altitude (m asl)	Site Dunbeg South

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	75		
Holcus lanatus	3		
Ranunculus acris	10		
Ranunculus repens	10		
Anthoxanthum odoratum	1		
Cynosurus cristatus	1		
Agrostis canina	1		
Deschampsia caespitosa	2		
Luzula multiflora	1		
Cirsium dissectum	1		
Cirsium palustre	5		
Leontodon autumnalis	1		
Potentilla erecta	10		
Rhytidiadelphis squarrosus	55		
Pseudoscleropodium purum	10		
Thuidium tamariscinum	15		
		Species Total	16

NVC Code	Site & Vegetation Description
M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community	Sward patchy, open and shorter than Q104. Grazing pressure light

MAVIS Plot Results	'Goodness of fit'
U4d	39.28
U5c	36.67
M25b	35.42

Quadrat no.	Date	Estimated Slope (°)
89	24th July 2017	9

Quadrat size	Grid Ref
2m x 2m	IC 74543 25414

Surveyor	Altitude (m asl)	Site
KH	288	Dunbeg South

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	85		
Ranunculus acris	10		
Ranunculus repens	5		
Luzula multiflora	1		
Leontodon autumnalis	2		
Molinia caerulea	3		
Anthoxanthum odoratum	1		
Epilobium palustre	1		
Cynosurus cristatus	1		
Pedicularis sylvatica	1		
Cirsium dissectum	2		
Taraxacum officinale	2		
Lysimachia nemorum	3		
Potentilla erecta	3		
Rhytidiadelphis squarrosus	70		
		Species Total	15

NVC Code	Site & Vegetation Description
M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community	Sward tall, dense & ungrazed

MAVIS Plot Results	'Goodness of fit'
M6d	31.75
M23a	31.41
MG8d	29.85

Quadrat no.		Date	Estimated Slope (°)
90		24th July 2017	7
Quadrat size		Grid Ref	
2m x 2m		IC 74534 25484	
Surveyor	Altitude (m asl)	Site	
KH	268	Dunbeg South	

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	85		
Holcus lanatus	10		
Molinia caerulea	3		
Viola palustris	1		
Epilobium palustre	1		
Leontodon autumnalis	1		
Cirsium palustre	3		
Ranunculus repens	5		
Ranunculus acris	5		
Carex panicea	1		
Anthoxanthum odoratum	1		
Potentilla erecta	5		
Rhytidiadelphis squarrosus	70		
Pseudoscleropodium purum	5		
		Species Total	14

NVC Code		Site & Vegetation Description
M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community		Sward tall, dense & ungrazed
MAVIS Plot Results	'Goodness of fit'	
M25b	44.15	
M23a	43.56	
M6d	42.12	

Quadrat no. 91	Date 24th July 2017	Estimated Slope (^{o}) 7
Quadrat size 2m x 2m	Grid Ref IC 74482 25565	

Surveyor KH	Altitude (m asl) 257	Site Dunbeg South

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	90		
Lysimachia nemorum	3		
Ranunculus repens	8		
Epilobium palustre	2		
Holcus lanatus	5		
Ranunculus flammula	15		
Cynosurus cristatus	1		
Trifolium repens	3		
Leontodon autumnalis	1		
Cirsium palustre	2		
Anthoxanthum odoratum	2		
Rhytidiadelphis squarrosus	55		
Thuidium tamariscinum	10		
Hylocomium splendens	5		
		Species Total	14

NVC Code	Site & Vegetation Description
M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community	Sward tall, dense, noticeably wet underfoot. Ungrazed

MAVIS Plot Results	'Goodness of fit'
MG6b	32.77
MG8d	32.75
M23a	32.62

Quadrat no.	Date	Estimated Slope (^{o})
92	24th July 2017	6
Quadrat size: 2m x 2m	Grid Ref: IC 74457 25601	
Surveyor: KH	Altitude (m asl): 246	Site: Dunbeg South

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	75		
Potentilla erecta	10		
Ranunculus flammula	15		
Epilobium palustre	2		
Holcus lanatus	8		
Anthoxanthum odoratum	1		
Molinia caerulea	10		
Cynosurus cristatus	1		
Luzula multiflora	1		
Cirsium dissectum	1		
Carex echinata	2		
Juncus bulbosus	1		
Carex panicea	1		
Pedicularis sylvatica	1		
Rhytidiadelphis squarrosus	65		
Calliergonella cuspidatum	15		
Thuidium tamariscinum	15		
		Species Total	17

NVC Code	Site & Vegetation Description
M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community	Sward tall but open; grazing pressure very light / absent. Much thatch in ground layer indicating light grazing pressure in past years. Wet underfoot

MAVIS Plot Results	'Goodness of fit'
M6d	41.12
M25b	38.21
M23a	37.62

Quadrat no. 93	Date 24th July 2017	Estimated Slope (^{o}) 4
Quadrat size 2m x 2m	Grid Ref IC 74401 25664	
Surveyor KH	Altitude (m asl) 244	Site Dunbeg South

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	75		
Holcus lanatus	10		
Potentilla erecta	5		
Pedicularis sylvatica	3		
Deschampsia caespitosa	2		
Nardus stricta	5		
Anthoxanthum odoratum	3		
Cirsium palustre	2		
Taraxacum officinale	3		
Leontodon autumnalis	2		
Rhytidiadelphis squarrosus	80		
Pseudoscleropodium purum	3		
		Species Total	12

NVC Code	Site & Vegetation Description
M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community	Sward tall but open; grazing pressure very light / absent. Much thatch in ground layer indicating light grazing pressure in past years

MAVIS Plot Results	'Goodness of fit'
M25b	34.70
U5c	32.50
U5d	32.48

Quadrat no.	Date	Estimated Slope (°)
94	24th July 2017	5
Quadrat size: 2m x 2m	Grid Ref: IC 74360 25675	

Surveyor	Altitude (m asl)	Site
KH	240	Dunbeg South

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	70		
Potentilla erecta	25		
Holcus lanatus	5		
Luzula multiflora	1		
Juncus conglomeratus	1		
Molinia caerulea	8		
Cirsium palustre	5		
Cirsium dissectum	2		
Taraxacum officinale	1		
Epilobium palustre	1		
Anthoxanthum odoratum	1		
Rhytidiadelphis squarrosus	60		
Thuidium tamariscinum	10		
Pseudoscleropodium purum	3		
Pleurozium schreberi	5		
		Species Total	15

NVC Code

M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community

MAVIS Plot Results	'Goodness of fit'
M25b	39.74
M25c	36.28
M24c	35.93

Site & Vegetation Description

Sward tall but open; grazing pressure very light / absent.

Quadrat no.	Date	Estimated Slope (^{o})
95	24th July 2017	8

Quadrat size	Grid Ref
2m x 2m	IC 74344 25659

Surveyor	Altitude (m asl)	Site
KH	241	Dunbeg South

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	80		
Cirsium dissectum	3		
Deschampsia caespitosa	1		
Holcus lanatus	10		
Trifolium repens	10		
Ranunculus acris	5		
Molinia caerulea	3		
Ranunculus flammula	5		
Taraxacum officinale	1		
Carex pulicaris	1		
Cirsium palustre	2		
Potentilla erecta	5		
Calliergonella cuspidatum	5		
Rhytidiadelphis squarrosus	60		
Thuidium tamariscinum	10		
		Species Total	15

NVC Code

M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community

MAVIS Plot Results	'Goodness of fit'
M23a	37.69
M26b	37.41
M24c	36.76

Site & Vegetation Description

Sward tall, patchy & dense with poor bryophyte layer. Grazing pressure very low / absent

Quadrat no. 96	Date 24th July 2017	Estimated Slope (^{o}) 8
Quadrat size 2m x 2m	Grid Ref IC 74320 25688	

Surveyor KH	Altitude (m asl) 114	Site Dunbeg South

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	70		
Potentilla erecta	10		
Molinia caerulea	8		
Luzula multiflora	1		
Agrostis canina	1		
Trifolium repens	5		
Cirsium palustre	10		
Deschampsia caespitosa	2		
Pedicularis sylvatica	2		
Viola palustris	1		
Galium palustre	1		
Carex flacca	1		
Cirsium dissectum	2		
Holcus lanatus	10		
Ranunculus acris	3		
Anthoxanthum odoratum	2		
Calliergonella cuspidatum	15		
Rhytidiadelphis squarrosus	50		
		Species Total	18

NVC Code	Site & Vegetation Description
M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community	Grazing pressure light. Sward open & patchy

MAVIS Plot Results	'Goodness of fit'
M23a	43.63
M25b	41.61
M24c	41.61

Quadrat no.	Date	Estimated Slope (^{o})
97	24th July 2017	5

Quadrat size	Grid Ref
2m x 2m	IC 74284 25677

Surveyor	Altitude (m asl)	Site
KH	228	Dunbeg South

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	65		
Potentilla erecta	20		
Juncus conglomeratus	2		
Holcus lanatus	15		
Molinia caerulea	5		
Agrostis canina	2		
Trifolium repens	5		
Luzula multiflora	1		
Anthoxanthum odoratum	2		
Cirsium palustre	3		
Deschampsia caespitosa	1		
Rhytidiadelphis squarrosus	60		
		Species Total	12

NVC Code	Site & Vegetation Description
M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community	Light grazing pressure. Sward open & patchy

MAVIS Plot Results	'Goodness of fit'
M25b	44.48
M6d	42.30
M25c	42.30

Quadrat no.	Date	Estimated Slope (°)
98	24th July 2017	5

Quadrat size	Grid Ref
2m x 2m	IC 74255 25662

Surveyor	Altitude (m asl)	Site
KH	233	Dunbeg South

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	70		
Euphrasia sp.	3		
Pedicularis sylvatica	5		
Molinia caerulea	20		
Carex pulicaris	1		
Carex panicea	1		
Linum catharticum	1		
Carex viridula	1		
Ranunculus flammula	5		
Carex flacca	1		
Cirsium palustre	10		
Cirsium dissectum	2		
Taraxacum officinale	2		
Pseudoscleropodium purum	25		
Rhytidiadelphis squarrosus	60		
		Species Total	15

NVC Code	Site & Vegetation Description
M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community	Sward short & open with moderate grazing pressure

MAVIS Plot Results	'Goodness of fit'
M24c	26.95
M24	26.10
CG9c	25.87

Quadrat no.	Date	Estimated Slope (^{o})
99	24th July 2017	6

Quadrat size	Grid Ref
2m x 2m	IC 74254 25693

Surveyor	Altitude (m asl)	Site
KH	231	Dunbeg South

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	85		
Trifolium repens	5		
Ranunculus flammula	5		
Potentilla erecta	10		
Pedicularis sylvatica	2		
Carex pulicaris	1		
Leontodon autumnalis	2		
Holcus lanatus	10		
Molinia caerulea	3		
Rhytidiadelphis squarrosus	50		
Pseudoscleropodium purum	20		
Calliergonella cuspidatum	15		
		Species Total	12

NVC Code	Site & Vegetation Description
M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community	Sward tall but more patchy than Q119. Grazing pressure light to moderate

MAVIS Plot Results	'Goodness of fit'
M6d	33.59
M25b	33.12
M25	31.91

Quadrat no. 100	Date 24th July 2017	Estimated Slope (°) 5
Quadrat size 2m x 2m	Grid Ref IC 74233 25679	

Surveyor KH	Altitude (m asl) 229	Site Dunbeg South

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	75		
Molinia caerulea	10		
Holcus lanatus	10		
Potentilla erecta	10		
Anthoxanthum odoratum	2		
Ranunculus flammula	5		
Carex nigra	1		
Leontodon autumnalis	1		
Luzula multiflora	1		
Narthecium ossifragum	2		
Rhytidiadelphis squarrosus	55		
Pseudoscleropodium purum	10		
Calliergonella cuspidatum	15		
		Species Total	13

NVC Code	Site & Vegetation Description
M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community	Sward tall but more patchy than Q119. Grazing pressure light to moderate

MAVIS Plot Resuls	'Goodness of fit'
M6d	43.51
M25b	42.20
M25	37.85

Quadrat no. 101	Date 24th July 2017	Estimated Slope (^{o}) 5
Quadrat size 2m x 2m	Grid Ref IC 74215 25694	

Surveyor KH	Altitude (m asl) 228	Site Dunbeg South

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	90		
Trifolium repens	5		
Holcus lanatus	5		
Molinia caerulea	10		
Luzula multiflora	1		
Anthoxanthum odoratum	1		
Ranunculus flammula	3		
Potentilla erecta	10		
Pedicularis sylvatica	1		
Carex nigra	1		
Carex pulicaris	1		
Leontodon autumnalis	1		
Rhytidiadelphis squarrosus	45		
Calliergonella cuspidatum	15		
		Species Total	14

NVC Code	Site & Vegetation Description
M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community	Sward uniformly tall & ungrazed

MAVIS Plot Resuls	'Goodness of fit'
M6d	40.00
M25b	37.76
U5c	35.48

Quadrat no. 102	Date 10th July 2017	Estimated Slope (^{o}) 4
Quadrat size 2m x 2m	Grid Ref IC 73549 25569	
Surveyor KH	Altitude (m asl) 188	Site Dunbeg South

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	30		
Holcus lanatus	60		
Cynosurus cristatus	10		
Deschampsia caespitosa	1		
Rumex acetosa	1		
Anthoxanthum odoratum	1		
Juncus effusus	2		
Trifolium repens	2		
Cirsium dissectum	1		
Cirsium palustre	3		
Ranunculus acris	5		
Festuca rubra	1		
Lolium perenne	2		
Rhytidiadelphis squarrosus	35		
Pseudoscleropodium purum	15		
Calliergonella cuspidatum	10		
		Species Total	16

NVC Code	Site & Vegetation Description
Festuca rubra/Holcus lanatus/ Anthoxanthum odoratum provisional grassland community (Rodwell et al. 2000)	Sward dense & tall hence poorly developed bryophyte layer. Grazing pressure very low

MAVIS Plot Result	'Goodness of fit'
MG6b	47.97
MG6d	43.84
MG6	43.74

Quadrat no.	Date	Estimated Slope (^{o})
103	10th July 2017	7

Quadrat size	Grid Ref
2m x 2m	IC 73595 25545

Surveyor	Altitude (m asl)	Site
KH	192	Dunbeg South

Species	DOMIN	Species	DOMIN
Cynosurus cristatus	25		
Holcus lanatus	35		
Juncus effusus	10		
Ranunculus acris	1		
Juncus acutiflorus	20		
Ranunculus repens	25		
Cirsium palustre	2		
Lolium perenne	3		
Trifolium repens	5		
Rumex acetosa	3		
Festuca rubra	1		
Deschampsia caespitosa	5		
Anthoxanthum odoratum	1		
Agrostis capillaris	1		
Taraxacum officinale	1		
Rhytidiadelphis squarrosus	40		
Calliergonella cuspidatum	25		
		Species Total	17

NVC Code	Site & Vegetation Description
Festuca rubra/Holcus lanatus/ Anthoxanthum odoratum provisional grassland community (Rodwell et al. 2000)	Heavily grazed sward within *Juncus acutiflorus* pasture; light poaching also evident. Sward open, patchy & short

MAVIS Plot Result	'Goodness of fit'
MG6d	55.95
MG6b	55.79
MG8d	50.46

Quadrat no.		Date	Estimated Slope (°)
104		10th July 2017	3
Quadrat size		Grid Ref	
2m x 2m		IC 73657 25503	

Surveyor	Altitude (m asl)	Site
KH	192	Dunbeg South

Species	DOMIN	Species	DOMIN
Holcus lanatus	90		
Cirsium arvense	10		
Ranunculus repens	5		
Rumex acetosa	5		
Lolium perenne	1		
Anthoxanthum odoratum	1		
Cynosurus cristatus	3		
Trifolium repens	2		
Agrostis stolonifera	2		
		Species Total	9

NVC Code		Site & Vegetation Description
Festuca rubra/Holcus lanatus/ Anthoxanthum odoratum provisional grassland community (Rodwell et al. 2000)		Species-poor mesotrophic grassland. Grazing pressure moderate with some poaching also evident. Sward dense with no bryophytes
MAVIS Plot Result	'Goodness of fit'	
MG6a	50.04	
MG6b	49.81	
MG6	48.70	

Quadrat no.	Date		Estimated Slope (^{o})
105	10th July 2017		10
Quadrat size	Grid Ref		
2m x 2m	IC 73688 25451		
Surveyor	Altitude (m asl)	Site	
KH	195	Dunbeg South	

Species	DOMIN	Species	DOMIN
Cynosurus cristatus	10		
Juncus articulatus	10		
Juncus effusus	25		
Trifolium repens	15		
Cirsium arvense	5		
Ranunculus flammula	1		
Ranunculus acris	15		
Lolium perenne	3		
Holcus lanatus	35		
Cirsium palustre	10		
Anthoxanthum odoratum	3		
Rumex acetosa	3		
Bellis perennis	1		
Rhytidiadelphis squarrosus	20		
Calliergonella cuspidatum	5		
		Species Total	15

NVC Code		Site & Vegetation Description
Festuca rubra/Holcus lanatus/ Anthoxanthum odoratum provisional grassland community (Rodwell et al. 2000)		Sward moderately grazed with some poaching. Situated c.3m to side of existing track. Sward short, dense & patchy. Scattered sheep dung also present
MAVIS Plot Results	'Goodness of fit'	
MG6b	49.49	
MG6	45.52	
MG8d	44.88	

Quadrat no. 106	Date 10th July 2017	Estimated Slope (^{o}) 11
Quadrat size 2m x 2m	Grid Ref IC 73713 25403	

Surveyor KH	Altitude (m asl) 199	Site Dunbeg South

Species	DOMIN	Species	DOMIN
Holcus lanatus	70		
Cynosurus cristatus	5		
Bellis perennis	2		
Trifolium repens	20		
Juncus articulatus	3		
Anthoxanthum odoratum	3		
Cirsium palustre	5		
Cirsium dissectum	1		
Achillea millefolium	3		
Rumex acetosa	2		
Luzula multiflora	1		
Sagina procumbens	1		
Prunella vulgaris	2		
Ranunculus repens	5		
Potentilla erecta	1		
Poa annua	1		
Rhytidiadelphis squarrosus	5		
Bare soil	2		
		Species Total	17

NVC Code

Festuca rubra/Holcus lanatus/ Anthoxanthum odoratum provisional grassland community (Rodwell et al. 2000)

MAVIS Plot Results	'Goodness of fit'
U4b	39.63
MG8d	38.22
MG5c	37.38

Site & Vegetation Description

Heavily grazed mesotrophic grassland sward c.3m to side of existing track, situated on a low earth ridge. Sward dense, to 1cm tall with some poaching evident

Quadrat no. 107	Date 10th July 2017	Estimated Slope (°) 13
Quadrat size 2m x 2m	Grid Ref IC 73743 25359	

Surveyor KH	Altitude (m asl) 211	Site Dunbeg South

Species	DOMIN	Species	DOMIN
Juncus articulatus	10	*Leontodon autumnalis*	2
Juncus effusus	15	*Cirsium dissectum*	2
Ranunculus flammula	5	*Carex nigra*	1
Bellis perennis	2		
Nardus stricta	25	*Brachythecium rutabulum*	15
Cynosurus cristatus	3	*Rhytidiadelphis squarrosus*	55
Cirsium palustre	5	*Calliergonella cuspidatum*	30
Molinia caerulea	15		
Prunella vulgaris	2	Bare soil	3
Ranunculus acris	3		
Carex viridula	1		
Juncus bulbosus	1		
Taraxacum officinale	2		
Cerastium fontanum	2		
Juncus acutiflorus	50		
Potentilla erecta	10		
Anthoxanthum odoratum	1		
Trifolium repens	2		
Carex panicea	1		
Carex pulicaris	1		
		Species Total	26

NVC Code

M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community

Site & Vegetation Description

Heavily grazed (mesotrophic) sward c.3m to side of existing track. Species-rich with some poaching and sheep dunging. Sward rather dense

MAVIS Plot Results	'Goodness of fit'
MG8c	39.54
MG8d	39.01
MG8	38.13

Quadrat no. 108	Date 10th July 2017		Estimated Slope (°) 10
Quadrat size 2m x 2m	Grid Ref IC 73803 25345		
Surveyor KH	Altitude (m asl) 221	Site Dunbeg South	

Species	DOMIN	Species	DOMIN
Cynosurus cristatus	2	*Thuidium tamariscinum*	15
Ranunculus acris	10	*Hylocomium splendens*	5
Potentilla erecta	10	*Rhytidiadelphis squarrosus*	10
Cirsium palustre	3		
Carex nigra	1		
Veronica officinalis	1		
Holcus lanatus	15		
Trifolium repens	3		
Galium saxatile	1		
Leontodon autumnalis	5		
Carex flacca	1		
Anthoxanthum odoratum	10		
Carex pulicaris	1		
Festuca ovina	3		
Carex pilulifera	1		
Deschampsia caespitosa	1		
Juncus acutiflorus	40		
Juncus articulatus	5		
		Species Total	21

NVC Code		Site & Vegetation Description
M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community		Moderately grazed, species-rich mesotrophic grassland. Sward dense, situated c.3m to side of existing track. Bryophyte layer poorly developed
MAVIS Plot Results	'Goodness of fit'	
U5c	44.00	
CG10a	42.66	
U4d	42.00	

Quadrat no.	Date	Estimated Slope (^{o})
109	10th July 2017	7
Quadrat size	Grid Ref	
2m x 2m	IC 73874 25338	

Surveyor	Altitude (m asl)	Site
KH	232	Dunbeg South

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	90		
Holcus lanatus	15		
Anthoxanthum odoratum	1		
Trifolium repens	2		
Ranunculus acris	3		
Epilobium palustre	1		
Galium palustre	1		
Cerastium fontanum	1		
Luzula multiflora	1		
Carex echinata	1		
Rhytidiadelphis squarrosus	35		
Pseudoscleopodium purum	30		
Plagiomnium undulatum	1		
Calliergonella cuspidatum	3		
Kindbergia praelonga	1		
		Species Total	15

NVC Code		Site & Vegetation Description
M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community		Grazing pressure very light. Sward tall & patchy, situated c.3m to side of existing track
MAVIS Plot Results	'Goodness of fit'	
M23a MG6b M23	34.98 34.26 32.02	

Quadrat no. 110	Date 1st September 2017	Estimated Slope (°) 7
Quadrat size 2m x 2m	Grid Ref IC 74221 25671	

Surveyor KH	Altitude (m asl) 228	Site Dunbeg South

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	75		
Molinia caerulea	10		
Carex echinata	2		
Juncus conglomeratus	2		
Anthoxanthum odoratum	2		
Ranunculus flammula	3		
Potentilla erecta	5		
Holcus lanatus	15		
Ranunculus acris	5		
Cirsium dissectum	1		
Trifolium repens	1		
Festuca ovina	2		
Deschampsia flexuosa	2		
Thuidium tamariscinum	35		
Rhytidiadelphis squarrosus	45		
		Species Total	15

NVC Code	Site & Vegetation Description
M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community	Sward very lightly grazed, patchy & relatively dense

MAVIS Plot Results	'Goodness of fit'
M6d	37.54
M26b	36.56
M25b	36.44

Quadrat no.	Date	Estimated Slope (°)
111	1st September 2017	6
Quadrat size	**Grid Ref**	
2m x 2m	IC 74271 25755	

Surveyor	Altitude (m asl)	Site
KH	228	Dunbeg South

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	65	*Rhytidiadelphis squarrosus*	65
Molinia caerulea	15	*Pseudoscleropodium purum*	35
Holcus lanatus	10	*Thuidium tamariscinum*	10
Deschampsia caespitosa	2	*Plagiomnium undulatum*	1
Cynosurus cristatus	2		
Ranunculus repens	3		
Ranunculus acris	5		
Potentilla erecta	3		
Luzula multiflora	1		
Trifolium repens	2		
Viola palustris	1		
Festuca ovina	1		
Carex nigra	1		
Anthoxanthum odoratum	1		
Nardus stricta	2		
Carex flacca	1		
		Species Total	20

NVC Code	Site & Vegetation Description
M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community	Sward very lightly grazed, patchy & relatively dense

MAVIS Plot Results	'Goodness of fit'
U4d	43.80
M26b	42.28
U5c	40.82

Quadrat no. 112	Date 1st September 2017	Estimated Slope (^{o}) 5
Quadrat size 2m x 2m	Grid Ref IC 74216 25740	
Surveyor KH	Altitude (m asl) 224	Site Dunbeg South

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	70	*Thuidium tamariscinum*	40
Holcus lanatus	15	*Plagiomnium undulatum*	1
Deschampsia caespitosa	2	*Rhytidiadelphis squarrosus*	70
Nardus stricta	2	*Pseudoscleropodium purum*	15
Molinia caerulea	10	*Calliergonella cuspidatum*	5
Potentilla erecta	10		
Ranunculus acris	5		
Epilobium palustre	1		
Carex echinata	1		
Trifolium repens	2		
Luzula multiflora	1		
Cirsium dissectum	2		
Anthoxanthum odoratum	1		
Agrostis capillaris	2		
Carex flacca	1		
		Species Total	20

NVC Code		Site & Vegetation Description
M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community		Very lightly grazed, patchy sward, more open than Q113 or Q114
MAVIS Plot Results	'Goodness of fit'	
U5c	41.81	
M26b	41.51	
U4d	41.37	

Quadrat no. 113	Date 1st September 2017		Estimated Slope (^{o}) 6
Quadrat size 2m x 2m	Grid Ref IC 74203 25662		
Surveyor KH	Altitude (m asl) 228	Site Dunbeg South	

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	85		
Holcus lanatus	5		
Agrostis capillaris	1		
Anthoxanthum odoratum	1		
Molinia caerulea	3		
Cirsium palustre	2		
Potentilla erecta	10		
Ranunculus acris	5		
Nardus stricta	2		
Cirsium dissectum	1		
Viola palustris	1		
Carex echinata	2		
Trifolium repens	2		
Cynosurus cristatus	1		
Rhytidiadelphis squarrosus	65		
Pseudoscleropodium purum	10		
Thuidium tamariscinum	20		
Plagiomnium undulatum	1		
		Species Total	18

NVC Code	Site & Vegetation Description
M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community	Sward very lightly grazed, patchy & relatively dense

MAVIS Plot Results	'Goodness of fit'
M25b	43.37
U4d	39.13
U5c	38.95

Quadrat no. 114	Date 1st September 2017	Estimated Slope (°) 5
Quadrat size 2m x 2m	Grid Ref IC 74167 25632	

Surveyor KH	Altitude (m asl) 231	Site Dunbeg South

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	70		
Molinia caerulea	5		
Holcus lanatus	5		
Anthoxanthum odoratum	1		
Potentilla erecta	15		
Festuca ovina	3		
Narthecium ossifragum	5		
Sphagnum palustre	70		
Sphagnum fallax	20		
Rhytidiadelphis squarrosus	35		
Hylocomium splendens	15		
		Species Total	11

NVC Code		Site & Vegetation Description
M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community		Sward rather open and lightly grazed. Flushed ground, notcieably wetter underfoot, hence Sphagna
MAVIS Plot Results	'Goodness of fit'	
M6d	51.65	
M25a	38.43	
M25	38.26	

Quadrat no. 115	Date 1st September 2017	Estimated Slope (^{o}) 9
Quadrat size 2m x 2m	Grid Ref IC 74135 25674	
Surveyor KH	Altitude (m asl) 224	Site Dunbeg South

Species	DOMIN	Species	DOMIN
Juncus acutiflorus	80		
Molinia caerulea	15		
Deschampsia caespitosa	5		
Potentilla erecta	15		
Anthoxanthum odoratum	2		
Festuca ovina	3		
Rhytidiadelphis squarrosus	55		
Sphagnum fallax	15		
Thuidium tamariscinum	15		
Calypogeia fissa	1		
Sphagnum palustre	3		
Bare soil	5		
		Species Total	11

NVC Code

M23a *Juncus effusus/acutiflorus-Galium palustre* rush pasture; *Juncus acutiflorus* sub-community

MAVIS Plot Results	'Goodness of fit'
M6d	44.67
M25a	35.27
M25	34.74

Site & Vegetation Description

Sward quite tall but open and very lightly grazed; some poaching evident

Appendix 6.4 – GWDTE Data & Photos 2016

Date 02/09/2016	Flush no. 1	Grid Ref IC74046 25795	Elevation (m) 204	Slope (°) 10

Species

Carex panicea
Carex demissa
Juncus acutiflorus
Ranunculus flammula
Juncus bufonius
Juncus bulbosus
Carex flacca
Euphrasia sp.
Narthecium ossifragum
Pedicularis palustris

Description

Small / short flush c.15m long x 2m wide which feeds into stream. Lacks dominant bryophyte component; more bare soil, less *Juncus acutiflorus* and more *Carex* spp. than surrounding M23a habitat (i.e. *J. acutiflorus* pasture). Slight cattle poaching evident.

Photo no. 6285	NVC type: M6d

Date	Flush no.	Grid Ref	Elevation (m)	Slope (°)
02/09/2016	2	IC74160 25682	218	5

Species

Juncus acutiflorus
Carex demissa
Carex panicea
Pedicularis palustris
Eriophorum angustifolium
Juncus bulbosus
Equisetum fluviatile
Carex echinata
Ranunculus flammula
Leontodon autumnalis
Calliergonella cuspidatum

Description

Small flush c.1.5m wide at top of small stream. Lacks dominant bryophyte component; with more bare soil, less *Juncus acutiflorus* and more *Carex* spp. than adjacent M23a habitat. Difficult to measure length as rather diffuse before entering stream, but more distinct section c.4m long.

Photo no.	NVC type:
6287	M29

Date	Flush no.	Grid Ref	Elevation (m)	Slope (°)
02/09/2016	3	IC74377 25542	242	

Species

Carex rostrata
Ranunculus flammula
Juncus acutiflorus
Leontodon autumnalis
Holcus lanatus
Ranunculus acris
Equisetum fluviatile
Potamogeton natans
Molinia caerulea
Calliergonella cuspidatum
Eurynchium striatum
Pedicularis palustris
Palustriella commutata

Description

Flat area between hills, dominated by *Carex rostrata* and *Juncus acutiflorus* with c.15m radius. Surrounding habitat M23a with wet hollow where groundwater has gathered to create small fen-like sward

Photo no.	6289	NVC type: S8c

Date	Flush no.	Grid Ref	Elevation (m)	Slope (°)
02/09/2016	4	IC74295 25449	247	2

Species

Molinia caerulea
Sphagnum palustre
Narthecium ossifragum
Eriophorum angustifolium
Erica tetralix
Sphagnum capillifolium
Potentilla erecta
Polygala serpyliifolia
Sphagnum papillosum
Sphagnum cuspidatum
Eriophorum vaginatum
Sphagnum fallax
Calluna vulgaris
Cladonia portentosa

Description

Edge of cutover bog which has reverted to pasture. *Molinia* dominant and *J. acutiflorus* rather scarce in area approx.10m x 40m. M23a habitat present beyond this. Flush situated in more or less level and low-lying basin down-slope a short distance from pond.

Photo no.	NVC type:
6290	M21b

Date	Flush no.	Grid Ref	Elevation (m)	Slope (°)
02/09/2016	5	IC74235 25334	251	0

Species

Juncus effusus
Carex nigra
Sphagnum capillifolium
Sphagnum fallax
Sphagnum palustre
Deschampsia flexuosa
Juncus acutiflorus
Juncus squarrosus
Anthoxanthum odoratum
Polytrichum commune
Rhytidiadelphis squarrosus
Molinia caerulea
Eriophorum angustifolium
Eriophorum vaginatum

Description

Flat area c.10m up-slope from pond. Adjacent habitat M23a. Sward shorter and dominated by *Molinia*, Sphagna and *Juncus squarrosus*. Flushed area approx 15m radius. Both *Juncus effusus* and *J. acutiflorus* quite uncommon within flushed area.

Photo no.	NVC type:
6291	M6c

Date	Flush no.	Grid Ref	Elevation (m)	Slope (°)
02/09/2016	6	IC74207 25273	247	0

Species

Juncus acutiflorus
Potamogeton natans
Ranunculus flammula
Equisetum fluviatile
Pedicularis palustris
Sphagnum palustre
Sphagnum fallax
Polytrichum commune
Holcus lanatus
Cardamine pratense
Carex nigra
Epilobium palustre
Molinia caerulea
Carex rostrata

Description

Linear flush between hills; adjacent habitat M23a. Flushed area waterlogged and dominated by *J. acutiflorus*, Sphagna, *Potamogeton natans* and *Carex rostrata*. Moderate poaching by sheep evident. Flushed area extends from above coordinates for c.120m to west and ends by draining into stream at IC74111 25294. Parallel to, and in close proximity to, flush no. 7.

Photo no.	NVC type:
6292	M4

Date	Flush no.	Grid Ref	Elevation (m)	Slope (°)
02/09/2016	7	IC74199 25261	249	2

Species

Calliergonella cuspidatum
Juncus acutiflorus
Ranunculus flammula
Carex rostrata
Carex nigra
Pedicularis palustris
Cardamine pratense
Ranunculus acris
Potamogeton natans
Potentilla erecta
Equisetum fluviatile
Cirsium palustre
Epilobium palustre
Eriophorum angustifolium
Molinia caerulea
Holcus lanatus

Description

Flush runs parallel to flush no. 6 at above coordinates and runs for c.125m to IC74101 25260 where discharges into stream. Both flush 6 and flush 7 run west from pond area into stream.

NVC type:

Photo no. 6293	M9b	

Date	Flush no.	Grid Ref	Elevation (m)	Slope (^{o})
02/09/2016	8	IC74859 24790	329	1

Species

Eriophorum angustifolium
Sphagnum capillifolium
Sphagnum papillosum
Sphagnum cuspidatum
Drosera rotundifolia
Erica tetralix
Trichophorum germanicum
Narthecium ossifragum

Description

Mire pools in low-lying hollows with standing water. Pools extend c.20m to north-east and c.20m to south-west from above coordinates.

Photo no. 6295	NVC type: M21	

Date	Flush no.	Grid Ref	Elevation (m)	Slope (°)
02/09/2016	9	IC74919 24773	326	0

Species

Trichophorum germanicum
Juncus squarrosus
Sphagnum cuspidatum
Carex echinata
Erica tetralix
Eriophorum vaginatum
Sphagnum palustre
Narthecium ossifragum
Eriophorum angustifolium
Juncus bulbosus

Description

Similar to flush no. 8 but smaller in size, extending c.10m to north-east and south-west from above coordinates. Another wet hollow within the mire.

Photo no.	6296	NVC type:	M17a

Date	Flush no.	Grid Ref	Elevation (m)	Slope (^{o})
02/09/2016	10	IC73454 24996	259	15

Species

Pedicularis palustris

Description

2 small streams flowing south to north along western fenceline; channels unvegetated except for occasional *Pedicularis palustris* plants. Good cover of *Calluna* along both stream bank-tops.

Photo no. 6297	NVC type: S9

<table>
<tr><td>Date

02/09/2016</td><td>GWDTE no.
11</td><td>Grid Ref IC73988 24723</td><td>Elevation (m)
284</td><td>Slope (^{o})
2</td></tr>
<tr><td colspan="5">Species

Juncus acutiflorus
Sphagnum palustre
Potentilla erecta
Succisa pratensis
Anthoxanthum odoratum
Deschampsia flexuosa
Sphagnum subnitens
Juncus bulbosus
Holcus lanatus
Leontodon autumnalis
Pedicularis palustris
Pinguicula vulgaris
Carex demissa
Ranunculus flammula
Sphagnum fallax
Carex echinata
Palustriella commutata</td></tr>
<tr><td colspan="5">Description

Small flush between hills, within M32a pasture. Consists of small area of shorter sward dominated by Sphagnum palustre in standing water. Extends c.5m to north and south from above coordinates.</td></tr>
<tr><td colspan="2"></td><td colspan="2">GWDTE type:</td><td></td></tr>
</table>

Photo no. 6298	M6d	

Date 02/09/2016	GWDTE no. 12	Grid Ref IC73973 24663	Elevation (m) 291	Slope (^{o}) 10

Species

Juncus acutiflorus
Pinguicula vulgaris
Triglochin palustris
Juncus bulbosus
Carex echinata
Carex demissa
Holcus lanatus
Carex panicea
Eurynchium striatum
Palustriella commutata

Description

Small flush between hills, within M23a habitat. Sward shorter and thinner than adjacent vegetation with standing water evident above peat surface. Extends to north-east for c.15m and feeds into flush no. 11

Photo no. 6299	GWDTE type: M10	

Date 02/09/2016	GWDTE no. 13	Grid Ref IC73962 24629	Elevation (m) 287	Slope (°) 3

Species

Ranunculus flammula
Holcus lanatus
Juncus acutiflorus
Equisetum fluviatile
Potamogeton natans
Leontodon autumnalis
Sphagnum palustre
Carex panicea
Cirsium palustre
Sphagnum fallax
Viola palustris

Description

Small flush extending c.30m downslope to the north-west.

	GWDTE type:

Photo no. 6300	M6d	

Date 02/09/2016	GWDTE no. 14	Grid Ref IC73960 24652	Elevation (m) 291	Slope (°) 3

Species

Holcus lanatus
Cirsium palustre
Cardamine pratense
Cynosurus cristatus
Palustriella commutata

Description

Approximately circular floating 'mat' with c.2m radius, within M23a habitat. Resembles spring; sward very spongy; dominated by a carpet of *Palustriella commutata*.

Photo no. 6301	GWDTE type: MG10a

Date 02/09/2016	Flush no. 15	Grid Ref IC73974 24585	Elevation (m) 294	Slope (^{o}) 2

Species

Molinia caerulea
Holcus lanatus
Ranunculus flammula
Sphagnum fallax
Sphagnum palustre
Viola palustris
Sphagnum subnitens
Carex demissa
Erica tetralix
Juncus bulbosus

Description

Small flush between hills. Extends to south for c.40m.

Photo no.	6302	GWDTE type: M6a

Date	Flush no.	Grid Ref	Elevation (m)	Slope (^{o})
02/09/2016	16	IC74387 24549	298	3

Species

Juncus acutiflorus
Carex rostrata
Equisetum fluviatile
Carex panicea
Carex echinata
Salix capraea
Molinia caerulea
Cirsium palustre
Eurynchium striatum
Carex nigra
Ranunculus flammula
Potamogeton natans
Carex demissa
Sphagnum capillifolium
Sphagnum papillosum
Erica tetralix

Description

Wide and shallow flush between two hills, situated within M23a pasture. Sward within flush shorter and thinner than in adjacent pasture, with some bare soil and standing water. Flush extends c.85m to IC74317 24737. At its northern extent the flush measured c.20m wide and was dominated by extensive rafts of *Carex rostrata.*

GWDTE type:

Photo no. 6303	M6d	

Date	GWDTE no.	Grid Ref	Elevation (m)	Slope (°)
02/09/2016	17	IC74360 24739	294	3

Species

Juncus acutiflorus
Equisetum fluviatile
Deschampsia flexuosa
Ranunculus flammula
Pedicularis palustris
Ranunculus acris
Narthecium ossifragum
Eurynchium striatum
Carex echinata
Holcus lanatus
Sphagnum palustre
Epilobium palustre
Carex nigra
Carex rostrata
Potamogeton natans

Description

Similar to flush no. 16; extends to north-west to IC74306 24787 where it merges into a small stream.

Photo no. 6304	GWDTE type: S9b

Date	Flush no.	Grid Ref	Elevation (m)	Slope (^{o})
02/09/2016	18	IC74316 24794	285	8

Species

Erica tetralix
Palustriella commutata
Narthecium ossifragum
Carex nigra
Triglochin palustris
Juncus acutiflorus
Molinia caerulea
Sphagnum fallax
Pedicularis palustris
Carex demissa
Carex echinata
Juncus bulbosus
Pinguicula vulgaris
Carex panicea
Eriophorum angustifolium
Potamogeton natans
Sphagnum palustre

Description

Muddy flush emerging from steep bank. Much bare soil present. Flush continues down-slope (westwards) to IC74286 24818 where vanishes beneath ground before re-emerging at a nearby stream, into which it empties.

Photo no.	6305	GWDTE type: M15a

Date 02/09/2016	GWDTE no. 19	Grid Ref IC74354 24861	Elevation (m) 289	Slope (°) 3

Species

Pedicularis palustris
Juncus acutiflorus
Potamogeton natans
Equisetum fluviatile
Carex echinata
Carex demissa
Palustriella commutata
Pinguicula vulgaris
Cirsium pratense
Pellia sp.
Sphagnum palustre
Carex panicea
Drosera rotundifolia
Sphagnum fallax

Description

Flush continues down-slope (to south-west) to IC74282 24817 at which point it disappears underground in close proximity to a small stream. Areas of bare soil scattered along length of flush.

Photo no. 6306	GWDTE type: M15a

Date 02/09/2016	GWDTE no. 20	Grid Ref IC74307 24906	Elevation (m)	Slope (°)

Species

Pedicularis palustris
Juncus acutiflorus
Potamogeton natans
Equisetum fluviatile
Carex echinata
Carex demissa
Palustriella commutata
Pinguicula vulgaris
Cirsium pratense
Pellia sp.
Sphagnum palustre
Carex panicea
Drosera rotundifolia
Sphagnum fallax

Description

Second 'arm' of flush no. 19 which extends down-slope to north-west, ending at IC74307 24906 where it empties into a small stream.

Photo no. 6307	GWDTE type: M15a

Date 02/09/2016	GWDTE no. 21	Grid Ref IC74338 24880	Elevation (m) 287	Slope (°) 8

Species

Equisetum fluviatile
Juncus acutiflorus
Potamogeton natans
Pinguicula vulgaris
Holcus lanatus
Pedicularis palustris
Carex demissa
Carex echinata
Succisa pratensis
Ranunculus flammula

Description

Flush extends down-slope to IC74311 24907 where it discharges into a small stream.

Photo no. 6308	GWDTE type: S8c

Date 02/09/2016	GWDTE no. 22	Grid Ref IC74365 24913	Elevation (m) 287	Slope (^{o}) 5

Species

Equisetum fluviatile
Juncus acutiflorus
Potamogeton natans
Pinguicula vulgaris
Holcus lanatus
Pedicularis palustris
Carex demissa
Carex echinata
Succisa pratensis
Ranunculus flammula

Description

Flush continues down-slope (to the west) here it empties into a shallow ditch at IC74299 24926.

Photo no. 6309	GWDTE type: S8c

Date 02/09/2016	GWDTE no. 23	Grid Ref IC74376 24949	Elevation (m) 289	Slope (°) 5

Species

Carex echinata
Carex demissa
Pedicularis palustris
Equisetum fluviatile
Juncus acutiflorus
Carex panicea
Ranunculus flammula
Potamogeton natans

Description

Flush extends to north-west where it disappears underground at IC74309 24980. Bare soil evident in scattered patches along length.

	GWDTE type:

Photo no. 6310	S8c	

Date 02/09/2016	Flush no. 24	Grid Ref IC74340 24986	Elevation (m) 282	Slope (°) 10

Species

Carex echinata
Carex demissa
Pedicularis palustris
Equisetum fluviatile
Juncus acutiflorus
Carex panicea
Ranunculus flammula
Potamogeton natans

Description

Flush extends towards the south-west until IC74295 24968 when it disappears underground. Runs
parallel to the fence-line for most of its length. Dense growth of *Juncus acutiflorus* along part of its length.

	NVC type:

Photo no. 6311	M6d	

Date 02/09/2016	Flush no. 25	Grid Ref IC73961 24971	Elevation (m) 249	Slope (°) 3

Species

Carex rostrata
Epilobium palustre
Juncus acutiflorus
Menyanthes trifoliata
Succisa pratensis
Mentha aquatica
Carex panicea
Carex demissa
Equisetum fluviatile
Pedicularis palustris
Holcus lanatus
Ranunculus flammula
Molinia caerulea
Cirsium palustre

Description

Wide, shallow flush extending down-slope (to the north); up to 10m wide. Extends to IC73950 25092
where it merges with a small stream that runs down-slope to the north-west.

NVC type:

Photo no. 6312	M9b	

Date 02/09/2016	Flush no. 26	Grid Ref IC73960 24981	Elevation (m) 252	Slope (°) 2

Species

Carex rostrata
Ranunculus flammula
Juncus acutiflorus
Menyanthes trifoliata
Pedicularis palustris
Mentha aquatica
Succisa pratensis
Ranunculus acris
Holcus lanatus
Potentilla erecta
Calliergonella cuspidatum
Cardamine pratense
Carex panicea
Molinia caerulea
Potamogeton natans

Description

Wider in upper reaches, merging with a small stream as it travels down-slope. Terminates at IC73949 25096. Heavy growth of *J. acutiflorus* in parts; other stretches dominated by wide carpets of *Carex rostrata*. Up to 10m wide in places.

Photo no. 6313	NVC type: M13a	

Appendix 6.5 – Bat Annex

Note; that the Bat Activity Indices for the manual transects have been provided in the main text of Chapter 6, and not within this Appendix. This is due to the fact that there were only 13 bats recorded in total for the three transects and separate tables were not therefore necessary.

2017 Static Monitoring Results

T1 Spring

	PIPY	PIPI	NYLE
22nd – 23rd May	-	-	-
23rd – 24th May	-	-	-
24th – 25th May	6	2	-
25th – 26th May	2	-	-
26th – 27th May	-	-	1
Totals	**8**	**2**	**1**

All nights data combined – five nights at 8 hours recording time per night = 40 hours recording

	PIPY	PIPI	NYLE
Total Passes	8	2	1
Passes (per/hr)	**0.2**	**0.05**	**0.025**

T1 Summer

	PIPY	PIPI	NYLE
7th – 8th July	-	-	2
8th – 9th July	-	1	3
9th – 10th July	1	1	-
10th – 11th July	-	-	2
11th – 12th July	-	1	8
Totals	**1**	**3**	**15**

All nights data combined – five nights at 8 hours recording time per night = 40 hours recording

	PIPY	PIPI	NYLE
Total Passes	1	3	15
Passes (per/hr)	**0.025**	**0.075**	**0.375**

T1 Autumn

	PIPY	PIPI	NYLE	DAU
1st – 2nd Sept	2	1	2	1
2nd – 3rd Sept	-	-	1	-
3rd – 4th Sept	8	12	-	-
4th – 5th Sept	1	9	9	-
5th – 6th Sept	-	-	3	-
Totals	**11**	**22**	**15**	**1**

All nights data combined – five nights at 8 hours recording time per night = 40 hours recording

	PIPY	PIPI	NYLE	DAU
Total Passes	11	22	15	1
Passes (per/hr)	**0.275**	**0.55**	**0.375**	**0.025**

T1 Feature

	PIPY	PIPI	NYLE
22nd – 23rd May	-	1	1
23rd – 24th May	-	-	-
24th – 25th May	5	5	3
25th – 26th May	3	9	3
26th – 27th May	-	1	8
Totals	**8**	**16**	**15**

All nights data combined – five nights at 8 hours recording time per night = 40 hours recording

	PIPY	PIPI	NYLE
Total Passes	8	16	15
Passes (per/hr)	**0.2**	**0.4**	**0.375**

T1 Feature

	PIPI
7th – 8th July	1
8th – 9th July	-
9th – 10th July	-
10th – 11th July	-
11th – 12th July	-
Totals	**1**

All nights data combined – five nights at 8 hours recording time per night = 40 hours recording

	PIPI
Total Passes	1
Passes (per/hr)	**0.025**

T1 Feature

	PIPY	PIPI	NYLE
1st – 2nd Sept	6	5	2
2nd – 3rd Sept	-	-	-
3rd – 4th Sept	10	5	-
4th – 5th Sept	-	1	-
5th – 6th Sept	-	-	2
Totals	**16**	**11**	**4**

All nights data combined – five nights at 8 hours recording time per night = 40 hours recording

	PIPY	PIPI	NYLE
Total Passes	16	11	4
Passes (per/hr)	**0.4**	**0.275**	**0.1**

2017 Static Monitoring Results

T2 Spring

	PIPY	PIPI	NYLE
22nd – 23rd May	-	1	-
23rd – 24th May	-	-	3
24th – 25th May	13	18	4
25th – 26th May	3	2	-
26th – 27th May	-	-	2
Totals	**16**	**21**	**9**

All nights data combined – five nights at 8 hours recording time per night = 40 hours recording

	PIPY	PIPI	NYLE
Total Passes	16	21	9
Passes (per/hr)	**0.4**	**0.525**	**0.225**

T2 Summer

	PIPI	NYLE
7th – 8th July	1	2
8th – 9th July	-	1
9th – 10th July	-	-
10th – 11th July	-	-
11th – 12th July	1	4
Totals	**2**	**7**

All nights data combined – five nights at 8 hours recording time per night = 40 hours recording

	PIPI	NYLE
Total Passes	2	7
Passes (per/hr)	**0.05**	**0.175**

T2 Autumn

	PIPI	NYLE	DAU
1st – 2nd Sept	1	1	1
2nd – 3rd Sept	-	-	-
3rd – 4th Sept	-	-	-
4th – 5th Sept	-	2	-
5th – 6th Sept	-	4	-
Totals	**1**	**7**	**1**

All nights data combined – five nights at 8 hours recording time per night = 40 hours recording

	PIPI	NYLE	DAU
Total Passes	1	7	1
Passes (per/hr)	**0.025**	**0.175**	**0.025**

T2 Feature

	PIPY	PIPI	NYLE
22nd – 23rd May	-	2	-
23rd – 24th May	-	-	5
24th – 25th May	9	16	2
25th – 26th May	24	37	11
26th – 27th May	1	2	6
Totals	**34**	**55**	**24**

All nights data combined – five nights at 8 hours recording time per night = 40 hours recording

	PIPY	PIPI	NYLE
Total Passes	34	55	24
Passes (per/hr)	**0.85**	**13.75**	**0.6**

T2 Feature

	PIPY	PIPI	NYLE
7th – 8th July	-	1	2
8th – 9th July	2	1	13
9th – 10th July	1	-	-
10th – 11th July	-	1	1
11th – 12th July	3	1	11
Totals	**6**	**4**	**27**

All nights data combined – five nights at 8 hours recording time per night = 40 hours recording

	PIPY	PIPI	NYLE
Total Passes	6	4	27
Passes (per/hr)	**0.15**	**0.1**	**0.675**

T2 Feature

	PIPY	PIPI	NYLE	DAU	PINA
1st – 2nd Sept	4	13	-	1	1
2nd – 3rd Sept	1	2	2	-	-
3rd – 4th Sept	-	-	-	-	-
4th – 5th Sept	-	-	-	-	-
5th – 6th Sept	-	-	3	-	-
Totals	**5**	**15**	**5**	**1**	**1**

All nights data combined – five nights at 8 hours recording time per night = 40 hours recording

	PIPY	PIPI	NYLE	DAU	PINA
Total Passes	5	15	5	1	1
Passes (per/hr)	**0.125**	**0.375**	**0.125**	**0.025**	**0.025**

T3 Spring

	PIPY	PIPI
22nd – 23rd May	-	-
23rd – 24th May	1	-
24th – 25th May	-	1
25th – 26th May	-	1
26th – 27th May	-	1
Totals	**1**	**3**

All nights data combined – five nights at 8 hours recording time per night = 40 hours recording

	PIPY	PIPI
Total Passes	1	3
Passes (per/hr)	**0.025**	**0.075**

T3 Summer

	NYLE
7th – 8th July	-
8th – 9th July	2
9th – 10th July	-
10th – 11th July	2
11th – 12th July	-
Totals	**4**

All nights data combined – five nights at 8 hours recording time per night = 40 hours recording

	NYLE
Total Passes	4
Passes (per/hr)	**0.1**

T3 Autumn

	PIPY	PIPI	NYLE
1st – 2nd Sept	5	-	1
2nd – 3rd Sept	-	-	-
3rd – 4th Sept	4	2	-
4th – 5th Sept	-	-	-
5th – 6th Sept	-	-	-
Totals	**9**	**2**	**1**

All nights data combined – five nights at 8 hours recording time per night = 40 hours recording

	PIPY	PIPI	NYLE
Total Passes	9	2	1
Passes (per/hr)	**0.225**	**0.05**	**0.025**

T3 Feature

	PIPY	PIPI	NYLE
22nd – 23rd May	-	-	-
23rd – 24th May	-	-	-
24th – 25th May	-	-	-
25th – 26th May	1	3	-
26th – 27th May	-	-	1
Totals	**1**	**3**	**1**

All nights data combined – five nights at 8 hours recording time per night = 40 hours recording

	PIPY	PIPI	NYLE
Total Passes	1	3	1
Passes (per/hr)	**0.025**	**0.075**	**0.025**

T3 Feature

	PIPY	NYLE
7th – 8th July	-	-
8th – 9th July	-	-
9th – 10th July	1	-
10th – 11th July	-	4
11th – 12th July	-	3
Totals	**1**	**7**

All nights data combined – five nights at 8 hours recording time per night = 40 hours recording

	PIPY	NYLE
Total Passes	1	7
Passes (per/hr)	**0.025**	**0.175**

T3 Feature

	PIPY	PIPI	NYLE	PLAU
1st – 2nd Sept	5	13	12	4
2nd – 3rd Sept	-	-	-	-
3rd – 4th Sept	1	2	-	-
4th – 5th Sept	-	1	3	-
5th – 6th Sept	-	-	6	-
Totals	**6**	**16**	**21**	**4**

All nights data combined – five nights at 8 hours recording time per night = 40 hours recording

	PIPY	PIPI	NYLE	PLAU
Total Passes	6	16	21	4
Passes (per/hr)	**0.15**	**0.4**	**0.525**	**0.1**

2017 Static Monitoring Results

T4 Spring

	PIPY	PIPI	NYLE
22nd – 23rd May	-	2	-
23rd – 24th May	-	1	1
24th – 25th May	-	1	-
25th – 26th May	1	1	-
26th – 27th May	-	-	2
Totals	**1**	**5**	**3**

All nights data combined – five nights at 8 hours recording time per night = 40 hours recording

	PIPY	PIPI	NYLE
Total Passes	1	5	3
Passes (per/hr)	**0.025**	**0.125**	**0.075**

T4 Summer

	NYLE
7th – 8th July	1
8th – 9th July	-
9th – 10th July	-
10th – 11th July	21
11th – 12th July	1
Totals	**23**

All nights data combined – five nights at 8 hours recording time per night = 40 hours recording

	NYLE
Total Passes	23
Passes (per/hr)	**0.575**

T4 Autumn

	PIPY	PIPI	NYLE
1st – 2nd Sept	12	23	49
2nd – 3rd Sept	-	-	1
3rd – 4th Sept	1	1	-
4th – 5th Sept	1	-	1
5th – 6th Sept	-	-	9
Totals	**14**	**24**	**60**

All nights data combined – five nights at 8 hours recording time per night = 40 hours recording

	PIPY	PIPI	NYLE
Total Passes	14	24	60
Passes (per/hr)	**0.35**	**0.6**	**1.5**

T4 Feature

	PIPI	NYLE
22nd – 23rd May	1	-
23rd – 24th May	-	2
24th – 25th May	1	1
25th – 26th May	-	-
26th – 27th May	-	-
Totals	**2**	**3**

All nights data combined – five nights at 8 hours recording time per night = 40 hours recording

	PIPI	NYLE
Total Passes	2	3
Passes (per/hr)	**0.05**	**0.075**

T4 Feature

	NYLE
7th – 8th July	-
8th – 9th July	-
9th – 10th July	-
10th – 11th July	13
11th – 12th July	3
Totals	**16**

All nights data combined – five nights at 8 hours recording time per night = 40 hours recording

	NYLE
Total Passes	16
Passes (per/hr)	**0.4**

T4 Feature

	PIPY	PIPI	NYLE
1st – 2nd Sept	25	19	27
2nd – 3rd Sept	1	-	2
3rd – 4th Sept	-	7	-
4th – 5th Sept	-	2	3
5th – 6th Sept	-	-	4
Totals	**26**	**28**	**36**

All nights data combined – five nights at 8 hours recording time per night = 40 hours recording

	PIPY	PIPI	NYLE
Total Passes	26	28	36
Passes (per/hr)	**0.65**	**0.7**	**0.9**

T5 Spring

	PIPY	PIPI	NYLE
27th – 28th May	-	-	-
28th – 29th May	1	1	-
29th – 30th May	3	-	-
30th – 31st May	-	-	1
31st – 1st June	-	-	-
Totals	**4**	**1**	**1**

All nights data combined – five nights at 8 hours recording time per night = 40 hours recording

	PIPY	PIPI	NYLE
Total Passes	4	1	1
Passes (per/hr)	**0.1**	**0.025**	**0.025**

T5 Summer

	PIPI	NYLE
13th – 14th July	-	1
14th – 15th July	-	-
15th – 16th July	-	-
16th – 17th July	-	-
17th – 18th July	2	-
Totals	**2**	**1**

All nights data combined – five nights at 8 hours recording time per night = 40 hours recording

	PIPI	NYLE
Total Passes	2	1
Passes (per/hr)	**0.05**	**0.025**

T5 Autumn

	PIPY	PIPI	NYLE
6th – 7th Sept	-	1	2
7th – 8th Sept	-	-	2
8th – 9th Sept	-	-	2
9th – 10th Sept	1	1	5
10th – 11th Sept	-	-	-
Totals	**1**	**2**	**11**

All nights data combined – five nights at 8 hours recording time per night = 40 hours recording

	PIPY	PIPI	NYLE
Total Passes	1	2	11
Passes (per/hr)	**0.025**	**0.05**	**0.275**

T5 Feature

	PIPY	PIPI	NYLE
27th – 28th May	-	-	-
28th – 29th May	13	13	2
29th – 30th May	4	3	1
30th – 31st May	-	1	3
31st – 1st June	-	-	-
Totals	**17**	**17**	**6**

All nights data combined – five nights at 8 hours recording time per night = 40 hours recording

	PIPY	PIPI	NYLE
Total Passes	17	17	6
Passes (per/hr)	**0.425**	**0.425**	**0.15**

T5 Feature

	PIPY
13th – 14th July	12
14th – 15th July	-
15th – 16th July	-
16th – 17th July	1
17th – 18th July	-
Totals	**13**

All nights data combined – five nights at 8 hours recording time per night = 40 hours recording

	PIPY
Total Passes	13
Passes (per/hr)	**0.325**

T5 Feature

	PIPY	PIPI	NYLE
6th – 7th Sept	-	2	-
7th – 8th Sept	-	-	1
8th – 9th Sept	1	1	1
9th – 10th Sept	19	31	1
10th – 11th Sept	-	-	-
Totals	**20**	**34**	**3**

All nights data combined – five nights at 8 hours recording time per night = 40 hours recording

	PIPY	PIPI	NYLE
Total Passes	20	34	3
Passes (per/hr)	**0.5**	**0.85**	**0.075**

2017 Static Monitoring Results

T6 Spring

22nd – 26th May	NO BATS RECORDED

T6 Summer

13th – 17th July	NO BATS RECORDED

T6 Autumn

	PIPY	PIPI	NYLE
1st – 2nd Sept	6	13	7
2nd – 3rd Sept	-	-	1
3rd – 4th Sept	-	1	-
4th – 5th Sept	3	1	-
5th – 6th Sept	-	-	3
Totals	**9**	**15**	**11**

All nights data combined – five nights at 8 hours recording time per night = 40 hours recording

	PIPY	PIPI	NYLE
Total Passes	9	15	11
Passes (per/hr)	**0.225**	**0.375**	**0.275**

T6 Feature

	PIPY	PIPI	NYLE
22nd – 23rd May	-	-	-
23rd – 24th May	-	-	2
24th – 25th May	1	2	5
25th – 26th May	1	1	6
26th – 27th May	-	-	-
Totals	**2**	**3**	**13**

All nights data combined – five nights at 8 hours recording time per night = 40 hours recording

	PIPY	PIPI	NYLE
Total Passes	2	3	13
Passes (per/hr)	**0.05**	**0.075**	**0.325**

T6 Feature

	PIPY	PIPI
13th – 14th July	-	-
14th – 15th July	-	-
15th – 16th July	-	-
16th – 17th July	-	-
17th – 18th July	1	2
Totals	**1**	**2**

All nights data combined – five nights at 8 hours recording time per night = 40 hours recording

	PIPY	PIPI
Total Passes	1	2
Passes (per/hr)	**0.025**	**0.05**

T6 Feature

	PIPY	PIPI	NYLE
1st – 2nd Sept	6	6	32
2nd – 3rd Sept	-	1	1
3rd – 4th Sept	-	-	-
4th – 5th Sept	1	-	3
5th – 6th Sept	-	-	10
Totals	**7**	**7**	**46**

All nights data combined – five nights at 8 hours recording time per night = 40 hours recording

	PIPY	PIPI	NYLE
Total Passes	7	7	46
Passes (per/hr)	**0.175**	**0.175**	**1.15**

2017 Static Monitoring Results

T7 Spring

27^{th} – 31^{st} May	NO BATS RECORDED

T7 Summer

	NYLE
13^{th} – 14^{th} July	-
14^{th} – 15^{th} July	-
15^{th} – 16^{th} July	3
16^{th} – 17^{th} July	2
17^{th} – 18^{th} July	1
Totals	**6**

All nights data combined – five nights at 8 hours recording time per night = 40 hours recording

	NYLE
Total Passes	6
Passes (per/hr)	**0.15**

T7 Autumn

	PIPY	PIPI	NYLE
6^{th} – 7^{th} Sept	1	-	1
7^{th} – 8^{th} Sept	-	-	-
8^{th} – 9^{th} Sept	-	-	9
9^{th} – 10^{th} Sept	3	9	2
10^{th} – 11^{th} Sept	-	-	-
Totals	**4**	**9**	**12**

All nights data combined – five nights at 8 hours recording time per night = 40 hours recording

	PIPY	PIPI	NYLE
Total Passes	4	9	12
Passes (per/hr)	**0.1**	**0.225**	**0.3**

T7 Feature

	PIPY	PIPI	NYLE
27^{th} – 28^{th} May	-	-	-
28^{th} – 29^{th} May	1	1	2
29^{th} – 30^{th} May	1	2	1
30^{th} – 31^{st} May	-	-	3
31^{st} – 1^{st} June	-	-	1
Totals	**2**	**3**	**7**

All nights data combined – five nights at 8 hours recording time per night = 40 hours recording

	PIPY	PIPI	NYLE
Total Passes	2	3	7
Passes (per/hr)	**0.05**	**0.075**	**0.175**

T7 Feature

13^{th} – 17^{th} July	NO BATS RECORDED

T7 Feature

	PIPY	PIPI
6^{th} – 7^{th} Sept	-	-
7^{th} – 8^{th} Sept	-	-
8^{th} – 9^{th} Sept	-	-
9^{th} – 10^{th} Sept	7	4
10^{th} – 11^{th} Sept	1	-
Totals	**8**	**4**

All nights data combined – five nights at 8 hours recording time per night = 40 hours recording

	PIPY	PIPI
Total Passes	8	4
Passes (per/hr)	**0.2**	**0.1**

2017 Static Monitoring Results

T8 Spring

	PIPY	PIPI
27th – 28th May	-	-
28th – 29th May	3	5
29th – 30th May	-	1
30th – 31st May	-	-
31st – 1st June	1	-
Totals	**4**	**6**

All nights data combined – five nights at 8 hours recording time per night = 40 hours recording

	PIPY	PIPI
Total Passes	4	6
Passes (per/hr)	**0.1**	**0.15**

T8 Summer

	PIPY
13th – 14th July	-
14th – 15th July	-
15th – 16th July	-
16th – 17th July	-
17th – 18th July	1
Totals	**1**

All nights data combined – five nights at 8 hours recording time per night = 40 hours recording

	PIPY
Total Passes	1
Passes (per/hr)	**0.025**

T8 Autumn

	PIPY	PIPI	NYLE
6th – 7th Sept	-	-	3
7th – 8th Sept	-	-	-
8th – 9th Sept	-	-	-
9th – 10th Sept	29	15	-
10th – 11th Sept	1	-	-
Totals	**30**	**15**	**3**

All nights data combined – five nights at 8 hours recording time per night = 40 hours recording

	PIPY	PIPI	NYLE
Total Passes	30	15	3
Passes (per/hr)	**0.75**	**0.375**	**0.075**

T8 Feature

	PIPY	PIPI	NYLE
27th – 28th May	-	-	-
28th – 29th May	1	3	2
29th – 30th May	-	1	3
30th – 31st May	-	1	5
31st – 1st June	-	-	-
Totals	**1**	**5**	**10**

All nights data combined – five nights at 8 hours recording time per night = 40 hours recording

	PIPY	PIPI	NYLE
Total Passes	1	5	10
Passes (per/hr)	**0.025**	**0.125**	**0.25**

T8 Feature

	PIPY
13th – 14th July	-
14th – 15th July	-
15th – 16th July	-
16th – 17th July	-
17th – 18th July	2
Totals	**2**

All nights data combined – five nights at 8 hours recording time per night = 40 hours recording

	PIPY
Total Passes	2
Passes (per/hr)	**0.05**

T8 Feature

	PIPY	PIPI
6th – 7th Sept	-	1
7th – 8th Sept	2	-
8th – 9th Sept	-	1
9th – 10th Sept	3	2
10th – 11th Sept	2	-
Totals	**7**	**4**

All nights data combined – five nights at 8 hours recording time per night = 40 hours recording

	PIPY	PIPI
Total Passes	7	4
Passes (per/hr)	**0.175**	**0.1**

T9 Spring

	PIPY	PIPI	NYLE
27th – 28th May	-	-	-
28th – 29th May	-	3	-
29th – 30th May	2	1	1
30th – 31st May	1	-	4
31st – 1st June	-	3	-
Totals	**3**	**7**	**5**

All nights data combined – five nights at 8 hours recording time per night = 40 hours recording

	PIPY	PIPI	NYLE
Total Passes	3	7	5
Passes (per/hr)	**0.075**	**0.175**	**0.125**

T9 Summer

	PIPI	NYLE
13th – 14th July	1	1
14th – 15th July	1	-
15th – 16th July	-	-
16th – 17th July	-	-
17th – 18th July	-	-
Totals	**2**	**1**

All nights data combined – five nights at 8 hours recording time per night = 40 hours recording

	PIPI	NYLE
Total Passes	2	1
Passes (per/hr)	**0.05**	**0.025**

T9 Autumn

	PIPY	PIPI	NYLE
6th – 7th Sept	-	-	2
7th – 8th Sept	3	-	-
8th – 9th Sept	2	-	3
9th – 10th Sept	6	7	2
10th – 11th Sept	-	-	-
Totals	**11**	**7**	**7**

All nights data combined – five nights at 8 hours recording time per night = 40 hours recording

	PIPY	PIPI	NYLE
Total Passes	11	7	7
Passes (per/hr)	**0.275**	**0.175**	**0.175**

T9 Feature

	PIPY	PIPI	NYLE
27th – 28th May	-	-	-
28th – 29th May	1	1	2
29th – 30th May	-	1	3
30th – 31st May	1	-	1
31st – 1st June	1	-	-
Totals	**3**	**2**	**6**

All nights data combined – five nights at 8 hours recording time per night = 40 hours recording

	PIPY	PIPI	NYLE
Total Passes	3	2	6
Passes (per/hr)	**0.075**	**0.05**	**0.15**

T9 Feature

	PIPY	PIPI	NYLE
13th – 14th July	2	2	1
14th – 15th July	2	-	-
15th – 16th July	-	-	1
16th – 17th July	-	-	1
17th – 18th July	-	-	1
Totals	**4**	**2**	**4**

All nights data combined – five nights at 8 hours recording time per night = 40 hours recording

	PIPY	PIPI	NYLE
Total Passes	4	2	4
Passes (per/hr)	**0.1**	**0.05**	**0.1**

T9 Feature

	PIPY	PIPI	NYLE
6th – 7th Sept	1	-	-
7th – 8th Sept	-	-	-
8th – 9th Sept	2	4	-
9th – 10th Sept	9	3	1
10th – 11th Sept	-	-	-
Totals	**12**	**7**	**1**

All nights data combined – five nights at 8 hours recording time per night = 40 hours recording

	PIPY	PIPI	NYLE
Total Passes	12	7	1
Passes (per/hr)	**0.3**	**0.175**	**0.025**

Photographs and Descriptions of Static Detector Locations

Location: Turbine 1 **Date:** 1st September 2017 **Source:** *Blackstaff Ecology*

Description

Old low stone wall in grassland within 30m of T1 with the microphone set towards the turbine location.

Wire-mesh is used to prevent sheep and other grazers from nibbling on the foam windshield which protects the microphone.

Detector: *SM2bat+ detector unit with SMX-U1 microphone attached*

Location: T1 feature **Date:** 20th September 2017 **Source:** *Blackstaff Ecology*

Description

Fence post within grassland with the microphone set towards the linear feature (drain/stream).

Wire-mesh is used to prevent sheep and other grazers from nibbling on the foam windshield which protects the microphone.

Detector: *SM2bat+ detector unit with SMX-U1 microphone attached*

Location: Turbine 2 **Date:** 1st September 2017 **Source:** *Blackstaff Ecology*

Description
Straining post in marshy grassland within 40m of T1 with the microphone set towards the turbine location.

Detector: *Anabat express detector unit*

Location: T2 feature **Date:** 1st September 2017 **Source:** *Blackstaff Ecology*

Description
Fence post above one of the streams which flows towards the Curly River some 100m from T2 with the microphone set to record anything moving past (up or down the stream corridor).

Detector: *Anabat express detector unit*

Location: Turbine 3 **Date:** 1st September 2017 **Source:** *Blackstaff Ecology*

Detector: *SM2bat+ detector unit with SMX-U1 microphone attached*

Description

Sitka spruce tree in heathland within 12m of T3 with the microphone set towards the turbine location.

Wire-mesh is used to prevent sheep and other grazers from nibbling on the foam windshield which protects the microphone.

Location: T3 feature **Date:** 1st September 2017 **Source:** *Blackstaff Ecology*

Detector: *SM2bat+ detector unit with SMX-U1 microphone attached*

Description

Straining post (above stream corridor) on the boundary between an area of wet heath and marshy grassland 73m from T with the microphone set to monitoring activity along the watercourse. No wire-mesh was necessary here as the microphone was higher than the sheep can reach.

Location: Turbine 4 **Date:** 1st September 2017 **Source:** *Blackstaff Ecology*

Description
Marshy grassland within 10m of T4 with the microphone set towards the turbine location.

Wire-mesh is used to prevent sheep and other grazers from nibbling on the foam windshield which protects the microphone.

Detector: *SM2bat+ detector unit with SMX-U1 microphone attached*

Location: T4 feature **Date:** 1st September 2017 **Source:** *Blackstaff Ecology*

Description
Straining post on a fence in grassland approximately 85m from T4 with the microphone set to monitor activity along the same stream/drain as for T3 (but further upslope). Wire-mesh is used to prevent sheep and other grazers from nibbling on the foam windshield which protects the microphone.

Detector: *SM2bat+ detector unit with SMX-U1 microphone attached*

Location: Turbine 5 **Date:** 1st September 2017 **Source:** *Blackstaff Ecology*

Detector: *SM2bat+ detector unit with SMX-U1 microphone attached*

Description

Old low stone wall in marshy grassland about 10m from T5 with the microphone set towards the turbine location.

Wire-mesh is used to prevent sheep and other grazers from nibbling on the foam windshield which protects the microphone.

Location: T5 feature **Date:** 1st September 2017 **Source:** *Blackstaff Ecology*

Detector: *SM2bat+ detector unit with SMX-U1 microphone attached*

Description

Collapsed gorse bushes in grassland about 140m from T5 with the microphone set to record activity along another tributary of the Curly River. This survey location is just within the 100m plus the rotor radius (150m) as required under Chapter 10 of the 2012 BCT guidance on windfarms.

Location: Turbine 6 **Date:** 1st September 2017 **Source:** *Blackstaff Ecology*

Description

Old hawthorn tree (the only raised structure nearby) in the side of a small crag in wet heath about 15m from T6 with the microphone set towards the turbine location.

Detector: *SM2bat+ detector unit with SMX-U1 microphone attached*

Location: T6 feature **Date:** 1st September 2017 **Source:** *Blackstaff Ecology*

Description

Straining post along fence which marks the boundary between the grassland/wet heath of the lower slopes with the blanket bog/wet heath of the plateau. within 44m of T7. Both watercourse (west and east of the turbine) are >150m as required BCT 2012.

Detector: *SM2bat+ detector unit with SMX-U1 microphone attached*

Location: Turbine 7 **Date:** 1st September 2017 **Source:** *Blackstaff Ecology*

Description

Fenceline some 25m from T7. Habitat is poor marshy grassland grazed by sheep.

Detector: *SM2bat+ detector unit with SMX-U1 microphone attached*

Location: T7 feature **Date:** 1st September 2017 **Source:** *Blackstaff Ecology*

Description

Fenceline near access track 150m from T7. The nearest river is >170m away and outside the required survey distance. Tracks are occasionally used as navigation aids by commuting bats (as echolocation is energy demanding) and this was monitored as a precaution.

Detector: *SM2bat+ detector unit with SMX-U1 microphone attached*

Location: Turbine 8 **Date:** 1st September 2017 **Source:** *Blackstaff Ecology*

Description

Fenceline over-looking poor marshy grassland within 15m of T8 with the microphone set towards the turbine location.

Detector: *SM2bat+ detector unit with SMX-U1 microphone attached*

Location: T8 feature **Date:** 1st September 2017 **Source:** *Blackstaff Ecology*

Description

Further along the same fenceline with the microphone orientated to capture any bat activity occurring between the dam pond and the adjacent forestry plantation.

Detector: *SM2bat+ detector unit with SMX-U1 microphone attached*

Location: Turbine 9 **Date:** 1st September 2017 **Source:** *Blackstaff Ecology*

Detector: *SM2bat+ detector unit with SMX-U1 microphone attached*

Description

In marshy (PMGRP) grassland within 10m of T9 with the microphone set towards the turbine location.

Wire-mesh is used to prevent sheep and other grazers from nibbling on the foam windshield which protects the microphone.

Location: T9 feature **Date:** 1st September 2017 **Source:** *Blackstaff Ecology*

Detector: *SM2bat+ detector unit with SMX-U1 microphone attached*

Description

Old fence at edge of coniferous plantation shelterbelt some 177m of T9 with the microphone to monitor along the edge of the trees.

Wire-mesh is used to prevent sheep and other grazers from nibbling on the foam windshield which protects the microphone.

Photographs of BRP (Bat Roost Potential) Survey of Old Building adjacent to Site Entrance.

Location: Site entrance **Date:** 17th September 2017 **Source:** *Blackstaff Ecology*

Description

Old building with a model tin roof near the proposed site entrance.

Location: Site entrance **Date:** 17th September 2017 **Source:** *Blackstaff Ecology*

Description

Interior of old building, sheep have access to the building and the interior was in a poor state of repair.

Location: Site entrance **Date:** 17th September 2017 **Source:** *Blackstaff Ecology*

Description

There is no space for a significant roost as there is no enclosed attic or insulated layer between the tin roof and the ceiling. The loose brickwork was searched with a high-powered torch and no evidence of bats was found.

Location: Site entrance **Date:** 17th September 2017 **Source:** *Blackstaff Ecology*

Description

There was lots of debris on the ground and most gaps appeared to have been used by nesting jackdaws or swallows.

Location: Site entrance **Date:** 17th September 2017 **Source:** *Blackstaff Ecology*

Description

Plenty of airspace for bats to fly in the building for socialising or as a night roost, however no droppings or other field signs were evident.

Location: Site entrance **Date:** 17th September 2017 **Source:** *Blackstaff Ecology*

Description

One of the rooms did have a lining between the interior and the tin sheeting, however this thin material was almost see-through with a high-powered torch. Again no evidence of bats was noted.

Appendix 6.7: Herpetological Survey Report

Introduction

1. This study has been commissioned as part of an Environmental Impact Assessment (EIA) for the construction and operation of the proposed wind farm. The study forms part of a series of ecological surveys, the results of which will be used to inform the ecological impact assessment for the proposed development. The specific aim of this study is to gather background information to inform a baseline ecological assessment of the herpetological interest of the site. The data was collected through a combination of desk study and field surveys, which were then used to identify constraints to be considered during the design, construction and operational phases of the development.
2. This report details the findings of the selected herpetological surveys undertaken at Dunbeg South, County Blackstaff Ecology was commissioned by RES UK & Ireland Ltd (RES) to provide information to inform a Habitat Regulations Assessment (HRA) for a proposed wind farm at Dunbeg South, near Limavady, Co. Derry/Londonderry.
3. in relation to a proposed wind farm application. Surveys were undertaken (under licence) during Spring 2017 in order to inform an assessment of the potential impacts the Development may pose to local lizard & newt populations. The surveys were undertaken with due regard to the Northern Ireland Environment Agency's (NIEA) specific requirements for lizard & newt surveys (in effect at the time of survey). In addition, any adhoc observations of these species recorded during visits to the site were used to supplement the surveys.

Statement of Authority

4. The author of this survey report is Cormac Loughran; he is a full member of the Chartered Institute of Ecology and Environmental Management (MCIEEM) and has worked professionally as a Consultant Ecologist for thirteen years. He holds an MSc (Distinction) in Environmental Management from the University of Ulster, and has extensive experience in herpetological surveys; having undertaken and coordinated similar surveys and impact assessments for numerous major infrastructure projects including several wind farm developments, roads schemes and overhead power lines.
5. Cormac is also an experienced field naturalist and prior to his consultancy work, he worked as a warden/ranger for The National Trust on a number of important nature reserves including Crom Estate in County Fermanagh, and Murlough NNR in

County Down; the former is a stronghold of the smooth newt while the latter is an important site for common lizards in Northern Ireland.

Common lizard *Zootoca vivipara*

Methodology

6. A common lizard survey was undertaken in accordance with the NIEA survey specification (NIEA 2017[1]) in order to establish the presence of common lizard within the survey site. An initial site visit was undertaken in April 2016 to identify suitable basking habitat and to design a walked transect. The site and surrounding area was initially walked to identify potential natural basking spots. However, in order to supplement these 'natural' basking areas within the site boundary, 40 artificial refugia were placed around the site.
7. In addition to the NIEA methodology, consideration was also given to the Draft survey protocols for the British herpetofauna. The latter document references (Sewell et al. 2012[2]) who demonstrated that four to five survey visits (depending on species) is usually sufficient to detect 95% of occupied sites, for the commoner British reptile species, providing a combination artificial refugia are used in addition to walked transect searches. The document also recommends that artificial refugia should be laid for a few weeks before surveys begin.
8. For presence/absence purposes, Sewell has demonstrated that surveys are acceptable providing artificial refugia are used in addition to transects; although, the number may need to be increased for surveys on marginal reptile sites. The same study suggested that at least 30 refugia should be laid for presence/absence purposes, but this number applied regardless of the size of site as long as the refugia were appropriately positioned.
9. Therefore, for this survey 40 refugia were used. Transects incorporated both walking slowly scanning the ground 3-4 m in front for the presence of basking lizards in suitable habitat, as well as checking the artificial refugia which had also been placed across a part of the site (see Figure 6.8).
10. The refugia were placed on site on the 20th & 27th April and the first survey commenced on the 21st June 2017. Forty bitumen backed carpet tiles (500 x 500mm) were placed on the ground, in vegetation or at the edge of vegetation; a south facing aspect was chosen whenever possible.

1 Common or Viviparous Lizard Surveys – NIEA Specific Requirements, Northern Ireland Environment Agency (17 February 2017).

2 Sewell, D., Guillera-Arroita, G., Griffiths, R.A. and Beebee, T.J.C. (2012). When is a species declining? Optimizing survey effort to detect population changes in reptiles. PLoS ONE 7(8): e43387. doi:10.1371/journal.pone.0043387

11. Transects were walked slowly scanning the ground 3-4m in front for the presence of basking lizards in suitable habitat. Surveys were undertaken across three visits during June, July and August 2016. All surveys were undertaken when weather conditions were forecast to consist of temperatures >9°C (and <18°C) with sunshine and little or no wind or precipitation. Surveys were also undertaken early in the day (or after 4pm), whenever possible on a day when the preceding night was cool, with little cloud cover. This is when lizards are in greater need of the thermal benefits of basking on artificial refugia and are therefore more easily observed.

Table 1: Results of the common/viviparous lizard surveys carried out during 2016

Date/Time	Weather	Results	Notes
21/06/16 (start 1005, finish 1335hrs)	12.5°C at start, and 17.5°C by end. Fine, dry and warm, but with a cool breeze after a clear cold night	3 lizards recorded	Smooth newt metamorph under one of the refugia also
08/07/16 (start 1730, finish 1930hrs)	15°C, 70% sun with a light breeze	3 lizards recorded (one while walking (& 2 newts also under refugia))	
31/08/16 (start 1030, finish 1230hrs)	16°C, 50% sun with a gentle breeze	No lizards recorded	1 newt metamorph (waypoint 353)

Further survey

12. The scope, extent and seasonal timings of the surveys completed for the Development are considered to be in line with current guidelines and more than adequate to allow a robust assessment of the potential impacts of the construction and operation of the proposed wind farm at Dunbeg South to be completed.

Evaluation

13. A maximum total of 6 adult lizards were recorded using a total of five refugia (see Figure 6.8). The results of the common lizard surveys reveal a population score of 2 (good population[3]) (with 6 individuals recorded). It is likely that the habitats surrounding T3 as well as adjacent to T5 and T6 are optimal habitat for this species. Albeit, optimal habitat that is partially degraded via overgrazing. Whereas the habitats surrounding T1, T2 & T4 are poorer quality habitat for common lizard (i.e. improved grassland). Finally, the habitats surrounding T7, T8

[3] Froglife Advice Sheet 10 Reptile Survey, an introduction to planning, conducting and interpreting surveys for snake and lizard conservation

& T9 are likely to be sub-optimal (due to heavy sheep grazing) but that lizards are likely to be present (at low population densities).

Mitigation measures

14. In the case of common lizard, it has been impossible to avoid impacts to this species, given the layout constraints. Therefore, the next course of action is to mitigate for any potential impacts.
15. The results of the common lizard surveys for the Development were assessed against the Key Reptile Site Survey Assessment Categories (HGBI 1998). This revealed that parts of the Site had a good population (with seven individuals recorded). However, given the location of the records, it is also likely that much of the site is sub-optimal habitat for this species. This is likely a consequence of over-grazing and drainage.
16. Depending on the commencement of construction on site, the works corridor will be mowed. If possible, this work will be undertaken before the end February (to avoid a conflict with the bird breeding season). If this is not possible, then mowing will take place between August and September, when common lizards are likely to be fully active. Should the latter be required, the corridor will be subjected to an active nest survey by a suitably qualified ornithologist immediately prior to the commencement of mowing operations.
17. Clearance of stones, tree stumps, logs, brash, rocks or piles of similar debris will be undertaken carefully and by hand. Although this is only required in a few areas where the proposed site tracks traverse low stone walls. This work will not take place during the hibernation period for common lizard (i.e. mid-October to mid-March).
18. Clearance of tall vegetation will be undertaken using a strimmer or brush cutter with all cuttings raked and removed the same day. Cutting will only be undertaken in a phased way which will either include:
    - Cutting vegetation to a height of no less than 30mm, clearing no more than one third of the site in anyone day or;
    - Cutting vegetation over three consecutive days to a height of no less than 150mm at the first cut, 75mm at the second cut and 30mm at the third cut;
19. Following removal of tall vegetation using the methods outlined above, the remaining vegetation will be maintained at a height of 30mm through regular mowing or strimming to discourage common lizards from returning. Ground clearance of any remaining low vegetation (if required) and any ground works will only be undertaken following the works described above.
20. As an additional precaution the ECoW will be present from the commencement of clearance/construction with a watching brief to ensure that no common lizards

remain within the construction corridor and remain in situ until the area is cleared to ensure no species or habitat conflicts emerge affecting damage to the local lizard population.

21. If any common lizards are found during excavation works, all works within the affected area will cease until the ECoW has safely removed them (under licence) from the construction corridor.

22. Should it prove necessary during site supervision (i.e. lizards are observed returning to the construction corridor); a protective lizard barrier fence will be installed along both sides of the construction corridor in order to prevent common lizards and/or smooth newts from entering the works area.

23. In total, there is >500 ha (of blanket bog; dry heath and marshy grassland) adjacent to the proposed construction corridor. These areas together provide more than sufficient suitable habitat.

Mitigation licences

24. There will be a requirement for a mitigation licence in order to; take, move and release common lizards and destroy their habitat as part of construction works.

Enhancement measures

25. Implementation of site specific enhancement measures as part of the outline HMP will also help to off-set potential significant effects for this species. The translocation/restoration of wet & PMGRP; will be of significant benefit to this species (i.e. the associated increase in availability of invertebrate prey).

26. It is not proposed to construct any artificial hibernacula within this site as there are numerous natural features on site (old earth banks) which provide this aspect of the common lizard life-cycle.

Summary

27. Based on the survey results, as well as the implementation of the recommended mitigation & enhancement measures. It is considered unlikely that there will be any significant effects to the local lizard & newt populations as a result of the construction and operation of the proposed wind farm.

Smooth Newt *Lissotriton vulgaris*

Background

28. Smooth newt Lissotriton vulgaris, formerly Triturus vulgaris, (sometimes referred to as common newt) is one of just two native amphibian species found in Northern Ireland, the second being common frog Rana temporaria. Although the species is believed to have a widespread distribution across Northern Ireland, it is under

recorded. Wetland habitats and scrubland have undergone a decline across Northern Ireland, principally as a result of drainage and clearance for agricultural improvement works, resulting in a loss of habitat for the species.

29. Smooth newts are protected under Article 10 of the Wildlife (Northern Ireland) Order 1985 (as amended). It is an offence to intentionally or recklessly kill, injure or take any wild animal included in Schedule 5 of this Order, which includes the smooth newt. It is also an offence to intentionally or recklessly:

    (i) Damage or destroy, or obstruct access to, any structure or place which newts use for shelter or protection;

    (ii) Damage or destroy anything which conceals or protects any such structure;

    (iii) Disturb a newt while it is occupying a structure or place which it uses for shelter or protection.

30. Being amphibians, newts require an aquatic environment for spawning and a terrestrial habitat outside of the breeding season for feeding and hibernating. Permanently wet ditches, ponds, and lakes are chosen for spawning with flowing water such as streams avoided. Newts hibernate over the winter so the adjacent terrestrial habitat must have suitable refugia such as fallen logs, rank dense vegetation, and loose stones etc. that offer protection from frosts. The breeding season for newts varies across Northern Ireland, with newts in lowland areas spawning earlier than those found at higher altitudes. In general the spawning season commences in March and can continue through to late May.

31. The dominant habitat type at Dunbeg South is heathland and grassland. Newts, unlike frogs, tend to avoid bogs as they display a preference for less acidic waters.

Methodology

32. The NIEA guidelines for smooth newt surveying require that;

    - A license to survey for newt presence and abundance must be obtained from the NIEA Wildlife Team before commencement of the survey. Bottle traps are not permitted in Northern Ireland.
    - NIEA recommends that all works comply with British Standard 42020:2013, which came into effect on 31 August 2013. The British Standard provides recommendations and guidance for those engaged in planning and development, whose work might affect or have implications for conservation, or the enhancement of biodiversity.
    - The applicant must ensure that the commissioned surveyor(s) has the necessary experience and qualifications to carry out this work. It is

preferable that the surveyor(s) is a member of the Chartered Institute of Ecology and Environmental Management (CIEEM).

- The date, time, weather conditions of the survey and the qualifications of the surveyor(s) must be included in the survey report.
- Newt surveys can only be carried out between mid-March and mid-June.
- Surveys must be carried out within one year of submission to the Department.
- The survey must establish whether newts are present, and if applicable, their status in the water-body and surrounding potential terrestrial refugia sites. The survey must include any suitable terrestrial habitat within 200m of the water body.
- The survey methods and survey effort must be proportional to the ecology and size of the site.
- The information must be presented in a written report and include large scale maps. The methods used for survey must be included within the survey report. All evidence of newts found, for example eggs, or sightings, must be included. Any equipment used must be included in the report.
- If necessary, the report should recommend the most appropriate ways in which newts can be protected from adverse impacts caused by the development. Mitigation measures should cover all phases of the development - before, during and after construction. The survey should also stipulate whether the proposed mitigation measures will require a Protected Species License.
- In the event that the planning application goes to appeal or public inquiry, persons contracted to carry out surveys may be required to appear at, or give evidence to the appeal or inquiry.

Surveys

33. Standard survey methodology for smooth newt consists of three principal components, one involving daytime searches of waterbodies and surrounding terrestrial refugia, the second involving searching for eggs on submerged vegetation, and the last which involves post-dusk torch searches of waterbodies. These three survey components ensure that all stages of the smooth newt's life cycle are considered; both aquatic and terrestrial.
34. Daytime surveys of waterbodies involve the surveyor walking around the waterbody's perimeter and searching every 2 metres of the shoreline to ensure all parts of the waterbody are searched. This involves both visual searches for adult

newts and larvae, but also searching submerged vegetation for eggs (which are deposited singly within a folded leaf).

35. Post-dusk waterbody surveying requires a torch (minimum of 500,000 candlepower) to ensure satisfactory illumination of the waterbody base. If newts are observed using torchlight, it is important that the torchlight beam is not held on them any longer than necessary so that potential damage to their eyes is avoided.

36. Terrestrial surveying of all potential refugia within a 200m diameter of waterbodies involves the lifting of stones, dead wood and other debris to check for smooth newt, particularly efts. Care must be taken to ensure any disturbed potential refugia are replaced carefully. Man-made debris and rubbish such as plastics, discarded tyres and timber, although undesirable on the landscape, are often used by smooth newt as refugia particularly in the vicinity of farms and should also be included in the search.

Results

37. Smooth newt surveys were carried out on site on the 8th June 2016 at the dam pond on the site (see Figure 6.8). This pond is located within 200m of the track between T5 and T7 and T7 and T8.

Table 2: Results of the 2016 surveys for smooth newt

Date/Time	Weather	Results	Notes
08/06/16 nocturnal survey	17^{o}C, cloudy, dry and mild with little wind.	2 adults recorded.	No eggs were found; however, 2 were recorded during torching. None under refugia

38. The majority of the habitats at Dunbeg South are not considered suitable for smooth newts, due to the abundance of heathland and grassland, however, the pond on site is clearly suitable. It has all the elements necessary for the smooth newts to complete their life-cycle. The pond has extensive coverage of dense vegetation cover, floating on the surface. This is the waterbody in which to breed and drier areas with abundant hibernacula. The only thing absent is woodland cover (often favoured by newts), however the conifer plantation to the east is likely to be a surrogate for native woodland in this instance.

Further survey

39. The scope, extent and seasonal timings of the surveys completed for the Development are considered to be in line with current guidelines and more than adequate to allow a robust assessment of the potential impacts of the construction and operation of the proposed wind farm at Dunbeg South to be completed.

Mitigation measures

40. The current infrastructure layout includes sections of track (illustrated on Figure 6.8) within the 200m buffer which surrounds the smooth newt breeding pond. Therefore, mitigation is required in order to reduce any potential significant effects to this protected species.

41. It is proposed that any newts migrating from adjacent coniferous plantation (Springwell Forest) towards the pond would be captured using a combination of drift fencing (during the construction phase), along with pitfall traps in order to prevent access by newts to the works area.

42. The drift fencing would consist of UV-resistant plastic stretched between poles with wire to present a barrier 50-60cm high and would be dug into a depth of 10-20cm below ground level to prevent access underneath. This would be positioned for 200m along both sides of the proposed access track (southwest of the smooth newt breeding pond (as shown on Figure 6.8)).

43. Twenty number plastic 10-litre buckets would be buried with the rim at ground level and placed firmly against the fence (ten either side of the track) in order to catch any newts migrating towards the pond. The traps would contain 10cm depth of water at all times and would be checked daily (between the first erection of the fence (prior to the 15 March) and the completion of construction. This mitigation program would be carried out during both the spring migration (mid-Feb to mid-Apr) towards the pond and the autumn migration (mid-June to mid-August) towards hibernation areas.

44. This would be carried out under licence; and once construction is completed the newt fencing would be removed to allow the newt's access to the wider site again. The Project EcoW would also be present on the site immediately prior to and during clearance of site vegetation in order to comply with any likely Wildlife Licence relating to the proposed mitigation. The EcoW would also supervise the erection of the drift fence, the checking of the pitfall traps (and associated removal of any newts to the breeding pond).

45. A newt hibernaculum would also be created (to the southeast side of the pond); so as to reduce the need for newts to have to cross the wind farm access track towards the conifer plantation (located on the opposite side of the new access track). An example of a suitable hibernaculum can be found below.

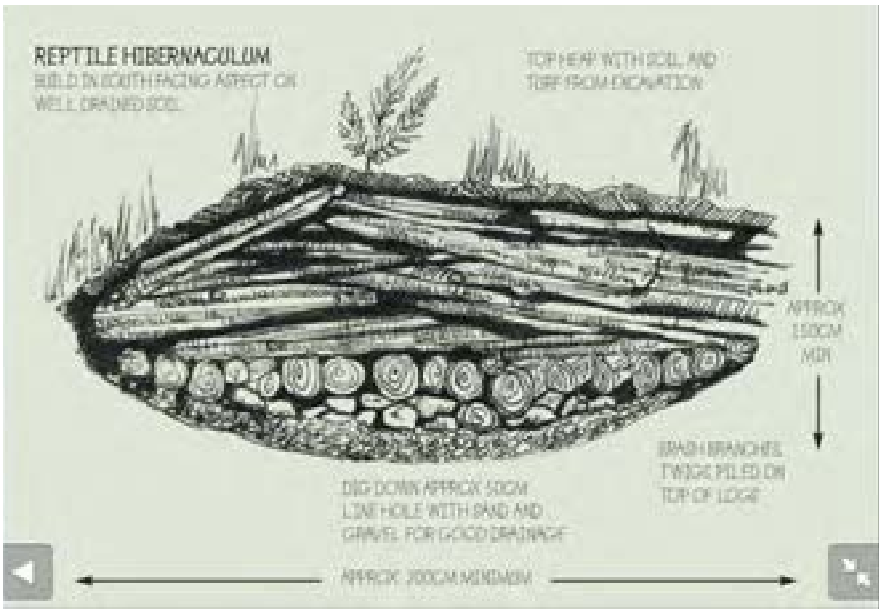

Plate 1 – An example of how the artificial refugia will be constructed

Appendix 6.8 –
Outline Habitat Management Plan

Dunbeg South Windfarm

Environmental Impact Assessment 2017

Appendix 6.8 - Outline Habitat Management Plan

041/2017-01

October 2017

Ecological Assessment | Ecological Clerk of Works | Bat Surveys | Badger Surveys
Biodiversity Checklists | Ornithological Assessment | Preliminary Ecological Appraisal

Blackstaff Ecology

041/2017-01

Document history

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Issue	Date	Revision Details
A	13/10/2017	First Issue

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Contents

Introduction

1. This outline Habitat Management Plan (HMP) has been produced by Blackstaff Ecology on behalf of the Developer, RES Ltd. The HMP seeks to deliver ecological mitigation and enhancement measures associated with Dunbeg South Windfarm. It is intended to inform a broad audience including DAERA (NIEA), Ecologists and Local Authority Planning Officers. It is intended to be simple and effective.

2. It is envisaged that the HMP will represent an iterative and adaptive process which will continue to be informed by new guidance and best practice and will be guided by the Project Ecologist/ECoW. The Project Ecologist will liaise with appropriate specialists from the Council, NIEA and RES Ltd. Subsequent document review will be informed by monitoring, to ensure the scope of the HMP remains appropriate and the objectives successfully achieved.

Background Information

3. The project has been subject to Environmental Impact Assessment through which a range of impacts on ecological features have been identified and mitigation measures set out.

Consultations

4. This HMP has been produced to enable the Development to meet the requirements of the DAERA consultation response (07 July 17), as detailed below;

> *A Habitat Management Plan should form part of the ES. This should show how the habitats, flora and fauna of the site will be protected during and after construction. It should include a long-term plan for the management of the site for nature conservation and, if appropriate, show details of compensation measures such as habitat creation.*
>
> *Habitat restoration and creation measures must be carefully considered and a rationale provided for the choice of measures. Techniques for habitat restoration and creation must be detailed, site specific and follow current best practice. Evidence should be provided which shows that the proposed measures have a reasonable likelihood of success. If proposed techniques are unproven then a more detailed description and rationale for their use will be required. Proposed measures must have clearly defined criteria for success so that they can be adequately measured and monitored.*
>
> *The HMP should include a long term monitoring plan, detailing how the ecology of the site will be monitored to demonstrate the success of any proposed mitigation, compensation or enhancement measures. The monitoring plan must span and appropriate time frame depending on the type of development, the habitats and/or species being monitored, and the likely timescales of and habitat restoration or creation measures. The monitoring plan must include measurable targets and details of contingency measures should monitoring reveal unfavourable results.*
>
> *Consideration mist be given to the long-term ecology of the site at the end of the lifetime of the development. For example, it may not be appropriate to leave infrastructure, such as access tracks, in place where sensitive habitats are present when this could lead to the long-term degradation of these habitats. Issues such as these must be adequately addressed within an appropriate Decommissioning and Restoration Plan.*

5. This HMP ensures the DAERA requirements described above are appropriately considered before, during and following construction works. This HMP also considers the requirement for an appropriate Decommissioning and Restoration Plan.

Planning Policy Statement 2

6. Planning Policy Statement 2 (Natural Heritage) - Policy NH 5 Habitats, Species or Features of Natural Heritage Importance states that; *Planning permission will only be granted for a development proposal which is not likely to result in the unacceptable adverse impact on, or damage to known*:

- *priority habitats;*
- *priority species;*
- *active peatland;*
- *ancient and long-established woodland;*
- *features of earth science conservation importance;*
- *features of the landscape which are of major importance for wild flora and fauna;*
- *rare or threatened native species;*
- *wetlands (includes river corridors); or*
- *other natural heritage features worthy of protection.*

7. A development proposal which is likely to result in an unacceptable adverse impact on, or damage to, habitats, species or features may only be permitted where the benefits of the proposed development outweigh the value of the habitat, species or feature. In such cases, appropriate mitigation and/or compensatory measures will be required.

8. Priority habitats and species may fall within and beyond designated sites. They include both European (as identified under Annex I and II of the Habitats Directive and Annex I of the Birds Directive) and Northern Ireland priority habitats and species, identified through the Northern Ireland Biodiversity Strategy (NIBS) 27 (in pursuance of the statutory duties under the Wildlife and Natural Environment (NI) Act 2011.)

9. To ensure international and domestic responsibilities and environmental commitments with respect to the management and conservation of biodiversity are met, the habitats, species and features mentioned above are material considerations in the determination of planning applications.

10. It is therefore expected that wind farm proposals will provide measures that enhance the site for biodiversity, and this expectation is reflected within the Causeway Coast & Glens Borough Council consultation responses from the Pre-Application Notice and in particular the response from DAERA NED. Accordingly, RES (supported by Blackstaff Ecology) have been exploring opportunities for habitat management at the site, which would operate throughout the wind farm's consented lifespan through a dedicated HMP.

Project Ecologist/ECoW

11. The role of the Project Ecologist/ECoW will be to measure the success of the HMP in line with objectives, ensure the frequency of monitoring is adhered to (and after year five), assess the requirement for any remedial measures or changes to the existing prescriptions in light of monitoring results and new emerging guidance and best practice. The ECoW will consult with and take advice (as appropriate) from representatives from the following key stakeholders:

- *DAERA (NIEA NED)*
- *The Planning Authority*
- *RES Ltd*

Summary of EIA Findings

12. The Dunbeg South Windfarm will result in permanent habitat loss of 6.9ha and temporary habitat loss of 3.3ha, largely comprising purple moor-grass & rush pasture (PMGRP) and wet (dwarf shrub) heath, although small areas of other habitats will also be lost, such as acid grassland mosaic and poor semi-improved grassland. Habitat loss figures are reported in Chapter 6 - Ecology.

13. A summary of the extent of loss of habitat types which represent Priority Habitats in the Northern Ireland Habitat Action Plan (HAP) are shown in Table 1 below. The habitat calculations provided in the ES distinguish between the 'permanent' and 'temporary' habitat loss. Also, the areas of 'permanent' represent real world calculations based on the experience of the author and best practice and are not 'idealised' calculations which can occasionally underestimate the 'permanent' while overestimating the 'temporary' habitat loss.

14. In summary, the loss of HAP habitats will comprise 0.7ha of 'wet heath'; in addition, the ES reported a loss of 5.44ha of purple moor-grass & rush pasture (PMGRP), which was likely to have been NI HAP habitat in the recent past (circa 15-20 years). The extent of habitat loss has been used to inform the prescriptions detailed in this HMP, including a commitment to establish at least twice the area lost for PMGRP and five times for wet heath (an NI Priority Habitat).

Table 1: Temporary and Long-Term Habitat Loss

Habitat	Temporary Loss (m2)*	Long Term Loss (m2)	Total Loss (m2)
M15/M15d	1785	7038	8823
M23a (turbines)	5355	21114	26469
M23a (new tracks)	21250	29750**	51000
M23a (upgraded track (existing track +3m)	2917.5	3500	6417.5
U4d (turbines)	892.5	3519	4411.5
Semi-improved grassland (Compound & substation)	982.9	4006.26	4989.16

**Based on a continuous 2.5m buffer around all construction structures*
***Based on 7m wide track (5m for running surface and 1m either side for drainage.*

15. The ES chapter specified a range of mitigation measures to avoid, or where this was not possible, minimise detrimental effects on certain habitats and species. Enhancement measures were also specified to achieve benefits for biodiversity within the site as a whole, in accordance with planning policy requirements. It is these mitigation and enhancement measures that will be delivered via this outline HMP and are illustrated on Figure 6.9 – Habitat Management.

NIEA HAP – Minimum Habitat Targets

16. Several NI Habitat Action Plans (HAP's) have been produced by NIEA. Each HAP contains a series of action plans covering the nationally threatened or declining habitats in Northern Ireland. Each action plan includes actions aimed at safeguarding that particular habitat. As a result, the HAP's for wet heath and PMGRP was used to guide and develop the objectives set out in this HMP to maximise the contribution towards the aims of the NI HAP. Table 2 below demonstrates how the HMP objectives will contribute to the NI HAP targets.

17. NIEA has suggested that habitat establishment should seek to provide five times the habitat area lost for habitat types represented in the HAP. As a result, minimum target areas have been established for each habitat type and are also provided in Table 2 below.

Table 2 - Minimum establishment targets for NI HAP habitats

Relevant component habitats	Associated species of principal importance	Contributing HMP objectives	Area to be lost to the Development	Area proposed to mitigate for the loss
Purple moor-grass and rush pasture	- Irish hare - Marsh fritillary - Various invertebrates - Various plants - Curlew, lapwing	Establish and maintain species- rich grasslands Retain, protect and maintain area of marshy grassland	5.44 ha	10.88 ha
Upland heath	- skylark, meadow pipit, cuckoo, grasshopper warbler, curlew, lapwing, golden plover, red grouse, hen harrier - Irish hare - Juniper, bog orchid, stags horn club moss, globeflower, wood bitter vetch	Establishment of heathland and acid/marshy grassland mosaic in semi-improved grassland Establishment of heathland and acid/marshy grassland mosaic alongside new access tracks	0.7 ha	3.5 ha

Other relevant Action Plan Targets

18. There are a number of NI HAP targets for Upland Heath which the actions within this OHMP could contribute towards meeting, including;

- Maintain the current extent and overall distribution of upland heathland which is currently in favourable condition.

- Improve by management at least 50% of upland heathland currently in unfavourable condition outside ASSIs by 2010.

- Seek to increase dwarf shrubs to at least 25% cover where they have been reduced or eliminated due to inappropriate management. A target of 2,000 ha is proposed for such restoration by 2010.

- Initiate management to re-create 100 ha of upland heathland by 2010 where heathland has been lost due to agricultural improvement or afforestation, with a particular emphasis on reducing fragmentation of existing heathland.

19. There are also similar HAP targets for PMGRP which the OHMP could potentially contribute towards, including;

- Maintain the total extent of PMGRP in Northern Ireland. at 18,919 ha.

- Maintain condition, where favourable, of the existing resource.

- For stands outside ASSIs, achieve favourable condition over 75% of the resource by 2015.

Mitigation for Wet Heath

Background

20. Turves of heathland vegetation and associated topsoil from construction activity represent a valuable resource that can be used in the restoration of bare areas. Turves must be cut so that they include the root systems and mineral soil as this will ensure any viable seeds are also captured. Turves can be laid in blocks or in a patchwork over bare areas; over time heathland will develop within gaps and will provide a mosaic of structure.

21. At both locations (around T3 & T6) the vegetated turves will be lifted to a depth of approximately 25-40cm, (i.e. total depth of topsoil at each location)

22. Approximately 7038m2 of turves, each measuring 1·2m x 2·3m x c.35cm, will be transferred to the translocation site using an excavator fitted with a steel tine bucket. Any prolonged spells of dry weather will necessitate irrigation of the turves between May and September (inclusive).

Recipient Site Preparation (translocation)

23. The process of habitat recreation & restoration will be divided into three distinct phases: The first phase is the preparation of the site. This will involve de-nutrification (by turf removal at the recipient site (although the resulting turves will be used for reinstatement along the track edges)) and localised landscaping to create a more natural uneven surface. This will be in the form of a single 30cm plough furrow and ridge will be made across the slope (i.e. following the contours of the land), this will be repeated at 3m intervals across the entire HMP area (for both wet heath & PMGRP). This will slow overland sheet flow (from rainfall) and significantly increase soil moisture levels over the current situation.

24. The turves in the recipient site will be removed in a patchwork (and not as a single 0.7ha block). This will (along with over-seeding detailed later) encourage heathland to develop in the gaps.

25. The second phase is the introduction of the wet heath by turf translocation. The invertebrate fauna will not have to be introduced as the restoration site is immediately adjacent to the established pockets of more species-rich sward.

26. The third phase is the manipulation of management techniques to drive the development of the plant communities towards the desired habitat type.

27. The most commonly used methods on heathland are mowing, burning and grazing, with grazing considered to be the only acceptable management technique. This programme of heathland restoration will involve the translocation of 0.7ha of turf from within the red line boundary (e.g. at turbine location) to a prepared site immediately outside the development area and within the Land Under Applicant Control (See Figure 6.9 – Habitat Management), which will maintain the provenance of the habitat.

28. The movements of translocated turves will only be permitted within the land under applicant control (i.e. the blue line on Figure 6.2). Macro-turving will only be permitted on to existing poor semi-improved (acid/marshy) grassland (and more diverse swards will be avoided). All works associated with the restoration and translocation will be carried out under the supervision of a suitably qualified Ecological Clerk of Works (EcoW).

Turf Translocation

29. Prior to the commencement of the main works, the areas of wet heath will be translocated into the restoration area using large-scale turfing equipment, using a technique known as "macro-turfing", (i.e. moving large, thick turves). This method has many advantages over traditional turfing, virtually eliminating problems of frost and drought damage, and because the turves are thick, most burrowing invertebrates and deep-rooted plants survive.

30. The timing of the main construction works will likely dictate when the area destined for restoration will become available. However, this work will be completed during the autumn/winter months if possible using macro-turfing methods to remove turf to the site, with the most species-rich turf being placed in the optimum positions and the less rich in less favourable areas.



Photos 1–3; Examples of (Macro-turf) Translocation.

31. Care will be taken to give a natural effect and recreate as closely as possible the original shape of the hill. The landscaping of the site will be carried out from the top downward in order to preserve areas of potentially useful turf. The restoration area will be surrounded by stock-proof fencing. This is to protect not only the developing turf and invertebrate populations in the early stages of colonisation. As soon as the turf develops sufficiently, sheep will be allowed access (to DARD CMS stocking levels (for wet heath) only) as they are seen as an important element in the management of this particular sward. The fencing will also allow close control of the grazing animals, and therefore close control of the condition of the habitat in the restoration area (See Figure 6.9 – Habitat Management).

Ground preparation (heather seeding)

32. The total area of wet heath restoration is 3.5ha, however the area of translocated turves is only 0.7ha, therefore additional measures are needed to convert the wider area to wet heath. This will be done by over-seeding of the area using material collected from upslope around T3.

33. Experience (by Plantlife) creating semi-natural habitats elsewhere has shown that, as long as the soil isn't too fertile and there aren't too many 'weeds' in the soil seed bank, the harder you hit the area at the start of the restoration the better the results in the end. This is especially the case were a thick layer of 'thatch' has built up, i.e. there is a deep mat of interwoven dead grass forming a barrier over the soil.

34. In order to ensure that there are sufficient germination sites within the prepared area, there is a need to remove as much of this thatch as possible and break open the soil surface so that seed from the brush-harvesting can find bare soil in which to germinate.

35. In order to achieve this, a tractor mounted flail mower will be used on the site. A flail mower is basically a large hedge cutter that sits on the ground and is pulled across the field by the tractor, a cylinder of heavy duty cast iron cutters rotate at high speed, ripping and cutting away the grasses/rushes down to the level of the soil surface. All the material generated will also be collected in a hopper. This work will be undertaken using specialist contractors experienced in the use of the restoration techniques prescribed.

36. After the completion of the flail cutting/material removal, the thick grass sward (within the wet heath HMA) will be replaced by a heavily worn-out looking field of vegetation consisting of grass less than an inch high, with numerous patches of bare soil. Once the HMA has been cut with the flail mower, the area will then be worked over with a harrow.

37. The harrow will be dragged behind a tractor, its sprung metal tines are used in order to remove the thick thatch and expose the soil. On long grass it will collect a huge amount of material, but will also create deep scratches in the earth, (which are left after the harrowing is complete) are perfect for seed germination.

38. Once both the heavy flailing and harrowing have been completed the HMA will be fully prepared with modest areas of bare ground available for germination. Importantly however, the grass roots are not completely removed or stripped. They will be left under the soil surface, and will grow back. Although, after this treatment the regrowth won't be as thick and there will be space for the heather and other harvested plants to grow.

39. The ground preparation will only be carried out after the 01 September (or before the 01 March (in any year)). However, the exact date (within the specified period) will be dependent on the commencement of construction, (as it is proposed that the restoration works will be carried out the same time (or immediately prior) to construction.

Photo 4: An example of a heavy-duty flail mower (& collector)

40. The heavy-duty flail mower above is capable of clearing grass/scrub up to 75mm diameter. Ideal for annual cutting of conservation and wild flower areas and scrub clearance

Photo 5: A harrow being used to prepare a grassland restoration area.

41. In order to assuage any concerns that part(s) of the proposed HMAs (where ground preparation is recommended) lie within/or near to hydrological buffer zones (which may not be appropriate for heavy works); as the photograph below illustrates the proposed management technique leaves the roots intact and therefore the potential for run-off into nearby streams is minimal. These works have less of an impact than ploughing an arable field or re-seeding grassland which is typical within local agricultural management systems.

Photo 6: The ground after both flailing and harrowing have been completed.

42. Prior to spreading of heather seed, the soil will be prepared in accordance with best practice to maximise the germination and rate of establishment of heather seed. The seed will be sown in spring (April) at a rate of 2-4 grams per m^2 and will be rolled after seeding to ensure contact with the soil. The area will remain fenced during establishment to encourage heather and dwarf shrubs to colonise. Once target habitats have established, grazing stock may be reintroduced as part of the existing management of the wider field enclosure and monitored to ensure continued maintenance of target habitat types.

Evidence that the proposed measures have a reasonable likelihood of success

43. A comparison of techniques for restoring heathland on abandoned farmland[1], found that the best result was from translocating turves. Although there is the potential for the loss of *E. tetralix* to potentially occur, causing the plant community to change from one which was wet heath to one which is transitional between humid and dry heathland, or even to one that is dry heath only. Therefore, methods have been recommended to match the soil drainage/retention characteristics of the donor and recipient sites and to maintain the soil moisture regime of the turves. This will involve both cutting at a depth of 350mm (i.e. as deep as is possible (given the peat depths at T3 & T6)) in order to lift all the roots and as much of the soil/peat as possible. In addition to this, the ground in the receptor site will be prepared in advance in order to create a varied surface topography, immediately prior to the placement of the donor turves. This varied topography will result in a range of hydrological conditions (e.g. wetter hollows and drier tussocks).

44. It should be noted however that dry heath is also part of the Upland Heath HAP and thus an NI Priority Habitat and this habitat (or indeed any transitional (upland) heathland habitat is acceptable compensatory habitat for the loss of wet heath as part of the Development.

Hydrological monitoring

[1] *Journal of Applied Ecology* (1995) 32, 400-411

45. A high-water table will be maintained in the translocation site throughout each year. Drop board sluices will be used to raise the water table in the main ditch/drain which traverses the HMA between T1 and the site compound. Hydrological data for the receptor site, including precipitation, water levels and inflows from the springs and surface runoff directly into the translocation site will be collected to give monthly values for data monitoring and analysis.

46. Precipitation data from the adjacent turbine will also be recorded. Groundwater inflow from the springs will also be measured using a standard V-notch weir; assuming that the flows are within the range possible for this type of weir, which is an accurate method of timed flow and measured volume. Inflow from surface runoff will be estimated using precipitation and evaporation data (Gustard et al., 1992) in relation to very small local catchment. The water level in relation to the ground level in the translocation site will also be measured using five casagrande tipped piezometers.

Monitoring

47. In order to ensure that the proposed translocation has been effective, botanical (NVC) monitoring will be carried out for a period of five years. The results of the monitoring of the translocated sward will enable an assessment of the success of the work and to give feedback to "fine-tune" the management (if required).

48. The translocated vegetation will be monitored annually in August, with sets of vegetation-monitoring data collected based on three fixed transects which run the length of the translocation area and also 25 fixed quadrats. The results will be provided to the Planning Authority/NIEA on an annual basis along with 25 permanent fixed-point photographs and recommendations arising from the monitoring regime.

49. Percentage cover abundance data for each rooted plant species in the 25 fixed 2mx2m quadrats will be assessed to derive the National Vegetation Classification (NVC) community type using the diagnostic tables and descriptions in Rodwell (1991) and in conjunction with the MAVIS computer programme, to assist the identification of NVC communities.

50. Species frequency data will also be obtained by recording the presence/absence of each plant species in a total of 100 mini quadrats (25x25cm) at 1 m intervals along three fixed transects 5 m apart, running the length of the translocation area. An apparent limitation of this method is that the mini quadrat size was small in relation to the patch size of different species present in the translocated vegetation. However, as many species were recorded in the combined mini-quadrats and in the fixed quadrats on most monitoring occasions. Therefore, less abundant and rare species were also being detected using this method. Thus, the combination of the two different approaches to monitoring vegetation were complementary in that the vegetation pattern at two different scales was assessed.

Mitigation for PMGRP

Background

51. The objective of this mitigation is to recreate 5.44ha of PMGRP 'lost' to the Development, again through macro-turving and translocation of turves in the same manner to that described for wet heath. The only difference is that PMGRP requires the hydrological regime to be wetter. Rainfall in the area is already high, however the drainage and slope can rapidly carry water off site and into the surrounding watercourses. Measures to reduce overland flow and hold back the water will be implemented in order to maximise the likelihood that the translocated turves will survive and that the desired habitat will be maintained.

52. Ditch blocking will therefore be carried out in the one available drain that tends to run across the contour (immediately to the south (upslope) of the PMGRP translocation area). Ditch blocking would be expected to have a localised effect across an area of the HMP zone by spreading sheet flow (see SuDS technical appendix). As it will be virtually impossible to prevent water leaving the drain at discrete locations (immediately upstream of dam locations) and creating narrow wet flowpaths as it works its way down the slope. In order to combat this contour ploughing will be used to increase the effectiveness of the ditching blocking measures by impeding and distributing overland flow across the slope.

Recipient Site Preparation

53. Immediately prior to the emplacement of translocated turves from the donor site, each strip will be ploughed to a depth of 30cm (across the slope) at 3m intervals.

54. Contour ploughing or bunding is the practice of ploughing across a slope following its elevation contour lines. This technique is often used in areas where soil erosion and poor water quality is an issue. This is due to the fact that the contour lines create a water break which reduces the formation of rills and gullies during times of heavy water run-off. The numerous water breaks produced by this ploughing technique also allows more time for the water to settle into the soil. In contour ploughing, the ruts made by the plough run perpendicular rather than parallel to slopes, resulting in furrows that curve around the land and are level.

55. In this case, the contour ploughing is recommended in order to hold more water on site and allow the soil to re-wet and counter the effects of historical land drainage. It will also introduce topographical variation into the HMA(s) and the associated benefits that come from the habitat mosaic that this technique can produce. Plate 1 (below) illustrates how this technique will work on site.

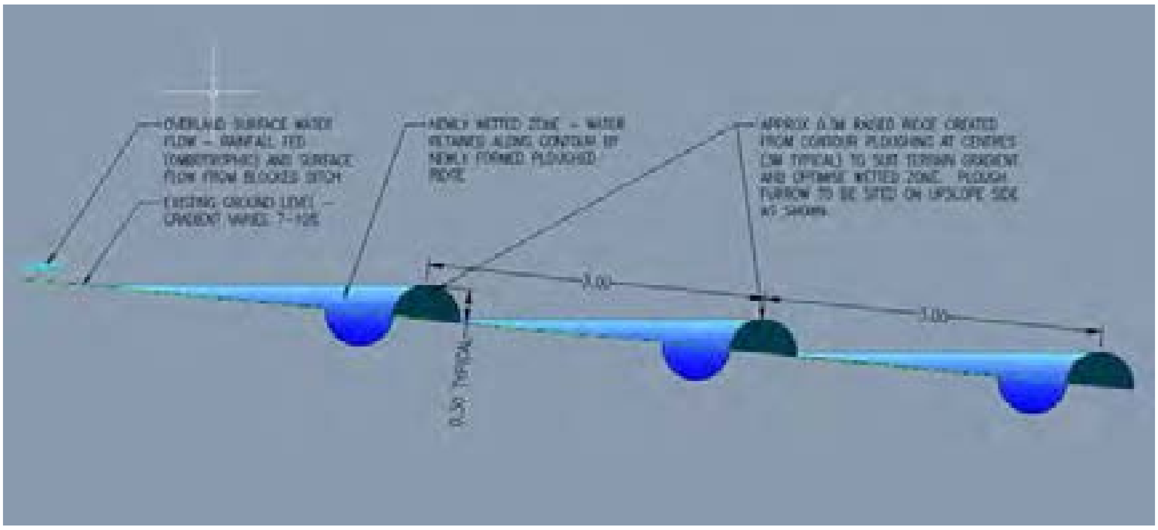

Plate 1: Schematic representation of the impact of contour ploughing at 3m intervals.

56. After each plot/strip has been ploughed, the translocated turves will be laid across the ridges and furrows in the normal way.

57. The macro-turving and translocation of the turves containing PMGRP is exactly the same as that described previously. The existing turves on the recipient site will be removed in a patchwork across the HMA. This will be done carefully and in stages (across the slope, starting at the top and working downslope) in order to minimise run-off during prolonged rainfall events. The grassland turves removed from the HMA will be saved for re-turfing the

sides of the access tracks and around the turbines. They will be reused within a day or so of excavation, and will not be stored for prolonged periods.

58. No macro-turfing will take place within the 50m hydrological buffer zones, in order to protect the water quality in the downstream SAC and adhere to mitigation as set out in the ES.

Habitat Management (PMGRP)

59. Nearly all PMGRP (species-rich) swards require management if they are not to be taken over by coarser vegetation, scrub, and eventually by woodland. The nature and speed of this process; and hence the intensity and frequency of management required to counter it, vary greatly with the depth and fertility of the soil, and with topography and local climate.

60. The species-rich sward created following the construction of the proposed Development will require annual management. Once the restoration area is considered robust enough to no longer require special treatment, the management of the reconstructed habitat will be grazed in the traditional way as grazed swards usually support a greater diversity and abundance of invertebrates than mown hay meadows, and a different, though not necessarily richer, flora.

61. Mowing is however, often the most satisfactory way of managing newly restored grassland, for the **first year or two** (post- translocation), as grazing by heavy livestock can damage the turves as they settle. On species-rich swards, an annual cut in late summer (after 15 August) is usually adequate to maintain the flora in the short term, but it is important that the cuttings are removed. In the longer term, rotational mowing can produce a more diverse grassland, supporting a wider range of invertebrates. Mowing will take place within the HMA should the Project ECoW deem this desirable (instead of grazing) depending on the results of annual monitoring and the results of the translocation process.

62. Grazing by cattle is however, the desired management for PMGRP sites (sheep will not be permitted). This 'light' cattle grazing will be to NICMS levels (i.e. 0.5-1 LU/Ha) and will include a minimum 8-week moratorium on grazing in spring/early summer. Again, the exact stocking densities will be guided by the Project ECoW using the results of the annual monitoring.

Prescriptions

Objective: Re-establish the characteristic floristic diversity of the PMGRP via ongoing management

63. As described in Chapter 6 of the ES the main issue reducing the overall conservation status of the PMGRP habitat on site is reduced by the absence of the characteristic suite of wildflowers which signify the species-rich variant of this habitat type (i.e. the NI Priority Habitat).

64. The aim of this management prescription is therefore to increase the floristic diversity of the habitat within a specified area (See Figure 6.9 – Habitat Management). The grassland in the translocation area will be managed as a traditional meadow in line with the following key measures:

- No grazing will be permitted between 1 January and 30 April.
- Grazing is permitted between 1 May and 31 December at a stocking density of 0.5 to 1.0 LU/ha (cattle only).

- Excess grass can be cut for hay but must not be cut until after 15 August (but area should be cut at least once every 3 years (to remove litter accumulation) with half mown in year one, half in year two and no cut in year 3).

- Introduction of livestock (cattle only) aftermath grazing from mid-August onwards to create gaps in the sward and trample in the seed.

- Grassland should not be grazed for a minimum period of about eight weeks in the spring and summer to maximise wild flower seeding.

- No use of inorganic fertilisers or widespread application of herbicides.

Objective: Establish, maintain and protect the hydrological regime on the translocation area

65. A key requirement for maintaining this area will be to establish and maintain suitable hydrological conditions, including water levels and quality, and management of habitat to maximise floristic diversity whilst preventing succession to willow scrub.

66. Maintaining water levels and quality, including prevention of contaminated run-off will be detailed within the CMS but in summary the main ditch which divides the wet heath translocation area from the PMGRP area, will be blocked in order to raise water-levels in the translocation area. In addition to this, the drainage associated with the infrastructure at T4 will be used to feed this area with (clean water) run-off, in line with existing conditions.

67. The contour ploughing at 3m intervals to a height of 30cm will be maintained for the lifetime of the Development. Should erosion or land settling require it, any damage to the plough furrows will be reinstated, in order to maintain the surface wetness, this will be carried out at the next available opportunity.

68. To prevent succession to willow scrub, the grassland will be mown on a three-year rotation. This approach seeks to provide a range of successional stages and maximise floristic diversity in any given year. This will only be carried out if the annual monitoring results indicate that it would be beneficial.

Objective: Establish, extend and maintain area of wet heath/acid grassland

69. This objective will be achieved using the chronological approach specified previously (i.e. translocation).

70. Upon completion of the translocation, the HMA will support a mosaic of upland habitat including wet heath and acid grassland. Specific prescriptions designed to achieve these objectives are detailed in Table 3 below.

Table 3: Approach to wet heath restoration and future enhancement

Task	Description	Timing
1	Prepare ground surface in translocation area ready for receiving translocated turf. This will include removal of the upper 30-40cm of nutrient rich soil layer. Fencing of site boundary (between the two HMAs) will be undertaken to protect establishing vegetation from grazing stock.	Autumn - winter

2	Cut species-rich wet heath turf from turbines 3 & 6 and immediately translocate to prepared ground in translocation area. Partially roll turf to firm in.	Autumn - winter
3	Create a varied surface topography in translocation area including wetter depressions (ridges and furrows (as a facsimile for hummock and hollow complex)) using contour ploughing.	Autumn/winter/spring
4	Heavily flail the surface of the habitat management area for wet heath (excluding the translocated turves) in order to break up and aerate the surface prior to seeding. This is required as there are very low numbers of heather plants visible in the surface sward (i.e. less than 5%).	Early March or September
5	Seeding of wider translocation area (25% per year) with heathland seed collected from within the donor area (in the vicinity of T3).	Spring (March/April) in each of years 1, 3 & 5.
6	No grazing during establishment of vegetation.	(years 1-5)
7	Grazing in line with existing DARD CMS management for wet heath from year 5 onwards.	Years 5 - 25
8	Ongoing monitoring and management prescriptions as required	As required

Objective: Establish, extend and maintain area of PMGRP

71. Following construction of the access track, PMGRP grassland will be translocated permanently from along the infrastructure route to areas of prepared soil within the HMA. The translocation will be undertaken between autumn - winter and (individual) turves will be cut, transported and laid in a single day to minimise potential damage to seeds and plants species. Turf will be collected using specialist machinery and will be extracted to a minimum depth of 30-40cm. Once laid, turfs will be partially rolled/pressed to firm in and will be watered regularly (if required) in spring to aid establishment.

72. Following the turf translocation and prior to sowing or soil preparation, a varied surface topography will be encouraged in the HMA. This varied topography will result in a range of hydrological conditions (drier ridges and wetter furrows). The effect that contour ploughing will create on the slopes of the HMA will be akin to terracing. This along with the high rainfall experienced in the area will maintain the wet conditions required by the target PMGRP habitat.

73. It is also expected that this area will colonise naturally from the adjacent wet grassland which will help to encourage habitat establishment and maximise habitat niche diversity of benefit for invertebrates, amphibians and upland birds.

Monitoring and Maintenance

74. Monitoring targets have been devised to measure the success of the objectives described above. Maintenance requirements have been established to maximise the likelihood of success. In years 1-5 the priority is habitat establishment rather than species diversity or structure. This is because it may take several years for habitat types to reach their floristic

and structural potential. This has been reflected in the broad nature of the targets outlined below. At Year 5, new specific habitat targets and maintenance requirements will be devised as informed by the results of habitat monitoring and assessment of achievement/failure against the targets.

75. Monitoring/maintenance checks will be carried out to ensure establishment of habitats in line with objectives in Years 1 to 5. The aim is to ensure the target habitats establish properly, and plants do not fail, particularly in the initial period after planting/sowing.

76. Monitoring of the access track restoration, PMGRP and heathland habitats will be undertaken using fixed $4m^2$ quadrats spaced, totalling approximately 75 quadrats (25 wet heath; 25 PMGRP and 25 along the infrastructure). The location of quadrats will be recorded using GPS and marked using marker stakes. Quadrat locations will be re-surveyed in subsequent years. Quadrat surveys will be undertaken between May – July. Quadrats will record vegetation structure and species % cover, including bare ground. Monitoring will also record ground conditions including topography and surface wetness.

77. Monitoring results, interpretation and identification of necessary remedial actions and repairs e.g. in relation to stock proof fencing, watering, cutting, spot treatment of weeds, re-seeding etc. will be reported annually and discussed by the Project ECoW to inform ongoing future prescriptions.

Objective	Monitoring/Maintenance Targets - Years 1-3	Monitoring/ Maintenance Targets - Years 4-5
Establish, protect and maintain wet heath in HMA.	- Successful establishment of 75% of translocated turf from T3 & T6 to Restoration Area (See Figure 6.9). - Successful establishment of heather cover: o 10% cover, 50mm height year 1 o 15% cover, 75mm height year 2 o 25% cover, 100mm height year 3 - Bare ground <10% in 75% of quadrats. - Non-target species <20% cover in any quadrat and less than 20% total cover in Field.	- Successful establishment of heather cover: o **25%** cover, **125mm** height year 4 o **30%** cover, **150mm** height year 5 - Bare ground **<5%** in all quadrats (excludes wet scrapes). - Non-target species **<10%** cover in any quadrat and **<5%** total cover.
Establish, protect and maintain area of PMGRP.	- No loss of species diversity - No increase in % cover of non-target species • Quadrat surveys undertaken in year 1 prior to construction to establish species diversity (minimum of 25 (2m x 2m) quadrats). Quadrats repeated in years 1 – 5 to assess species change.	As per years 1-3

Mitigation for GWDTE's

78. Where tracks cross a watercourse (or seepage) which feeds (or emanates) from a GWDTE (flush or seepage), flow across the watercourse will be preserved by installing flow-balancing cross drainage pipes laterally through the track structure, retaining the hydraulic gradient across the footprint of the track. Pipes will be installed at a high frequency (nominally 5m intervals), subject to observational design by the ECoW to suit particular water channels observed on site. No longitudinal drainage is to be installed parallel to and adjacent to the track, in order that no unnecessary flow path that would significantly alter flow routes is introduced. Drainage arrangements are shown on site layout drawings (SuDS technical appendix) appended to the Water Framework Directive Assessment prepared by McCloy Consulting and submitted in annex 1 of the CMS.

Timeframe

79. The timings required for habitat creation, establishment and management are detailed above. In summary, habitat creation and establishment will be undertaken as soon as possible after construction with the exception of turf translocation which will be undertaken during construction to facilitate successful transfer and establishment. Management operations will be undertaken as specified above and as informed by monitoring conclusions post-construction.

Implementation of HMP

Roles and Responsibilities

80. It will be the responsibility of wind farm owner to ensure that the HMP is implemented in accordance with the specifications detailed herein for the 30-year lifetime of the wind farm. The wind farm owner will assume the lead role and responsibility in ensuring tasks are undertaken in accordance with the necessary timings specified. Many of the on-site monitoring tasks and overseeing of method statements and ensuring adequate implementation by contractors during construction will be undertaken by the Ecological Clerk of Works, who will be appointed prior to commencement of construction works. Following construction, the wind farm owner will manage and oversee the operation of the wind farm including implementation of the requirements set out within this HMP.

81. The role of DAERA NED will be primarily advisory in that they will provide support and advice as necessary to ensure that HMP prescriptions and objectives are appropriate, realistic, successfully implemented and in accordance with the requirements set out in any potential future Planning Conditions.

Reporting

82. Monitoring of specific features will be undertaken in line with the timeframes (in years 1- 5) which have been outlined previously. In line with these timings monitoring reports will be provided by end of December in each year.

Photographic Records

83. A baseline photographic record of the site will be completed prior to construction. Photographs will be mapped using 6 figure grid references and accompanied by comments as appropriate, including a compass orientation. A photographic record will be repeated every 5 years. This will provide a valuable aide memoir and will include the specific habitat

features including (but not limited to):

- All turbine locations;
- Access track verges (including areas subject to heathland/grassland seeding, turf translocation); and,
- Habitat Management Areas

Sharing of Data

84. Monitoring data will be provided to DAERA, The Council and CEDaR in a suitable format (i.e. Microsoft Excel for data, and ArcGIS for mapping).

Contingency

85. The following measures (in addition to the proposed macro-turfing and translocation of wet heath) will be completed. This is to both, to ensure that there is a 'Net Gain' for biodiversity and to allow for the any failure in the translocation process due to unforeseen events.

Brush-harvesting for reseeding

86. In advance of the construction works on the access tracks, turbine bases and hardstanding a 50m wide corridor (near T3) will be used to (brush) harvest seed (from within the area of wet heath). This is required in order to provide sufficient material for the proposed over-seeding of the wet heath compensation area (as the total area of translocated turves is 0.7ha while the entire compensation area is 3.5ha). The harvesting corridor is 2.8ha in area; this will provide sufficient material to over-seed a similar area in the compensation area (if required).

87. Restoration of the wet heath HMA will be completed as soon as possible after construction has commenced. To ensure that this is successfully completed sufficient seed will be gathered in advance of the commencement of construction (i.e. the summer and autumn immediately prior to works starting (if necessary). However, if timelines allow the seed will be harvested/gathered using a combination of brush-harvesting (and/or vacuum-collection) and spread onto the HMA immediately.

88. These techniques are considered by Floral Locale to be the most effective and wildlife-friendly method for whole-field harvesting as it lightly brushes seed off, with minimal chaff and minimal wildlife "bycatch". It also only takes a proportion of seed and unripe seed will not be taken (i.e. plants will still seed sufficiently to maintain their populations).

Guaranteed Local origin

89. Brush-harvesting/vacuum collection offers the only really practical field-scale solution for obtaining seeds of known local origin. Which often have to be collected over steep uneven terrain. This approach is also one of the few ways to obtain the full range of native plants and grasses (of local provenance) that are associated with semi-natural habitats (such as those found in the uplands). It is also an invaluable technique for restoring or extending ecologically sensitive sites.

Efficiencies of scale

90. It enables large quantities of seed to be collected with minimal effort. For example, one hectare of land harvested produces sufficient seed for an equivalent area (but seed can be spread more thinly if desired, especially if used to inoculate floristically-poor habitats).

Species diversity

91. The composition of harvested seed mixtures directly reflects that of the donor site (in this case the seed(s) will be collected directly from within the land under applicant control (the season(s) prior to the commencement of construction of the wind farm)). If this is not possible (due to timing) then the areas immediately adjacent to the construction corridor will be used to harvest seed).

92. Many of the species which will be sampled, include a number that are simply not available from usual commercial sources. The overall diversity of locally harvested mixes is often

much greater than can be obtained in proprietary seed mixes. The latter are often of British provenance which would not be suitable for use on the site.

Post-harvesting and sowing

93. Restoration of bare areas will be completed as soon as possible after each turbine base/section of track is completed and where practicable harvested seed will be sown directly onto bare areas upon completion of each section of the works. In the case of this Development, seed harvesting will be undertaken in two separate periods. Once during late July/early August in order to collect nurse crop grasses; with a second during the period mid-October/November (in order to target heather (*Calluna vulgaris*)).

94. Where it is not possible to immediately use the harvested material, it will be stored for later use (as the optimum window for seeding may not coincide with the harvesting). Correct storage of the harvested seed will be ensured in order to maintain viability (i.e. an appropriate experienced contractor will be engaged to complete the works).

95. Harvesting is best carried out between August and November (depending on the range of species being targeted). August is better when targeting those species which flower during the summer months (i.e. this is when the main native grasses, Common bent (Agrostis capillaris), crested dog's-tail (*Cynosurus cristatus*), floating sweet grass (*Glyceria fluitans*), marsh foxtail (*Alopecurus geniculatus*), purple moor grass (*Molinia caerulea*), red fescue (*Festuca rubra*), sweet vernal grass (*Anthoxanthum odoratum*) are most likely to hold ripe seed). While for heather (i.e. *Calluna vulgaris*), late Autumn/early winter is better.

96. Brush harvesting is a fair-weather operation that can only be carried out in dry weather, and once the morning dew has evaporated. In addition to this, harvesting only collects seed and does not cut the grass, so the donor area can be grazed normally afterwards.

Methods

97. The harvester is towed across the site and seed is brushed into a hopper; the seed is emptied on to tarpaulins when the hopper is full (about every 20 minutes). If it is not to be sown directly, the seed is spread out to dry and raked through during the day to help it to dry. Long stalks are also raked out. The seed can be dried outside if the weather is fine, but may need to be taken inside and dried in well-ventilated barns if rain is threatened. It can take between two and seven days to dry, and must be regularly raked through to prevent it becoming mouldy. If the seed from a day’s harvesting has to be transported any distance, it should not be kept on-masse for more than a few hours until it is dry, as it will heat up and the seed will become unviable.

Seed yield

98. The seed yield will vary from site to site, from field to field and within fields. It can also vary from year to year on the same site. However, for illustration purposes a yield of between 10-25kg per acre is considered a low-average yield.

Processing and sowing

99. Once dry it can be stored, then cleaned using a combine or seed cleaner to remove most of the stalky material and husks. It is best broadcast using a spinner. Seed of wild flora should always be drilled or broadcast on the soil surface and never buried at any depth. Unprocessed seed can be directly sown by bagging it up straight from the hopper or tarpaulin and taking it across to the receptor site, where it can be broadcast by hand or from the back of a trailer or pickup.

100. It cannot be guaranteed that all local native species will be successfully harvested/reseeded; however, the technique proposed (and timings); should ensure that sufficient diversity is achieved during the reseeding process.

Protection of restored areas

101. All restored areas will be protected against livestock grazing, for at least the first 3 years, as reviewed by the ECoW (See Figure 6.9 – Habitat Management). Ideally protection should be by exclusion fencing.

Resourcing

102. Detailed prescriptions in terms of requirement for, and timing and frequency of tasks are detailed within specific topic sections above. This will be largely dependent on the monitoring findings. Most tasks specified will be undertaken by contracted specialists with appropriate expertise as specified below. Time and costs associated with the specified tasks will vary in line with market forces as part of the bidding and tendering process. Compliance of tasks will be monitored on site by the ECoW (during construction) and overseen by the RES environmental management team (during operation).

Table 4: Resourcing Breakdown

Task	Frequency years 1-5	Frequency year 6-30	Expertise Required
Access Tracks			
Preparation/ Planting			
Seed preparation - scarifying of HMAs	once	n/a	Experienced contractor
Collection of heather (wet heath HMA)	once	n/a	Experienced contractor
Ploughing at 3m intervals across the HMAs (along the contour lines	Once	n/a	Landowner/tenant
Preparing ground for turf translocation (HMAs)	once	n/a	Experienced contractor
Translocating turves	once	n/a	Experienced contractor
Over-seeding HMA with heather seed		n/a	Experienced contractor
Creating varied topography and preparing ground for seeding (PMGRP HMA)	once	n/a	Experienced contractor
Maintenance/ Monitoring			
Mowing grassland in late summer	twice annually	twice annually	landowner/ tenant
Weed spot treatments	annually	if required	landowner/ tenant
Hay cut, turning and tedding	annually	annually	landowner/ tenant
Grazing of heathland/PMGRP	n/a	per DARD CMS prescriptions	landowner/ tenant
Quadrat monitoring (HMA)	annually, from years 1-5	years 10, 15, 20, 25	Experienced Ecologist
Quadrat monitoring of heathland (HMA)	annually	years 10, 15, 20, 25	Experienced Ecologist
Interpretation of monitoring results, reporting and planning	annually	years 10, 15, 20, 25	Experienced Ecologist

Decommissioning and Restoration

103. One of the main advantages of wind power generation over other forms of energy production is the ease of decommissioning and the simple removal of components from the site. The residual impact on the site is limited to the continued presence of the foundations and access tracks. All above ground structures can be removed from the site.

104. If the Development obtains planning approval it is expected that a planning condition would be set to provide for the decommissioning and restoration of the site in accordance with a scheme agreed in writing with Causeway Coast & Glens BC, which would consider the long-term restoration of the site at the end of the lifetime of the Development.

105. The Development will be decommissioned in accordance with best practice at that time and/or in compliance with any planning conditions. Current best practice includes the removal of all above ground structures (e.g. turbines, substation etc); the removal of certain underground structures where required (e.g. cables); and reinstatement of disturbed areas all of which will be subject to any necessary consents. Consideration will be given to the retention of wind farm access tracks if they utilise pre-existing farm infrastructure or are not located on sensitive habitats (if such continued use could lead to the long-term degradation of these habitats).

Construction and Decommissioning Management

106. This section details the environmental management controls that would be implemented by RES and its contractors during the construction of the Development to ensure that potential significant adverse effects on the environment are, wherever practicable, prevented, reduced and where possible offset.

107. A CDMS will be agreed with the relevant statutory consultees prior to construction commencing. The purpose of the CDMS is to:

- Provide a mechanism for ensuring that measures to prevent, reduce and where possible offset potentially adverse environmental impacts identified in the ES are implemented;
- Ensure that good construction practices are adopted and maintained throughout the construction of the proposed wind farm;
- Provide a framework for mitigating unexpected impacts during construction;
- Provide a mechanism for ensuring compliance with environmental legislation and statutory consents;
- Provide a framework against which to monitor and audit environmental performance.
- The CDMS will, as a minimum, include details of the following:
- Pollution prevention measures
- Peat slide, erosion and compaction management
- Control of contamination/pollution prevention
- Drainage management
- Control of noise and vibration
- Control of dust and other emissions to air.

Site Induction

108. The principal contractor would ensure that all employees, sub-contractors, suppliers and other visitors to the site are made aware of the content of the CDMS and its applicability to

them. Accordingly, environmental specific induction training would be prepared and presented to all categories of personnel working on and visiting the site.

109. As a minimum, the following information would be provided to all inductees:

- Identification of specific environmental risks associated with the work to be undertaken on site by the inductee
- Summary of the main environmental aspects of concern at the site as identified in the CDMS
- Environmental Incident and Emergency Response Procedures (including specific Environmental Communication Plan requirements).

110. A conveniently sized copy of an Environmental Risk Map or equivalent would be provided to all inductees showing all of the sensitive areas, exclusion zones and designated washout areas. The map would be updated and reissued as required. Any updates to the map would be communicated to all inductees through a tool box talk given by specialist environmental personnel. Regular tool box talks would be provided during construction to provide ongoing reinforcement and awareness of environmental issues.

Pollution Prevention, Water Quality Monitoring and Emergency Response Plan

111. The CDMS will detail a number of measures to deal with pollution prevention, including RES' policies and procedures such as 'Environmental Requirements of Contractors', 'Water Quality Monitoring Procedure' and 'Procedure in the Event of a Contaminant Spill'.

112. Contractors and sub-contractors would be required to follow all pertinent Pollution Prevention Guidance. The following pollution control measures will be incorporated into the CDMS:

- Equipment shall be provided to contain and clean up any spills in order to minimise the risk of pollutants entering watercourses, waterbodies or flush areas
- Trenching or excavation activities in open land shall be restricted during periods of intense rainfall and temporary landscaping shall be provided as required to reduce the risk of oil or chemical spills to the natural drainage system
- Sulphate-resistant concrete shall be used for the construction of turbine bases to withstand sulphate attack and limit the resultant alkaline leaching into groundwater
- All refuelling will be undertaken at designated refuelling points. There will be no refuelling within catchments contributing to water supply points
- Equipment, materials and chemicals shall not be stored within or near a watercourse. At storage sites, fuels, lubricants and chemicals shall be contained within an area bunded to 110%. All filling points shall be within the bund or have secondary containment. Associated pipework shall be located above ground and protected from accidental damage
- Any on-site concrete wash-out shall occur in allocated bunded areas
- Drip trays shall be placed under machinery left standing for prolonged periods
- All solid and liquid waste materials shall be properly disposed of at appropriate off-site facilities
- Routine maintenance of vehicles shall be undertaken outwith the site
- There shall be no unapproved discharge of foul or contaminated drainage from the proposed wind farm either to groundwater or any surface waters, whether direct or via soakaway
- Sanitary facilities shall be provided and methods of disposal of all waste shall be approved by regulatory bodies

- A programme of surface water quality monitoring would be undertaken during the construction phase to provide assurances as to the absence of water quality impacts
- RES has a policy that no wind turbines, auxiliary and electrical equipment would contain askarels or Polychlorinated biphenyls (PCBs).

113. In the unlikely event of an environmental pollution incident, there will be an emergency response procedure to address any accidental pollution incident. For example, a procedure requiring the use of spill kits to contain the material and procedures to ensure that NIEA is notified on their Pollution Hotline number (0800 807060) within 30 minutes of an incident (unless unsafe to do so), will be applied.

General Drainage Design

114. As set out in Chapter 9: Geology and the Water Environment, buffers to watercourses have taken account of and infrastructure designed in accordance with best practice guidance.

115. The potential impact of preferential routing of drainage and associated erosion and sediment wash-off within the sub-catchments draining the site would be mitigated through the following measures which would be incorporated into the SuDS Design:

- Site track construction materials would be free draining, strong, durable and well graded
- Attenuation ponds and silt fences would be provided adjacent to the drains to prevent pollution and sedimentation of watercourses
- Direct drainage into existing watercourses would also be avoided to ensure that sediment and runoff from disturbed ground is not routed directly to the watercourses
- Larger drains would be piped directly under the track through appropriately sized drainage pipes or culverts. Appropriate scour prevention and energy dissipation structures would be constructed at each culvert outlet. Where appropriate, a shallow, lateral drainage swale would be installed at the toe of site track cuttings to intercept the natural runoff. This lateral drain would be piped under the track at regular intervals through correctly sized cross drains away from watercourses. Again, appropriate scour prevention and energy dissipation structures would be constructed at each culvert outlet
- Flow and sediment transport in any track drainage swales would be minimised by reducing concentrated flows, installing regular cross culverts and the use of check dams placed at regular intervals within the trackside drainage swales
- Track drainage swales, where required, would discharge into attenuation ponds excavated on the downslope side, or silt fences. A shallow drainage swale would be cut directly downhill as a fan and at minimum slope until the bottom of the swale reaches the natural surface level. The discharge point of track drains would be constructed to minimise concentrated flows and ensure flows are dispersed over a large area with appropriate surface protection
- The depth of individual drainage swales would be kept to the minimum necessary to allow free drainage of the tracks and swale lengths would be minimised to avoid disruption of natural drainage paths. Direct drainage into existing watercourses would be avoided to ensure that sediment and runoff from disturbed ground is not routed directly to the watercourses.

Runoff and Sediment Control Measures

116. The following measures would be used to mitigate any potential impacts on the water quality of the sub-catchments through peat erosion, stream acidification and metals leaching during construction. These are incorporated into the CDMS:

- Appropriate sediment control measures (silt fences, attenuation ponds, etc.) would be used in the vicinity of watercourses, springs or drains where natural features (e.g. hollows) do not provide adequate protection

- Sediment control measures (e.g. check dams, silt fences etc.) would be employed within the existing artificial drainage network during construction. These would be regularly checked and maintained during construction and for an appropriate period following completion
- Watercourses would be monitored throughout the construction period by the ECoW to identify any enhanced scouring of the catchment surface. If sediment from disturbed peat is excessively mobilised through the minor channels network these would be mitigated by temporary sediment control measures (e.g. geotextiles/straw/bales/brash)
- The extent of all excavations would be kept to a minimum and during construction activities surface water flows shall be captured through a series of cut-off drains to prevent water entering excavations or eroding exposed surfaces. If dewatering of excavations is required, pumped discharges would be passed through attenuation ponds and silt fences to capture sediments before release to the surrounding land
- Where there is a permanent relocation of peat, the ground would be reinstated with vegetation as soon as practicable
- Where practicable, vegetation over the width of the cable trenches would be lifted as turfs and replaced after trenching operations to reduce disturbance
- The movement of construction traffic would be controlled to minimise soil compaction and disturbance. Vehicle movements outside the defined tracks and hardstandings would be avoided
- Trenching or excavation activities in open land would be restricted during periods of intense rainfall and temporary landscaping would be provided, as required, to reduce the risk of sediment transport to the natural drainage system
- Construction of the track and cable crossings will cease during periods of heavy rain (>25mm in 24 hours), significant snow event (>75mm lying) or extended period of freezing conditions (ground penetration>100mm). If necessary, upstream of the crossing would be dammed and water pumped around the construction zone. The construction period would be minimised as far as practicable.

Peat Slide, Erosion and Compaction Management

117. Management of the risk of peat slides is now recognised in literature, and a range of measures have now become standard engineering practice for construction of roads over peat. These measures would be adopted, as appropriate, on site, ensuring that:

- Concentrated loads, such as those arising from stockpiling of material from turbine foundation excavations, would not be placed on marginally or potentially marginally stable ground
- Concentrated water flows arising from any aspect of construction or operation of the Development would not be directed onto peat slopes and unstable excavations
- Construction would be supervised on a full-time basis by engineers fully qualified and experienced in geotechnical matters
- Robust drainage plans would be developed
- Work practices would be reviewed, modified as necessary and adopted to ensure that existing stability is not compromised
- Appropriate ground investigation and movement monitoring practices would be adopted.

118. The major contributory factor resulting in peat slide is heavy rain. Almost invariably, peat-slide events are preceded by unusual weather conditions typically characterised by a long dry summer that leads to desiccation cracking of the peat profile followed by a prolonged continuous rainfall including exceptionally heavy rainstorms.

119. A separate Peat Slide Risk Assessment is provided as Technical Appendix 9.4. This document would be updated during the detailed design stage and agreed with Causeway Coast & Glens BC prior to construction.

Peat Management Plan

120. A separate Draft Peat Management Plan is provided as Technical Appendix 9.5. This provides details of the predicted volumes of peat that would be excavated for the Development, the characteristics of the peat that would be excavated, and how the excavated peat would be reused and managed. This document would be updated during the detailed design stage and agreed with Causeway Coast & Glens BC prior to construction.

Construction Environmental Management Plan

121. A Construction Environmental Management Plan (CEMP) would be prepared and implemented through the CDMS to set out the measures required to protect and enhance ecology and hydrology at the Development during the construction phase, including pre-construction surveys, habitat management and biodiversity enhancement. The detail of the CEMP would be prepared and agreed with Department for Agriculture, Environment & Rural Affairs (DAERA) and Causeway Coast & Glens BC prior to commencement of construction.

Potential Construction and Decommissioning Phase Environmental Impacts

122. Construction is predominantly a civil engineering operation and would be phased over an approximate 18-month period. Construction of tracks and foundations would be progressive, minimising the number of simultaneously active locations and ensuring that traffic density is kept low. Erection would span approximately nine weeks toward the end of the work programme.

123. A programme of site reinstatement and enhancement would be put in place to minimise the visual and ecological impacts on the land, in accordance with this Outline Habitat Management Plan.

124. The Development would operate for approximately 30 years and would require only limited maintenance and inspection visits.

125. A detailed restoration plan / Decommissioning Method Statement would be prepared and agreed with the relevant authorities towards the end of the Development's operational life.

References

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JNCC (2001) *National Vegetation Classification: Field guide to woodland.* JNCC, Peterborough

Appendix 6.9 – DAERA NED Consultations

Summary of the DAERA NIEA Natural Heritage Division Consultation Response

Summary of NIEA Natural Environment Division response
Designated sites *Please note that this proposal may be subject to the Conservation (Natural Habitats, etc) Regulations (Northern Ireland) 1995 (as amended) (known as the Habitats Regulations): the site lies within the watershed of the River Roe and Tributaries SAC and ASSI.* *Gortcorbies ASSI, which is designated for Purple moor-grass and rush pastures, lies adjacent to the northern boundary of the proposed site.* *Ballyrisk More ASSIm which has also been designated for Purple Moor-grass and rush pastures, lies close to the western boundary of the proposed site.* *The site lies within the Binevenagh AONB.* *Habitats and protected species* *The proposed development site is located within rough pasture and upland heath. Other habitats in the surrounding area include semi-improved grassland, scrub and extensive coniferous plantation. There is an active quarry within 500m.* *NED data layers suggest that the southern section of the site may support peatland habitats.* *From data held by NED, it is recommended that an extended Phase 1 Habitat Survey and bat surveys area carried out for this proposal. The results of the Phase 1 survey may indicate that further habitat and species surveys are required. NED survey specifications and other planning related advice can be found at: https://www.daera-ni.gov.uk/articles/site-surveys.* *NED recommends that all survey works comply with British Standard 42020:2013, which came into effect on 31 August 2013. The BS provided recommendations and guidance for those engaged in planning and development, whose work might affect or have implications for conservation, or the enhancement of biodiversity.* ***NIEA would emphasise the following**:* *The ES should describe both habitats and species of flora and fauna present. It should cover both the proposed site and the surrounding area. It should include any designated sites and protected species which may be affected.* *Proposals which may impact on a European site, however distant (i.e. Special Areas of Conservation and Special Protection Areas), will require a Habitats Regulations Assessment (HRA). Sufficient information must be provided to the competent authority to enable them to complete this.* *The topography, geology, soils and water environment of the site and surrounding area should be described.* *The ES should include a description of the likely significant effects, both positive and negative, at all stages of the development to include direct, indirect, secondary and cumulative effects in the short, medium and long term. A description of the forecasting methods used to predict these effects should also be included.* *A description of proposed measures to prevent, reduce or offset any significant adverse effects on the environment (i.e. Avoidance, Mitigation, Compensation, and Enhancement) must be included.* *An indication of any difficulties encountered during the EIA process, limitations of surveys and any uncertainties in the data must be included.* *The different chapters of the ES should be inter-related and the ecology chapter should be cross referenced where appropriate.* *Flora and Fauna* *The ecological baseline of the site must be characterised. Following from this, the extent and nature of any further survey work that may be required should be identified. Surveys must cover flora and fauna present in all seasons.* *A habitat survey (i.e. JNCC Phase 1) should be carried out to map the habitats on site and identify areas which are likely to be of high nature conservation value or particularly*

Summary of NIEA Natural Environment Division response
vulnerable to impact from the proposed development. Areas thus identified should be subject to more detailed survey, i.e. National Vegetation Classification (NVC). *Surveys should highlight any Northern Ireland or European priority habitats and species which may be present on the site or surrounding area.* *Baseline surveys conducted over a short period may not identify long term trends and reference should be made to previous records.* *Protected species surveys should be carried out to NED specifications. Note that these maybe updated in the light of new knowledge at any time. Therefore, it is advised to check the NIEA website for the most up to date specifications immediately prior to commencement of surveys.* *Full survey reports should be included in the appendix of the ES. All maps and diagrams should be of an appropriate scale for interpretation.* *NIEA reserve the right to determine whether the survey information submitted is adequate or when additional information is required.* *Survey information regarding species vulnerable to persecution should be included as a confidential annex to the ES, which should not be made publicly available. The species of concern are badgers (Meles meles), freshwater pearl mussel (Margaritifera margaritifera), goshawks (Accipiter gentilis), hen harrier (Circus cyaneus) and peregrines (Falco peregrinus).* *A **Habitat Management Plan** should form part of the ES. This should show how the habitats, flora and fauna of the site will be protected during and after construction. It should include a long-term plan for the management of the site for nature conservation and, if appropriate, show details of compensation measures such as habitat creation.* *Habitat restoration and creation measures must be carefully considered and a rationale provided for the choice of measures. Techniques for habitat restoration and creation must be detailed, site specific and follow current best practice. Evidence should be provided which shows that the proposed measures have a reasonable likelihood of success. If proposed techniques are unproven then a more detailed description and rationale for their use will be required. Proposed measures must have clearly defined criteria for success so that they can be adequately measured and monitored.* *The HMP should include a long term monitoring plan, detailing how the ecology of the site will be monitored to demonstrate the success of any proposed mitigation, compensation or enhancement measures. The monitoring plan must span and appropriate time frame depending on the type of development, the habitats and/or species being monitored, and the likely timescales of and habitat restoration or creation measures. The monitoring plan must include measurable targets and details of contingency measures should monitoring reveal unfavourable results.* *Consideration mist be given to the long-term ecology of the site at the end of the lifetime of the development. For example, it may not be appropriate to leave infrastructure, such as access tracks, in place where sensitive habitats are present when this could lead to the long-term degradation of these habitats. Issues such as these must be adequately addressed within an appropriate Decommissioning and Restoration Plan.*

Meeting Minutes

Project:	Dunbeg South Wind Farm
Client:	RES Ltd
Subject:	NVC Habitat Survey, HMP and Ecology Chapter
Location:	Klondyke Building
Date:	4th August 2017 @ 1100 hrs
Attendees:	Cormac Loughran — Blackstaff Ecology Ltd Garth McGimpsey — RES Ltd Chris Perry — NIEA NED
Apologies:	None
Compiled by:	Cormac Loughran

NVC Results

1. CL explained the background the meeting request. That there are significant areas of purple moor-grass & rush pasture on site, and that compensation of the loss of NI Priority Habitat will be required as part of the HMP associated with the EcIA Chapter. Although it was also pointed out that the infrastructure layout has been designed to avoid the areas of better habitat on site and that all turbines & tracks had been shifted downslope and out of the plateau area which contained significant extents of both blanket bog and wet heath.

2. CP stated that he had looked at the species list for the latest quadrat data that had been provided around the infrastructure layout in advance of the meeting. CP mentioned that NED would have concerns of the presence of *Cirsium dissectum* in a number of the quadrats and that this could potentially indicate the presence of M24 *Molinia* Meadows (an Annex 1 habitat).

3. CP also stated that he would like to confer with the NIEA grassland specialist (Alastair Church) regarding the species assemblage in the quadrats and further commented that NIEA might have surveyed the area previously (when assessing areas for possible ASSI designations). CP would revert with this information in due course.

4. CP mentioned that the NVC classifications are not an exact match for Ireland and that this should be considered when categorising the habitats to NVC level. CL confirmed that the method used to obtain the results sent to NIEA was simply to process the species data & abundance (as recorded) using the (MAVIS) analysis software, and use the results without alteration.

5. CP raised concerns regarding the potential for water run-off during the construction phase (due to the presence of an ASSI downslope (across the main road opposite the site)). GG confirmed that this would be addressed in the ES and that sufficient information would be provided to allow NIEA to consider the mitigation within associated documents and appendices.

6. CP stated that the quality of the habitat on site would influence the extent of compensatory habitat that might be required over and above the area to be lost.

7. CL agreed, and asked if it would be acceptable to use one large block of a single NI Priority Habitat (on site) as compensation rather than like for like losses (i.e. patch of wet heath, patch of M23, patch of dry heath etc). CP confirmed that this should be acceptable to substitute one NI Priority Habitat for another (of similar value) and used the example of Smulgedon Windfarm HMP where heathland was the focus of habitat compensation rather than a patchwork of both heathland and grassland.

8. CP stated that it will be next to impossible to recreate species-rich grassland from scratch and that it would be preferable to work with the existing grasslands on site. CL confirmed that this was the management strategy that would be employed within the HMP.

9. CP also asked if the landowner(s) were in the CMS historically or any environmental schemes? GG gave an undertaking to investigate this, CP asked if they were in the CMS what habitats (i.e. DARD mapping) were the focus of the grazing management on site?

10. GG explained the layout and illustrated how the existing tracks on site were utilised as much as practically possible during infrastructure design; and also described a further alteration to the layout which was being made in order to decrease the area of existing tracks to be used. GG also explained that the crane-pads had been reduced from 40x30 m to 40x20m and that this would further reduce the area of habitat loss.

11. CP confirmed that the use of existing tracks was preferable, due to the fact that the associated hydrology adjacent to the tracks had already been altered and that it was preferable to reuse these areas than building a new track in another area of the site.

12. CP referred again to the fact that the quality of the habitat to be lost to development would influence how long it would take for any enhancement to occur. This was in response to a question regarding how long the HMP should run for (by CL) .i.e. how much time would need to be allow for any time-lags. When asked about ratios of lost habitat to compensation, CP stated that 5 times was a guide, but again depending on habitat quality. CL asked if it was possible to increase the area of compensatory habitat provided, rather than increasing the normal 25 year lifetime of the HMP. CP stated that this was possible, but each HMP is considered on a case-by-case basis and on the individual merits of each plan overall. CP also referred to having additional enhancement of the faunal value of the site.

13. CP stated that he didn't like the grid approach take during the NVC surveys and mentioned that several of the quadrats appeared to be located on transition zones between habitats. CL stated that he understood the concerns, but that the entire site was a mosaic of differing habitats and was therefore full of transition zones; and that the grid was used to start the habitat mapping process. CL mentioned that additional quadrats were surveyed along the entire length of the site infrastructure.

14. CP understood but said that a number of quadrats were needed in each larger block of contiguous habitat type in order to give confidence in the NVC habitat assignment/mapping. CL confirmed that this would be taken on board when finalising the habitat mapping for the ES and associated figures.

Meeting Minutes

Bats

15. CL – A full year of surveys have been carried out during 2017 (based on a low risk site). Final surveys will take place during first half of September.

16. CP asked what sort of activity levels are there on site. CL confirmed that there have been low numbers during the walked transects; with slightly higher numbers recorded during the automated monitoring session. But overall the numbers corroborate that the site is low risk.

Birds

17. CP asked about Hen Harrier. GG Advised that he thought 1 male bird had been spotted foraging, that there was one pair of Grouse off site and that snipe are present as would be expected. There was one curlew spotted once 3 years ago, but no observation since then.

Postscript (summary of e-mail exchange between CP and CL)

18. CP was chatting to Bobbie Hamill (NIEA CDP) about the software and procedure they use. They use a software package called Match and BH says that they do not omit species and take the results from the software at face value even though they know that there are differences with Irish NVC classifications.

19. Additionally, CP also looked again at the quadrat results (post-meeting) and stated that although a few of the 2016 classifications appear to be very odd, most of them are probably fine.

20. As stated in the meeting CP was most worried about the frequency of *Cirsium dissectum* in some of the NVC results, but on further analysis, most of these quadrats don't have a great species richness and some do not even have *Molinia*.

21. CP would still wish to discuss the results with Alistair Church once he returns to work, however CP recommended that the 2017 data is processed using Match and sent in to NIEA then.

22. CL stated that he was pleased to hear that the approach used by BH is the same his. Only difference is that CL use MAVIS as opposed to MATCH; although both programmes are designed for similar purposes

23. CL went on to comment that only one of the quadrats resulted in an M24 classification (using MAVIS), but that he intends to send through the final MAVIS analysis results when complete. He also advised that he will attempt to obtain a copy of the MATCH software and see if the outputs are any different to what MAVIS has produced.

24. CP state that as far as he knew MAVIS is slightly different to MATCH but it should bring up comparable results. CP reiterated that the problem with this site, is that the quadrat locations have been totally randomised and haven't been selected to pick up homogenous stands of habitat. Therefore you are likely to have got several results from transitional areas.

25. CP also states that BH highlighted the importance of grouping the quadrat results (from similar habitats together before processing them using the software. This requires some preliminary mapping to identify different areas of habitat. For example you need to be careful not to group grassland quadrat results with bog or heath quadrats and putting those through the software together it is likely to produce spurious results.

26. CL acknowledged that (for the meeting) he had only analysed each quadrat individually, but that he will group similar plots (based on habitat type) together and processing them again when mapping the site. The results of this exercise will allow him to focus attention on areas were additional NVC quadrat work should be carried out.

27. CL also asked how many quadrats from each habitat type are sufficient (when analysed as a group) in order to ensure the results are statically accurate (in BH's experience)?

28. CP answered that for the MATCH software, 5 would be the minimum number of quadrat results to group from each habitat type. He was not sure about MAVIS.

26th September 2017

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Ornithology

Appendix 7: Ornithology

Ornithology Appendices

Appendix 7.1: Monthly Summary of Vantage Point Survey Effort

Month	Baseline Year / Vantage Point / Hours Effort								
	2015			2016			2017		
	VP1	VP2	VP3	VP1	VP2	VP3	VP1	VP2	VP3
Jan	0	0	0	6	5.5	4.25	8	3	11
Feb	0	0	0	6.25	7	7	7	8.25	0
Mar	0	0	0	5.75	6	6	4	11.25	9
Apr	0	0	0	6	5	9	6	3	9
May	0	0	0	3	3	3	6	6	6
Jun	0	0	0	6	7	6	6	6.5	3
Jul	0	0	0	6	6	6	6	6	9
Aug	0	0	0	9	9	9	6	6	6
Sep	0	0	0	3	6	6	-	-	-
Oct	0	0	0	7	6	6.5	-	-	-
Nov	0	0	0	6	5.5	8	-	-	-
Dec	8	5.25	3	5	6	5	-	-	-

Appendix 7.2 – Details of Vantage Point Watches

Date (D/M/Y)	Vantage Point	Observer	Time Start	Duration (hours)	Weather / Remarks
03/12/15	1	DS	1530	1	Overcast, late brightness, cold, near calm
04/12/15	1	DS	1000	3	Bright, sunny spells, SW breeze F4-5, mild
08/12/15	1	DS	1430	1	Bright after shower, cold, W breeze F4
22/12/15	1	DS	1130	2	Sunny, mild, SW breeze F4-5
31/12/16	1	DS	1520	1	Bright, cold, wintry shower, S breeze F3
06/01/17	1	DS	1230	4	Partial cloud, bright spells, SE breeze F2-3
14/01/16	1	DS	1200	2	Partial cloud, bright, snow shower, NW breeze F2
10/02/16	1	DS	0800	3	Sunny, cold, NW breeze F1-2, sunrise 0802
10/02/16	1	DS	1630	1.5	Sunny, cold, light NW breeze F1-2
11/02/16	1	DS	1130	2	Fog clearing to sunny, cold conditions, near calm
09/03/16	1	DS	1000	3	Partial cloud, sunny spells, NW breeze F3
10/03/16	1	DS	1430	2.75	Light cloud, weak sun, S breeze F2
05/04/16	1	DS	1000	3	Sunny spells, NW breeze F2, hail shower
29/04/16	1	DS	1330	3	Partial cloud, sunny spells, cold, NW breeze F3
02/05/16	1	DS	1800	3	Fine after shower, cool, W breeze F3
09/06/16	1	DS	1415	3	Partial cloud, hazy warm sun, SE breeze F1-2
09/06/16	1	DS	1045	3	Warm and sunny, slight haze, S breeze F3
26/07/16	1	DS	1800	3	Fine and sunny after rain, light S breeze F1-2
29/07/16	1	DS	1600	3	Light cloud, N breeze F2-3
18/08/16	1	DS	1100	3	Warm and humid, moderate haze, E breeze F1-2
20/08/16	1	DS	0800	3	Sunny and warm, S breeze F2-3
31/08/16	1	DS	1200	3	Light cloud, SW breeze F3 increasing F4
13/09/16	1	DS	1620	2	Mainly sunny, cool N breeze F2
19/09/16	1	DS	0900	1	Bright, mild, near calm then NW breeze F1-2
03/10/16	1	DS	1200	3	Bright, mild, SE breeze F3 gusting F4
03/10/16	1	DS	1530	2	Bright, mild, SE breeze F3 gusting F4
07/10/16	1	DS	0930	2	Cloudy, mild, some light rain, SE breeze F1-2
01/11/16	1	DS	1000	1	Sunny, light N breeze F2
01/11/16	1	DS	1600	1	Sunny, light N breeze F2
10/11/16	1	DS	1300	4	Sunny spells, rain showers, NW breeze F2-3
08/12/16	1	DS	1000	2	Partial cloud, bright, S breeze F1-2

Date (D/M/Y)	Vantage Point	Observer	Time Start	Duration (hours)	Weather / Remarks
19/12/16	1	DS	1100	2	Sunny, passing cloud, mild, NW breeze F2
29/12/16	1	DS	1045	1	Sunny, cold, SW breeze F2
16/01/17	1	DS	1230	3	Light cloud, mild, W breeze F1-2
23/01/17	1	DS	1200	3	Partial cloud, sunny spells, cold, SE breeze F2
23/01/17	1	DS	1530	2	Partial cloud, sunny spells, cold, SE breeze F2
10/02/17	1	DS	1030	2	Light cloud, very cold, SE breeze F2
14/02/17	1	DS	1030	2.5	Light cloud, hazy sun, cold, SE breeze F4-5
14/02/17	1	DS	1400	2.5	Bright, cold, increasing haze, SE breeze F4-5
14/03/17	1	DS	1330	3	Partial cloud, sunny spells, mild, W breeze F4
06/04/17	1	DS	0700	2.5	Partial cloud, sunny spells, cool, NW breeze F2-3
26/04/17	1	DS	1530	3	Sunny after shower, cool, near calm
10/05/17	1	DS	1400	3	Light cloud, sunny spells, cool NE breeze F2-3
24/05/17	1	DS	1430	3	Cloudy, warm and humid, near calm
12/06/17	1	DS	1500	3	Mainly cloudy, rain shower, NW breeze F3-4
19/06/17	1	DS	1500	3	Light cloud, N breeze F3
18/07/17	1	DS	1800	3	Cloudy, warm and humid
25/07/17	1	DS	1700	3	Warm and sunny, S breeze F3 increasing F4
18/08/17	1	DS	1230	3	Partial cloud, rain showers, NW breeze F3-4
18/08/17	1	DS	1600	3	Partial cloud, long sunny spells, NW breeze F3-4
08/12/15	2	DS	1100	3	Increasing cloud, showers, W breeze F4-5
22/12/15	2	DS	1400	2.25	Sunny, SW breeze F4
20/01/16	2	DS	1100	3	Sunny, cold, slight haze, SE breeze F3
20/01/16	2	DS	1430	2.5	Sunny, cold, slight haze, SE breeze F3
11/02/16	2	DS	1400	3	Partial cloud, sunny spells, cold, near calm
10/02/16	2	DS	1200	4	Sunny, cold, NW breeze F1-2, light wintry shower
09/03/16	2	DS	1400	3	Light cloud, NW breeze F3-4, sleet / hail shower
30/03/16	2	DS	1000	3	Sunny, slight shimmer, hail shower, NW breeze F2
05/04/16	2	DS	1400	3	Partial cloud, light rain showers, W breeze F3
17/04/16	2	DS	1500	2	Sunny start then cloudy, W breeze F3-4, cool
02/05/16	2	DS	1400	3	Bright, cool, showers, W breeze F3-4
04/06/16	2	DS	1530	3	Cloudy, warm, humid, nearly calm
23/06/16	2	DS	1030	3	Partial cloud, warm sunny spells, S breeze F3

Date (D/M/Y)	Vantage Point	Observer	Time Start	Duration (hours)	Weather / Remarks
23/06/16	2	DS	1400	1.5	Cloudy, shower then rain arriving from south
26/07/16	2	DS	1145	3	Mainly cloudy, some light drizzle, SW breeze F2
26/07/16	2	DS	0800	3	Cloudy, bright spells, S breeze F2-3
18/08/16	2	DS	1230	3	Light cloud, warm, humid, E breeze F1-2, haze
18/08/16	2	DS	1630	3	Partial cloud, warm hazy sun, E breeze F2-3
29/08/16	2	DS	1600	3	Light cloud, mild, SW breeze F2-3
19/09/16	2	DS	1100	3	Light cloud, sunny spells, mild, W breeze F1-2
19/09/16	2	DS	1430	3	Partial cloud, warm sunny spells, near calm
04/10/16	2	DS	0800	3	Cloudy, mild, SE breeze F3
04/10/16	2	DS	1200	3	Cloudy, bright spells, mild, SE breeze F3-4
25/11/16	2	DS	1030	2.25	Sunny, calm, air temperature minus1C
25/11/16	2	DS	1315	3.25	Sunny, calm, air temperature 0C
08/12/16	2	DS	1300	3	Partial cloud, sunny spells, mild, S breeze F2
19/12/16	2	DS	1330	3	Sunny, light W breeze F2-3
30/01/17	2	DS	0800	3	Cloudy, cold, some mist, SE breeze F3-4
09/02/17	2	DS	1130	3	Light cloud, very cold, SE breeze F2-3
09/02/17	2	DS	1500	2.75	Light cloud, light snow shower, SE breeze F3
10/02/17	2	DS	1330	3	Light cloud, very cold, E breeze F1-2
22/03/17	2	DS	1400	3	Partial cloud, long sunny spells, NE breeze F4-5
23/03/17	2	DS	1030	1	Light cloud, cold, NE breeze F3
23/03/17	2	DS	1530	1	Light cloud, hazy sun, cold, NE breeze F2
23/03/17	2	DS	1200	3	Light cloud, brighter spells, NE breeze F2-3
30/03/17	2	DS	1400	4.25	Partial cloud, sunny spells, mild, SW breeze F3-4
28/04/17	2	DS	1500	3	Light cloud, cool, W breeze F2
31/05/17	2	DS	1130	3	Warm sunny spells, S breeze F3
31/05/15	2	DS	1500	3	Warm sunny spells, S breeze F3-4
19/06/17	2	DS	1000	3.5	Warm sunny spells, W breeze F2-3
20/06/17	2	DS	1840	3	High thin cloud, warm, near calm
28/07/17	2	DS	0800	3	Bright, passing showers, blustery W breeze F4-5
28/07/17	2	DS	1130	3	Bright, passing showers, blustery W breeze F4-5
30/8/17	2	DS	0900	3	Sunny then cloudy, shower, SW breeze F3
30/08/17	2	DS	1300	3	Warm sunny spells, showers, SW breeze F2-3

Date (D/M/Y)	Vantage Point	Observer	Time Start	Duration (hours)	Weather / Remarks
31/12/15	3	DS	1200	3	Partial cloud, cold, S breeze F4
07/01/16	3	DS	1200	3	Sunny, cold, W breeze F3-4
07/01/16	3	DS	1515	1.25	Bright, cold, W breeze F3-4
03/02/16	3	DS	1400	3	Weak sun, light sleet shower, W breeze F2-3
12/02/16	3	DS	1100	4	Increasingly bright, SE breeze F2-3
10/03/16	3	DS	1030	3	Light cloud, nearly calm of NW breeze F1-2
22/03/16	3	DS	1400	3	Cloudy, near calm, mild, dry
21/04/16	3	DS	1500	3	Sunny, cool N breeze F3
26/04/16	3	DS	1000	3	Long sunny spells, cold, N breeze F4-5/6
26/04/16	3	DS	1400	3	Sunny spells, light hail showers, N breeze F4-5/6
02/05/16	3	DS	0800	3	Fine and bright but cool
04/06/16	3	DS	1100	3	Cloudy, warm and humid, near calm
04/06/17	3	DS	0730	3	Cloudy, warm and humid, near calm
29/07/16	3	DS	1200	3	Light cloud, warm sunny spells, N breeze F2-3
29/07/16	3	DS	0830	3	Partial cloud, warm sunny spells, N breeze F2-3
29/08/16	3	DS	1200	3	Warm and sunny, SW breeze F3
31/08/16	3	DS	1600	3	Cloudy, bright spells, light shower, W breeze F4
13/09/16	3	DS	1145	4	Light cloud, warm sunny spells, N breeze F2
26/09/16	3	DS	1545	2	Partial cloud, sunny spells, SW breeze falling calm
10/10/16	3	DS	1200	3	Sunny, mild, SE breeze F1-2
10/10/16	3	DS	1530	1.5	Sunny, mild, SE breeze F1-2
20/10/16	3	DS	0830	1	Sunny, very mild, near calm
20/10/16	3	DS	1530	1	Sunny, very mild, near calm
07/11/16	3	DS	1000	3	Sunny spells, sleet showers, N breeze F2
30/11/16	3	DS	1100	3	Partial cloud, sunny spells, NW breeze F2
30/11/16	3	DS	1430	2	Mainly sunny, cold, W breeze F2-3
20/12/16	3	DS	1020	2	Fine start, rain arriving later, W breeze F3-4
29/12/16	3	DS	1230	3	Mainly sunny, quite mild, S breeze F3-4
17/01/17	3	DS	1130	3	Light cloud, mild, SW breeze F1-2
26/01/17	3	DS	1100	3	Hazy sun, cold, SE breeze F5 gusting F6
26/01/17	3	DS	1430	2	Hazy sun, cold, SE breeze F5 gusting F6
30/01/17	3	DS	1200	3	Cloudy, slight haze, SE breeze F4 gusting F5

Date (D/M/Y)	Vantage Point	Observer	Time Start	Duration (hours)	Weather / Remarks
13/03/17	3	DS	1000	3	Hazy sun, mild, W breeze F3-4
13/03/17	3	DS	1330	3	Hazy sun, mild, W breeze F3-4
14/03/17	3	DS	1000	3	Partial cloud, becoming mild, W breeze f4
07/04/17	3	DS	1100	3	Light cloud, bright, W breeze F2-3
19/04/17	3	DS	0930	3	Cloudy, light rain shower, NW breeze F1-2
28/04/17	3	DS	1000	3	Sunny start, clouding over, W breeze F1-2, cool
03/05/17	3	DS	1030	4	Warm and sunny, cooling SE breeze F3
31/05/17	3	DS	0830	2	Fine and sunny, S breeze F3
19/06/17	3	DS	1400	3	Warm sunny spells, W breeze F2-3
28/07/17	3	DS	1530	3	Mainly sunny, passing shower, W breeze F3-4
31/07/17	3	DS	0800	4	Sunny spells and blustery showers, W breeze F4-5
31/07/17	3	DS	1230	2	Sunny spells, breeze easing F3-4, rain shower
18/08/17	3	DS	0830	3	Increasing cloud then showers, W breeze F3-4
22/08/17	3	DS	1000	3	Mainly cloudy, warm and humid, SE breeze F3-4

Appendix 7.3 – Details of Watches Completed to Dusk (Roost Survey)

Date (D/M/Y)	Vantage Point	Time Start	Duration (hours)	Sunset	Summary of Hen Harrier Roosting Activity
03/12/15	1	1530	1	1603	No activity
31/12/15	1	1520	1	1607	No activity
06/01/16	1	1515	1.5	1614	No activity
10/02/16	1	1630	1.5	1720	No activity
01/11/16	1	1600	1.5	1650	No activity
10/11/16	1	1300	4	1633	No activity
23/01/17	1	1530	2	1644	No activity
22//12/15	2	1400	2.25	1600	No activity
20/01/16	2	1430	2.5	1637	No activity
25/11/16	2	1315	3.25	1610	No activity
08/12/16	2	1500	1.5	1559	No activity
19/12/16	2	1330	3	1559	No activity
09/02/17	2	1500	2.75	1715	No activity
20/06/16	2	2100	1.75	2210	No activity
07/01/16	3	1515	1.5	1615	No activity
03/02/16	3	1600	1.5	1700	No activity
30/11/16	3	1430	2.25	1605	No activity

Appendix 7.4 – Details of Wider Area Survey Effort

Date (D/M/Y)	Time Start	Duration (hours)	Observer	Remarks
21/04/16	1000	5	DS	-
27/04/16	0900	6	DS	-
28/04/16	0800	6	DS	-
21/05/16	0930	8	DS	-
09/06/16	0840	2	DS	-
12/06/16	0800	4	DS	-
14/06/16	1830	2	DS	-
15/06/16	0900	3	DS	-
02/07/16	0800	4	DS	-
04/07/17	0800	4	DS	-
27/03/17	0800	9	DS	-
19/04/17	1300	3	DS	-
25/04/17	1000	6	DS	-
30/04/17	1000	5	DS	-
22/05/17	1000	6	DS	-
12/06/17	1100	3	DS	-
27/07/17	0930	6	DS	-
31/07/17	1500	4	DS	-
03/08/17	1130	6.5	DS	-

Appendix 7.5 – Details of Raptor Sightings (Activity Assessment Survey)

Key to Species Codes: HH = hen harrier; PE = peregrine; ML = merlin; WS = whooper swan; BZ = buzzard; K = kestrel.

Target Species (BTO Code)	VP	Date (D/M/Y)	Time	No. birds	Age / sex	Behaviour	Duration (seconds) in Height Band (meters)					
							<25	25-50	50-100	100-150	>150	Total
HH	1	18/08/17	1700	1	juvenile	foraging	50	0	0	0	0	50
HH	2	23/03/17	1405	1	male	foraging	110	0	0	0	0	110
HH	2	20/03/17	1815	1	male	foraging	300	0	0	0	0	300
HH	2	28/04/17	1625	1	male	foraging	297	0	0	0	0	297
HH	2	24/05/17	1420	1	male	foraging	150	0	0	0	0	150
HH	2	19/06/17	1220	1	male	foraging	30	0	0	0	0	30
HH	2	28/07/17	1230	1	male	foraging	192	0	0	0	0	192
HH	2	28/07/17	1245	1	female	foraging	271	86	13	0	0	370
HH	2	28/07/17	1255	1	male	foraging	160	0	0	0	0	160
HH	2	28/07/17	1310	1	male	foraging	366	0	0	0	0	366
HH	3	31/12/15	1340	1	male	drifting in wind	0	15	0	0	0	15
HH	3	21/04/16	1720	1	female	foraging	87	0	0	0	0	87
HH	3	20/10/16	1630	1	ringtail	foraging	340	0	0	0	0	340
HH	3	19/04/17	1230	1	male	foraging	300	0	0	0	0	300
HH	3	28/04/17	1300	1	male	circling	0	0	0	220	36	256
HH	3	28/07/17	1605	1	male	foraging	174	0	0	0	0	174
HH	3	28/07/17	1620	1	male	foraging	265	0	0	0	0	265
HH	3	28/07/17	1730	1	female	foraging	205	0	0	0	0	205
HH	3	31/07/17	0905	1	male	foraging	630	0	0	0	0	630
HH	3	31/07/17	1005	1	male	foraging	125	0	0	0	0	125
HH	3	31/07/17	1045	1	male	foraging	230	0	0	0	0	230
HH	3	18/08/17	0915	2	juvenile	foraging	250	0	0	0	0	250
HH	3	18/08/17	1000	1	juvenile	foraging	930	0	0	0	0	930
PE	1	14/01/16	1210	1	adult	travelling flight	0	0	20	0	0	20
PE	2	19/12/16	1545	1	adult	flying low	100	0	0	0	0	100
PE	2	09/02/17	1425	1	1st-year	low direct flight	31	0	0	0	0	31

Target Species (BTO Code)	VP	Date (D/M/Y)	Time	No. birds	Age / sex	Behaviour	Duration (seconds) in Height Band (meters)					
							<25	25-50	50-100	100-150	>150	Total
PE	3	13/09/16	1410	1	-	travelling flight	162	70	100	210	0	542
PE	3	30/11/16	1340	2	-	circling / chasing	42	268	0	0	0	310
PE	3	30/11/16	1355	1	juvenile	low circling	50	102	0	0	0	152
PE	3	20/12/16	1100	1	-	drifting in wind	0	0	135	18	0	153
ML	2	30/05/16	1000	1	female	low direct flight	45	0	0	0	0	45
ML	2	19/09/16	1515	1	female	low direct flight	23	0	0	0	0	23
ML	2	09/02/17	1325	1	male	low direct flight	10	0	0	0	0	10
ML	2	30/03/17	1805	1	female	low direct flight	40	0	0	0	0	40
ML	2	06/04/17	1500	1	female	low direct flight	30	0	0	0	0	30
WS	1	01/11/16	1720	8	-	flying northeast	0	0	30	33	0	63
WS	3	20/10/16	0910	6	-	flying southwest	0	0	0	70	70	140
WS	-	21/11/16	1230	18	-	flying southwest	0	0	0	65	0	65
BZ	1	10/02/16	1025	1	-	foraging	0	100	80	0	0	180
BZ	1	10/02/16	1100	1	-	circling	50	52	51	0	0	153
BZ	1	10/02/16	1700	1	-	circling	0	180	100	0	0	280
BZ	1	05/04/16	1240	1	-	foraging	95	25	25	0	0	145
BZ	1	09/06/16	1450	1	-	foraging	0	300	0	0	0	300
BZ	1	14/03/17	1425	2	-	foraging	670	365	0	0	0	1035
BZ	1	26/04/17	1555	2	-	low circling	535	175	0	0	0	710
BZ	1	10/05/17	1415	1	-	soaring high	0	125	27	40	108	300
BZ	1	10/05/17	1600	2	-	low circling	80	250	0	0	0	330
BZ	1	24/05/17	1655	1	-	foraging	0	72	145	43	72	332
BZ	1	19/06/17		1	adult	foraging	300	0	0	0	0	300
BZ	1	18/08/20	1450	1	adult	travelling	50	164	0	0	0	214
BZ	2	30/03/16	1130	2	-	soaring	0	0	191	62	538	791
BZ	2	05/04/16	1535	1	-	foraging	0	0	0	345	0	345
BZ	2	28/04/17	1220	1	-	travelling	49	0	0	0	0	49

Target Species (BTO Code)	VP	Date (D/M/Y)	Time	No. birds	Age / sex	Behaviour	Duration (seconds) in Height Band (meters)					
							<25	25-50	50-100	100-150	>150	Total
BZ	3	22/03/16	1145	2	-	circling	0	0	216	145	0	361
BZ	3	22/03/16	1240	2	-	circling	0	0	370	0	0	370
BZ	3	21/04/16	1620	1	-	foraging	0	116	34	73	165	388
BZ	3	26/04/16	1115	1	-	foraging	0	85	56	20	74	235
BZ	3	26/04/16	1220	1	-	foraging	336	97	0	0	0	433
BZ	3	26/04/16	1650	1	-	foraging	0	36	30	30	100	196
BZ	3	29/07/16	1120	1	-	foraging	0	77	0	0	0	77
BZ	3	29/07/16	1245	1	-	foraging	71	64	0	0	0	135
BZ	3	13/03/17	1015	1	-	travelling	0	0	89	0	0	89
BZ	3	13/03/17	1055	1	-	foraging	80	275	0	0	0	355
BZ	3	13/03/17	1210	1	-	foraging	70	142	150	0	0	362
BZ	3	13/03/17	1445	1	-	foraging	70	0	0	0	0	70
BZ	3	13/03/17	1455	1	-	foraging	0	92	0	0	0	92
BZ	3	14/03/17	1235	1	-	foraging	43	100	0	0	0	143
BZ	3	19/04/17	1100	2	-	circling	90	58	84	0	0	232
BZ	3	19/04/17	1140	1	-	foraging	51	0	0	0	0	51
BZ	3	03/05/17	1320	3	-	soaring high	0	0	0	0	130	130
BZ	3	31/07/17	940	1	-	foraging	0	130	0	0	0	130
K	1	05/04/16	1300	1	male	foraging	55	90	0	0	0	145
K	1	29/04/16	1420	1	male	foraging	100	121	0	0	0	221
K	1	31/08/16	1830	1	male	foraging	0	69	68	0	0	137
K	1	31/08/16	1905	1	male	foraging	280	0	0	0	0	280
K	1	10/11/16	1310	1	male	foraging	100	64	0	0	0	164
K	1	10/11/16	1635	1	male	foraging	165	0	0	0	0	165
K	1	23/01/17	1335	1	male	foraging	350	0	0	0	0	350
K	1	26/04/17	1635	1	-	foraging	105	0	0	0	0	105
K	1	10/05/17	1415	1	male	foraging	95	70	0	0	0	165
K	1	10/05/17	1705	1	male	foraging	240	60	0	0	0	300
K	1	18/08/17	1640	1	juvenile	foraging	100	20	0	0	0	120
K	2	20/01/16	1245	1	male	travelling flight	300	0	0	0	0	300

Target Species (BTO Code)	VP	Date (D/M/Y)	Time	No. birds	Age / sex	Behaviour	Duration (seconds) in Height Band (meters)					
							<25	25-50	50-100	100-150	>150	Total
K	2	10/02/16	1330	1	female	foraging	600	0	0	0	0	600
K	2	30/03/16	1040	1	female	foraging	120	73	0	0	0	193
K	2	23/06/16	1245	1	female	foraging	0	185	0	0	0	185
K	2	26/07/16	1350	1	male	foraging	148	193	0	0	0	341
K	2	18/08/16	1710	1	juvenile	foraging	1200	0	0	0	0	1200
K	2	19/06/17	1005	1	female	foraging	120	360	90	37	0	607
K	2	19/06/17	1020	1	male	foraging	170	0	0	0	0	170
K	2	19/06/17	1625	1	male	foraging	48	182	0	0	0	230
K	2	19/06/17	1735	1	male	foraging	0	89	65	29	0	183
K	2	30/08/17	1600	1	male	foraging	0	190	0	0	0	190
K	3	12/02/16	1135	1	male	foraging	75	120	0	0	0	195
K	3	21/04/16	1520	1	-	foraging	120	0	0	0	0	120
K	3	21/04/16	1600	1	-	foraging	117	97	154	0	0	368
K	3	29/07/16	1030	1	male	foraging	65	165	174	0	0	404
K	3	29/07/16	1135	1	male	foraging	123	344	0	0	0	467
K	3	29/07/16	1235	1	male	foraging	47	136	0	0	0	183
K	3	29/07/16	1320	1	male	foraging	131	183	61	0	0	375
K	3	13/09/16	1335	1	-	foraging	90	0	0	0	0	90
K	3	13/09/16	1530	1	male	foraging	0	0	272	85	90	447
K	3	10/10/16	1400	1	-	foraging	47	176	0	0	0	223
K	3	30/11/16	1115	1	male	foraging	167	93	0	0	0	260
K	3	30/01/17	1225	1	male	foraging	282	0	0	0	0	282
K	3	28/04/17	1200	1	-	travelling flight	0	0	0	180	0	180
K	3	31/07/17	1105	1	male	travelling flight	180	0	0	0	0	180
K	3	31/07/17	1130	1	male	foraging	240	150	150	0	0	540
K	3	31/07/17	1205	1	juvenile	travelling flight	250	0	0	0	0	250
K	3	22/08/17	1030	1	juvenile	foraging	90	0	0	0	0	90
K	3	07/01/16	1240	1	male	foraging	600	0	0	0	0	600

Appendix 7.6 – Details of Hen Harrier Habitat Displacement Calculations

Table – Habitat Displacement Calculation for Proposed Dunbeg South Wind Farm

Details	Area (ha)	Remarks
Total harrier foraging range	2090.2	Suitable foraging habitat within 4km radius of confirmed nest location
Area of suitable foraging habitat within 500m of Proposed Dunbeg South Wind Farm array	257.0	12.30% of total 2090 ha
52 % reduction in foraging activity within 500m of array equivalent to habitat loss of	133.6 (52% of 257.0)	6.40% of total 2090 ha

Table – Cumulative Habitat Displacement Calculation

Details	Area (ha)	Remarks
Total harrier foraging range	2090.2	Suitable foraging habitat within 4km radius of confirmed nest location
Area of suitable foraging habitat within 500m of existing Rigged Hill array	155.0	
Area of suitable foraging habitat within 500m of consented / under-construction ST1 / ST2 cluster	65.0	
Sub-total	220.0	155.0 + 65.0
Area of suitable foraging habitat within 500m of Proposed Dunbeg South Farm array	257.0	
Cumulative total	**477.0**	**22.80% of total 2090 ha**
52 % reduction in foraging activity within 500m of cumulative arrays equivalent to habitat loss of	248.0 (52% of 477.0)	11.80% of total 2090 ha
Cumulative total excluding existing Rigged Hill array	**322.0**	**15.40% of total 2090 ha**
52 % reduction in foraging activity within 500m of cumulative arrays (excluding Rigged Hill) equivalent to habitat loss of	167.0	8.00% of total 20190 ha

Appendix 7.7 – Details of Collision Risk Assessment

Wind Farm Parameters

The wind farm parameters input to the Collision Risk Model (CRM) are given in the table below.

Table – Wind Farm Parameters Input to the Collision Risk Model

Parameter	Input Value	Remarks
Size of wind farm envelope	1	Optional input (a value of 1 or more must be entered) - this value has no effect on collision risk
Number of turbines	9	
Rotor diameter (m)	99.8	Value is rounded to 100m by the CRM spreadsheet
Hub height (m)	100	
Rotor depth (m)	-	Not available – optional input
Rotor chord (m)	4	
Rotor pitch (degrees)	6	
Rotation period (seconds)	5.19	Indicated range is 3.73 – 6.64
Turbine operation time (%)	91.66	Value is rounded to 92 by the CRM spreadsheet

Bird Parameters

The bird parameters input to the CRM are given in the table below. In line with SNH guidance[1], flight speeds and wing-spans are taken from Alerstam *et al*.[2] Bird lengths are taken from Forsman[3], which is the standard published reference for raptor identification in Europe. *Note: some input values are rounded by the CRM spreadsheet.*

Table – Bird Parameters Input to the Collision Risk Model

Species	Wing-span (m)	Length (m)	Flight speed (m / s)
Hen harrier	1.1	0.48	9.1
Buzzard	1.24	0.54	12.5 (range 11.6 - 13.3)
Kestrel	0.73	0.32	10.1

Band Used To Define Risk Height

The band used to define risk height in the CRM is:

- Maximum height 150m;
- Minimum height 50m.

[1] SNH (2014): Flight Speeds and Biometrics for Collision Risk Modelling (SNH Guidance Note, October 2014)
[2] Alerstam, T. *et al.* (2007): Flight Speeds Among Bird Species – Allometric and Phylogenetic Effects (PLoS Biol. 5)
[3] Forsman, D. (1999): The Raptors of Europe and the Middle East – A Handbook of Field Identification (Poyser)

Watch Data

The watch data input to the CRM are given in the table below. The time at each vantage point is taken from Table 7.3A in the Ornithology Chapter. For hen harrier (because activity was negligible in baseline year 1) the CRM was carried out using the data from year 2 only (therefore the observation time totals are correspondingly less). Areas visible at lowest edge of risk height (50m) are calculated from the viewpoint coverage shown in Figure 7.1.

Table – Watch Data Input to the Collision Risk Model

Vantage Point	Area Visible at Risk Height (ha)	Time (hours)	
		Baseline Years 1 and 2 (Buzzard and Kestrel)	Baseline Year 2 Only (Hen Harrier)
VP1	303.8	126.0	70.0
VP2	249.3	127.8	73.5
VP3	277.7	131.8	78.5
Total	830.8	385.5	222.0

Summary of Collision Risk Model Results

The results of the CRM are summarized in the table below. The avoidance rates used are those recommended by SNH[4]. For hen harrier, the CRM has been carried out separately for a 99% avoidance rate (recommended by SNH) and also (for comparison) using a lower avoidance rate of 98%. For buzzard, the CRM has been carried out separately for potential presence of nine months (assuming nil or negligible activity during mid-winter) and 12 months (assuming year-round activity). The bird flight data (total duration and duration at risk height) are taken form Appendix 7.5. *Note: one CRM Excel spreadsheet for each species is supplied separately in electronic format.*

Table – Summary of Results of the Collision Risk Model

Species	Baseline	No. of Months Potentially Present	Total Duration (s)	Duration at Risk Height (s)	Avoidance Rate	Equivalent Collision Rate
Hen harrier	year 2 only	12	5832	233	99%	one bird every 126.1 years
Hen harrier	year 2 only	12	5832	233	98%	one bird every 63.1 years
Kestrel	years 1 and 2	12	11605	1365	95%	one bird every 8.0 years
Buzzard	years 1 and 2	9	9313	2406	98%	one bird every 10.8 years
Buzzard	years 1 and 2	12	9313	2406	98%	one bird every 8.1 years

[4] SNH (2016): Avoidance rates for the SNH onshore wind farm Collision Risk Model (SNH Guidance Note, October 2016)

Appendix 7.8 – IEEM Probability Scale

The IEEM probability scale used in the Assessment of Effects is given below:

- Certain / near-certain – probability estimated at 95% or higher
- Probable – probability estimated at above 50% but below 95%
- Unlikely – probability estimated at above 5% but below 50%
- Extremely unlikely – probability estimated at less than 5%

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Geology & Water Environment

Appendix 9: Geology & Water Environment

McCloy Consulting

Water Framework Directive Assessment

Dunbeg South Wind Farm

115-77_DG02 | November 2017

WATER & ENVIRONMENTAL CONSULTANTS

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DOCUMENT CONTROL

DOCUMENT FILENAME	MCL115-77_DG02 Appendix 9.1 WFD Assessment Rev 2 DRAFT.Docx
DOCUMENT REFERENCE	115-77_DG02
TITLE	Water Framework Directive Assessment
CLIENT	RES Ltd
CLIENT CONTACT	Garth McGimpsey
PROJECT MANAGER	Kyle Somerville
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REVISION HISTORY

Rev. Ref.	Date	Prep	Chk	App	Amendments	Reason for Issue
1	XX/XX/XXXX	XX	XX	XX	Original	For Review
2	30/10/2017	CMQ	DKS	DKS	Updated to RES comments	For Review

DISTRIBUTION

Recipient	Revision					
	1	2	3	4	5	6
FILE	✓	✓				
RES Ltd	✓	✓				

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1 INTRODUCTION

1.1 Terms of Reference

RES Ltd (RES) has appointed McCloy Consulting Ltd to undertake a Water Framework Directive (WFD) Assessment for a planning application for the proposed Dunbeg South Wind Farm. The purpose of this WFD assessment is to:

- Determine if specific components or activities related to the development of the proposed Development will compromise the attainment of a WFD objective or result in the deterioration in the ecological status of any waterbodies in the vicinity of the site.
- Provide details of proposed mitigation measures specifically in relation to management of surface water from the developed site if there is initially a perceived risk of deterioration in the ecological status of any affected waterbody.

The assessment is intended to supplement the Environmental Statement (and in particular Chapter 9, Geology and Water Environment) submitted in support of the planning application for the proposal.

1.2 Statement of Authority

McCloy Consulting is an independent environmental consultancy specialising in the water environment, with specialist knowledge of hydrological and hydrogeological assessments, sustainable drainage systems (SuDS), drainage, river modelling, and flood risk assessment.

McCloy Consulting has ongoing involvement in numerous geology and water environment studies and SuDS projects across the UK and has developed a particular expertise in surface water management for wind farms. The company has successfully designed a number of SuDS/silt management solutions for wind farms in accordance with current best practice guidance. The primary personnel responsible for undertaking this hydrology assessment are:

- Catherine McQuillan BSc(Hons) MSc FGS - Environmental Consultant with experience in environmental assessment and monitoring for onshore wind energy projects in the UK, groundwater screening and hydrogeological assessments.
- Kyle Somerville BEng (Hons) CEng MIEI - Chartered Engineer with experience in the fields of hydrology, surface water management, groundwater screening assessments and geology assessments for wind farm developments in the UK and Ireland, and has overseen outline and detailed design of surface water management for in excess of thirty onshore wind farm developments in the UK and Ireland.

1.3 Water Framework Directive

The EU Water Framework Directive (2000/60/EC, as amended by Directives 2008/105/EC, 2013/39/EU and 2014/101/EU) was established in law in Northern Ireland in December 2003.

The Directives is transposed in Northern Ireland through the Water Environment (Water Framework Directive) Regulations (Northern Ireland) 2017.

A fundamental requirement of the Water Framework Directive (WFD) is to attain good ecological water status and that deterioration in the status of water is prevented. Any new development must ensure that this fundamental requirement of the directive is not compromised.

1.3.1 River Basin Districts

The WFD is implemented through River Basin Planning which introduces a six-yearly cycle of planning, action and review. The plans will include identifying river basin districts, identifying water bodies and protected areas, identifying pressures and risks, monitoring and setting environmental objectives, classification systems and standards.

The WFD was initially implemented in Northern Ireland through three River Basin Management Plans (RBMPs) that were published in December 2009; as required by WFD the plans are reviewed and updated every six years.

A second set of Plans was published in 2015.

1.3.2 Local Management Areas

The RBMPs have been put into practice by a Local Management Area (LMA) Action Plans during the planning cycle from 2009 to 2015.

LMAs outline some of the measures carried out locally that will contribute to protecting or improving waterbody status, while others involve long-term projects and multiple partners.

1.3.2.1 Water Framework Directive Assessment

The aims, objectives and processes of a WFD Assessment are outlined by the Northern Ireland Environment Agency (NIEA) Water Management Unit within their report published in March 2012[1] which outlines how to carrying out a Water Framework Directive Assessment on EIA Developments.

A WFD Assessment should be used as a decision making tool; the proposer of the scheme should use the conclusions of the assessment to decide whether to proceed with the development or to amend proposed works and / or instigate mitigating measures prior to proceeding.

Each specific component of the proposed Development, that may interact with or pose a risk to a waterbody, is required to have its potential impact assessed. The cumulative effect of a number of such impacts should also be considered.

This report provides a description of the specific activity being undertaken (construction of compounds, hardstandings, tracks, trenches and turbine excavations, and electrical cabling etc.), identifies the potentially impacted waterbodies and provides baseline data for the waterbody.

The potential impact of the proposed works is then assessed in light of the relevant WFD classification and the following WFD key environmental objectives:

- To prevent deterioration in the ecological status of the waterbody.
- To prevent the introduction of impediments to the attainment of 'Good' WFD status of the waterbody.
- To ensure that the attainment of the WFD objectives for the waterbody are not compromised.
- To ensure the achievement of the WFD objectives in the other waterbodies within the same catchment are not permanently excluded or compromised.

1.3.3 Approach to the Assessment

This WFD Assessment will be carried out in line with the NIEA guidance / methodology outlined in Section 1.3.2.1 and will comprise of three stages:

- Stage I: Review of WFD Waterbody catchments, classifications and LMA Plans.
- Stage II: Assessment of proposals for the Proposed Dunbeg South Wind Farm.
- Stage III: Proposed mitigation measures where key WFD objectives are not met.

[1]NIEA (2012) Carrying Out A Water Framework Directive (WFD) Assessment on EIA Developments. Available: https://www.daera-ni.gov.uk/publications/guidance-note-carrying-out-water-framework-directive-assessment-environmental-impact [Accessed 12/10/2017]

2 STAGE I: WATERBODY IDENTIFICATION AND CLASSIFICATION

2.1 Approach

The first stage identifies those surface water and groundwater bodies with potential to be affected by the development and reviews any available WFD information to classify the waterbody including a review of the current WFD status, future status, identified environmental constraints and any existing / proposed 'mitigation approaches' for the waterbody.

Hydrological catchment boundaries established are as per online NIEA River Basin Plan Interactive Map and classification information was primarily sourced from RBMP documents for the relevant LMA.

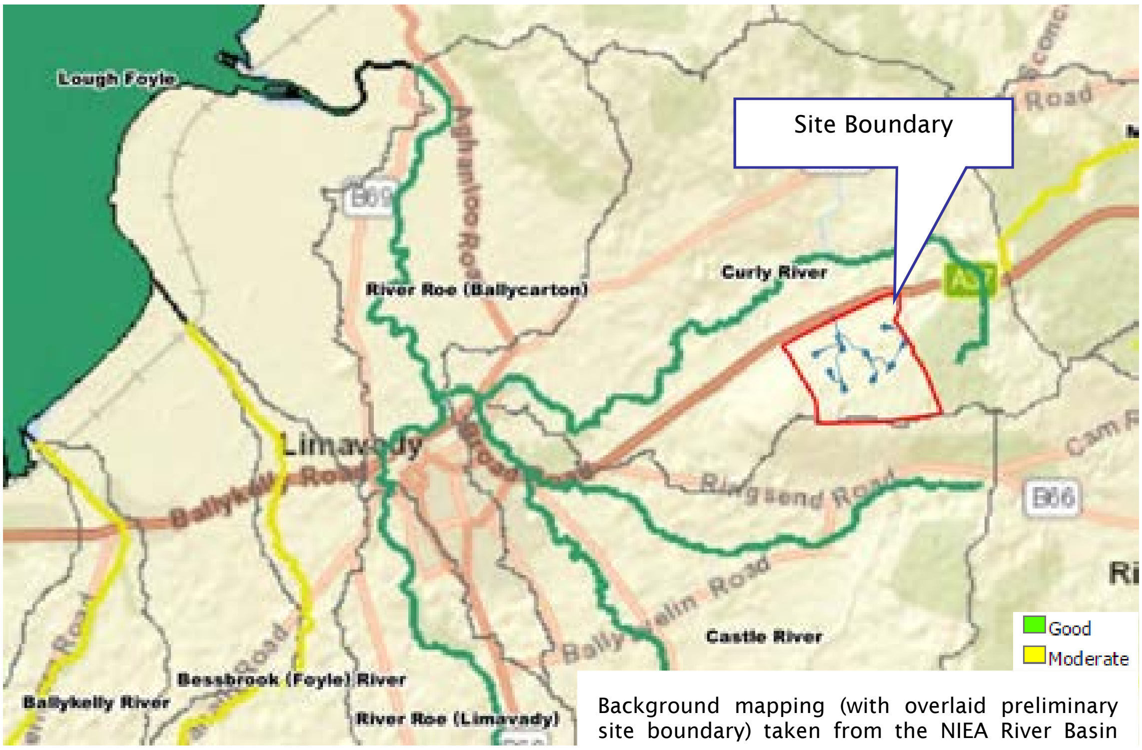
2.2 Surface Waterbody Identification

The site boundary considered as part of this assessment falls entirely with the Curly River.

From the end of 2015 the number of water bodies within the Roe LMA was reduced. This resulted in the two Curly River waterbodies (UKGBNI1NW02022013 & UKGBNI1NW02022049) being merged to form a single entity as Curly River (UKGBNI1NW020204060).

The Curly River flows into the River Roe (UKGBNI1NW20202024) 5.2 km west of the site.

Figure 2.1: WFD Surface Waterbody



Background mapping (with overlaid preliminary site boundary) taken from the NIEA River Basin

2.3 Surface Waterbody Classification

The following section is intended to provide a qualitative appraisal of existing surface water quality in the waterbody whose catchment the proposed development lies within.

As identified within Section 2.2; for purposes of classification under the WFD the Curly River which is located within the Roe Local Management Area[2, 3] and the Lower Foyle Catchment Stakeholder Group. The River Roe and its tributaries are located within the North Western River Basin District[4].

Following the publication of the Water Framework Directive waterbodies are given a WFD classification based on annual average / percentile results from several individual monitoring stations. WFD classification or status is a combination of chemical, biological and hydromorphological elements, whereby the overall status is the lowest of the combined constituents.

A number of biological and chemical water quality elements used in classification in the Roe Catchment can be affected by both diffuse and point source pollution. Within the LMA Plan the main impact has been assessed as affecting invertebrate communities. This element is associated with organic enrichment.

2.3.1 Surface Water Quality

The current Overall Current Status for the Curly River (UKGBNI1NW020204060[5]) is 'Good' with an objective to maintain 'Good' status through to 2021 and 2027. The Curly River is designated under the WFD as a Freshwater Fish Directive protected area due to the presence of economically significant species.

Prior to 2015 the Curly River comprised two separate bodies UKGBNI1NW020204049 and UKGBNI1NW020202013, both of which were subject to 2009 – 2014[6] classifications. The previous body directly downgradient of the site was UKGBNI1NW020204049 and as such the classifications for that body have been used to inform of the 2009 -2014 status.

The WFD results are detailed within Table 2.1.

[2] DAERA (2012) Roe Local Management Area Action Plan 2009 to 2015 https://www.daera-ni.gov.uk/publications/roe-local-management-area-action-plan-2009-2015

[3] Roe Local Management Areas Action Plan and Update (2013) https://www.daera-ni.gov.uk/sites/default/files/publications/doe/roe-swmi-joined.PDF

[4] DAERA (2015) North Western River Basin Management Plan 2015 to 2010 https://www.daera-ni.gov.uk/publications/north-western-river-basin-management-plan-2015-2021

[5] NIEA (2015) Reasons for status of the water bodies within the Roe LMA https://www.daera-ni.gov.uk/sites/default/files/publications/doe/roe-historical-status-historical-status.pdf [Accessed 14/06/2017]

[6] NIEA (2014) Reasons for status for the water bodies within the Roe LMA. https://www.daera-ni.gov.uk/sites/default/files/publications/doe/water-report-reasons-for-status-for-water-bodies-within-roe-lma-2014.pdf [Accessed 14/06/2017]

Table 2.1: Curly River LMA Waterbody Classification

River Classification Element		2010 Status	2011 Status	2012 Status	2013 Status	2014 Status	2015 Status
Overall Status		Good	Good	Good	Moderate	Moderate	Good
Confidence in Overall Status		High	High	Medium	Medium	Medium	Medium
Biological	Benthic Invertebrates	Good	Good	Good	Good	Good	Good
	Macrophytes	High	High	High	High	High	High
	Phytobenthos	-	-	-	Moderate	Moderate	Good
	Fish	Good	-	-	-	-	-
Chemical / Physio-chemical	Ammonia	High	High	High	High	High	Good/ High
	Dissolved Oxygen	High	High	High	High	High	High
	pH	High	High	High	High	High	High
	Soluble Reactive Phosphate	High	High	High	High	High	High
	Biological Oxygen Demand*	High	Good	High	High	High	High
	Temperature*	High	High	High	High	High	High
Specific Pollutants	Dissolved Copper	Pass	-	-	Pass	Pass	-
	Total Zinc	Pass	-	-	Pass	Pass	-
Hydro-morphology	Hydrological Regime	High	High	Moderate	Moderate	Good	High
	Morphological conditions#	-	-	-	-	-	-

No Morphological Conditions recorded for the Curly River. Rive Roe(Limavady) recorded as good (2015).

*Element does not contribute to overall classification.

2.3.2 Roe Local Management Area Action Plan and Update

The LMA Action Plan and Update states that many rivers (62 %) within the River Roe Catchment have been classified as less than 'Good' status. The main pressures being abstraction and flow regulation, diffuse and point source pollution, changes to morphology (physical habitat).

Catchment wide actions to be implemented to maintain and improve the water environment are outlined within the Action Plan and the plan also outlines surface water catchment specific actions to be undertaken to maintain and improve the Catchment as follows:

2.3.2.1 Catchment Wide Actions

- Carry out agricultural advisory site visits where identified as an issue through river walks and spot checks or as identified by stakeholders.
- Carry out fish habitat improvement works at identified areas within the LMA.
- Conduct a water resource assessment to inform an ongoing review of abstraction licences within Northern Ireland.
- Encourage riparian zone management with an aim to improve biodiversity and minimise sedimentation through practical management measures on farms.
- Raise awareness and promote the benefits of effective farm nutrient and waste management.

- Support local environmental initiatives such as river clean-up campaigns.
- Review of groundwater abstraction and planning applications where necessary.
- Provide advice on protected area designations to work towards improving the condition assessment of the 'River Roe & its tributaries' Special Area of Conservation (SAC).

2.3.2.2 Curly River Actions

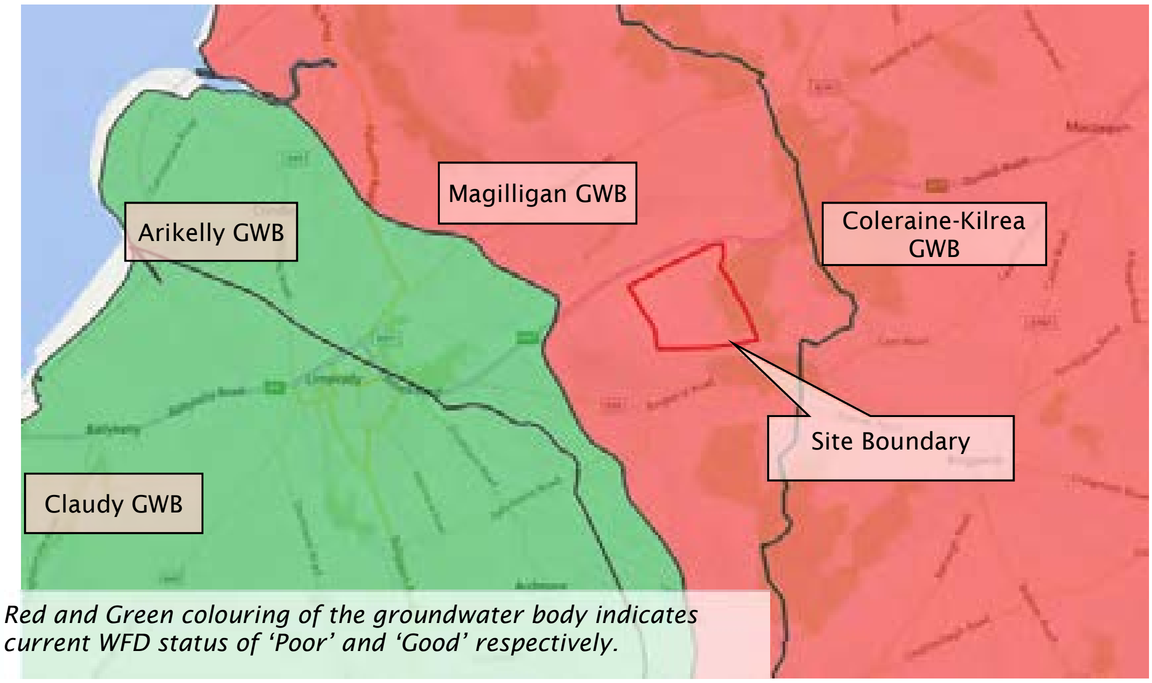
- Maintain current regulatory controls.
- Investigate identified water quality impacts by assessing sources of organic pollution.
- Carry out pollution prevention and enforcement measures if necessary at active quarries.

The actions within the plan applicable to the construction of the Dunbeg South Wind Farm are to be adhered to throughout the construction process to ensure maintenance and, where feasible, improvement of water quality classifications in the catchment.

2.4 Groundwater Body Identification

The proposed Development is situated within the catchment of the Magilligan Groundwater Body (UKGBNI4NW001), within the North-Western River Basin District as shown on Figure 2.2.

Figure 2.2: WFD Groundwater Body



2.5 Groundwater Body Classification

The groundwater body is located on the east of Lough Foyle. The body includes the area between Castlerock and Magilligan on the north coast, extending southwards towards the Glenshane Pass. The body is associated with minor population centres and dominantly agricultural land use (58.9% improved grassland).

The groundwater body is defined to the west and south mostly by the geological contact between older Carboniferous and Triassic (Sherwood Sandstone Group) rocks of the adjacent body. Younger Triassic (Mercia Mudstone Group) and Palaeogene (basalts) rocks comprise the majority of the body. The eastern boundaries are defined by the surface water catchment with the northern boundary formed by the coastline.

The chemical composition of the natural waters is variable with geology[7]. For example the Mercia Mudstone Group which has limited groundwater may report elevated sulphates due to evaporitic minerals such as gypsum and halite.

Ulster White Limestone (chalk) and Hibernian Greensands is overlain eastwards by Palaeogene basalts which form the eastern part of the body. The resultant natural waters contain calcium bicarbonates, with a sodium signature also present in the basalt in places.

The bedrock aquifers may be locally confined where overlain by thicker deposits of clayey Till. Depth to water table is unknown but expected to be shallow (<10m).

Characterisation of the groundwater body in the vicinity of the site is summarised within Table 2.2.

Table 2.2: Characterisation of Magilligan Groundwater Body

Region	Geological Characteristics	Aquifer Type	
All Infrastructure	Palaeogene Basalt Bedrock	Bm (f)	Bedrock with moderate potential. Intergranular porosity negligible and fracture flow dominant. Flow mostly short (hundreds of metres) although some limited regional flow may also occur. Potentially some vertical hydraulic connection with the underlying Chalk (Ulster White Limestone).
North-western corner of Preliminary Boundary	Ulster White Limestone	Bh(f-k)	High productivity potential locally or where exploited with overlying basalts. Intergranular flow is negligible with fracture flow dominant. Karstic conditions may exist based upon evidence from where the chalk occurs elsewhere in NI but no specific evidence within this body.

2.5.1 Groundwater Body WFD Classifications

Following publication of the NIEA River Basin Management Plan in 2009 only an initial characterisation had been carried out for this groundwater body. The plan classified the quantitative, chemical, and overall status of the groundwater body as ‘Poor’.

Second cycle results for the 2015-2021 cycle indicated water quality (quantitative, chemical, and overall) remained classified as ‘Poor’.

2.5.2 Groundwater Body WFD Objectives

The updated RBMP document “What We Plan to Achieve by 2021 and Beyond”[8,9] produced in December 2014 following the second cycle; highlights changes to original 2009-2015 WFD objectives. The RBMP

[7] NIEA (2012) Characterisation of groundwater bodies within Northern Ireland. Available: https://www.daera-ni.gov.uk/sites/default/files/publications/doe/water-report-characterisation-of-groundwater-bodies-within-Northern-Ireland-June-2012.pdf [Accessed 05/06/2017]
8 NIEA (2014) RBMP What we plan to achieve by 2021 and beyond https://www.daera-ni.gov.uk/sites/default/files/publications/doe/water-plan-what-we-plan-to-achieve-by-2021-beyond-2014.pdf [Accessed 14/06/2017]
9 NIEA (2015) Review of the Environmental Objects for the Second Cycle RBMP Available: https://www.daera-ni.gov.uk/publications/what-we-plan-achieve-by-2021-and-beyond-2015 [Accessed 15/06/2017]

now aims to achieve 'Good' status and ensure there is no deterioration in the water quality of these waters.

2.5.3 Local Management Area Action Plans

The Roe Action Plan and Update published in December 2013 highlighted any actions which had been implemented to date. Catchment wide actions to be implemented to maintain and improve the groundwater environment were outlined within the Action Plan as follows:

- Review of groundwater abstraction and planning applications where necessary; and
- Authorisation of discharges to groundwater.

3 STAGE II: ASSESSMENT OF PROPOSALS

3.1 Approach

The next stage undertaken will identify the nature of the development, the construction activities proposed and the potential specific detrimental effect to the water environment based on the key WFD objectives.

3.2 Development Description

The proposed Development comprises:

- Construction of an enabling works compound, construction of new access tracks and upgrade of an existing track;
- Construction of a construction compound throughout the construction period and a permanent substation;
- Excavation of nine turbine foundations and associated dewatering and concrete pouring activities and construction of nine crane pads and lay-down areas;
- Construction of two bottomless crossings watercourses five culvert crossings of other watercourses;
- Installation of underground power and telemetry cables;
- Temporary and permanent stockpiling of soils associated with all of the above.

3.3 Potential Effects

The proposed Development works include works over, in and in close proximity to waterbodies. There are a number of potential adverse effects to both surface and groundwater and these will be considered in the following sections. The risks will be considered on a case by case basis in the WFD Schedules presented later on this assessment. Potential effects of wind farm construction are outlined in greater detail in **Chapter 9: Geology and Water Environment**.

3.3.1 Surface Water

The primary risks of degradation of surface water bodies, i.e. streams and drains, are summarised as follows:

- Changes in runoff and flow patterns;
- Silt / suspended solid pollution of surface waters;
- Chemical pollution of surface waters e.g. Oil / fuels.

3.3.2 Groundwater

Groundwater is not at risk from as many sources of pollution as surface waters. However, potential risks are considered to be as listed below:

- Chemical pollution of groundwater e.g. Oil / fuels;
- Due to the nature of the works (deep excavations / importing of fill material) it is considered that there is potential for disturbance of aquifers and aquifer recharge.

3.4 Site Specific Proposals Assessment

The following sections (Table 3.1-Table 3.5) detail those areas where the proposed Development has potential to affect the water environment, detailing the nature and extent of work required and potential for adverse impact.

The format generally mirrors that required by the guidance provided by NIEA Northern Ireland Environment Agency Water Management Unit (NIEA WMU) in ‘Carrying out a Water Framework Directive Assessment on EIA Developments’. It is noted that the “Current” status shown is taken from the most recent year a particular parameter was tested for and can vary between watercourses and parameters.

3.4.1 Potential Effect of Construction - Changes in Runoff and Flow Patterns

Table 3.1: Potential Impact of Changes in Runoff and Flow Patterns on site affecting the Curly River

WATERCOURSE		
	Waterbody Name	Curly River
	WFD Waterbody ID	(UKGBNI1NW020202060)
	Local Management Area	Roe
	Objective 2021- 2027	Good Status

UNMITIGATED IMPACT DISCUSSION

Proposed Works

Installation of new temporary or permanent impermeable surfaces.

New temporary or permanent excavations and structures acting as barriers to runoff.

Temporary Compaction of soils due to plant and site traffic.

Potential Impacts

Increased rate and volume of surface runoff, ponding and alterations to preferential flow routes, reduced surface permeability on site.

Consequences

Temporary or permanent redirection of surface water flows can result in potential adverse effects to down gradient dependant habitats either through starvation of areas where water currently flows, or flooding.

Temporary or permanent increases in surface water runoff rates and volumes can result in increased flood risk and increased effects of erosion and scour in down gradient watercourses.

Adopting a precautionary approach, flow changes in affected watercourses may affect benthic invertebrate communities, given that individual species are adapted to specific flow conditions.

Changes to flow patterns causing sediment movement may impact adversely on any macrophytes via smothering or changes to water depth.

Soluble reactive phosphate status concentrations may be expected to increase if sediment concentrations increase (as a result of changes to flow patterns and runoff characteristics).

A reduced water depth may also be associated with increased water temperatures; and consequently dissolved oxygen decreases.

Changes to flow patterns have the potential to affect the hydrological regime of the river.

WFD CLASSIFICATION

WFD Element	Current Status	Assessed Change
Benthic Invertebrates	Good	Moderate
Phytobenthos	Good	Moderate
Ammonia	Good /High	Good /High
Dissolved Oxygen	High	Good
pH	High	High
Soluble Reactive Phosphate	High	Good
Biological Oxygen Demand	High	Good
Temperature	High	Good
Hydrological Regime	High	Good
Morphological conditions	-	

ASSESSMENT	Does the component comply with WFD Objectives 1, 2, 3 and 4?		
	No		Do not proceed or complete Article 4.7 assessment.
	Yes (Justification provided)		Proceed after NIEA agreement.
	Yes, with mitigation	✓	Complete Schedule B.

3.4.2 Potential Effect of Construction - Silt / Suspended Solid Pollution of Surface Waters

Table 3.2: Potential Impact of Silt / suspended solid pollution on watercourses leading to the Curly River

WATERCOURSE	Waterbody Name	Curly River
	WFD Waterbody ID	(UKGBNI1NW020202060)
	Local Management Area	Roe
	Objective 2021-2027	Good Status

UNMITIGATED IMPACT DISCUSSION	
	Proposed Works Excavations, ground disturbance, stripping of top soil and temporary soil deposition will be required during construction of the wind farm infrastructure. Importing, handling and placement of aggregate for access tracks. Plant and maintenance vehicle movement across disturbed soils and stone access tracks and washing down plant and machinery. Potential Impacts The proposed works have the potential to release fine sediments, fine soil, clay and aggregate particles into surface runoff or where construction is in the vicinity off watercourses. Shallow groundwater gathering in excavations will come in contact with excavated surfaces and aggregate. Traffic movements can transport silts and find grade aggregates. Consequences Polluted groundwater within excavations will have to be pumped and (without treatment) if discharged to nearby watercourses will result in the release of a potentially heavily polluted effluent. Sediments and debris entering watercourses have the potential to adversely modify stream morphologies, smother habitats, harm aquatic flora / fauna and increase risk of blockage to culverts / drainage channels. Increased suspended sediment concentrations may affect benthic invertebrate communities given that individual species are adapted to specific water quality conditions. Changes to suspended sediment concentrations may impact adversely on macrophytes via smothering or changes to water depth and flow patterns for example.

WFD CLASSIFICATION	WFD Element	Current Status	Assessed Change
	Benthic Invertebrates	Good	Poor
	Phytobenthos	Good	Good
	Ammonia	Good /High	Good /High
	Dissolved Oxygen	High	Moderate
	pH	High	High
	Soluble Reactive Phosphate	High	Poor
	Biological Oxygen Demand	High	Poor
	Temperature	High	Good
	Hydrological Regime	High	Good

Table 3.2: Potential Impact of Silt / suspended solid pollution on watercourses leading to the Curly River

	Soluble reactive phosphate status concentrations may be expected to increase given that phosphorus adheres strongly to some sediment particles. BOD concentrations may increase if it is presumed that some of the sediment fraction is organic. Some influence on water temperature may be exhibited due to changes to the turbidity. A reduced water depth (caused by sediment build up) may also be associated with increased water temperatures – in reality this is unlikely to increase the temperature to such a degree that the WFD status is affected; however a precautionary approach is adopted here. Some increased concentrations of metals may occur (given their association with sediments) but such increases are likely to be negligible.		Morphological conditions	-	
ASSESSMENT	Does the component comply with WFD Objectives 1, 2, 3 and 4?				
	No		Do not proceed or complete Article 4.7 assessment.		
	Yes (Justification provided)		Proceed after NIEA agreement.		
	Yes, with mitigation	✓	Complete Schedule B.		

3.4.3 Potential Effect of Construction - Chemical Pollution of Surface Waters

Table 3.3: Potential Impact of Chemical pollution on the Curly River

WATERCOURSE	Waterbody Name	Curly River
	WFD Waterbody ID	(UKGBNI1NW0202020460)
	Local Management Area	Roe
	Objective 2021-2027	Good Status

UNMITIGATED IMPACT DISCUSSION

Proposed Works

The proposed works will require the temporary presence of chemicals, fuels and other oils and alum flocculants along with permanent presence of oils and lubricants associated with turbine maintenance.

Excavations, deforestation / replanting, soil stripping, concrete pouring and construction of temporary welfare facilities.

Potential Impacts

There is the potential for chemicals to enter a watercourse through accidental spillage, improper transport and refuelling or inappropriate storage and disposal procedures.

Earthworks in areas previously forested may cause the release of residual fertilisers and in areas of peat excavations may cause acidification of surface waters.

Unregulated use of flocculants can result in large doses entering surface waters.

Cementitious materials and discharge from temporary welfare activities have the potential to enter the watercourses.

Consequences

Oils and chemicals entering watercourses have the potential to adversely affect water quality, with associated effects to fish and aquatic ecology.

Release of forestry fertilisers and acidification from peat may adversely affect nitrate and pH levels and unregulated use of flocculants has the potential to cause locally significant fluctuations in pH, with adverse effects to fish.

Wastewater and associated coliforms discharged to subsoil irrigation or to the ground surface can percolate through to underlying aquifer and adversely affect water quality.

WFD CLASSIFICATION

WFD Element	Current Status	Assessed Change
Benthic Invertebrates	Good	Poor
Phytobenthos	Good	Good
Ammonia	Good /High	Good /High
Dissolved Oxygen	High	High
pH	High	Moderate
Soluble Reactive Phosphate	High	High
Biological Oxygen Demand	High	Moderate
Temperature	High	High
Hydrological Regime	High	High
Morphological conditions	-	

ASSESSMENT	Does the component comply with WFD Objectives 1, 2, 3 and 4?		
	No		No
	Yes (Justification provided)		Yes (Justification provided)
	Yes, with mitigation	✓	Yes, with mitigation

3.4.4 Potential Effect of Construction - Chemical Pollution of Groundwater Bodies

Table 3.4: Potential Impact of Chemical pollution to Magilligan Groundwater body

<table>
<tr><td rowspan="6">WATERCOURSE</td><td>Groundwater Body</td><td colspan="2">Magilligan</td><td rowspan="6">UNMITIGATED IMPACT DISCUSSION</td><td rowspan="6"><u>Proposed Works</u>
The proposed works will require the temporary presence of chemicals, fuels and other oils and alum flocculants along with permanent presence of oils and lubricants associated with turbine maintenance on the site. Excavations, deforestation / replanting, soil stripping, concrete pouring and construction of temporary welfare facilities.
<u>Potential Impacts</u>
There is the potential for chemicals to enter the groundwater through accidental spillage, improper transport and refuelling or inappropriate storage and disposal procedures.
Earthworks in areas previously forested may cause the release of residual fertilisers into the groundwater and shallow groundwater can gather in significant excavations.
Unregulated use of flocculants can result in large doses entering groundwater.
Cementitious materials have the potential to enter the groundwater.
Leakage from the discharge from temporary welfare activities (above ground storage and taken off-site by licensed waste disposal team) has the potential to enter shallow groundwater.
<u>Consequences</u>
Oils and chemicals entering groundwater have the potential to adversely affect water quality.
Acidification from peat may adversely affect pH levels.
Unregulated use of flocculants has the potential to cause locally significant fluctuations in pH.
Wastewater and associated coliforms discharged to subsoil irrigation or to the ground surface can percolate through to underlying aquifer and adversely affect water quality.</td></tr>
<tr><td>WFD Waterbody ID</td><td colspan="2">(UKGBNI4NW001)</td></tr>
<tr><td>River Basin District</td><td colspan="2">North Western</td></tr>
<tr><td>WFD Element</td><td>Current Status</td><td>Assessed Change</td></tr>
<tr><td>Chemical Status</td><td>Poor</td><td>Poor</td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td rowspan="4">ASSESSMENT</td><td colspan="5">Does the component comply with WFD Objectives 1, 2, 3 and 4?</td></tr>
<tr><td>No</td><td></td><td colspan="3">Do not proceed or complete Article 4.7 assessment.</td></tr>
<tr><td>Yes (Justification provided)</td><td></td><td colspan="3">Proceed after NIEA agreement.</td></tr>
<tr><td>Yes, with mitigation</td><td>✓</td><td colspan="3">Complete Schedule B.</td></tr>
</table>

3.4.5 Potential Effect of Construction - Disturbance of Groundwater Bodies

Table 3.5: Potential Impact of Construction Disturbance of Aquifer / Aquifer Recharge to Magilligan GWB

<table>
<tr><td rowspan="6">WATERCOURSE</td><td>Groundwater Body</td><td colspan="2">Magilligan</td><td rowspan="6">UNMITIGATED IMPACT DISCUSSION</td><td rowspan="6"><u>Proposed Works</u>
Installation of new temporary or permanent impermeable surfaces.
<u>Potential Impacts</u>
Reduced surface permeability.
The detailed geology and hydrogeology assessment for the project has determined that works proposed are unlikely to encounter caustic features in limestone, and that potential for causing morphological change to fractured groundwater flow is not a significant consideration at the site.
<u>Consequences</u>
Reduction permeable areas on the site can reduced the potential for groundwater recharge.</td></tr>
<tr><td>WFD Waterbody ID</td><td colspan="2">(UKGBNI4NW001)</td></tr>
<tr><td>River Basin District</td><td colspan="2">North Western</td></tr>
<tr><td>WFD Element</td><td>Current Status</td><td>Assessed Change</td></tr>
<tr><td>Chemical Status</td><td>Poor</td><td>Poor</td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td rowspan="4">ASSESSMENT</td><td colspan="5">Does the component comply with WFD Objectives 1, 2, 3 and 4?</td></tr>
<tr><td>No</td><td></td><td colspan="3">Do not proceed or complete Article 4.7 assessment.</td></tr>
<tr><td>Yes (Justification provided)</td><td></td><td colspan="3">Proceed after NIEA agreement.</td></tr>
<tr><td>Yes, with mitigation</td><td>✓</td><td colspan="3">Complete Schedule B.</td></tr>
</table>

4 STAGE III: MITIGATING MEASURES

4.1 Approach

Sections 4 to 10 of this report detail the third stage of the assessment; the approach to implementation of specific mitigation measures to be applied at the site.

In order to mitigate the potential degradation of surface and groundwater quality and morphology, identified in Section 3 as a result of construction activities associated with the development, mitigation measures are to be implemented during all stages of the construction process.

4.2 Introduction

The construction phase of all projects is a period within which there is increased potential for pollution, in particular silt pollution to local watercourses due to unearthed clay surfaces. The focus of this document is to provide sufficient detail to ensure that water pollution will not occur as a result of construction activities at the site and to minimise the risk of any such occurrence.

Chapter 9: Geology and Water Environment has identified particular downstream receptors, of most significance from a drainage perspective being watercourses with fisheries potential and should be referred to for a detailed appraisal of the site hydrology and hydrogeology.

The main objectives of the following sections are to demonstrate that sufficient measures have been put in place so as to protect those identified receptors and to ensure that drainage is constructed to relevant guidance and standards, particularly as follows:

- To propose appropriate, robust and buildable SuDS techniques for the prevention of erosion and the removal of silts and pollutants from construction runoff;
- To ensure that permanent drainage at the development is designed to a sufficient hydraulic capacity to contain a pre-determined return period rainfall event;
- To give consideration of the control and monitoring proposals for the dewatering of excavations;
- To ensure that surrounding heath and agricultural lands are not negatively affected by surface water runoff from the site.

The drainage design adopts a SuDS approach, using temporary SuDS for the drainage of the temporary works during the construction phase.

Where construction activities near water courses and water bodies are essential, steps have been undertaken to identify sufficient mitigation measures for the protection of the watercourses against pollution and have been presented on drawings accompanying this report within Annex A and Annex B. Silt management and pollution prevention during all elements of construction has been given due consideration within the design statement and within the scope of the full SuDS design.

This report gives both specific and general details on the drainage method for temporary works, permanent site drainage and pollution prevention measures for silt management.

4.3 Additional References

This document refers to and should be read in conjunction with the Dunbeg South Environmental Statement, in particular:

- Chapter 06: Ecology / Chapter 09: Fisheries;
- Technical Appendix 6: Outline Habitat Management Plan;
- Technical Appendix 9.4: Peat Slide Risk Assessment;

Chapters are contained within Volume 2 and Technical Appendices are included within Volume 4 of the ES. In addition; the following accompanying drawings included within Annex A and Annex B of this Technical Appendix:

- DWG 01 Preliminary SuDS General Arrangement (Planning Stage Drainage Layout);
- DWG 02 – 08 Preliminary SuDS Typical Details (Planning Stage Drainage Details).

5 SITE DRAINAGE INFORMATION

5.1 Site Area

The proposed Development is located approximately 8 km to the east of Limavady, County Londonderry and lies on the north-eastern slopes of Keady Mountain.

The area within the preliminary site boundary (hereafter referred to as "the Site") considered within this assessment; occupies an area of approximately 31km² (31 Ha) and contains the proposed Wind Farm infrastructure consisting of nine Wind turbines and associated infrastructure.

5.2 Topography

Topography on the Site is dictated by Keady Mountain. The highest point of the site is in the south-west corner with land generally falling to the north, towards the Curly River Valley. Levels fall from approximately 341 m AOD(Above Ordnance Datum) to 137 m AOD.

5.3 Site Hydrology

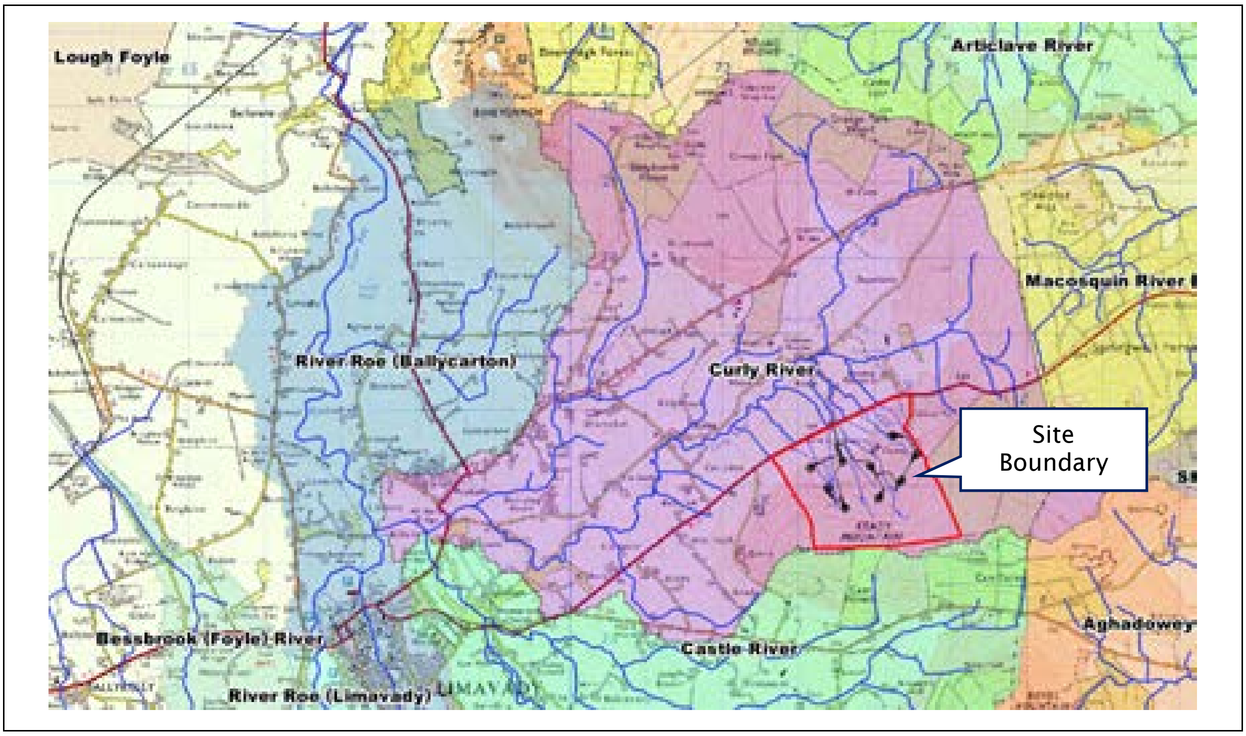
The following is based on a combination of desktop study and walkover survey observations. Main stream reach lengths identified are as per OSNI 1:2,500 scale mapping, validated or otherwise by means of visual survey on-site.

Several undesignated watercourses within on site drain to the north into the Curly River, as described in full within **Chapter 9: Geology and Water Environment** and shown on Figure 5.1 below.

The proposed Development is located entirely within the Curly River Catchment. The Curly River joins the main channel section of the River Roe 5.2 km to the west of the site. The Roe River discharges into Lough Foyle 8.2 km to the north-west of the site.

Based on NIEA River Basin Management Plan boundaries; the Site is situated within the Roe Local Management Area (LMA) which is within the Lower Foyle Catchment Stakeholder Group and falls under the control of the North Western Basin District.

Figure 5.1: Site Hydrology



6 RELEVANT GUIDANCE AND LEGISLATIVE REQUIREMENTS

6.1 Relevant Guidance and Legislative Requirements

It is proposed that all drainage relating to Dunbeg South Wind Farm will be constructed using best practice and in conformance with the requirements of the relevant regulatory authorities. The key legislation and guidance which will be adhered to are defined as follows:

6.1.1 National Planning Policy

- EU Water Framework Directive (2000/60/EC);
- Groundwater Daughter Directive to the Water Framework Directive (2006/118/EC);
- Priority Substance Daughter Directive to the Water Framework Directive (2008/105/EC);
- Freshwater Fish Directive (2006/44/EC);
- Environmental Liability Directive (2004/35/EC);
- Dangerous Substances Directive (2006/11/EC);
- UK Environmental Standards and Conditions Phase 1 and Phase 2 (UK TAG 2008);
- Control of Pollution (Oil Storage) (Amendment) Regulations (NI) 2011;
- Drainage (Environmental Impact Assessment) Regulations (NI) 2006;
- Environmental Liability (Prevention and Remediation) (Amendment) Regulations (NI) 2009;
- Groundwater Regulations (NI) 2009 and Groundwater (Amendment) Regulations (NI) 2014;
- Nature Conservation and Amenity Lands (NI) Order 1985;
- Private Water Supplies Regulations (NI) 2009 and Private Water Supplies (Amendment) Regulations (NI) 2010;
- Surface Waters (Dangerous Substances) (Classifications) Regulations (NI) 1998;
- The Drainage (NI) Order 1973 and The Drainage (Amendment) (NI) Order 2005;
- The Environment (NI) Order 2002;
- The Fisheries (NI) Act 1966;
- Water Act (NI) 1972 and The Water (NI) Order 1999;
- Water Supply (Water Quality) Regulations (NI) 2007
- Water Supply (Water Quality) (Amendment) Regulations (NI) 2010;
- Water Environment (Water Framework Directive) Regulations (NI) 2003;
- Water Framework Directive (Priority Substances and Classification) (Amendment) Regulations (NI) 2012;
- Water Framework Directive (Classification, Priority Substances and Shellfish Water Regulations (NI) 2015.

6.1.2 Regional and Local Planning Policy

- Revised Planning Policy Statement 15 - Planning and Flood Risk;
- Planning Policy Statement 18: Renewable Energy (and supplementary Planning Guidance: Wind Energy Development in Northern Ireland’s Landscapes);
- Northern Area Plan (2015);
- Sustainable Development Strategy, “Everyone's Involved" (2010);

6.1.3 NIEA Guidance Notes and Selected Industry Guidance

- Good Practice during Wind Farm Construction - Scottish Renewables, Scottish Natural Heritage, Scottish Environment Protection Agency, Forestry Commission Scotland (2010);
- SNIFFER - WFD111 Coarse Resolution Rapid - Assessment Methodology to Assess Obstacles to Fish Migration (2010);
- CIRIA C523 - Sustainable Urban Drainage Systems; Best Practice Manual (2001);

- CIRIA C532 - Control of Water Pollution from Construction-sites (2001);
- CIRIA C692 - Environmental Good Practice on-Site (2010);
- CIRIA C609 - Sustainable Drainage Systems, hydraulic, structural and water quality (2004);
- CIRIA C753 - The SuDS Manual (2015)
- CIRIA C689 - Culvert Design and Operation Guide (2010);
- Code of Practice for Earthworks (2009) - BS6031;
- Environment Agency - Policy Regarding Culverts: Technical Guidance on Culverting Proposals (1999);
- Scottish Executive - River Crossings and Migratory Fish: Design Guidance (2002);
- DEFRA - Good Practice Guide for Handling Soils (2000);
- DEFRA - Construction Code of Practice for the Sustainable Use of Soils on Construction-sites (2009);
- NIEA Guidance for Pollution Prevention (GGP)
    - GPP2 Above Ground Oil Storage Tanks;
    - GPP4 Treatment and disposal of Wastewater where there is no connection to the public foul sewer
    - GPP5 Works and Maintenance in or near Water;
- Pollution Prevention Guidance Notes (PPGs);
    - PPG1 Understanding Your Environmental Responsibilities: Good Environmental Practice;
    - PPG3 Use and Design Of Oil Separators in Surface Water Drainage Systems;
    - PPG6 Working at Construction and Demolition-sites;
    - PPG7 The Safe Operation of Refuelling Facilities;
    - PPG18 Managing Fire, Water and Major Spillages;
    - PPG20 Dewatering Underground Ducts and Chambers;
    - PPG21 Pollution Incident Response Planning;
    - PPG26 Drums and Intermediate Bulk Containers.

7 SUDS DESIGN APPROACH

In order to meet the design criteria and objectives detailed previously in this report and regulatory authority requirements, the following design philosophy has been developed.

7.1 Controlling Runoff

- Track and hardstanding runoff will be handled by sheet flow to trackside ditches or swales.
- Tracks and hardstanding areas are to be constructed from unbound aggregate and are not surfaced, thus helping to reduce runoff volumes. This has been allowed for within the design philosophy through the utilisation of a reduced runoff coefficient of 70 %, and a heavy silt loading assumed as defined by D'Arcy et al (2000), for light industrial and engineering land uses.
- Piped under track drainage will be provided with associated sumps and check dams. The under track drainage will provide a means for flows to pass from a swale on the uphill side to the downhill side of the slope.
- In cases where the tracks must run significantly downhill, transverse drains ('grips') will be constructed where appropriate in the surface of the tracks to divert any runoff flowing down the track into the adjacent drainage ditch/across open ground.
- Rate and volume of runoff will be attenuated using check dams located in trackside swales and ponds located at significant new hardstanding areas. Attenuation features will also reduce flow velocities preventing scour, and allow settlement of silts prior to discharge.
- The use of large balancing ponds is to be avoided and there will be no merit in using other methods such as filter drains or hard permeable surfacing due to the lack of infiltration capacity and likely high groundwater levels.

7.2 Water Quality and Treatment

- Clean / dirty water separation will be maintained on site in all practicable instances. Clean water will be prevented from entering excavations and dirty water drainage swales through use of clean water diversion / cut-off ditches.
- A treatment train will be designed with a minimum of two stages of treatment for polluted runoff from the site during the construction phase.
- All treatment settlement features (check dam backwaters and ponds) are to be designed to offer sufficient retention time to settle out the silt grain sizes anticipated.
- Silt laden runoff within trackside swales will be treated through the provision of small check dams at specified centres along the swales (to be specified as part of detailed design). Note that steeper swale sections will require a greater frequency of check dams.
- Appropriate site management measures will be taken to ensure that runoff from the construction site is not contaminated by fuel or lubricant spillages. Earth spillages into any existing streams will also be avoided. There will be no discharge of trade effluent, sewage effluent or contaminated drainage into any watercourse system or ditch. Any dewatering from excavations will be via surface silt traps, check dams and settlement ponds to ensure sediment does not enter surrounding watercourses.
- Areas stripped of vegetation should be kept to a minimum. Stripped vegetation should be reinstated on slopes as early as possible. Further details on habitat management are included within **Technical Appendix 6.8: Outline Habitat Management Plan**.

7.3 Preserving Hydrology and Groundwater Recharge / Amenity & Biodiversity

- Drainage design will seek to aid in habitat enhancement and improvement measures (refer to **Chapter 6: Ecology** and **Technical Appendix 6.8: Outline Habitat Management Plan**) where improvement is sought to wetland habitats, by ensuring that water flows are maintained or increased to areas where re-wetting is proposed; and by providing treatment to runoff to ensure re-wetted areas are not affected by siltation or nutrient enrichment; that streams feeding flushed areas are preserved; and by routing drainage to maximise overland flows in areas where wet conditions are desirable for habitat creation and enhancement..
- Drainage design will ensure natural streams are piped directly through appropriately sized drainage pipes on their original alignment.

- Runoff from new hardstanding areas will be collected and attenuated before discharge to receiving drainage networks.
- Settlement ponds will be designed to cater for infilling and rehabilitation post construction phase of the project; however subject to requirements of habitat management or enhancement plans for the site, water features may be retained for the whole life of the project as a means of providing wetland habitat on the site.

7.4 Summary

The proposed SuDS design provides a surface water management train that will seek to mitigate potentially adverse impacts on the hydrology of the proposed Development

Application of the above design philosophy in the detailed design and construction of site specific elements is considered in the following sections of this report.

8 DRAINAGE DESIGN PHASE - DETAILED CONSIDERATIONS

8.1 Preamble

The following key considerations have been identified in the preliminary design of hydrology and drainage (including foul) for the site in order to preserve water quality, downstream hydrology and preserve stream morphology. These issues and development of suitable mitigating measures will be given further consideration during the detailed design stage of the project.

- Identification of watercourse crossings and drainage paths across the site;
- Sizing and definition of hydraulic capacity requirements for watercourse crossings;
- Requirement for fish passes / consideration of migratory fish;
- Detailed design of track and hardstanding drainage and silt management;
- Separation of ‘clean’ and ‘dirty’ water;
- Spoil storage;
- Management and discharge of runoff in areas of upland heath and in areas of improved grassland;
- Requirement for attenuation storage;
- Definition of Buffer Zones.

Note that the infrastructure layout and associated SUDS design prepared for purposes of Planning is preliminary only. Post consent, track layout design and associated SuDS design will be further developed to minimise and mitigate for the effects of pollution to all local watercourses.

Preliminary drainage layout is shown on accompanying drainage management drawings **DWG 01** within **Annex A.**

8.2 Watercourses and Watercourse Crossings

8.2.1 Identification of Watercourse Crossings

Watercourses significant for purposes of environmental design have been identified within the Hydrology Assessment undertaken for the Environmental Statement for the project. Sensitive water features on the site comprise natural watercourses and main flowing drains.

- Three crossings of significant watercourses are required to allow development (two of which are significant in terms of fisheries potential as outline within **Chapter 8: Fisheries,** Stream C).
- Four crossings of minor watercourses are proposed to allow development

Additional consideration will be given to design of drainage crossings at detailed (post-planning) design stage, including other drainage crossings where other drainage crossings may be ditches and drains as encountered alongside existing roads tracks and field boundaries or moorland / peatland drainage.

Works to watercourse crossings will be subject to authorisation by DfI Rivers under Schedule 6 of the Drainage (Northern Ireland) Order 1973. Works causing disturbance to the river bed shall similarly be subject to Loughs Agency Section 46/47 permit.

8.2.2 Design of Watercourse Crossings

Full design of watercourse crossings will be undertaken at detailed design stage, post planning consent. Outline designs sufficient to allow assessment of environmental effects have been prepared as part of this assessment.

The following guidance has been adhered to in the outline design and will be similarly applied in the detailed design of watercourse crossings:

- Hydrological assessments made using a number of methods including Flood Estimation Handbook to determine the design flow;
- SNIFFER WFD 111 documents;
- CIRIA Culvert design and operation guide (C689);

- Fisheries considerations shall incorporate guidance stated in Loughs Agency Guidelines for Fisheries Protection during Development Works (2011) and Scottish Executive (2002) River Crossings and Migratory Fish: Design Guidance (where appropriate).

Watercourse crossings on the site shall comprise two bottomless culvert crossings and eight conventional closed culverts, with the requirement for bottomless culverts driven by consideration of fish passage determined in conjunction with the site specific fisheries assessment included with the Environmental Statement.

Factors considered in the design and orientation of all watercourse crossings includes:

- Crossing direction to generally be perpendicular with access track direction, therefore minimising the length of stream affected;
- Consideration of the passage of out-of-bank flood flows;
- Crossings are generally located in an area where bank slopes are the shallowest available, thus reducing the potential for runoff to carry sediment into the watercourse.
- Additional mitigation will be designed to prevent pollution of the watercourse during the construction of the watercourse crossing to reduce residual risk; comprising the temporary installation of silt fences in the stream channel downstream or similarly effective measures.
- Typical in-channel silt Fence arrangements are shown on drawing **DWG03** included in **Annex B.**

8.2.2.1 Bottomless Culvert Crossings

Bottomless Culvert crossings will be utilised as directed by **Chapter 8: Fisheries**, to ensure that the stream bed and bank remains undisturbed / intact and negate the need for in-channel works in order to preserve fish habitat and will avoid introducing structures that would inhibit fish passage.

A bottomless culvert crossing detail representing an outline design is shown on drawing **DWG02** included in **Annex B.**

8.2.2.2 Culvert Crossings

Conventional piped or closed bottom culverts are proposed at minor water features (based on site observations and catchment size < 0.25 km^2), and at water features where the requirement to maintain fish habitat in the channel has been determined to be not applicable within **Chapter 8: Fisheries**. These crossings and other culverts for surface flood conveyance or similar, shall be piped culverts.

Design requirements will be imposed to ensure that culverts are installed at a level lower than existing bed levels in order to create a "stilling" effect and reduce potential for increased local flow velocities in the culvert in addition to promoting the formation of a natural substrate within the culvert. Mitigation of construction of the culvert within watercourses is discussed further in Section 9.2.2.

A typical culvert representing an outline design is shown on drawing **DWG04** included in **Annex B.**

8.2.3 Preservation of Overland Flow Routes

Where appropriate, on areas of heath on the relatively elevated areas of the Site, overland flow will be preserved by the provision of under-track cross drainage (cross drains) at regular intervals and at all natural depressions and flow collection points.

Conventional cross drains sizes will be confirmed at detailed design stage and increased locally at all points where water would tend to accumulate due to land drainage or natural drainage paths. Frequency and location of specific cross drains will be specified following inspection of topographical data, with cross drain frequency dictated by:

- Terrain gradients lateral to the proposed access track;
- Terrain gradients longitudinal to the proposed track;
- Location of natural depressions and points of flow collection.

8.2.4 Water Feature Buffer Zones

Buffer zones to water features have been established for the Site within **Chapter 9: Geology and Water Environment** for the project and are shown on accompanying drainage management drawings **DWG01** within **Annex A.**

Infrastructure designed to lie outwith stated hydrological buffer zones comprises those elements of the works associated with significant earthworks, and greatest potential for spillage or leakage of chemical pollutants, i.e.:

- All turbine bases, met mast foundations, crane pads, and associated working areas including spoil storage areas.
- Areas designated for temporary or permanent spoil management or storage.
- Substation buildings and compounds, temporary construction compounds, fuel and chemical storage areas, and any other platforms.

Buffers would be imposed during the construction phase in order to limit the types of construction activities permissible in proximity to water. Where the local site environment requires additional protection (e.g. steep slopes or lack of vegetation between construction corridor and watercourse) the buffer zone will be increased or stringent mitigation measures introduced. Buffer areas will act as riparian zones allowing filtration and settlement, minimising sediment transport, attenuating flows and maximising infiltration.

All turbines and infrastructure are outside the recommended buffers (other than unavoidable watercourse crossings) as described in **Chapter 3**: **Design Evolution & Alternatives**.

8.3 Temporary Drainage

8.3.1 Clean / Polluted Water Separation

Drainage management will ensure that clean water is not permitted to mix with contaminated water from sources such as excavation dewatering or track runoff, where “clean water” should be interpreted as natural surface runoff unaffected by construction / earthworks runoff.

Design will ensure that upslope cut off ditches are to be installed in order to intercept and divert clean upslope surface water runoff flowing overland or within forestry drainage prior to it coming in contact with areas of excavation. Design will ensure that clean water cut off ditches are installed ahead of main earthworks wherever practical. This is intended to reduce the flow of clean water onto any exposed areas of rock and soil, thereby reducing the amount of potential silt laden runoff requiring treatment.

Installed drainage will allow provision for clean water intercepted in cut-off ditches to pass through and under track structures separate to drainage provided for track runoff.

Temporary silt / pollution prevention and scour protection measures will be provided in artificial clean water drainage installed in order to mitigate potential for scouring and transport of sediment from newly excavated channels.

Diversion drainage is to discharge either to existing watercourse channels (via silt removal features) or be dispersed over vegetated ground. Diversions are to be designed to avoid collection and interception of large catchments creating significant point flows, with associated risks due to scour and hydraulic capacity.

8.4 Track Drainage

8.4.1 Trackside Drainage

The cross fall on the track will be aligned to divert “dirty” surface water (i.e. contaminated surface water from track surface or excavations) into trackside swales by overland sheet flow or via track surface grips.

The swale and track shoulder will be vegetated as soon as possible after construction, in order to reduce potential for runoff from exposed aggregates and clays, and promote removal of suspended solids within runoff by filtration in vegetation. Any vegetation used will be appropriate to the local area. Temporary erosion protection may be required until the vegetation becomes established (coir matting or similar).

All swales will be kept as shallow as possible so that they pose no health and safety risk to plant or personnel. Maximum depth of standing water will be limited to 0.5m within the ponds and 0.3m within the swales.

Drainage swales shall be designed to satisfy the following conveyance and water quality criteria:

- Hydraulic conveyance of runoff appropriate to the protection of the surrounding land use, with additional consideration of effect of a 100-yr (flood protection) event (i.e. exceedance event);
- Store treatment volume (T_v) (15 mm rainfall on drained area).

Under-track piped drainage crossings will be provided to allow up-slope swales to drain to the down slope side. Crossings will be provided at regular intervals (to be determined at detailed design stage) and at all localised low points. Outlets from crossing pipes shall generally coincide with swale breakouts.

Note that dirty water under track crossings and breakouts are to be maintained separate from clean water crossings (see Section 8.3.1).

Where appropriate on areas of upland heath, there will be regular outflow points ("breakouts") from the swales throughout the SuDS system to eliminate the potential for the generation of large flows at single outflow points. This will assist the drainage network in maintaining the natural hydrological response displayed by the natural catchment. Outflows will be directed away from watercourses and across open vegetation to increase the drainage path and buffer zone between the point of discharge and the watercourse.

Typical trackside swale arrangements are shown on **DWG01** within **Annex A** and track drainage details are shown on **DWG05** and **DWG07** in **Annex B.**

8.4.2 Drainage Grips

Drainage grips may be installed on the track surface where deemed a requirement in order to direct runoff into trackside drainage or to downslope settlement / filtration features. Positioning of grips will be determined at detailed design stage and on an observational basis during construction, however in general the need for grips will be greatest in areas on steep longitudinal track gradient.

Installation of grips will prevent extensive rutting of the track structure and aids drainage of the track surface, which in turn reduces potential for trafficking of the surface to cut the track and generate silt.

Drainage grips will generally comprise a steel channel section installed flush to the track surface, with concrete haunching as may be required in areas of heavy trafficking.

8.4.3 Runoff Attenuation

Runoff from large hardstanding areas such as the site compound, turbine hardstandings, and substation will be attenuated to mimic natural runoff patterns. Flow rates from tracks will be reduced through use of attenuating check dams within swales installed adjacent to all hardstanding areas, providing immediate attenuation "at source", with pass-forward flow rate reduced by filtration and temporary detention.

Frequent breakouts from swales to discharge accumulated runoff overland at regular frequencies will further encourage attenuation of runoff peaks by dispersing runoff over vegetation where losses would be expected by vegetative retention, transpiration, and infiltration.

Attenuation will utilise shallow ponds to aid removal of suspended solids. Calculations for the determination of storage requirements will be undertaken at detailed design stage.

Consideration will be given to the potential for further storage features across the site.

8.5 Management of Suspended Solids

Runoff from the site shall be required to ensure that water quality in the receiving watercourses, including those draining to areas of fisheries interest, is not adversely affected in terms of key water quality parameters. The primary means by which the development could cause adverse effect is by release of suspended solids.

Detailed drainage design shall ensure that settlement and filtration of runoff from the site is designed such that the water quality standard is preserved.

8.5.1 Check Dams

Initial treatment will be provided "at source" by check dams installed within trackside swales at regular frequencies, in order to reduce flow velocities and improve conditions for the settlement of solids in transit.

Check dams shall ideally be of stone formation however compacted clay check dams may be used should suitable stone be unavailable locally.

Where stone is used, the aggregate used to form check dams will be a small 'clean' graded stone. On steeper slopes the check dams will be anchored using larger stone placed on the downhill side of the check dam to prevent washing away of the smaller graded stone. The frequency of the check dams will be determined at detailed design stage.

The check dams will serve dual functions, by both removing and settling out silts and reducing flow velocities, therefore mitigating against the effects of erosion within the swale and improving the design life of end of line infiltration features.

Where feasible and where observed site conditions allow, the frequency of installed check dams may be reduced post-construction phase, due to reduced silt loading anticipated following completion of construction activities and reduced site traffic.

Typical swale check dam arrangements are shown on track drainage drawings **DWG05** and **DWG06** in **Annex B.**

8.5.2 Settlement Ponds

All locations where significant accumulations of dirty water discharge in the vicinity of watercourses will pass through one or a sequence of settlement lagoons in order that suspended solid concentrations released can demonstrably be shown to have no detrimental effect to downstream fish life.

Temporary and permanent settlement lagoons shall be sized to allow treatment of the levels of silt and suspended solids anticipated in construction phase and operational phase runoff respectively and shall be informed by intrusive site investigation post consent.

Where runoff contains solids unlikely to settle adequately in conventional settlement lagoons, it shall be subject to additional treatment by flocculent. In such a scenario, secondary lagoons or a containerised system would be used in which flocculent dosing and final settlement would occur. Particular requirements for flocculent dosing (in terms of type of dosing, concentration, flocculent type etc) would be determined on an observational basis to suit the nature of suspended solids within the runoff measured on site. Treated water from settlement ponds would be discharged over intact vegetation for further treatment.

Typical settlement lagoon arrangements are shown on drawing **DWG07** included in **Annex B.**

8.5.3 Vegetative Filtration

In areas not classified as improved agricultural grassland; all runoff from swales, ponds, or other pumped discharges will be dispersed over undisturbed intact vegetation, nominally over agreed riparian watercourse buffer zones, in order to allow vegetative filtration of runoff prior to water entering the receiving watercourse.

8.5.4 Dewatering and Washout Pits

Washout pits to be located local to significant excavations will be designed to accommodate the anticipated volume of contaminated water to be removed from the excavation, either through unavoidable surface water runoff or accumulation of shallow groundwater. Washout pits shall be sized to accommodate the volume for a period until such times as the water has been clarified, with the water subsequently pumped out and into the site drainage system.

8.6 Temporary Spoil Management

Management of spoil, including temporary and permanent spoil generated from excavations, will be considered as part of a Construction Method Statement to be approved by the planning authority prior to construction and is discussed further within **Technical Appendix 9.5: Peat Management Plan**. Site and drainage design would ensure the following in terms of drainage for temporary spoil management areas:

- There will be no depositing of material within the watercourse buffer zones.
- Spoil shall be placed in such a manner so as to ensure no ponding of surface water on top of spoil heaps. Temporary spoil should be graded to ensure that all direct precipitation will run directly off the surface.
- Temporary spoil deposition areas will be designed to ensure that natural flow paths (drainage channels) are not be altered or blocked by deposited spoil.
- Spoil heaps in the vicinity of watercourses would be surrounded on the low side with silt fences in order to trap fine sediment in runoff.

8.7 Foul Drainage

In order to prevent the requirement for a discharge of treated effluent of poor quality to a watercourse or percolation to groundwater that may cause nutrient enrichment of habitats, foul water from temporary compounds and the permanent substation will drain to temporary or permanent chemical facilities.

There will be no treated foul water discharge from the facilities. Emptying of chemical facilities (by tanker or similar) will be undertaken by a licensed haulier and waste will be disposed of at a suitable licensed waste disposal facility.

Detailed foul design (to establish suitability of cesspool or septic tank etc.) will be determined at detailed design stage incorporating results from percolation tests.

9 CONSTRUCTION PHASE – DETAILED CONSIDERATIONS

Specific requirements to be imposed on any Contractor involved in the construction of the scheme will be further detailed in a Construction Method Statement to be approved by NIEA / the relevant local planning authority prior to construction.

All site personnel will be made aware of their environmental responsibilities at the site induction prior to being allowed to work on site, and through the production of a Method Statement, outlining Environmental Requirements for Sub-Contractors, which will include environmental emergency response procedures to deal with spillages, should they occur.

This section of the report outlines the steps which will be undertaken during the construction phase of the project to ensure compliance with the relevant guidance and legislation outlined in Section 6.1 of this report. Site visits by the SuDS Engineer will be agreed in advance and will be undertaken at various stages of the construction process to ensure that the proposed SuDS scheme is being constructed in line with the design.

Essential mitigation measures relevant to controlling erosion and runoff from construction of the SuDS are described in NIEA's Guidance for Pollution Prevention and Pollution Prevention Guidance notes.

9.1 Planning and Phasing of Drainage Works

9.1.1 Site-Wide Requirements

Temporary or permanent drainage and silt management features (SuDS) will be constructed prior to earthworks (including preliminary or enabling works) proceeding to construct any linear works (tracks / hardstanding areas / cable routes), turbine bases, and other infrastructure. Drainage will be provided to temporary works and reinstated to suit the final footprint of the completed development.

Temporary measures may include:

- Temporary silt fences erected in areas where risk of pollution to watercourses has been identified e.g. watercourse crossing locations and areas where tracks or other infrastructure lie within watercourse buffer zones.
- Upslope cut-off drainage channels approximately parallel to the proposed track alignment installed in advance of any excavated cuttings for the track or turbine hardstanding areas. This will prevent washout by surface flows of exposed clays in excavations and fine sediments in track makeup, and increase efficiency of silt removal in future trackside drainage swales.
- Watercourses, drains, natural flow paths and cut-off drain outlet locations should be identified and charted, in order to ensure that piped crossings can be installed in advance of or adjacent to the track construction.
- Settlement ponds should be constructed in advance of commencing excavations for foundations and at any other locations identified as required at detailed design stage.
- Trackside drainage swales should be installed in parallel with track construction. Note that this may require that drainage swales are reformed on an ongoing basis as temporary track alignments are modified to their eventual finished design level.

In addition, spoil management is to be planned in advance of earthworks and on an ongoing basis, in order to allow planning of drainage required in advance of spoil being deposited.

Suitable prevention measures should be in place at all times to prevent the conveyance of silts to receiving watercourses.

9.1.2 Timing of Works

Works on the site likely to cause a high risk to surface water will be programmed so as to avoid unfavourable prevailing ground conditions and high volumes or extended periods of seasonal rainfall. Site clearance will take place in advance of construction works.

9.2 Specific Construction Phase Measures

9.2.1 Working in the Vicinity of Water / Buffer Zones

The following procedures apply to the general construction activities either within watercourses or in the vicinity of watercourses (i.e. within buffer zones):

- Due cognisance will be given to the prevailing ground conditions and season when programming the execution of the works, in order to seek to undertake the works in a period with low potential to cause introduction of silt laden runoff to the watercourse.
- Works will plan so that trackside drains do not discharge directly into watercourses, but rather through a buffer area of adequate width or via a constructed settlement feature such as pond or sequence of silt fences.
- Cement and concrete will be kept outwith buffer zone to avoid contamination of watercourses.
- Runoff from excavations will NOT be pumped directly to watercourses. Where dewatering of excavations is required, water shall be pumped to the head of a treatment train (swale, basin, or detention pond) in order to receive full treatment prior to re-entry to the natural drainage system.
- SuDS treatment techniques will be utilised to remove silts from runoff prior to the discharge of flows over open vegetated areas.

Construction buffer zones to drainage features will be set as stated within **Chapter 9: Geology and Water Environment** and are shown on the accompanying Drainage Management Drawings within **Annex A.**

In the event that a specific short term risk to water quality is identified on site, specific localised measures will be implemented including:

- Placing temporary filtration silt fences within drainage channels where siltation is observed.
- Installing temporary constructed settlement features such as sumps or settlement ponds / lagoons where required.

9.2.2 Watercourse Crossings

Residual risk to watercourses specific to the construction stage will be fully addressed in the Contractor's construction method statement and, in addition to those points outlined in Section 8.2.2, will include the following:

- Works to install all crossings shall be programmed to coincide with a period of anticipated low drain flow and firm ground conditions in order to minimise potential for silt laden runoff draining toward the stream.
- Geotextile or equivalent splash-guards shall be erected to the track embankment over the culvert or clear span crossing prior to trafficking.

Additional particular considerations (dependant on the crossing type) are stated subsequently.

9.2.2.1 Bottomless Culvert Crossings

Fisheries considerations shall be as per the guidance stated in Guidelines for Fisheries Protection during Development Works[10] as published by Loughs Agency in the absence of particular guidelines outside of Loughs Agency controlled catchments. Where bottomless culvert crossings are determined to be required:

- Works to construct bottomless culvert footings shall be constructed from the bank; civil works within the stream bed will be eliminated wherever practicable.
- Channel and banks will be retained intact within the bottomless culvert.

[10] Loughs Agency (2011) Guidelines for Fisheries Protection during Development Works. Available: http://www.loughs-agency.org/wp-content/uploads/2015/05/loughs-agency-guidelines-for-fisheries-protection-during-development-works.pdf [Accessed 17/06/201]

9.2.2.2 Culvert Crossings

The following shall apply to the construction of culvert crossings at the site:

- The channel will be dammed upstream of the proposed culvert location using sandbags or similar in order to provide a dry working environment at the culvert location. Dammed flows will be pumped out of channel and returning directly to the drain shortly downstream of the culvert location. Erosion protection shall be placed at the point of pump return. All pumping will be controlled on a contractor permit-to-pump scheme, such that pumping operations can be carefully planned, installed and monitored.
- Geotextile silt fences shall be installed adjacent to the drain bank upstream and downstream of the culvert location in order to filter contaminated runoff that may be caused by plant movement associated with the culvert installation. A sequence (minimum 2 no.) in-channel geotextile check dams will be installed within the drain channel downstream of the culvert location and downstream of the pump-return.
- The stream bed shall be excavated to permit the culvert to be installed at a suitable level to ensure a constant depth of water within the culvert in order to allow potential for fish passage.
- The culvert comprising pre-cast concrete or pre-formed plastic pipes shall be installed and backfilled with suitable aggregate. Headwalls and scour protection to the drain bed shall be formed at the culvert inlet and outlet using dry formed components (lean-mix concrete-filled sandbags or similar). Washed gravel or pebbles (including if feasible that material recovered from the natural substrate excavated to permit the culvert installation) shall be introduced to cover and protect the extent of the drain channel affected by excavations. No wet concrete or cementitious material shall be required to be used within the drain channel.
- Over pumping and upstream dams shall be removed and water permitted to pass through the culvert. Downstream in-channel filtration check dams shall be retained and renewed as necessary in order to trap sediment until any residual washout of sediment from the exposed excavation has stabilised to a normal (pre-construction) level.

9.2.3 Turbine Bases and Crane Pads

Excavated turbine foundations are likely to result in large volumes of displaced excavated material as spoil, as well as concrete operations. Specific measures are therefore required to manage potential for silt laden runoff from spoil, silt laden runoff from pumped dewatering, and cementitious contamination in pumped dewatering from turbine bases.

Concrete will not be allowed to enter watercourses under any circumstances, and drainage from excavations in which concrete is being poured will not be discharged directly into existing watercourses without appropriate treatment. Delivery trucks, tools and equipment will be cleaned at designated washout areas located conveniently and within a controlled area of the construction compound. Runoff from wash-out areas will be appropriately stored within bunded containers and removed off-site by an appropriate waste disposal company. In addition the following drainage measures will apply;

- Installation of cut-off drains around the working areas to intercept clean surface runoff and divert it around and away from the works.
- Minimising the stockpiling of materials and locating essential stockpiles outside any watercourse buffer zone.
- Polluted (silt laden) water collected in the base of any excavation would be gathered in a sump, and pumped at a low flow rate into either the mini-settlement pond or track swale for treatment. Dewatering of excavations direct to watercourses will not be permitted.
- The foundation working areas should be re-vegetated as soon as possible after construction.

9.2.4 Cable Trenches

It is noted that where feasible, the design of cable trench alignment will avoid the creation of preferential flow routes. The following shall apply to the construction of all cable trenches at the site:

- To minimise impacts from disturbance, cables will be laid in small trenches along the side of access tracks, as far as possible.
- Due cognisance will be given to the prevailing ground conditions and season when programming the execution of the works, in order to seek to undertake the works in a period with low potential to cause introduction of silt laden runoff from excavations.

- Excavation of cable trenches will be carried out over short distances, with frequent backfilling of trenches, in order to minimise opportunity for the ingress of water into open trenches.
- Temporary silt traps will be provided in longer trench runs and on steeper slopes.
- Where constructed trackside swales are disturbed by cable installation, swale slopes will be correctly reinstated post infilling of the cable trench.

9.2.5 Dewatering

In order to control dewatering activities and to ensure that all dewatering allows for pollution prevention measures, a permit-to-work system will be imposed on the Contractor, particularly to ensure pumped dewatering from excavations is controlled. A permit will be required to be issued to a competent person prior to allowing any specific dewatering to commence.

9.2.6 Use of Flocculant

The use of flocculant is generally discouraged where possible in favour of using conventional settlement techniques to remove suspended solids, due to the preference to avoid introducing artificial chemicals to the surface water environment.

Where flocculant is preferred or required, due to the presence of extremely fine particles within clays or aggregates that cannot be effectively removed using filtration or settlement ponds, then its use will be strictly regulated with a permit scheme to be put in place and competent person installed to oversee installation, monitoring and removal of flocculant.

Flocculant would generally be installed within an existing settlement pond in liquid form, or installed in solid form in a culvert with water allowed to flow around the flocculant block. Flocculant would be required to be removed immediately upon reduction of the observed pollution risk that prompted its use.

Typical location of flocculant dosing in conjunction with settlement lagoons is shown on drawing **DWG07** in **Annex B.**

9.2.7 Excavated Track Drainage

Where an excavated type track construction is specified, all track runoff (polluted water) would be directed to flow to track-side drainage channels as per Section 8.4, to be installed as tracks are constructed.

Due to anticipated low rates of infiltration and high ground water tables, as is common in predominately peat conditions, it is likely across the majority of the site that flows will not percolate through the base of the swale and will therefore be discharged from the swale via frequent spillways created through the embankments on the downhill sides of the access tracks.

Drainage swales and track shoulders will be re-vegetated as soon as feasible after completion of the track and drainage across the site. Full details on the re-establishment of vegetation are outlined within **Chapter 6: Habitat Assessment** and **Technical Appendix 6.8: Outline Habitat Management Plan**.

Typical drainage installation for excavated tracks is shown on drawing **DWG05** in **Annex B.**

9.2.8 Floated Track Drainage

Where a floating type track construction is specified, existing drainage paths are not to be unnecessarily re-routed or changed. Existing drainage paths and overland flow-routes should be maintained through the placement of drainage pipes at existing land drainage locations and/or at regular intervals.

Track runoff will be directed over the edge of the track structure to discharge across existing vegetation to allow filtration / settlement of suspended solids.

Typical drainage installation for floated tracks is shown on drawing **DWG06** in **Annex B.**

10 MAINTENANCE

10.1 Construction Phase

The following is intended to inform the detailed drainage / SuDS maintenance manual for the construction phase.

It is envisaged that an Engineer specialising in surface water management and SuDS would be required to undertake regular site inspections during the construction phase of the wind farm, in order to validate that any detailed SuDS design and associated requirements to ensure construction methods are adhered to on site, and in order to identify areas where additional or enhanced mitigation is required.

In addition to the regular site inspections carried out by the Engineer, the following construction inspections will be undertaken during the construction phase of the project. The list is not exhaustive and should be added to as per the requirements of the site.

10.1.1 Swales / Check Dams

- All check dams and settlement basins to be checked weekly in dry weather and daily during periods of heavy rainfall via a walkover survey during the construction phase. Excess trapped silt to be removed and disposed of/ re-used as may be agreed with relevant authorities.
- Where check dams have become fully blocked with silt, they should be replaced. Procedure for replacement of the check dam as follows:
    - silt deposits to be removed from the upstream side of check dams.
    - removed silt to be buried or re-used by spreading in an area of the site where surface runoff will not convey silt deposits back to a watercourse.
    - where there are regular incidents of check dam blockage further check dams to be installed (every 15-20 m intervals) within the swales.
- Monitor side slopes of swales and basins and reinstate any areas of slope slippage by battering back or otherwise as may be appropriate;
- Should there be noticeable effects of erosion along the swales or at discharge points, suitable erosion protection measures such as placement of large stones or erosion protection textiles should be installed at the area affected;
- Any temporarily stored or stockpiled material will be placed in a manner to ensure stability and set back sufficiently far such that in the case of unforeseen collapse, spoil would not cause infilling of swales.

10.1.2 Settlement / Detention Basins

- Basin inlets to be cleared of debris.
- Silt in aggregate forebays to be removed by excavator and disposed of. Any aggregate removed to be replaced with clean stone.
- Any flow control device (orifice, weir or similar) to be checked and cleared of any debris.

10.2 Operational Phase

A post construction phase maintenance manual will be produced upon production of as built drainage survey for the site. This maintenance manual will contain recommendations identified above, augmented with further drainage findings collected during the construction phase which are deemed to assist in provision of long term drainage management for the site.

11 ASSESSMENT OF MITIGATION

11.1 Assessment of Mitigation against WFD Objectives

Table 11.1: Schedule B – Assessment of Specific Mitigation Against WFD Objectives

Scheme Component / Effect	Objective 1	Objective 2	Objective 3	Objective 4
	To prevent deterioration in the ecological status of the waterbody.	To prevent the introduction of impediments to the attainment of Good WFD status for the waterbody.	To ensure the attainment of the WFD objectives for the waterbody are not compromised.	To ensure the achievement of WFD objectives in other waterbodies within the same catchment are not permanently excluded or compromised.
	Describe mitigation required to meet objective 1:	Describe mitigation required to meet objective 2:	Describe mitigation required to meet objective 3:	Describe mitigation required to meet objective 4:
Changes in Runoff and Flow Patterns In relation to the surface water body.	Detailed in Sections 3.3 to 3.4, and summarised as follows: • Track and hardstanding runoff will be handled by sheet flow to trackside ditches or swales; • Tracks and hardstanding areas are to be constructed from unbound aggregate and are not surfaced, thus helping to reduce runoff volumes; • Piped under track drainage will be provided with associated sumps and check dams. The under track drainage will provide a means for flows to pass from a swale on the uphill side of the slope to the downhill side of the slope; • In cases where the tracks must run significantly downhill, transverse drains ('grips') will be constructed where appropriate in the surface of the tracks to divert any runoff flowing down the track into the adjacent drainage ditch/across open ground; • Rate and volume of runoff will be attenuated using check dams. Attenuation features will reduce flow velocities preventing scour, and allow settlement of silts prior to discharge; • Drainage design will ensure natural streams are piped directly through appropriately sized drainage pipes on their original alignment; • Settlement ponds will be designed to cater for infilling and rehabilitation post construction phase of the project; however subject to requirements of habitat management or enhancement plans for the site, water features may be retained for the whole life of the project as a means of providing wetland habitat on the site; • Buffer zones to water features will be established.			

Table 11.1: Schedule B – Assessment of Specific Mitigation Against WFD Objectives

Scheme Component / Effect	Objective 1	Objective 2	Objective 3	Objective 4
	To prevent deterioration in the ecological status of the waterbody.	To prevent the introduction of impediments to the attainment of Good WFD status for the waterbody.	To ensure the attainment of the WFD objectives for the waterbody are not compromised.	To ensure the achievement of WFD objectives in other waterbodies within the same catchment are not permanently excluded or compromised.
	Describe mitigation required to meet objective 1:	Describe mitigation required to meet objective 2:	Describe mitigation required to meet objective 3:	Describe mitigation required to meet objective 4:
Silt / Suspended Solid pollution of surface water In relation to the surface water body.	Detailed in Sections 3.3 to 3.4, and summarised as follows: • Clean / dirty water separation will be maintained on site in all practicable instances; • A treatment train will be designed with a minimum of two stages of treatment for polluted runoff from the site during the construction phase; • All treatment settlement features (check dam backwaters and ponds) are to be designed to offer sufficient retention time to settle out the silt grain sizes anticipated; • Silt laden runoff within trackside swales will be treated through the provision of small check dams at specified centres along the swales; • Areas stripped of vegetation should be kept to a minimum and any stripped vegetation should be reinstated on slopes as early as possible. • Earth spillages into any existing streams will also be avoided; • Any dewatering from excavations will be via surface silt traps, check dams and settlement ponds to ensure sediment does not enter surrounding watercourses; • Runoff from new hardstanding areas will be collected and attenuated before discharge to receiving drainage networks.			
Chemical Pollution of surface water and groundwater In relation to the surface water body and groundwater body.	Detailed in Sections 3.3 to 3.4, and summarised as follows: • Appropriate site management measures will be taken to ensure that runoff from the construction site is not contaminated by fuel or lubricant spillages; • There will be no discharge of trade effluent, sewage effluent or contaminated drainage into any watercourse.			

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12 SUMMARY AND CONCLUSION

12.1 Assessment of Post-Construction WFD Status

In all instances, the mitigation described previously is sufficient to meet the WFD Objectives 1 to 4. The post-construction assessment of WFD elements for the on-site WFD waterbody is summarised in Table 12.1 below.

Table 12.1: Summary of post-construction WFD Status

WFD Element	Current Status	Assessed Post-Works Status - No Mitigation	Assessed Post-Works Status - With Mitigation
Curly River (2015)			
Benthic Invertebrates	Good	Poor	Good
Phytobenthos	Good	Good	Good
Ammonia	Good /High	High	Good /High
Dissolved Oxygen	High	Moderate	High
pH	High	Good	High
Soluble Reactive Phosphate	High	Poor	High
Biological Oxygen Demand	High	Poor	High
Temperature	High	Moderate	High
Hydrological Regime	High	Moderate	High
Morphological conditions	-		
Magilligan Groundwater Body			
Chemical Status	Poor	Poor	Poor

12.2 Summary

This Water Framework Assessment has been undertaken to determine the effects of Dunbeg South Wind Farm on the ecological quality status of waterbodies potentially affected by construction activities associated with the development.

In order to consider and assess potential impacts, the elements that constitute the current and predicted status for the waterbodies affected have been considered in the context of the proposed development initially assuming no mitigation measures are implemented. This approach allows the identification of the activities with the potential to cause an adverse impact on the current and / or predicted WFD status of the waterbody.

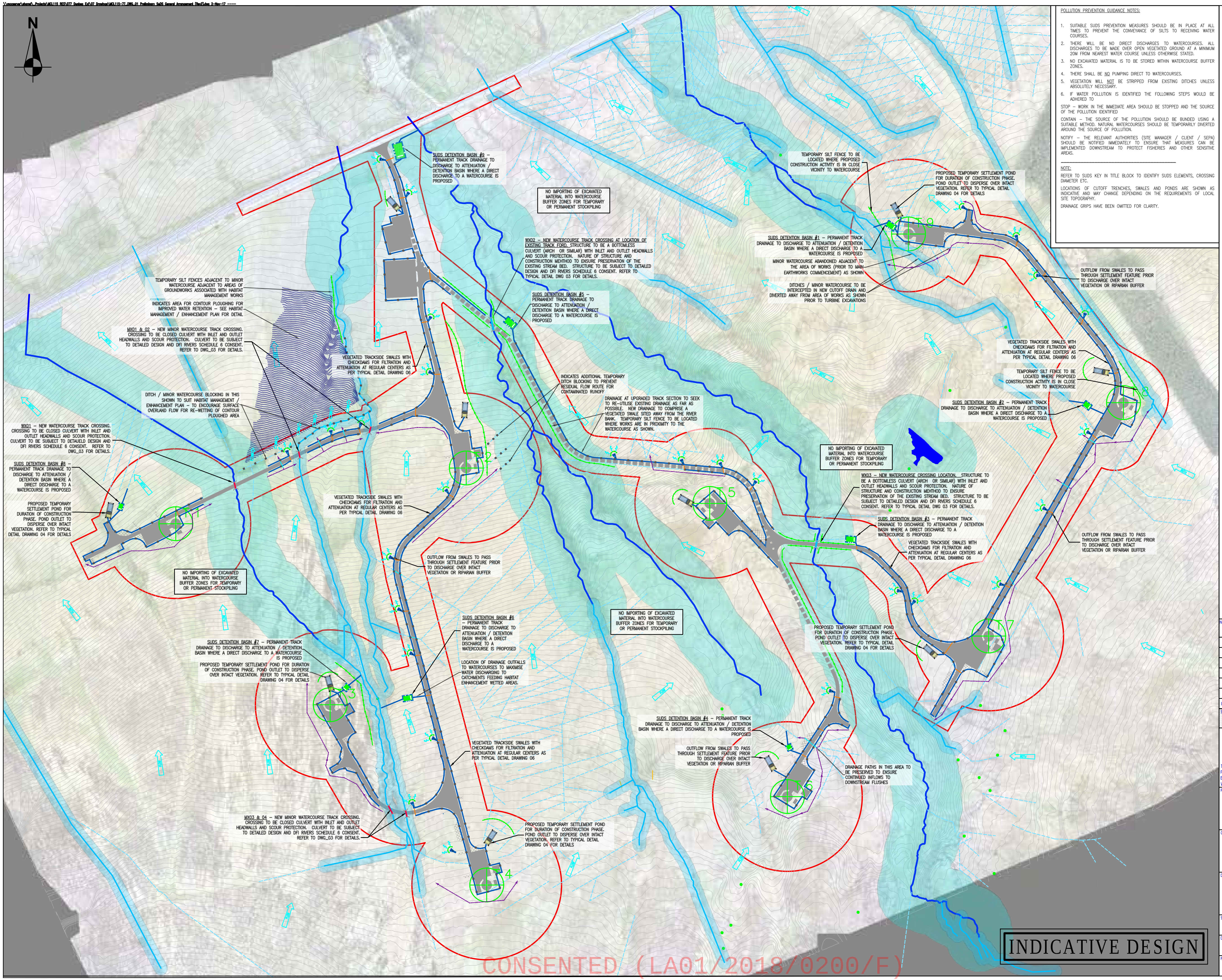
Consideration was then given to the design and mitigation measures incorporated into the scheme. Further mitigation measures were outlined where required and general pollution prevention measures were presented.

12.3 Conclusion

Following incorporation of site-wide general binding mitigation control measures, NIEA approved Guidance for pollution prevention (GPPs) and pollution prevention guidelines (PPGs), and site specific mitigation, no adverse effect is anticipated to the Water Framework Directive classification of the affected waterbodies caused by the Dunbeg South Wind Farm Development.

Annex A

Drainage Management - General Arrangement



POLLUTION PREVENTION GUIDANCE NOTES:

1. SUITABLE SUDS PREVENTION MEASURES SHOULD BE IN PLACE AT ALL TIMES TO PREVENT THE CONVEYANCE OF SILTS TO RECEIVING WATER COURSES.
2. THERE WILL BE NO DIRECT DISCHARGES TO WATERCOURSES. ALL DISCHARGES TO BE MADE OVER OPEN VEGETATED GROUND AT A MINIMUM 20M FROM NEAREST WATER COURSE UNLESS OTHERWISE STATED.
3. NO EXCAVATED MATERIAL IS TO BE STORED WITHIN WATERCOURSE BUFFER ZONES.
4. THERE SHALL BE NO PUMPING DIRECT TO WATERCOURSES.
5. VEGETATION WILL NOT BE STRIPPED FROM EXISTING DITCHES UNLESS ABSOLUTELY NECESSARY.
6. IF WATER POLLUTION IS IDENTIFIED THE FOLLOWING STEPS WOULD BE ADHERED TO

STOP – WORK IN THE IMMEDIATE AREA SHOULD BE STOPPED AND THE SOURCE OF THE POLLUTION IDENTIFIED

CONTAIN – THE SOURCE OF THE POLLUTION SHOULD BE BUNDED USING A SUITABLE METHOD. NATURAL WATERCOURSES SHOULD BE TEMPORARILY DIVERTED AROUND THE SOURCE OF POLLUTION.

NOTIFY – THE RELEVANT AUTHORITIES (SITE MANAGER / CLIENT / SEPA) SHOULD BE NOTIFIED IMMEDIATELY TO ENSURE THAT MEASURES CAN BE IMPLEMENTED DOWNSTREAM TO PROTECT FISHERIES AND OTHER SENSITIVE AREAS.

NOTE:

REFER TO SUDS KEY IN TITLE BLOCK TO IDENTIFY SUDS ELEMENTS, CROSSING DIAMETER ETC.

LOCATIONS OF CUTOFF TRENCHES, SWALES AND PONDS ARE SHOWN AS INDICATIVE AND MAY CHANGE DEPENDING ON THE REQUIREMENTS OF LOCAL SITE TOPOGRAPHY.

DRAINAGE GRIPS HAVE BEEN OMITTED FOR CLARITY.

NOTES

1. DRAINAGE LAYOUT SHOWN IS INDICATIVE AND IS INTENDED TO BE FURTHER DEVELOPED POST DETERMINATION OF THE ASSOCIATED PLANNING APPLICATION. DRAINAGE FEATURES SHOWN ARE SUBJECT TO CHANGE DEPENDANT ON DETAILED INFRASTRUCTURE DESIGN AND LOCAL TOPOGRAPHY.
2. LOCATION OF CROSSINGS, SWALES, BREAKOUTS, SETTLEMENT PONDS ETC. IS INDICATIVE ONLY FOR PURPOSES OF PRELIMINARY PLANNING DRAWING LAYOUT.
3. THE LEVEL OF SILT IN RUNOFF DURING CONSTRUCTION IS TO BE MONITORED VISUALLY AND EXCESSIVE SILT LEVELS IN ANY AREA TO BE TEMPORARILY MANAGED BY PLACING SILT FENCES & GEOTEXTILE BARRIERS AT THE PROBLEM AREAS.
4. SUDS SYSTEM TO BE CONSTRUCTED PRIOR TO, OR AT THE SAME TIME, AS THE ACCESS ROAD. INTERIM MEASURES SUCH AS THE PLACEMENT OF SILT FENCES TO BE EMPLOYED IN ALL INSTANCES WHERE WORK CARRIED OUT TO CONSTRUCT THE ACCESS ROAD IS LIKELY TO CAUSE ADVERSE ENVIRONMENTAL IMPACTS.
5. SUITABLE PREVENTION MEASURES SHOULD BE IN PLACE AT ALL TIMES TO PREVENT THE CONVEYANCE OF SILTS TO RECEIVING WATER COURSES.
6. DRAINAGE SWALES TO BE CONSTRUCTED ADJACENT TO THE ACCESS TRACK. REGULAR CROSS DRAINS TO BE LOCATED ALONG ACCESS TRACKS TO PREVENT EXCESSIVE VOLUMES OF WATER COLLECTING IN THE SWALES. SURFACE WATER WILL NOT BE ALLOWED TO DISCHARGE DIRECTLY INTO EXISTING WATER COURSES. SUMPS /PONDS TO BE CONSTRUCTED FOR PEAT AND SILT COLLECTION FROM EXCAVATIONS & SPOIL HEAPS.
7. ROADSIDE SWALES TO BE SHALLOW WITH MODERATE GRADIENTS TO PREVENT SCOURING. IN STEEP AREAS CHECK–DAMS HAVE BEEN DESIGNATED TO REDUCE FLOW RATE & PROVIDE SOURCE CONTROL SILT CONTAINMENT. WHERE NECESSARY THESE HAVE BEEN DESIGNATED IN CONJUNCTION WITH SETTLEMENT PONDS AND/OR CROSS–DRAINS.
8. AREAS STRIPPED OF VEGETATION SHOULD BE KEPT TO A MINIMUM.
9. CLEAN STONE FLOW CONTROL CHECK–DAMS TO BE LOCALLY WON WELL GRADED STONE. AGGREGATE SIZE FOR STONE CHECK DAMS TO BE TYPICALLY 20/40MM CLEAN STONE. ON SLOPING SECTIONS OF THE ACCESS ROAD, 20/40MM CHECK DAMS TO BE PROTECTED FROM WASHING AWAY THROUGH THE PLACEMENT OF 100MM STONE ON THE DOWNHILL FACE OF THE CHECK–DAM.
10. BUILD UP OF SILT LEVELS AT CHECK–DAMS TO BE REMOVED AND DISPOSED OF APPROPRIATELY. SILT LEVELS AT CHECK DAMS TO BE VISUALLY INSPECTED AS PART OF AN ONGOING MAINTENANCE PROGRAM DURING THE CONSTRUCTION PHASE. WHERE CHECK–DAMS BECOME CLOGGED WITH SILT OR VEGETATION, STONE CHECK DAM TO BE REMOVE AND REPLACED.
11. SPACING AND FREQUENCY OF CHECK DAMS WILL BE DEPENDANT UPON LONGITUDINAL GRADIENT OF SWALE. LOCATION OF FILTRATION CHECK DAMS TO BE GENERALLY AS PER THE SITE LAYOUT PLAN. FLOW FILTRATION CHECK DAMS TO BE CONSTRUCTED FROM RECYCLED RAILWAY SLEEPERS OR SIMILAR APPROVED. MATERIALS USED TO CONSTRUCT FLOW FILTRATION CHECK DAM TO BE BOLTED TO SUPPORTS WHERE ACCESSIBLE.
12. OIL FUEL SHOULD BE STORED WITHIN CONTAINMENT AND CEMENT SHOULD BE MIXED WITHIN COMPOUND / CONTAINMENT, TOOLS WASHED IN THE SAME AREA AND WATER RECYCLED (IN THE CEMENT MIX).
13. WATERCOURSES SHOWN ARE AS PER CLIENT PROVIDED OS MAPPING AND DRAWINGS; LOCATIONS SHOWN ARE APPROXIMATE ONLY AND MAY REQUIRE FURTHER INVESTIGATION FOR DETAILED DESIGN.
14. NO DIRECT DISCHARGE TO WATERCOURSES – MAINTAIN APPROPRIATE VEGETATION BUFFER.

SuDS KEY

- UNDERTRACK DRAINAGE (CONSTRUCTION RUNOFF)
- UNDERTRACK DRAINAGE (NATURAL RUNOFF)
- PROPOSED NEW TRACK
- PROPOSED UPGRADE TO EXISTING TRACK
- DRAINAGE SWALE / INDICATIVE BREAKOUT & CHECK DAM
- NATURAL RUNOFF CUT–OFF DITCH
- SILT FENCE
- WATERCOURSE / SIGNIFICANT DRAIN CROSSING
- SETTLEMENT POND TO BE INSTALLED PRIOR TO CONSTRUCTION OF TURBINE BASE
- ATTENUATION / DETENTION LAGOON
- 50M BUFFER TO WATERCOURSE
- 10M BUFFER TO DRAIN / MINOR WATERCOURSE

MAP KEY

- PLANNING APPLICATION BOUNDARY
- MAJOR WATER COURSE
- MINOR WATERCOURSE / DRAIN / CHANNEL
- EPHEMERAL / LAND DRAINAGE
- NATURAL OVERLAND FLOW DIRECTIONS

NOTE: THIS DRAWING IS BASED ON 3RD PARTY INFRASTRUCTURE / PROPOSAL DRAWING:

03219D1001–01

ISSUE	DRN	APP	DATE	NOTES / DESCRIPTION
2	CD	DKS	30/10/2017	FOR PLANNING
1	MR	DKS	05/10/2016	ORIGINAL DRAFT – FOR INFORMATION

STATUS

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PROJECT

PROPOSED DUNBEG SOUTH WIND FARM

CLIENT

res

DRAWING TITLE

DRAINAGE MANAGEMENT DRAWINGS SITE GENERAL ARRANGEMENT SHEET 1

SCALE	ORIGINAL SIZE	
1: 5000 @ A3	A3	
DRAWN	CHECKED	DATE
MR	DKS	05/10/2017
PROJECT No.	DRAWING No.	ISSUE NO.
MCL115–77	DWG_01	2

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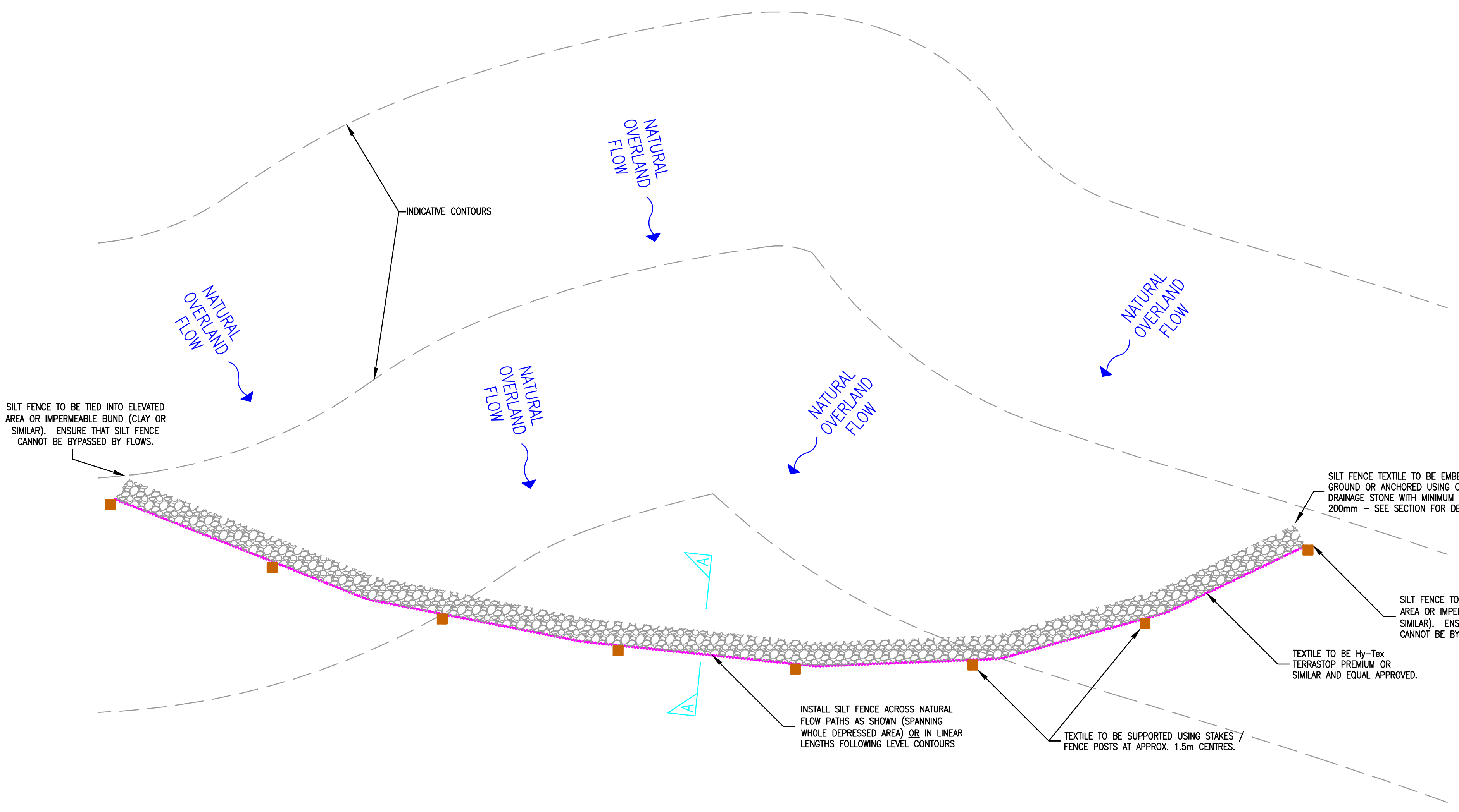
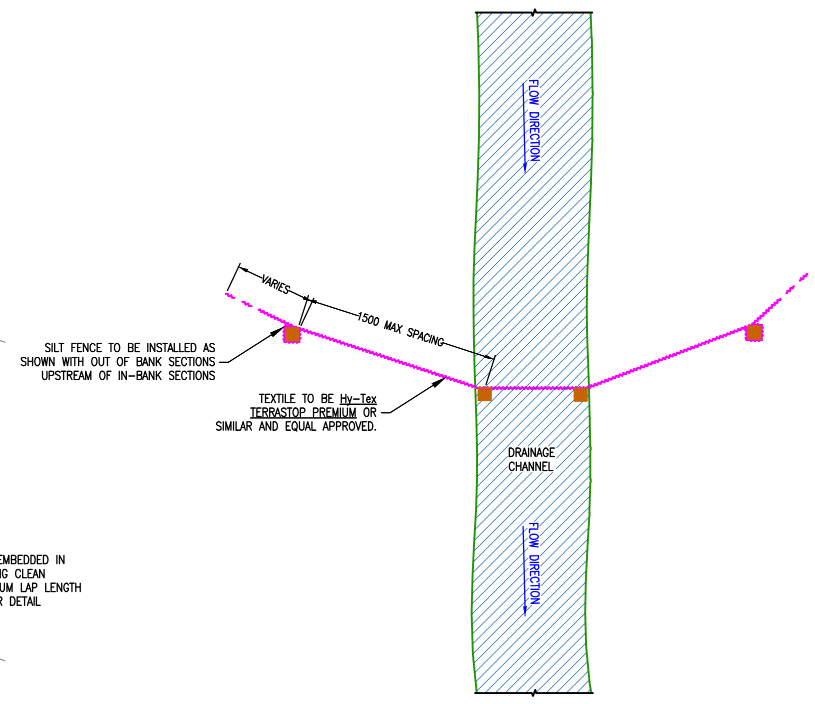
Annex B

Drainage Management – Typical Details

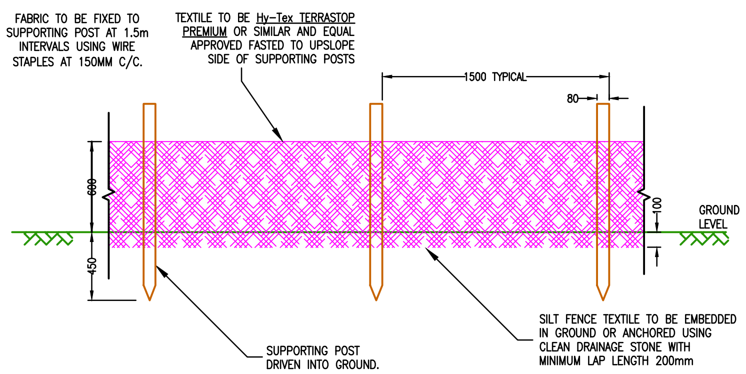
MCL115-77 DWG 02	Silt Fence
MCL115-77 DWG 03	Bottomless Culvert
MCL115-77 DWG 04	Piped Culverts
MCL115-77 DWG 05	Drainage at Excavated (Cut) Track
MCL115-77 DWG 06	Drainage at 'Floated' Track
MCL115-77 DWG 07	Settlement Lagoon Arrangement
MCL115-77 DWG 08	Attenuation Pond



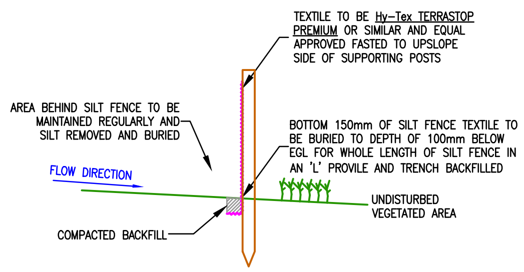
TYPICAL OVERLAND SILT FENCE PLAN
SCALE 1:25



TYPICAL CHANNEL SILT FENCE PLAN
SCALE 1:25

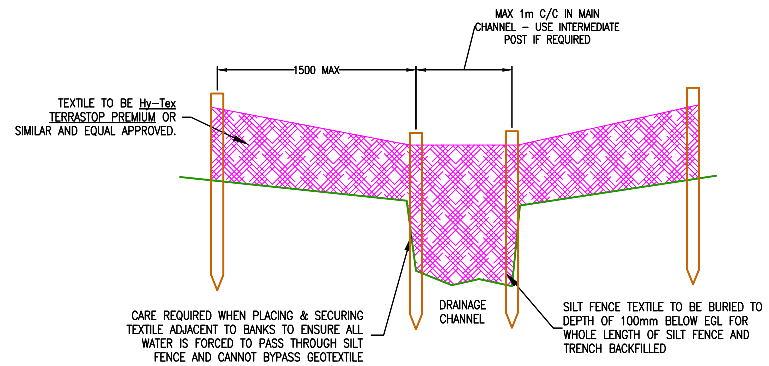


ELEVATION
SCALE 1:25



SECTION A–A
BURIED TYPE OPTION
SCALE 1:25

EXAMPLE OF CHANNEL SILT FENCE INSTALLATION
NTS



TYPICAL CHANNEL SILT FENCE ELEVATION
SCALE 1:25

NOTE: THIS DRAWING IS BASED ON 3RD PARTY INFRASTRUCTURE / PROPOSAL DRAWING:
N/A

ISSUE	DRN	APP	DATE	NOTES / DESCRIPTION
2	DKS	DKS	02/11/2017	FOR PLANNING
1	DL	CMQ	18/10/2017	ORIGINAL – FOR INFORMATION

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PROJECT
PROPOSED DUNBEG SOUTH WINDFARM

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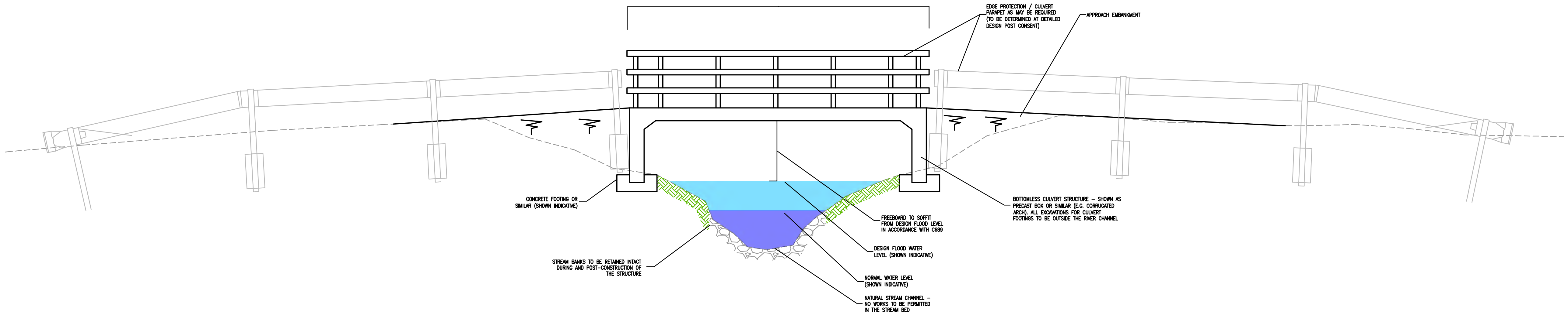
DRAWING TITLE
DRAINAGE MANAGEMENT (SuDS) INDICATIVE TYPICAL DETAILS SILT FENCE

SCALE	ORIGINAL SIZE	
AS SHOWN	A1	
DRAWN: DL	CHECKED: CMQ	DATE: 17/10/2017
PROJECT No.: MCL115-77	DRAWING No.: DWG_02	ISSUE No.: 2

INDICATIVE DESIGN



TYPICAL BOTTOMLESS CULVERT
WATERCROSSING
NTS

NOTE: THIS DRAWING IS BASED ON 3RD PARTY INFRASTRUCTURE / PROPOSAL DRAWING:
N/A

ISSUE	DRN	APP	DATE	NOTES / DESCRIPTION
2	DKS	DKS	02/11/2017	FOR PLANNING
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PROJECT
PROPOSED DUNBEG SOUTH WINDFARM

CLIENT
res

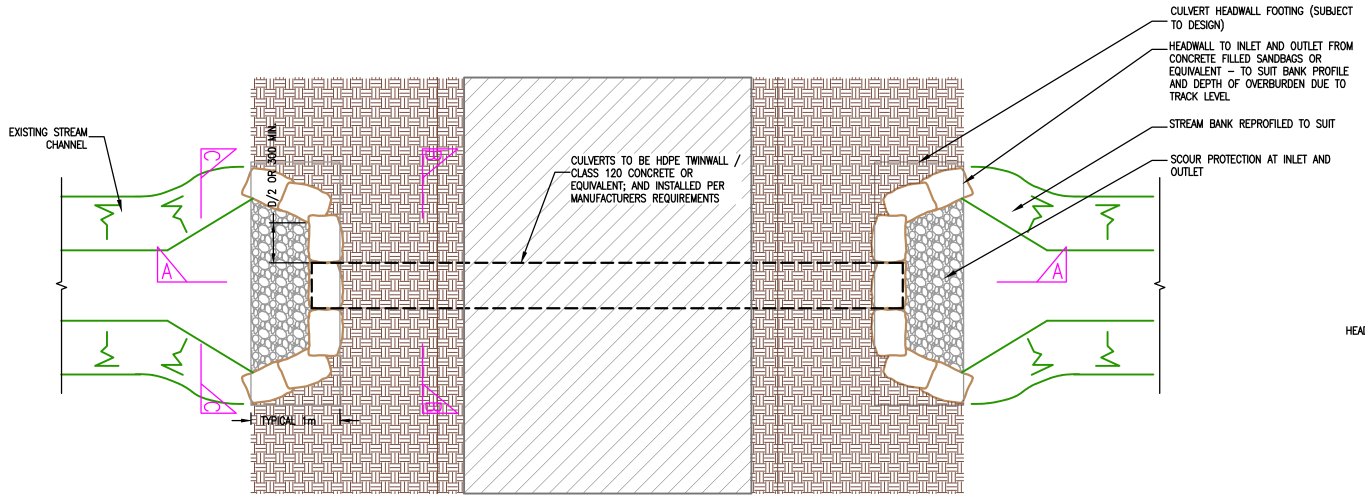
DRAWING TITLE
DRAINAGE MANAGEMENT (SuDS) INDICATIVE TYPICAL DETAILS BOTTOMLESS CULVERT

SCALE	ORIGINAL SIZE
AS SHOWN	A1

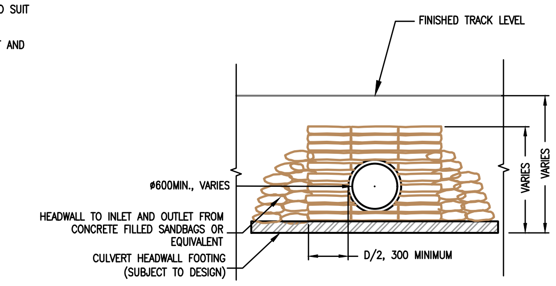
DRAWN	CHECKED	DATE
DL	CMQ	17/10/2017

PROJECT No.	DRAWING No.	ISSUE NO.
MCL115–77	DWG_03	2

INDICATIVE DESIGN



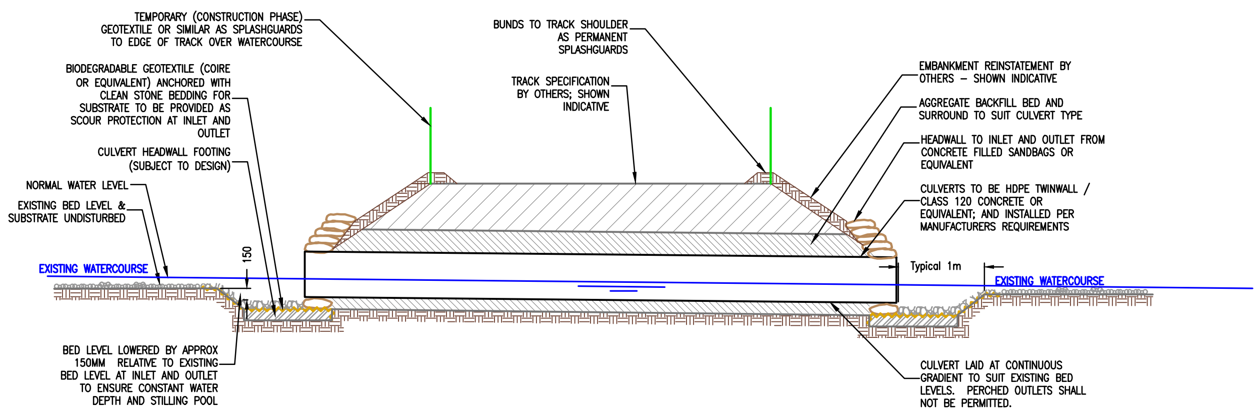
PLAN
SCALE 1:50



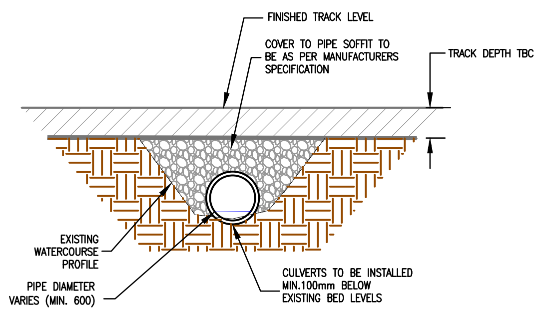
ELEVATION C–C (WITH HEADWALL)
1:50

NOTES FOR CONSTRUCTION METHODS & ENVIRONMENTAL PROTECTION

1. WORKS TO BE PROGRAMMED TO SUIT PERIODS OF LOW RIVER FLOW AND RAINFALL. DUE COGNISANCE GIVEN TO THE PREVAILING GROUND CONDITIONS AND SEASONAL WEATHER CONDITIONS.
2. CULVERT LOCATION TO BE DAMMED UPSTREAM BY USE OF SANDBAGS OR EQUIVALENT AND OVERPUMPED IN ORDER TO PROVIDE A DRY WORKING ENVIRONMENT.
3. IN CHANNEL SILT FENCING TO BE INSTALLED DOWNSTREAM OF THE WORKS AND DOWNSTREAM OF OVERPUMPING FOR THE DURATION OF THE CULVERT INSTALLATION WORKS.



SECTION A–A
SCALE 1:50



SECTION B–B
SCALE 1:50

NOTE: THIS DRAWING IS BASED ON 3RD PARTY INFRASTRUCTURE / PROPOSAL DRAWING:
N/A

ISSUE	DRN	APP	DATE	NOTES / DESCRIPTION
2	DKS	DKS	02/11/2017	FOR PLANNING
1	DL	CMQ	18/10/2017	ORIGINAL – FOR INFORMATION

STATUS
FOR PLANNING

McCloy Consulting

T: 028 9084 8694
F: 028 9084 1525
E: info@mccloyconsulting.com
W: www.mccloyconsulting.com
Mossley Mill, Lower Ground (West), Carnmoney Road North, Newtownabbey, Co. Antrim BT36 5QA

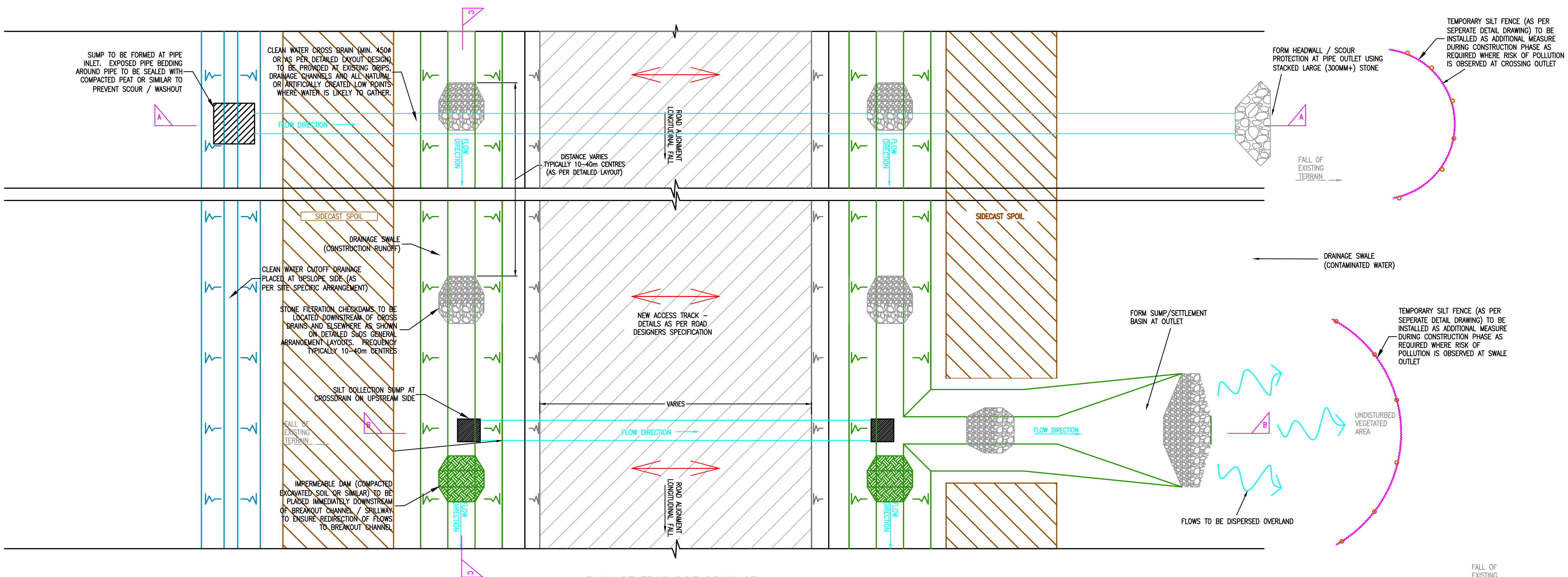
PROJECT
PROPOSED DUNBEG SOUTH WINDFARM

CLIENT
res

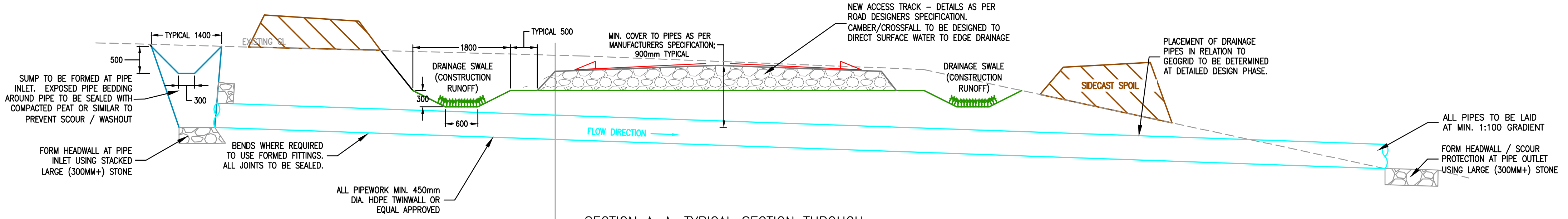
DRAWING TITLE
DRAINAGE MANAGEMENT (SuDS) INDICATIVE TYPICAL DETAILS PIPED CULVERTS

SCALE	ORIGINAL SIZE	
AS SHOWN	A1	
DRAWN	CHECKED	DATE
DL	CMQ	17/10/2017
PROJECT No.	DRAWING No.	ISSUE NO.
MCL115-77	DWG_04	2

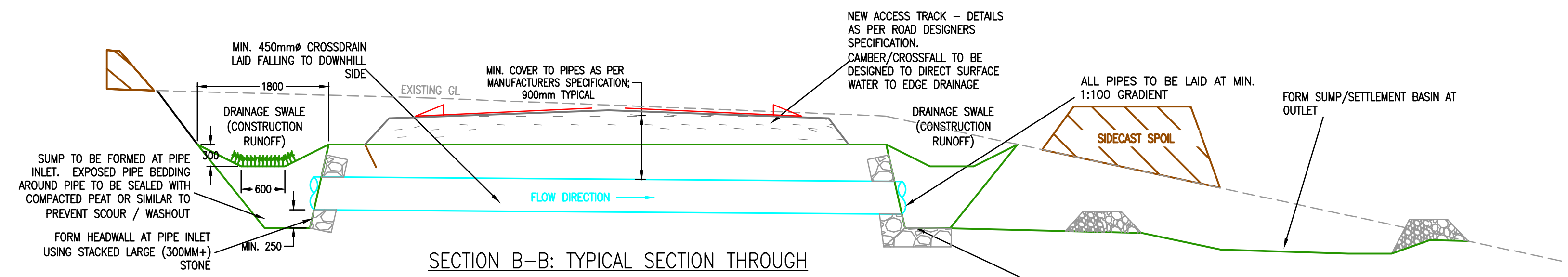
INDICATIVE DESIGN



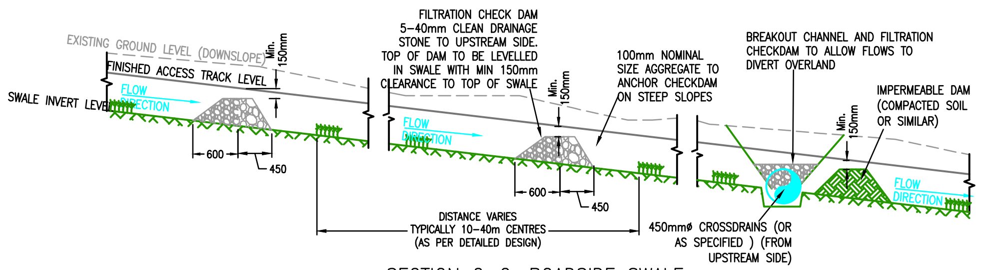
PLAN OF TRACKSIDE DRAINAGE – ROAD SECTIONS IN CUT
SCALE 1:50



SECTION A–A: TYPICAL SECTION THROUGH CLEAN WATER TRACK CROSSING
SCALE 1:50



SECTION B–B: TYPICAL SECTION THROUGH DIRTY WATER TRACK CROSSING
SCALE 1:50



SECTION C–C: ROADSIDE SWALE & CHECK DAMS
SCALE 1:50

NOTES:
1. ROAD CONSTRUCTION TO BE AS PER HIGHWAY ENGINEERS DESIGN & SPECIFICATION
2. REFER TO DETAILED PLAN SuDS DRAWINGS FOR DETAILS OF CHECK DAM / CROSS DRAIN / CUTOFF DRAIN / OUTFALL LOCATIONS ETC.
3. FEATURES SHOWN ARE PERMANENT SITE DRAINAGE. TEMPORARY SITE DRAINAGE OVER AND ABOVE THAT SHOWN ON DRAWINGS MAY BE REQUIRED TO SUIT TEMPORARY ROAD ALIGNMENTS AND LEVELS.

INDICATIVE DESIGN

CONSENTED (LA01/2018/0200/F)

NOTE: THIS DRAWING IS BASED ON 3RD PARTY INFRASTRUCTURE / PROPOSAL DRAWING:
N/A

ISSUE	DRN	APP	DATE	NOTES / DESCRIPTION
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1	DL	CMQ	18/10/2017	ORIGINAL - FOR INFORMATION

STATUS
FOR PLANNING

McCloy Consulting

T: 028 9084 8694
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W: www.mccloyconsulting.com
Mossley Mill, Lower Ground (West), Carnmoney Road North, Newtownabbey, Co. Antrim BT36 5QA

PROJECT
PROPOSED DUNBEG SOUTH WINDFARM

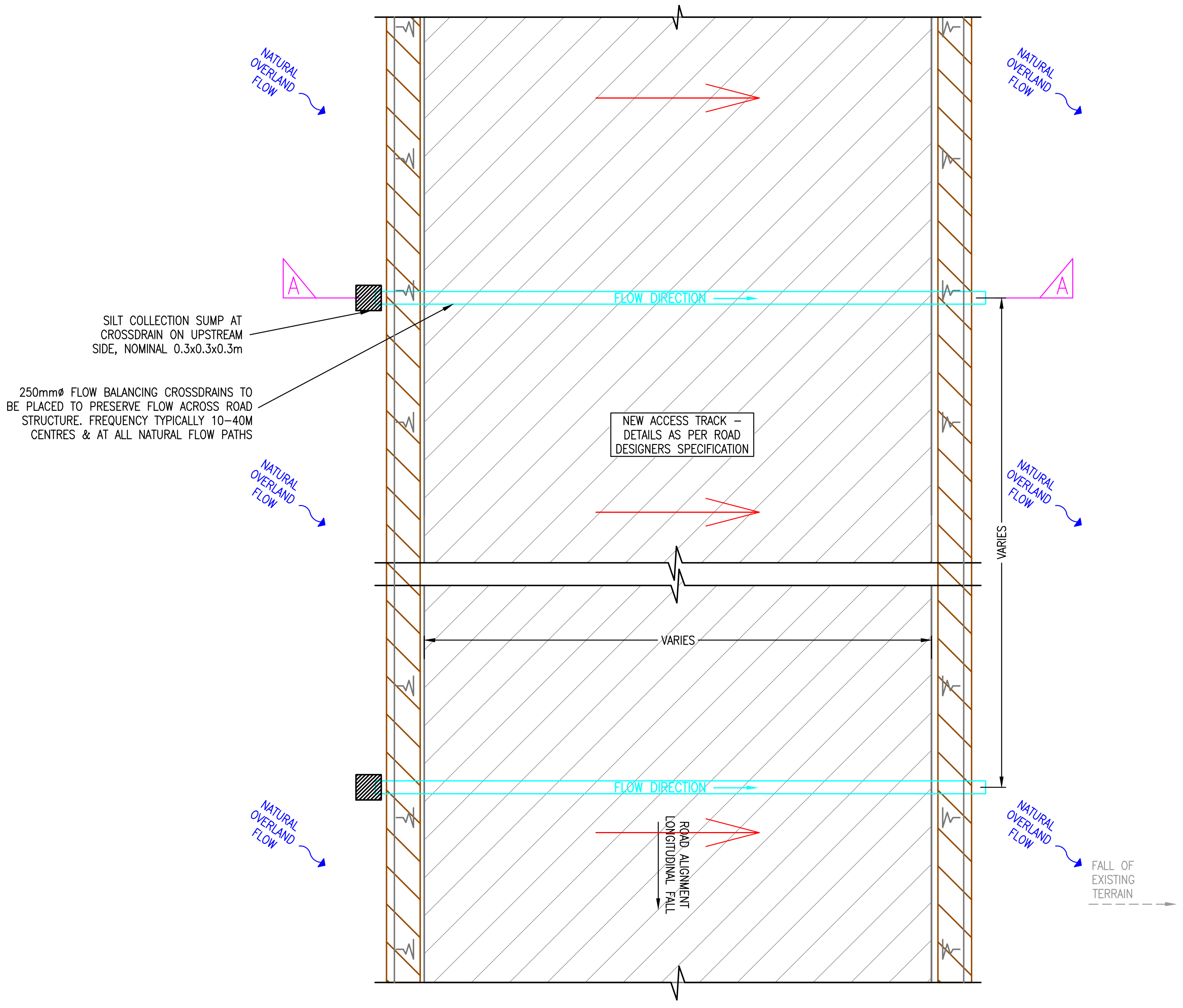
CLIENT
res

DRAWING TITLE
DRAINAGE MANAGEMENT (SuDS) INDICATIVE TYPICAL DETAILS DRAINAGE AT EXCAVATED (CUT) TRACK

SCALE	ORIGINAL SIZE
AS SHOWN	A1

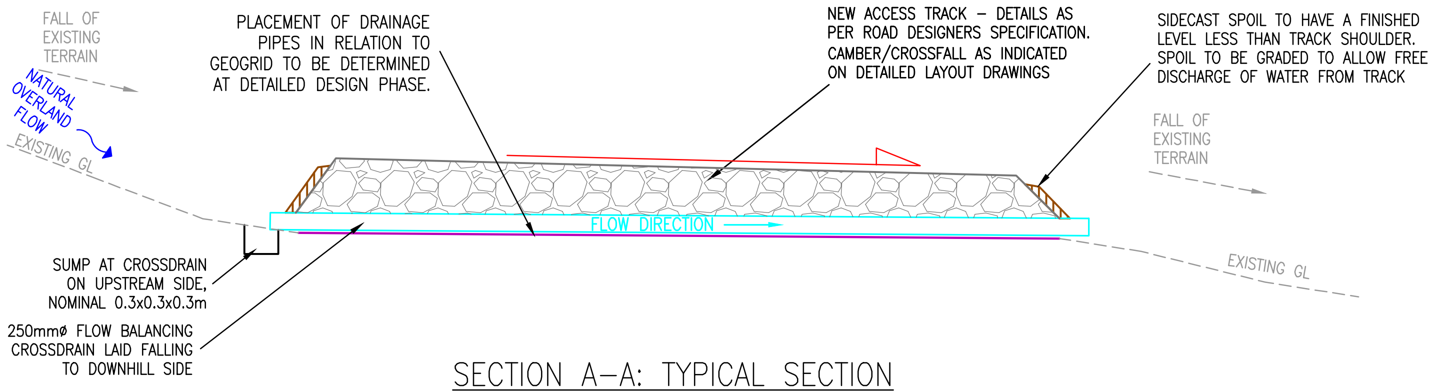
DRAWN	CHECKED	DATE
DL	CMQ	17/10/2017

PROJECT No.	DRAWING No.	ISSUE NO.
MCL115-77	DWG_05	2



PLAN OF ROADSIDE DRAINAGE – FLOATED ROAD SECTIONS

SCALE 1:50



SECTION A–A: TYPICAL SECTION

SCALE 1:50

INDICATIVE DESIGN

CONSENTED (LA01/2018/0200/F)

NOTE: THIS DRAWING IS BASED ON 3RD PARTY INFRASTRUCTURE / PROPOSAL DRAWING:
N/A

ISSUE	DRN	APP	DATE	NOTES / DESCRIPTION
2	DKS	DKS	02/11/2017	FOR PLANNING
1	DL	CMQ	18/10/2017	ORIGINAL – FOR INFORMATION

STATUS
FOR PLANNING

McCloy Consulting
T: 028 9084 8694
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E: info@mccloyconsulting.com
W: www.mccloyconsulting.com
Mossley Mill, Lower Ground (West), Carnmoney Road North, Newtownabbey, Co. Antrim BT36 5QA

PROJECT
PROPOSED DUNBEG SOUTH WINDFARM

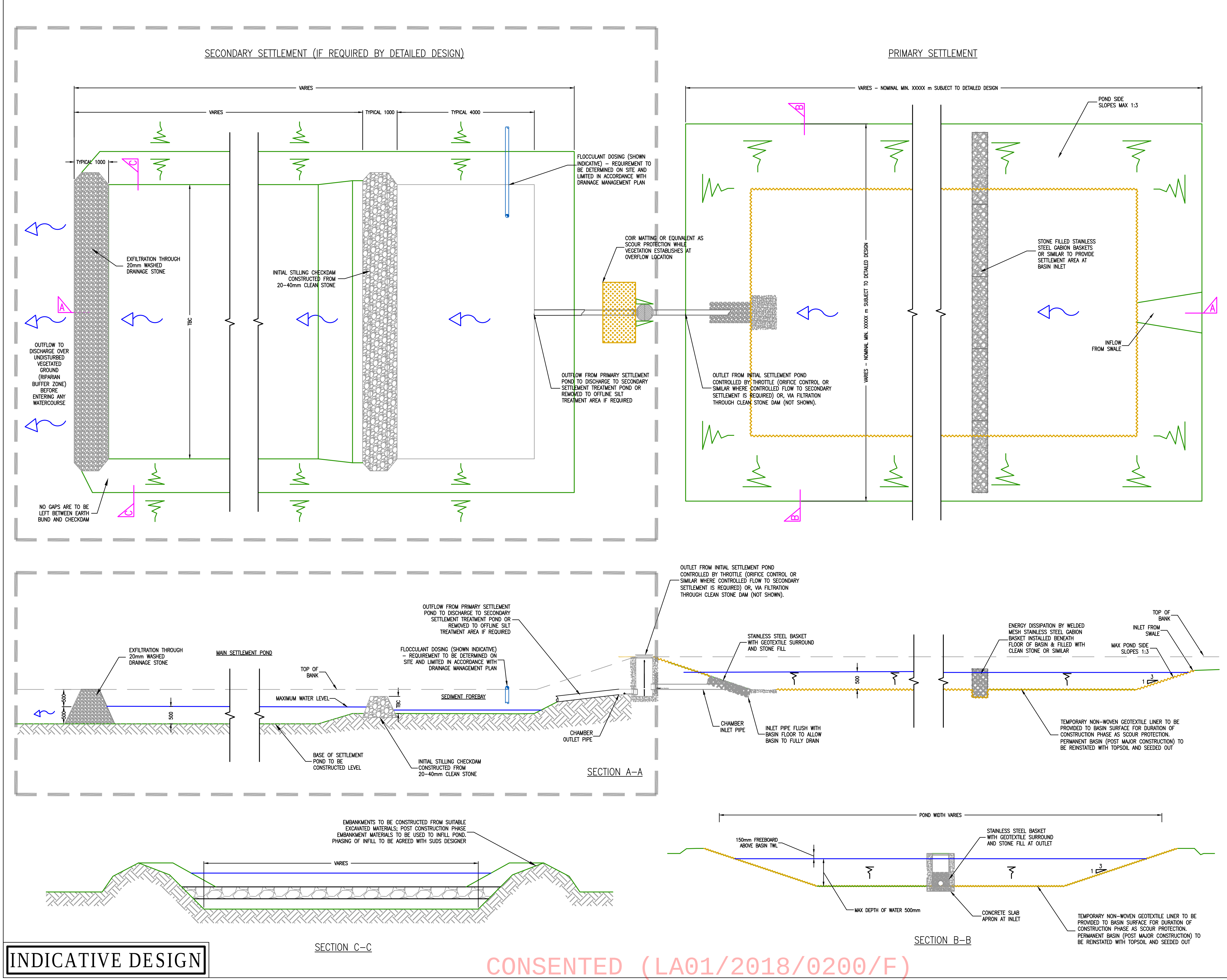
CLIENT
res

DRAWING TITLE
DRAINAGE MANAGEMENT (SuDS) INDICATIVE TYPICAL DETAILS DRAINAGE AT FLOATED TRACK

SCALE	ORIGINAL SIZE
AS SHOWN	A1

DRAWN	CHECKED	DATE
DL	CMQ	17/10/2017

PROJECT No.	DRAWING No.	ISSUE NO.
MCL115-77	DWG_06	2



INDICATIVE DESIGN

CONSENTED (LA01/2018/0200/F)

NOTE: THIS DRAWING IS BASED ON 3RD PARTY INFRASTRUCTURE / PROPOSAL DRAWING:
N/A

ISSUE	DRN	APP	DATE	NOTES / DESCRIPTION
2	DKS	DKS	02/11/2017	FOR PLANNING
1	DL	CMQ	18/10/2017	ORIGINAL – FOR INFORMATION

STATUS
FOR PLANNING

McCloy Consulting
T: 028 9084 8694
F: 028 9084 1525
E: info@mccloyconsulting.com
W: www.mccloyconsulting.com
Mossley Mill, Lower Ground (West), Carnmoney Road North, Newtownabbey, Co. Antrim BT36 5QA

PROJECT
PROPOSED DUNBEG SOUTH WINDFARM

CLIENT
res

DRAWING TITLE
DRAINAGE MANAGEMENT (SuDS) INDICATIVE TYPICAL DETAILS SETTLEMENT LAGOON ARRANGEMENT

SCALE	ORIGINAL SIZE
AS SHOWN	A1

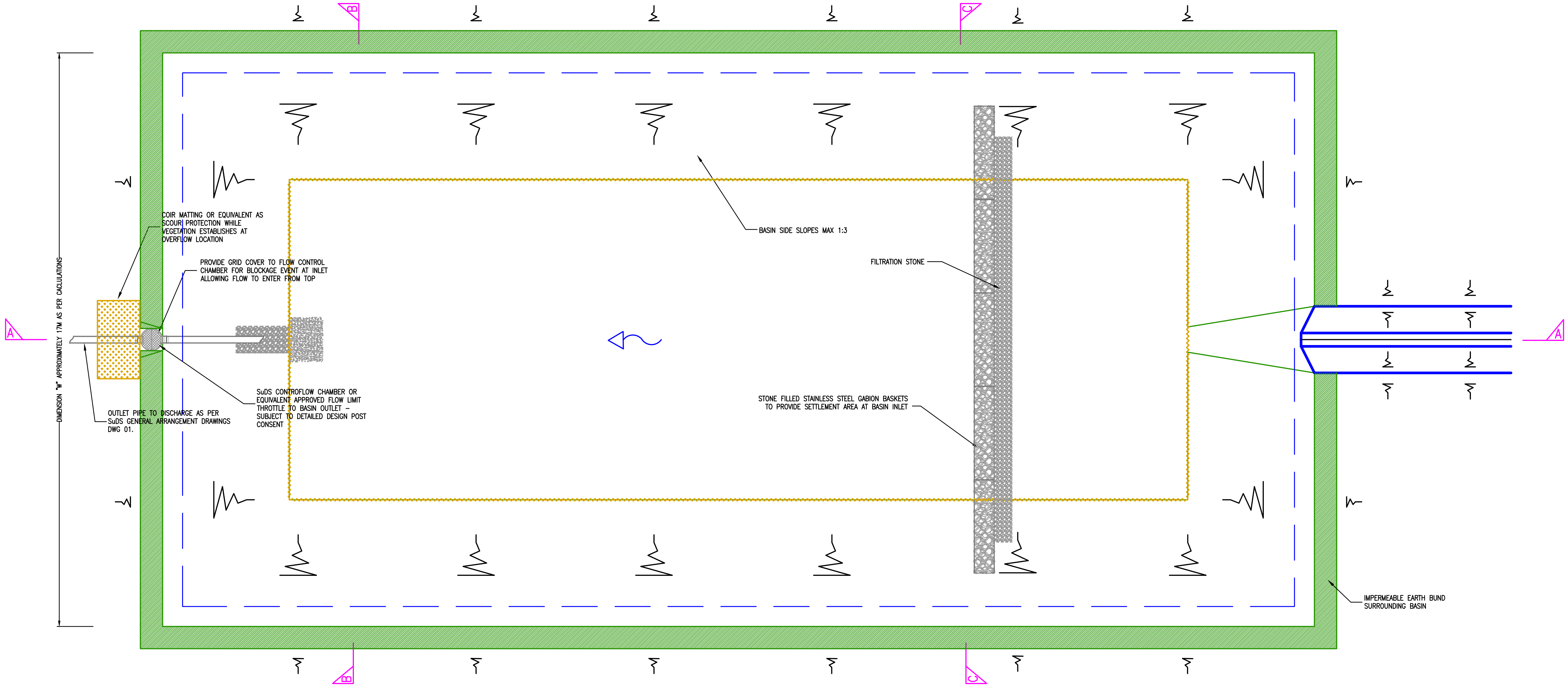
DRAWN	CHECKED	DATE
DL	CMQ	17/10/2017

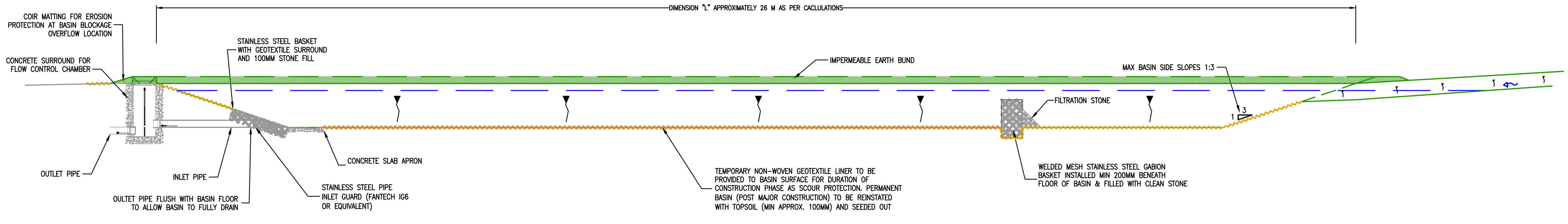
PROJECT No.	DRAWING No.	ISSUE NO.
MCL115-77	DWG_07	2

INDICATIVE DESIGN

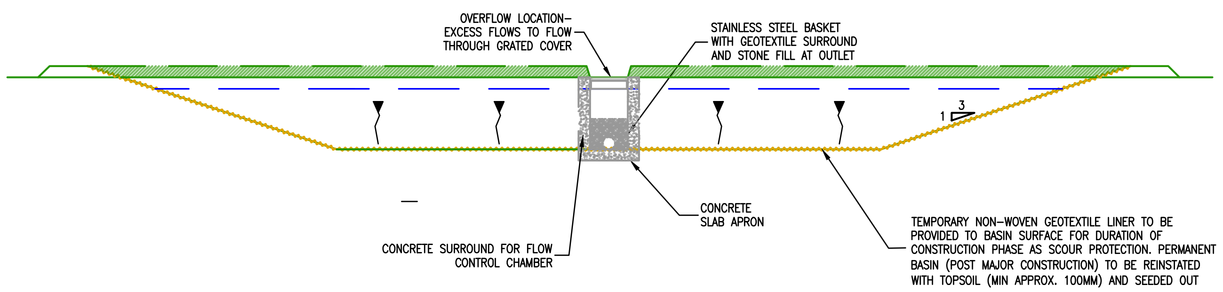
SuDS ATTENUATION / DETENTION BASIN PLAN

SCALE 1:50

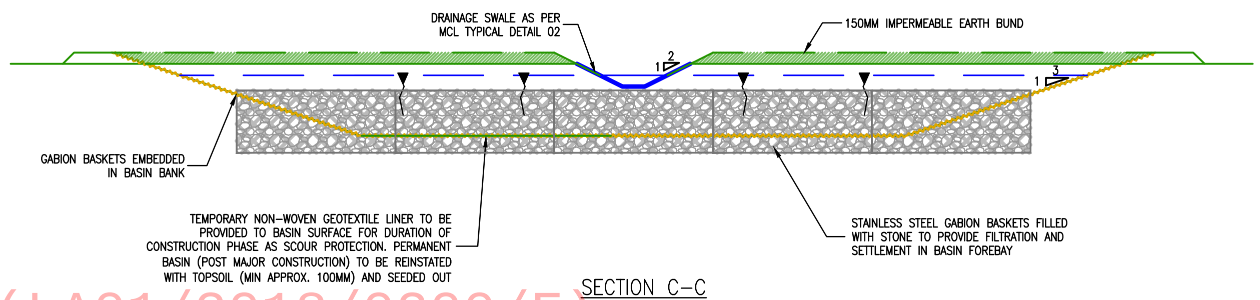




SECTION A–A



SECTION B–B



SECTION C–C

NOTE: THIS DRAWING IS BASED ON 3RD PARTY INFRASTRUCTURE / PROPOSAL DRAWING:

N/A

ISSUE	DRN	APP	DATE	NOTES / DESCRIPTION
2	DKS	DKS	02/11/2017	FOR PLANNING
1	DL	CMQ	18/10/2017	FOR INFORMATION

STATUS

FOR PLANNING

McCloy Consulting

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F: 028 9084 1525
E: info@mccloyconsulting.com
W: www.mccloyconsulting.com

Mossley Mill, Lower Ground (West), Carnmoney Road North, Newtownabbey, Co. Antrim BT36 5QA

PROJECT

PROPOSED DUNBEG SOUTH WINDFARM

CLIENT

res

DRAWING TITLE

DRAINAGE MANAGEMENT (SuDS) OUTLINE TYPICAL DETAILS DETENTION BASIN/ ATTENUATION POND

SCALE	ORIGINAL SIZE
AS SHOWN	A1

DRAWN	CHECKED	DATE
DL	CMQ	17/10/2017

PROJECT No.	DRAWING No.	ISSUE NO.
MCL115-77	DWG_08	2

Appendix 9.2 Consultation Records

Causeway Coast & Glens

Shared Environmental Services

Catherine McQuillan

Subject: FW: EIR request - Proposed site at Dunbeg

From: Joanne OKane [mailto:Joanne.OKane@causewaycoastandglens.gov.uk]
Sent: 04 July 2017 16:54
To: Catherine McQuillan <Catherine.McQuillan@mccloyconsulting.com>
Subject: RE: EIR request - Proposed site at Dunbeg

Hi Catherine

Apologies for the delay

I can't find my previous email where I identified some of the springs etc in the vicinity of Dunbeg

I've had a look at our maps again - I have listed the coordinates of some I can find on historical maps in our office. Some of these may duplicate the ones I gave you before

Spring at 73252603
Pond at 72192626
Pond at 76492802
Spring at 25567149
Spring at 24917093
Spring at 25567118
Spring at 231739

Our information is limited as we have to rely on the historical OSNI maps we have. We have no access to electronic maps as we do not have the relevant licences to access them

I hope this information is of use

Regards

Joanne

Joanne O'Kane
Environmental Health Officer | Environmental Services
7 Connell Street, Limavady, BT49 0HA
Tel: 028 77760302

Joanne.OKane@causewaycoastandglens.gov.uk

Causeway Coast & Glens Borough Council
www.causewaycoastandglens.gov.uk

Catherine McQuillan

Subject: FW: EIR request - Proposed site at Dunbeg

From: Joanne OKane [mailto:Joanne.OKane@causewaycoastandglens.gov.uk]
Sent: 24 August 2016 16:23
To: Catherine McQuillan <Catherine.McQuillan@mccloyconsulting.com>
Subject: RE: EIR request - Proposed site at Dunbeg

Hi Catherine

I've checked to see what Private Water Supplies we have within a 1km radius of your location. On the basis of the information that we hold I can only identify 1 spring which would be just on the periphery of the 1km zone. It serves 6 properties, 58,66,84,86,92 &93 Ringsend Road Limavady. With regard to 84 Ringsend Road it is used in a commercial premises attached to the domestic property. Whilst I do not have the exact coordinates of the spring it is in the vicinity of 55.055046,-6.864975.

There would be a few springs/wells in the vicinity of Gortgarn Road/Broad Road but they would be beyond the 1km radius and as far as we are aware they are not currently used as Private Water Supplies. Mains water would be available.

I trust that this information is of use. If you require any clarification please give me a ring,

Regards

Joanne

Joanne O'Kane
Environmental Health Officer | Environmental Services
7 Connell Street, Limavady, BT49 0HA
Tel: 028 77760302
Fax: 028 77767298
Joanne.OKane@causewaycoastandglens.gov.uk

Causeway Coast & Glens Borough Council
www.causewaycoastandglens.gov.uk

Catherine McQuillan

From:	Chris Burns <Chris.Burns@midandeastantrim.gov.uk> on behalf of Shared Environmental Services <sharedenvironmentalservice@midandeastantrim.gov.uk>
Sent:	16 May 2017 15:51
To:	Catherine McQuillan
Cc:	Fiona Henry
Subject:	RE: Consultation - Proposed Site at Dunbeg, Co. Londonderry

Dear Catherine,

A planning application for the proposal will be subject to a Habitat Regulations Assessment (HRA) to be completed by Shared Environmental Service (SES) on behalf of Causeway Coast and Glens Borough Council Planning. This assessment will be to determine if there could be any significant effects on the conservation objectives/features and hence integrity of any European Sites that could be a material issue for planning approval.

As such SES would advise that the following Northern Ireland European Sites are potentially connected by a hydrological route and therefore may have the potential to be affected by this proposal:

River Roe and Tributaries SAC and Lough Foyle SPA/Ramsar

https://www.daera-ni.gov.uk/publications/reasons-designation-special-area-conservation-river-roe-and-tributaries

https://www.daera-ni.gov.uk/publications/lough-foyle-special-protection-area

https://www.daera-ni.gov.uk/articles/lough-foyle-ramsar-site

The applicant as part of the application process for the proposal will be required to provide for assessment the following information supported by detailed scientific reasoning.

Evidence that no significant environmental pathway that could cause adverse effects on site integrity exists between the proposal and the identified European Sites or any other European Site that the applicant may subsequently identify.

If a significant pathway or pathways to a European Site are identified, the applicant should supply detailed information of the mitigation, if any, that will be put in place during the development/construction of the proposal that will negate potential adverse effects on the integrity of those European Sites.

The applicant will also need to include in these assessments detailed information relating to the operational lifetime of the varied parts of the development that make up the proposal that could potentially cause adverse effects on the integrity of any European Sites.

Best regards

Chris Burns

Chris Burns
Shared Environmental Service
County Hall, 182 Galgorm Road
Ballymena, BT42 1QF
T: 028 25633251
M: 07890 886550
E: chris.burns@midandeastantrim.gov.uk

From: Catherine McQuillan [mailto:Catherine.McQuillan@mccloyconsulting.com]
Sent: 16 May 2017 13:58
To: Shared Environmental Services <sharedenvironmentalservice@midandeastantrim.gov.uk>
Subject: FW: Consultation - Proposed Site at Dunbeg, Co. Londonderry

DAERA

Rivers Agency

Inland Fisheries

Fisheries Inspectorate

NIEA: Natural Environment Division

NIEA: Water Management Unit

NIEA: Drinking Water Inspectorate

NIEA: Land and Groundwater Team

Western Region Coleraine Area

37 Castleroe Road
Coleraine
Co.Londonderry
BT51 3RL

Tel: 028 703 42357

Our reference:IN1-16-4904

18 July 2016

Catherine McQuillan
McCloy Consulting
52 Mallusk Enterprise Park
Mallusk Drive
NEWTOWNABBEY
BT36 4GN

Dear Catherine

DRAINAGE ORDER (NORTHERN IRELAND) 1973 - ADVISORY - FLOODING / WATERCOURSE INFORMATION REQUEST ON LANDS AT DUNBEG, LIMAVADY.

Thank you for your correspondence dated 04 July 2016. Rivers Agency comments are as follows;

The lands as outlined in red on your enclosed location plan are not affected by any watercourses that are designated under the terms of the Drainage (Northern Ireland) Order 1973. However, Rivers Agency records would suggest that are several undesignated watercourses within these lands (see copy map enclosed). Rivers Agency does not obtain a database of undesignated watercourses which may be present at this location. In this regard, you are advised to consult with Ordnance Survey and/or undertake site inspections etc.

Rivers Agency has no records of flooding at this locus. However, there may be localised flooding the Agency is unaware of. Flood Maps (NI) would indicate that part of the site lies within the 1 in 100 year fluvial floodplain and part of the site will be affected by surface water flooding (see attached map). Unfortunately, Rivers Agency does not have any Q100 flood levels available at this location. Historic and predicted 100 year floodplain extents can now be viewed on the Strategic Flood Map for Northern Ireland by accessing the Department for Infrastructure website at www.infrastructure-ni.gov.uk/articles/what-flood-maps-ni. These flood map layers have been developed using industry standard methodologies that have been applied consistently throughout the United Kingdom. The methodology involves the use of computers to combine a digital model of the ground surface with hydraulic models for all rivers with catchments greater than $3km^2$.

Under the terms of Schedule 6 of the Drainage (Northern Ireland) Order 1973 an application must be submitted to Rivers Agency for its consent on any proposal to carry out works which might affect a watercourse.

For all Schedule 6 applications Rivers Agency requires a completed application form and any accompanying information to be returned to this office before the application can be processed.

The Schedule 6 Application Form can be accessed:

- by logging onto www.infrastructure-ni.gov.uk/publications/schedule-6-application-consent-undertake-works-watercourse

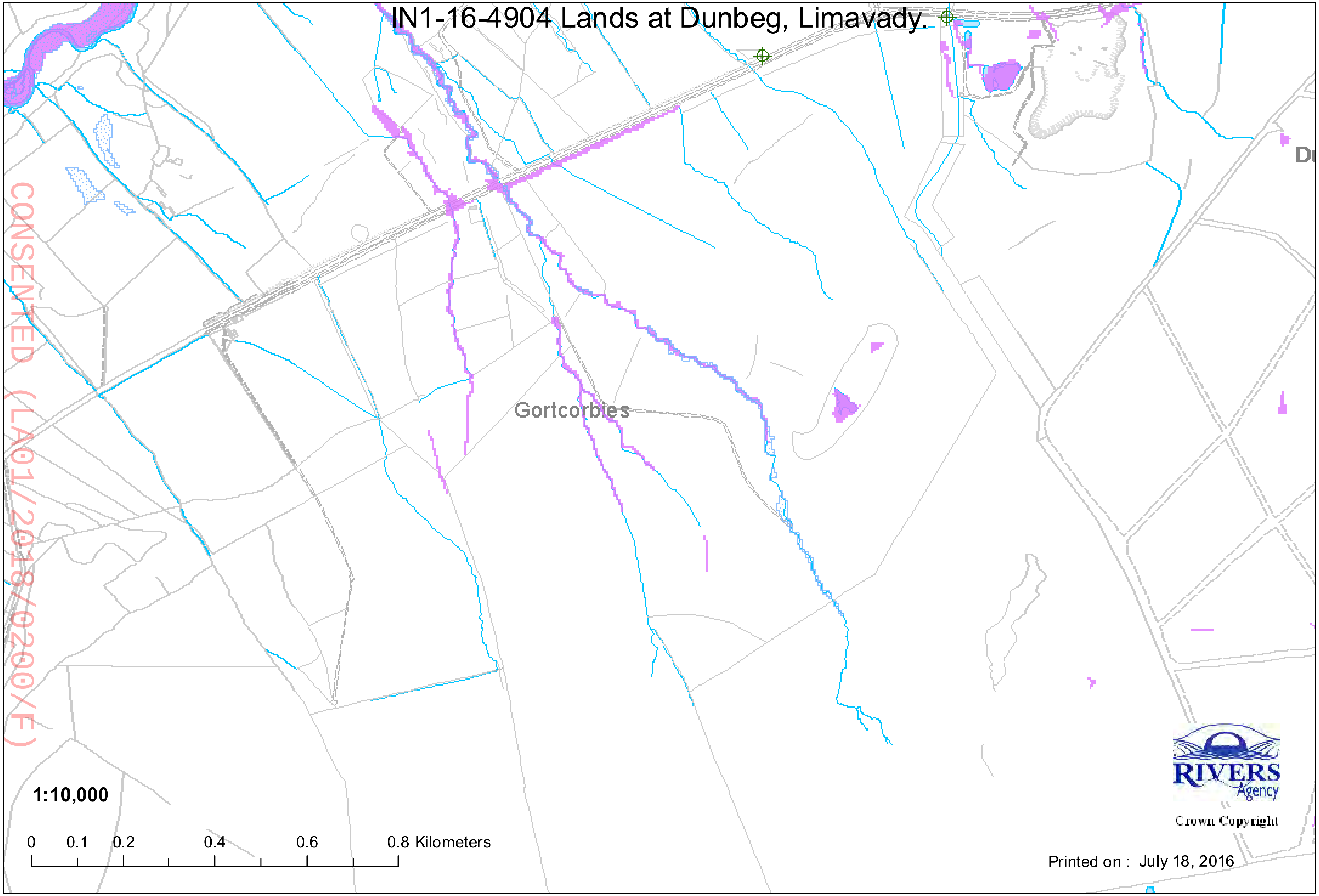
If you require any further information or clarification, please contact me at the above address.

Please quote the reference number above on any future correspondence.

Yours faithfully

Ian Lowe
Rivers Agency – Coleraine Area

IN1-16-4904 Lands at Dunbeg, Limavady.



Catherine McQuillan

Subject: FW: Dunbeg Wind Farm
Attachments: FW: MCL115-77 Dunbeg Wind Farm: Request for Consultee Response

---

From: Hayes, Jim [mailto:Jim.Hayes@daera-ni.gov.uk]
Sent: 10 August 2016 16:55
To: Catherine McQuillan < >
Subject: Dunbeg Wind Farm

Dear Catherine

The location of the proposed development is noted. The site lies within the Loughs Agency area of jurisdiction and consequently said agency should be consulted regarding fisheries interests in the vicinity of the proposal.

Regards,

J Hayes

Inland Fisheries
Department of Agriculture, Environment and Rural Affairs
Causeway Exchange
1-7 Bedford Street
Belfast, BT2 7EG
Tel: 028 9051 5109 (ext: 75109)
Mob: 07711 534 283
Web: www.daera-ni.gov.uk

Catherine McQuillan

Subject: FW: Proposed Dunbeg Wind Farm

From: Ferguson, Paul [mailto:Paul.Ferguson@daera-ni.gov.uk]
Sent: 10 August 2016 13:59
To: Catherine McQuillan <Catherine.McQuillan@mccloyconsulting.com>
Cc: Frew, Clare <Clare.Frew@daera-ni.gov.uk>; McGuigan, John (DAERA) <John.McGuigan@daera-ni.gov.uk>
Subject: Proposed Dunbeg Wind Farm

Hi Catherine,

I have forwarded your e-mail to DCAL for their attention. We have looked at this proposal from a sea fisheries/aquaculture aspect and as we have no aquaculture sites in the area we have no issues or concerns, but we would like to remind the applicant that:

> It is an offence under Article 47 of the Fisheries Act (NI) 1966 to cause pollution which is subsequently shown to have a deleterious effect on fish stocks.

Regards
Paul Ferguson
DAERA
Fisheries Inspectorate
02844618064

Catherine McQuillan

Subject: FW: MCL115-79 Dunbeg - request for infomation from Natural Heritage Consultee Response

From: Hempsey, Claire [mailto:Claire.Hempsey@daera-ni.gov.uk]
Sent: 26 September 2016 15:44
To: Catherine McQuillan <Catherine.McQuillan@mccloyconsulting.com>
Cc: DAERA Planning Response Team <PlanningResponse.Team@daera-ni.gov.uk>
Subject: FW: MCL115-79 Dunbeg - request for infomation from Natural Heritage Consultee Response

Dear Catherine,

In relation to your queries,

The data on the website is currently accurate and there are no candidate Natural Heritage European sites in this area.
Although the SAC is not located within the site, Salmon spawning may occur within the site which should also be considered.
There is peatland within the site which should be considered.

Loughs Agency should also be consulted in this case for information as they cover this region.

Claire Hempsey
Countryside, Coast and Landscapes
NIEA, Natural Environment Division
DAERA

From: Catherine McQuillan [mailto:Catherine.McQuillan@mccloyconsulting.com]
Sent: 19 August 2016 12:08
To: DAERA Corporate Communications
Cc: DAERA NIEA Plan
Subject: FW: MCL115-79 Dunbeg - request for infomation from Natural Heritage Consultee Response

MCL115-79 Dunbeg site.
FAO NIEA Natural Heritage

McCloy Consulting has been commissioned to undertake a geology and Hydrology assessment as part of an Environmental Impact Statement (to be incorporated in a future planning application) at the above.
The site centroid is at **IGR 273957, 425262**;

We would be grateful if NIEA Natural Heritage as a statutory consultee confirm that the GIS datasets available on the NIEA website are the most current information available for designated areas including ASSI, SAC, SPA, and provide any further information relating to candidate sites in the site vicinity where applicable;

- Advise of any watercourse fishery designations in the vicinity of the site (i.e. salmonid);
- Advise any further considerations that are deemed appropriate for a hydrological assessment at the site from your perspective.

A separate request has been sent to NIEA Water Management Unit and DCAL Fisheries etc for their comment.

We would be grateful if you could acknowledge receipt of this request and provide an indicative timescale for the issue of a response. If you have any queries regarding this request please do not hesitate to contact me.

Kind regards
Catherine

Catherine McQuillan
Senior Project Consultant

McCloy Consulting
Water Engineering Solutions

52 Mallusk Enterprise Park
Mallusk Drive, Newtownabbey
BT36 4GN
T: +44 (0) 28 9084 8694
F: +44 (0) 28 9084 1525
W: www.mccloyconsulting.com

Catherine McQuillan

Subject: FW: Consultation - Proposed Site at Dunbeg, Co. Londonderry PWS525
Attachments: MCL115-77 Proposed Site at Dunbeg - Consultation Request.pdf; shape files.zip

From: Derby, Martin [mailto:Martin.Derby@daera-ni.gov.uk]
Sent: 11 July 2016 11:16
To: Catherine McQuillan <Catherine.McQuillan@mccloyconsulting.com>
Subject: FW: Consultation - Proposed Site at Dunbeg, Co. Londonderry PWS525

Hello Catherine,

Site at Dunbeg, Londonderry

The Drinking Water Inspectorate only holds information on private water supplies registered with the Inspectorate under The Private Water Supplies Regulations (Northern Ireland) 2009 and has provided this below.

There is one private drinking water supply registered with the Inspectorate within 5km of the outlined site.

Site ID	Grid reference
CG009J	277937/427518

There are two dairy farms using private water supplies within 5km of the outlined site.

Site ID	Grid reference
464	269708/423221

Site ID	Grid reference
658	272876/420643

Please note the information provided in this e-mail is accurate in accordance with our latest records only. In particular, the information the Inspectorate holds on dairy farms may not be up to date. If you require more up to date information on the latter, you should contact the Quality Assurance Branch at the Department of Agriculture, Environment and Rural Affairs at Dundonald House, Upper Newtownards Road, Belfast. Tel. (028) 90 525001.

It is important that you note that the Drinking Water Inspectorate does not hold information on private water supplies which supply single dwellings. Details on these may be obtained from the Environmental Health Department of the local council.

You may also wish to contact Northern Ireland Water for information on any Northern Ireland Water sites in the area - Tel. 03457 440088 or Email: waterline@cs.niwater.com .

NIEA Water Management Unit can be contacted regarding other information that you may require: waterinfo@daera-ni.gov.uk.

You should also undertake your own scoping exercise of premises in the vicinity of the development as there may be private water supplies for which records are not held by the above agencies. This should include a survey of the surrounding properties to determine if they have a private water supply. This scoping exercise should include a desk study of relevant OS maps or other relevant information. If it has been assessed, in undertaking this assessment, that private drinking water supplies could be impacted upon by the development then the applicant should propose appropriate steps to mitigate against either a deterioration of drinking water quality or sufficiency of supply. This should include appropriate monitoring and sampling of the supply, if deemed appropriate. Details of any assessment of private water supplies should be made available to the DWI.

The Inspectorate is not in a position to comment on what other information may be relevant to a hydrology assessment.

Regards,

Martin

Martin Derby
Drinking Water Inspectorate
Northern Ireland Environment Agency
Klondyke Building
Cromac Avenue
Gasworks Business Park
Lower Ormeau Road
Belfast
BT7 2JA

From: Catherine McQuillan [mailto:Catherine.McQuillan@mccloyconsulting.com]
Sent: 04 July 2016 16:18
To: DWI
Subject: Consultation - Proposed Site at Dunbeg, Co. Londonderry

MCL 115-77 Hydrology, Geology & Hydrogeology Assessment
Proposed Site at Dunbeg, Co. Derry

FAO NIEA DWI

McCloy Consulting has been commissioned to undertake a Geology & Water Environment assessment as part of an Environmental Statement for a proposed development at Dunbeg, east of Limavady Co, Derry. As part of this assessment McCloy Consulting will assess the baseline hydrological conditions and review impact on water abstractions in the area.

We would be grateful if DWI could provide the following:

- Surface Water abstraction sites within the downstream catchment of the site;
- Groundwater abstractions within 5 km of the proposed site;

- Advise any further considerations that are deemed appropriate for a hydrological, hydrogeological or geological assessment at the site from your perspective.

A separate request has been sent to NIEA WMU and local council environmental health sections requesting supplementary data they may hold.

The site location and downstream catchment is as shown on the attached map and the **site centroid is at IGR 273957, 425262**; I have also attached shape files of the 5km radius.

We would be grateful if you could acknowledge receipt of this request and provide an indicative timescale for the issue of a response.

If you have any queries regarding this request please do not hesitate to contact me.

Kind Regards

Kind regards
Catherine

Catherine McQuillan
Senior Project Consultant

McCloy Consulting
Water Engineering Solutions

52 Mallusk Enterprise Park
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W: www.mccloyconsulting.com

ice award 2016 winner
ICE London Civil Engineering Awards

Catherine McQuillan

From: DAERA NIEA Water Info <WaterInfo@daera-ni.gov.uk>
Sent: 07 July 2017 08:35
To: Catherine McQuillan
Subject: NIEA - WMU - WQU10837 - WMU Response
Attachments: NIEA - WMU - WQU10837 - Surface Water Quality - Response - Classification.XLSX; NIEA - WMU - WQU10837 - Surface Water Quality - Response.DOCX; NIEA - WMU - WQU10837 - Response Letter.DOCX

Dear Catherine,

Our Ref: WQU10837

Your Ref: MCL115-77

Re: Site at Dunbeg, Co Londonderry

Please see attached Water Management Unit's response to your information request regarding the site detailed above.

If you require any further water related environmental information about this or any other site please e-mail details of your information request to WaterInfo@daera-ni.gov.uk

Many thanks

Information Management
Water Management Unit
Department of
Agriculture, Environment and Rural Affairs
www.daera-ni.gov.uk

River Waterbody Number	Monitoring Station	Monitoring Station Location	Irish Grid Reference	2009 Station Classification	Classify by site(s) or by other water body	2009 River Waterbody Classification	2010 Station Classification	Classify by site(s) or by other water body	2010 River Waterbody Classification	2011 Station Classification	Classify by site(s) or by other water body	2011 River Waterbody Classification
GBNI1NB030301221	F10416	ARTICLAVE RIVER AT ARDINA BRIDGE	C789349	POOR	Classify	POOR	MODERATE	Classify	MODERATE	MODERATE	Classify	MODERATE
GBNI1NB030301224	F10898	METTICAN RIVER AT METTICAN BRIDGE	C844171	MODERATE	Classify	MODERATE	MODERATE	Classify	MODERATE	GOOD	Classify	GOOD
GBNI1NW020203027	F10183	BURNFOOT RIVER AT RUSH HALL	C646241	MODERATE	Classify	MODERATE	MODERATE	Classify	MODERATE	MODERATE	Classify	MODERATE
GBNI1NW020202011	F10912	CASTLE RIVER AT CASTLE BRIDGE	C682240	GOOD	Classify	MODERATE	HIGH	Classify	MODERATE	HIGH	Classify	MODERATE
GBNI1NW020202011	F10176	CASTLE RIVER AT DRUMMOND BRIDGE	C688232	MODERATE	Classify using F10176 upstream	MODERATE	MODERATE	Classify biol using F10176 upstream	MODERATE	MODERATE	ogy using F10165 and F10176 bo	MODERATE
GBNI1NW020202011	F10165									MODERATE	ogy using F10165 and F10176 bo	MODERATE
GBNI1NW020202044	F10165	CASTLE RIVER TRIBUTARY AT DRENAGH	C691232	POOR	Classify	POOR	MODERATE	Classify	MODERATE	MODERATE	Classify	MODERATE
GBNI1NW020202045	F10176	CASTLE RIVER AT DRUMMOND BRIDGE	C688232	MODERATE	Classify	MODERATE	MODERATE	Classify	MODERATE	MODERATE	Classify	MODERATE
GBNI1NW020202012	F10160	GELVIN RIVER AT LOWER GELVIN BRIDGE	C692139	GOOD	Classify	GOOD	GOOD	Classify	GOOD	GOOD	Classify	GOOD
GBNI1NW020202013	F10177	CURLY RIVER AT ARTIKELLY BRIDGE	C684246	GOOD	Average with others	MODERATE	GOOD	Average with others	MODERATE	GOOD	Average with others	MODERATE
GBNI1NW020202013	F10912	CASTLE RIVER AT CASTLE BRIDGE	C682240	GOOD	Average with others	MODERATE	HIGH	Average with others	MODERATE	HIGH	Average with others	MODERATE
GBNI1NW020202013	F10176	CASTLE RIVER AT DRUMMOND BRIDGE	C688232	MODERATE	Average with others	MODERATE	MODERATE	Average with others	MODERATE	MODERATE	Average with others	MODERATE
GBNI1NW020202013	F10165	CASTLE RIVER TRIBUTARY AT DRENAGH	C691232	POOR	Average with others	MODERATE	MODERATE	Average with others	MODERATE	MODERATE	Average with others	MODERATE
GBNI1NW020202049	F10177	CURLY RIVER AT ARTIKELLY BRIDGE	C684246	GOOD	Average with F10166	GOOD	GOOD	Average with F10166	GOOD	GOOD	Classify	GOOD
GBNI1NW020202049	F10166	CURLY RIVER AT GALLOWS KNOWE	C735268	HIGH	Average with F10177	GOOD	GOOD	Average with F10177	GOOD			GOOD
GBNI1NW020202018	F10172	ROE RIVER AT DOG LEAP	C679203	GOOD	Average with others	MODERATE	GOOD	Average with others	MODERATE	GOOD	Average with F10171	MODERATE
GBNI1NW020202018	F10174	ROE RIVER AT DUNGIVEN BRIDGE	C685095	GOOD	Average with others	MODERATE	GOOD	Average with others	MODERATE			MODERATE
GBNI1NW020202018	F10171	ROE RIVER AT LIMAVADY	C668229	MODERATE	Average with others	MODERATE	MODERATE	Average with others	MODERATE	MODERATE	Average with F10172	MODERATE
GBNI1NW020202024	F10170	ROE RIVER AT ROE BRIDGE	C670296	GOOD	Average with F10171	MODERATE	GOOD	Average with F10171	MODERATE	GOOD	Average with F10171	MODERATE
GBNI1NW020202024	F10171	ROE RIVER AT LIMAVADY	C668229	MODERATE	Average with F10170	MODERATE	MODERATE	Average with F10170	MODERATE	MODERATE	Average with F10170	MODERATE
GBNI1NW020202039	F10160	GELVIN RIVER AT LOWER GELVIN BRIDGE	C692139	GOOD	Classify using F10160 downstream	GOOD	GOOD	Classify using F10160 downstream	GOOD	GOOD	Classify using F10160 downstream	GOOD

NOTE

GBNI1NB030301074, GBNI1NB030301077 and GBNI1NB030301225 MERGED to GBNI1NB030308220

GBNI1NW020203027 Burnfoot River is renamed Bessbrook (Foyle) River

GBNI1NW020202011, GBNI1NW020202045 and GBNI1NW020202044 MERGED to GBNI1NW020204061

GBNI1NW020202013 and GBNI1NW020202049 MERGED to GBNI1NW020204060

River Waterbody Number	Monitoring Station	Monitoring Station Location	Irish Grid Reference	2012 Station Classification	Classify by site(s) or by other water body	2012 River Waterbody Classification	2013 Station Classification	Classify by site(s) or by other water body	2013 River Waterbody Classification	2014 Station Classification	Classify by site(s) or by other water body	2014 River Waterbody Classification
GBNI1NB030301221	F10416	ARTICLAVE RIVER AT ARDINA BRIDGE	C789349	MODERATE	Classify	MODERATE	MODERATE	Classify	MODERATE	MODERATE	Classify	MODERATE
GBNI1NB030301224	F10898	METTICAN RIVER AT METTICAN BRIDGE	C844171	GOOD	Classify	GOOD	MODERATE	Classify	MODERATE	MODERATE	Classify	MODERATE
GBNI1NW020203027	F10183	BURNFOOT RIVER AT RUSH HALL	C646241	MODERATE	Classify	MODERATE	MODERATE	Classify	MODERATE	MODERATE	Classify	MODERATE
GBNI1NW020202011	F10912	CASTLE RIVER AT CASTLE BRIDGE	C682240	HIGH	Classify	MODERATE	HIGH	Classify	MODERATE	MODERATE	Classify	MODERATE
GBNI1NW020202011	F10176	CASTLE RIVER AT DRUMMOND BRIDGE	C688232	MODERATE	iology using F10165 and F10176 both	MODERATE	MODERATE	logy using F10165 and F10176 bot	MODERATE	MODERATE	otherwise - av biol using F10165	MODERATE
GBNI1NW020202011	F10165			GOOD	iology using F10165 and F10176 both	MODERATE	MODERATE	logy using F10165 and F10176 bot	MODERATE	MODERATE	otherwise - av biol using F10165	MODERATE
GBNI1NW020202044	F10165	CASTLE RIVER TRIBUTARY AT DRENAGH	C691232	GOOD	Classify	GOOD	MODERATE	Classify	MODERATE	MODERATE	Classify	MODERATE
GBNI1NW020202045	F10176	CASTLE RIVER AT DRUMMOND BRIDGE	C688232	MODERATE	Classify	MODERATE	MODERATE	Classify	MODERATE	MODERATE	Classify	MODERATE
GBNI1NW020202012	F10160	GELVIN RIVER AT LOWER GELVIN BRIDGE	C692139	GOOD	Classify	GOOD	MODERATE	Classify	MODERATE	MODERATE	Classify	MODERATE
GBNI1NW020202013	F10177	CURLY RIVER AT ARTIKELLY BRIDGE	C684246	GOOD	Average with others	GOOD	MODERATE	Average with others	MODERATE	MODERATE	Average with others	MODERATE
GBNI1NW020202013	F10912	CASTLE RIVER AT CASTLE BRIDGE	C682240	HIGH	Average with others	GOOD	HIGH	Average with others	MODERATE	MODERATE	Average with others	MODERATE
GBNI1NW020202013	F10176	CASTLE RIVER AT DRUMMOND BRIDGE	C688232	MODERATE	Average with others	GOOD	MODERATE	Average with others	MODERATE	MODERATE	Average with others	MODERATE
GBNI1NW020202013	F10165	CASTLE RIVER TRIBUTARY AT DRENAGH	C691232	GOOD	Average with others	GOOD	MODERATE	Average with others	MODERATE	MODERATE	Average with others	MODERATE
GBNI1NW020202049	F10177	CURLY RIVER AT ARTIKELLY BRIDGE	C684246	GOOD	Classify	GOOD	MODERATE	Classify	MODERATE	MODERATE	Classify	MODERATE
GBNI1NW020202049	F10166	CURLY RIVER AT GALLOWS KNOWE	C735268			GOOD			MODERATE			MODERATE
GBNI1NW020202018	F10172	ROE RIVER AT DOG LEAP	C679203	GOOD	Average with F10171	MODERATE	GOOD	Average with F10171	GOOD	GOOD	Average with F10171	GOOD
GBNI1NW020202018	F10174	ROE RIVER AT DUNGIVEN BRIDGE	C685095			MODERATE			GOOD			GOOD
GBNI1NW020202018	F10171	ROE RIVER AT LIMAVADY	C668229	MODERATE	Average with F10172	MODERATE	MODERATE	Average with F10172	GOOD	MODERATE	Average with F10172	GOOD
GBNI1NW020202024	F10170	ROE RIVER AT ROE BRIDGE	C670296	GOOD	Average with F10171	MODERATE	GOOD	Average with F10171	MODERATE	GOOD	Average with F10171	MODERATE
GBNI1NW020202024	F10171	ROE RIVER AT LIMAVADY	C668229	MODERATE	Average with F10170	MODERATE	MODERATE	Average with F10170	MODERATE	MODERATE	Average with F10170	MODERATE
GBNI1NW020202039	F10160	GELVIN RIVER AT LOWER GELVIN BRIDGE	C692139	GOOD	Classify using F10160 downstream	GOOD	MODERATE	Classify using F10160 downstream	MODERATE	MODERATE	Classify using F10160 downstream	MODERATE

Water Management Unit
17 Antrim Road
Tonagh
Lisburn
BT28 3AL
Tel: 028 9262 3004

Catherine McQuillan
McCloy Consulting
52 Mallusk Enterprise Park
Mallusk Drive
Newtownabbey
BT36 4GN

Our Ref: WQU10315

Your Ref: MCL115-77

Date: 25 July 2016

Dear Catherine,

Re: Site at Dunbeg, Co Londonderry, Grid reference C 7395 2526

Thank you for your email sent on 5 July 2016 relating to an area within a various radius of the site detailed above.

WMU hold the following information relating to Water which may be of use when carrying out your assessment:-

Surface Freshwater Quality

Please see attached - **NIEA – WMU – WQU10315 – Water Quality – Response**

Please note that under the EC Freshwater Fish Directive (repealed December 2013) the Curly River was designated as Salmonid.

Groundwater/Hydrogeology

Regional information on groundwater aquifer classification and/or groundwater vulnerability is now available directly from the Geoindex on the British Geological Survey (BGS) website: http://mapapps2.bgs.ac.uk/GSNI_Geoindex/home.html. **Please see attached Groundwater Guidance Note**.
(Important: Please change the current theme on the top right-hand side to "hydrogeology". Click on the "+" sign in front of the layer name for a legend. For supporting information and background on the layer being queried and to note limitations on its use, click on the layer name.)

A search of the Groundwater Monitoring Database has found that there were 4 groundwater monitoring points within the requested 5 km radius search area.

Please see attached - **NIEA – WMU – WQU10315 – Groundwater Quality – Data**

Abstractions

There are 4 current abstraction licence applications within the specified search area of this site. These are detailed below.

AIL Ref No.	Company Name	IGR	Source
AIL\2007\0152	Whitemountain Quarries Ltd	C7783824591	Groundwater
AIL\2008\0221	Alcorn	C7288320648	Groundwater
AIL\2010\0026	Hydro Power	C7456022040	Surface Water
AIL\2010\0041	Hydro Power	C7838626946	Surface Water

There are public water supply abstractions within this area. However we are unable to put information on these into the public domain. The applicant may come in person to inspect the information on these.

Note this information relates to abstraction licence applications where:

(i) An application for an abstraction licence may have been received by the Department and the information contained within it has been determined to be complete, but a licence may not have been issued.

(ii) An application for an abstraction licence may have been authorised by the Department (i.e. as an existing activity where an application for an abstraction licence was received before 1 February 2008), or

(iii) An abstraction licence may have been issued by the Department.

The information provided was generated from the Abstraction & Impoundment Licensing Database at the time this query was created, and is subject to change.

For information on private water supplies in this area, please contact the Drinking Water Inspectorate: dwi@daera-ni.gov.uk.

Pollution Incidents

Please see attached - **NIEA – WMU – WQU10315 – Pollution Incidents – Response**

NIW Ltd. Discharges

NIWL operational assets within 5km of the supplied grid ref:

Name	Type	Asset Grid Ref	Discharge Grid Ref
Ballyavelin Road ST	Septic Tank	273464-422090	273449-422103
Bolea WwTW	WwTW	271278-425617	271290-425617

Consented Industrial Discharges

Please see attached - **NIEA – WMU – WQU10315 – Industrial Consents – Response.xls**

Consented Agricultural Discharges

There are waste sheep dip groundwater authorisations at each of the sites listed below which are within the 5km search radius:

APPREFNO	GEOAREA	GRIDREF
GR993/99	28725.19	C 70139 27124
GR41/02	17890.11	C 69367 26945
GR5/02	19797.16	C 69075 25562
GR48/01	7174.91	C 71523 27330
GR1058/99	49557.82	C 71215 26520
GR100/03	13875.85	C 73482 20652
GR107/03	79551.04	C 72736 25657
GR120/03	54821.81	C 71773 23570
GR771/99	495430.66	C 75589 30255
GR637/99	21000.87	C 69462 25570
GR637/99	199095.14	C 69132 26060
GR481/99	83881.37	C 71095 28373
GR264/99	20295.01	C 69154 25354
GR196/99	32457.54	C 71252 26262
GR1011/99	64490.23	C 73807 22143
GR214/03	7720.48	C 73711 22976
GR681/99	40505.52	C 71141 26577
GR36/06	10840.94	C 72395 25087

If you require any further water related environmental information about this or any other site please email details of your information request to WaterInfo@daera-ni.gov.uk

Yours sincerely,

Information Management
Water Management Unit

StationCode	FileRef	CompanyName	Address1	Address2	Town	Postcode	GridRef	Easting	Northing	IndustryDescription	DateOpened	ConsentNumber
61206	TC121/00_1	John Gray & Sons	111 Broad Road	Limavady	Co Londonderry	BT49 0QP	C7184024650	271840	424650	Site Drainage : Unspecified	20/02/2001	10/01
67377	NC408/13_1		151 Bolea Road	Limavady			C7380027160			Private sewage: domestic	13/09/2013 09:40	11269/13/1
68934	NC814/14_1		151 Bolea Road		Limavady	Bt49 0QU	C7378027170			Private sewage: domestic	30/07/2014 11:16	962/14/1
72179	TC139/15_1		121 Broad Road		Limavady	BT49 0QP	C7220024320			Site Drainage : Unspecified	01/02/2016 10:51	111/16/1

WQU 10315 Time Taken 30 mins

POLLUTIION INCIDENTS

IncidentNu	Investigat	Incident Severity	Source	Category
WR 1/12/0079	24/05/2012	Low	Domestic	Sewage
WR 1/13/0136	24/09/2013	Low	Industry	Sewage
WR 1/13/0174	13/12/2013	Low	Industry	Suspended Solids
WR 1/14/0054	19/05/2014	Low	Domestic	Sewage
WR 1/14/0154	27/11/2014	Low	Farm	Agriculture
WR 1/14/0153	27/11/2014	Low	Domestic	Sewage
WR 1/15/0002	08/01/2015	Low	Other	Suspended Solids
WR 1/15/0025	10/02/2015	Low	Farm	Agriculture
WR 2/15/0073	23/06/2015	Low	Domestic	Sewage
WR 1/15/0084	24/06/2015	Low	Domestic	Sewage

Catherine McQuillan

Subject: FW: NIEA - WMU - WQU10315 - WMU Response
Attachments: NIEA - WMU - WQU10315 - Pollution Incidents - Response.XLSX; NIEA - WMU - WQU10315 - Groundwater Quality - Data.XLSX; NIEA - WMU - WQU10315 - Industrial Consents - Response.XLSX; NIEA - WMU - WQU10315 - Response Letter.DOCX; NIEA - WMU - WQU10315 - Water Quality - Response.DOCX; NIEA - WMU - WQU10315 - Water Quality - Response - Classification.XLSX; Groundwater Guidance Note May 2011.pdf

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From: McCarney, Una [mailto:Una.McCarney@daera-ni.gov.uk]
Sent: 25 July 2016 11:14
To: Catherine McQuillan <Catherine.McQuillan@mccloyconsulting.com>
Subject: FW: NIEA - WMU - WQU10315 - WMU Response

Catherine,

I should also have said that I can confirm the status of the Curley River is currently 'Good'.

Many thanks

Una

9262 3004 (30004)

From: NIEA Water Info
Sent: 25 July 2016 11:10
To: 'Catherine McQuillan'
Subject: NIEA - WMU - WQU10315 - WMU Response

Dear Catherine,

Our Ref: WQU10315

Your Ref: MCL 115-77

Re: Site at Dunbeg, Co Londonderry

Please see attached Water Management Unit's response to your information request regarding the site detailed above.

If you require any further water related environmental information about this or any other site please e-mail details of your information request to WaterInfo@daera-ni.gov.uk

Many thanks

Loughs Agency

Catherine McQuillan

Subject: FW: MCL115-77 Dunbeg: Request for Consultee Response

From: Declan Lawlor [mailto:Declan.Lawlor@loughs-agency.org]
Sent: 11 January 2017 13:47
To: Catherine McQuillan <Catherine.McQuillan@mccloyconsulting.com>
Subject: MCL115-77 Dunbeg: Request for Consultee Response

Hi Catherine

In considering the proposed location at Dunbeg and the concerns of fisheries, I would take this opportunity to advise you on the potential impact that wind farm developments can have on water courses,
water quality and migratory and other fish species. Such impacts could include:

- Obstruction to upstream and downstream migration both during and after construction
- Disturbance of spawning beds during construction – timing of works is critical
- Increases in silt and sediment loads resulting from construction works (including tracks and turbine foundations).
- Point source pollution incidents during construction.
- Drainage issues

The Agency is aware of some wind farm schemes in upland areas where coffer dams have been used to create drainage plugs after wind farms have been completed. This situation is to be avoided.

The Loughs Agency would advise the applicant that it is an offence to remove or disturb any material, including sand or gravel from the bed of any freshwater river within the Foyle and Carlingford Areas
without the consent of the Loughs Agency contrary to Section 46 of the Foyle Fisheries Act (NI) 1952, as amended by Article 18(3) of the Foyle and Carlingford Fisheries (NI) Order 2007. The applicant may
apply to the Loughs Agency for consent prior to the construction of any culverts associated with this proposal.

Fish surveys undertaken by the Loughs Agency indicate the presence of both salmon and trout in the Curley River which borders the site to the south west. In this regard, the Agency would be concerned about this development, particularly the construction and future decommissioning phases and the associated potential for increased sediment loading of watercourses.

I hope you find this information helpful.

Many thanks

Declan

Dr Declan Lawlor, CEnv,MCIEEM, MIFM, MIEnvSc,
Environmental Officer

Catherine McQuillan

Subject: FW: MCL115-77 Dunbeg: Request for Consultee Response
Attachments: MCL115-77 Proposed Site at Dunbeg rev2 - Consultation Request.pdf

From: Catherine McQuillan
Sent: 16 August 2016 20:21
To: general@loughs-agency.org
Subject: MCL115-77 Dunbeg: Request for Consultee Response

MCL115-77
Dunbeg ES

McCloy Consulting has been commissioned to undertake a Geology, Hydrology & Hydrogeology assessment as part of an Environmental Statement for the attached proposed site at Dunbeg, County Londonderry.

In order to undertake the assessment could you please provide the following:

- Any comment with regard to matters relating to the conservation and protection of surface water, ground water, and water quality in the Curley River and other water courses in the vicinity of the site.
- Any other information you may feel is relevant to a hydrology, hydrogeology or geology assessment at the site and within the remit of Loughs Agency

The site location is as shown on the attached map. The site centroid is at IGR **IGR 273957, 425262**;

We would be grateful if you could acknowledge receipt of this request and provide an indicative timescale for the issue of a response.

If you have any queries regarding this request please do not hesitate to contact me.

Thank you for your help.

Kind regards
Catherine

Catherine McQuillan
Senior Project Consultant

McCloy Consulting
Water Engineering Solutions
52 Mallusk Enterprise Park
Mallusk Drive, Newtownabbey
BT36 4GN
T: +44 (0) 28 9084 8694
F: +44 (0) 28 9084 1525
W: www.mccloyconsulting.com

ice award winner 2016
ICE London Civil Engineering Awards

Department for the Economy Northern Ireland

Geological Survey of Northern Ireland

Catherine McQuillan

Subject: FW: Re: Consultation - Proposed Site at Dunbeg, Co. Londonderry

From: Wilson, Paul (DETI)
Sent: 06 July 2016 13:25
To: DfE GSNI
Subject: RE: Re: Consultation - Proposed Site at Dunbeg, Co. Londonderry

Dear Catherine,

Thank you for your enquiry for details of any particular concerns or geohazards that would not be known based on current published GSNI mapping for a site centred on IGR 273095, 425262.

Hydrogeology
A review of the Northern Ireland Groundwater Data Repository has identified a number of boreholes and springs in close proximity to the site in question.

> Springs – Gortcorbies and Wellglass Springs are located 850 and 1500m to the north respectively of the site centroid. Both were formally used as a Northern Ireland Water abstraction points and provide a significant amount of baseflow in to the resulting streams and adjoining rivers. Wellglass spring is known to drain from the Ulster White Limestone whereas the pathway and source of the water draining from Gortcorbies is unknown. Wellglass Spring has been monitored by the NIEA for both quantity and quality for some years.
>
> Boreholes – There are a number of former Northern Ireland Water abstraction boreholes at Bolea and Gortgarn (1800 and 2200m to the west from the site centroid). The current status of these is unknown. These access water from the Sherwood Sandstone Group.
> Our records show that there are at least 8 private water supplies that rely upon groundwater within a 5km radius of the site. Some of these are registered with the Drinking Water Inspectorate (DWI) who should be contacted for further details on these. There are also a number of private boreholes that are used for domestic water supply purposes and are therefore not registered with the DWI. I would advise that an appropriate water features survey be carried out to identify boreholes that provide a water supply that may be at risk from the development.

Karst – The Ulster White Limestone (Chalk), outcrops beneath the basalt within the area of the site details you have supplied. This is known to be karstified and in other parts of the province has resulted in enclosed depression, sinks and springs. Our karst dataset does not contain any details of karst features within this area other than Wellglass Spring. However, there has been no targeted survey of this area to identify karst features. It is advised that such a survey should be carried out as part of your assessment of the potential geohazards. Experience from other sites has found that such features are not always confined to the mapped outcrop of the chalk since it dips beneath the basalt, therefore the extent of such a survey should take account of this.

Peat slide hazards:

Peat - A large proportion of the proposed site is composed of upland peat, covering high ground and moderate to steep slopes. Mapping of these areas by GSNI does not include estimates of peat depth. Peat depth may be in excess of 3 m. Cutting into peat is liable to result in dewatering and incipient peat failure. Depending on the nature of the development it may be necessary to include a Peat Slide Hazard Risk Assessment as part of your Environmental Statement, following the recommendations made by Scottish Nature (Scottish Nature, 2007).

Scottish Nature, **2006**, *Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Generation Developments*, Scottish Executive, Edinburgh, 72 pp.

Paul Wilson
Hydrogeologist
The Geological Survey of Northern Ireland
British Gelogical Survey
Dundonald House
Upper Newtownards Road
Belfast, BT4 3SB
Tel: 028 9052 0973 (ext: 20973)

Need a Borehole?

From: DfE GSNI
Sent: 06 July 2016 09:42
To: Wilson, Paul (DETI)
Subject: FW: Re: Consultation - Proposed Site at Dunbeg, Co. Londonderry

---

From: Catherine McQuillan [mailto:Catherine.McQuillan@mccloyconsulting.com]
Sent: 05 July 2016 08:54
To: DfE GSNI
Subject: FW: Re: Consultation - Proposed Site at Dunbeg, Co. Londonderry

MCL 115-75 Hydrology, Geology & Hydrogeology Assessment
Proposed Site at Dunbeg, Co. Derry

FAO GSNI

McCloy Consulting has been commissioned to undertake a Geology & Water Environment assessment as part of an Environmental Statement for a proposed development at Dunbeg, east of Limavady, Co, Derry. As part of this assessment we intend to determine baseline hydrologeological conditions / constraints and identify any particular geohazards.

We would be grateful if GSNI could assist in providing details of any particular concerns or geohazards that would not be known based on current published GSNI mapping.

The site location is as shown on the attached map and the **site centroid is at IGR 2730957, 425262**

We would be grateful if you could acknowledge receipt of this request and provide an indicative timescale for the issue of a response.

If you have any queries regarding this request please do not hesitate to contact me.

Kind regards
Catherine

Catherine McQuillan
Senior Project Consultant

McCloy Consulting
Water Engineering Solutions
52 Mallusk Enterprise Park
Mallusk Drive, Newtownabbey
BT36 4GN
T: +44 (0) 28 9084 8694
F: +44 (0) 28 9084 1525
W: www.mccloyconsulting.com

Northern Ireland Water

Catherine McQuillan

From: waterline <waterline@niwater.com>
Sent: 28 April 2017 16:14
To: Catherine McQuillan
Subject: Re: Screening Assessment of Water Receptors

Follow Up Flag: Follow up
Flag Status: Completed

Dear Ms McQuillan

CMS Ref: 9120417/42909

Re: Screening Assessment of Water Receptors

Thank you for your email dated 12 April 2017 regarding the above and whether they are still in use.

After liaising with our Water Supply Area Manager, I can confirm that the water intake locations are no longer in service and are not used in anyway by Northern Ireland Water.

I hope you find this helpful.

Yours Sincerely

VICTORIA MARKEY
Customer Service Centre

Should you need to contact us in the future, our contact details can be found on our website:

http://www.niwater.com/contact-us/

Catherine McQuillan

Subject: FW: Acitve NI intake - Dunbeg FW: NI Water - Acknowledgement

Importance: High

From: Catherine McQuillan
Sent: 17 August 2016 08:53
To: 'john.collins@niwater.com' <john.collins@niwater.com>
Cc: 'Leah.Tumilty@niwater.com' <Leah.Tumilty@niwater.com>; 'catherine.mcq@hotmail.co.uk' <catherine.mcq@hotmail.co.uk>
Subject: Acitve NI intake - Dunbeg FW: NI Water - Acknowledgement
Importance: High

Morning John, Leah

I submitted a request for an adjacent site on the site day through the same email account; though i have had an email receipt to say the request for information has been received i have not received an acknowledgment such as the below and i therefore resubmit.

I simply require confirmation if the below 5 NIW intakes are still active ? as the buffer zone will impact on my site in addition to it being down catchment.

WMU would not confirm if the intakes were active 'due to the nature of the abstractions', however the GSNI stated they were 'formally intakes' from springs .
I believe possible references are as below

Easting IGR	Northing IGR	Historical name	Possible NIW ref
272773	426817	Wellglass	W100006215
273280	426035	Gortcobies No. 2	
273244	426012	Gortcobies No. 1	W100006369

Are you able to confirm please? If there is a charge for this time can administration/accounts please contact me on the below and i can pay over the phone.
I believe McCloy emails are being blocked by NIW chosen virus protector therefore i have also sent this email from my personal account.

APPENDIX 9.3 - ABSTRACTION RECORDS

Local Council Consultation

Causeway Coast & Glens

Table 9.3.1: Private Water Supplies (PWS) Identified within 5km of the Site Centroid

CBC Reference	Location	Grid Reference Number	Type
N/A	58,66,84,86,92 &93 Ringsend Road Limavady	272840, 423276	PWS / Spring

Water Management Unit

Table 9.3.2: Current WMU Abstraction Licences Downstream of the Proposed Site

AIL Ref No.	Company Name	IGR	Source
AIL\2007\0152	Whitemountain Quarries Ltd	277836, 424591	Groundwater
AIL\2008\0221	Alcorn	272883, 420648	Groundwater
AIL\2010\0026	Hydro Power	274560, 422040	Surface Water
AIL\2010\0041	Hydro Power	278386, 426946	Surface Water

Drinking Water Inspectorate Consultation

Table 9.3.3: Information on PWS within 5km of the Site Centroid

Object ID	X	Y	Water Source
CG009J	277937	427518	Not Stated

Table 9.3.4: Information on Dairy Farm PWS within 5km of the Site Centroid

Object ID	X	Y	Water Source
464	269708	423221	Not Stated
658	272876	420643	Not Stated

Dunbeg South Wind Farm

Peat Slide Risk Assessment Phase Two

30th October 2017

Client Name: Renewable Energy Systems Limited

Site Address: Dunbeg South Wind Farm, Off A37

North East of Limavady

Co.Londonderry,

Northern Ireland

Author: Mae Aldridge, Geophysical Project Engineer

1149761

Document history

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Approved	Gavin Germaine	01/09/2017

Client Details	
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Issue	Date	Revision Details
A	06/09/2017	First Issue
B	27/09/2017	Re-issue to address RES comments
C	03/10/2017	Re-issue again to address RES comments
D	20/10/2017	Re-issue again to address RES comments
E	30/10/2017	Re-issue again to address RES comments

we are ISO 9001:2008 certified (NPC - UK & Ireland) (NPS - UK)

we are ISO 14001:2004 certified (NPC - UK & Ireland) (NPS - UK)

UVDB Verify empowered by Achilles Verified

IEMA - EIA -

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Contents

1. Introduction

This report details the Peat Stability Assessment undertaken at the proposed Dunbeg South Wind Farm on behalf of Renewable Energy Systems Limited (RES). The proposed development comprises x9 wind turbine generators, crane hard standings, access tracks, and a temporary construction compound. The indicative wind farm layout is presented within Appendix C Environmental Impact Zonation Map (GB200135_M_008_C).

2. Peat slide Hazard – Risk Assessment Method

Natural Power Consultants (NPC) undertook the peat stability assessment following the principles of the Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Generation Developments (Scottish Executive 2007) hereafter referred to as PLHRAG, (2007). The guide provides current best practice methods which should be applied to identify, mitigate and manage peat slide hazard and associated risks in respect of consent application for electricity generation projects in the UK.

The assessment of potential instability at the Development was carried out according to the following work programme:

- Desk Study and review of existing site information issued August 2016, document reference 1122279.
- Site reconnaissance survey (August 2016). This comprised a walkover survey of the site and identification of potential geo-hazards.
- Full peat probing survey comprising: An initial site wide peat probe survey within the turbine envelope on a grid resolution of 100m (August 2016).
- Assessment of peat undrained shear strength through in-situ hand shear vane testing across representative turbine locations within the design envelope (August 2016 and July 2017).
- Development-wide check of salient features such as active, incipient or relic instability within the peat deposits, geomorphological features, peat depth and composition (August 2016).
- Quantitative slope stability assessment based on in-situ shear strength data.
- Assessment of the potential risk of peat failure across the turbine envelope.
- Comparison of the potential risk of peat failure with the site hydrological model including proximity to watercourses and sensitivity of those features.
- Recommendations for detailed design/construction control with specific examination the need for measures to mitigate potential peat failure as part of any future Wind farm development.

2.1. Processes Contributing to Peat Instability

To provide a framework for the assessment; it is important to highlight the key principals of the peat slide risk assessment set out in PLHRAG, (2007). The guidance describes ongoing natural peatland processes which can influence forces leading to peat slope failure. Discussion of the factors which can contribute to peat failure have been reiterated below in order to provide a basis for understanding the assessment process:

2.1.1. Groundwater Infiltration

There are two processes which may facilitate groundwater infiltration: These are periods of drying, resulting in cracking of the peat surface and slope creep resulting in additional tension cracks. Drying out of the upper peat, particularly in areas of thinner peat, is likely to result in the development of near-surface cracks which could facilitate ingress of water into the peat.

2.1.2. Surface Loading

Any mechanisms which increase the load on a peat deposit can increase the likelihood of failure. This can include continued peat growth, increased water content and surcharge loading, for example; construction works, stockpiling and forestry operations.

2.1.3. Vegetation

Factors which alter the surface vegetation may be important, particularly if the vegetation provides strength to the peat deposit through a dense fibrous root network. Loss of vegetation can have a negative impact making the peat susceptible to weathering and increased rates of infiltration.

2.1.4. Weathering

Weathering can weaken in-situ peat materials and destabilise a slope system. This may be in the form of weathering of peat or underlying mineral soils which could reduce shear strength. Vertical cracking and slope creep may slowly break down peat structure over long periods of time. This can develop into peat 'hagging', which is a strong indication that natural weathering processes are active. Peat hags expose the peat to increased weathering rates and may provide preferential surface water flow pathways.

2.1.5. Precipitation

A dominant trigger for peat failures are intense rainfall events. Many documented failures are associated with extreme rainfall events; reference is made to the Llyn Ogwen peat failure documented by Nichol et al., (2007). The Derrybrien Wind farm final report on landslide of October 2003 AGEC, (2004) provides further evidence. An example is also highlighted in the characteristics of the Shetland Isles (UK) Peat Slides of 19 September 2003, Dykes & Warburton, (2008). The aforementioned 'A5' Llyn Ogwen Peat Slide of 2005 is a useful example of a rainfall induced slide. Peat deposits were approximately 1m thick with undrained shear strength of 10-15kPa, (Nichol et al., 2007).

The likely failure mechanism following a period of heavy rainfall is linked to the infiltration of surface water into the ground. There is a resulting build-up of pore water pressures and therefore reduced effective shear strength, which may be focussed within the peat deposit or at the interface between the peat and underlying mineral soil. Secondary effects may include swelling of the peat deposit and increased loading due to surface water ponding. Snow and subsequent melt can have a similar effect and is a potential factor across upland sites such as wind farms.

2.1.6. Slope Morphology

A number of case studies on peat failures note the presence of a convex break in slopes (Dykes & Warburton 2008). There are three main effects of such slope morphology:

Firstly, the concentration of tensile stress at the apex of a convex slope predisposes the slope for failure initiation at that point. In a convex slope the material lower down supports the material above which is held in compression. A concave slope has the opposite characteristics as material below the 'roll-over' maintains the apex in tension. The roll over is particularly vulnerable to additional destabilising forces in addition to propagation of tension cracks.

Secondly it can be postulated that at the point of maximum slope convexity, because of the favourable down-slope drainage conditions (below the roll over), a body of relatively well-drained and relatively strong peat material develops. This body of peat acts as a barrier providing containment for growth of peat upslope. This relatively well drained body of peat can subsequently fail due to a build-up of lateral pressure on the upslope face. In this scenario the slope is not supported from below so eventually the lateral pressures exceed the forces resisting sliding. The apex or point of convexity is also a likely initiation point for slope failure due to the slope tension being concentrated at this point.

Thirdly a failure mechanism, analogous to a piping failure underneath dams, is postulated where springs are present in locations immediately down-slope of the relatively well drained peat body. Under these circumstances high pore pressure gradients within the peat can lead to hydraulic failure and undermining of the relatively well drained peat body resulting in a breach and loss of lateral support to peat upslope. Evolving slope morphology can be significant;

for example in the case of slope undercutting by water erosion. Any mechanism by which mass is removed from a slope toe or deposited on a slope crest will have some destabilising impact. This would include the case of material deposited by landslides as noted in PLHRAG, (2007).

2.1.7. Peat Depth & Slope Angle

The PHLRAG, (2007) guidance provides the following information on peat slides with respect to peat depth and slope angle:

'Peat slide – slab like shallow translational failure, (Hutchinson, 1988) with a shear failure mechanism operating within a discrete shear plane at the peat substrate interface, below this interface, or more rarely within the peat body, (Warburton et al., 2004). The peat surface may break up into large rafts and smaller blocks which are transported down slope mainly by sliding. Rapid re-moulding during transport may lead to the generation of organic slurry in which blocks of peat are transported.'

Peat slides correspond in appearance and mechanism to translational landslides, (DoE, 1996) and tend to occur in shallow peat (up to 2.0m) on slopes between (5° – 15°). A great majority of recorded peat landslides in Scotland, England & Wales are of the peat slide type. MacCulloch, (2005) highlights that a slope angle of 20° appears to be the limiting gradient for the formation of deep peat. Therefore the risk assessment has assigned slope angles >20° to be an unlikely contributory factor to failure. Slope angle indicators and corresponding probability factors have been similarly adapted from MacCulloch, (2005).

Boylan et al, (2008) indicates that the vast majority of peat failures occur on slope angles between 4° and 8°. It is postulated that this may correspond to the slope angles that allow a significant amount of peat to develop that over time becomes potentially unstable. The same author also stipulates that a number of failures have been recorded on high slope angles (>20°) but, based on the authors' inspection of such failures, peat cover is generally thin and the failure tends to involve underlying mineral soils, as opposed to peat deposits.

Peat depth and slope angle indicators for probability of peat failure have been similarly adapted from MacCulloch, (2005). These are set out in Table 2.4.

2.1.8. Drainage

Natural and poorly executed man-made drainage measures designed to reduce the water content in the peat have often been identified as a contributory factor of peat failure. Preferential drainage paths may allow the migration of water to a failure plane therefore triggering failure when groundwater pressures become elevated. Within a peat mass, peat pipes can enable flow into a failure plane and facilitate internal erosion of slopes. It is also noted that in some instances, agricultural works can lead to the disturbance of existing drainage networks and cause failures. See Warburton et al., (2004). Forestry preparations and harvesting may also impact upon man-made drainage networks.

2.1.9. Recurrent Failures

The clustering of relict failures and any indication of previous instability are often important, indicating that particular site conditions exist that are conducive to peat failure. Relict peat slides may be dormant over long periods and be re-activated by any number of the contributory factors discussed here.

2.1.10. Pre-existing Weak Layers

Several peat failure reports identify the possibility of relative weaker layers within the peat (AGEC, 2004). In most cases, these weak layers are at the base of the peat deposit where there is usually the highest degree of peat humification and lowest relative peat strength. Alternatively, where failure is triggered by the ingress of water into the peat, there is a tendency for water to build-up at the base of the peat causing a reduction in effective stress at the base of the peat which can contribute to eventual failure.

2.1.11. Anthropogenic Effects

Man-made impacts on peat environments can include a range of affects associated with Wind farm construction. Activities such as drainage, tracks across peat, peat cutting and slope loading are all examples. Rapid ground acceleration is one such example where shear stress may be increased by trafficking or mechanical vibrations. The peat failure at Derrybrien, County Galway is one such example where construction activity has been cited as a contributing factor during Wind farm construction (AGEC, 2004).

2.2. Peat Failure Definitions

Peat failure in this assessment refers to the mass movement of a body of peat that would have a significant adverse impact on the surrounding environment. This definition excludes localised movement of peat, for example movement that may occur below an access track, creep movement or erosion events and failures in underlying mineral soils.

The potential for peat failure at this site is examined with respect to the activities envisaged during construction and operation of the Development. There are several classification systems for the mass movement of peat that were drawn together by PLHRAG, (2007) and by AGEC at Derrybrien in Ireland, (Boylan et al., 2008).

Hutchinson (1988) defines the two dominant failure mechanisms namely peat flows and peat slides

- **Peat Flows & Bog Bursts:** are debris flows involving large quantities of water and peat debris. These flow down slope using pre-existing channels and are usually associated with raised bog conditions.
- **Peat Slides:** comprise intact masses of peat moving bodily down slope over comparatively short distances. A slide which intersects an existing surface water channel may evolve into a debris flow and therefore travel further down-slope. Slides are historically more common within blanket bog settings.

Due to the open topographic relief across the Development and a prevalence of surface watercourses, peat flows are considered the dominant mode of potential peat failure. However consideration should be given to the potential for peat slides as a result of the slope geometry over some parts of the development area. Peat depths are generally shallow <1.0m across the Development and infrastructure has been positioned away from any detected pockets of deep peat. It is not envisaged that this site will be susceptible to bog burst events.

2.3. Geotechnical Principles

The main geotechnical parameters that influence peat stability are understood to be: -

- Shear strength of peat.
- Peat depth.
- Pore water pressure (PWP).
- Loading conditions.

The stability of any slope is defined by the relationship between resisting and destabilising forces. In the case of a simple infinite slope model with a translational failure mode, sliding is resisted by the shear strength of the basal failure plane and the element of self-weight acting normal to the failure plane. The stability assessments within this study considers an undrained 'total stress' scenario when the internal angle of friction (φ') = zero.

An undrained peat deposit may be destabilised by; mass acting down the slope, angle of the basal failure plane and any additional loading events. The ratio between these forces is the Factor of Safety (FOS). When the FOS is equal to unity (1) the slope is in a state of 'limiting equilibrium' and is sensitive to small changes in the contributory factors leading to peat failure.

The infinite slope model (Skempton & DeLory, 1957) has been adapted to determine the FOS of a slope. A modified approach has been used; assuming a minimum FOS (Typically 1.3 after, BS6031: 2009) and back calculating minimum undrained shear strength (Cu_{min}) for stability. Thus establishing the likely potential for peat sliding based on the measured in-situ values for undrained shear strength or Cu_{min} value for peat depth and slope angle parameters.

2.3.1. Infinite Slope Analysis

The purpose of the analysis is to identify the baseline FOS and the minimum undrained shear strength (Cu_{min}) required for stability of peat deposits at each proposed turbine base and sensitive access track sections. When in-situ measured peat undrained shear strength values (Cu) exceed the minimum value (Cu_{min}) there is limited potential for peat failure to occur. The Cu_{min} analysis uses a Factor of Safety (FoS) of 1.3; based on BS6031:2009: Code of practice for Earthworks (BSI, 2009).

The infinite slope analysis (Skempton and DeLory, 1957), as recommended in PLHRAG, (2007) is based on a translational slide, which represents the prevalent mechanism for peat failures. This analysis adopts total stress (undrained) conditions in the peat. This state applies to short-term conditions that occur during construction and for a time following construction until construction induced pore water pressures dissipate (PWP takes time to dissipate as the hydraulic conductivity can be low in peat deposits). The following assumptions were used in the analysis of peat deposits across the Development:

- The groundwater is resting at ground level.
- Minimum acceptable factor of safety required is **1.3** after, (BS6031:2009).
- Failure plane assumed at the basal contact of the peat layer.
- Slope angle on base of sliding assumed to be parallel to ground surface and that the depth of the failure plane is small with respect to the length of the slope.
- Thus, the slope is considered as being of infinite length with any end effect ignored.
- The peat is homogeneous at each location.
- In the surcharged case a 20kPa stress is modelled, this is approximately equivalent to a 2m high peat stockpile or 1.5m high subsoil stockpile.

The analysis method for a planar translational peat slide along an infinite slope was for calculated using the following equation in total stress terms highlighted by MacCulloch, (2005) and originally reported by Barnes, (2000):

$$\mathbf{F = Cu / (\gamma * z * \sin\beta * \cos\beta)}$$

Where:

F = Factor of Safety (FOS)

Cu = Undrained shear strength of the peat (kPa)

γ = Bulk unit weight of saturated peat (kN/m^3)

z = Peat depth in the direction of normal stress

β = Slope angle to the horizontal and hence assumed angle of sliding plane (degrees)

Undrained shear strength values (Cu) are used throughout this assessment. Effective strength values are not applicable for the case of rapid loading of the peat during short term construction phase of works hence the Barnes, (2000) formula cited above, has been adopted throughout.

2.4. Contributory Factors to Peat Failure – Assumptions

The analysis is termed preliminary due to the nature of the in-situ strength testing. The low peat strengths are at the lower detectable limit for light weight hand shear vanes used during the field surveys. Therefore any error in the preliminary Cu value will have a proportionally large effect on the overall sensitivity of the slope stability analysis.

Furthermore the slope angle of the ground surface does not necessarily represent the true slope angle at the base of the peat. In the absence of more detailed data, the surface slope angle gives an indication of the likely slip surface angle at the base of the peat. It should be highlighted that a key controlling factor on potential instability may be the internal structure of the peat and not the underlying interface with the superficial deposits.

The occurrence of a severe rainstorm event controlled by meteorological factors and to a lesser degree topography is not factored by the assessment. NPC considers blanket peat on upland sites would be considered to be more susceptible to intense rainstorm events due to the larger catchment potential across the peat surface. However the wide range of contributory factors included in this assessment can be indirectly linked to rainfall and precipitation.

The thinning and cracking of peat can allow ready ingress of surface water into the base of the peat mass. Deeper deposits of peat may therefore be less likely to be affected by cracking. The preliminary analysis assumes that the groundwater rests at ground level. This is conservative and considered a worst case scenario for the development.

The assumption was made that the ground surface is loaded by a nominal vertical 20kPa surcharge. Vehicle trafficking, construction of access roads and stockpiling of peat/soil during excavations all cause an increase in applied stress which can, without engineering control, increase the risk of peat slide. Surface loading in particular has been shown to have resulted in a number of construction related peat failures (AGEC, 2004). The effects of cyclic loading are also not covered by the slope stability model. It is further highlighted that loading rates can be important in managing peat deformation under construction conditions.

2.4.1. Drained Shear Strength

A drained slope stability analysis requires effective cohesion (c') and effective friction angle (φ') parameters. These values can be difficult to obtain because of disturbance experienced when sampling peat. There are also difficulties in interpreting test results due to the excessive strain induced within the peat during test failure. During a laboratory test the point of failure may be arbitrary as a threshold strain measurement. To highlight suitable drained strength values a review of published information on peat has been outlined below.

As obtaining effective stress parameters for peat is difficult to achieve with confidence due to the aforementioned problems; sample disturbance, low stress and high strain behavior, reliability of standard test methods etc. A summary of literature values is presented in Table 2.1 below:

Table 2.1: Literature Review of Effective Stress (Drained) Parameters

Reference	Effective Cohesion C' (kPa)	Effective Friction Angle Ø'(°)	Test Method / Comment
Hanrahan et al (1967)	5 - 6	36 to 43	Triaxial
Rowe and Mylleville (1996)	2.5	28	Simple shear apparatus
Landva (1980)	2 - 3	27.1 - 32.5	Ring shear with normal stress >13 kPa
Landva (1980)	5 - 6	-	Ring shear with zero normal stress
Carling (1986)	6.5	0	-
Farrell and Hebib (1998)	0	38	Ring shear and shear box, results considered unrealistic.
Rowe, McLean & Soderman (1984)	1.1	26	Simple Shear
	3	27	Direct Simple Shear
Sandorini et al (1984)	4.5	28	Triaxial
Hunger & Evans (1985)	3.3	-	Back analysis
Dykes and Kirk (2006)	3.2	30.4	Acrotelm
	4	28.8	Catotelm
Warburton et al (2003)	5 -	23.9	Basal Catotelm
	8.74	21.6	Fibrous Acrotelm
Natural Power (2009)	3	28	Advanced in-situ CPT testing
	Mean	Mean	
	4	28	

From Table 2.1 the values for c’ ranged from 0 to 9kPa and φ’ ranged from 0 to 43°. The average c’ and φ’ values are 4kPa and 28° respectively. Based on the above data review, it is recommended to adopt a conservative approach and to use design values below the averages. It was not deemed appropriate to undertake effective stress analysis at this stage. An effective stress analysis may be considered if required as part of detailed design prior to construction and as part of detailed ground investigation. The values presented here may provide a useful starting point to continue the detailed design assessment or further investigations as part of detailed site investigation post consent.

2.5. Peat Slide Risk Assessment Methodology

A semi quantitative risk assessment has been used to determine the risk of peat failure and hence impact on the proposed development and surrounding environment. The methodology is well defined in PLHRAG, (2007) and has been further augmented with methods set out by Clayton (2001).

The assessment approach uses the infinite slope stability analysis and presents a comparison of the Cu_{min} values calculated across the site with the measured peak Cu values acquired during site reconnaissance. This assessment has analyzed terrain conditions across the proposed development and utilised this information to clarify the preliminary peat slide risk ranking map (map reference: GB200135_M_010_C, Appendix I).

In addition to the peat slide risk ranking is the environmental impact zonation which has assessed the potential for a peat failure to detrimentally impact surface water courses (map reference: GB200135_M_008_C, Appendix C) depicts the Environmental Impact Zones based on proximity buffer zones applied to the sensitive watercourses within the Development. Water courses have therefore been determined to be a primary sensitive receptor to a peat failure event. Table 2.2 denotes the potential impact scales to the environment.

Table 2.2: Environmental Impact Scales

Critera/Exposure	Potential Environmental Impact (Ei)	Impact Scale
Proposed access road/turbine within 50m of watercourse	High	4
Proposed access road/turbine within 50-100m of watercourse	Medium	3
Proposed access road/turbine within 100-150m of watercourse	Low	2
Proposed access road/turbine greater than 150m from watercourse	Negligible	1

Source: MacCulloch, (2005)

Table 2.3: Development Impact Scales

Criteria / Exposure	Impact as % of total development cost or time	Impact Scale
Extremely high impact	>100% of project	5
Very high impact	10 – 100%	4
High impact	4 – 10%	3
Low impact	1 – 4%	2

Criteria / Exposure	Impact as % of total development cost or time	Impact Scale
Very low impact	<1% of project	1

Source: PLHRAG, 2007

An assessment of the risk assessment Hazard Ranking across the turbine envelope is presented in Section 6 (Peat Slide Risk Assessment). The assessment uses the following contributory factors to peat failure, identified from desk study and the detailed peat survey:

- Slope angle evaluated during field reconnaissance and digital elevation models;
- Peat depth determined during a multi-phased probing survey;
- FOS evaluated from infinite slope analysis;
- Evidence of groundwater flow;
- Surface water flow from maps and site walkover observations;
- Evidence of previous slope instability within the site wide geomorphological setting;
- Land management, qualitative based on previous site use.

Probability values for each contributory factor are summarised on Table 2.4 along with a brief discussion of the influencing factors.

Table 2.4: Contributory Factors and Probability Values

Contributing Factors	Comment	Criteria	Probability	Scale
Peat Depth (A)	Peat slides tend to occur in shallow peat (up to 2.0m) on A great majority of recorded peat landslides in Scotland, England & Wales are of the peat slide type, (PHLRAG, 2007)	0 – 0.5m	Negligible	1
		>3.0m	Unlikely	2
		0.5 – 1.0m	Likely	3
		2.0 – 3.0m	Probable	4
		1.0 – 2.0m	Very likely	5
Slope Angle (B)	It has been acknowledged that peat slide tend to occur in shallow peat (up to 2.0m) on slopes between 5o and 15o. Slopes above 20° tend to be devoid of peat or only host a thin veneer deposit.	0 – 3°	Negligible	1
		>20°	Unlikely	2
		4 – 9°	Likely	3
		16 – 20°	Probable	4
		10 – 15°	Very likely	5
FOS (C)	Values are from Infinite slope model using Cu derived from hand shear vane in-situ testing. Slope angle and peat depth also input to this factor.	≥ 1.3	Negligible	1
		1.29-1.20	Unlikely	2
		1.10-1.19	Likely	3
		1.00-1.09	Probable	4
		<1.0	Very likely	5
Cracking (D)	Depth and cause of cracking are important. E.g. tension cracks appear as excess tension is released. Cracks can form during dry period and provide a water ingress pathway. Subjective requiring interpretation.	None	Negligible	1
		Few	Unlikely	2
		Frequent	Likely	3
		Many	Probable	4
		Continuous	Very likely	5
Groundwater (E)	Hard to evaluate without very detailed mapping. Look for entry / exit. Often collapsed pipes are the first sign. May hear running water during wet periods.	None	Negligible	1
		Few	Unlikely	2
		Frequent	Likely	3
		Many	Probable	4

Contributing Factors	Comment	Criteria	Probability	Scale
		Continuous	Very likely	5
Surface Hydrology (F)	Ranging from wet flushes to running burns to hags. Must be evaluated in conjunction with the season and weather preceding the site visit.	None	Negligible	1
		Few	Unlikely	2
		Frequent	Likely	3
		Many	Probable	4
		Continuous	Very likely	5
Previous Instability (G)	Visual survey, scale and age are important as small to medium relict failures may be easy to detect but very large ones may require remote imaging. Recent failures should be obvious due to the scar left.	None	Negligible	1
		Few	Unlikely	2
		Frequent	Likely	3
		Many	Probable	4
		Continuous	Very likely	5
Land Management (H)	Anthropogenic influences such as forestry operations, felling and removal of vegetation can be associated with de-stabilising peat deposits. This can occur as a result to surface disturbance and re-molding of peat through excavation, vehicle movements and loading. Changes in land use activities may also be associated with changes in drainage conditions. Criteria based on evidence of disturbance of peat deposit, i.e. broken surface, scarring or disrupted hydrology.	None	Negligible	1
		Few	Unlikely	2
		Frequent	Likely	3
		Many	Probable	4
		Continuous	Very likely	5

A qualitative Hazard Ranking is assessed from the combined probability of occurrence for the main contributory factors which are greater than (1), multiplied by the highest impact scale. Table 2.5 identifies the hazard ranking based on PLHRAG, (2007).

Hazard Rank = ((Sum A:H) if (A:H>1)) x (Ei)

Table 2.5: Risk Rating and Control Measures

Hazard Ranking Zone	Control Measures
17 - 25	**Serious:** re-location or specialist control measures. (Avoid project development at these locations)
11 - 16	**Substantial:** specialist control measures required (Project should not proceed unless hazard can be avoided or mitigated at these locations, without significant environmental impact, in order to reduce hazard ranking to significant or less).
5 - 10	**Significant:** routine control measures required. (Project may proceed pending further investigation to refine assessment and mitigate hazard through relocation or re-design at these locations).
1 - 4	**Insignificant**: none or only routine measures (Project should proceed with monitoring and mitigation or peat landslide hazards at these locations as appropriate).

Source: PLHRAG, 2007

Table 2.6 below further breaks down the Hazard Ranking score into a risk matrix adapted from Clayton, (2001):

Table 2.6: Risk Rating

Highest Probability for Contributory Factor to Peat Failure						
Environmental Impact Scale	**Score**	**1**	**2**	**3**	**4**	**5**
	5	**5**	**10**	**15**	**20**	**25**
	4	**4**	**8**	**12**	**16**	**20**
	3	**3**	**6**	**9**	**12**	**15**
	2	**2**	**4**	**6**	**8**	**10**
	1	**1**	**2**	**3**	**4**	**5**

Source: Clayton, 2001

3. Site Information

3.1. Location

The Development is located within the county of Derry/Londonderry approximately 6 kilometres northeast of the town of Limavady along the A37. The Development extends from the A37, south east up an approximately 4-9° hill running from A37 in the northwest to Keady Mountain (337m) in the fourth east. Access is via a gate at Irish Grid Reference 273460E, 425814N. Vegetation is mixed; grass, heather and occasional rock outcrops. The site is currently being used for grazing of sheep and cattle.

3.1.1. Topography

The site occupies a north facing hill side, with high relief in places. The development rises from 150m at the A37 to 337m at the top of Keady Mountain in the south-western portion of the site. The hill side rises gradually from the A37 with numerous deeply incised channels halfway up and to the east of the site. The south eastern part of the site is characterised by moderately level topography with a few rock outcrops and steep fluvial channels, while the south west is a broad hillside with moderately steep slopes. Slope map Appendix B (GB200135_M_003_E).

Source: Google Earth Professional

Figure 3.1: View South Across the site boundary

4. Desk Study and Site Reconnaissance

4.1. Desk Study

A desk study was completed as part of the phase 1 study, issued in August 2016 (document reference 1122279). All the relevant background data to the Development including available information regarding geomorphology, peat depths and water courses has been reviewed. This review of available literature, maps, and data was undertaken together with a general review of peat failures across the British Isles. The primary data sources with respect to the Development include:

- 1:50,000 scale series Solid & Drift Geology Map Scale, British Geological Survey
- Ordnance Survey plans including review of historical maps and aerial imagery
- Northern Ireland Rivers Agency Flood Map

4.2. Site Reconnaissance

The site reconnaissance included a visual assessment of the superficial ground conditions across the Development supplemented with peat probing and hand shear vane testing. Disturbed samples were also acquired for visual inspection using a Russian peat corer. Samples were classified using the Von Post scale as outlined in Hobbs, (1986). The testing, sampling and probing methodology is summarised as follows:

- Peat probing at 100 m intervals across the full development (phase 1 survey)
- Peat probing at each 50 m interval; three probe locations aligned perpendicular to the track alignment, one at the centre of the track with two further probes spaced 10 m from the centre on either side of the track;
- Peat probing at all turbine bases across a 50x50 m area at 10 m probe spacing;

- Peat probing at all crane hard standings and the construction compound at 20 m spacing across the indicative footprint of the infrastructure element.
- Peat coring at each wind turbine location and selected access track locations (~10% of probe locations). Peat coring include Von Post humification classifications with depth to inform the Peat Management Plan. Superficial peat samples taken where depths exceeded 0.5 m along access track alignment. Core samples were examined by hand, and samples retained for laboratory and geochemical analysis;
- Hand shear vane testing at wind turbine locations and along access track alignment to establish the approximate range of undrained shear strength values and variability with depth or humification;

Drawing GB200135_M_005_D, Appendix A indicates the distribution of peat sampling locations across the development. A total of 1101 peat probes were taken across the development.

The phase one study found the peat depth across the site was relatively shallow, but depths over 2m were found in pockets around the site, the conditions typical to peat slide events are observed to be rare due to shallow peat depths on steeper slopes, and deep peat being found in small localities with relatively shallow gradients. The deepest areas were located in gullies and basins on the eastern side of the site. Generally the depths are low as for significant peat mass to form waterlogged conditions and slow drainage is required which has been inhibited by the high relief of the site. The peat depth contour data across the site is presented in Appendix A, GB200135_M_005_D. Aerial imagery and site walkover was assessed to identify any relict slides across the site and determine the wider geomorphological features across the site. The aerial photographic assessment has been used along with field observations to derive the geomorphological map (Drawing GB200135_M_004_D, Appendix A).

4.3. Principal Geological Units

4.3.1. Superficial Deposits

The following geological units have been identified across the site and are presented in Appendix D and E:

Peat: Dunbeg South has relatively shallow blanket deposit across higher plateau areas of the development. The blanket peat has formed deeper deposits in discrete areas across the site often in topographic depressions and in close proximity to water courses. Due to the high topographic relief across the site; the main control on peat depth is inferred to be the proximity to watercourses.

Smith, (2006) describes peat as a form of organic soil and is typically almost entirely comprised of lightly to fully decomposed vegetation. Peat can exist in one of three forms:

- Fibrous – Non plastic with a firm structure and only slightly altered by decomposition;
- Pseudo-fibrous – Peat in this form still has a fibrous appearance but is much softer and more plastic than fibrous peat. The change is due to more prolonged sub-mergence in airless water than to decomposition;
- Amorphous – With this type of peat decomposition has destroyed the original fibrous vegetation structure so that it has virtually become organic clay.

The peat encountered across the development is typically moist, firm, plastic, pseudofibrous, dark brown, PEAT with little amorphous material due to the low depths encountered. Von Post classes are predominantly H7-H9

Glacial Till:

Diamicton Glacial Till – Observed to be clast poor in river cut banks on site, the Diamicton till ranges in depths from 0 at the top of the site, to possiblt >10m in some fluvially cut features on site. Both rock outcrops and glacial till are exposed on various parts of the site. Typically, tills are poorly sorted and often have clasts of many sizes, including boulders, within a finer matrix of gravel, sand and clay sized particles derived from fine-grained sediments and rock flour. Tills may contain erratic blocks of apparently un-weathered rock, which in a site investigation may be sufficiently large to be mistaken for bedrock.

4.3.2. Solid Geology

Upper Antrim Basalts:

The 1:50,000 scale BGS data indicates the entire site is underlain by plateau basalts from the Upper Antrim Basalts, these are composed of extrusive basic magmas, sills and dykes; some basalt outcrops can be found at the top of the site. These overlie the Hibernian Greensands Formation and Ulster White Limestone formations, which are composed of chalks and sandstones. These are mapped to an outcrop at the western base of Keady hill.

4.4. Hydrogeology

Background information on the hydrogeology of the Dunbeg South Wind Farm is given below, it should be noted that detailed hydrogeological and flooding assessments are out with the scope of this assessment. For further information refer to Chapter 9 of the Environmental Statement. Information from the desk study and observations from the site reconnaissance indicates various streams and associated surface water within the east to north eastern parts of the site. The streams start as wet flushes within topographic basins and depressions at the top of the site, as they flow down the main slope they are confined to deeply incised channels which have been eroded into the glacial till. Upon reaching the base of the slope before the A37, the streams are partially choked by vegetation and spread out, saturating larger areas of land. Base flow is provided to the streams and lower areas of the site by peat deposits at the top of the site. Drainage is dominated by overland flow due to impermeable clay rich subsoils and impermeable bedrock.

The plateau basalts underlying the main site are classified by the BGS as a moderately productive aquifer with yields ranging from 0.5 to 20 l/s with typical rates around 5 to 10 l/s. ground water movement is confined to fractures within the rock, rather than intergranular flow. As previously mentioned the sedimentary rocks beneath the plateau basalts are classified as highly productive aquifers, which is a regionally important aquifer up to 150m thick. Due to the karstic characteristics of the limestones, the flow is confined to relatively large fractured pathways allowing yields at springs of up to 32 l/s, yields in boreholes are typically less, around 5 l/s. Care should be taken when drilling not to puncture this boundary unless absolutely necessary. In such cases permissions will be required from the relevant Environmental Agency.

The site is partially covered by peat or peat rich soils, which also forms an aquifer. Groundwater within such peat aquifers is generally perched on the less permeable basement they overlie. The peat aquifers, together with the weathered bedrock zone, provide base flow to the local surrounding watercourses.

4.5. Hydrology, Flooding and Draining

The Development falls within the catchment of the River Roe, a Special Area of Conservation. Watercourses on site drain northward into a tributary of the River Roe which flows west to join the Roe at Limavady. The watercourses on site are typical upland watercourses, situated in areas of saturated ground forming incised channels.

Flood information provided the Northern Ireland Rivers Agency Flood Map indicates the entire site is not within an area anticipated to be at risk of flooding from rivers or the sea. This mapping resource is indicative only and does not constitute a detailed flood risk assessment, out-with the scope of this report. There is the potential for overland flow to occur due to the dominance of slowly permeable peat and/or peaty soils underlying the site. As such, drainage measures must be constructed to take this negligible storage capacity into account and protect vulnerable infrastructure. A small patch of the site has been classified as within the 100 year surface water flood risk, this is located well away from any infrastructure and is not expected to impact the wind farm.

4.6. Peat Depth Analysis

4.6.1. Peat Probe Data

In total 1101 peat probes were taken across the Dunbeg South Wind Farm site. As can be seen in Figure 4.1 the majority of the peat probes taken were between 0-0.5m in depth with 82% of the total probes undertaken being between 0-0.5m in depth. A peat contour map was generated from the peat data and is presented in Appendix 0.

Source: Natural Power

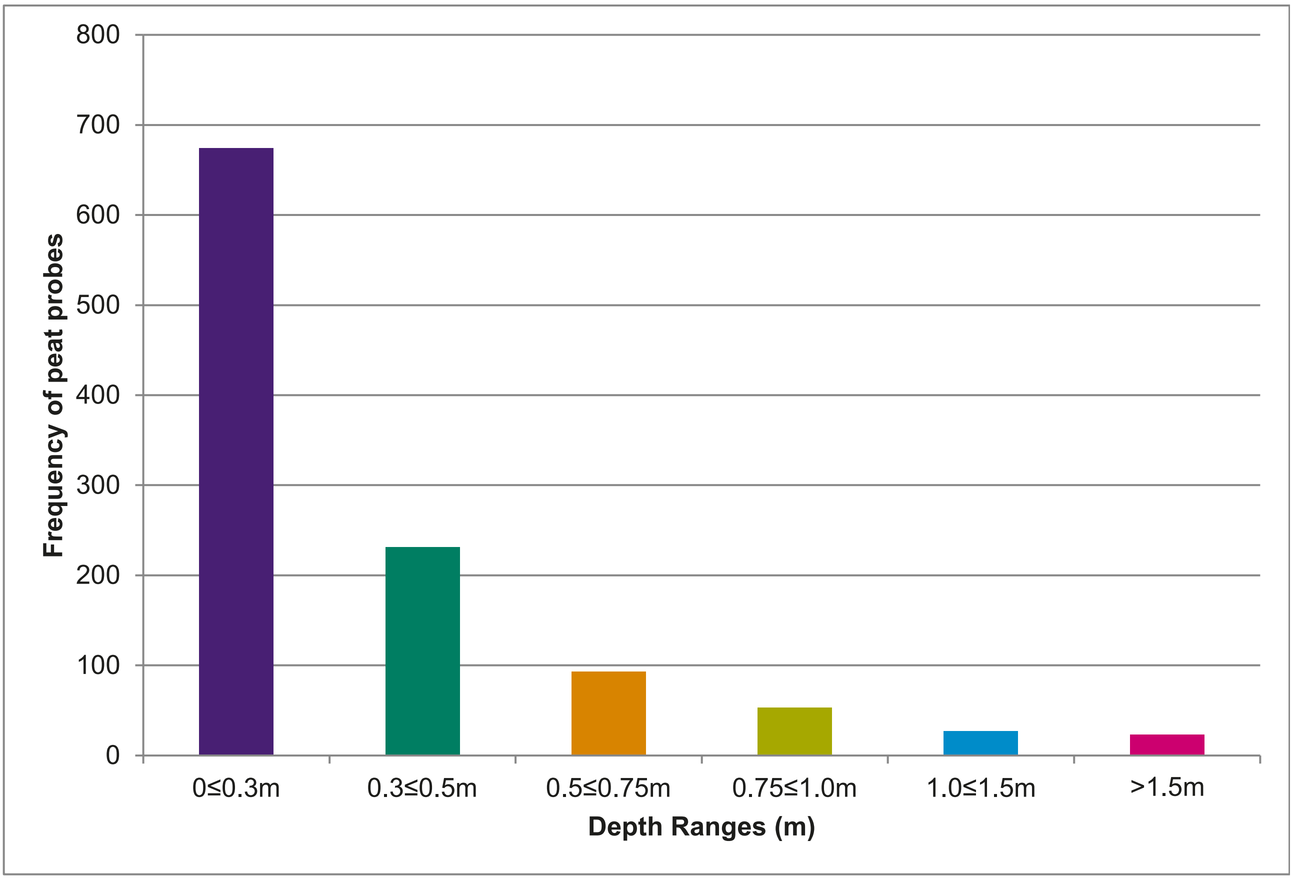

Figure 4.1: Site Peat Depth Frequency

4.6.2. Peat Depth at Turbine Bases

Table 4.1 below; summarises peat depths recorded across the proposed wind turbine location, construction compound and substation.

Table 4.1: Overview of Peat Depths at Turbines

Depth Range*	0 – 1.0 m	1.0 – 2.0 m		2.0 – 3.0 m	>3.0 m
Location	Peat Depth (m) Centre	Peat Depth (m) Mean Wider Area (50 m)	Slope Geometry (degrees)	Comments	
T1	0.2	0.2	9	Located on exposed grassland on hillside.	
T2	0.3	0.2	9	Located on exposed grassland on hillside.	
T3	0.4	0.4	10	Located on exposed grassland on hillside.	
T4	0.6	0.8	4	Located on exposed grassland on hillside.	
T5	0.2	0.2	6	Located on exposed grassland on hillside.	
T6	0.6	0.7	6	Located on exposed grassland on hillside.	
T7	0.3	0.3	7	Located on exposed grassland on hillside.	
T8	0.2	0.4	8	Located on exposed grassland on hillside.	
T9	0.4	0.4	6	Located on exposed grassland on hillside.	

4.6.3. Peat Depth along Access Tracks

Table 4.2 below summarises the peat depth along discrete sections of the proposed wind farm access tracks. The peat depths across the proposed access tracks are generally low, all maintaining an average of below 0.5m. There are some areas of deeper peat between 1- 2.5m deep on the track to T7 and the track to T9. Deeper areas are confined to localised pockets and the majority of this area of the track is still less than 0.5m average.

Table 4.2: Overview of Peat Depths at Proposed Access Tracks

Depth Range*	0 – 1.0 m	1.0 – 2.0 m	2.0 – 3.0 m	>3.0 m
Location	Mean Peat Depth (m)	Comments		
Track 1 Site Entrance to T1	0.1	Minimal peat, located on exposed grassland on hillside.		
Track 2 T2 to T4	0.4	Minimal peat, located on exposed grassland on hillside.		
Track 3 Track to T3	0.4	Located on exposed grassland on hillside.		
Track 4 Track to T5	0.2	Located on exposed grassland on hillside.		
Track 5 Track to T6	0.3	Located on exposed grassland on hillside.		
Track 6 Track to T7	0.6	Located on exposed grassland on hillside.		
Track 7 Track To T8	0.4	Minimal peat, located on exposed grassland on hillside.		
Track 8 Track To T9	0.4	Minimal peat, located on exposed grassland on hillside.		

4.7. Estimation of Peat Shear Strength

A 25mm ‘GeoNor’ hand shear vane was used at each turbine centre to record the undrained shear strength of the in-situ peat deposits. No laboratory based shear strength testing has been currently undertaken. This is attributed to the difficulties of obtaining undisturbed samples of peat through the use of hand operated instruments. The location of hand shear vanes undertaken is presented in map reference: GB200135_M_006_C, Appendix G.

The method of determining un-drained shear strength was carried out by inserting a steel vane vertically into the peat deposit. At increasing depth increments within the peat a torque head is turned at the surface which rotates the shear vane within the peat deposit. The maximum shearing resistance is recorded on the torque head which is calibrated to the peak un-drained shear strength of the peat. Once the peak un-drained shear strength was determined the shearing resistance of the free turning shear vane was recorded and is representative of the re-moulded un-drained shear strength.

It is highlighted that the shear vane has a small surface area compared to the larger scale soil structure within the peat. This scale factor is highlighted as the main limitation of this in-situ test method. The scale effect can lead to an underestimation of peat strength. The hand shear vane therefore only provides a preliminary and conservative estimate of peak and re-moulded un-drained shear strength.

Shear vane tests were generally undertaken within the deepest representative deposit of peat at each proposed wind turbine location. Where a significant increase in the un-drained shear strength was recorded at the basal contact of the peat, it is inferred from peat cores derived from the same location that the highest un-drained shear strength values represent the glacial till interface. This material comprises clay bound granular materials.

The un-drained shear strength (Cu) ranges from 10kPa to the equipment max of >130kPa with a mean value of 44kPa. The minimum un-drained shear strength (Cu) across the proposed infrastructure locations was 10kPa recorded at T06. Lower shear strengths down to 2kPa were recorded but these were to the east side of the site, not close to the proposed infrastructure locations.

Figure 4.2 below depict the un-drained shear strength profiles with depth.

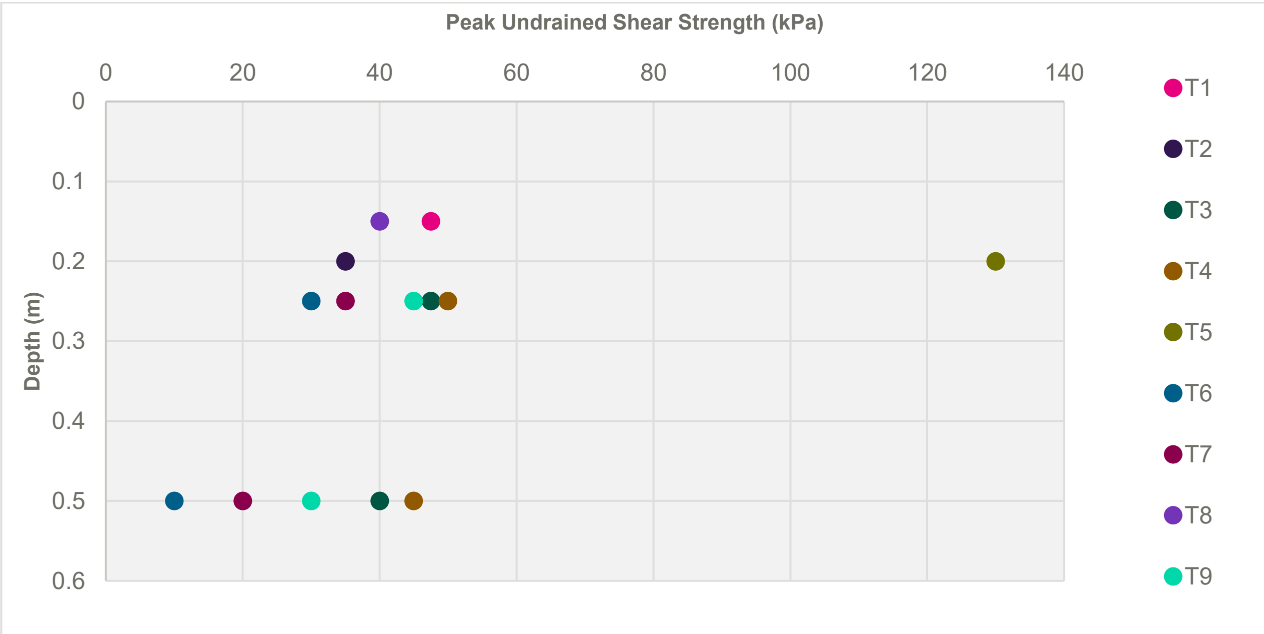

Figure 4.2: Peak Undrained Shear Strength at Turbine Locations

4.8. Humification of Peat

The characteristic of the peat deposits and specifically the degree of humification has been recorded at locations where peat was deep enough to obtain a sample. Peat sample locations are presented in GB200135_M_007_C, Appendix H. The peat has been characterised according to the von Post Classification (Von Post & Granland, 1926).

Table 4.3 sets out the classification and Table 4.4 presents the classifications at each turbine location.

Table 4.3: Von Post Classification

Degree of Humification	Peat Description
H1	Completely unconverted and mud-free peat which when pressed in the hand only gives off clear water. Plant remains are easily identified.
H2	Practically unconverted and mud free peat which when pressed in the hand gives off almost clear colourless water. Plant remains are still easily identifiable.
H3	Very slightly decomposed or very slightly muddy peat which when pressed in the hand gives off marked muddy water, but no peat substance passes through the fingers. The pressed residue is thickish. Plant remains have lost some of their identifiable features.
H4	Slightly decomposed or slightly muddy peat which when presses in the hand gives off marked muddy water. The pressed residue is thick. Plant remains have lost more of their identifiable features.
H5	Moderately decomposed or muddy peat. Growths structure evident but slightly obliterated. Some amorphous peat substance passes through the fingers when pressed but, mostly muddy water. The pressed residue is very thick.
H6	Moderately decomposed or very muddy peat with indistinct growth structure. When pressed approximately 1/3 of the peat substance passes through the fingers. The remainder extremely thick but with more obvious growth structure than in the case of unpressed peat
H7	Fairly well decomposed or markedly muddy peat but the growth structure can just be seen. When pressed about half the peat substance passes through the fingers. If water is also released this is dark and peaty.
H8	Well decomposed or very muddy peat with very indistinct growth structure. When pressed about 2/3 of the peat substance passes through the fingers and at times a thick liquid. The remainder consists mainly of more resistant fibres and roots.
H9	Practically completely decomposed or mud-like peat in which almost no growths structure is evident. Almost all the peat substance passes through the fingers as a uniform paste when pressed.
H10	Completely decomposed or mud peat where no growth structure can be seen. The entire peat substance passes through the fingers when pressed.

Source: Von Post & Granland, 1926.

Table 4.4: Von Post Classifications at Turbine Locations

WTG ID	Von Post Degree of Decomposition	Description
T1	H9	Soft, dark brown, peaty, sandy TOPSOIL;
T2	H8	Soft, dark brown, amorphous PEAT;
T3	H8	Very soft, dark brown, amorphous PEAT with few rootlets and plant remains;
T4	H8	Very soft, dark brown, amorphous PEAT passing to light brown, slightly gravelly, sandy CLAY;
T5	H9	Soft, dark brown, slightly sandy TOPSOIL/PEAT (fully converted PEAT as TOPSOIL);
T6	H7	Soft, Dark brown, pseudo-fibrous PEAT with abundant rootlets and plant remains;
T7	H8	Soft, Dark brown, amorphous PEAT almost fully converted to topsoil with few rootlets and plant remains;
T8	H8	Very soft, dark brown, pseudo-fibrous PEAT with rootlets and few plant/woody fragments;
T9	H8	Very soft, dark brown, amorphous PEAT passing to dark brown, sandy, silty, gravelly CLAY;

Source: Natural Power

5. Stability Analysis of Peat Slopes

5.1. Introduction

Using the desk study, site layout and ground investigation data; a preliminary infinite slope analysis and subsequent peat failure risk assessment has been undertaken. Slope stability was assessed at each turbine location using slope angle measurements, peat depth, and undrained shear strength measured using an in-situ hand shear vane. The PLHRAG, (2007) assessment should be viewed as semi – quantitative as it draws on both qualitative assumptions and numerical parameters.

For each proposed turbine location the recorded peak undrained shear strength values has been input into the infinite slope model in order to calculate the potential factor of safety against peat slide.

5.2. Undrained Slope Analysis

No peat failures have been observed across the Development. The current baseline peat condition is assumed to be in a state of equilibrium. Surcharge loading has been considered to demonstrate the effect of construction works proposed as part of the Development.

As previously discussed (Section 2.4) it should be acknowledged that the in-situ measurement of undrained shear strength of peat is problematic due to scale effects of shear vane testing. Hence the use of Cu_{min} (Section 2.3.1) allows additional judgement to be made on peat slide likelihood and slope sensitivity to loading. Is it reiterated that the Cu_{min} is calculated based on the depth of peat and surface slope geometry only and therefore this method is a simple means of screening slope sensitivity across the proposed Development.

The factor of safety (FOS) against sliding has been calculated at the centre of proposed turbine locations. Table 5.1 below summarises the results.

Table 5.1: Infinite Slope Analysis Wind Turbines

Location	Peak Shear Strength	Unit Weight (γ)	Depth (z)	Slope Geometry	Factor of Safety (FOS = C_u / γ z sinβ cosβ)		Cu_{min}
	kPa	kN/m³	metres	(ß°)	No Applied Load	Surcharge 20 kPa	kPa
WTG 1	47.5	10.00	0.15	8.8	208.6	14.6	4.2
WTG 2	35	10.00	0.2	9.1	112.2	10.2	4.5
WTG 3	47.5	10.00	0.25	9.8	112.8	12.5	4.9
	40	10.00	0.5	9.8	47.5	9.5	5.5
WTG 4	50	10.00	0.25	4.3	269.5	29.9	2.2
	40	10.00	0.5	4.3	107.8	21.6	2.4
WTG 5	130	10.00	0.2	5.9	639.9	58.2	2.9
WTG 6	30	10.00	0.25	5.9	117.4	13.0	3.0
	10	10.00	0.5	5.9	19.6	3.9	3.3
WTG 7	35	10.00	0.25	6.9	118.0	13.1	3.5
	20	10.00	0.5	6.9	33.7	6.7	3.9
WTG 8	40	10.00	0.15	8.1	191.3	13.3	3.9
WTG 9	45	10.00	0.25	6.3	165.9	18.4	3.2
	30	10.00	0.5	6.3	55.3	11.1	3.5

5.3. Discussion of Stability Analysis

The preliminary stability analysis indicates limited potential for translational peat slide at the proposed development area under current equilibrium conditions. The slope stability is termed 'preliminary' as the nature of input parameters are index values only. The un-drained shear strength recorded across the development is at the higher detectable limit for the light weight portable shear vane apparatus in some cases, four of the thirty-nine shear vane readings were in this bracket. It is highlighted that any inaccuracy in the preliminary Cu value will have a proportionally large effect on the slope stability analysis results. This means if an inaccuracy in the vane measurement caused the result to be higher than the actual shear strength of the soil the slope stability could be over predicted, likewise if the vane measured result was lower than the actual shear strength of the soil the stability would be under predicted.

The slope angle of the ground surface does not necessarily represent the true slope angle within the peat. In the absence of more detailed sub-surface data, the surface slope angle has been used as a reference to the likely slope surface angle at the base of the peat in the analysis.

Further advanced in-situ test methods may be considered as part of a detailed site investigation phase usually carried out post-consent. This may adopt large size shear vane apparatus which allows a greater volume of peat to be tested. This may offer more representative results of mass behaviour and reduce the smaller scale fabric effects within the peat.

Cone penetration testing (CPT) which uses a full flow ball penetrometer or 'T-bar' penetrometer will allow for higher repeatability and accurate in-situ test results. Un-disturbed sampling with thin walled samplers will allow for laboratory testing to be undertaken. However issues of sample preservation and disturbance are important factors to address. Such methods are generally suited to deep peat deposits (i.e.>2m) and require plant mobilisation. The potential of disturbing sensitive peat deposits during pre-construction survey access should be taken as a future consideration in investigation planning.

5.3.1. Wind Turbines

FOS values for the turbine locations, when allowing for a 20kPa surcharge load have been derived. (BS6031:2009 Code of Practice for Earth Works). The lowest FOS was calculated as 3.9 for proposed turbine T6. The FOS values allowing for a 20kPa surcharge load are generally high; this is probably due to the shallow peat depths and moderate to high humification of the peat.

Overall the FOS values across the site are high for 20kPa surcharge. This is not surprising, as the average peat depth for turbines is generally below 0.5 m, and as stated in PHLRAG, (2007) conditions conducive to peat instability are unlikely to be present. It should be reiterated that the natural slope condition has been calculated to be stable and was observed to be so during the field survey.

5.3.2. Access Tracks

The average peat depths across the discrete sections of track are generally below the 0.5 m depth indicated by PHLARG, (2007) as being the typical peat depth above which conditions conducive to peat instability are likely to be present. It must be stated however that this does not imply that failure cannot occur within peat below this depth or that failure within soils not classified as peat may not occur.

6. Peat Slide Risk Assessment

6.1. Risk Assessment of Peat Failure

In line with the recommendations set out in PLHRAG, (2007); the potential environmental impact rating for proposed wind farm infrastructure is obtained from assessing the proximity to watercourses and drainage ditches, see Environmental Impact Zonation Map Appendix C. The peat stability assessment also includes consideration for the potential impact to the proposed development infrastructure from peat slide. This was conducted as a qualitative assessment in terms of time and cost (See Table 2.3). Assessment of the proposed layout with respect to peat failure hazard zones was taken into account. If for example infrastructure was down-slope of a potential failure site the development impact scale is increased. This is based on a subjective assessment of a resultant peat slide inundating infrastructure and rendering damage. The time and cost for the project would be increased due to the requirement for remediation.

Probability values were assessed for combined contributory factors recorded across the turbine locations and added together values >1 (See Table 2.4). The highest impact rating is then combined with this probability of peat slide based on the cumulative effects of the contributory factors recorded. This is to convey the overall hazard ranking accounts for increased susceptibility when multiple contributor factors are identified.

The environmental impact rating is then combined with the highest probability contributory factor to produce a hazard ranking based on the following; Degree of risk = Likelihood (Hazard) x Effect (Exposure). Hazard rankings for the proposed turbine positions are presented in Table 6.1. Map reference: GB200135_M_010_C, (Appendix I) depicts the Peat Slide Risk Ranking for Dunbeg South Wind Farm. This risk ranking map is based on the infinite slope analysis discussed in section 2.3.1. It should be noted that the peat slide risk ranking map may calculate lower hazard rankings for specific infrastructure than the risk assessment as it takes into consideration fewer contributory factors. However the Peat Slide Risk Ranking is considered to be a valid tool for screening the wider site area against peat slide hazard.

Factors including peat depth, slope geometry and distance to watercourses were the main contributing factors in assessing likely areas of failure. An indicative residual risk rating is also provided assuming implementation of appropriate mitigation measures. Further detail of the risk assessment is highlighted within the preliminary geotechnical risk register (Section 7).

Table 6.1: Hazard Ranking Proposed Turbine Locations

WTG ID	Impact Scale		Contributory Factors (Probability)		Hazard Ranking	
	Development Infrastructure	Environmental				
T1	1	1	Peat Depth (Mean = 0.23m)	1	= 5 x 1	[5] Significant
			Slope Angle (8.8°)	3		
			FOS (Min = 14.6)	1		
			Cracking / Infiltration	1		
			Groundwater Flow	1		
			Hydrology	2		
			Previous Instability	1		
			Land Management	1		
T2	1	1	Peat Depth (Mean = 0.23m)	1	= 5 x 1	[5] Significant
			Slope Angle (9.1°)	3		
			FOS (Min=10.2)	1		
			Cracking / Infiltration	1		
			Groundwater Flow	1		
			Hydrology	2		
			Previous Instability	1		
			Land Management	1		
T3	1	1	Peat Depth (Mean = 0.42m)	1	= 6 x 1	[6] Significant
			Slope Angle (9.8)	3		
			FOS (Min=9.5)	1		
			Cracking / Infiltration	1		
			Groundwater Flow	1		
			Hydrology	3		
			Previous Instability	1		
			Land Management	1		
T4	1	1	Peat Depth (Mean = 0.8m)	3	= 8 x 1	[8] Significant
			Slope Angle (4.3°)	3		
			FOS (Min = 21.6)	1		
			Cracking / Infiltration	1		
			Groundwater Flow	1		
			Hydrology	2		
			Previous Instability	1		
			Land Management	1		
T5	1	1	Peat Depth (Mean = 0.21m)	1	= 5 x 1	[5] Significant
			Slope Angle (5.9°)	3		
			FOS (Min = 58.2)	1		
			Cracking / Infiltration	1		
			Groundwater Flow	1		
			Hydrology	2		
			Previous Instability	1		
			Land Management	1		
T6	1	1	Peat Depth (Mean = 0.69m)	3	= 6 x 1	[6] Significant
			Slope Angle (5.9°)	3		
			FOS (Min = 3.9)	1		
			Cracking / Infiltration	1		
			Groundwater Flow	1		

			Hydrology	1		
			Previous Instability	1		
			Land Management	1		
T7	1	1	Peat Depth (Mean = 0.27m)	1	= 3 x 1	[3] Insignificant
			Slope Angle (6.9°)	3		
			FOS (Min = 6.7)	1		
			Cracking / Infiltration	1		
			Groundwater Flow	1		
			Hydrology	1		
			Previous Instability	1		
			Land Management	1		
T8	1	1	Peat Depth (Mean = 0.35m)	1	= 3 x 1	[3] Insignificant
			Slope Angle (8.1°)	3		
			FOS (Min = 13.3)	1		
			Cracking / Infiltration	1		
			Groundwater Flow	1		
			Hydrology	1		
			Previous Instability	1		
			Land Management	1		
T9	1	2	Peat Depth (Mean = 0.43m)	1	**= 7 x 2**	**[14] Substantial**
			Slope Angle (6.3°)	3		
			FOS (Min=11.1)	1		
			Cracking / Infiltration	1		
			Groundwater Flow	1		
			Hydrology	4		
			Previous Instability	1		
			Land Management	1		

6.1.1. Turbine Bases

Table 6.2 below summarises the risk assessment outcome and hazard ranking assignments for each turbine location. The principal contributory factors and impact scales used to derive these assignments are also stated.

Table 6.2: Summary of Turbine Hazard Ranking and Contributory Factors

Turbine ID	Hazard Ranking Uncontrolled	Principal Contributory Factors in Risk Assessment	Hazard Ranking With Targeted Mitigation and Best Practice Construction
T1	**Significant**	Hydrology, Slope Angle;	Insignificant
T2	**Significant**	Slope Angle, Hydrology	Insignificant
T3	**Significant**	Slope Angle, Hydrology	Insignificant
T4	**Significant**	Peat Depth, Slope Angle, Hydrology;	Insignificant

T5	**Significant**	Slope Angle, Hydrology	Insignificant
T6	**Significant**	Peat Depth, Slope Angle	Insignificant
T7	**Insignificant**	Slope Angle	Insignificant
T8	**Insignificant**	Slope Angle	Insignificant
T9	**Substantial (Amber/Orange)**	Environmental Impact Scale, Slope Angle, Hydrology	Insignificant

The risk assessment reflects the probability of peat material entering the surface water course and being entrained to an offsite receptor without any mitigation. The risk rating should be reduced to an insignificant level where targeted and appropriate mitigation measures are incorporated into the construction method statement (CMS) and construction environmental management plan (CEMP). The wider geomorphological assessment and evidence from recorded peat depths would indicate that a large scale translational mass movement of peat deposits is highly unlikely.

In the case of T9, the water course in close proximity to the turbine has been classified as a minor water course due to the low volume of flow in the channel. However because the channel flows into a significant water course further downstream this provides a pathway to transport peat into the water course below. As such this location is still at risk of the peat causing environmental impact and this risk rating has been left at "Substantial" to reflect this but is expected to be insignificant following appropriate mitigation measures. Suggested mitigation includes diversion of the minor water course away from the construction works.

6.1.2. Access Tracks

In addition to the turbine bases the sections of track have also been reviewed across the site. The highest risk areas would be where track alignments cross the watercourses. Without mitigation measures this drastically increases the likelihood for localised peat failure being entrained in the adjacent watercourse.

7. Preliminary Geotechnical Risk Register

A preliminary geotechnical Risk Register has been produced for each proposed turbine location (Table 7.1). The risk register is intended for use by the Applicant and future Principal Contractor who may be appointed for the construction of the site. A complete geotechnical risk register should be utilised throughout the construction phase and amended accordingly as new information is received. Key mitigation control measures are highlighted in bold for each infrastructure location.

Table 7.1: Preliminary Geotechnical Risk Register Proposed Turbine Locations

Turbine ID	Contributory Factors to Potential Peat Failure	Probability of Causing a Peat Failure	Specific Control Required?	Probability Scale for Contributory Factors	Cumulative Rating	Impact Scale	Environmental Impact Scale
T1 [273157E, 425253N]	Peat Depth (Mean = 0.23m)	Negligible	No	1	5	1	1 (100m from surface water course)
	Slope Angle (8.8º)	Likely	Yes	3			
	FOS (Min = 14.6)	Negligible	No	1			
	Cracking / Infiltration – None evident	Negligible	No	1			
	Groundwater Flow – None evident	Negligible	No	1			
	Hydrology – nearby watercourse	Unlikely	No	2			
	Previous Instability - None	Negligible	No	1			
	Land Management - None	Negligible	No	1			
	Hazard Ranking					= 5 x 1	[5] Significant
	Control Measures						
	A) Micro for optimum position avoiding deep peat and slope risk;		E) For overburden and dedicated peat storage areas calculate the factor of safety against failure;				
	B) Pre-construction detailed geotechnical investigation and design;		F) Consider the changing properties of stockpiled materials including weathering protection;				
	C) Maintain hydrology of local area to prevent ponding or 'dam' effect'		G) Use experienced geotechnical personnel throughout investigation and monitoring;				
	D) Prevent surcharge loading of peat slopes;		H) Use experienced civil contractor with trained operators to design and implement CMS				
	Hazard Ranking with applied Control Measures					(Insignificant)	
T2 [273584E, 425335N]	Peat Depth (Mean = 0.23m)	Negligible	No	1	5	1	1 (100m from surface water course)
	Slope Angle (9.1º)	Likely	Yes	3			
	FOS (Min=10.2)	Negligible	No	1			
	Cracking – None evident	Negligible	No	1			
	Groundwater flow – None evident	Negligible	No	1			
	Surface Hydrology- nearby watercourse	Unlikely	No	2			
	Previous Instability – None	Negligible	No	1			
	Land Management - None	Negligible	No	1			
	Hazard Ranking					= 5 x 1	[5] Significant
	Control Measures						
	A) Micro for optimum position avoiding deep peat and slope risk;		E) For overburden and dedicated peat storage areas calculate the factor of safety against failure;				
	B) Pre-construction detailed geotechnical investigation and design;		F) Consider the changing properties of stockpiled materials including weathering protection;				
	C) Maintain hydrology of local area to prevent ponding or 'dam' effect'		G) Use experienced geotechnical personnel throughout investigation and monitoring;				
	D) Prevent surcharge loading of peat slopes;		H) Use experienced civil contractor with trained operators to design and implement CMS				
	Hazard Ranking with applied Control Measures					(Insignificant)	

Turbine ID	Contributory Factors to Potential Peat Failure	Probability of Causing a Peat Failure	Specific Control Required?	Probability Scale for Contributory Factors	Cumulative Rating	Impact Scale	Environmental Impact Scale
T3 [273384E, 424987N]	Peat Depth (Mean = 0.42m)	Negligible	No	1	6	1	1 (60m from surface water course)
	Slope Angle (9.8°)	Likely	Yes	3			
	FOS (Min=9.5)	Negligible	No	1			
	Cracking – None evident	Negligible	No	1			
	Groundwater flow – None evident	Negligible	No	1			
	Surface Hydrology- nearby watercourse	Likely	Yes	3			
	Previous Instability – None	Negligible	No	1			
	Land Management - None	Negligible	No	1			
	Hazard Ranking					= 6 x 1	[6] Significant
	Control Measures						
	A) Micro for optimum position avoiding deep peat and slope risk;		E) For overburden and dedicated peat storage areas calculate the factor of safety against failure;				
	B) Pre-construction detailed geotechnical investigation and design;		F) Consider the changing properties of stockpiled materials including weathering protection;				
	C) Maintain hydrology of local area to prevent ponding or 'dam' effect'		G) Use experienced geotechnical personnel throughout investigation and monitoring;				
	D) Prevent surcharge loading of peat slopes;		H) Use experienced civil contractor with trained operators to design and implement CMS				
	Hazard Ranking with applied Control Measures					(Insignificant)	
T4 [273614E, 424722N]	Peat Depth (Mean = 0.8m)	Likely	Yes	3	8	1	1 (138m from surface water course)
	Slope Angle (4.3°)	Likely	Yes	3			
	FOS (Min = 21.6)	Negligible	No	1			
	Cracking – None evident	Negligible	No	1			
	Groundwater flow – None evident	Negligible	No	1			
	Surface Hydrology- nearby watercourse	Unlikely	No	2			
	Previous Instability – None	Negligible	No	1			
	Land Management - None	Negligible	No	1			
	Hazard Ranking					= 8 x 1	[8] Significant
	Control Measures						
	A) Micro for optimum position avoiding deep peat and slope risk;		E) For overburden and dedicated peat storage areas calculate the factor of safety against failure;				
	B) Pre-construction detailed geotechnical investigation and design;		F) Consider the changing properties of stockpiled materials including weathering protection;				
	C) Maintain hydrology of local area to prevent ponding or 'dam' effect'		G) Use experienced geotechnical personnel throughout investigation and monitoring;				
	D) Prevent surcharge loading of peat slopes;		H) Use experienced civil contractor with trained operators to design and implement CMS				
	Hazard Ranking with applied Control Measures					(Insignificant)	

Turbine ID	Contributory Factors to Potential Peat Failure	Probability of Causing a Peat Failure	Specific Control Required?	Probability Scale for Contributory Factors	Cumulative Rating	Impact Scale	Environmental Impact Scale
T5 [273942E, 425283N]	Peat Depth (Mean = 0.21m)	Negligible	No	1	5	1	1 (108m from surface water course)
	Slope Angle (5.9°)	Likely	Yes	3			
	FOS (Min = 58.2)	Negligible	No	1			
	Cracking – None evident	Negligible	No	1			
	Groundwater flow – None evident	Negligible	No	1			
	Surface Hydrology- nearby watercourse	Unlikely	No	2			
	Previous Instability – None	Negligible	No	1			
	Land Management - None	Negligible	No	1			
	Hazard Ranking					= 5 x 1	[5] Significant
	Control Measures						
	A) Micro for optimum position avoiding deep peat and slope risk;		E) For overburden and dedicated peat storage areas calculate the factor of safety against failure;				
	B) Pre-construction detailed geotechnical investigation and design;		F) Consider the changing properties of stockpiled materials including weathering protection;				
	C) Maintain hydrology of local area to prevent ponding or 'dam' effect'		G) Use experienced geotechnical personnel throughout investigation and monitoring;				
	D) Prevent surcharge loading of peat slopes;		H) Use experienced civil contractor with trained operators to design and implement CMS				
	Hazard Ranking with applied Control Measures					(Insignificant)	
T6 [274056E, 424852N]	Peat Depth (Mean = 0.69m)	Likely	Yes	3	6	1	1 (175m from surface water course)
	Slope Angle (5.9°)	Likely	Yes	3			
	FOS (Min = 3.9)	Negligible	No	1			
	Cracking – None evident	Negligible	No	1			
	Groundwater flow – None evident	Negligible	No	1			
	Surface Hydrology- None	Negligible	No	1			
	Previous Instability – None	Negligible	No	1			
	Land Management - None	Negligible	No	1			
	Hazard Ranking					= 6 x 1	[6] Significant
	Control Measures						
	A) Micro for optimum position avoiding deep peat and slope risk;		E) For overburden and dedicated peat storage areas calculate the factor of safety against failure;				
	B) Pre-construction detailed geotechnical investigation and design;		F) Consider the changing properties of stockpiled materials including weathering protection;				
	C) Maintain hydrology of local area to prevent ponding or 'dam' effect'		G) Use experienced geotechnical personnel throughout investigation and monitoring;				
	D) Prevent surcharge loading of peat slopes;		H) Use experienced civil contractor with trained operators to design and implement CMS				
	Hazard Ranking with applied Control Measures					(Insignificant)	

Turbine ID	Contributory Factors to Potential Peat Failure	Probability of Causing a Peat Failure	Specific Control Required?	Probability Scale for Contributory Factors	Cumulative Rating	Impact Scale	Environmental Impact Scale
T7 [274352E, 425088N]	Peat Depth (Mean = 0.27m)	Negligible	No	1	3	1	1 (176m from surface water course)
	Slope Angle (6.9°)	Likely	Yes	3			
	FOS (Min = 6.7)	Negligible	No	1			
	Cracking – None evident	Negligible	No	1			
	Groundwater flow – None evident	Negligible	No	1			
	Surface Hydrology- None	Negligible	No	1			
	Previous Instability – None	Negligible	No	1			
	Land Management - None	Negligible	No	1			
	Hazard Ranking					= 3 x 1	[3] Insignificant
	Control Measures						
	A) Micro for optimum position avoiding deep peat and slope risk;		E) For overburden and dedicated peat storage areas calculate the factor of safety against failure;				
	B) Pre-construction detailed geotechnical investigation and design;		F) Consider the changing properties of stockpiled materials including weathering protection;				
	C) Maintain hydrology of local area to prevent ponding or 'dam' effect'		G) Use experienced geotechnical personnel throughout investigation and monitoring;				
	D) Prevent surcharge loading of peat slopes;		H) Use experienced civil contractor with trained operators to design and implement CMS				
	Hazard Ranking with applied Control Measures					(Insignificant)	
T8 [274550E, 425431N]	Peat Depth (Mean = 0.35m)	Negligible	No	1	3	1	1 (250m from surface water course)
	Slope Angle (8.1°)	Likely	Yes	3			
	FOS (Min = 13.3)	Negligible	No	1			
	Cracking – None evident	Negligible	No	1			
	Groundwater flow – None evident	Negligible	No	1			
	Surface Hydrology- None	Negligible	No	1			
	Previous Instability – None	Negligible	No	1			
	Land Management - None	Negligible	No	1			
	Hazard Ranking					= 3 x 1	[3] Insignificant
	Control Measures						
	A) Micro for optimum position avoiding deep peat and slope risk;		E) For overburden and dedicated peat storage areas calculate the factor of safety against failure;				
	B) Pre-construction detailed geotechnical investigation and design;		F) Consider the changing properties of stockpiled materials including weathering protection;				
	C) Maintain hydrology of local area to prevent ponding or 'dam' effect'		G) Use experienced geotechnical personnel throughout investigation and monitoring;				
	D) Prevent surcharge loading of peat slopes;		H) Use experienced civil contractor with trained operators to design and implement CMS				
	Hazard Ranking with applied Control Measures					(Insignificant)	

Turbine ID	Contributory Factors to Potential Peat Failure	Probability of Causing a Peat Failure	Specific Control Required?	Probability Scale for Contributory Factors	Cumulative Rating	Impact Scale	Environmental Impact Scale
T9 **[274234E, 425679N]**	Peat Depth (Mean = 0.43m)	Negligible	No	1	**7**	**1**	**2** (<22m from surface water course)
	Slope Angle (6.3°)	Likely	Yes	3			
	FOS (Min=11.1)	Negligible	No	1			
	Cracking – None evident	Negligible	No	1			
	Groundwater flow – None evident	Negligible	No	1			
	Surface Hydrology- Nearby watercourse	Highly Likely	Yes	4			
	Previous Instability – None	Negligible	No	1			
	Land Management – None	Negligible	No	1			
	Hazard Ranking					= 7 x 2	[14] Substantial
	Control Measures						
	A) Micro for optimum position avoiding deep peat and slope risk and away from watercourse;	E) For overburden and dedicated peat storage areas calculate the factor of safety against failure;					
	B) Pre-construction detailed geotechnical investigation and design;	F) Consider the changing properties of stockpiled materials including weathering protection;					
	C) Maintain hydrology of local area to prevent ponding or 'dam' effect'	G) Use experienced geotechnical personnel throughout investigation and monitoring;					
	D) Prevent surcharge loading of peat slopes;	H) Use experienced civil contractor with trained operators to design and implement CMS					
	Hazard Ranking with applied Control Measures					(Insignificant)	

8. Summary of Construction Risks and Management

8.1.1. Construction Risks

The factors which influence natural and induced peat slope failures were discussed in detail in Section 2.1. The following construction related factors are highlighted for consideration:

- Movement can occur following over-loading of peat slopes, e.g. by placement of fill, stockpiling and end-tipping directly onto peat slopes;
- Suitability of drainage measures and the prevailing groundwater conditions are also key factors to consider during construction. Increasing pore water pressures within peat deposits decreases the stability of a slope;
- In extreme events, peat can act as a viscous fluid and travel over very shallow slopes. The re-working or excessive handling of peat can reduce the shear strength to residual levels and hence lead to ‘liquid’ peat behaviour;
- The rate of construction can have a major influence on the stability of peat land environments. Rapid loading and limited time for excess pore pressure dissipation can also decrease the stability state of peat slopes;
- Excavation across a side slope, in particular a convex slope / break in slope can induce peat failure.

The consequence of peat failure at the development may result in a number of negative impacts; external public infrastructure has been excluded due to the remote nature of the proposed development. Therefore the most significant but unlikely impact is considered to be death or injury to site personnel. More likely is disruption to the proposed infrastructure through infrastructure damage leading to time and cost impacts on the development. Impact through degradation of the hydrological and peat land environment has been considered. Impacts such as the contamination of surface water courses are considered as this may in turn impact ground water supplies, this is particularly high risk at T09 where the turbine location is extremely close to a minor water course.

8.1.2. General Risk Management Recommendations

The following recommendations, when incorporated into the design of the project will assist in the management of the risk from peat instability:

- The use of experienced and competent construction contractors;

Detailed monitoring programme of geomorphology and hydrology across the critical areas as part of the construction management; this should be focussed across all infrastructure elements where a hazard ranking of ‘Significant’ or higher has been identified; map reference: GB200135_M_010_C, Appendix I, as well as areas with high Environmental Impact, in the case of Dunbeg generally located in close proximity to watercourses identified on map reference: GB200135_M_008_C Appendix C;

- Refine the environmentally sensitive zones across the site and integrate these areas into the detailed Construction Method Statement (CMS);
- Implement appropriate peat mitigation measures at T09 to protect nearby watercourses, including diversion of minor water course away from construction works.
- Review micro-siting options if further detailed analysis reveals significant or substantial hazard rank areas.
- Apply conservative design parameters across the elevated hazard zones (i.e. where undrained shear strengths are low and there is shallow groundwater interaction);
- Produce a robust drainage design which preserves the natural hydrological regime across the development. The control of silt and suspended solids should be carefully planned to avoid detrimental environmental effects. All drainage discharges should be under consent from the relevant SEPA control unit and performed in an environmentally compliant manner;
- A documented procedure should be in place and rapid reaction strategy in place prior to the commencement of construction on peatland. This strategy should be easily enacted should signs of peat movement be recorded

across the development. This approach requires periodic and continued monitoring of the construction process by a suitably qualified geotechnical engineer;

- A detailed Construction Method Statement (CMS) should incorporate the conclusions of the peat stability report and continuously update the assessment and develop appropriate mitigations to respond to the peat slide risk;
- A Geotechnical Risk Register should be maintained as a 'live' document and updated and amended as required throughout the pre-construction and construction phase of development.

The proposed turbine layout design has been arrived at through an iterative design process. The design has included consideration across a wider set of environmental constraints. As part of this process specific consideration including steepness of terrain, peat depth and associated environmental sensitivities has been given. The proposed layout has emerged from an iterative design process during which technical requirements; environmental and visual considerations have been identified and addressed. During this process the proposed development has sought to avoid steep terrain and areas of deep peat where practicable. Where significant layout changes are implemented it is recommended that the peat stability assessment is updated accordingly.

9. Amended Infrastructure Layout

As part of the design evolution an amended layout was provided to Natural Power on 04/09/2017 with the following amendments to infrastructure:

- Use of the upgraded track utilising an existing track present on the site. This is at locations close to the site entrance and between T5 and T6
- Some of the turning spaces have swapped sides.
- Construction Compound and substation have moved North West.
- Tracks have changed slightly

The revised locations of infrastructure (track, hardstandings and substation) are all situated within low risk areas in terms of peat slide risk and proximity to water courses

It should be noted that the original assessment was undertaken for the original site boundary which covered a much greater area around the wind farm infrastructure, the site boundary has since been greatly reduced to cover only the area immediately surrounding the infrastructure. This is why the presented results show information out with the current site boundary.

10. Conclusions

The peat depths across the site are predominantly shallow (<1m). It should be noted that where peat probes indicate shallow depths 0.1m to 0.3m that the deposits are likely to be composed of a topsoil and subsoil and that conditions conducive to the formation of peat are isolated to areas of wet flush where saturated ground conditions prevail. This is supported by the high shear vane values reported across the site within shallower deposits.

The mean un-drained shear strength determined across the Development is high (32.9kPa)

It can be concluded that conditions conducive to peat instability across the site are largely unlikely to be present. This is due to the low peat depths (<1m) and the high un-drained shear strengths calculated. Therefore the hazard or likelihood of a peat landslide event occurring is low.

Limited cover of superficial deposits highlights a low risk of mass movement. This is supported by BGS data which **does not** highlight any mass movement across the site.

Some significant, and substantial hazard rankings have been assigned to the proposed turbine bases. The main contributory factors are the Environmental Impact Scale, highly influenced by proximity to water courses on the site, and slope angle. The risk ratings are a combination of the likelihood and the effect of a peat landslide event. With increased proximity to watercourses the effect or exposure of such an event is vastly increased as watercourses act as a sensitive off-site receptor. This consequently increases the risk ranking for these locations but is not indicative of conditions conducive to peat instability on this site.

The derived risk rankings are based on the risk of peat failure occurring without appropriate mitigation and control measures in place during construction. It should be highlighted that through geotechnical risk management, strict construction management and implementation of relevant control measures the risk of peat failure or environmental event across the development will be reduced to “Insignificant” residual levels for all infrastructure locations.

The qualitative risk assessment should be reviewed prior to construction and further refined as part of future intrusive ground investigation. If more accurate data is available at the pre-construction stage the analysis should be reviewed and updated accordingly. The respective risk ratings should be central to development of the Construction Method Statement (CMS) in order to ensure that extra care is taken with respect to the contributory factors at the time of the construction process and that geotechnical risk is adequately managed.

11. Recommendations

The preliminary geotechnical risk register for peat at the development cites key control measures which are required to reduce the risk of peat slide to residual levels. These control measures apply to the infrastructure locations. However there should be wider consideration of these measures across all areas of the proposed development which may be influenced by the proposed construction. This is critical where infrastructure may impact terrain and slope conditions beyond the proposed working areas.

- A detailed intrusive ground investigation should be carried out (post-consent) and as part of the pre-construction phase of development. This investigation should seek to further characterise the peat deposits with emphasis on, advanced in-situ shear strength testing and targeted undisturbed sampling and laboratory testing. All peat samples recovered should be classified in accordance with the Von Post system, (Hobbs, 1986) and current British and Eurocode standards for site investigation.
- In-situ large diameter shear vane testing should be undertaken at proposed infrastructure locations, where peat depth is greater than 0.5m. The test should be implemented at 0.3m depth intervals using a drive in shear vane such as the mechanical Geonor H-10 (75mm diameter vane). At each test location at least one vane test should be carried out within the lowest 0.2m of peat and in the underlying substrate if applicable. The applicability of more advanced in-situ test methods should also be considered.
- Laboratory based shear strength testing should be undertaken on recovered undisturbed peat samples. This should approximate to 10% of the number of shear vane testing, in order to validate in-situ shear vane results. Selected test samples should be undisturbed as far as is practicable and testing performed under laboratory quick, un-drained triaxial conditions. Natural moisture content tests should be undertaken for all samples recovered. Testing at a range of depths and locations is important to ensure spatial variability is represented. Advanced laboratory testing may also be implemented depending upon the quality of samples obtained. These may comprise a series of direct simple shear tests which may provide a more representative shear strength result.
- Groundwater level information should be collated as part of any future ground investigation;
- The results of a detailed ground investigation should be assessed with respect to refining the peat stability assessment at all infrastructure locations. All pertinent control measures and mitigation measures should be revised and their implementation supervised following the results of the ground investigation and construction design phase of works.
- Continued assessment and monitoring throughout the construction phase of works and at suitable intervals post construction should be implemented to ensure the control measures are suitable and are providing adequate mitigation against peat slide.

T09 is located close to a water course and the relocation or micrositing of this turbine away from this water course or the diversion of this water course away from the turbine location should be considered to avoid environmental impact of construction and groundworks close to this water course.

11.1. Construction Method Statement

Construction practices shall be managed through the Construction Method Statement (CMS) and within the wider context of the Construction Environmental Management Plan (CEMP). The CMS should be prepared by the appointed principal contractor and reviewed by a suitably experienced geotechnical engineer who has read and understood this report. The following general recommendations are provided in line with the Good practice during wind farm construction, (2010) guidance:

- Avoidance of arisings being placed as local concentrated loads on peat slopes without first establishing the stability condition of the ground and slope system. Stockpiling on areas of deep peat and in close proximity to steep slopes should be avoided.
- Avoidance of uncontrolled and concentrated surface water discharge onto peat slopes as this may act as contributory factor to failure. All water discharged from excavations during construction phase should be directed away from all areas identified as susceptible to peat failure and should managed by a suitably designed site drainage management plan.
- All excavations where required should be adequately supported to prevent collapse and the destabilising peat deposits adjacent to excavations.
- A system of daily reporting should be established during construction and utilised to monitor the geotechnical performance of slopes including peat, sub-soil and bedrock. This should be implemented and undertaken by a suitable experienced and qualified geotechnical engineer. Post construction this monitoring procedure should be curtailed to allow for annual or ad-hoc inspection as required.

11.1.1. ‘Floating’ Track Construction

MacCulloch, (2005) advises that a ‘floating’ type road construction which leaves the peat deposits in situ may be advantageous with respect to preventing peat failure. This method of construction has a lower impact on the internal groundwater flow within the peat land. However there are cases where groundwater flow within the peat can be detrimentally affected. The following control measures should be implemented as part of the design and construction of ‘floating’ access track:

- Prevent the rupture of vegetation surface of the peat by avoiding the use of large sharp rock fill;
- Prevent the overloading and subsequent shearing of the peat throughout construction and use of the ‘floating’ track;
- Prevent the collapse of integral drainage channels through ongoing monitoring and maintenance;
- Monitoring of the long term settlement of the ‘floating’ track is necessary to predict the effects of reducing permeability within the peat and hence increasing groundwater pressures beneath the track construction. Through ongoing monitoring additional drainage relief measures can be implemented when conditions for peat failure are predicted;
- Do not position ‘floating’ access track on or adjacent to convex side slopes.

An additional control on the construction and use of ‘floating’ track is through the strict management of construction traffic loading. This may involve the timing between heavy traffic to be staggered to prevent the effect of cyclic loading over short time periods reducing the shear strength of the peat. In order to assess the maximum loading rate or timing between heavy construction traffic it may be necessary to monitor the vertical deformation of the ‘floating’ track sections following loading and recording the time taken for recovery of vertical deformation. The use of simple settlement plates and survey pegs can be used to achieve this. The frequency of trafficking for heavy loads must then be timed to allow deformation of the ‘floating’ road to recover its deformation.

MacCulloch, (2005) generally advises that in order to prevent injury or an environmental incident, it is important that there is a robust procedure in place should it become apparent that a peat failure is imminent.

11.1.2. 'Cut' Track Construction

Across areas of the Development not mantled by deep blanket peat as found at Dunbeg South the construction of proposed access tracks should be considered by excavation and replacement method, (MacCulloch, 2005). Excavated peat is carefully placed along bunds at either side of the access track. Imported aggregate would be used to form the subgrade and running surface of the track.

For 'Cut' track construction the risk of peat failure is therefore focussed on the peat deposits adjacent to the access track, and the placement of peat arisings. In these areas the following control measures are listed by MacCulloch, (2005):

- Careful excavation of peat deposits by appropriate machine excavator to limit localised peat failures which can occur on the edge of the track excavation. This is in order to prevent a minor failure triggering retrogressive peat failure affecting a larger area of peat adjacent to the track;
- Temporary drainage systems followed by establishment of a permanent drainage network. Silt traps and small retaining structures may be required especially in proximity to water crossings to prevent siltation and blockage of watercourses;
- Ongoing monitoring and on demand maintenance when silt traps require emptying and temporary drainage reinstated if blocking occurs. This will assist in maintaining hydrology baseline conditions;
- The permanent drainage system must direct surface water flow away from the 'cut' track to prevent peat failure within the track bunds.

11.1.3. Existing Track Upgrade

There is an existing farm track on the Dunbeg South wind farm site. The upgrade of this track has been identified as a possibility for two sections along the access track. This method of construction will require the existing track to be widened and surface upgrades of the existing track to ensure it is laid to the required engineering specification. The widening of the track will be performed similarly to the cut track method discussed above.

The locations where upgraded track is proposed are both in areas of shallow peat. Peat probes depths measured along the proposed upgraded areas are generally 0.1 - 0.2m, this is expected to be peaty topsoil. It is envisaged the peat cut in making this widening will be very small and easily incorporated in the verge of the tracks.

11.1.4. Foundation Excavation and Crane Pads

Where excavation into deep areas of peat is unavoidable; the use of a rock cofferdam or rock fill ring structure around the excavation should be considered. The rock retaining wall should be designed to retain peat and groundwater from an excavation and prevent ingress or failure on the periphery of the working area. This technique may not be required for the proposed turbine locations due to the low peat depth and low Hazard Rankings. This should be re-assessed following detailed site investigation (post-consent).

Piling of turbine foundations should also be considered at the detailed design stage. This method of foundation construction can reduce the requirement for deep and large excavations within peat and hence reduce the associated risk of failure when excavating. Full consideration must however be given to the plant requirements and working area which may need to be formed on a 'floated' hard standing or working platform. Control measures relevant to these elements are addressed is Section 10.1.1.

Rock fill displacement methods, which are sometimes employed for crane pads in deep peat, should be subject to thorough risk assessment, particularly in the vicinity of slope crests where the lateral loading may add to slope destabilising forces.

11.1.5. Drainage Measures

Environmentally compliant drainage designs for the proposed Development will form a primary control and mitigation for maintaining surface hydrology and shallow groundwater flow across the Development.

Detailed design for drainage measures is out with the scope of this report. Further advice and recommendations for site specific drainage measure on Dunbeg South Wind Farm are provided in Chapter 9 of the Environmental Statement.

All drainage management plans including any proposed drainage blocking should be agreed with the relevant statutory bodies prior to starting construction

11.1.6. Earthworks

It has been identified that there is a likely requirement for the excavation of considerable volumes of peat and superficial deposits during construction of the wind farm. Initially the vegetated peat layer and any topsoil should be stripped and temporarily stockpiled away from areas of deep peat. The design of this stockpile must be agreed by a suitably qualified geotechnical engineer. When working in areas of deep peat (i.e. >1.5m) no peat or overburden should be stored on such deposits as this may lead to instability.

The following options for peat storage may be considered:

- Dedicated peat storage area, designed under the advisement of a suitable qualified geotechnical engineer and conform to up to date SEPA regulations and waste directives.
- Removal of excess material off site to a licensed disposal area (It is anticipated that due to the large volumes of peat and remote nature of the site removal of peat off site is not a preferred option).
- Re-use of peat in dressing off of batters on access tracks, finishing of cable trenching works, the landscaping of turbine bases. Excavated glacial till and weathered rock may be used as backfill to turbine bases should material be deemed geotechnically suitable. All related works must be carried out in accordance with an agreed CEMP and conform to site restoration plans.

For in-situ and undisturbed peat; site vehicle movements must be minimised across such areas, throughout construction and post construction. Observation and monitoring for settlement, deformation or signs of failure along access tracks and critical working areas must be implemented. This may be achieved with a network of settlement plates and survey markers which can be periodically re-surveyed and any differential movements identified. It is recommended that all earthworks are designed in accordance with current standards. Suitable guidance for temporary workings in peat is outlined in Table 11.1 below, after Construction Health and Safety, Earthworks, (2005). Observations suggest ‘soft non-fibrous wet peat’ is predominant on site.

Table 11.1: Temporary Slope Geometry (1-14 days)

Peat Type	‘Dry’ Site* Degrees from horizontal (min/max)	‘Wet’ Site**
Soft non-fibrous	10/20	5 / 10
Firm non-fibrous	15/25	10 / 15
Firm fibrous	35/40 (6)	20 / 25 (6)
Stiff fibrous	35/45 (6) (7)	25 / 35 (6) (7)

’Dry’ Site: minor or no seepage from excavation faces, with minor or no surface runoff.

***’Wet’ Site: submerged or widespread seepage from excavated faces*

11.1.6.1. Potential Peat Storage Area

The following areas have been identified as potential temporary peat storage locations based on their distance from water courses, low volume of peat, slope angle and proximity to infrastructure to limit transport of peat around the site.

Source: Natural Power

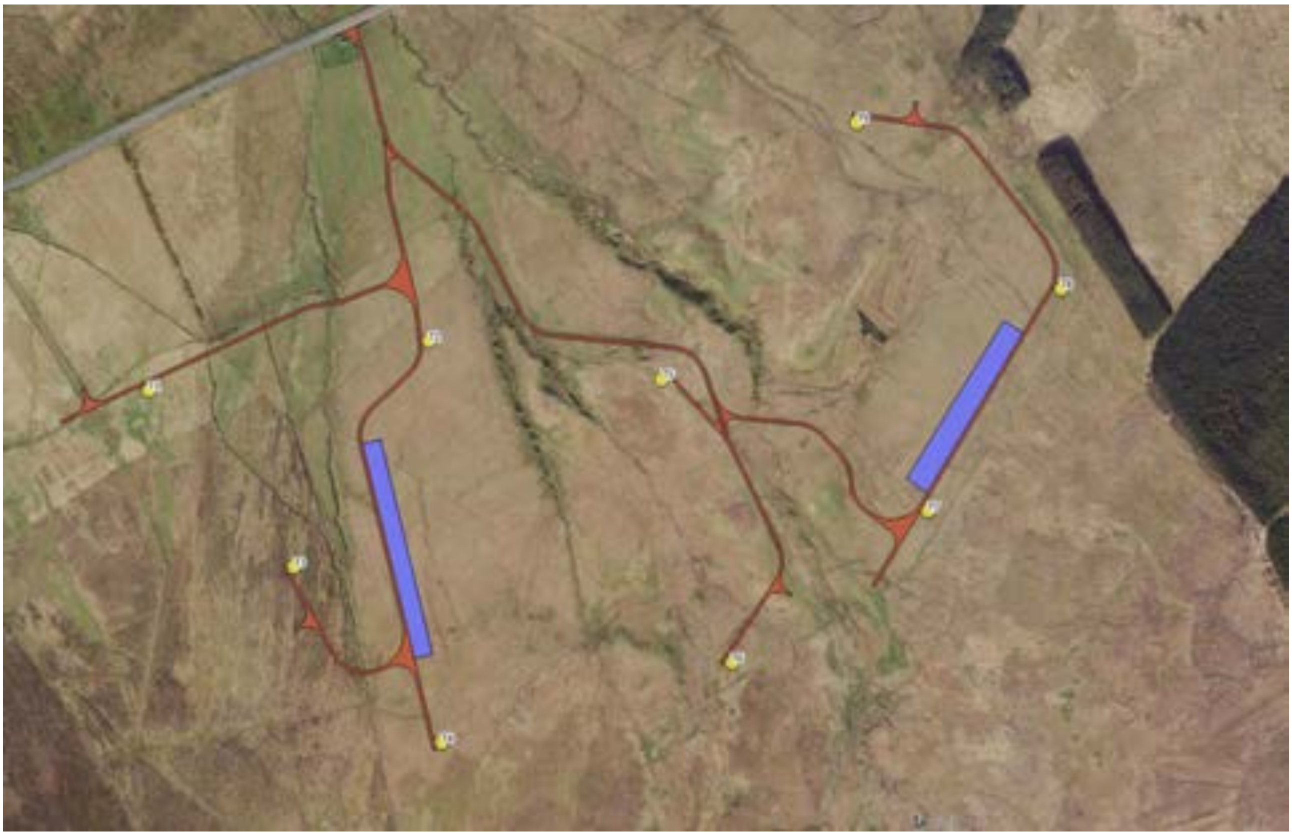

Figure 11.1: Potential Temporary Peat Storage locations shown in blue.

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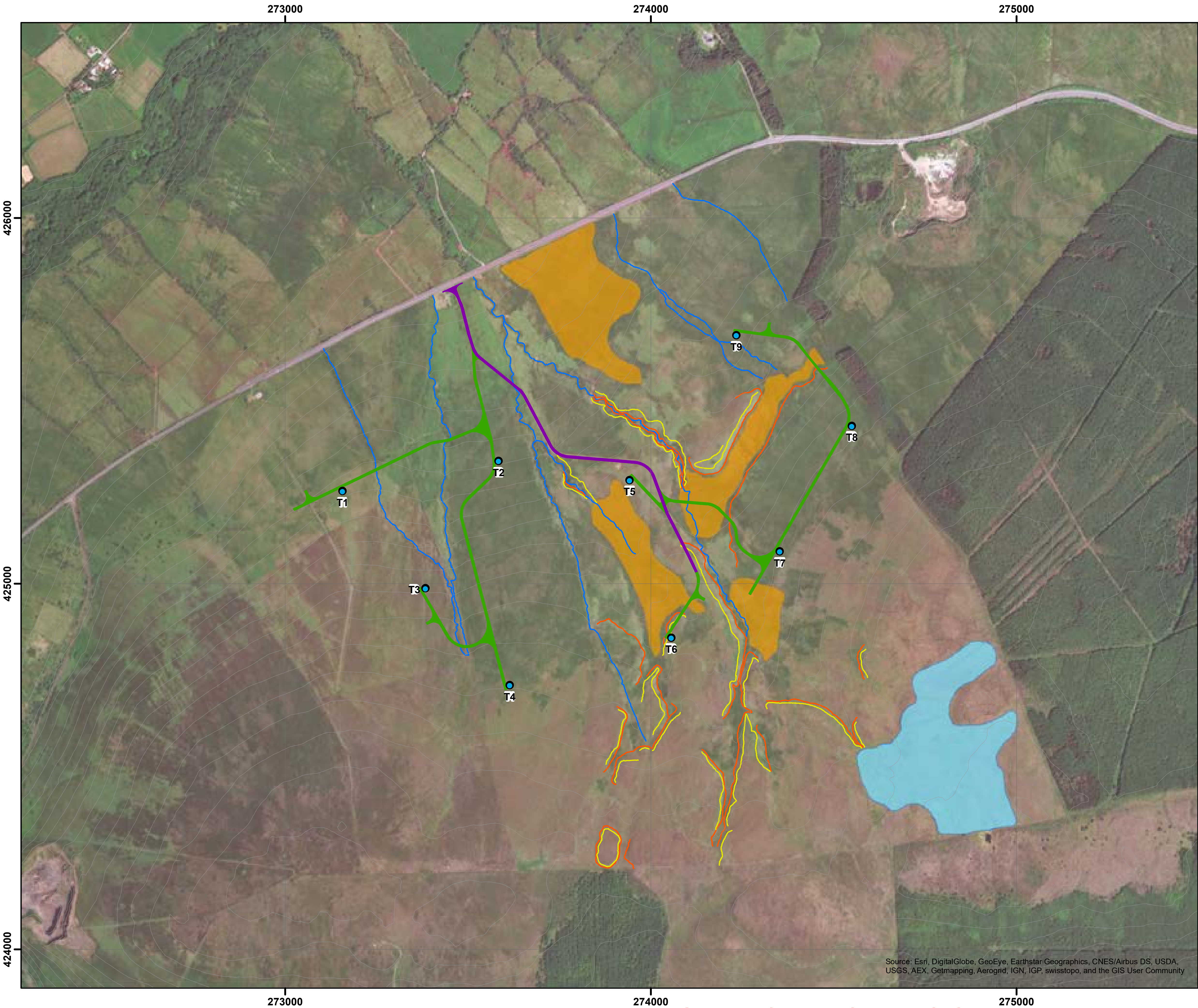
Appendices

A. Geomorphological Map



Project:

Dunbeg South Wind Farm, Co. Londonderry, Northern Ireland

Title:

Geomorphology Map

Key

- Proposed turbine
- Proposed new track
- Exisiting track to be upgraded
- 10 m Contours
- Convex break in slope
- Concave break in slope
- Water course
- Saturated ground
- Peat cutting

Notes:

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Scale @ A3: 1:10,000

Coordinate System: TM65 Irish Grid

0 125 250 500 m

N

Date: 30-10-17	Prepared by: IW	Checked by: MA
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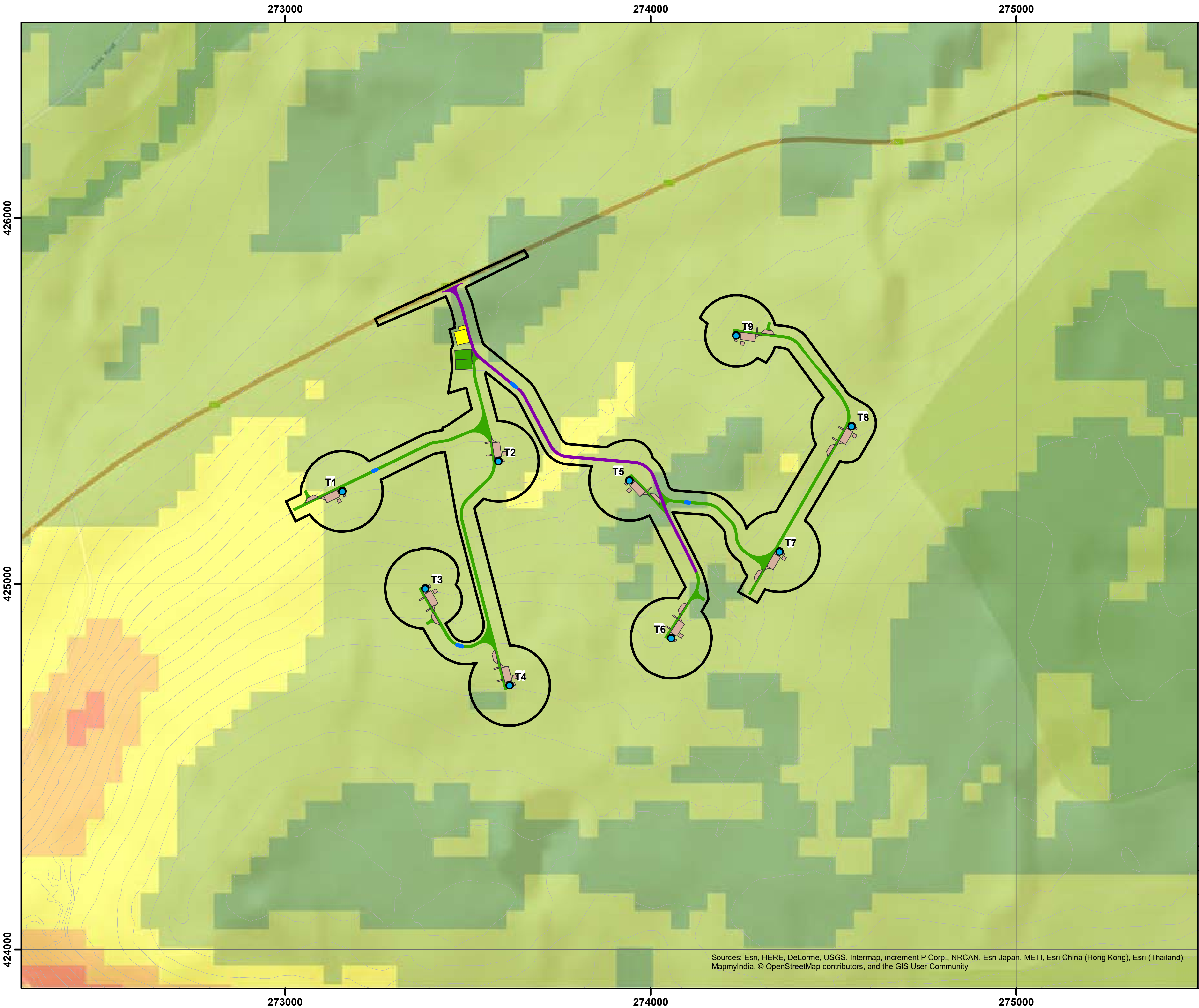
B. Slope Angle Map



Project:

Dunbeg South Wind Farm, Co. Londonderry, Northern Ireland

Title:

Slope Angle

Key

- Planning application boundary
- Proposed turbine
- Proposed crane pad
- Proposed compound and energy storage area
- Proposed substation
- Proposed new track
- Exisiting track to be upgraded
- Water crossing
- 10 m contour

Slope angle

- 0 - 4°
- 4 - 10°
- 10 - 16°
- 16 - 20°
- >20°

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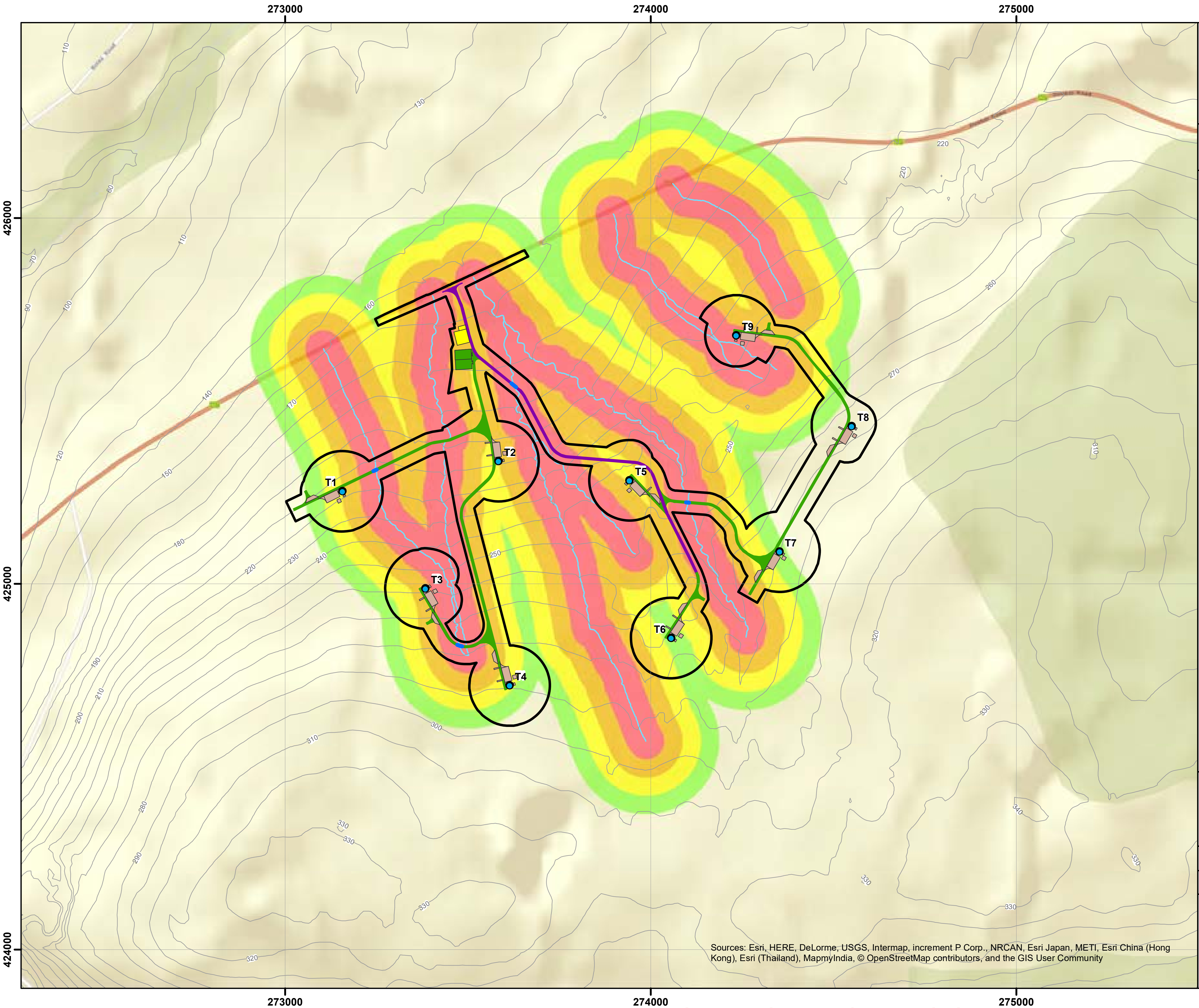
C. Environmental Impact Zonation Map (EIZM)



Project:

Dunbeg South Wind Farm, Co. Londonderry, Northern Ireland

Title:

Environmental Impact Zones

Key

- Planning application boundary
- Proposed turbine
- Proposed crane pad
- Proposed compound and energy storage area
- Proposed substation
- Proposed new track
- Exisiting track to be upgraded
- Water crossing
- 10 m contour
- Watercourse

Environmental impact zones

- 4 (0 - 50 m from watercourse)
- 3 (50 - 100 m from watercourse)
- 2 (100 - 150 m from watercourse)
- 1 (150 - 200 m from watercourse)

Notes:

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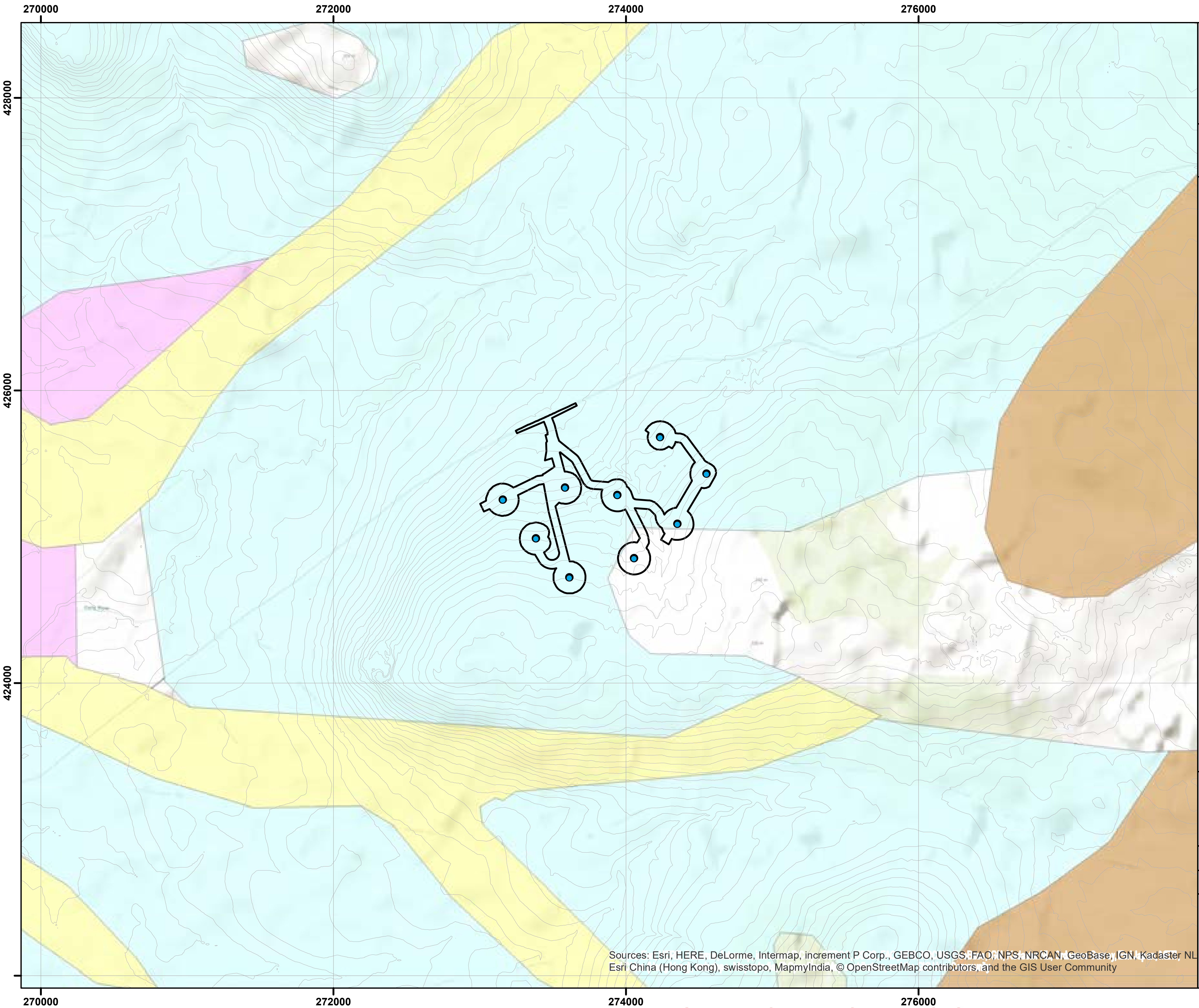
D. Superficial Geology Map



Project:

Dunbeg South Wind Farm, Co. Londonderry, Northern Ireland

Title:

Superficial Geology Map

Key

Planning application boundary

Proposed turbine

10 m Contour

UK 625k superficial geology

Peat

Alluvium

Glacial sand and gravel

Till

No superficials

Source: Onshore GeoIndex British Geological Survey

Notes:
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Scale @ A3: 1:25,000

Coordinate System: TM65 Irish Grid

0 0.25 0.5 1 km

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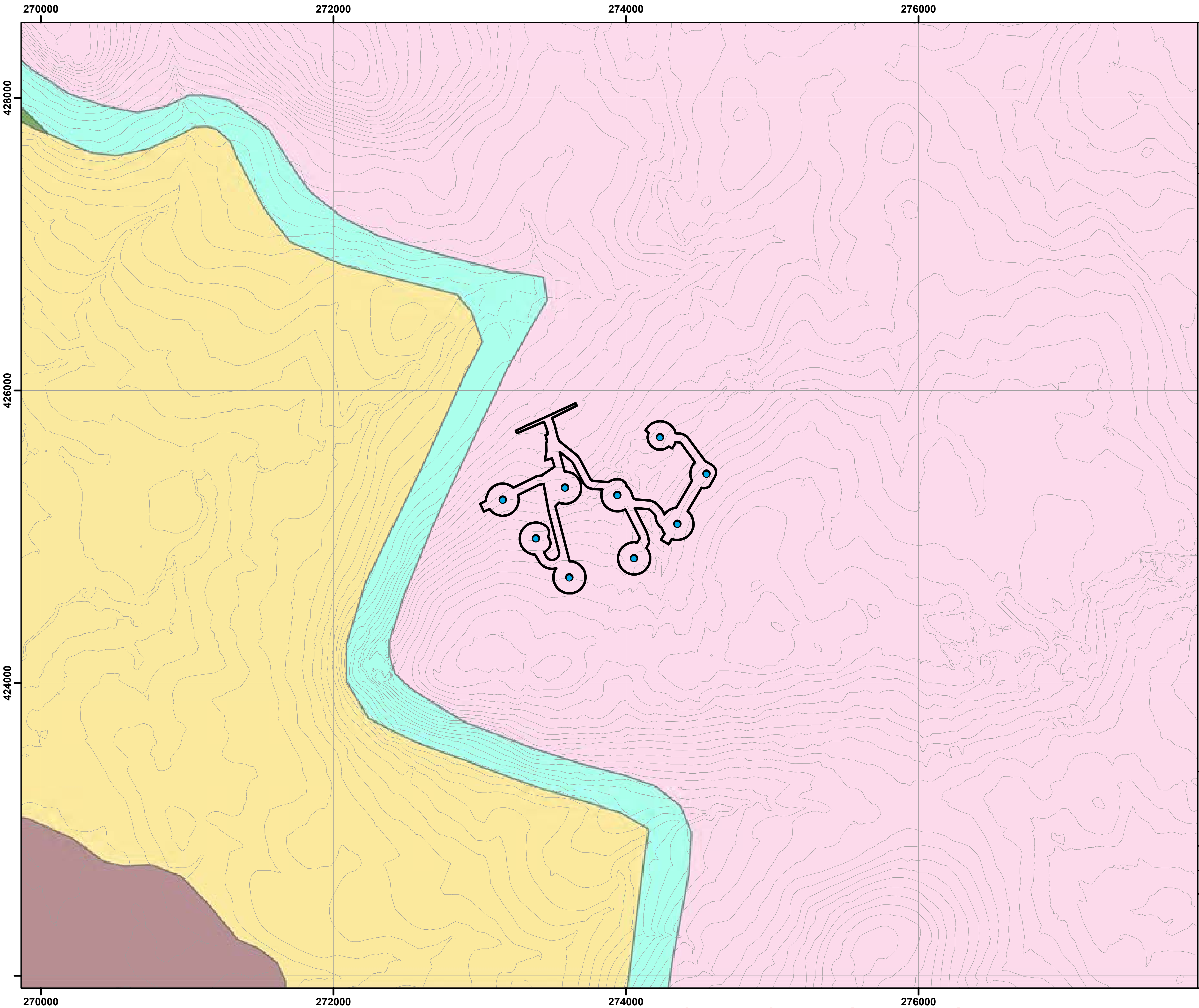
E. Solid Geology Map



Project:

Dunbeg South Wind Farm, Co. Londonderry, Northern Ireland

Title:

Solid Geology Map

Key

- Planning application boundary
- Proposed turbine
- 10 m contours

Formation

- Upper Basalt formation
- Upper Cretaceous limestone
- Lr Jurassic mudstone
- Triassic sandstone
- COURCEYAN "basal clastics"

Source: Onshore GeoIndex British Geological Survey

Notes:

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Scale @ A3: 1:25,000

Coordinate System: TM65 Irish Grid

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F. Peat Depth Contour Map

Project:

Dunbeg South Wind Farm, Co. Londonderry, Northern Ireland

Title:

Peat Depth

Key

- Planning application boundary
- Proposed turbine
- Proposed crane pad
- Proposed compound and energy storage area
- Proposed substation
- Proposed new track
- Exisiting track to be upgraded
- Water crossing
- Peat probe
- 10 m contour

Peat depth (m BGL)

- 3.75 - 4.00
- 3.50 - 3.75
- 3.25 - 3.50
- 3.00 - 3.25
- 2.75 - 3.00
- 2.50 - 2.75
- 2.25 - 2.50
- 2.00 - 2.25
- 1.75 - 2.00
- 1.50 - 1.75
- 1.25 - 1.50
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- 0.75 - 1.00
- 0.50 - 0.75
- 0.25 - 0.50
- 0.00 - 0.25

Notes:

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Scale @ A3: 1:10,000

Coordinate System: TM65 Irish Grid

0 0.125 0.25 0.5 km

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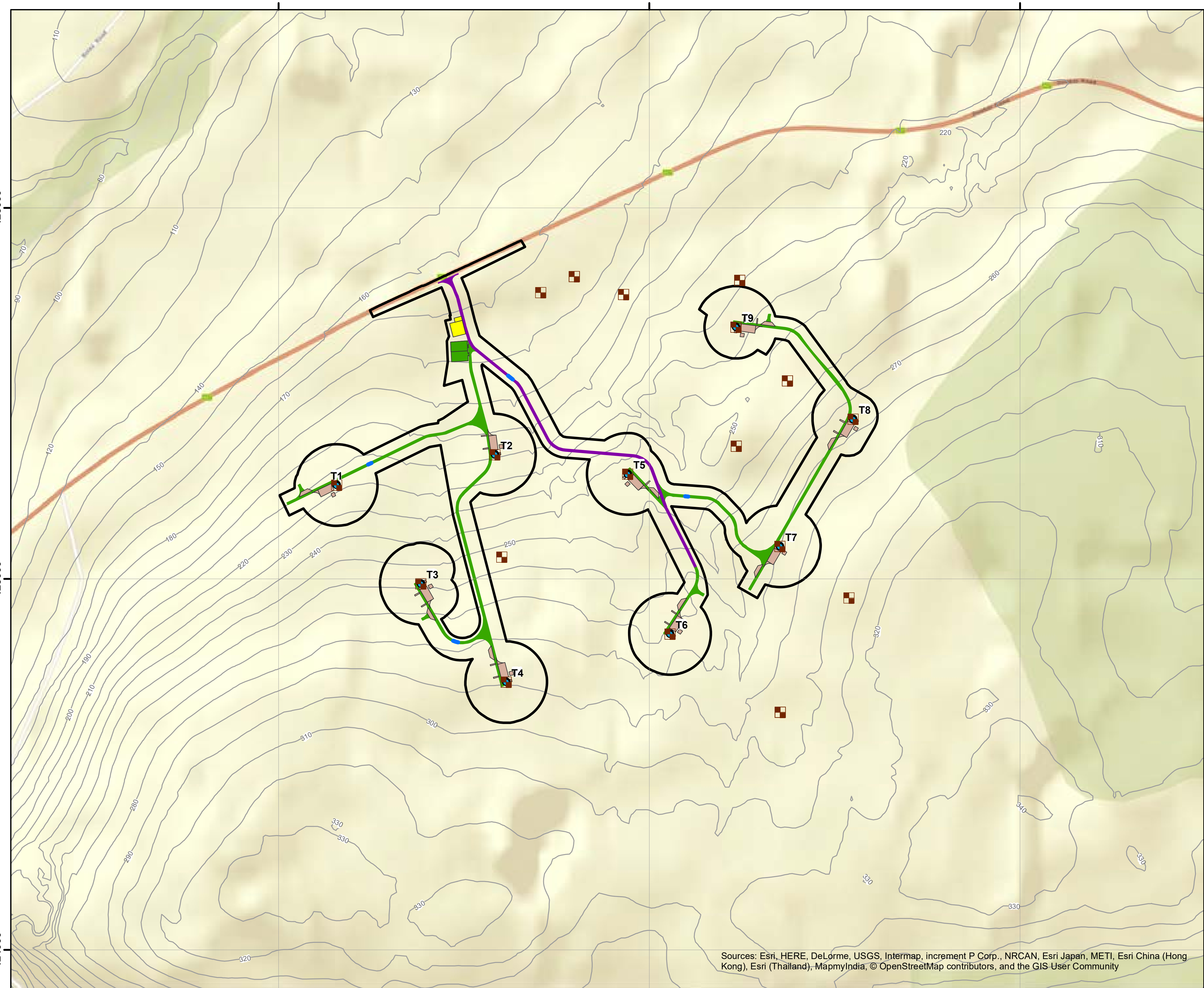
G. Hand Shear Vane Locations



Project:

Dunbeg South Wind Farm, Co. Londonderry, Northern Ireland

Title:

Shear Vane Locations

Key

- Planning application boundary
- Proposed turbine
- Proposed crane pad
- Proposed compound and energy storage area
- Proposed substation
- Proposed new track
- Exisiting track to be upgraded
- Water crossing
- 10 m contour
- Shear vane

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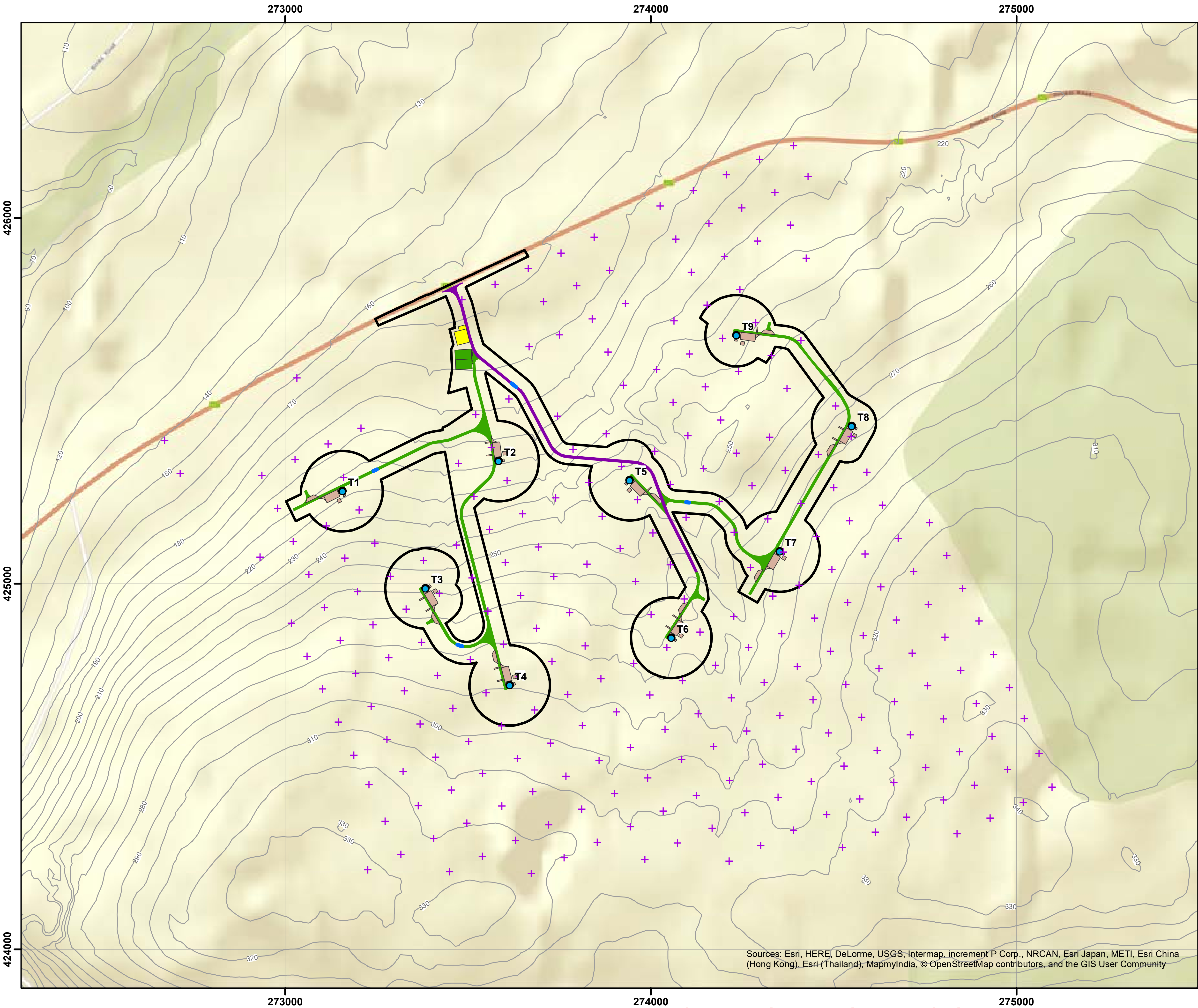
H. Peat Core Locations



Project:

Dunbeg South Wind Farm, Co. Londonderry, Northern Ireland

Title:

Peat Core Locations

Key

- Planning application boundary
- Proposed turbine
- Proposed crane pad
- Proposed compound and energy storage area
- Proposed substation
- Proposed new track
- Exisiting track to be upgraded
- Water crossing
- 10 m contour
- Peat core

Notes:

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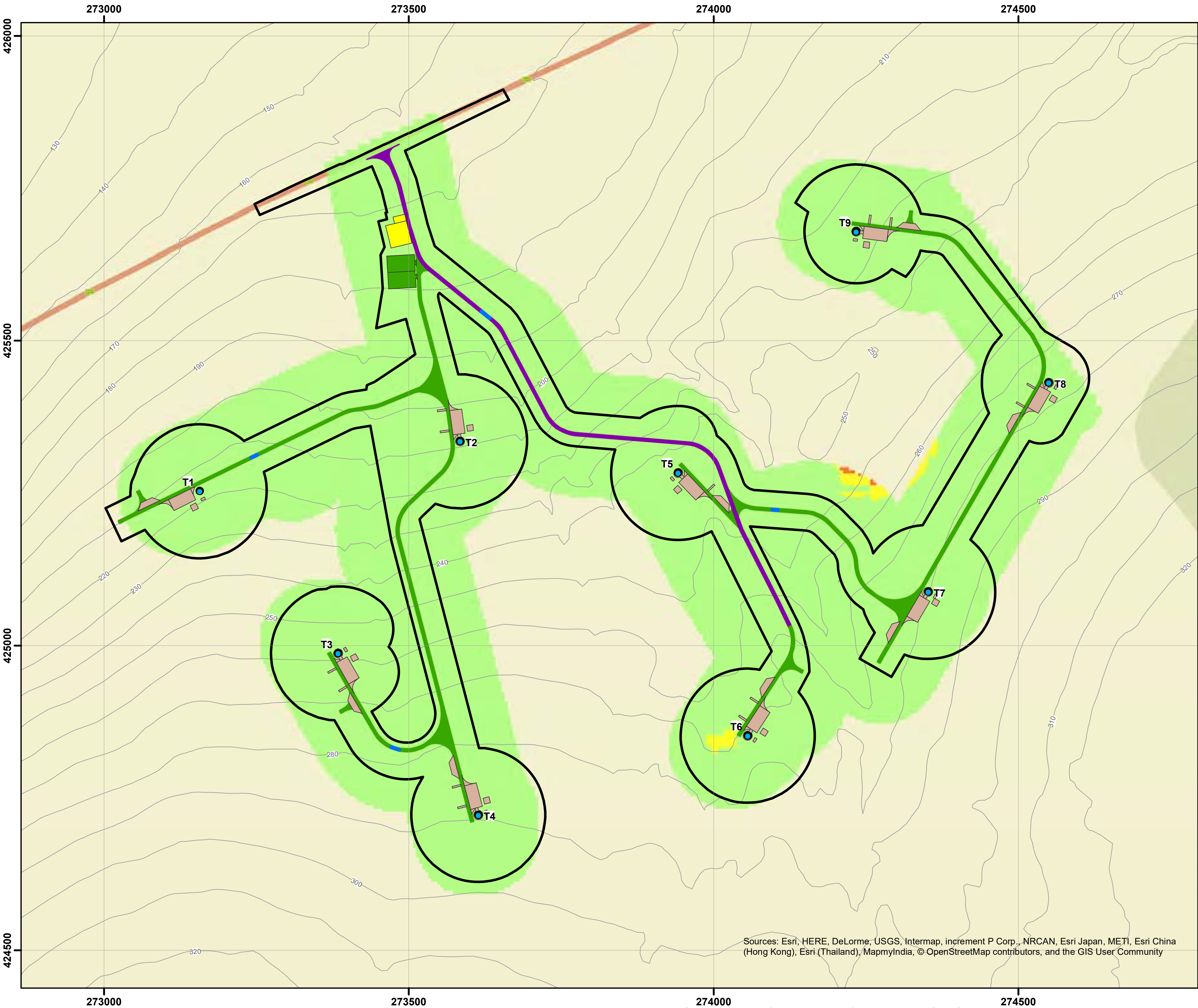
I. Peat Slide Risk Ranking



Project:

Dunbeg South Wind Farm, Co. Londonderry, Northern Ireland

Title:

Peat Slide Risk Ranking

Key

- Planning application boundary
- Proposed turbine
- Proposed crane pad
- Proposed compound and energy storage area
- Proposed substation
- Proposed new track
- Exisiting track to be upgraded
- Water crossing
- 10 m contour

Peat slide risk ranking

- 1 - Insignificant (Cu > 2.00 Cu_{min})
- 2 - Significant (Cu <= 2.00 Cu_{min})
- 3 - Substantial (Cu <= 1.25 Cu_{min})
- 4 - Serious (Cu < Cu_{min})

N.B. There are no serious risk areas.

Notes:

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Scale @ A3: 1:6,000

Coordinate System: TM65 Irish Grid

0 50 100 200 m

N

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What we do

Natural Power is a leading independent renewable energy consultancy and products provider. The company offers proactive and integrated consultancy, management and due diligence services, backed by an innovative product range, across the onshore wind, offshore wind, wave, tidal, renewable heat, solar pv and hydro sectors, whilst maintaining a strong outlook on other new and emerging renewable energy sectors.

Established in the mid 1990s, Natural Power has been at the heart of many groundbreaking projects, products and portfolios for more than two decades, assisting project developers, investors, manufacturers, research houses and other consulting companies. With its iconic Scottish headquarters, The Green House, Natural Power has expanded internationally and now employs more than 330 renewable energy experts.

Creating a better environment

Our global expertise

Natural Power delivers services and operates assets globally for our clients, with eleven offices across Europe and North America and agencies active in South America and AsiaPac.

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Business Centre, Dochgarroch
Inverness, IV3 8GY
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Dublin, Ireland
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Dublin 18
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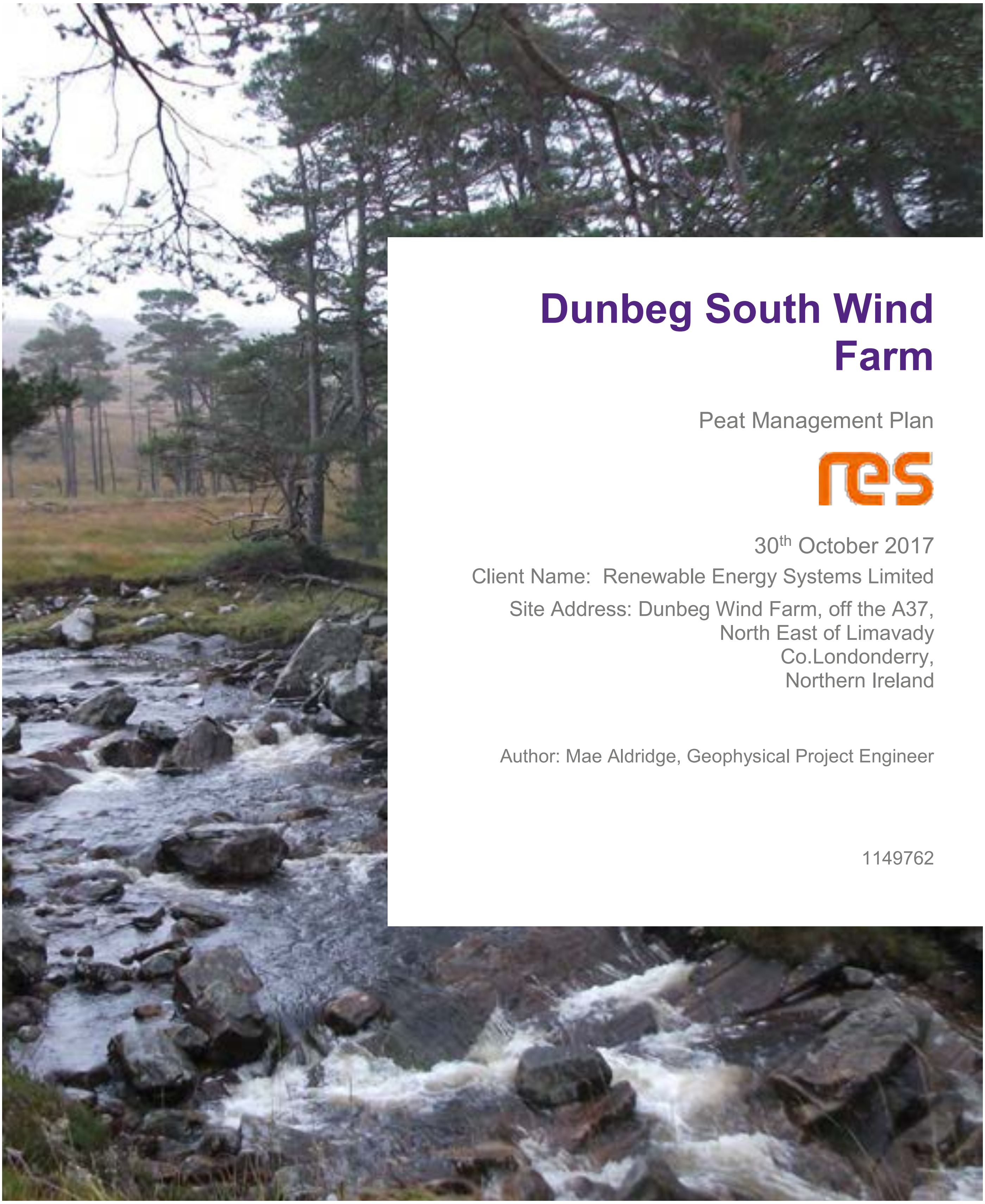

Dunbeg South Wind Farm

Peat Management Plan

30th October 2017

Client Name: Renewable Energy Systems Limited

Site Address: Dunbeg Wind Farm, off the A37,
North East of Limavady
Co.Londonderry,
Northern Ireland

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1149762

Document history

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Issue	Date	Revision Details
A	06/09/2017	First Issue
B	27/09/2017	Re-issue to include comments from RES
C	03/10/2017	Re-issue again for comments from RES
D	20/10/2017	Re-issue again for comments from RES
E	30/10/2017	Re-issue again for comments from RES

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Contents

1. Introduction

The Peat Management Plan (PMP) for the development provides information and guidance on the environmentally compliant re-use and management of excavated peat across the proposed Dunbeg South Wind Farm.

The information presented in this plan should be used to inform the wider assessments carried out for Dunbeg South Wind Farm. The study has drawn on information collected as part of a two phase peat study including desk study, phase one peat probing exercise followed up by phase two site reconnaissance. The PMP as outlined in this document; **estimates** the total volumes of excavated peat likely to be produced by the development and proposes suitable reuse methods in line with regulatory requirements and best practice methods.

This strategy should be adopted to ensure peat is managed in a sustainable manner, minimising excavation via the adoption of appropriate construction methods. Targeted re-use of peat as part of the reinstatement works shall also be a primary consideration.

1.1. Regulatory Requirements

This document addresses the following requirements in line with the SEPA Regulatory Position Statement – Developments on Peatland:

- **Prevention** – The best management option for waste peat is to prevent its production; and
- **Re-use –** Developers should attempt to re-use as much of the peat produced on site as is possible.

The aspects of peat management outlined in this document are also based on the principles of the "*Development on Peatland: Guidance on the Assessment of Peat Volumes, Reuse of Excavated Peat and Minimisation of Waste"*, document published in 2012.

1.2. Limitations

The information presented in this report is based on the results of peat surveys carried out over several phases by Natural Power between August 2016 and July 2017. It is highlighted that whilst all attempts have been made to collect detailed peat depth and condition information, further investigations should be carried out as part of detailed site investigation (post consent). This process will provide further information across all infrastructure locations, which should be used to refine the peat excavation and reuse volumes provided in this report.

The PMP forms part of a site specific Construction Environmental Management Plan (CEMP) and should be considered as a live document throughout the planning and any future pre-construction phase of works. As such, additional information can be incorporated following the results of detailed site investigations carried out prior to construction as well as from any discussions with Northern Ireland Environment Agency (NIEA) or other engaged stakeholders throughout the development process.

2. Amended Infrastructure Layout

This Peat Management Plan was first issued to the client on 06/09/2017, following this an amended layout was provided to Natural Power on 04/09/2017 with the following amendments to infrastructure:

- Use of the upgraded track utilising an existing track present on the site. This is at locations close to the site entrance and between T5 and T6
- Some of the turning spaces have swapped sides.
- Construction Compound and substation have moved North West.
- Tracks have changed slightly

It is assumed where the upgraded track is used no new cut tracks are required. The use of the existing track will reduce the peat cut during the construction of the site access tracks. There are two sections where developer proposed to upgrade the existing track these are approximately 440m in length between T05 and T06 and 370m in length at the site entrance.

Assuming no peat cut along these lengths of access track the developer could expect to reduce excavated peat volumes by up to 913 m^3 in comparison to the original layout. Peat volumes quoted in this study are for the amended layout described above.

The other infrastructure amendments are not expected to impact the results of this peat management plan.

3. Excavated Peat Volume

In order to quantify the volume of peat that may be excavated and re-used across the development, the proposed wind farm layout has been analysed using a comprehensive peat depth dataset. The proposed 9 wind turbine layout has been appraised to obtain a preliminary estimate of the size and extent of the infrastructure footprint. The peat depth dataset comprises a total of 1101 individual peat probe points. The peat depth data was collected across a multi-phase survey with final peat probing carried during July 2017 to cover the final layout configuration:

The peat depth data has been processed into a peat depth contour map (Ref: GB200135_M_005_D, Appendix F of the Peat Slide Risk Assessment). The volumetric analysis of excavated peat volumes incorporates the mean peat depths recorded across each discrete infrastructure element. Therefore average peat depths have been assessed based on relevant data points as opposed to anomalous site wide averages.

The estimation of peat extraction and re-use volumes relies on a series of design assumptions that may vary on a small scale according to discrete changes in ground conditions. Therefore it should be highlighted that the peat volume estimates stated in this report are a preliminary indication only. Volumetric calculations should be re-evaluated if more detailed intrusive site investigation data becomes available. Design assumptions with regard to the likely access track construction methods have also been taken. Natural Power does not warrant these assumptions as a final engineering design for the wind farm. The design of the detailed site layout should be confirmed with a comprehensive site investigation.

3.1. Design Assumptions

3.1.1. Excavation & Replacement

Excavate and replacement ('cut') type construction of tracks, passing places, turning areas and crane pads are proposed where peat depths are consistently shallower than 1.0 m, along section of access track and/or where gradients are in excess of 1:10. This type of construction may also be adopted where there are cross slopes to be negotiated. The cut and fill construction method requires the removal of peat deposits down to a suitable sub-grade layer within the superficial or bedrock geology. Excavated peat is then reinstated carefully along access track landscaped verges on either side of the track or utilised in appropriate landscaping across the development infrastructure. Slope Angle Constraints (Ref: GB200135_M_003_E, Appendix B of the Peat Slide Risk Assessment) depicts the slope angle changes and has been used to inform this part of the assessment.

Excavate and replacement track construction sequences shall be designed in accordance with local ground conditions and following a detailed site investigation. A general good practice construction sequence has been provided below and has been adapted and informed by Scottish Natural Heritage (SNH) Guidance, (2005):

1. The route of the cut / fill access track shall be marked out on the ground well ahead of the construction activity. This will allow for advanced checks of any newly developed or unforeseen constraints.

2. As part of this process, the most sensitive sections of the access track route shall be defined. This will include water crossings, peat hags, slopes and steep slopes. These defined zones shall become established management zones where specific mitigation measures and construction techniques shall be implemented to minimise impacts during the construction phase.

3. Where possible, the construction of the cut tracks shall avoid periods of wet weather (when peat deposits are particularly susceptible to deformation and when there is an increased risk of run-off carrying unacceptable levels of sediment. Similarly, the construction of access tracks shall, where possible, avoid periods of very dry weather; when there is a high risk of excavated and exposed peat soils drying out

4. The cut access track construction shall typically proceed in an uphill direction, thus allowing drainage to be managed with a greater degree of control. The access track side and cut-off ditches shall be generally constructed first. It shall be ensured that these discharge to a suitable buffered watercourse in line with hydrological assessment and relevant drainage controls. It shall be important to ensure that surface water run-off is directed away from the track formation layer. This will act to reduce disturbance by the prevention of water-logging and erosion.

5. A progressive construction method shall typically be adopted whereby the cut track is excavated to a suitable formation and up-filled to the track running surface. Following this, the newly constructed track verges will be restored with peat and vegetation from the next advancing section of track under construction. The sequence of excavation, up-fill and restoration will be managed to minimise the time between excavation and restoration as far as is practicable.

6. Plant machinery shall work where practicable from the section of access track most recently completed. The re-use of peat turves and peat from newly excavated sections onto the verges of the most recently completed section of track will act to reduce the overall disturbance of excavated peat. Excavators with long reach arms are also beneficial in reducing vehicle manoeuvres over peat deposits.

3.1.2. Floating Access Track

Floating type construction of access track may be proposed where peat depths are consistently deeper than 1m. Slope geometry also should been taken into account with floating track construction considered unsuitable across gradients in excess of 1:10 (~6°) and along cross slopes. Reference is also made to the Peat Stability Risk Assessment in which peat slide risk and proposed construction methods have been discussed in detail.

The floating construction design leaves the peat deposit in place and utilises a construction of layered geo-grid, geo-textiles and aggregate fill, which is placed over the peat deposits. This system forms a 'floating' platform to spread the construction loads over the peat. A comprehensive description of this construction method is presented by Forestry Commission Engineering (FCE) & Scottish National Heritage (SNH), (2010). This sequence of construction may need to be adapted to localised ground conditions that may only become fully evident following a detailed site investigation:

1. Mark out the alignment of the road and install advance drainage ahead of construction where necessary.

2. Clear the intended floating road area of major protrusions such as rocks, trees, down to ground level leaving any residual stumps and roots in place.

3. Leave the local surface vegetation and soils in place if possible. In many cases the existing vegetation and root system may be the strongest layer in the system providing increased tensile strength at surface, and care shall be taken to preserve the integrity of this layer.

4. Any local hollows or depressions along the route alignment shall be in-filled with a suitable lightweight fill such as tree brash, logs or a combination of lightweight fill and suitable materials. Similarly a brash mat and fascines (bundles of brash material) may be adopted to form the initial surface across uneven ground surface.

5. Broken vegetation surfaces such as peat hags and very wet areas with high fines content, may need to be covered with a separator grade geo-membrane to prevent contamination of the aggregate layers. This geotextile may be covered with a thin regulating layer of aggregate prior to installing the main geo-grid.

6. Geo-grids shall be placed by hand along the alignment of the road, directly onto the prepared area. Each grid section shall overlap adjacent sections using a simple overlapping arrangement generally in accordance with the relevant manufacturer's specification. A minimum transverse overlap is normally set at 400mm. This overlap may be increased where necessary, depending on the amount of displacement and transverse tension caused by un-even terrain and taking the manufacturer's recommendations into account.

7. Place the first layer of aggregate material onto the geo-grid, this shall be a suitable 'well graded material' that will be able to achieve a sound interlock with the geo-grid. The final specification of the aggregate grading shall be dictated by the chosen geo-grid mesh size. Care shall be taken at all times to avoid damage to the geo-grids.

8. The degree of compaction required will be dictated by the local ground conditions along the route alignment. Across exceptionally soft areas of peat there may be a requirement not to apply mechanical vibratory compaction and instead rely on compaction of aggregate through trafficking of wheels and tracks of the construction plant alone.

3.1.3. Access Track Dimensions

Proposed access tracks have been assumed to accommodate a 5m running width. The peat volume calculations have assumed a 6m wide access track excavation with a batter angle of 45° to the excavation sides. This geometry includes the additional width of 0.5m along either side of the track to accommodate drainage and cabling. Figure 3.1 below depicts the indicative dimensions adopted in the assessment.

Source: Natural Power, Not to scale, do not use for design

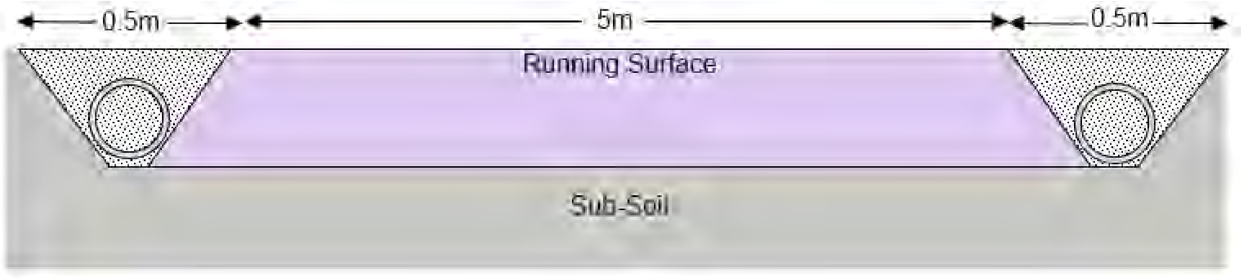


Figure 3.1: Indicative Cut Track Dimensions

Turning areas and passing places have been omitted from this analysis as it is assumed that any peat excavated as part of their construction would be accommodated along the periphery of these infrastructure elements, used to form landscaped verges.

3.1.4. Foundations and Hard-standing

The surface working area of the wind turbine foundation excavation has been assumed to be a 24x24m square excavation into which a reinforced concrete gravity base will be constructed. This dimension has been assumed based on a typical 18m diameter foundation founded at 3m below ground level. Assuming a batter angle to the excavation of 45° then a working area projected at the surface of 24x24m has been calculated. This is a conservative assumption as a number of the foundations may be constructed using a different design. Detailed design may also allow for a smaller foundation footprint. The final formation level for the wind turbine foundation will be dictated by the local ground conditions. These shall be only defined following a detailed intrusive site investigation. Where suitable formation layers are identified at a shallower level, there may be scope to reduce the foundation working area. The geotechnical performance of the formation layer shall also input into the design dimensions of the gravity foundations.

The limit of disturbance in the peat deposits surrounding the foundation working areas should be controlled where appropriate with plastic sheet piling. This shall be particularly important in excavations of peat in excess of 1.5m where localised failures in the sides of the excavation need to be prevented from developing into retrogressive failures affecting larger areas outside of the foundation working area.

The final design chosen for the wind turbine foundations shall be informed by a detailed intrusive site investigation carried out during a post consent phase. Of particular importance shall be the underlying depth of superficial glacial deposits and the quality of the rock mass beneath each wind turbine location. The requirement for a detailed site investigation and design analysis out-with the scope of this peat management plan; dictates that the option of piling can only be fully considered during the pre-construction phase.

The client has provided information on the crane pad detailing the expected footprint to be 40x20m with a total working area of 800m^2. It should be noted if the selected turbine changes it could be necessary to alter the crane pad size which could increase the volume of peat extracted. A working area of 40x20m for the crane pad volume calculations has been assumed with a batter angle of 45^o to the excavation sides.

3.1.5. Ancillary Infrastructure

A temporary construction compound and control building has been modelled based on a concrete foundation of 100m x 50m with a 45^o batter angle to the excavation sides.

It is assumed that the substation and associated transformers will have a foundation requiring the removal of all peat beneath these structure. For the temporary construction compound buildings it is assumed these with be erected on a levelled surface overlain with hardcore. It was assumed that up to 0.5m would be cleared in order to level the area in preparation for laying the hardcore.

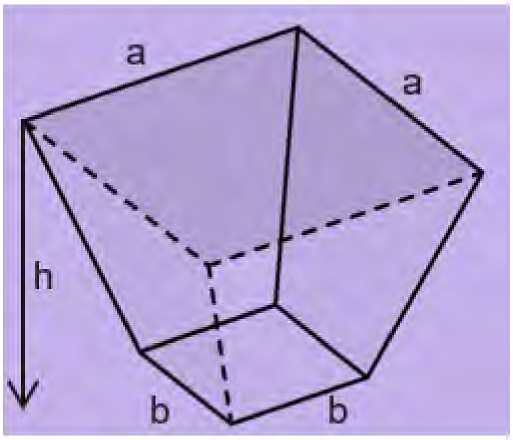
3.2. Excavated Peat Volumes

The estimate of excavated peat volume has been completed following a desk-based appraisal of the wind farm layout supplemented by digital terrain analysis. There has been further refined spatial analysis of the peat depth data set using GIS software.

The following sequence of tables provides a summary of the indicative peat extraction volume calculation for each infrastructure element. The relevant design assumptions are also confirmed within each table. The volumetric calculations are set out diagrammatically below.

For base volume calculations the volume of a truncated square pyramid has been used with the following expression as shown in Figure 3.2 below:

Source: Natural Power



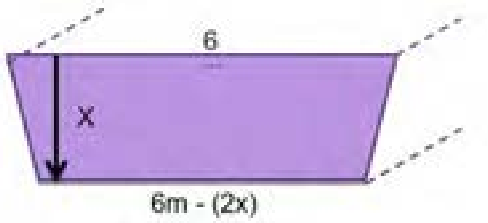
Volume = 1/3 (a^2 + ab + b^2) x h

Where: a = surface width of working area; b = (a – 2h) ; h = mean peat depth

Figure 3.2: Volume of a truncated square pyramid (foundation and crane hard standing calculations)

For excavation and replacement access track construction the volume of a trapezoid has been adopted as depicted in Figure 3.3 below

Source: Natural Power



Volume = (X * ((6 + (6-2X)) / 2)) * Length of access track

Figure 3.3: Volume of access track excavation based on a trapezoid

Table 3.1: Wind Turbines

Turbine ID	Average Peat Depth (m) Turbine	Crane Pad	Crane Pad Peat Volume (m^3)	Foundation Peat Volume (m^3)	Total Peat Extraction Volume (m^3)
T1	0.23		184	130	314
T2	0.23		184	130	314
T3	0.42		336	234	570
T4	0.8		640	431	1071
T5	0.21		168	119	287
T6	0.69		552	375	927
T7	0.27		216	152	368

Turbine ID	Average Peat Depth (m)		Crane Pad Peat Volume (m³)	Foundation Peat Volume (m³)	Total Peat Extraction Volume (m³)
	Turbine	Crane Pad			
T8	0.35		280	196	476
T9	0.43		344	239	583
				Total Peat Extraction (m³)	4,900

Source: *Natural Power*

Table 3.2: Access Track

Access Track Section	Average Peat Depth (m)	Approximate Length (m)	Type of Track Construction	Total Peat Extraction Volume (m³)
Track 1: Site Entrance to T1	0.14	858	Cut Track	704
Track 2: T2 to T4	0.39	814	Cut Track	1781
Track 3: Track to T3	0.42	312	Cut Track	731
Track 4: Track to T5	0.18	587	Cut Track	615
Track 5: Track to T6	0.26	516	Cut Track	770
Track 6: Track to T7	0.62	400	Cut Track	1334
Track 7: Track To T8	0.43	551	Cut Track	1320
Track 8	0.43	485	Cut Track	1162
			Total Peat Extraction (m³)	8,417

Source: ** Site Wide Track Average Used due to Data Gap*

Table 3.3: Ancillary Infrastructure

Location ID	Average Peat Depth (m)	Indicative Working Area (m²)	Total Peat Extraction Volume (m³)
Temporary Construction Compound and Control Building	0.16	5,000	800
		Total Peat Extraction (m³)	800

Source: *Natural Power*

An initial estimate of required rock volumes has been prepared to provide an indication of the scale of rock extraction required as part of the Development. These indicative required rock volumes are detailed below in Table 3.4.

Table 3.4: Indicative Rock Fill Requirements

Infrastructure Element	Total Volume of Rock Fill (m³)
New 'Cut' Access Tracks	21,659
New Floating Access Tracks	-
Crane Hardstand Areas	16,290
Temporary Construction Compound and Control Building and other infrastructure	4,356

Infrastructure Element	Total Volume of Rock Fill (m^3)
Total Rock Fill Requirements	42,305

*Notes: *All rock is expected to be imported to Dunbeg wind farm, quarried off-site.*

3.2.1. Peat Extraction Volume Summary

Table 3.5 below provides a Development wide indicative value of the total volume of excavated peat required as part of the construction phase of development. Values have been rounded to the nearest 100m^3 so as to not convey a false level of accuracy.

Table 3.5: Total Peat Extraction (Indicative) Site Wide

Construction Element	Peat Extraction Volume (m^3)
Wind Turbine Foundations & Hardstand	4,900
New Access Tracks	8,400
Ancilliary Infrastructure	800
TOTAL	**14,100**
TOTAL (including 25% bulking factor)*	**17,600**

*Notes: *after Trenter, (2001)*

A bulking factor of 25% has been added to the total volume of peat extraction. It is reported by Trenter, (2001) that a range of bulking factors between 25 and 45% can be expected for peat. The bulking or effective volume increase of the peat occurs over the process of excavation, transport and replacement. The magnitude of the bulking factor will depend upon site specific ground conditions and the physical properties of the excavated peat. A primary factor will be in the amount of handling which the excavated peat deposits experience.

4. Re-use Volumes of Excavated Peat

4.1. Access Infrastructure

In order to estimate the volume of peat that would potentially be re-used as part of construction and restoration, an indicative estimate has been calculated based on best practice and past project experience. Table 4.1 below provides an approximate total volume of peat that could be accommodated across the site. The following assumptions salient to the best practice re-use of excavated peat are highlighted below:

Floating tracks are not expected to be required on the Dunbeg South wind farm. The following information is given to inform the reader should any sections require floating track.

Source: FCE, SNH, (2010)

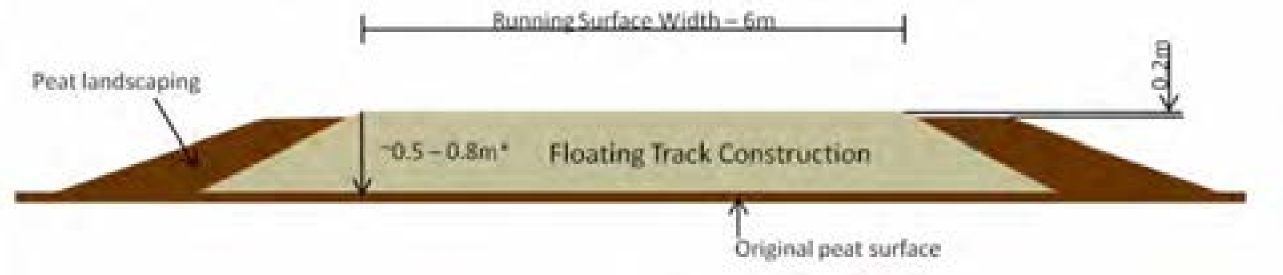


Figure 4.1: Typical Arrangement for Peat Verges on Floating Access Tracks

The final construction thickness of any floating track construction will be a function of the local ground conditions, including geotechnical properties of the peat, hydrology and design load requirements. An indicative range of 0.5 – 0.8m has been indicated as a typical thickness for upland wind farm floated access tracks, (FCE & SNH, 2010). The depth of peat on the landscaped verge would therefore be a function of the total depth of floating track. It would be a priority for the landscaped verge only to re-instate the track edge and any disturbed peat along the corridor of the access track. No undisturbed peat shall be smothered by the landscaping. Landscaped verges should be lowered by 0.2m below the running surface of the access track is to ensure any surface water can drain naturally, and diffusely where it arises. This shall aid in maintaining hydrology within the peat and prevent it oxidising and drying out. This approach is taken to provide visual continuity between the raised infrastructure and surrounding peat land while maintaining important hydrological and drainage conditions.

For ‘cut’ access track construction across the site, it is assumed that 1m^3 of peat per linear metre of track constructed may be accommodated as part of the reinstatement works. This is an indicative figure only and will vary according with the prevailing ground conditions.

4.2. Preserving Peat Structure

During the excavation and re-use of peat deposits the two layered structure of the ‘acrotelm’ and underlying ‘catotelm’ shall be preserved as far as is practicable (Figure 4.2). This approach will aid in the successful re-vegetation and prevent drying and desiccation of the peat. Where the catotelmic peat becomes separated appropriate measures shall be in place to ensure this material is stabilised prior to re-use. This will be verified by a suitably qualified geotechnical engineer.

Source: Good Practice During Wind Farm Construction

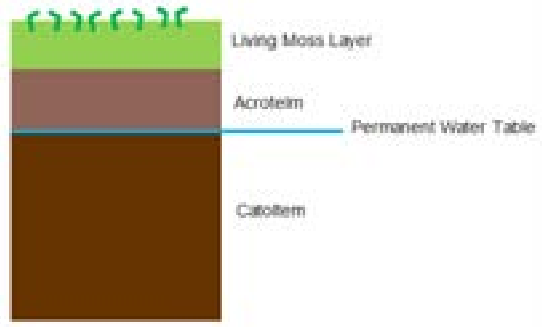


Figure 4.2: Diagram showing idealised Peat Structure

Re-use Volume Estimate

Table 4.1: Estimate of Peat Re-use Volumes

Construction Element	Peat Extraction Volume (m^3)	Peat Re-use Volume (m^3)	Surplus (+) or Deficit (-) (m^3)
Turbine Foundations & Hardstand	4,900	13,300	**4,700**
New Access Track	8,400	4,500	3,900
Ancillary Infrastructure	800	2,500	**1,700**
TOTAL*	14,100	20,300	**6,200**
TOTAL (including 25% bulking factor)*	**17,600**	20,300	**2,700**

It should be noted that this assessment has not accounted for excavation volumes of glacial sub-soils or weak bedrock material, which may be deemed unsuitable for incorporation into foundations and hardstand elements. The estimate is that there is approximately 20,300m^3 of capacity for excavated peat to be accommodated in the construction of the wind farm and utilised in the finishing and landscaping across all infrastructure elements when adopting the strategy set out above. This figure is based on re-use of peat in circumstances where there is an identified and suitable use.

Comparing the total volume of re-usable peat with total volumes of excavated peat, allowing a bulking factor of 25% it is indicated that all peat excavated during the construction of the proposed infrastructure can be reused on the Dunbeg South Wind Farm. Where factors which contribute to the bulking of the peat deposit are mitigated the total volume of excess excavated peat may be reduced to balance with re-use volumes through:

- Reduction of peat handling with re-use of peat undertaken as close as possible to the excavation site;
- Maintaining the integrity of the excavated peat mass including preservation of the surface acrotelm layer as far as is practicable;
- Prevent the drying and desiccation of excavated peat deposits through timely re-vegetation and preservation of the surface hydrology systems.

4.3. Temporary Peat Storage

Consideration for the storage of peat has been undertaken with input gathered from the Scottish Renewables Guidance on the Assessment of Peat Volumes, Reuse of Excavated Peat and Minimisation of Waste, (2012).

The temporary storage of excavated peat shall seek to minimise disturbance of deposits by minimising haul distance between temporary peat storage sites and re-use areas. In general it shall be a priority to avoid a single site dedicated temporary peat storage area. A progressive construction method which re-cycles peat through excavation and timely re-instatement in a continuous process shall be adopted for the construction of access tracks, hardstand areas and foundation elements. However temporary infrastructure elements shall require storage of peat prior to re-instatement at the end of the construction phase.

For the temporary construction compound, it is proposed that stripped peat and superficial deposits are temporarily stored in stockpiles / bunds adjacent and surrounding each infrastructure site. The exact areas identified for temporary storage shall only be defined following a detailed site investigation.

Surrounding these areas the peat stability, drainage and pollution prevention mitigations shall be appraised as part of the detailed construction method statement. In general areas of deep peat (>1.5m) shall be avoided for dedicated temporary storage areas. It would be a priority to ensure that a future detailed site investigation provides information on the suitability of these temporary peat storage areas including the topographic profile, groundwater regime, and geotechnical properties of deposits underlying the temporary storage sites. Furthermore it may be necessary to undertake further peat stability calculations based on finalised placement of temporary peat storage areas.

In temporary storage areas; peat shall be stored on geo-textile matting which acts as a protective barrier to the underlying soils and vegetation. The geo-textile shall be designed to prevent ingress of groundwater and erosion and de-stabilisation of the base of the stored peat. Peat shall be stored to a maximum depth of 1m with the peat turfs stored separately from underlying peat. The peat turfs or vegetation layer shall be stored in a single layer.

A system of watering the stored peat and turfs / vegetation shall be in place to ensure that the peat remains damp and prevents drying out and desiccation. The vegetation layer and seed bank shall therefore be sustained. This is an important element in the restoration of infrastructure, providing continuity with surrounding local vegetation upon reinstatement. For the duration of the temporary storage it shall be necessary to periodically monitor the condition of the stored peat and ensure the stability is maintained. This may need to be undertaken by a suitably qualified geotechnical engineer.

4.3.1. Temporary Peat Storage Suggested Locations

The following areas have been identified as potential peat storage locations based on their distance from water courses, low volume of peat, slope angle and proximity to infrastructure to limit transport of peat around the site.

Source: Natural Power

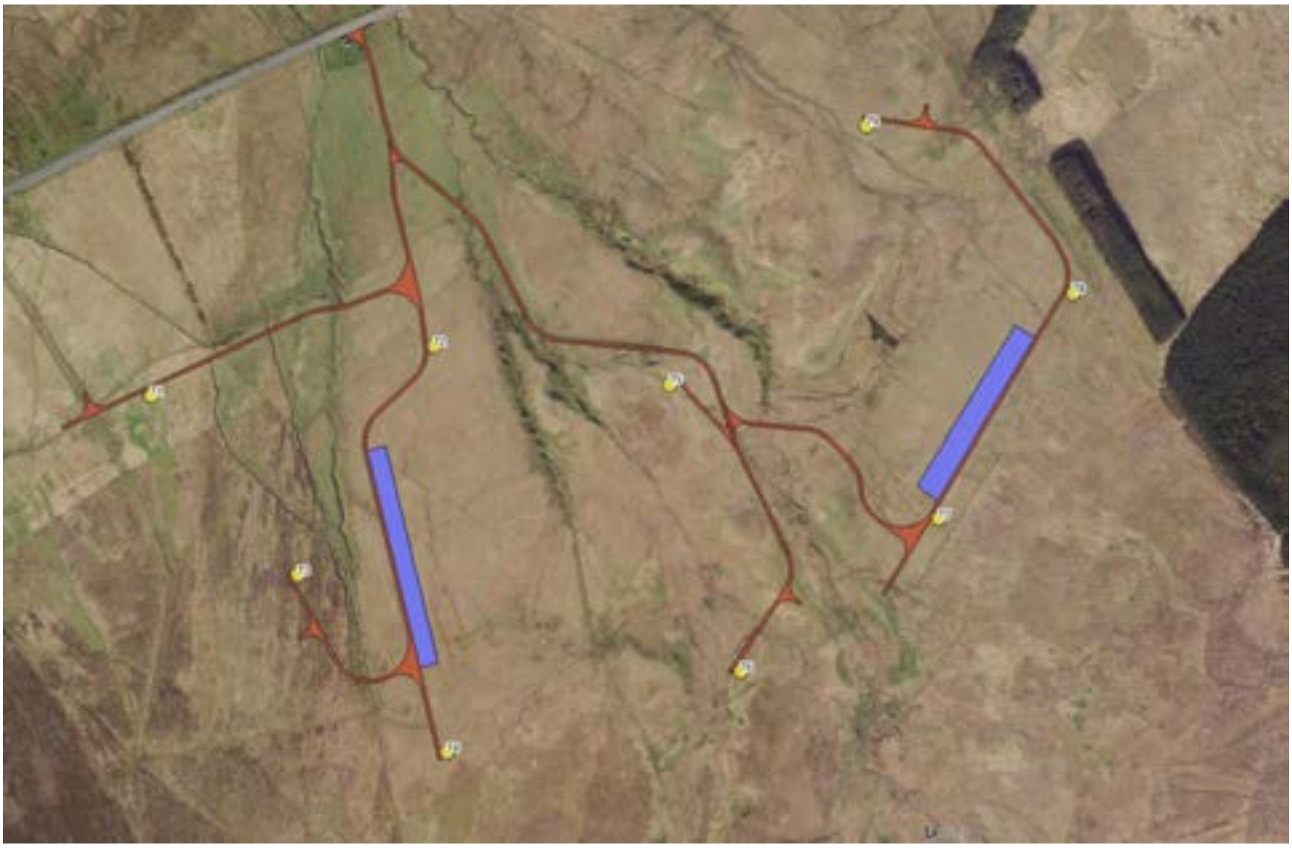


Figure 4.3: Potential Peat Storage locations shown in blue.

4.4. Limitation of Assessment

The peat extraction and re-use volumes are intended as a preliminary indication. The total peat volumes are based on a series of assumptions for the development layout and peat depth data averaged across discrete areas of the development. Such parameters can still vary over a small scale and therefore local topographic changes in the bedrock profile may impact the total accuracy of the volume calculation. Where total volumes have been stated these have been rounded to the nearest $100m^3$ in order not to convey a false accuracy.

The accuracy of these predictions may be improved though detailed site investigation (post consent). It is therefore important that the Peat Management Plan remains a live document throughout pre-construction and construction phases and is encapsulated within the wider Environmental Management Plan. The peat management plan and volumetric assessments can be updated as more accurate information becomes available.

In general the following guidance has fed into the design assumptions and subsequent selection of appropriate construction methods based on the distribution of peat depths across the site:

- Developments on Peatland: Guidance on the assessment of peat volumes, re-use of excavated peat and the minimisation of waste (A joint publication by Scottish Renewables, Scottish Natural Heritage, Scottish Environmental Protection Agency, Forestry Commission Scotland, 2012);
- Floating Roads on Peat (Forestry Civil Engineering & Scottish Natural Heritage, 2010);
- Good practice during wind farm construction (A joint publication by Scottish Renewables, Scottish Natural Heritage, Scottish Environmental Protection Agency, Forestry Commission Scotland, 2010).

The Peat Depth Contour Map reference (GB200135_M_005_D) provided within the Peat Slide Risk Assessment; illustrates the peat depth across the site, thus giving an indicative assessment of the peat depths at various infrastructure locations. As will be discussed in the following sections, the excavated peat and peaty soils across the site can be used in a variety of scenarios including dressing side slopes on the roads; backfill over turbine bases; and infill of artificial drainage. These further details on the best practice measures to re-use the excavated peat and peaty soils at the development are discussed in the following section.

5. Reinstatement Methodologies

Prior to commencing the construction excavation works, consideration will be given to methods for handling and holding the excavated materials, particularly peat or peaty soils. Haulage distances for the excavated material will be kept to a minimum, in order to reduce the potential impact on the peat/soil structure. Peat has the potential to lose structural integrity upon excavation particularly when double handled or moved around the site. Peat handling can also increasing the bulking factor of the material which has the overall effect of increasing the volume of peat which will need to be re-used across the site (Table 4.1)

The following paragraphs discuss the reinstatement measures that can be adopted for the main infrastructure components associated with the development.

5.1. Access Tracks

During track excavation works, where possible the vegetated top layer of material, which holds the seedbank, will be stripped and carefully set to the side of the worked area for re-use in the re-profiling and track verge reinstatement works (Photograph 1a). The vegetative layer will be stripped as whole turves and will be set aside vegetation side up (Photograph 1b).

Photo 1a: Track verge reinstatement works

Source: Natural Power

Photo 1b: Effective turf management

Source: Natural Power

If cut and fill tracks are required in areas of peat or remnant peat habitat, then reinstatement will involve laying subsoil peat on the cut batters and then placing peat turves and clods on top of this. Reinstatement will be completed as soon as possible following construction to minimise the risk of turf drying. Restoration will be carried out as track construction progresses (Photo 2).

Photo 2: Example of floating track verge reinstatement whilst access track construction continues

Source: Natural Power

In order to obtain the best results the previously stripped soils, vegetated layers or turves will be brought back over the verges of constructed tracks within as short a time period as reasonably possible, to give the seed bank and vegetation the best chance of an early regeneration (Photograph 3). Where possible, turves and topsoil will be matched to the adjacent habitat.

Photo 3: Example of good track reinstatement with heather turves re-established

Source: Natural Power

Where practical, if storage is required, the layers will be correctly stored in their respective soil/peat horizons, i.e. in the layers that they were stripped in, so when reinstated they can be put back in the correct order. This also provides the seedbank and vegetation the best chance of early regeneration. If temporary storage of excavated materials is required, then such material will be stored safely and the method of storage will not lead to any areas of additional disturbance. If materials are to be stored for any length of time, then these designated areas will be agreed prior to the storage of any material. Consideration will also be given to periodically wetting the vegetation layers in order to prevent drying out. If this method is implemented, any runoff will be dealt with appropriately and will not be allowed to discharge into any adjacent watercourses unless treated.

Materials used for the construction process will not be used on the track edges unless it is being used for re-profiling purposes, in order to tie in with the adjacent topography. Peat and peaty soils will only be used to re-profile or finish off the edges of the track or where construction has damaged the surface layer (Photograph 4). In order to re-establish vegetation in these areas as quickly as possible peat or peaty soil turves will be utilised wherever practical.

Photo 4: Example of excavate and replacement access track verge reinstatement with peat turves

Source: Natural Power

The soil and peat material that is utilised for the track edge reinstatement will not be spread too thinly. If the material is spread too thinly then there is a tendency for it to dry out and crack, particularly during prolonged dry periods. This subsequently means that the soil/peat material will be unstable because the root system has not had an opportunity to establish. This is very much dependent upon the time of year that the work is taking place and also the altitude. These factors affect the growing performance of the vegetated turf. Early reinstatement will be undertaken as this provides for the most beneficial results.

Care will also be taken to ensure that excessive material is not used during the re-profiling and reinstatement of the track verges. In addition, excess peat will also not be used for reinstatement of track edges as it can lead to the additional loss of habitat, by smothering the existing adjacent vegetation and preventing re-growth of the vegetation next to the tracks. The addition of excessive materials, may cause instability at the track edges and increase the risk of the creation of sediment laden runoff and lead to potential carbon losses.

During the construction works, in areas where the spreading of seed rich materials or natural re-growth are considered to be impractical, not plausible or ineffective, then consideration should be given to re-seeding methods (Photo 5). The seed type and mix will be agreed by SNH and the local planning authority (the seed bank mix will be of local native species). In the event that vegetation re-establishment is observed to be failing during the post-construction monitoring stage, the potential for using re-seeding methods will be considered and discussed in consultation with SNH and the local planning authority.

Photo 4: Example of re-seeded track verge following construction

Source: Natural Power

The fundamental aspects of track reinstatement are summarised as follows:

- Consider haulage methods and specified storage locations in relation to areas being worked. Haulage distances to storage locations will be minimal;
- Vegetated turves and topsoil will be stripped with care and stored correctly i.e. separated in horizons and vegetation stored vegetation side up;
- For track reinstatement peat/peaty soil will be placed back in the correct horizon order and topsoil containing the seed bank will be on the top. If vegetated turves have been previously stripped then these will be placed on top to maximise vegetation growth potential;
- Reinstatement of verges will be completed as soon as possible to minimise turf drying i.e. reinstatement can take place whilst track construction continues;
- Peat/peaty soil will not be spread too thinly during verge reinstatement in order to prevent cracking/drying out and excessive amounts of peat will also not be used as this can lead to unstable surfaces, effect drainage, loss of habitat via smothering of adjacent vegetation and create sediment laden runoff; and
- Natural regeneration of vegetation is the preferred option for reinstatement and restoration, however, if required, following consultations with SNH re-seeding using a native species mix will be considered.

5.2. Cable Trenches

The reinstatement and storage of any excavated materials for the cable trenches will involve replacement of previously stripped soils, vegetated layers or turves (Photo 5). Timing of trench reinstatement works will also take into account adjacent construction activities which may disturb any reinstatement works already carried out.

Photo 5: Reinstatement of cable trench adjacent to access track with excavated materials

Source: Natural Power

The amount of time between the excavation of the trench and subsequent reinstatement following cable laying will be minimised as much as practically possible. The reason for this is that the longer the stripped turves are stored for the more they will degrade and become unsuitable for successful reinstatement. The optimum scenario for the cable trench works will be to ensure that no cable trenches are excavated until the electrical contractor has their cables ready for installation on site. Reinstatement will take place as soon as possible, trenches which are left open for a long period of time will have a tendency, to act as conduits for surface water runoff, thus potentially leading to increased sediment loading due to erosion. This could potentially affect the sites watercourses and lead to the occurrence of a pollution event.

The type of vegetation used for reinstatement will not differ from the adjacent area. The fundamental aspects of cable trench reinstatement are summarised as follows:

- Cable trenches will be constructed to the relevant detailed design specifications;
- The majority of cable trenches will be constructed adjacent to access tracks, i.e. reducing construction impacts on virgin ground;
- Scheduling of cable trenches will be considered in conjunction with access track construction, i.e. track verges will not be reinstated and then disturbed again for cable trench works;
- Stripping, storage and reinstatement of excavated materials will be as per the information presented in Section 4;
- Time between trench excavations and reinstatement will be as short as possible in order to reduce the potential for stored turf layers to dry out and decompose. In addition if excavations are left open for any length of time they have a tendency to act as conduits for surface water runoff; and
- Natural regeneration of vegetation is the preferred option for reinstatement and restoration. However, if required, following consultations with SNH, re-seeding using a native species mix will be considered.

5.3. Wind Turbine Foundations

Where practical the peat turves and topsoil will be stored around the perimeter of the foundation excavation, as shown in Photo 6. A plan showing where the material is to be stored will be created prior to the works commencing. In areas where storage of the peat turves or excavated material adjacent to the works is not possible, then the material will be taken to the nearest agreed storage areas as soon as possible.

Photo 6: Excavated material stockpiled around the perimeter of the foundation excavation

Source: Natural Power

The turbine foundations will be backfilled with the excavated material. Not all excavated material will be suitable for backfilling or reinstatement. The material unsuitable for backfilling and reinstatement will be taken to its final agreed location as soon as possible in order to reduce the risk of a pollution event or contamination of adjacent land or stockpiles. The previously stripped and stored soils, and vegetated layers or turves will then be spread over the disturbed area, caused by turbine foundation construction (Photo 7). Where turbine bases are constructed in peat, reinstatement will involve laying subsoil peat on the backfilled area and then placing the vegetated peat turves on top. Reinstatement will be carried out as soon as practically possible following completion of foundation construction to minimise the risk of turves/vegetated layers drying out.

Photo 7: Reinstatement of turbine bases using excavated materials (in peat)

Source: Natural Power

Re-seeding will be considered for surfaces where natural re-growth and spreading of seed rich material is unlikely to be effective, or where re-establishment of vegetation is observed to be failing during monitoring. In the event that re-seeding is required, the seed type and mix will be agreed in consultation with SNH and local planning authority. The fundamental aspects of turbine foundation reinstatement are summarised as follows:

- Construction works will be carried out to the detailed specification of the turbine foundation design however excavations will be kept to a minimum to reduce the amount of peat excavated;
- Stripping, storage and reinstatement of excavated materials will be as per the information provided in Section 4;
- A detailed plan of where excavated material will be stored will be created;
- Subsoil/peat will be spread over the backfilled area during reinstatement. Peat turves will then be placed on top to encourage natural re-growth of the vegetation;
- Time between turbine foundation excavation and reinstatement will be as short as possible in order to reduce the potential for stored turf layers to dry out and decompose; and
- Natural regeneration of vegetation is the preferred option for reinstatement and restoration. However, if required, following consultations with SNH, re-seeding using a native species mix will be considered.
-

5.4. Crane Hardstanding

As detailed within the "Good practice during wind farm construction" document (2010), reinstatement of the crane pads will not occur:

- Re-use of crane pads following construction is higher than previously estimated;
- In the past crane pads have been reinstated using a layer of peat following construction. On many sites this layer has been stripped back within 2-3 years of operation to allow maintenance works to take place; and
- When the peat is stripped back, it mixes with the stone from the hardstanding, thus contaminating the peat/peaty soil layer and making it unsuitable for re-use for reinstatement.

Due to the requirement for hardstandings to remain in place, and use of crane pad areas during maintenance activities, levels of vegetation re-growth are liable to be low if crane hardstandings are covered.

The area around the crane pad and any exposed batters will be reinstated with previously stripped soils, vegetated layers and turves, using the same methods to those described for track reinstatement in section 4 of this document.

The fundamental aspects of crane hardstanding reinstatement are summarised as follows:

- Crane pads will not be reinstated – in line with best practice; and
- Stripping, storage and reinstatement of excavated materials will be as per the information presented in Section 4, this will however, only be in relation to the area around the crane pad and any exposed batters.

5.5. Ancillary Infrastructure

All temporary construction areas will be removed and reinstated as quickly as possible following construction. Following removal of temporary site accommodation, storage, equipment and materials, all areas will then be reinstated. The hardstanding surface will be lifted prior to re-soiling to aid with drainage and re-generation. Installation of a geo-grid base/geotextile during construction of the compound would help to facilitate removal of the hardstanding if this is required.

The reinstatement will involve reprofiling/landscaping to ensure that the reinstated area blends in with the surrounding area. Suitable materials i.e. topsoil and peat will then be replaced over the area in appropriate horizons i.e. in the correct order (Photo 9). The material used for the reinstatement works (often that which was excavated for the temporary construction area), will be stored and managed adjacent to the temporary construction areas but away from watercourses and other sensitive receptors.

It is highly probable that the temporary construction areas, such as the site compound will only be required for the duration of the construction period. Therefore it is unlikely that any stripped turves would be suitable for reinstatement, as the vegetation would have decomposed if stored for any length of time. Vegetation will therefore be allowed to regenerate naturally. Natural regeneration could take several years and is dependent upon the type of adjacent vegetation and the altitude of the location. Re-seeding will be considered if required. In the event that re-seeding is required, the seed type and mix will be agreed in consultation with SNH and local planning authority. In addition, temporary fencing of the areas to prevent grazing by deer will also be considered in order to help accelerate the re-vegetation process (Photo 8).

The fundamental aspects of temporary construction reinstatement is summarised as follows:

- Areas will be re-profiled/landscaped to ensure they blend in with the surrounding area;
- Topsoil/peat will then be spread over the area in its appropriate horizons;
- Material used for the reinstatement will be stored appropriately where practical adjacent to the temporary construction area;
- Stripped turves may dry out due to the length of time they are stored (compound required for duration of construction period) therefore will not be suitable for reinstatement; and
- Natural regeneration of vegetation is the preferred option for reinstatement and restoration. However, if required, following consultations with SNH, re-seeding using a native species mix will be considered.

Photo 8: Example of temporary compound reinstatement

Source: Natural Power

6. Peat Restoration

The area within which the wind farm will be located has not been subject to extensive modification via the installation of widespread and deep artificial drainage or peat cuttings. However where suitable there may be further scope of restoration of artificial drainage if deemed to be of hydrological benefit and where this will not create any increased risk of peat instability.

It is reiterated that Table 4.1 has indicated that there is approximately 20,300 m^3 of capacity for excavated peat to be accommodated in the construction of the wind farm and utilised in the finishing and landscaping across all infrastructure elements. This figure is based on re-use of peat in circumstances where there is an identified and suitable use. The peat excavation volume calculations predict on the order of 17,600 m^3 of peat which will require excavation as part of the wind farm proposals. With the 25% bulking factor there will be deficit of 2,700 m^3 meaning the total volume of extracted peat should be able to be restored on site. It is important to follow the appropriate mitigations outlined in the reuse section in order to lower the bulking factor and reduce the volume of excess peat. Extraction and reuse volumes for each infrastructure element are outlined in Figure 6.1 below.

Source: Natural Power

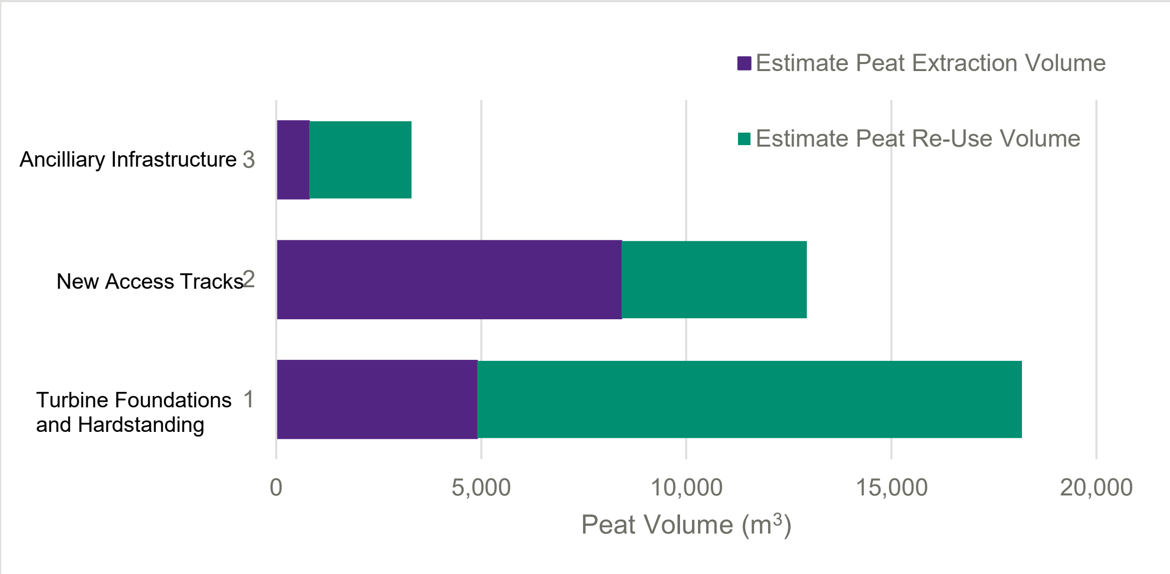


Figure 6.1: Graphical Representation of Estimated Peat Excavation and Re-use Volumes

7. Monitoring

The success of construction and the subsequent re-use of peat across the site can be monitored to ensure that effects on the peat land environment are appropriately understood and subsequently reduced via any remedial works that can be undertaken. The details of any required monitoring would be discussed and agreed with Northern Ireland Environment Agency (NIEA), National Heritage Ireland and Local Planning Authority prior to commencement. Appropriate monitoring is important to:

- Provide reassurance that established in-place mitigation and reinstatement measures are effective and that the site is not having an significant adverse impact upon the local and/or wider environment;
- Indicate whether further investigation is required and, where pollution is identified or unsuccessful reinstatement, the need for additional mitigation measures to prevent, reduce or remove any impacts on the environment; and
- Understand the long term effects of the site on the natural environment.

Due to the nature of the construction activities and the possibility that such works can increase the volume of dissolved and particulate matter from entering the natural drainage network a robust hydrological monitoring strategy will be implemented.

A reinstatement monitoring strategy can also be implemented, where surveys can be carried out to monitor the success of peat re-use and subsequent reinstatement. Complimentary to the hydrological monitoring highlighted above and best practise geotechnical monitoring, the success of vegetation reinstatement can provide an insight into the effects of the wind farm on the local environment. Full details of the environmental monitoring strategies will be finalised following consultation with SNH, NIEA and Local Planning Authority.

8. References

British Geological Survey (Scotland) Solid & Drift Geology, 1:50,000.

British Standards Institute (2009). BS6031:2009 Code of practice for Earthworks.

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Scottish Executive (2007). Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Generation Developments. http://www.scotland.gov.uk/Publications/2006/12/21162303/0.

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Developments on Peatland – Guidance on the assessment of peat volumes, re-use of excavated peat and the minimisation of waste – Scottish Natural Heritage (SNH), Scottish Renewables, SEPA, Forestry Commission Scotland (FCS), 2012;

Developments on Peatland – Site Survey, Scottish Government Guidance, Soil Survey of Scotland, 2012.

Floating Roads on Peat – Report into Good Practice in Design, Construction and Use of Floating Roads on Peat with particular reference to Wind Farm Developments in Scotland, FCS, SNG, 2010;

Good Practice During Windfarm Construction, A joint publication by; Scottish Renewables, SNH, SEPA, FCS, 2010;

Web Resources

http://www.bgs.ac.uk/

http://www.sepa.org.uk

https://www.daera-ni.gov.uk/

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Drainage Assessment

Dunbeg South Wind Farm

115-77_DG03 | November 2017

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DOCUMENT CONTROL

DOCUMENT FILENAME	MCL115-77 Dunbeg South_Drainage Assessment [FOR PLANNING] Rev 1.Docx
DOCUMENT REFERENCE	115-77_DG03
TITLE	Drainage Assessment
CLIENT	RES Ltd
CLIENT CONTACT	Garth McGimpsey
PROJECT MANAGER	Kyle Somerville
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REVISION HISTORY

Rev. Ref.	Date	Prep	Chk	App	Amendments	Reason for Issue
1	02/11/2017	CD	KS	KS	Original	For Planning
2	06/11/2017	KS	CMQ	KS	Minor Amendments	For Planning

DISTRIBUTION

Recipient	Revision					
	1	2	3	4	5	6
FILE	✓					
RES Ltd.	✓					

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APPENDICES

McCloy Consulting

1 INTRODUCTION

1.1 Terms of Reference

This Drainage Assessment report (DA) was commissioned by RES UK & Ireland to support a planning application for a wind farm at Dunbeg, east of Limavady.

This assessment is intended to primarily address FLD3. The assessment will therefore determine potential sources of flooding at the site and their associated risk to life and property. The assessment will determine the suitability of the site for development in relation to flood risk from sources other than rivers and sea, and propose appropriate design and mitigation measures where appropriate.

The assessment is intended to supplement the Environmental Statement (and in particular Chapter 9, Geology and Water Environment) submitted in support of the planning application for the proposal.

1.2 Statement of Authority

This report and assessment has been prepared and reviewed by qualified professionals with appropriate experience in the fields of flood risk, drainage, wastewater, and hydraulic modelling studies. The key staff members involved in this project are as follows:

- Caítríona Downey BSc (Hons) –Graduate Consultant with experience in the fields of flood risk and drainage assessment.
- Kyle Somerville BEng (Hons) CEng MIEI – Chartered Engineer specialising in flood risk assessment, flood modelling, drainage and surface water management design.

1.3 Approach to the Assessment

Consideration has been given to the sources and extent of flooding of the site from pluvial sources, infrastructure failure, overland flow and ponding of localised rainfall within the site.

For the purposes of this study, the following have been considered:

- Available information on historical surface water flooding in the area;
- Site level information based on a 3rd party survey (see in Appendix A);
- Site walkovers (June 27th 2016, 21st April 2017);
- Assessment of potential flooding to the site from sources other than rivers;
- Assessment of potential flood risk to adjacent lands caused by development at the site; and
- Determination of the availability of safe discharge of surface water from the site.

Further guidance is also provided in the CIRIA Research Project 624 "Development and Flood Risk: Guidance for the Construction Industry" and Revised PPS 15 – Planning and Flood Risk.

1.4 Application Site

The Site is located approximately 8 km to the east of Limavady, and lies on the north-eastern slopes of Keady Mountain which has a peak of approximately 337 m AOD (Above Ordnance Datum). The Site has an area within the application boundary of 52 Ha.

1.4.1 Existing Land Use

Currently the site is undeveloped and agricultural land for grazing, of varying quality. The land comprises of rush pasture, wet heath and occasional flushed areas. Topography on the Site is dictated by the slopes of Keady Mountain. Levels fall from approximately 341 m AOD in the south-eastern area of the site to 137 m AOD adjacent the northern boundary where it meets the Broad Road (A37). The majority of the Site slope gradients vary from 0 ° to 5 °, however within the centre of the Site within river valleys gradients increase to 17 °. Towards the western boundary gradients are typically 15 °.

1.4.2 Proposed Land Use

The proposed Development is for a windfarm with nine turbine and associated hardstanding, access tracks, a temporary site compound and an electrical substation. The scheme includes seven crossings of watercourses to permit access.

A schematic showing change of land use is included on the following figure. Key proposal drawings on which this assessment is based are included in Appendix A for ease of reference

1.5 Site Hydrology

There are no designated watercourses on the Site[1]. The hydrology of the site comprises of a number of natural source streams, artificially modified ditches and a number of artificially modified peat drains in the Southern area of the Site. The whole site is located within the catchment of the Curly River; the Curly River becomes a Designated Watercourse approved by Drainage Council (NI) 3.7 km to the west of the Site. The Curly River joins the main section of the River Roe 5.2 km to the west of the Site. The Roe River discharges into Lough Foyle 8.2 km to the north-west of the Site.

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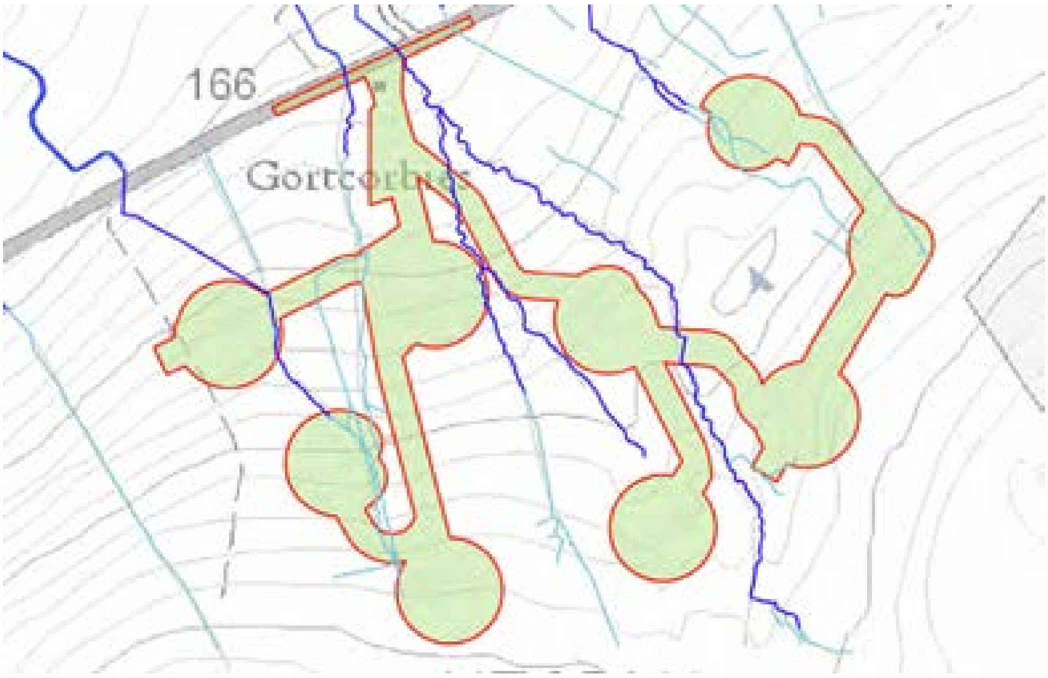
[1] DfI Rivers (2017) Designations approved by Drainage Conuncil (NI). Available at: http://riversagency.maps.arcgis.com/apps/webappviewer/index.html?id=28b901c557054dd488953180d2309903 . Accessed 24/10/2017

Existing Use			
Land Use	Agricultural	Impermeable Area	0 %



Proposed Site			
Land Use	Wind farm l	Impermeable Area	10 %

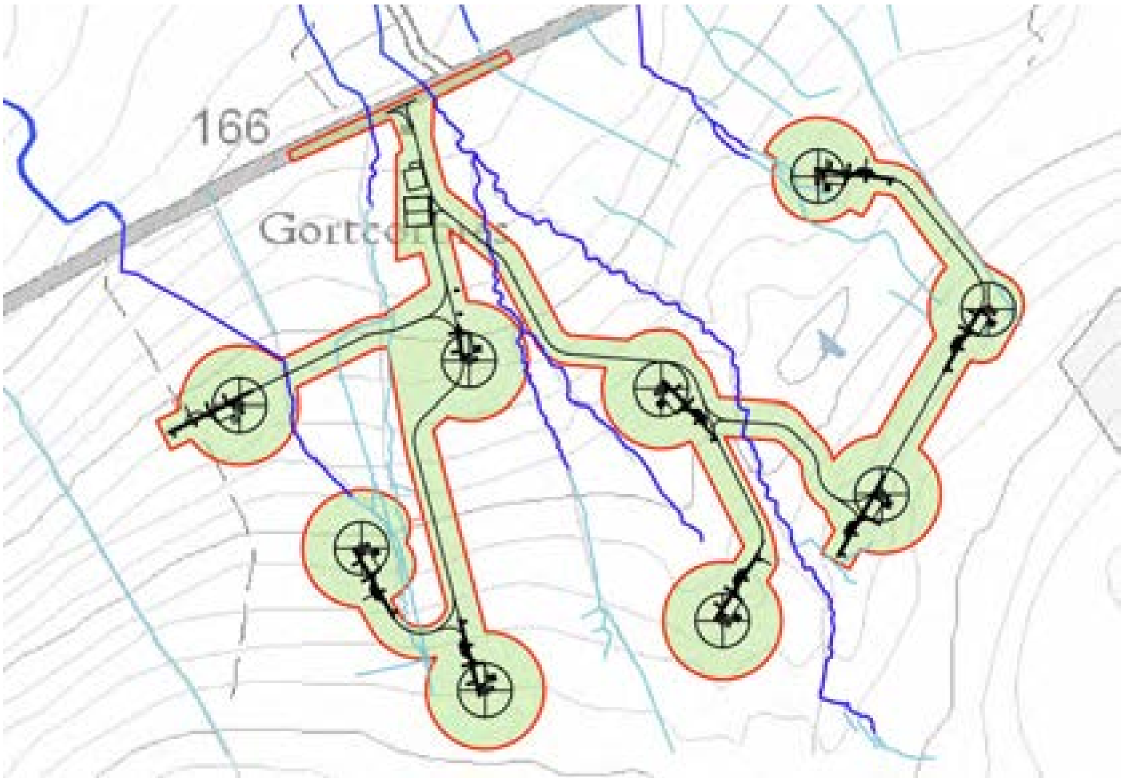


Figure 1-1: Summary of Land Use Change

2 BACKGROUND INFORMATION REVIEW

As part of the study data collection phase, a number of available sources of information were investigated in order to build an understanding of the potential risk of flooding to the site. The following review highlights the key findings of the anecdotal evidence collection exercise.

2.1 Internet / Media / Background Search

A brief media search was carried out for the purpose of this report, which found a one incidence of flooding on the Broad Road. There was no conductive evidence of flooding within the vicinity of the site.

- BBC News (Nov 2014) reported the Broad Road was closed due to flooding[2]

No indication of sewer flooding was returned from an internet search.

2.2 Northern Ireland Water

NI Water has indicated verbally that it is unable to provide comment or data in relation to out of sewer flooding.

NI Water asset information shows no sewer network within the vicinity of the development. Due to the rural nature of the site there was no consultation was undertaken with NI Water in relation to sewer infrastructure.

2.3 DfI Rivers

Through correspondence undertaken as part of the planning process, DfI Rivers have stated that they hold no record of flooding at the Site, however, part of the Site lies within the indicative 1 in 100 year floodplain and part of the Site will be affected by surface water flooding.

2.3.1 Flood Maps NI

The extent of development was reviewed with reference to Flood Maps (NI)[3]. Extracts from the flood maps are shown in Figure 2.1 and Figure 2.2 are summarised as follows:

- There is no evidence of historic flooding within the vicinity of the Site.
- The indicative 1% AEP fluvial flood map shows no significant out of bank flooding on the site in areas where development is proposed.
- The indicative 0.5% AEP surface water flood map indicates the Site is affected by predicted surface flooding, generally coinciding with the route of surface watercourses; west of T2, at the Site entrance, adjacent to the access track leading to T5.
- There is no potential for the Site to affected by reservoir flooding.

2.3.2 Designated Watercourses

The nearest designated watercourse to the Site is the Curly River, which becomes designated 3.7 km to the west of the Site. The Curly River joins the main section of the River Roe, 5.2 km to the west of the Site. The Roe River discharges into Lough Foyle 8.2 km to the north west of the Site.

[2] BBC News (2014) Met Office: Some flooding after amber warning for Northern Ireland. Available from: http://www.bbc.co.uk/news/uk-northern-ireland-29929336 [Accessed 25/10/2017]

[3] Flood Maps (NI). (2016) Flood Hazard & Flood Risk Maps for NI. Available from: http://riversagency.maps.arcgis.com/apps/webappviewer/index.html?id=fd6c0a01b07840269a50a2f596b3daf6. [Accessed: 25/10/2017].

Figure 2-1: Extract from Flood Maps (NI) – Detailed Fluvial Flood Extents 1% AEP

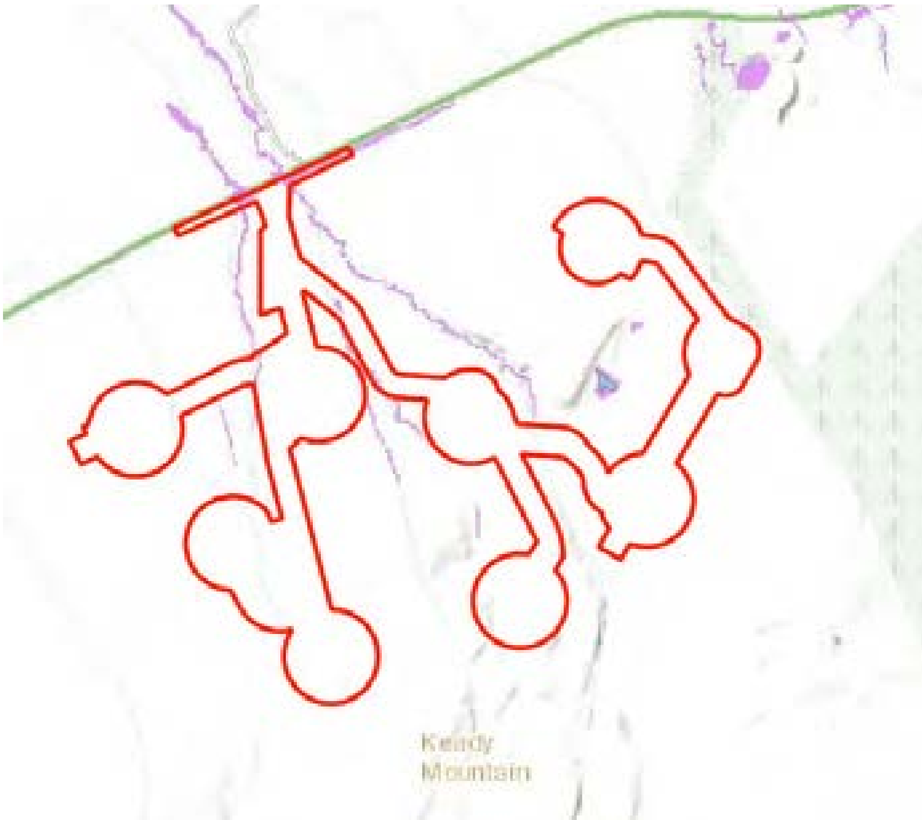


Figure 2-2: Extract from Flood Maps (NI) – Indicative Surface Water Flood Extents 0.5% AEP

3 FLOOD RISK ASSESSMENT

3.1 Initial Assessment

The following flood mechanism and policy screening is made on the basis of the initial information obtained and in the in the absence of any existing DfI Rivers consultation response.

Table 3.1: Initial Assessment - Flood Mechanism and Policy Screening

Policy	Flood Mechanism	Initial Assessment	Assess Further?	Policy Applies?
FLD 1 - Development in Fluvial & Coastal Flood Plains	Fluvial Flooding	The indicative 1% AEP fluvial flood map shows no significant out of bank flooding on the site in areas where development is proposed. Development comes in proximity to flooding only at a proposed watercourse crossing perpendicular to the direction of flow and in an area where flooding is generally contained within bank.	No	No
	Coastal Flooding	The site is unaffected by any coastal floodplain as indicated on Flood Maps NI.	No	
	Flood Defence / Failure	The site does not lie in a defended area.	No	
FLD 2 - Protection of Flood Defence & Drainage Infrastructure	Development near drainage or flood defence assets	The site causes development adjacent to or over (culvert for access) a number of drainage features.	Yes	Yes
FLD 3 – Development and Pluvial Flood Risk Outside Flood Plains	Surface water flooding	Flood Maps (NI) indicates the site is affected by predicted surface water flooding coinciding with watercourses only.	No	Yes
	Surface water discharge	The development would potentially modify surface water runoff characteristics on site/off site. The scale of development is required to demonstrate that safe discharge of surface water is feasible.	Yes	
	Culvert Blockage	No existing culverted watercourses have potential to affect the site.	No	
	Urban Drainage / Local Drainage Failure	The site is rural.	No	
	Groundwater	Not a consideration in due to underlying geology and soil types.	No	
FLD 4 – Artificial Modification of Watercourses	Development affecting watercourses	The site infrastructure crosses several watercourses to permit access.	Yes	Yes
FLD 5 - Development in Proximity to Reservoirs	Reservoir Flooding	The site does not have potential to be affected by inundation from a controlled reservoir.	No	No

3.2 Surface Water

3.2.1 Surface Runoff on Site

There are areas of surface water flooding within the site boundary, predominately coinciding with the route of surface watercourses. The proposed development has been designed in such a way to ensure that there is minimal infrastructure within the floodplain boundary. A constraints buffer has been applied which situates turbines and associated infrastructure outside of the areas of surface flooding.

3.2.2 Surface Runoff from Site

The site falls from south to north at a steep gradient, influenced by the slopes of Keady mountain. Overland flooding from the site will runoff in this direction. Lands downgradient of the proposed development comprise of the Broad Road and underdevelopment agricultural land.

Mitigation of any direct risk to adjacent land shall be by provision of a suitable surface water drainage network; particular requirements are stated in Section 4.2.3.3.

3.2.3 Surface Discharge

Currently the extent of development within the application boundary currently comprises entirely of greenfield. The proposed wind farm development, therefore, will lead to an increase in the impermeable area of the site, resulting in an increase to the rate and volume of runoff from the site, when compared to the existing scenario.

3.2.3.1 Sub Catchments

For the purposes of this drainage assessment the land within the areas where development is proposed has been divided in nine sub catchments draining to an outfall, shown on Figure 1.2, all of which ultimately drain to the Curly River.

An estimate of unmitigated post-development runoff for the extent of development has been made as part of this assessment. Runoff estimates are based on plans submitted as part of the present planning application. The runoff estimates are based on the impermeable area in each sub catchment. A comparison of existing and proposed runoff rates in litres per second (l/s) are given in Table 3.2 – Table 3.10, relating to the area subject to development draining to each outfall.

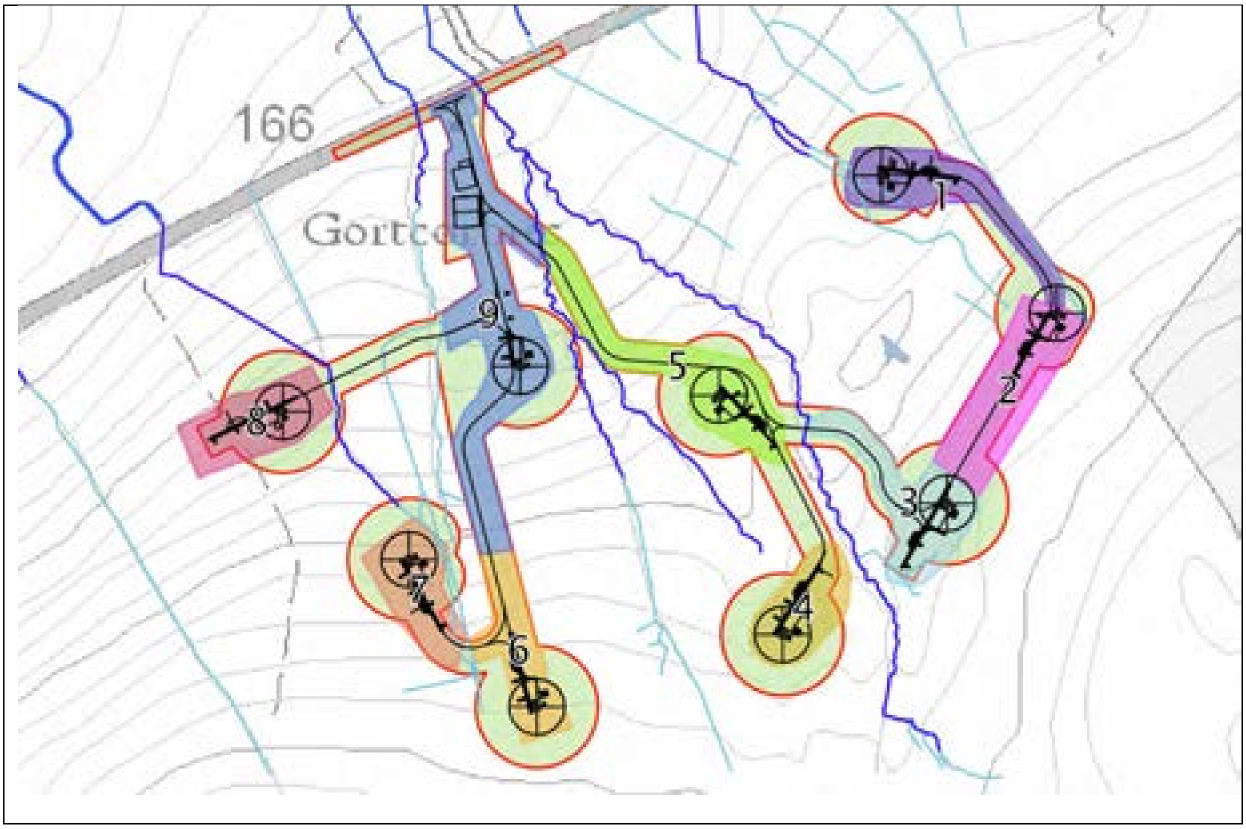


Figure 3-1: Sub catchments

Table 3.2: Outfall 1 Comparison of Surface Water Runoff Rates (Peak [1hr] Runoff Rates)

Return Period	Existing Site (lps)	Proposed Site (lps)	Increase (lps)
1 in 2 year (1hr)	5.8	15.4	*9.6*
1 in 30 year (1hr)	10.1	37.4	*27.3*
1 in 100 year (1hr)	12	53.3	*41.4*

Table 3.3: Outfall 2 Comparison of Surface Water Runoff Rates (Peak [1hr] Runoff Rates)

Return Period	Existing Site (lps)	Proposed Site (lps)	Increase (lps)
1 in 2 year (1hr)	4.6	12.3	*7.7*
1 in 30 year (1hr)	8	29.7	*21.7*
1 in 100 year (1hr)	9.5	42.4	*32.9*

Table 3.4: Outfall 3 Comparison of Surface Water Runoff Rates (Peak [1hr] Runoff Rates)

Return Period	Existing Site (lps)	Proposed Site (lps)	Increase (lps)
1 in 2 year (1hr)	5.6	14.9	*9.3*
1 in 30 year (1hr)	9.7	36	*26.3*
1 in 100 year (1hr)	11.5	51.4	*39.9*

Table 3.5: Outfall Comparison of Surface Water Runoff Rates (Peak [1hr] Runoff Rates)

Return Period	Existing Site (lps)	Proposed Site (lps)	Increase (lps)
1 in 2 year (1hr)	3.2	8.5	*5.3*
1 in 30 year (1hr)	5.5	20.5	*15*
1 in 100 year (1hr)	6.6	29.3	*22.7*

Table 3.6: Outfall 5 Comparison of Surface Water Runoff Rates (Peak [1hr] Runoff Rates)

Return Period	Existing Site (lps)	Proposed Site (lps)	Increase (lps)
1 in 2 year (1hr)	8	21.3	*13.3*
1 in 30 year (1hr)	13.9	51.6	*37.7*
1 in 100 year (1hr)	16.5	73.7	*57.1*

Table 3.7: Outfall 6 Comparison of Surface Water Runoff Rates (Peak [1hr] Runoff Rates)

Return Period	Existing Site (lps)	Proposed Site (lps)	Increase (lps)
1 in 2 year (1hr)	5.4	14.3	*8.9*
1 in 30 year (1hr)	9.3	34.7	*25.3*
1 in 100 year (1hr)	11.1	49.5	*38.3*

Table 3.8: Outfall 7 Comparison of Surface Water Runoff Rates (Peak [1hr] Runoff Rates)

Return Period	Existing Site (lps)	Proposed Site (lps)	Increase (lps)
1 in 2 year (1hr)	3.4	9.1	*5.7*
1 in 30 year (1hr)	5.9	22	*16.*
1 in 100 year (1hr)	7	31.4	*24.3*

Table 3.9: Outfall 8 Comparison of Surface Water Runoff Rates (Peak [1hr] Runoff Rates)

Return Period	Existing Site (lps)	Proposed Site (lps)	Increase (lps)
1 in 2 year (1hr)	3.3	8.8	*5.5*
1 in 30 year (1hr)	5.8	21.4	*15.6*
1 in 100 year (1hr)	6.9	30.6	*23.7*

Table 3.10: Outfall 9 Comparison of Surface Water Runoff Rates (Peak [1hr] Runoff Rates)

Return Period	Existing Site (lps)	Proposed Site (lps)	Increase (lps)
1 in 2 year (1hr)	19.2	51	*31.8*
1 in 30 year (1hr)	33.3	123.5	*90.2*
1 in 100 year (1hr)	39.6	176.3	*136.7*

Site drainage will discharge to undesignated watercourses, within the vicinity of the site, the nine discharge locations are shown on concept drawing Figure 4.1. An application for discharge consent has been made to DfI under Schedule 6 of the Drainage (NI) Order 1973, (ref IN1-17-41559).

Considerations particular to the attenuation and discharge of surface water based on the outline proposals at the site are discussed in Section 4.2.

3.3 Summary of Findings

An assessment of site drainage to address any flood risk beyond floodplains was undertaken. The development of the site causes an increase in peak rate and volume of runoff from the site.

Protection of watercourses, and mitigation of surface water flood risk to the development by providing an adequate drainage system, is discussed below.

3.4 Design Considerations

3.4.1 Land Use

All built development is sited outside of predicted 1% fluvial floodplains to comply with policy FLD1. Unavoidable watercourse crossings are sited in areas where there is no significant out of bank flooding. Requirements for culverts / bridges are stated separately subsequently in this report.

3.4.2 Drainage Design

It has been demonstrated that the proposed development of the site will cause an increase in the peak rate and volume of runoff from the site without mitigation. All drainage from the site will ultimately discharge to the tributaries of the Curley River.

Due to the nature of the development, a formalised conventional drainage system is not feasible or practical at the site. A SuDS strategy is submitted as part of a Water Framework Directive Assessment (Environmental Statement Appendix 9.1) submitted in support of the application details the drainage strategy for the site. In summary:

- The drainage system will cater for a 1-in-30 year storm, with additional site protection up to a 1-in-100 year event, common to the standard of protection afforded by Sewers for Adoption..
- Runoff from hard standing areas will be collected in open swales and attenuated behind check dams in order to reduce peak runoff rates and encourage infiltration.
- Runoff will be encouraged to discharge overland on peat and heather rather than accumulate concentrated peak flows to discharge to watercourses.
- Settlement / attenuation basins will be provided where drainage from significant areas of hard standing discharge directly to streams and watercourses.

3.4.2.1 Discharge Locations

In order to demonstrate the principle that safe discharge of surface water from the proposed wind farm site is feasible, an indicative drainage design has been prepared and is included in Appendix A. The proposal indicates that surface water from the proposed development shall discharge directly into nine watercourses, at the locations indicated on the drainage design..

Direct discharges to watercourses shall be subject to discharge consent under Schedule 6 of the Drainage (Northern Ireland) Order 1973. An application has been made to DfI Rivers (ref. IN1-17-41559, see Appendix B) for the discharges noted.

3.4.2.2 Discharge Rates and Attenuation

Surface runoff shall be limited to the greenfield equivalent rate of 10lps/ha for the developed site area. The rate is subject to consent by DfI Rivers (ref. IN1-17-41559, see Appendix B).

The drainage strategy for the site intends to discharge surface water overland on rough moor at regular frequencies from shallow swales, the effect of which would be to avoid accumulations of flow at low points where water would discharge to existing watercourses. Water discharged overland would be attenuated as it was forced to filter across undisturbed rough vegetation.

However, for purposes of this assessment and in order to present a highly conservative scenario, the following drainage and attenuation estimates ignore the effect of overland losses, and assume all runoff discharges to watercourses directly. Preliminary outline drainage calculations based on the information available result in the following limiting discharge rates and attenuation volumes per catchment considered. Results relate to area subject to development (change of surface) only.

Table 3.11: Attenuation Requirements

Catchment and Impermeable Area	Adopted Greenfield Runoff Rate	Limiting Rate	Preliminary Attenuation Volume
Outfall 1 – 0.54 Ha	10 lps/Ha	5.4 lps	115 m3
Outfall 2 – 0.43 Ha	10 lps/Ha	4.3 lps	91 m3
Outfall 3 – 0.52 Ha	10 lps/Ha	5.2 lps	111 m3
Outfall 4 – 0.29 Ha	10 lps/Ha	2.9 lps	63 m3
Outfall 5 – 0.74 Ha	10 lps/Ha	7.4 lps	158 m3
Outfall 6 – 0.5 Ha	10 lps/Ha	5.0 lps	106 m3
Outfall 7 – 0.32 Ha	10 lps/Ha	3.2 lps	68 m3
Outfall 8 – 0.31 Ha	10 lps/Ha	3.1 lps	66 m3
Outfall 9 – 1.77 Ha	10 lps/Ha	17.8 lps	378 m3

Attenuation volumes stated are based on preliminary information and conservatively assume all runoff will be discharged to watercourses. Drainage catchments and areas contributing to discharge are subject to change dependant on the finalised layout of any drainage layout. Volumes stated are dependent on the type and efficiency of the flow control method used; ultimately the final design (to be completed and agreed post-consent) must comply with the limiting discharge rate (per hectare) applied to the drained development area to each point of discharge. It is noted that limiting rates less than 5 lps may not be practicably achieved as noted in industry guidance documents[4]; in such instances a maximum 5 lps throttle will be adopted.

The following relevant drawing details are included in Annex A of this assessment:

- Preliminary SuDS layout - Drawing 01 (reproduced from ES Appendix 9.1 Water Framework Directive Assessment)
- Typical attenuation lagoon arrangement - Drawing 08 (reproduced from ES Appendix 9.1 Water Framework Directive Assessment)
- Attenuation & Outfall Locations – Figure 9.6

3.4.3 Watercourse Crossings

Design of culverts where streams are crossed by proposed access tracks will be designed as to mitigate potential for pluvial flooding of infrastructure.

Culverts will be designed to accommodate track crossings and minimise length of affected channel in order to comply with Revised PPS15 policy FLD4. Hydraulic design of crossings will be undertaken as per the guidance and requirements provided in CIRIA C689 “Culvert Design and Operation Guide” (or other standard as may be required by DfI Rivers in post-consent consultation), with primary parameters likely to include:

- Width of the culvert will be greater than the width of the active drainage channel;
- Alignment of the culvert will suit the alignment of the drainage channel, i.e. preserve the existing direction of flow;
- The slope of the culvert will not exceed the slope of the bed of the existing drainage channel.

[4] Code for Sustainable Homes – Technical Guidance Note 001, BRE GLOBAL 16 December 2009

Detailed design of crossings will assume a hydraulic capacity requirement of 1% Annual Equivalent Probability flow as a conservative measure. Detailed hydraulic design of culverts and similar structures post-determination of the planning application is normal and accepted practice for wind farms in Northern Ireland.

In instances where fish passage is a requirement, the structure will be a bottomless culvert. Elsewhere culverts shall be of a closed conduit type. Typical design drawings for a bottomless culvert and closed culvert have been provided as part of the planning application and are included as part of the Drainage Management Drawings within Technical Appendix 9.1: Water Framework Directive Assessment.

Consultation and approval will be sought from all relevant parties as required by the Department of the Environment Surface Waters Alteration Handbook (December 2013), including Loughs Agency permitting under Section 69 of the Foyle Fisheries Act (Northern Ireland), and DfI Rivers in particular, at the pre-construction detailed design stage for all works in and affecting watercourses and drains, as per the requirements of Schedule 6 of the Drainage (Northern Ireland) Order 1973 and subsequent amendments.

3.4.4 Protection of Watercourses

All infrastructure other than unavoidable watercourse crossings is sited a minimum of 10m from any mapped watercourse and as such exceeds the normal requirements (5m) stated in policy FLD2 in relation to provision for maintenance.

3.5 Maintenance Requirements

3.5.1 Maintenance of SUDS

Maintenance considerations relative to drainage at the site have been considered in detail in ES Appendix 9.1 Water Framework Directive Assessment submitted in support of the application.

The developer / wind farm operator is to ensure that maintenance of the drainage system is provided for as part of the overall management plan for the site. Detailed drainage layout for the site is to ensure that key SuDS features requiring maintenance (e.g. flow control devices) are located in accessible locations.

Maintenance plans for SuDS are to include (where applicable):

- Cyclical (min. annual) check of any flow control device – in particular clearing of debris;
- Seasonal maintenance of any surface water feature (swales / ponds) – nominally to include management of vegetation, clearing of obstructions etc.

3.5.1 Maintenance of Watercourse

The operator is reminded of their statutory obligations set out in the Drainage (Northern Ireland) Order 1973 in relation their role as a riparian landowner to the watercourse coinciding with the site boundary.

3.6 Planning Policy Summary

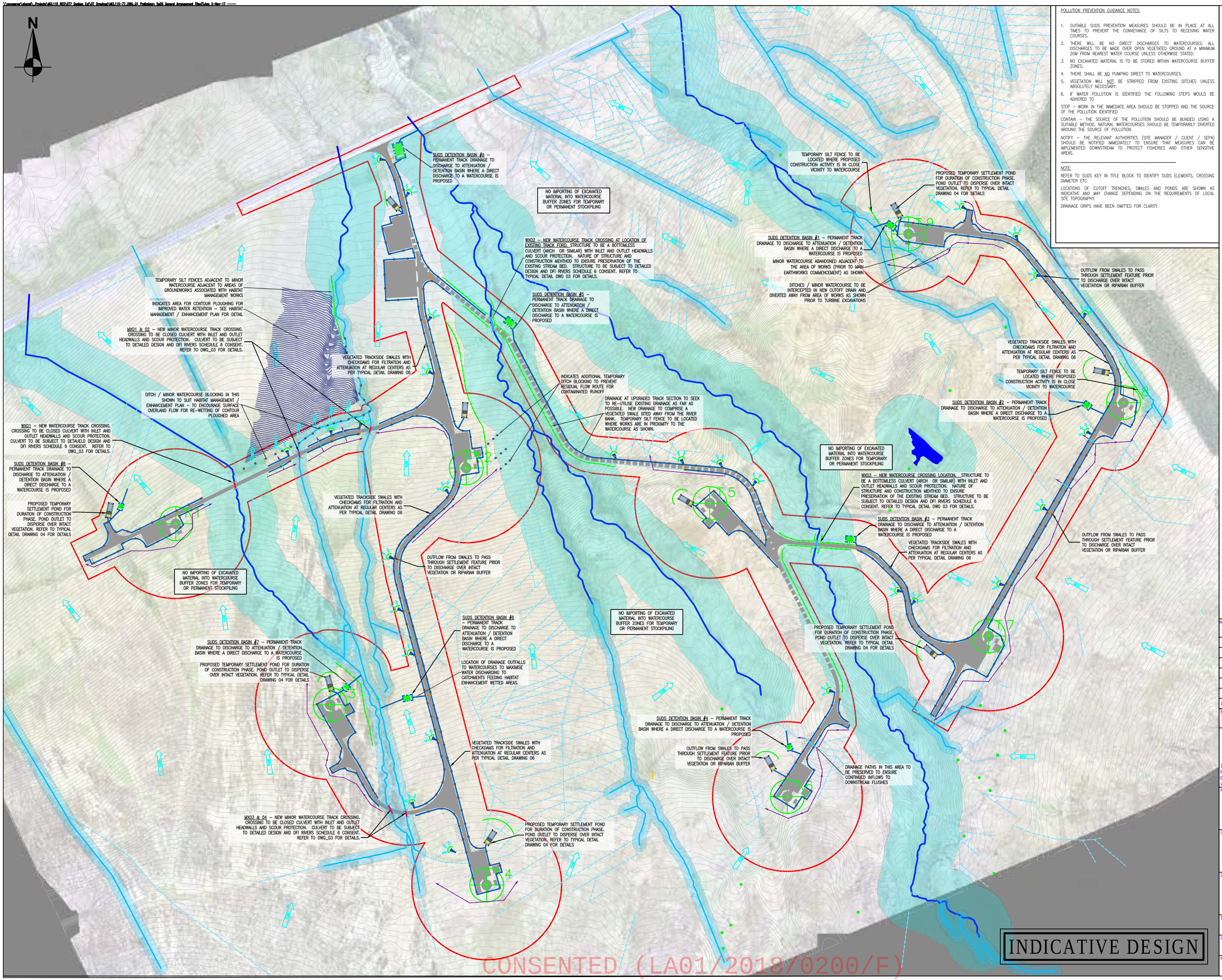
The following table summarises the findings, mitigation, and policy context of those flood mechanisms and policies deemed to be required to be investigated further by the initial assessment.

Table 3-12: PPS15 Policy Summary

Policy	Flood Mechanism	Assessment / Mitigation	Complies?
FLD 1 - Development in Fluvial & Coastal Flood Plains	Does not apply (see Table 3.1))		
FLD 2 - Protection of Flood Defence & Drainage Infrastructure	Development near drainage or flood defence assets	The proposal makes provision for a buffer / maintenance strip exceeding the normal requirements stated in FLD2 for works adjacent to watercourses	Yes
FLD 3 – Development and Pluvial Flood Risk Outside Flood Plains	Surface water discharge	Drainage design to adopt the hydraulic requirements of Sewers for Adoption. Surface water can be safely disposed of to a watercourses within the application site. Site drainage adopts a SuDS approach. Direct discharges to watercourses will be limited to greenfield equivalent. Surface water attenuation can be accommodated within the site boundary.	Yes
FLD 4 – Artificial Modification of Watercourses	Culverting of Watercourses	Culverts are proposed for access only and are a permissible exception under FLD4. Culverts will be designed to accommodate a 1% AEP flow and shall be subject to DfI Rivers consent.	Yes
FLD 5 - Development in Proximity to Reservoirs	Does not apply (see Table 3.1)		

Annex A

Drawings & Details



CONSENTED (LA01/2018/0200/F)

POLLUTION PREVENTION GUIDANCE NOTES:

1. SUITABLE SUDS PREVENTION MEASURES SHOULD BE IN PLACE AT ALL TIMES TO PREVENT THE CONVEYANCE OF SILTS TO RECEIVING WATER COURSES.
2. THERE WILL BE NO DIRECT DISCHARGES TO WATERCOURSES. ALL DISCHARGES TO BE MADE OVER OPEN VEGETATED GROUND AT A MINIMUM 20M FROM NEAREST WATER COURSE UNLESS OTHERWISE STATED.
3. NO EXCAVATED MATERIAL IS TO BE STORED WITHIN WATERCOURSE BUFFER ZONES.
4. THERE SHALL BE NO PUMPING DIRECT TO WATERCOURSES.
5. VEGETATION WILL NOT BE STRIPPED FROM EXISTING DITCHES UNLESS ABSOLUTELY NECESSARY.
6. IF WATER POLLUTION IS IDENTIFIED THE FOLLOWING STEPS WOULD BE ADHERED TO

STOP – WORK IN THE IMMEDIATE AREA SHOULD BE STOPPED AND THE SOURCE OF THE POLLUTION IDENTIFIED

CONTAIN – THE SOURCE OF THE POLLUTION SHOULD BE BUNDED USING A SUITABLE METHOD. NATURAL WATERCOURSES SHOULD BE TEMPORARILY DIVERTED AROUND THE SOURCE OF POLLUTION.

NOTIFY – THE RELEVANT AUTHORITIES (SITE MANAGER / CLIENT / SEPA) SHOULD BE NOTIFIED IMMEDIATELY TO ENSURE THAT MEASURES CAN BE IMPLEMENTED DOWNSTREAM TO PROTECT FISHERIES AND OTHER SENSITIVE AREAS.

NOTE:

REFER TO SUDS KEY IN TITLE BLOCK TO IDENTIFY SUDS ELEMENTS, CROSSING DIAMETER ETC.

LOCATIONS OF CUTOFF TRENCHES, SWALES AND PONDS ARE SHOWN AS INDICATIVE AND MAY CHANGE DEPENDING ON THE REQUIREMENTS OF LOCAL SITE TOPOGRAPHY.

DRAINAGE GRIPS HAVE BEEN OMITTED FOR CLARITY.

NOTES

1. DRAINAGE LAYOUT SHOWN IS INDICATIVE AND IS INTENDED TO BE FURTHER DEVELOPED POST DETERMINATION OF THE ASSOCIATED PLANNING APPLICATION. DRAINAGE FEATURES SHOWN ARE SUBJECT TO CHANGE DEPENDANT ON DETAILED INFRASTRUCTURE DESIGN AND LOCAL TOPOGRAPHY.
2. LOCATION OF CROSSINGS, SWALES, BREAKOUTS, SETTLEMENT PONDS ETC. IS INDICATIVE ONLY FOR PURPOSES OF PRELIMINARY PLANNING DRAWING LAYOUT.
3. THE LEVEL OF SILT IN RUNOFF DURING CONSTRUCTION IS TO BE MONITORED VISUALLY AND EXCESSIVE SILT LEVELS IN ANY AREA TO BE TEMPORARILY MANAGED BY PLACING SILT FENCES & GEOTEXTILE BARRIERS AT THE PROBLEM AREAS.
4. SUDS SYSTEM TO BE CONSTRUCTED PRIOR TO, OR AT THE SAME TIME, AS THE ACCESS ROAD. INTERIM MEASURES SUCH AS THE PLACEMENT OF SILT FENCES TO BE EMPLOYED IN ALL INSTANCES WHERE WORK CARRIED OUT TO CONSTRUCT THE ACCESS ROAD IS LIKELY TO CAUSE ADVERSE ENVIRONMENTAL IMPACTS.
5. SUITABLE PREVENTION MEASURES SHOULD BE IN PLACE AT ALL TIMES TO PREVENT THE CONVEYANCE OF SILTS TO RECEIVING WATER COURSES.
6. DRAINAGE SWALES TO BE CONSTRUCTED ADJACENT TO THE ACCESS TRACK. REGULAR CROSS DRAINS TO BE LOCATED ALONG ACCESS TRACKS TO PREVENT EXCESSIVE VOLUMES OF WATER COLLECTING IN THE SWALES. SURFACE WATER WILL NOT BE ALLOWED TO DISCHARGE DIRECTLY INTO EXISTING WATER COURSES. SUMPS /PONDS TO BE CONSTRUCTED FOR PEAT AND SILT COLLECTION FROM EXCAVATIONS & SPOIL HEAPS.
7. ROADSIDE SWALES TO BE SHALLOW WITH MODERATE GRADIENTS TO PREVENT SCOURING. IN STEEP AREAS CHECK-DAMS HAVE BEEN DESIGNATED TO REDUCE FLOW RATE & PROVIDE SOURCE CONTROL SILT CONTAINMENT. WHERE NECESSARY THESE HAVE BEEN DESIGNATED IN CONJUNCTION WITH SETTLEMENT PONDS AND/OR CROSS-DRAINS.
8. AREAS STRIPPED OF VEGETATION SHOULD BE KEPT TO A MINIMUM.
9. CLEAN STONE FLOW CONTROL CHECK-DAMS TO BE LOCALLY WON WELL GRADED STONE. AGGREGATE SIZE FOR STONE CHECK DAMS TO BE TYPICALLY 20/40MM CLEAN STONE. ON SLOPING SECTIONS OF THE ACCESS ROAD, 20/40MM CHECK DAMS TO BE PROTECTED FROM WASHING AWAY THROUGH THE PLACEMENT OF 100MM STONE ON THE DOWNHILL FACE OF THE CHECK-DAM.
10. BUILD UP OF SILT LEVELS AT CHECK-DAMS TO BE REMOVED AND DISPOSED OF APPROPRIATELY. SILT LEVELS AT CHECK DAMS TO BE VISUALLY INSPECTED AS PART OF AN ONGOING MAINTENANCE PROGRAM DURING THE CONSTRUCTION PHASE. WHERE CHECK-DAMS BECOME CLOGGED WITH SILT OR VEGETATION, STONE CHECK DAM TO BE REMOVE AND REPLACED.
11. SPACING AND FREQUENCY OF CHECK DAMS WILL BE DEPENDANT UPON LONGITUDINAL GRADIENT OF SWALE. LOCATION OF FILTRATION CHECK DAMS TO BE GENERALLY AS PER THE SITE LAYOUT PLAN. FLOW FILTRATION CHECK DAMS TO BE CONSTRUCTED FROM RECYCLED RAILWAY SLEEPERS OR SIMILAR APPROVED. MATERIALS USED TO CONSTRUCT FLOW FILTRATION CHECK DAM TO BE BOLTED TO SUPPORTS WHERE ACCESSIBLE.
12. OIL FUEL SHOULD BE STORED WITHIN CONTAINMENT AND CEMENT SHOULD BE MIXED WITHIN COMPOUND / CONTAINMENT, TOOLS WASHED IN THE SAME AREA AND WATER RECYCLED (IN THE CEMENT MIX).
13. WATERCOURSES SHOWN ARE AS PER CLIENT PROVIDED OS MAPPING AND DRAWINGS; LOCATIONS SHOWN ARE APPROXIMATE ONLY AND MAY REQUIRE FURTHER INVESTIGATION FOR DETAILED DESIGN.
14. NO DIRECT DISCHARGE TO WATERCOURSES – MAINTAIN APPROPRIATE VEGETATION BUFFER.

SuDS KEY

- UNDERTRACK DRAINAGE (CONSTRUCTION RUNOFF)
- UNDERTRACK DRAINAGE (NATURAL RUNOFF)
- PROPOSED NEW TRACK
- PROPOSED UPGRADE TO EXISTING TRACK
- DRAINAGE SWALE / INDICATIVE BREAKOUT & CHECK DAM
- NATURAL RUNOFF CUT-OFF DITCH
- SILT FENCE
- WATERCOURSE / SIGNIFICANT DRAIN CROSSING
- SETTLEMENT POND TO BE INSTALLED PRIOR TO CONSTRUCTION OF TURBINE BASE
- ATTENUATION / DETENTION LAGOON
- 50M BUFFER TO WATERCOURSE
- 10M BUFFER TO DRAIN / MINOR WATERCOURSE

MAP KEY

- PLANNING APPLICATION BOUNDARY
- MAJOR WATER COURSE
- MINOR WATERCOURSE / DRAIN / CHANNEL
- EPHEMERAL / LAND DRAINAGE
- NATURAL OVERLAND FLOW DIRECTIONS

NOTE: THIS DRAWING IS BASED ON 3RD PARTY INFRASTRUCTURE / PROPOSAL DRAWING:
03219D1001-01

ISSUE	DRN	APP	DATE	NOTES / DESCRIPTION
2	CD	DKS	30/10/2017	FOR PLANNING
1	MR	DKS	05/10/2016	ORIGINAL DRAFT – FOR INFORMATION

STATUS
FOR PLANNING

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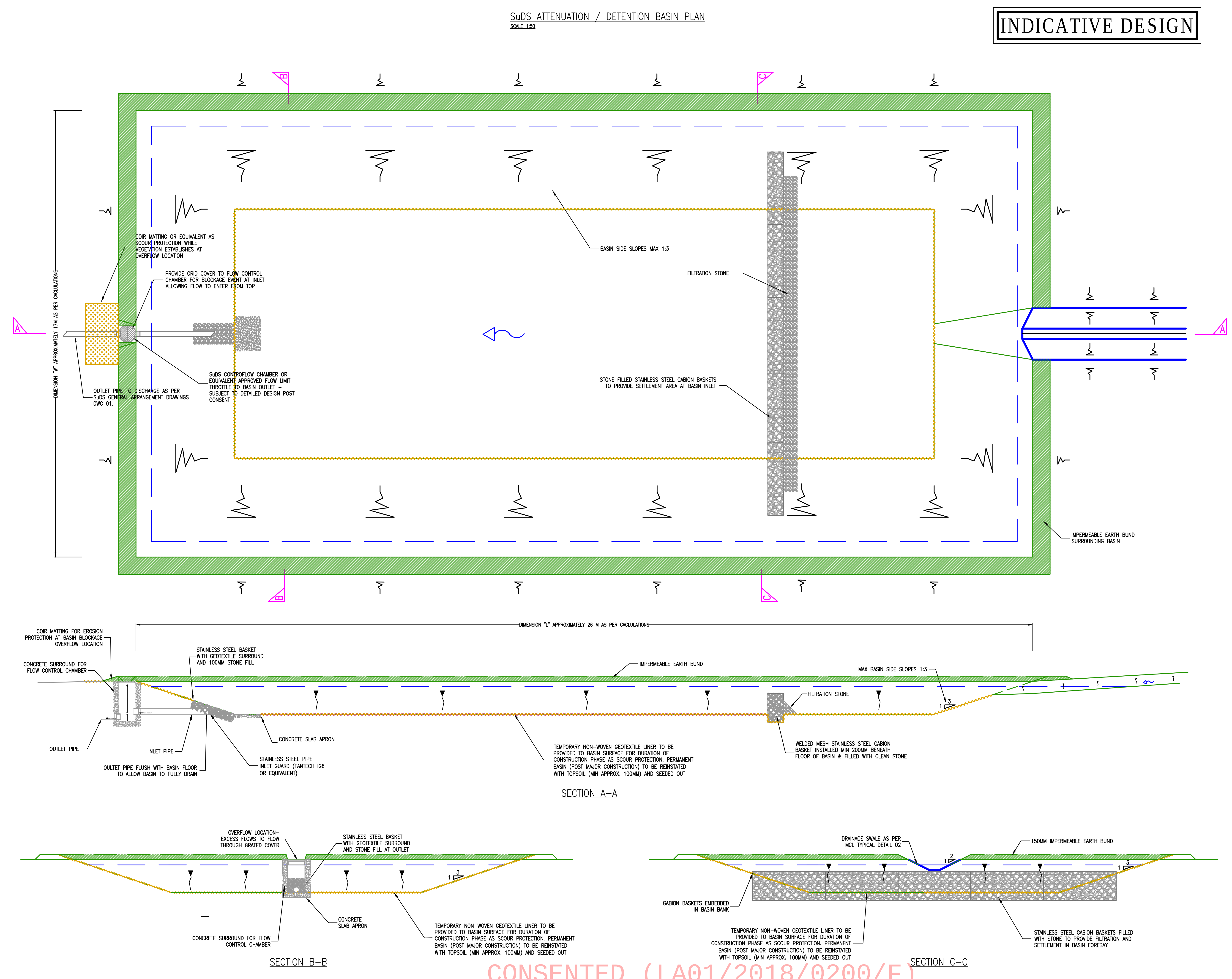
BT36 5QA

PROJECT
PROPOSED DUNBEG SOUTH WIND FARM

CLIENT
res

DRAWING TITLE
DRAINAGE MANAGEMENT DRAWINGS
SITE GENERAL ARRANGEMENT
SHEET 1

SCALE	ORIGINAL SIZE	
1: 5000 @ A3	A3	
DRAWN	CHECKED	DATE
MR	DKS	05/10/2017
PROJECT No.	DRAWING No.	ISSUE NO.
MCL115-77	DWG_01	2



NOTE: THIS DRAWING IS BASED ON 3RD PARTY INFRASTRUCTURE / PROPOSAL DRAWING:
N/A

ISSUE	DRN	APP	DATE	NOTES / DESCRIPTION
2	DKS	DKS	02/11/2017	FOR PLANNING
1	DL	CMQ	18/10/2017	FOR INFORMATION

STATUS
FOR PLANNING

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PROJECT
PROPOSED DUNBEG SOUTH WINDFARM

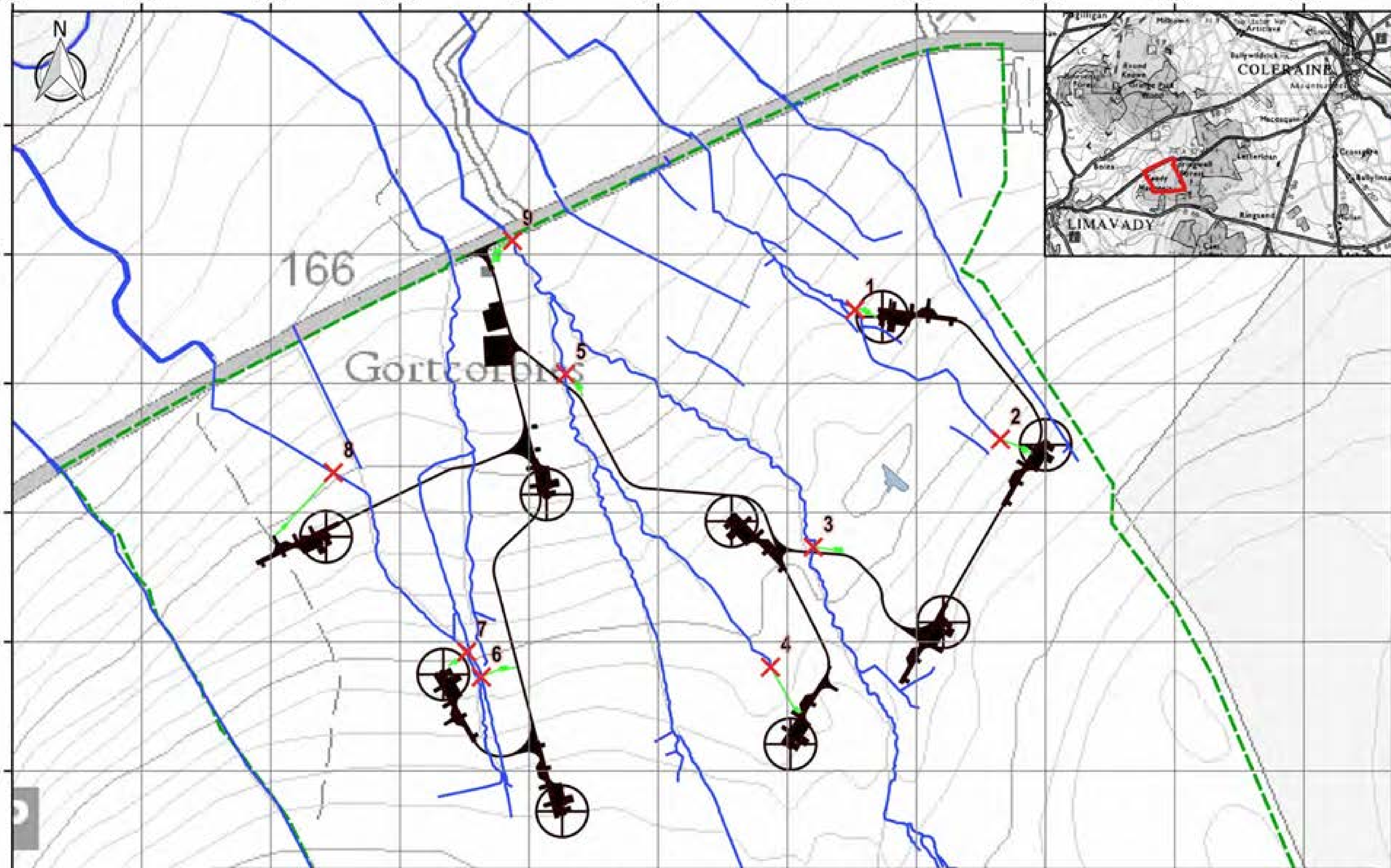
CLIENT
res

DRAWING TITLE
DRAINAGE MANAGEMENT (SuDS) OUTLINE TYPICAL DETAILS DETENTION BASIN/ ATTENUATION POND

SCALE	ORIGINAL SIZE
AS SHOWN	A1

DRAWN	CHECKED	DATE
DL	CMQ	17/10/2017

PROJECT No.	DRAWING No.	ISSUE NO.
MCL115-77	DWG_08	2



res

DUNBEG SOUTH WIND FARM

FIGURE 9.6

PRELIMINARY DRAINAGE DETAILS - DISCHARGE TO WATERCOURSES

Legend

Proposed Layout

- Site Boundary
- Proposed Infrastructure Layout
- Watercourse
- Pond

Preliminary Discharge Infrastrcture

- Location of Discharge to Watercourse
- Outfalls
- Attenuation Basins

NOTES:

1. REFER TO DRAWING MCL115-77_DWG_08 FOR DETAILS OF ATTENUATION BASIN / OUTFALL / FLOW CONTROL
2. ALL OUTFALLS TO WATERCOURSES VIA SUITABLE HEADWALL AND SCOUR PROTECTION - SEE INDICATIVE HEADWALL DETAIL
3. FLOW CONTROLS VIA ORIFICE OR HYDROBRAKE OR SIMILAR - SEE INDICATIVE DETAIL / DATA SHEET.
4. DRAWING DETAIL IS PRELIMINARY ONLY INTENDED TO ESTABLISH PRINCIPLE OF SAFE DISCHARGE OF RUNOFF TO WATERCOURSES.

DRAWING NUMBER
MCL115-77 Fig 9.6

SCALE
AS SHOWN @ A3

DRAINAGE ASSESSMENT

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Newtownabbey BT36 5QA
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E: info@mccloyconsulting.com
w: www.mccloyconsulting.com

PRELIMINARY DISCHARGE LOCATIONS AND ATTENUATION VOLUMES

ID	Prelim. Discharge Location X	Prelim. Discharge Location Y	Impermeable Area (Ha)	Limiting Rate (Greenfield Equivalent)	Preliminary Attenuation (m3)	Indicative Dimensions
1	274181	425692	0.54	5.37	115	15.5 x 10 x 0.75
2	274462	425441	0.43	4.27	91	12.5 x 10 x0.75
3	274100	425233	0.56	5.63	120	16 x 10 x 0.75
4	274017	425001	0.29	2.95	63	9.5 x 9 x 0.75
5	273620	425567	0.74	7.42	158	18.5 x 11.5 x 0.75
6	273458	424982	0.5	4.98	106	15 x 9.5 x 0.75
7	273429	425030	0.32	3.16	68	10 x 9.5 x 0.75
8	273171	425377	0.31	3.08	66	11 x 8 x 0.75
9	273517	425826	1.78	17.75	378	25 x 15.5 x 1

Annex B

Correspondence

Caitriona Downey

Subject: FW: HPRM: MCL115-77 Dunbeg South Windfarm - Schedule 6 Application for discharge to watercourses

From: DfI Rivers Coleraine [mailto:Rivers.Coleraine@infrastructure-ni.gov.uk]
Sent: 24 October 2017 11:17
To: Caitriona Downey
Subject: RE: HPRM: MCL115-77 Dunbeg South Windfarm - Schedule 6 Application for discharge to watercourses

Thank you for your email dated 24th October 2017 regarding the above. We are considering your request and will reply as soon as possible.
Please continue to forward emails to Rivers.Coleraine@infrastructure-ni.gov.uk please quote reference IN1-17-41559 on all future correspondence.

Regards

DFI Rivers

Department for Infrastructure
www.infrastructure-ni.gov.uk
37 Castleroe Road
Coleraine
BT51 3RL
Tel: 028 7034 2357

From: Caitriona Downey
Sent: 23 October 2017 16:56
To: DfI Rivers Coleraine
Cc: Kyle Somerville
Subject: HPRM: MCL115-77 Dunbeg South Windfarm - Schedule 6 Application for discharge to watercourses

Our Reference: MCL115-77

Re. Proposed windfarm development on lands at Dunbeg South

Dear Sir / Madam

Please find attached information relating to an application for consent to discharge storm water from a site at Dunbeg under Schedule 6 of the Drainage (NI) Order 1973, to accompany a drainage assessment in support of a planning application.

Consent is requested for the discharge rates from the site based on the equivalent greenfield run-off rate of 10lps / Ha, specific details are supplied on the enclosed Location Map.

We would appreciate if in the first instance you would acknowledge receipt of this application and confirm any applicable TRIM reference.

If there are any queries or if you require any further information please do not hesitate to contact this office.

Kind regards,

Caítríona

Caitriona Downey

Graduate Consultant | Belfast

E: Caitriona.Downey@mccloyconsulting.com | T: +44 (0) 28 9084 8694 | W: www.mccloyconsulting.com
Mossley Mill, Lower Ground (West), Carnmoney Road North, Newtownabbey BT36 5QA

Check out our new website at www.mccloyconsulting.com

Annex C

Calculations

Project	Dunbeg South WF - Area 1	McCloy Consulting
Ref	MCL115-77	Water Engineering Solutions
Date	25/10/2017	

Purpose

To estimate the change in runoff rate on a greenfield (undeveloped) site caused by the proposed redevelopment, by comparison of IH-124 greenfield runoff rates and Modified Rational Method for developed runoff rates

Inputs

Length (m)	400	m	From Survey
Total Developed Area (m2)	5387	m2	From Survey
Total Developed Area (ha)	0.5	Ha	Calculated
Max Height	275.0	mAOD	From DTM
Min Height	222.9	mAOD	From Survey
SAAR	1247	mm	From FEH3
SAAR4170	1301	mm	From FEH3
UCWI	112	mm	From Figure 4.4, CIRIA C697
SOIL	5	n/a	From WRAP maps
M5-60	13.3		From FEH3
M5-2D	71.6		From FEH3

Proposed Site Impermeable Areas	A1	A2	A3	A4	TOTAL	
Roof					0.0	m^2
Bitmac / Paved / Hardstanding	5368.97				5369.0	m^2
					5369.0	m^2
				or	0.537	ha

IoH124Parameters		Modified Rational Method Parameters		
Region:	I	DeltaH	52.100	m
		Slope (%)	13.03	%
		Te (mins)	8.17	mins
		ARF	0.987	n/a
		SOIL	0.50	n/a
		DEEPSTOR	0.21	n/a
		PIMP	99.666	%
		PR	83.19	%
		Cv	0.83	n/a
		Cr	1.3	n/a
		Wallingford Ratio r	0.2	n/a

Summary of Results - Peak (1-hr) Runoff Rates

Results relate to area subject to development (change of surface) only

Return Period	Existing Scenario (lps)	Proposed Scenario (1-hr) (lps	*Increase (lps)*	Increase (%)
1 in 2 year	5.80	15.42	*9.62*	166%
1 in 30 year	10.07	37.35	*27.28*	271%
1 in 100 year	11.98	53.33	*41.36*	345%

By	Checked	Revision	Reason for Change	Date
CD	KDS	1		25/10/2017

R:_Projects\MCL115 RES\077 Dunbeg Ext\06 Report\DG03 Drainage Assessment\Appendix\C\MMR\[MCL115-77_Area 2 IoH124 vs Mod Rat Method Site Comparison (U

Project	Dunbeg South WF - Area 2
Ref	MCL115-77
Date	25/10/2017

McCloy Consulting
Water Engineering Solutions

Purpose

To estimate the change in runoff rate on a greenfield (undeveloped) site caused by the proposed redevelopment, by comparison of IH-124 greenfield runoff rates and Modified Rational Method for developed runoff rates

Inputs

Length (m)	390	m	From Survey
Total Developed Area (m2)	4270	m2	From Survey
Total Developed Area (ha)	0.4	Ha	Calculated
Max Height	295.0	mAOD	From DTM
Min Height	277.0	mAOD	From Survey
SAAR	1247	mm	From FEH3
SAAR4170	1301	mm	From FEH3
UCWI	112	mm	From Figure 4.4, CIRIA C697
SOIL	5	n/a	From WRAP maps
M5-60	13.3		From FEH3
M5-2D	71.6		From FEH3

Proposed Site Impermeable Areas	A1	A2	A3	A4	TOTAL	
Roof					0.0	m^2
Bitmac / Paved / Hardstanding	4270.18				4270.2	m^2
					4270.2	m^2
				or	0.427	ha

IoH124Parameters

Region: I

Modified Rational Method Parameters

DeltaH	18.000	m
Slope (%)	4.62	%
Te (mins)	10.82	mins
ARF	0.990	n/a
SOIL	0.50	n/a
DEEPSTOR	0.34	n/a
PIMP	100.000	%
PR	83.47	%
Cv	0.83	n/a
Cr	1.3	n/a
Wallingford Ratio r	0.2	n/a

Summary of Results - Peak (1-hr) Runoff Rates

Results relate to area subject to development (change of surface) only

Return Period	Existing Scenario (lps)	Proposed Scenario (1-hr) (lps	*Increase (lps)*	Increase (%)
1 in 2 year	4.61	12.26	*7.65*	166%
1 in 30 year	8.01	29.70	*21.70*	271%
1 in 100 year	9.52	42.42	*32.89*	345%

By	Checked	Revision	Reason for Change	Date
CD	KDS	1		25/10/2017

R:_Projects\MCL115 RES\077 Dunbeg Ext\06 Report\DG03 Drainage Assessment\Appendix\C\MMR\[MCL115-77_Area 2 IoH124 vs Mod Rat Method Site Comparison (U

Project	Dunbeg South WF - Area 3
Ref	MCL115-77
Date	25/10/2017

McCloy Consulting
Water Engineering Solutions

Purpose

To estimate the change in runoff rate on a greenfield (undeveloped) site caused by the proposed redevelopment, by comparison of IH-124 greenfield runoff rates and Modified Rational Method for developed runoff rates

Inputs

Length (m)	250	m	From Survey
Total Developed Area (m2)	5175	m2	From Survey
Total Developed Area (ha)	0.5	Ha	Calculated
Max Height	283.2	mAOD	From DTM
Min Height	248.2	mAOD	From Survey
SAAR	1247	mm	From FEH3
SAAR4170	1301	mm	From FEH3
UCWI	112	mm	From Figure 4.4, CIRIA C697
SOIL	5	n/a	From WRAP maps
M5-60	13.3		From FEH3
M5-2D	71.6		From FEH3

Proposed Site Impermeable Areas	A1	A2	A3	A4	TOTAL	
Roof					0.0	m^2
Bitmac / Paved / Hardstanding	5174.18				5174.2	m^2
					5174.2	m^2
				or	0.517	ha

IoH124Parameters		Modified Rational Method Parameters		
Region:	I	DeltaH	35.000	m
		Slope (%)	14.00	%
		Te (mins)	7.52	mins
		ARF	0.987	n/a
		SOIL	0.50	n/a
		DEEPSTOR	0.20	n/a
		PIMP	99.985	%
		PR	83.46	%
		Cv	0.83	n/a
		Cr	1.3	n/a
		Wallingford Ratio r	0.2	n/a

Summary of Results - Peak (1-hr) Runoff Rates

Results relate to area subject to development (change of surface) only

Return Period	Existing Scenario (lps)	Proposed Scenario (1-hr) (lps	*Increase (lps)*	Increase (%)
1 in 2 year	5.59	14.86	*9.27*	166%
1 in 30 year	9.70	35.99	*26.29*	271%
1 in 100 year	11.54	51.40	*39.86*	345%

By	Checked	Revision	Reason for Change	Date
CD	KDS	1		25/10/2017

R:_Projects\MCL115 RES\077 Dunbeg Ext\04 Calcs\MMR\[MCL115-77_Area 5 IoH124 vs Mod Rat Method Site Comparison (Undeveloped - Developed)_Greenfield Area

Project	Dunbeg South WF - Area 4	
Ref	MCL115-77	
Date	25/10/2017	

McCloy Consulting
Water Engineering Solutions

Purpose

To estimate the change in runoff rate on a greenfield (undeveloped) site caused by the proposed redevelopment, by comparison of IH-124 greenfield runoff rates and Modified Rational Method for developed runoff rates

Inputs

Length (m)	175	m	From Survey
Total Developed Area (m2)	2947	m2	From Survey
Total Developed Area (ha)	0.3	Ha	Calculated
Max Height	274.5	mAOD	From DTM
Min Height	270.7	mAOD	From Survey
SAAR	1247	mm	From FEH3
SAAR4170	1301	mm	From FEH3
UCWI	112	mm	From Figure 4.4, CIRIA C697
SOIL	5	n/a	From WRAP maps
M5-60	13.3		From FEH3
M5-2D	71.6		From FEH3

Proposed Site Impermeable Areas	A1	A2	A3	A4	TOTAL	
Roof					0.0	m^2
Bitmac / Paved / Hardstanding	2947.20				2947.2	m^2
					2947.2	m^2
				or	0.295	ha

IoH124Parameters		Modified Rational Method Parameters		
Region:	I	DeltaH	3.800	m
		Slope (%)	2.17	%
		Te (mins)	11.96	mins
		ARF	0.991	n/a
		SOIL	0.50	n/a
		DEEPSTOR	0.49	n/a
		PIMP	100.000	%
		PR	83.47	%
		Cv	0.83	n/a
		Cr	1.3	n/a
		Wallingford Ratio r	0.2	n/a

Summary of Results - Peak (1-hr) Runoff Rates

Results relate to area subject to development (change of surface) only

Return Period	Existing Scenario (lps)	Proposed Scenario (1-hr) (lps	*Increase (lps)*	Increase (%)
1 in 2 year	3.18	8.46	*5.28*	166%
1 in 30 year	5.53	20.50	*14.98*	271%
1 in 100 year	6.57	29.28	*22.70*	345%

By	Checked	Revision	Reason for Change	Date
CD	KDS	1		25/10/2017

R:_Projects\MCL115 RES\077 Dunbeg Ext\04 Calcs\MMR\[MCL115-77_Area 5 IoH124 vs Mod Rat Method Site Comparison (Undeveloped - Developed)_Greenfield Area

Project	Dunbeg South WF - Area 5	McCloy Consulting
Ref	MCL115-77	Water Engineering Solutions
Date	25/10/2017	

Purpose

To estimate the change in runoff rate on a greenfield (undeveloped) site caused by the proposed redevelopment, by comparison of IH-124 greenfield runoff rates and Modified Rational Method for developed runoff rates

Inputs

Length (m)	605	m	From Survey
Total Developed Area (m2)	7416	m2	From Survey
Total Developed Area (ha)	0.7	Ha	Calculated
Max Height	250.0	mAOD	From DTM
Min Height	179.5	mAOD	From Survey
SAAR	1247	mm	From FEH3
SAAR4170	1301	mm	From FEH3
UCWI	112	mm	From Figure 4.4, CIRIA C697
SOIL	5	n/a	From WRAP maps
M5-60	13.3		From FEH3
M5-2D	71.6		From FEH3

Proposed Site Impermeable Areas	A1	A2	A3	A4	TOTAL	
Roof					0.0	m^2
Bitmac / Paved / Hardstanding	7415.99				7416.0	m^2
					7416.0	m^2
				or	0.742	ha

IoH124Parameters		Modified Rational Method Parameters		
Region:	I	DeltaH	70.500	m
		Slope (%)	11.65	%
		Te (mins)	8.90	mins
		ARF	0.986	n/a
		SOIL	0.50	n/a
		DEEPSTOR	0.22	n/a
		PIMP	100.000	%
		PR	83.47	%
		Cv	0.83	n/a
		Cr	1.3	n/a
		Wallingford Ratio r	0.2	n/a

Summary of Results - Peak (1-hr) Runoff Rates

Results relate to area subject to development (change of surface) only

Return Period	Existing Scenario (lps)	Proposed Scenario (1-hr) (lps	*Increase (lps)*	Increase (%)
1 in 2 year	8.01	21.30	*13.28*	166%
1 in 30 year	13.91	51.59	*37.68*	271%
1 in 100 year	16.54	73.67	*57.13*	345%

By	Checked	Revision	Reason for Change	Date
CD	KDS	1		25/10/2017

R:_Projects\MCL115 RES\077 Dunbeg Ext\04 Calcs\MMR\[MCL115-77_Area 5 IoH124 vs Mod Rat Method Site Comparison (Undeveloped - Developed)_Greenfield Area

Project	Dunbeg South WF - Area 6	
Ref	MCL115-77	
Date	25/10/2017	

McCloy Consulting
Water Engineering Solutions

Purpose

To estimate the change in runoff rate on a greenfield (undeveloped) site caused by the proposed redevelopment, by comparison of IH-124 greenfield runoff rates and Modified Rational Method for developed runoff rates

Inputs

Length (m)	300	m	From Survey
Total Developed Area (m2)	4982	m2	From Survey
Total Developed Area (ha)	0.5	Ha	Calculated
Max Height	290.4	mAOD	From DTM
Min Height	260.0	mAOD	From Survey
SAAR	1247	mm	From FEH3
SAAR4170	1301	mm	From FEH3
UCWI	112	mm	From Figure 4.4, CIRIA C697
SOIL	5	n/a	From WRAP maps
M5-60	13.3		From FEH3
M5-2D	71.6		From FEH3

Proposed Site Impermeable Areas	A1	A2	A3	A4	TOTAL	
Roof					0.0	m^2
Bitmac / Paved / Hardstanding	4981.65				4981.7	m^2
					4981.7	m^2
				or	0.498	ha

IoH124Parameters		Modified Rational Method Parameters		
Region:	I	DeltaH	30.400	m
		Slope (%)	10.13	%
		Te (mins)	8.42	mins
		ARF	0.988	n/a
		SOIL	0.50	n/a
		DEEPSTOR	0.23	n/a
		PIMP	100.000	%
		PR	83.47	%
		Cv	0.83	n/a
		Cr	1.3	n/a
		Wallingford Ratio r	0.2	n/a

Summary of Results - Peak (1-hr) Runoff Rates

Results relate to area subject to development (change of surface) only

Return Period	Existing Scenario (lps)	Proposed Scenario (1-hr) (lps	*Increase (lps)*	Increase (%)
1 in 2 year	5.38	14.31	*8.92*	166%
1 in 30 year	9.34	34.65	*25.31*	271%
1 in 100 year	11.11	49.49	*38.37*	345%

By	Checked	Revision	Reason for Change	Date
CD	KDS	1		25/10/2017

R:_Projects\MCL115 RES\077 Dunbeg Ext\06 Report\DG03 Drainage Assessment\Appendix\C\MMR\[MCL115-77_Area 2 IoH124 vs Mod Rat Method Site Comparison (U

Project	Dunbeg South WF - Area 7
Ref	MCL115-77
Date	25/10/2017

McCloy Consulting
Water Engineering Solutions

Purpose

To estimate the change in runoff rate on a greenfield (undeveloped) site caused by the proposed redevelopment, by comparison of IH-124 greenfield runoff rates and Modified Rational Method for developed runoff rates

Inputs

Length (m)	190	m	From Survey
Total Developed Area (m2)	3156	m2	From Survey
Total Developed Area (ha)	0.3	Ha	Calculated
Max Height	277.7	mAOD	From DTM
Min Height	256.5	mAOD	From Survey
SAAR	1247	mm	From FEH3
SAAR4170	1301	mm	From FEH3
UCWI	112	mm	From Figure 4.4, CIRIA C697
SOIL	5	n/a	From WRAP maps
M5-60	13.3		From FEH3
M5-2D	71.6		From FEH3

Proposed Site Impermeable Areas	A1	A2	A3	A4	TOTAL	
Roof					0.0	m^2
Bitmac / Paved / Hardstanding	3155.57				3155.6	m^2
					3155.6	m^2
				or	0.316	ha

IoH124Parameters		Modified Rational Method Parameters		
Region:	I	DeltaH	21.200	m
		Slope (%)	11.16	%
		Te (mins)	7.72	mins
		ARF	0.989	n/a
		SOIL	0.50	n/a
		DEEPSTOR	0.22	n/a
		PIMP	100.000	%
		PR	83.47	%
		Cv	0.83	n/a
		Cr	1.3	n/a
		Wallingford Ratio r	0.2	n/a

Summary of Results - Peak (1-hr) Runoff Rates

Results relate to area subject to development (change of surface) only

Return Period	Existing Scenario (lps)	Proposed Scenario (1-hr) (lps	*Increase (lps)*	Increase (%)
1 in 2 year	3.41	9.06	*5.65*	166%
1 in 30 year	5.92	21.95	*16.03*	271%
1 in 100 year	7.04	31.35	*24.31*	345%

By	Checked	Revision	Reason for Change	Date
CD	KDS	1		25/10/2017

R:_Projects\MCL115 RES\077 Dunbeg Ext\06 Report\DG03 Drainage Assessment\Appendix\C\MMR\[MCL115-77_Area 2 IoH124 vs Mod Rat Method Site Comparison (U

Project	Dunbeg South WF - Area 8	
Ref	MCL115-77	
Date	25/10/2017	

McCloy Consulting
Water Engineering Solutions

Purpose

To estimate the change in runoff rate on a greenfield (undeveloped) site caused by the proposed redevelopment, by comparison of IH-124 greenfield runoff rates and Modified Rational Method for developed runoff rates

Inputs

Length (m)	195	m	From Survey
Total Developed Area (m2)	3075	m2	From Survey
Total Developed Area (ha)	0.3	Ha	Calculated
Max Height	219.8	mAOD	From DTM
Min Height	205.7	mAOD	From Survey
SAAR	1247	mm	From FEH3
SAAR4170	1301	mm	From FEH3
UCWI	112	mm	From Figure 4.4, CIRIA C697
SOIL	5	n/a	From WRAP maps
M5-60	13.3		From FEH3
M5-2D	71.6		From FEH3

Proposed Site Impermeable Areas	A1	A2	A3	A4	TOTAL	
Roof					0.0	m^2
Bitmac / Paved / Hardstanding	3075.13				3075.1	m^2
					3075.1	m^2
				or	0.308	ha

IoH124Parameters		Modified Rational Method Parameters		
Region:	I	DeltaH	14.100	m
		Slope (%)	7.23	%
		Te (mins)	8.72	mins
		ARF	0.990	n/a
		SOIL	0.50	n/a
		DEEPSTOR	0.27	n/a
		PIMP	100.000	%
		PR	83.47	%
		Cv	0.83	n/a
		Cr	1.3	n/a
		Wallingford Ratio r	0.2	n/a

Summary of Results - Peak (1-hr) Runoff Rates

Results relate to area subject to development (change of surface) only

Return Period	Existing Scenario (lps)	Proposed Scenario (1-hr) (lps	*Increase (lps)*	Increase (%)
1 in 2 year	3.32	8.83	*5.51*	166%
1 in 30 year	5.77	21.39	*15.63*	271%
1 in 100 year	6.86	30.55	*23.69*	345%

By	Checked	Revision	Reason for Change	Date
CD	KDS	1		25/10/2017

R:_Projects\MCL115 RES\077 Dunbeg Ext\06 Report\DG03 Drainage Assessment\Appendix\C\MMR\[MCL115-77_Area 2 IoH124 vs Mod Rat Method Site Comparison (U

Project	Dunbeg South WF - Area 9
Ref	MCL115-77
Date	25/10/2017

McCloy Consulting
Water Engineering Solutions

Purpose

To estimate the change in runoff rate on a greenfield (undeveloped) site caused by the proposed redevelopment, by comparison of IH-124 greenfield runoff rates and Modified Rational Method for developed runoff rates

Inputs

Length (m)	815	m	From Survey
Total Developed Area (m2)	17748	m2	From Survey
Total Developed Area (ha)	1.8	Ha	Calculated
Max Height	260.0	mAOD	From DTM
Min Height	165.0	mAOD	From Survey
SAAR	1247	mm	From FEH3
SAAR4170	1301	mm	From FEH3
UCWI	112	mm	From Figure 4.4, CIRIA C697
SOIL	5	n/a	From WRAP maps
M5-60	13.3		From FEH3
M5-2D	71.6		From FEH3

Proposed Site Impermeable Areas	A1	A2	A3	A4	TOTAL	
Roof					0.0	m^2
Bitmac / Paved / Hardstanding	17748.00				17748.0	m^2
					17748.0	m^2
				or	1.775	ha

IoH124Parameters

Region: I

Modified Rational Method Parameters

DeltaH	95.000	m
Slope (%)	11.66	%
Te (mins)	9.26	mins
ARF	0.982	n/a
SOIL	0.50	n/a
DEEPSTOR	0.22	n/a
PIMP	100.000	%
PR	83.47	%
Cv	0.83	n/a
Cr	1.3	n/a
Wallingford Ratio r	0.2	n/a

Summary of Results - Peak (1-hr) Runoff Rates

Results relate to area subject to development (change of surface) only

Return Period	Existing Scenario (lps)	Proposed Scenario (1-hr) (lps	*Increase (lps)*	Increase (%)
1 in 2 year	19.18	50.97	*31.79*	166%
1 in 30 year	33.28	123.46	*90.18*	271%
1 in 100 year	39.59	176.30	*136.71*	345%

By	Checked	Revision	Reason for Change	Date
CD	KDS	1		25/10/2017

R:_Projects\MCL115 RES\077 Dunbeg Ext\06 Report\DG03 Drainage Assessment\Appendix\C\MMR\[MCL115-77_Area 2 IoH124 vs Mod Rat Method Site Comparison (U

CRM Stormflow   Stormwater Management Software

Client:	RES
Project:	MCL115-77
Location:	Dunbeg
Catchment:	Dunbeg WF_Area 1

Catchment Details:

Buildings	0	m^2	x 95 %
Dense surfacing	5368.97	m^2	x 90 %
Effective Area	4832.07 3	m^2	

Storage Details:

Volume	115	m^3
Porosity	100	%
Area Increase	0	%

Rainfall Details - FEH Method:

Return Period		30	years
Climate Change Factor		0	%
c	-0.029	d1	0.4603
d2	0.48541	d3	0.33282
e	0.29305	f	2.18189

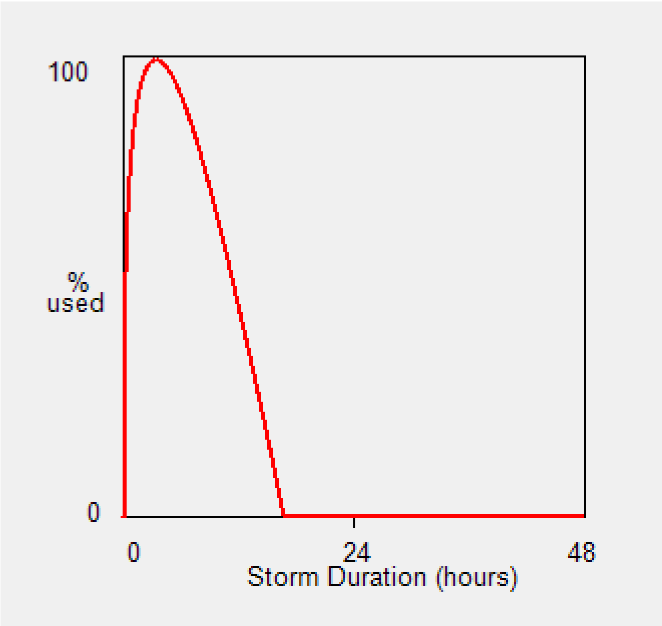
	mm	mm/h	storage (m^3)
30 min	18.6	37.2	80.163
45 min	21.5	28.7	89.538
60 min	23.9	23.9	96.129
2 hours	30.7	15.4	109.743
6 hours	45.7	7.6	104.934
24 hours	76.9	3.2	0.000

Outflow Details:

Infiltration rate	0	m/hr
Attenuation Control	Fixed Outflow	
Control Diameter	-	mm
Discharge rate	5.37	l/s

Results:

Outcome:	Pass
Critical Storm Duration	3.37 hrs
Hmax	0.992 m
Time to half empty	3 hrs



Client:	RES
Project:	MCL115-77
Location:	Dunbeg
Catchment:	Dunbeg WF_Area 2

Catchment Details:

Buildings	0	m^2	x 95 %
Dense surfacing	4270.18	m^2	x 90 %
Effective Area	3843.16 2	m^2	

Storage Details:

Volume	91	m^3
Porosity	100	%
Area Increase	0	%

Rainfall Details - FEH Method:

Return Period 30 years

Climate Change Factor 0 %

c	-0.029	d1	0.4603
d2	0.48541	d3	0.33282
e	0.29305	f	2.18189

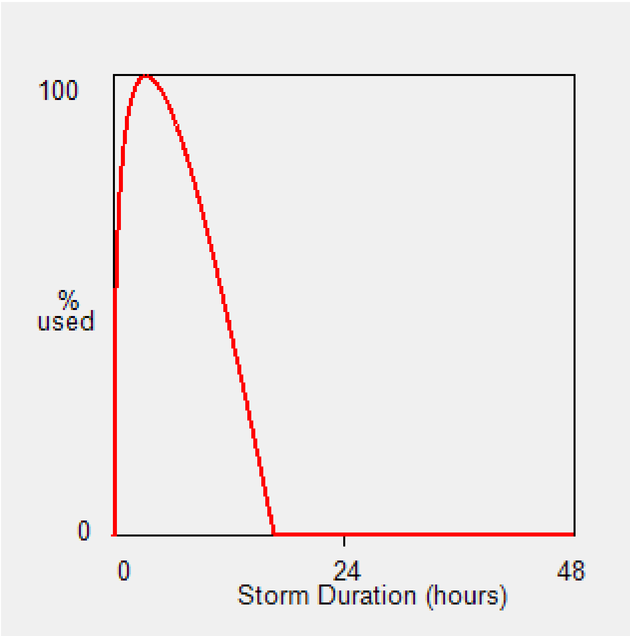
	mm	mm/h	storage (m^3)
30 min	18.6	37.2	63.759
45 min	21.5	28.7	71.216
60 min	23.9	23.9	76.459
2 hours	30.7	15.4	87.291
6 hours	45.7	7.6	83.480
24 hours	76.9	3.2	0.000

Outflow Details:

Infiltration rate	0	m/hr
Attenuation Control	Fixed Outflow	
Control Diameter	-	mm
Discharge rate	4.27	l/s

Results:

Outcome:	Pass
Critical Storm Duration	3.37 hrs
Hmax	0.998 m
Time to half empty	3 hrs



CRM Stormflow Stormwater Management Software

Client:	
Project:	
Location:	
Catchment:	Dunbeg Area 3

Catchment Details:

Buildings	0	m^2	x 95 %
Dense surfacing	5626.46	m^2	x 90 %
Effective Area	5063.81 4	m^2	

Storage Details:

Width	120	m^3
Porosity	100	%
Area Increase	0	%

Rainfall Details - FEH Method:

Return Period		30	years
Climate Change Factor		0	%
c	-0.029	d1	0.4603
d2	0.48541	d3	0.33282
e	0.29305	f	2.18189

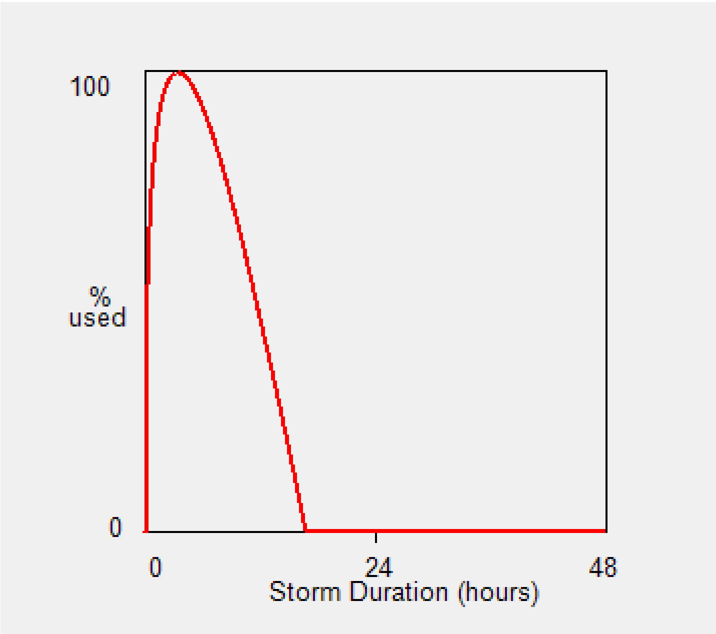
	mm	mm/h	storage (m^3)
30 min	18.6	37.2	84.003
45 min	21.5	28.7	93.826
60 min	23.9	23.9	100.730
2 hours	30.7	15.4	114.989
6 hours	45.7	7.6	109.913
24 hours	76.9	3.2	0.000

Outflow Details:

Infiltration rate	0	m/hr
Attenuation Control	Fixed Outflow	
Control Diameter	-	mm
Discharge rate	5.63	l/s

Results:

Outcome:	Pass
Critical Storm Duration	3.37 hrs
Hmax	0.747 m
Time to half empty	2.9 hrs



CRM Stormflow Stormwater Management Software

Client:	RES
Project:	MCL115-77
Location:	Dunbeg
Catchment:	Dunbeg WF_Area 4

Catchment Details:

Buildings	0	m^2	x 95 %
Dense surfacing	2947.2	m^2	x 90 %
Effective Area	2652.48	m^2	

Storage Details:

Volume	63	m^3
Porosity	100	%
Area Increase	0	%

Rainfall Details - FEH Method:

Return Period		30	years
Climate Change Factor		0	%
c	-0.029	d1	0.4603
d2	0.48541	d3	0.33282
e	0.29305	f	2.18189

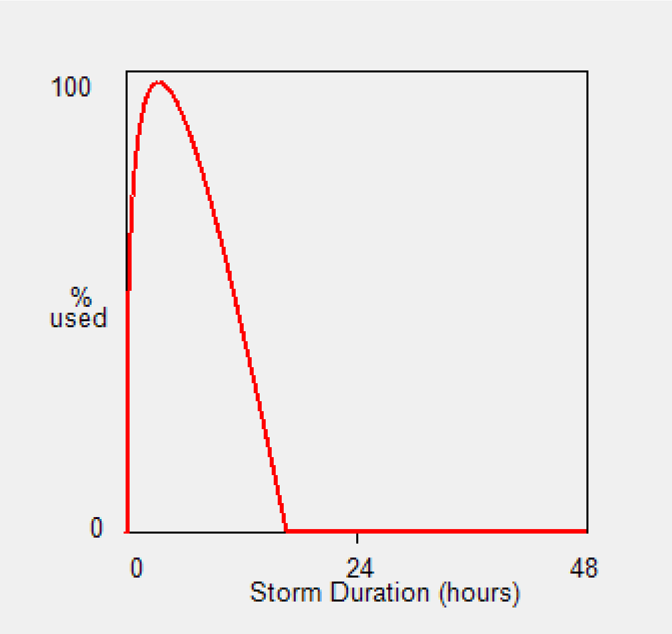
	mm	mm/h	storage (m^3)
30 min	18.6	37.2	44.000
45 min	21.5	28.7	49.144
60 min	23.9	23.9	52.760
2 hours	30.7	15.4	60.225
6 hours	45.7	7.6	57.553
24 hours	76.9	3.2	0.000

Outflow Details:

Infiltration rate	0	m/hr
Attenuation Control	Fixed Outflow	
Control Diameter	-	mm
Discharge rate	2.95	l/s

Results:

Outcome:	Pass
Critical Storm Duration	3.37 hrs
Hmax	0.732 m
Time to half empty	2.9 hrs



CRM Stormflow Stormwater Management Software

Client:	RES
Project:	MCL115-77
Location:	Dunbeg
Catchment:	Dunbeg WF_Area 5

Catchment Details:

Buildings	0	m^2	x 95 %
Dense surfacing	7415.99	m^2	x 90 %
Effective Area	6674.39	m^2	
	1		

Storage Details:

Volume	158	m^3
Porosity	100	%
Area Increase	0	%

Rainfall Details - FEH Method:

Return Period		30	years
Climate Change Factor		0	%
c	-0.029	d1	0.4603
d2	0.48541	d3	0.33282
e	0.29305	f	2.18189

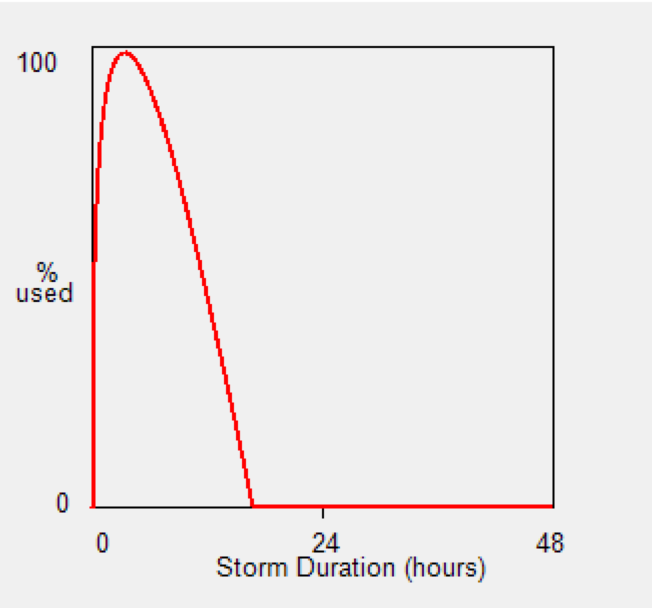
	mm	mm/h	storage (m^3)
30 min	18.6	37.2	110.722
45 min	21.5	28.7	123.669
60 min	23.9	23.9	132.771
2 hours	30.7	15.4	151.566
6 hours	45.7	7.6	144.886
24 hours	76.9	3.2	0.000

Outflow Details:

Infiltration rate	0	m/hr
Attenuation Control	Fixed Outflow	
Control Diameter	-	mm
Discharge rate	7.42	l/s

Results:

Outcome:	Pass
Critical Storm Duration	3.37 hrs
Hmax	0.741 m
Time to half empty	3 hrs



CRM Stormflow Stormwater Management Software

Client:	RES
Project:	MCL115-77
Location:	Dunbeg
Catchment:	Dunbeg WF_Area 6

Catchment Details:

Buildings	0	m^2	x 95 %
Dense surfacing	4981.65	m^2	x 90 %
Effective Area	4483.48 5	m^2	

Storage Details:

Volume	106	m^3
Porosity	100	%
Area Increase	0	%

Rainfall Details - FEH Method:

Return Period		30	years
Climate Change Factor		0	%
c	-0.029	d1	0.4603
d2	0.48541	d3	0.33282
e	0.29305	f	2.18189

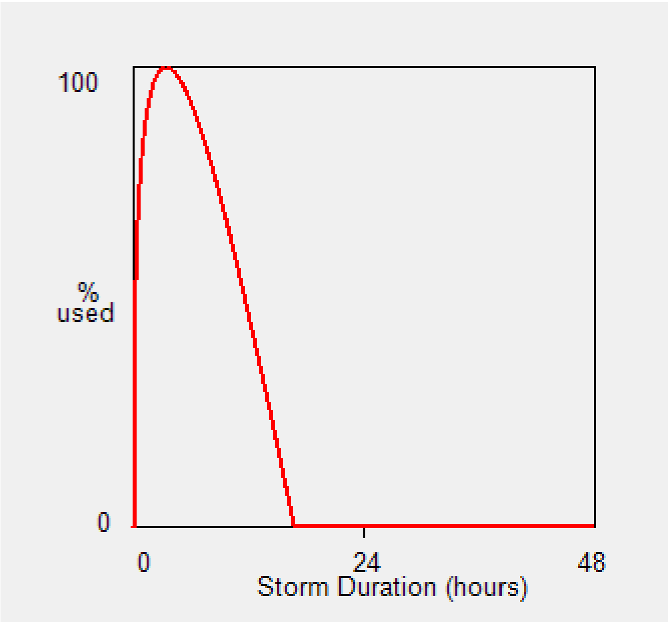
	mm	mm/h	storage (m^3)
30 min	18.6	37.2	74.385
45 min	21.5	28.7	83.086
60 min	23.9	23.9	89.204
2 hours	30.7	15.4	101.845
6 hours	45.7	7.6	97.420
24 hours	76.9	3.2	0.000

Outflow Details:

Infiltration rate	0	m/hr
Attenuation Control	Fixed Outflow	
Control Diameter	-	mm
Discharge rate	4.98	l/s

Results:

Outcome:	Pass
Critical Storm Duration	3.37 hrs
Hmax	105.925 m
Time to half empty	3 hrs



CRM Stormflow Stormwater Management Software

Client:	RES
Project:	MCL115-77
Location:	Dunbeg
Catchment:	Dunbeg WF_Area 7

Catchment Details:

Buildings	0	m^2	x 95 %
Dense surfacing	3155.57	m^2	x 90 %
Effective Area	2840.013	m^2	

Storage Details:

Volume	68	m^3
Porosity	100	%
Area Increase	0	%

Rainfall Details - FEH Method:

Return Period		30	years
Climate Change Factor		0	%
c	-0.029	d1	0.4603
d2	0.48541	d3	0.33282
e	0.29305	f	2.18189

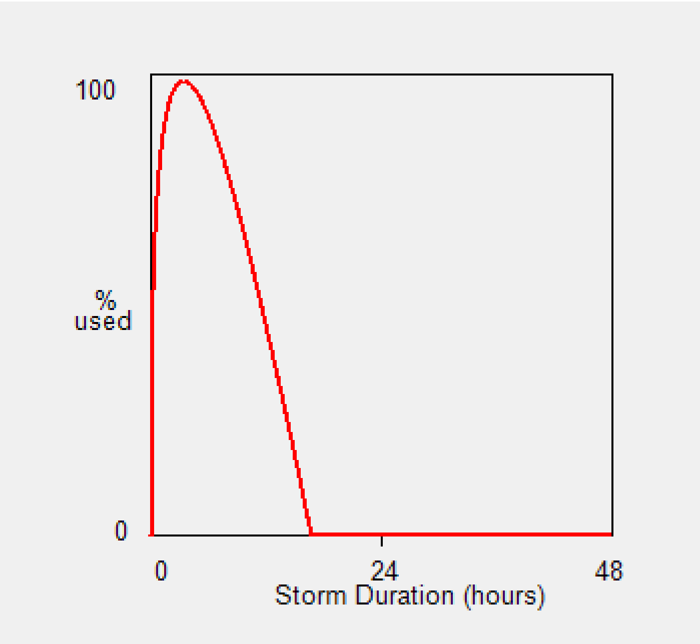
	mm	mm/h	storage (m^3)
30 min	18.6	37.2	47.108
45 min	21.5	28.7	52.615
60 min	23.9	23.9	56.485
2 hours	30.7	15.4	64.473
6 hours	45.7	7.6	61.592
24 hours	76.9	3.2	0.000

Outflow Details:

Infiltration rate	0	m/hr
Attenuation Control	Fixed Outflow	
Control Diameter	-	mm
Discharge rate	3.16	l/s

Results:

Outcome:	Pass
Critical Storm Duration	3.37 hrs
Hmax	0.706 m
Time to half empty	2.9 hrs



CRM Stormflow Stormwater Management Software

Client:	RES
Project:	MCL115-77
Location:	Dunbeg
Catchment:	Dunbeg WF_Area 8

Catchment Details:

Buildings	0	m^2	x 95 %
Dense surfacing	3075.13	m^2	x 90 %
Effective Area	2767.61 7	m^2	

Storage Details:

Volume	66	m^3
Porosity	100	%
Area Increase	0	%

Rainfall Details - FEH Method:

Return Period		30	years
Climate Change Factor		0	%
c	-0.029	d1	0.4603
d2	0.48541	d3	0.33282
e	0.29305	f	2.18189

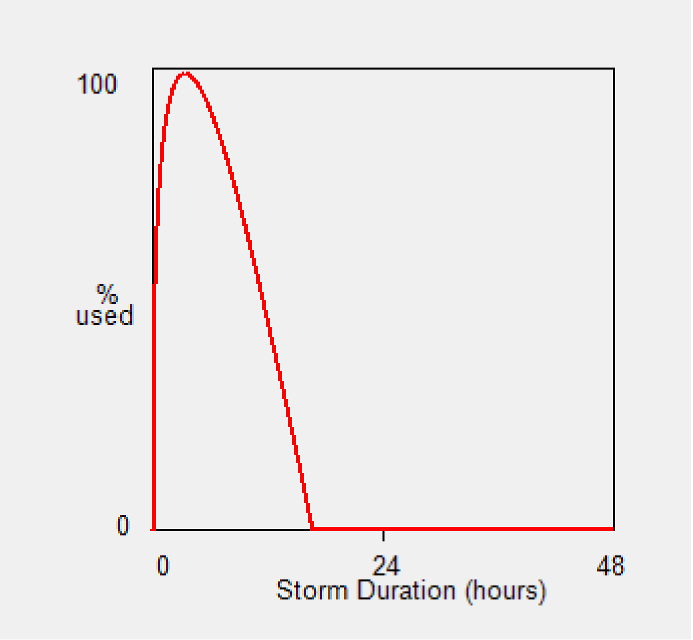
	mm	mm/h	storage (m^3)
30 min	18.6	37.2	45.906
45 min	21.5	28.7	51.272
60 min	23.9	23.9	55.043
2 hours	30.7	15.4	62.826
6 hours	45.7	7.6	60.010
24 hours	76.9	3.2	0.000

Outflow Details:

Infiltration rate	0	m/hr
Attenuation Control	Fixed Outflow	
Control Diameter	-	mm
Discharge rate	3.08	l/s

Results:

Outcome:	Pass
Critical Storm Duration	3.37 hrs
Hmax	0.742 m
Time to half empty	2.9 hrs



CRM Stormflow Stormwater Management Software

Client:	RES
Project:	MCL115-77
Location:	Dunbeg
Catchment:	Dunbeg WF_Area 9

Catchment Details:

Buildings	0	m^2	x 95 %
Dense surfacing	17748	m^2	x 90 %
Effective Area	15973.2	m^2	

Storage Details:

Volume	378	m^3
Porosity	100	%
Area Increase	0	%

Rainfall Details - FEH Method:

Return Period	30	years	
Climate Change Factor	0	%	
c	-0.029	d1	0.4603
d2	0.48541	d3	0.33282
e	0.29305	f	2.18189

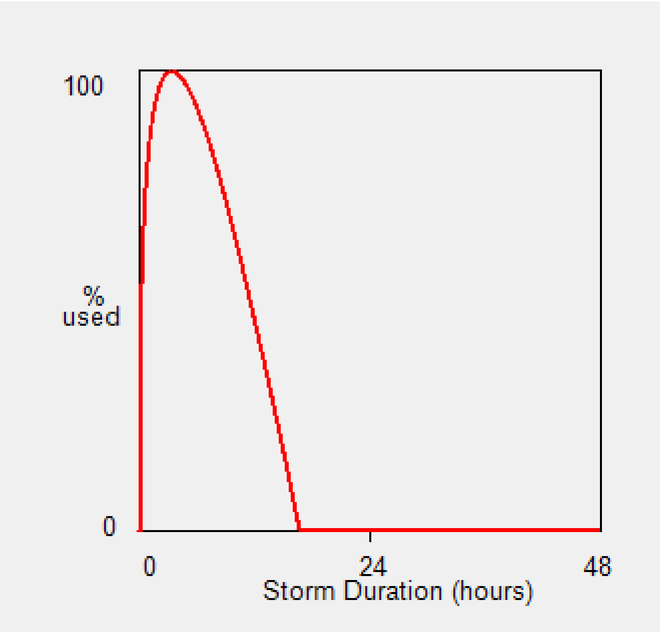
	mm	mm/h	storage (m^3)
30 min	18.6	37.2	264.994
45 min	21.5	28.7	295.986
60 min	23.9	23.9	317.775
2 hours	30.7	15.4	362.784
6 hours	45.7	7.6	346.907
24 hours	76.9	3.2	0.000

Outflow Details:

Infiltration rate	0	m/hr
Attenuation Control	Fixed Outflow	
Control Diameter	-	mm
Discharge rate	17.75	l/s

Results:

Outcome:	Pass
Critical Storm Duration	3.37 hrs
Hmax	0.998 m
Time to half empty	3 hrs



10

Noise

Appendix 10: Noise

Technical Appendix 10.1: Assessment of Energy Storage Facility

10.153 In addition to the wind farm it is also proposed to include energy storage on site. An acoustic assessment in accordance with BS 4142: 2014[30] has been undertaken in order to determine the acoustic impact due to the operation of this part of the Development.

10.154 The baseline data adopted is the worst case of that recorded during the background sound measurement campaign undertaken to inform the acoustic assessment of the operational wind farm, i.e. 28 dB L_{A90} during the night and 31 dB L_{A90} during the day, corresponding to that recorded at H25 for a standardised 10m wind speed of 1 ms^{-1}.

10.155 The main sources of sound within the proposed development are the two inverters and transformer housed within each of the two Power Conversion System (PCS) units and air conditioning for the Energy Storage Systems (ESS). The four ESS units are expected to be continuously charging and discharging. If there are any rest periods for the PCS units these are likely to be infrequent and the Heating Ventilation and Air Conditioning systems (HVAC) will still be functioning.

10.156 Acoustic emission data for the proposed equipment is detailed in Table 10.1.1. The data corresponds to the maximum acoustic emission for each device as advised by the manufacturer. Predictions based on this data therefore represent the worst case and the sound levels would be expected to be less when the site isn't operating at maximum capacity.

Table 10.1.1 - Acoustic Emission Data

Equipment	Sound Pressure Level at 1m, dB L_{Aeq}
Inverter within PCS unit	77
ESS unit	78
Transformer within PCS unit	65

10.157 Predicted specific sound levels due to the proposed energy storage facility at nearby residential properties, calculated using the ISO 9613-2 propagation model, are detailed in Table 10.1.2. A sound footprint for the energy storage facility is shown in Figure 10.1.1.

10.158 The propagation model takes account of sound attenuation due to geometric spreading and atmospheric absorption. The assumed temperature and relative humidity are 10 ˚C and 70 % respectively.

10.159 Ground effects are also taken into account by the propagation model, with a ground factor of 0.5 adopted to reflect a mix of hard and porous ground between the site and the assessment locations. A 4 m receiver height has been used. Terrain and the effect of surface features such as buildings and trees have not been considered. There is a degree of conservatism built into the model as a result of the adoption of these settings.

10.160 ISO 9613-2 is a downwind propagation model. Where conditions less favourable to sound propagation occur, such as when the assessment locations are crosswind or upwind of the proposed energy storage facility, the predicted sound levels would be expected to be less and the downwind predictions presented here would be regarded as conservative.

[30] "Methods for rating and assessing industrial and commercial sound", The British Standards Institution 2014

Table 10.1.2 - Predicted Specific Sound Levels

House ID	Sound Pressure Level, dB L_{Aeq}
H6	21
H7	18
H8	18
H9	17
H10	16
H11	14
H12	15
H13	13
H14	13
H15	13
H16	13
H17	13
H18	13
H19	13
H21	10
H22	10
H23	9
H24	9
H25	11
H26	12
H27	12
H28	12
H29	14
H30	14
H31	14
H32	12
H33	12
H34	12
H35	9
H36	9
H37	9
H38	9
H39	7
H40	13
H41	18

10.161 The sound emitted by the inverter cooling fans and HVAC units can have distinctive character. A correction of 4 dB has been applied as a conservative measure in the event that tones are clearly perceptible at the assessment locations.

10.162 The results of an acoustic assessment at the property with the maximum predicted specific sound level, H6, are shown in Table 10.1.3.

Table 10.1.3 - BS4142: 2014 Assessment Results

Results	Day	Night
Residual sound level	40 dB $L_{Aeq, 16 hour}$	35 dB $L_{Aeq, 8 hour}$
Background sound level	31 dB $L_{A90, 10 min}$	28 dB $L_{A90, 10 min}$
Predicted specific sound level	21 dB L_{Aeq}	
Acoustic feature correction	4 dB	
Rating sound level	25 dB L_{Aeq}	
Excess of rating level over background	-6 dB	-3 dB
Predicted ambient sound level	40 dB $L_{Aeq, 16 hour}$	35 dB $L_{Aeq, 8 hour}$
Conclusion	Low impact	Low impact

10.163 The proposed energy storage facility is predicted to have a low impact during both day and night time periods as the rating sound level is below the existing background sound level.

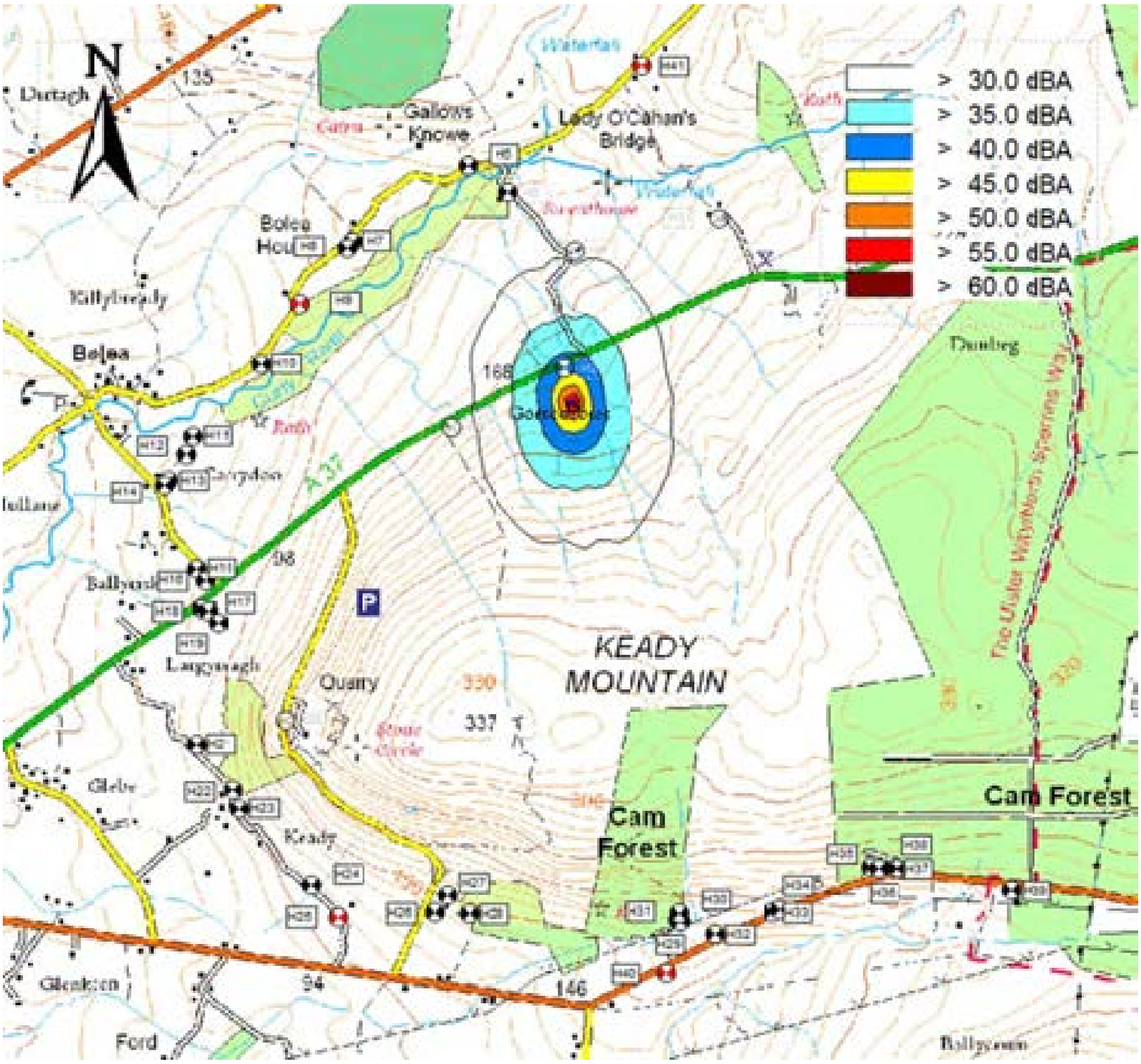
10.164 There is expected to be no change in the ambient sound level due to the introduction of the energy storage facility, consistent with it having a low impact.

10.165 The sound levels due to the proposed energy storage facility are predicted to be greater than 10 dB below the cumulative predicted wind farm sound levels such that they would be deemed insignificant in comparison.

10.166 In conclusion, the acoustic assessment shows that the impact due to the operation of the proposed energy storage site is predicted to be low during both day and night time periods such that no adverse impacts would be expected.

10.167 Sound emitted during construction of the energy storage facility, including that due to associated traffic flows, is not predicted to exceed the criteria specified in BS 5228-1:2009 such that significant effects would not be anticipated.

Figure 10.1.1 – Predicted Energy Storage Sound Footprint



Technical Appendix 10.2: Scope of Assessment

Low Frequency Noise

10.168 The frequency range of 'audible noise' is generally taken to be 20 Hz to 20,000 Hz, with the greatest sensitivity to sound typically in the central 500 Hz to 4,000 Hz region. The range from 10 Hz to 200 Hz is generally used to describe 'low frequency noise', and noise with frequencies below 20 Hz used to describe 'infrasound'[31], although there is sometimes a lack of consistency regarding the definition of these terms in both common usage and the literature.

10.169 Low frequency noise is always present, even in an ambient 'quiet' background[31]. It is generated by natural sources, including the sea, earthquakes, the rumble of thunder and wind. It is additionally an emission from many artificial sources found in modern life, such as household appliances (e.g. washing machines, dishwashers) and all forms of transport.

10.170 Noise emitted from wind turbines covers a broad spectrum from low to high frequencies. In relation to human perception of the broadband noise produced by wind turbines, the dominant frequency range is not the low frequency or infrasonic ranges[32]. The reason for this is that the perception threshold for hearing in these ranges is much higher than for speech frequencies of between 250 Hz and 4000 Hz. As a result of this decreased sensitivity, wind turbine noise at the lowest frequencies of the range described as 'low frequency noise' would be below the average hearing threshold.

10.171 A comprehensive literature review of 'Low Frequency Noise and Infrasound Associated with Wind Turbine Generator Systems', undertaken for the Ontario Ministry for the Environment in 2010, indicated that low frequency noise from wind turbines crosses the threshold boundary, and thus would be considered to become audible, above frequencies of around 40-50 Hz[32]. The degree of audibility depends upon the wind conditions, the degree of masking from background noise sources and the distance from the wind turbines[32].

10.172 Although audible under some conditions, a paper; 'Infrasound and low frequency noise from wind turbines: exposure and health effects'[33], published by the authors of a literature review on the subject prepared for the Swedish Environmental Protection Agency in 2011[34], concludes that the level of low frequency noise produced by wind turbines does not exceed levels from other common sources, such as road traffic noise[33].

10.173 In response to an article published in the national press in 2004, alleging that low frequency noise from wind turbines may give rise to adverse health effects, the Department of Trade and Industry (DTI) commissioned the Hayes McKenzie Partnership

[31] 'A Review of Published Research on Low Frequency Noise and Its Effects', Leventhall, Report for DEFRA, 2003

[32] 'Low Frequency Noise and Infrasound Associated with Wind Turbine Generator Systems, a Literature Review', Ontario Ministry of the Environment, OSS078696, December 2010

[33] 'Infrasound and low frequency noise from wind turbines: exposure and health effects', Bolin et al, Environmental Research Letters Volume 6, September 2011

[34] 'A literature review of infra and low frequency noise from wind turbines: exposure and health effects', prepared for Swedish Environmental Protection Agency, November 2011

to perform an independent study to investigate these claims[35]. The Government released the following advice based on the report's findings[36]:

"The report concluded that there is no evidence of health effects arising from infrasound or low frequency noise generated by wind turbines."

10.174 This is re-iterated in the review undertaken for the Ontario Ministry for the Environment, which concludes that publications by medical professionals indicate that; at typical setback distances, the noise levels produced by wind turbines, including noise at low and infrasound frequencies, do not represent a direct health risk.

10.175 The Oregon Health Authority's Public Health Division conducted a strategic Health Impact Assessment in response to a convergence of questions about potential health impacts from wind energy facilities in Oregon. The report, titled 'Strategic Health Impact Assessment on Wind Energy Development in Oregon[37]' states that:

"Some field studies have found that in some locations near wind turbine facilities, low frequency noise (frequencies between 10 and 200 Hz) may be near or at levels that can be heard by humans. However, there is insufficient evidence to determine if low frequency noise from wind turbines is associated with increased annoyance, disturbance or other health effects".

10.176 Whilst low frequency content of the noise from wind farms shall be considered through the use of octave band specific noise emission and propagation modelling within the assessment presented here, it is considered that specific and targeted assessment on low frequency content of noise emissions from the proposed wind farm is unjustified.

Infrasound

10.177 In relation to infrasound in general, frequencies below 20 Hz may be audible, although tonality is lost below 16 - 18 Hz, thus losing a key element of perception[31]. In relation to modern, upwind turbines; there is strong evidence that the levels of infrasound produced will be well below the average threshold of human hearing[32]. The aforementioned DTI report extended this conclusion to more sensitive members of the population[35]:

"Even assuming the most sensitive members of the population have a hearing threshold which is 12 dB lower than the median hearing threshold, measured infrasound levels are well below this criterion".

10.178 As such[33]:

"infrasound from wind turbines is not audible at close range and even less so at distances where residents are living".

10.179 In February 2005, the BWEA[38] published background information on low frequency noise from wind farms[39]. The conclusion states that:

[35] 'The Measurement of Low Frequency Noise at Three UK Wind Farms', Hayes, Contract Number W/45/00656/00/00, URN 06/1412, 2006, www.berr.gov.uk/files/file31270.pdf

[36] 'Advice on findings of the Hayes McKenzie report on noise arising from Wind Farms', DTI, URN 06/2162, November 2006, www.berr.gov.uk/files/file35592.pdf

[37] 'Strategic Health Impact Assessment on Wind Energy Development in Oregon', Sujata Joshi et al, Prepared By: Public Health Division Oregon Health Authority, March 2013, www.healthimpactproject.org

[38] BWEA is now known as RenewableUK, a group representing the concerns of companies in the Renewable Energy Industry

"It has been repeatedly shown, by measurements of wind turbine noise undertaken in the UK, Denmark, Germany and the USA over the past decade, and accepted by experienced noise professionals, that the levels of infrasonic noise and vibration radiated from modern upwind configuration wind turbines are at a very low level; so low that they lie below the threshold of perception, even for those people who are particularly sensitive to such noise, and even on an actual wind turbine site".

10.180 The BWEA report goes on to quote Dr Geoff Leventhall, author of the DEFRA report on 'Low Frequency Noise and its Effects', as saying:

"I can state, quite categorically, that there is no significant infrasound from current designs of wind turbines".

10.181 With regard to health effects, the DTI report quotes the document 'Community Noise', prepared for the World Health Organisation (WHO), which states that[35]:

"there is no reliable evidence that infrasound below the hearing threshold produce physiological or psychological effects".

10.182 The DTI report goes on to conclude that:

"infrasound associated with modern wind turbines is not a source which will result in noise levels which may be injurious to the health of a wind farm neighbour".

10.183 Furthermore, researchers at Keele University explain that:

"The infrasound generated by wind turbines can only be detected by the most sensitive equipment, and again this is at levels far below that at which humans will detect the low frequency sound. There is no scientific evidence to suggest that infrasound has an impact on human health."[40]

10.184 In January 2013 the Environment Protection Authority, South Australia, presented their findings of a study into the level of infrasound within typical environments with a particular focus on comparing wind farm environments to urban and rural environments away from wind farms[41]. The report states:

"This study concludes that the level of infrasound at houses near the wind turbines assessed is no greater than that experienced in other urban and rural environments, and is also significantly below the human perception threshold. Also, that the contribution of wind turbines to the measured infrasound levels is insignificant in comparison with the background level of infrasound in the environment."

10.185 The Australian Medical Association[42] in March 2014 issued a position statement which detailed their findings on the health impacts due to the generation of infrasound from wind turbines. The findings concluded that:

"The available Australian and international evidence does not support the view that the infrasound or low frequency sound generated by wind farms, as they are currently regulated in Australia, causes adverse health effects on populations residing in their

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[39] 'Low Frequency Noise and Wind Turbines', The British Wind Energy Association, 2005, www.bwea.com/ref/lowfrequencynoise.html & Technical Annex www.bwea.com/pdf/lfn-annex.pdf

[40] 'Wind farm noise', Styles, & Toon, printed in the Scotsman newspaper as a rebuttal of claims made by the Renewable Energy Foundation, August 2005

[41] 'Infrasound Levels Near Windfarms and in Other Environments' Environment Protection Authority & Resonate Acoustics, January 2013, www.epa.sa.gov.au

[42] "AMA Position – Wind Farms and Health 2014", Australian Medical Association, March 2014

vicinity. The infrasound and low frequency sound generated by modern wind farms in Australia is well below the level where known health effects occur, and there is no accepted physiological mechanism where sub audible infrasound could cause health effects".

10.186 In April 2015, at the International Conference on Wind Turbine Noise in Glasgow[43], a number of papers were presented on Low Frequency Noise and Infrasound. The findings of the research work undertaken were as follows.

10.187 A paper by Berger et al[44], investigates whether current audible noise-based guidelines for wind turbines account for the protection of human health, given the levels of infrasound and low frequency noise typically produced by wind turbines. New field measurements of indoor infrasound and outdoor low frequency noise at locations between 400m and 900m from the nearest turbine, which were previously underrepresented in the scientific literature, are reported and put into context with existing published work. The findings concluded that:

"The analysis showed that indoor IS (infrasound) levels were below auditory threshold levels while LFN (low frequency noise) levels at distances >500m were similar to background LFN levels. Overall, the available data from this and other studies suggest that health-based audible noise wind turbine siting guidelines provide an effective means to evaluate, monitor, and protect potential receptors from audible noise as well as IS and LFN".

10.188 Research by Hansen et al[45] proposed to examine the effect of infrasound tonal components on perceived low frequency noise annoyance for short exposure durations. The investigated spectra were synthesized based on measured wind turbine noise, which consisted of amplitude modulated tonal components. Listening test were developed, based on data measured outside a residence, 1.3 km from a wind farm in South Australia. The research concluded that:

"For evaluation times of 5 minutes, it has been shown that for the persons tested, the presence of infrasound at realistic levels does not influence audibility, annoyance or ability to fall asleep."

10.189 Leventhall[46] presented a paper which assesses the scientific basis of the "Plympton-Wyoming bylaw". This is a bylaw which has recently introduced limits on infrasound from wind turbines. The author concludes:

"Science does not support the conditions of the bylaw, which is largely aimed at restricting blade pass tones. There is no evidence that the very low level of blade pass tones affects humans, whilst there is evidence that it does not."

[43] International Conference on Wind Turbine Noise, An INCE Series of International Conferences on Wind Turbine Noise Held Biennially, Wind Turbine Noise 2015, 20th – 23rd April 2015, Glasgow

[44] "Health-based Audible Noise Guidelines Account for Infrasound and Low Frequency Noise Produced by Wind Turbines", Berger et al, Sixth International Meeting on Wind Turbine Noise, Glasgow 20-23 April 2015, Frontiers in Public Health, 24 February 2015

[45] "Perception and annoyance of low frequency noise versus infrasound in the context of wind turbine noise", Hansen et al, Sixth International Meeting on Wind Turbine Noise, Glasgow 20-23 April 2015

[46] "On the overlap region between wind turbine infrasound and infrasound from other sources and its relation to criteria", G Leventhall, Sixth International Meeting on Wind Turbine Noise, Glasgow 20-23 April 2015

10.190 The work carried out by Tonin et al[47] was an investigation into the effect on the reported pathological symptoms of simulated infrasound produced by wind turbines. The infrasound waveform was generated using a custom-made headphone apparatus. Volunteers were manipulated into states of either high or low expectancy of negative effects from infrasound and their reactions to either infrasound or a sham noise were recorded in a double blind experiment. The findings of the investigation state that:

"It was found, at least for the short-term exposure times conducted here-in, that the simulated infrasound has no statistically significant effect on the symptoms reported by volunteers, however the state of prior concern that volunteers had about the effect of infrasound has a statistically significant influence."

10.191 A study by Walker & Celano[48] considered the subjective effects of wind turbine noise in a controlled environment and how to faithfully generate acoustic signatures produced by actual turbines. Field measurements indicate that theses signatures encompass a wide frequency range, extending from below 1Hz to several kHz. The authors present conceptual descriptions and preliminary demonstrations of an infrasound synthesizer that is capable of producing turbine-faithful signals at least 10 dB greater than experienced in the field. The authors concluded from their research:

"It has been demonstrated that simulation of wind turbine noise and infrasound levels representative of those observed at distances of 100 meters can be accomplished in a typical residential-sized room with a modest array of electro-acoustic actuators. To date, subjective reactions to the synthesized signals are not conclusive due to the small number of test subjects and constrained exposure times. However, no individual thus far has reported and sensation when exposed to infrasound alone at peak levels up to 97dB."

10.192 Therefore, in accordance with literature, it is not considered appropriate or relevant to undertake specific assessment in relation to infrasound for the proposed wind farm.

Sleep Disturbance

10.193 ETSU-R-97 states that different limits should be applied during daytime and night-time periods. The daytime limits are intended to preserve outdoor amenity, while the night-time limits are intended to prevent sleep disturbance. The night-time criterion is derived from the 35 dB(A) sleep disturbance criterion referred to in ETSU-R-97, with an allowance of 10 dB(A) for attenuation through an open window (which is conservative) and a correction of 2 dB(A) to allow for the use of L_{A90}, rather than L_{Aeq}.

10.194 A report entitled 'Sleep Disturbance and Wind Turbine Noise' by Dr Christopher Hanning reviewed the potential consequences of wind turbine noise and its effect on sleep and health, and made recommendations on setback distances[49]. The report was created on behalf of 'Stop Swinford Wind Farm Action Group' (SSWFAG).

10.195 Dr Hanning states that:

[47] "Response to Stimulated Wind Farm Infrasound Including Effect of Expectation", Tonin et al, Sixth International Meeting on Wind Turbine Noise, Glasgow 20-23 April 2015

[48] "Progress Report on Synthesis of Wind Turbine Noise and Infrasound", Walker & Celano, Sixth International Meeting on Wind Turbine Noise, Glasgow 20-23 April 2015

[49] 'Sleep Disturbance and Wind Turbine Noise', Hanning, on behalf of Stop Swinford Wind Farm Action Group (SSWFAG), June 2009

"There can be no doubt, that groups of industrial wind turbines ("wind farms") generate sufficient noise to disturb the sleep and impair the health of those living nearby."

10.196 Dr Hanning's paper fails to acknowledge the link between noise level and sleep disturbance. This link is acknowledged in the most recent advice published by the World Health Organisation Night Noise Guidelines for Europe[50]. This report recommends acceptable levels of night time noise below which no appreciable adverse effects on sleep can reasonably be identified and levels above which sleep effects may be expected. The levels identified in these guidelines indicate an outdoor annualised free field noise level of 40 dB(A). Such averaging would allow short term levels in excess of this. In comparison to the likely noise limits to be imposed upon the wind farm, based upon ETSU-R-97 recommendations, this 40 dB(A) annualised limit is much more lenient. There will be significant portions of time that the noise levels shown in this report, due to wind direction, wind speed or conservatism in modelling, are not realised.

10.197 In another article published by Dr Hanning and Professor Alun Evans, in the British Medical Journal[51] it states:

"A large body of evidence now exists to suggest that wind turbines disturb sleep and impair health at distances and external noise levels that are permitted in most jurisdictions, including the United Kingdom."

10.198 Research evidence supports the conclusion that noise from any source will result in measurable effects on sleep when it reaches a certain level. Such effects may comprise changes in sleep state without those exposed actually awakening, or they may comprise complete awakenings. Either of these responses may or may not have a consequential long term effect on wellbeing depending on the subjects concerned and the extent of the effects being considered.

10.199 There is no reason why wind turbine noise should be any different to other forms of noise, in that there will be a certain level at which wind turbine noise would impact on the sleep of those exposed to it. As with other forms of noise, some variability in response across the exposed population would be expected, with some people being more noise sensitive and others more noise tolerant.

10.200 In a report by the Chief Medical Officer of Health of Ontario[52], in response to public health concerns about wind turbine noise, the review concluded that:

"...while some people living near wind turbines report symptoms such as dizziness, headaches, and sleep disturbance, the scientific evidence available to date does not demonstrate a direct causal link between wind turbine noise and adverse health effects. The sound level from wind turbines at common residential setbacks is not sufficient to cause hearing impairment or other direct health effects..."

10.201 A report published the Massachusetts Department of Environmental Protection concludes that[53]:

[50] 'Night Noise Guidelines for Europe', World Health Organisation, 2009

[51] 'Wind Turbine Noise', Hanning et al, British Medical Journal, March 2012

[52] 'The Potential Health Impact of Wind Turbines', Chief Medical Officer of Health (CMOH) Report, May 2010

[53] 'Wind Turbine Health Impact Study: Report of Independent Expert Panel'" Jeffrey M. Ellenbogen et al, Prepared for: Massachusetts Department of Environmental Protection Massachusetts Department of Public Health, January 2012

"Evidence regarding wind turbine noise and human health is limited. There is limited evidence of an association between wind turbine noise and both annoyance and sleep disruption, depending on the sound pressure level at the location of concern".

10.202 Since ETSU-R-97 accounts for sleep disturbance when setting night time noise limits it is therefore concluded that protection from sleep disturbance is considered within this acoustic impact for the proposed wind farm.

Vibration

10.203 Structure borne noise, originating in vibration, is also low frequency, as is neighbour noise heard through a wall, since walls generally block higher frequencies more than lower frequencies.

10.204 In 2004/2005, researchers at Keele University investigated the effects of the extremely low levels of vibration resulting from wind farms on the operation of the seismic array at Eskdalemuir, one of the most sensitive installations in the world[40]. The results of this study have frequently been misinterpreted and, to clarify the position, the authors have explained that:

"The levels of vibration from wind turbines are so small that only the most sophisticated instrumentation and data processing can reveal their presence, and they are almost impossible to detect."

10.205 They go on to say:

"Vibrations at this level and in this frequency range will be available from all kinds of sources such as traffic and background noise - they are not confined to wind turbines. To put the level of vibration into context, they are ground vibrations with amplitudes of about one millionth of a millimetre. There is no possibility of humans sensing the vibration and absolutely no risk to human health."

10.206 The Ministry of Defence's approach to safeguarding the Eskdalemuir seismic array is to allocate a budget in terms of the cumulative level of seismic vibration from wind turbines. This restricts the number of wind farms that can be located within a certain distance of the Eskdalemuir seismic array (EKA) without adversely impacting upon its operation. In June 2014, a report was prepared by Xi Engineering Consultants with the full cooperation and significant input from the Ministry of Defence[54]. The report builds on initial Phase 0 work which identified that the current budget over estimates the seismic vibration produced by wind turbines and that there is a likelihood of significant prospective head room that would allow the building of wind farms without breaching the 0.336 nm threshold. The goal of the research was to produce an algorithm that will better predict the amplitude of seismic vibrations produced by wind turbines in the 0.5 to 0.8 Hz passband, which might allow the exploitation of wind resource in the Southern Uplands while maintaining protection of the detection capabilities of EKA. The work of the research allows for the determination of how close to EKA wind turbines can be built while optimising the generating capacity within the consultation zone. The application of a physics based algorithm allowed for the calculation of cumulative seismic vibration at EKA. From these calculations they were able to predict that:

[54] "Seismic vibration produced by wind turbines in the Eskdalemuir region. Release 2.0 of Substantial Research project" prepared by Xi Engineering Consultants Ltd, Document Number FMB_203_FINAL_V5R, 15th June 2014

"The cumulative amplitude of all turbines currently allocated budget and currently subject to objection with a utilisation factor of unity and minimum hub height of 40 m is 0.193833 nm."

This value falls well below the 0.336 nm threshold as set by the MOD.

10.207 A scientific advisory panel comprising independent experts in acoustics, audiology, medicine and public health conducted a comprehensive review of the available literature on the issue of perceived health effects of wind turbines, titled 'Wind Turbine Sound and Health Effects - An Expert Panel Review', and prepared a report for the American and Canadian Wind Energy Associations in December 2009[55]. The authors explain that:

"Vibration of the body by sound at one of its resonant frequencies occurs only at very high sound levels and is not a factor in the perception of wind turbine noise".

10.208 The authors further state that:

"Airborne sound can cause detectable body vibration, but this occurs only at very high levels — usually above sound pressure levels of 100 dB. There is no scientific evidence to suggest that modern wind turbines cause perceptible vibration in homes or that there is an associated health risk".

10.209 Therefore, in accordance with literature, it is not considered appropriate or relevant to undertake specific assessment in relation to vibration caused by the operation of the proposed wind farm.

Aerodynamic Modulation

10.210 A noise sometimes associated with wind turbines and commonly referred to as 'blade swish' is the modulation of aerodynamic noise produced at blade passing frequency (the frequency at which a blade passes a fixed point). This noise character is acknowledged by, and accounted for, in the recommendations of ETSU-R-97[2]. However the aforementioned DTI report[35] noted that 'Aerodynamic Modulation', alternatively referred to as 'Amplitude Modulation' (AM) was, in some isolated circumstances, occurring in ways not anticipated by ETSU-R-97. AM above and beyond that considered by ETSU-R-97 is often referred to as Excess, or Other, Amplitude Modulation (EAM/OAM).

10.211 In December 2013, the wind industry trade association, RenewableUK, published detailed new scientific research[4] into causes and effects of wind turbine AM. The work was carried out by a group of independent experts, including academics from the Universities of Salford and Southampton, the National Aerospace Laboratory of the Netherlands, Hoare Lea Acoustics, Robert Davies Associates and DTU Riso in Denmark.

10.212 The Chairman of the IOA Noise Working Group said of the study:

"This research is a significant step forward in understanding what causes amplitude modulation from a wind turbine, and how people react to it."

10.213 The RenewableUK work encouraged further research in the area, which has led to the identification of suitable mitigation methods. At the EWEA Technology Workshop on Wind Turbine Sound in 2014, Hoare Lea Acoustics presented a paper entitled: "Measurements to assess the effectiveness of turbine modifications to reduce the

[55] 'Wind Turbine Sound and Health Effects - An Expert Panel Review' W.D. Colby et al, 2009

occurrence of AM in the far-field"[56]. The paper concludes that turbine blade modifications can result in significant reductions in AM in the far-field and that similar effects can also be achieved through blade pitch modification.

10.214 The authors state that:

"This shows that effective mitigation of AM on operational turbines is technically feasible."

10.215 The other notable outcome of the RenewableUK research was a proposed planning condition informed by listening tests and work undertaken to determine how AM should be measured. The IOA recommended a period of testing and validation before the condition was adopted such that the work again proved valuable as a catalyst for further research.

10.216 The IOA created a dedicated AM Working Group to undertake the further testing and validation recommended. A discussion document[57] on methods for rating amplitude modulation in wind turbine noise was published in April 2015. The document proposed a definition of AM and provided a literature review of the available metrics before selecting three for detailed discussion. The intention was to obtain feedback from the acoustic community, allowing a preferred rating method to be selected following the consultation period. The final report[5], detailing the recommended metric for the quantification of the level of AM in wind turbine noise, and the reasoning behind it, was published in August 2016.

10.217 A separate, government funded, study was commissioned by the Department of Energy and Climate Change (DECC) with a view to recommending how an appropriate AM threshold should be defined. A report summarising the work[58], undertaken by WSP Parsons Brinkerhoff, was published in August 2016 and proposes an appropriate penalty scheme informed by studies into subjective response to a given level of AM.

10.218 Following the research detailed above, should a planning condition specific to AM be deemed necessary it is suggested that it take a form that is consistent with the findings of these studies. However it should also be acknowledged that the likelihood of OAM occurring and the frequency of its occurrence vary depending upon the characteristics of the site in question such that a planning condition relating to AM may not satisfy the tests of being necessary, relevant to the development to be permitted, or reasonable in all cases.

10.219 Given that occurrences of OAM depend upon the detailed characteristics of the installed turbine type as well as the site, it is not considered appropriate to undertake a specific assessment in relation to AM above and beyond that considered by ETSU-R-97 that may potentially be produced by the operation of the proposed wind farm development based on a candidate machine. It should also be noted that the aforementioned identification of effective AM mitigation methods may mean that, should planning permission be granted, such options are available as standard by the time the proposed site comes to be built.

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56 "Measurements to assess the effectiveness of turbine modifications to reduce the occurrence of AM in the far-field", Bullmore & Cand, Hoare Lea Acoustics, EWEA Technology Workshop: Wind Turbine Sound 2014, Malmo, Sweden, 9-10 December 2014

57 Institute of Acoustics, IOA Noise Working Group (Wind Turbine Noise), Amplitude Modulation Working Group, Discussion Document, "Methods for Rating Amplitude Modulation in Wind Turbine Noise", April 2015

58 WSP Parsons Brinckerhoff, Wind Turbine AM Review, Phase 2 Report, August 2016

Wind Turbine Syndrome

10.220 The condition proposed by paediatrician Dr Nina Pierpont in her report 'Wind Turbine Syndrome: A Report on a Natural Experiment' cites a range of physical sensations and effects as being caused by living near a wind farm[59]. This study is based on a series of interviews comprising a study group of 10 families. It is a self-published report with none of the research being published in any peer reviewed medical journal.

10.221 In a NHS response to the Pierpont report, a report titled 'Are wind farms a health risk?' states that there is no conclusive evidence that wind turbines have an effect on health or are causing the set of symptoms described as 'wind turbine syndrome'[60]. It was noted that the group study by Pierpont was not sufficient to grant the claims stated.

10.222 The aforementioned report 'Wind Turbine Sound and Health Effects - An Expert Panel Review'[55], prepared by a scientific advisory panel for the American and Canadian Wind Energy Associations, concludes that Wind Turbine Syndrome is:

"not a recognized medical diagnosis, is essentially reflective of symptoms associated with noise annoyance and is an unnecessary and confusing addition to the vocabulary on noise".

10.223 The report went on to say:

"There are no unique symptoms or combinations of symptoms that would lead to a specific pattern of this hypothesized disorder."

10.224 An independent review of the state of knowledge about the alleged health condition was carried out[61]. This report includes three expert opinions provided by: Richard J.Q. McNally - Reader in Epidemiology at the Institute of Health and Society Newcastle University; Geoff Leventhall – an independent consultant specialising in low frequency noise, infrasound and vibration; and Mark E. Lutman - Professor of Audiology at the University of Southampton. Their critique of Pierpont's study concludes that the reported symptoms are the effects mediated by stress and anxiety when exposed to an adverse element in their environment. There is no evidence that they are patho-physiological effects of wind turbine noise.

10.225 A paper by Pedersen explores data from three cross-sectional studies comprising A-weighted sound pressure levels of wind turbine noise, and subjectively measured responses from 1,755 people, to find the relationships between sound levels and aspects of health and well-being[62]. It was concluded that there is no consistent association between wind turbine noise exposure and the symptoms associated with Wind Turbine Syndrome.

10.226 A study conducted by Simon Chapman, Professor of Public Health at Sydney University, provides evidence that noise and health complaints about wind turbines are psychogenic[63]. The authors conclude that:

[59] 'Wind Turbine Syndrome - A Report on a Natural Experiment', Pierpont, K-Selected Books, 2009

[60] 'Are wind farms a health risk?', NHS, 2009, www.nhs.uk

[61] 'Wind Turbine Syndrome (WTS) - An independent review of the state of knowledge about the alleged health condition', RenewableUK, 2010, www.bwea.com

[62] 'Health aspects associated with wind turbine noise—results from three field studies' Pedersen, Noise Control Engineering Journal, Volume 59, Issue 1, 2011

[63] 'Spatio-temporal differences in the history of health and noise complaints about Australian wind farms: evidence for the psychogenic, communicated disease hypothesis', Chapman et al, University of Sydney, 2013

"In view of scientific consensus that the evidence for wind turbine noise and infrasound causing health problems is poor, the reported spatio-temporal variations in complaints are consistent with psychogenic hypotheses that health problems arising are communicated diseases with nocebo effects likely to play an important role in the aetiology of complaints".

10.227 Therefore, in accordance with literature, it is not considered appropriate or relevant to undertake specific assessment in relation to Wind Turbine Syndrome potentially caused by the operation of the proposed wind farm.

Wind Turbine Noise and Associated Health Effects Studies

10.228 In 2014 Health Canada released its findings from the "Wind Turbine Noise and Health Study"[64]. Health Canada, in partnership with Statistics Canada, conducted the study between residents of southern Ontario and Prince Edward Island where there were a sufficient number of homes within the vicinity of wind turbine installations. Twelve and six wind turbine developments were sampled in Ontario and PEI, representing 315 and 84 wind turbines, respectively. All potential homes within approximately 600 m of a wind turbine were selected, as well as a random selection of homes between 600 m and 10 km. A total of 1,238 households participated out of a possible 1,570.

10.229 The study was comprised of three parts: an in-person questionnaire given to randomly selected participants living at various distances from wind turbines; a collection of physical health measures that assessed stress levels using hair cortisol, blood pressure and resting heart rate as well as measures of sleep quality; and more than 4,000 hours of wind turbine noise measurements conducted by Health Canada to support calculations of wind turbine noise levels (WTN) in all homes in the study.

10.230 Health Canada broke the findings into five parts: illness and chronic disease, stress, sleep, annoyance and quality of life and noise.

10.231 Under Self-reported Illnesses and Chronic Diseases, Health Canada states:

"Self-reports of having been diagnosed with a number of health conditions were not found to be associated with exposure to WTN levels. These conditions included, but were not limited to chronic pain, high blood pressure, diabetes, heart disease, dizziness, migraines, ringing, buzzing or whistling sounds in the ear (i.e., tinnitus)".

10.232 Under the heading of Self-reported Stress, Health Canada states no association was found between the multiple measures of stress (such as hair cortisol, blood pressure, heart rate, self-reported stress) and exposure to wind turbine noise.

"Self-reported stress, as measured by scores on the Perceived Stress Scale, was not found to be related to exposure to WTN levels".

10.233 For Self-reported Sleep:

"Results of self-reported measures of sleep, that relate to aspects including, but not limited to general disturbance, use of sleep medication, diagnosed sleep disorders and scores on the Pittsburgh Sleep Quality Index (PSQI), did not support an association between sleep quality and WTN levels".

64 "Wind Turbine Noise and Health Study: Summary of Results", Health Canada, November 2014, http://www.hc-sc.gc.ca/ewh-semt/noise-bruit/turbine-eoliennes/summary-resume-eng.php

10.234 However, the study states, while some people reported some of the aforementioned health conditions, their existence was not found to change in relation to exposure to wind turbine noise.

10.235 An association was found, however, between increasing levels of wind turbine noise and individuals reporting to be very or extremely annoyed. No association was found with any significant changes in reported quality of life or with overall quality of life and satisfaction with health. This was assessed using the abbreviated version of the World Health Organization's Quality of Life Scale.

"The overall conclusion to emerge from the study findings is that the study found no evidence of an association between exposure to WTN and the prevalence of self-reported or measured health effects beyond annoyance. Collectively, the findings related to annoyance suggest that health and well-being effects may be partially related to activities that influence community annoyance, over and above exposure to WTN. Therefore, efforts that aim to identify and mitigate high levels of annoyance with wind turbines may have benefits that go beyond annoyance".

10.236 Lastly, under noise, calculated noise levels were found to be below levels that would be expected to directly affect health, according to the World health Organization Community Noise Guidelines, 1999.

10.237 A review conducted by McCunney et al in[65] November 2014, examines the literature related to health effects of wind turbines. The review was intended to assess the peer-reviewed literature regarding evaluations of potential health effects among people living in the vicinity of wind turbines. It included analysis and commentary of the scientific evidence regarding potential links to health effects, such as stress, annoyance, and sleep disturbance, among others, that have been raised in association with living in proximity to wind turbines. Also addressed were specific components of noise associated with wind turbines such as infrasound and low-frequency sound and their potential health effects.

10.238 The review attempts to address the following questions regarding wind turbines and health:

- Is there sufficient scientific evidence to conclude that wind turbines adversely affect human health? If so, what are the circumstances associated with such effects and how might they be prevented?
- Is there sufficient scientific evidence to conclude that psychological stress, annoyance, and sleep disturbance can occur as a result of living in proximity to wind turbines? Do these effects lead to adverse health effects? If so, what are the circumstances associated with such effects and how might they be prevented?
- Is there evidence to suggest that specific aspects of wind turbine sound such as infrasound and low-frequency sound have unique potential health effects not associated with other sources of environmental noise?

10.239 The co-authors represent professional experience and training in occupational and environmental medicine, acoustics, epidemiology, otolaryngology, psychology, and public health.

65 "Wind Turbines and Health: A Critical Review of the Scientific Literature" McCunney et al, Journal of Occupational & Environmental Medicine, November 2014

10.240 The findings of the review are summarised thus:

- Measurements of low-frequency sound, infrasound, tonal sound emission, and amplitude-modulated sound show that infrasound is emitted by wind turbines. The levels of infrasound at customary distances to homes are typically well below audibility thresholds.
- No cohort or case–control studies were located in this updated review of the peer-reviewed literature. Nevertheless, among the cross-sectional studies of better quality, no clear or consistent association is seen between wind turbine noise and any reported disease or other indicator of harm to human health.
- Components of wind turbine sound, including infrasound and low-frequency sound have not been shown to present unique health risks to people living near wind turbines.
- Annoyance associated with living near wind turbines is a complex phenomenon related to personal factors. Noise from turbines plays a minor role in comparison with other factors in leading people to report annoyance in the context of wind turbines.

Technical Appendix 10.3: Calculating Standardised Wind Speed

10.241 In order to derive appropriate noise limits the ETSU-R-97 guidance requires the correlation of background noise survey data with wind speed data referenced to 10 m height. In contrast to this, acoustic emission measurements on wind turbines are undertaken in accordance with international standard IEC 61400-11, 'Wind Turbine Generator Systems – Part 11: Acoustic Noise Measurement Techniques'[66], which specifies that the turbine noise emission should be reported as a function of 'standardised' wind speed at 10 m height. In practice this translates as extrapolation of wind speed at hub height down to 10 m height using a specified, and fixed, relationship.

10.242 The use of a fixed relationship between hub height and 10 m wind speed means that potential exists for the background noise data and acoustic emission data to be misaligned i.e. a wind speed measured at 10 m height is not necessarily equivalent to a 'standardised' 10 m wind speed of the same magnitude, with the difference depending upon the site specific shear exponent (the rate of change of wind speed with height).

10.243 To account for the effects of wind shear, the background noise data is referenced to the same wind speed as the acoustic emission data. This approach is defined as appropriate, both by a group of independent acoustic consultants who have undertaken work on behalf of wind farm developers, local planning authorities and third parties in the IoA Bulletin, and in the subsequent IoA GPG. The methodology outlined below is followed to convert the wind speed measured concurrently with the background noise data to 'standardised' 10 m height:

- The 'standardised' 10 m wind speed is determined from the measured hub height wind speed according to the procedure specified in IEC 61400-11. The 'standardised' wind speed is essentially a proxy for hub height wind speed (the primary driver of noise emission from the turbine) and is found by extrapolating the hub height wind speed to 10 m height according to the following formula:

$$v_S = v_Z \left[\frac{\ln \frac{z_{ref}}{z_{0ref}}}{\ln \frac{z}{z_{0ref}}} \right]$$

Where: v_S is the 'standardised' wind speed
v_Z is the wind speed at height z (the hub height wind speed)
z_{0ref} is the reference roughness length (0.05 m)
z_{ref} is the reference height, 10 m
z is the proposed hub height

- The resulting 'standardised' 10 m wind speed is correlated with the measured background noise survey data.

[66] 'Wind turbine generator systems – Part 11: Acoustic noise measurement techniques', IEC 61400-11:2003 (Amendment 1: 2006)

Technical Appendix 10.4: Propagation Height & Valley Effect

10.244 To model the propagation of noise between each proposed turbine and residential property in accordance with the IoA GPG the mean propagation height has to be calculated in order to determine whether the correction specified by the guidance for propagation over a concave ground profile, or where the ground falls away significantly between the source and receiver, is applicable.

10.245 Instances where the threshold specified by the IoA GPG is exceeded, and 3 dB(A) has therefore been added to the noise level predicted by the ISO 9613-2 propagation model due to that specific turbine at that specific property, are highlighted in Table 10.4.1.

Table 10.4.1 – Instances Where Ground Correction Applied

House ID	T1	T2	T3	T4	T5	T6	T7	T8	T9
H6	0	0	0	3	0	0	0	0	0
H7	3	0	3	3	3	0	3	3	0
H8	3	0	3	3	3	0	3	3	0
H9	3	0	0	0	0	0	0	0	0

Cells highlighted grey for turbine and house locations where correction applied

Technical Appendix 10.5: Background Noise Survey Photos

Photo 1: Noise Apparatus in Relation to H9

Photo 2: Noise Apparatus in Relation to H25

Photo 3: Noise Apparatus in Relation to H40

Technical Appendix 10.6: Instrumentation Records

Survey Location	Meter Type	Meter S/N	Calibration Certificate No.	Date of Issue	Microphone S/N	Preamp S/N	Calibrator Type	Calibrator S/N	Calibrator Certificate No.	Date of Issue
H9	Rion NL-31	00983380	URCT15/1016	14/01/2015	315831	28713	Rion NC-74	34851904	URCT16/1026	11/01/2016
H25	Rion NL-31	00952272	URCT16/1027	12/01/2016	309098	17123	Rion NC-74	34851904	URCT16/1026	11/01/2016
H40	Rion NL-31	00952274	8513	21/07/2015	321532	17126	Rion NC-74	34851904	URCT16/1026	11/01/2016

Technical Appendix 10.7: Charts

Chart 10.1: Wind Speed and Direction during the Background Noise Survey

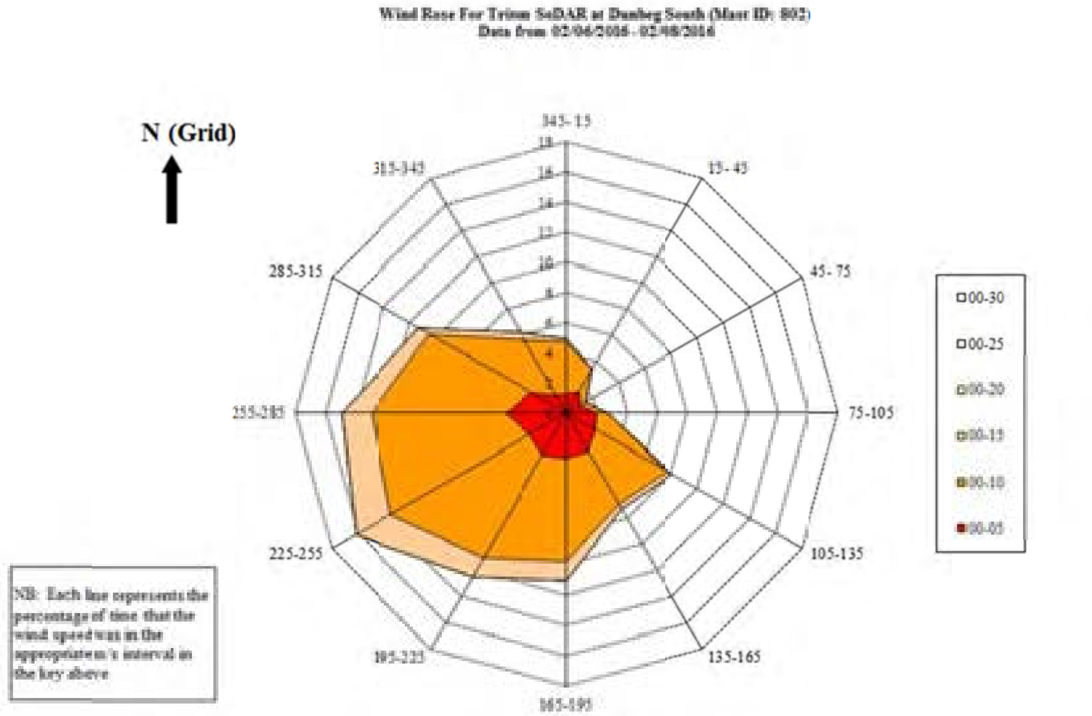


Chart 10.2: Measured Wind Rose over an Extended Period

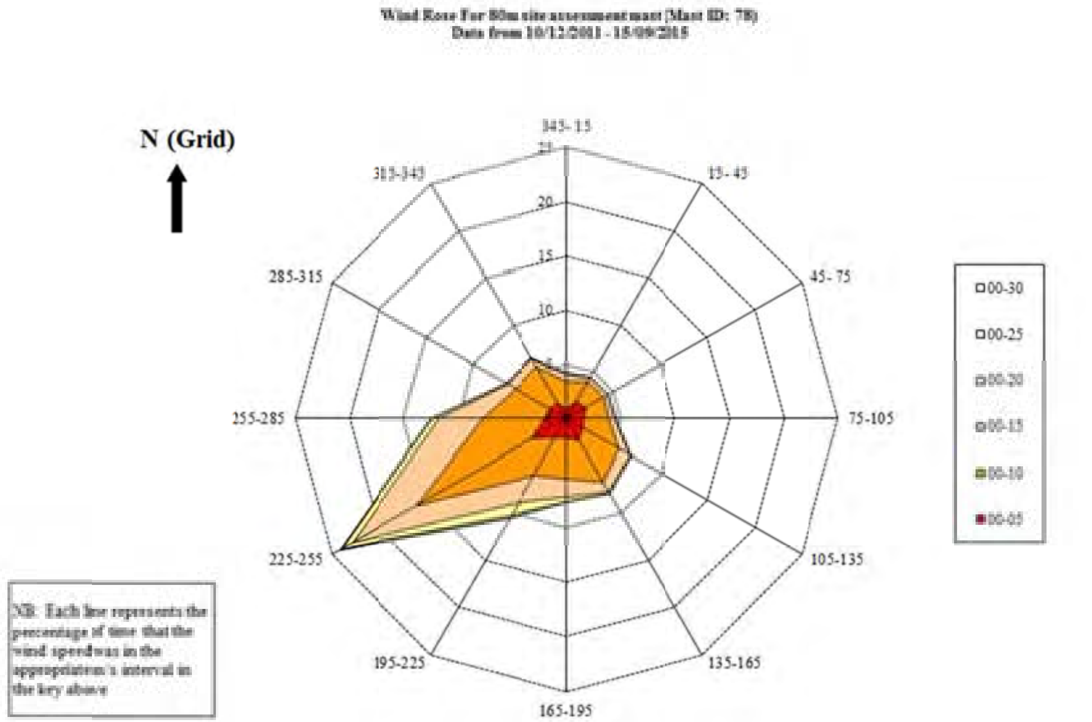


Chart 10.3: Downwind Predicted Noise Levels, Noise Limits and Background Noise Levels during Quiet Daytime Periods at H9

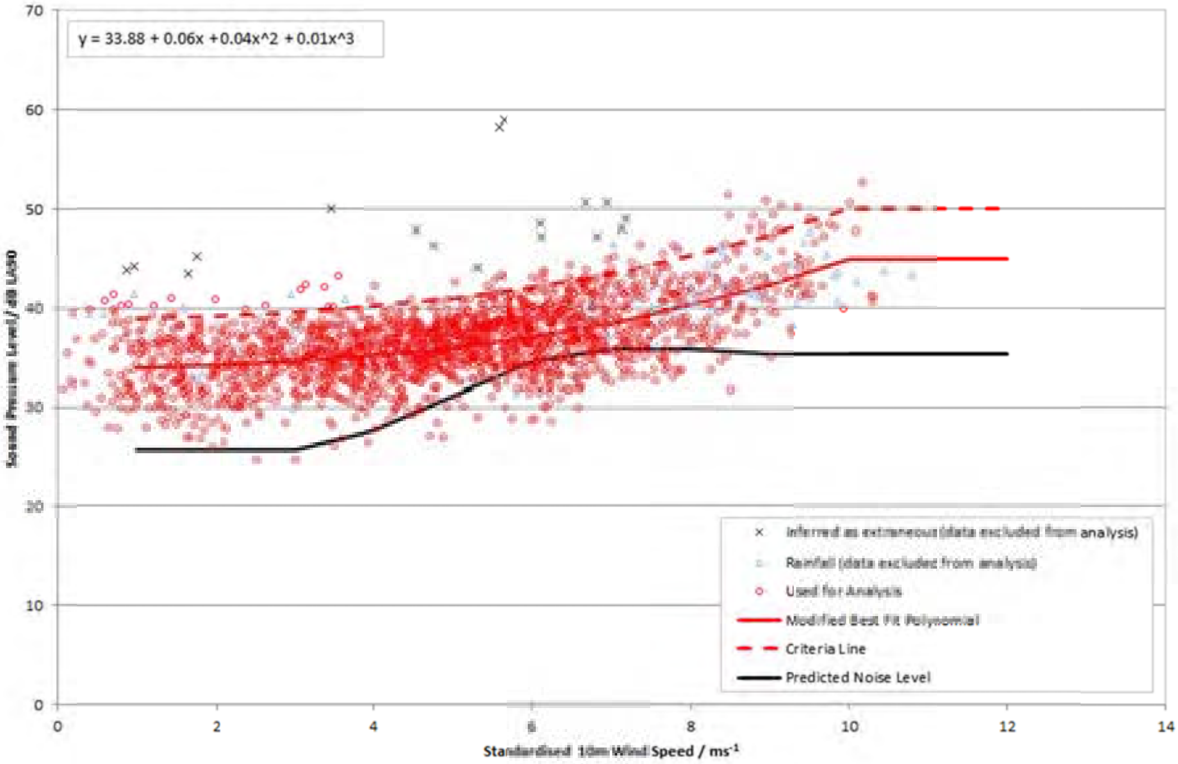


Chart 10.4: Downwind Predicted Noise Levels, Noise Limits and Background Noise Levels during Quiet Daytime Periods at H25

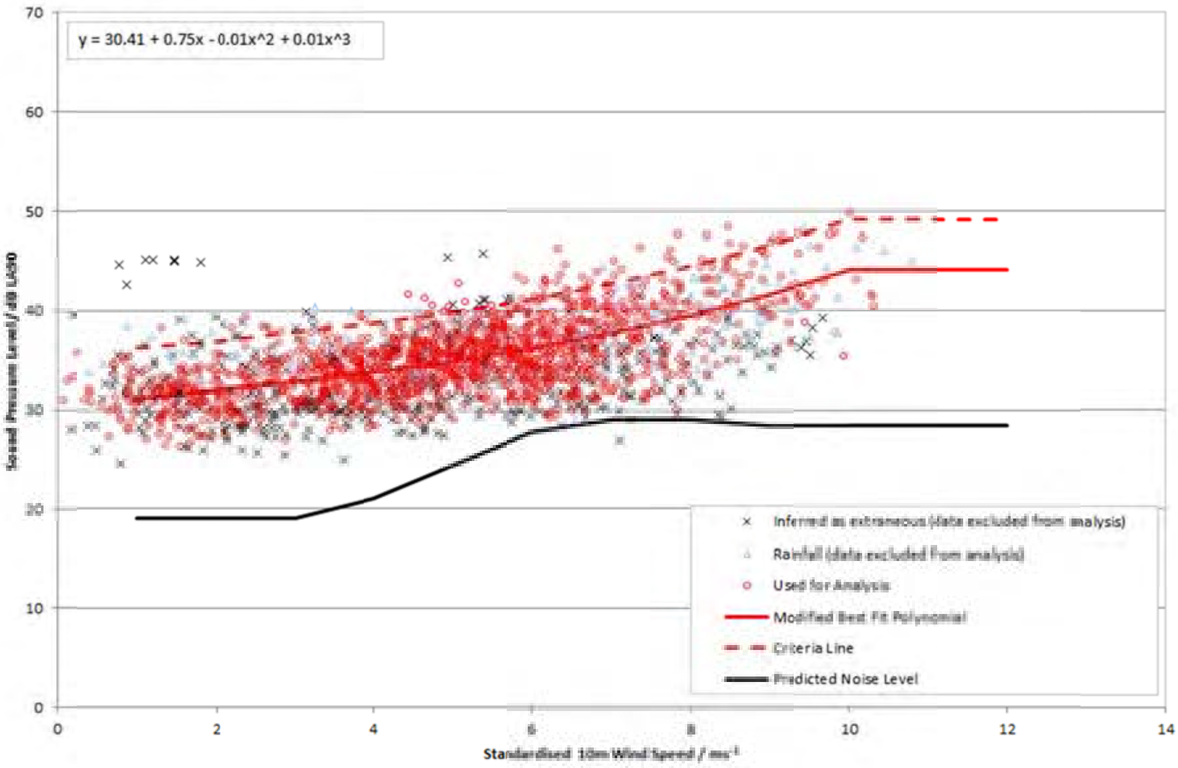


Chart 10.5: Downwind Predicted Noise Levels, Noise Limits and Background Noise Levels during Quiet Daytime Periods at H40

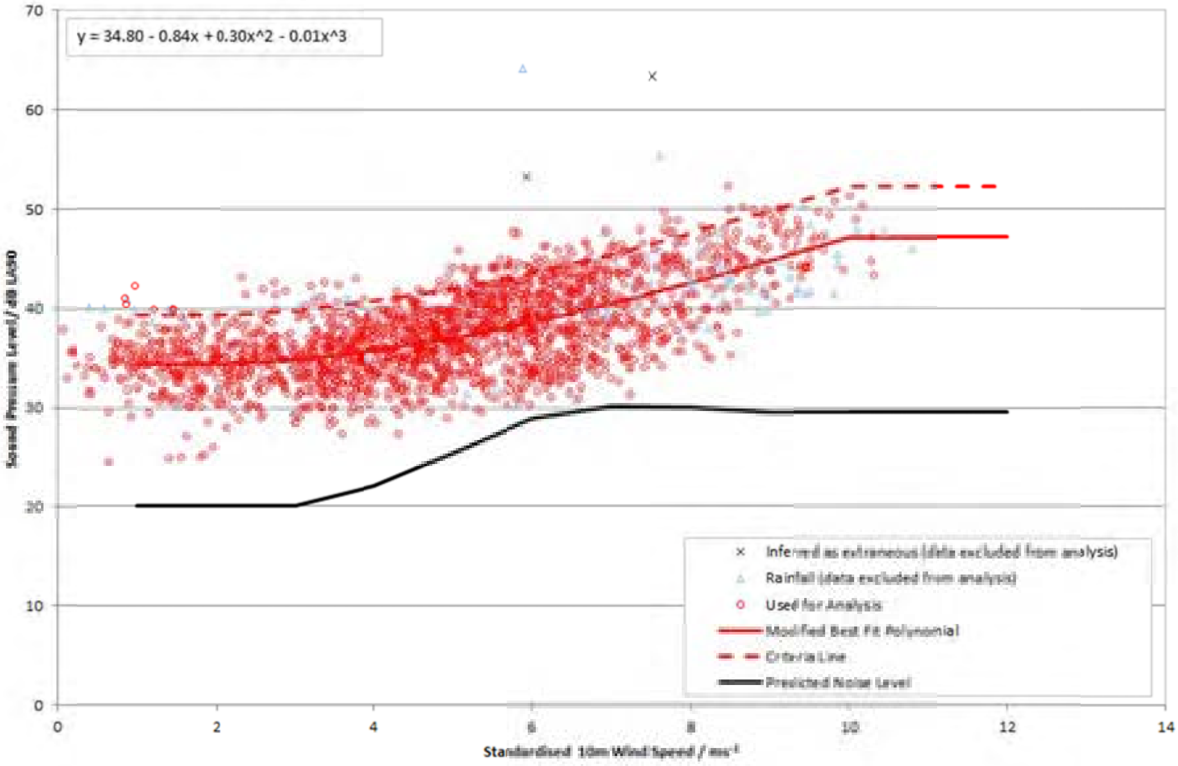


Chart 10.6: Downwind Predicted Noise Levels, Noise Limits and Background Noise Levels during Night-Time Periods at H9

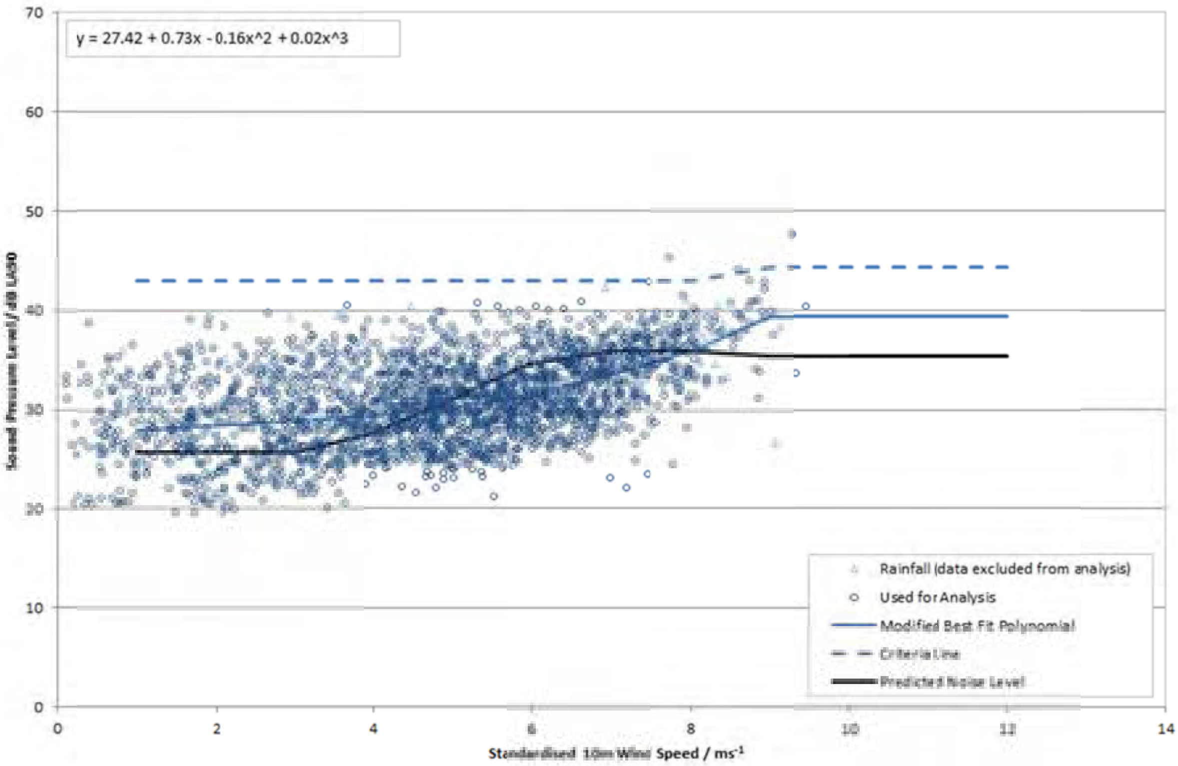


Chart 10.7: Downwind Predicted Noise Levels, Noise Limits and Background Noise Levels during Night-Time Periods at H25

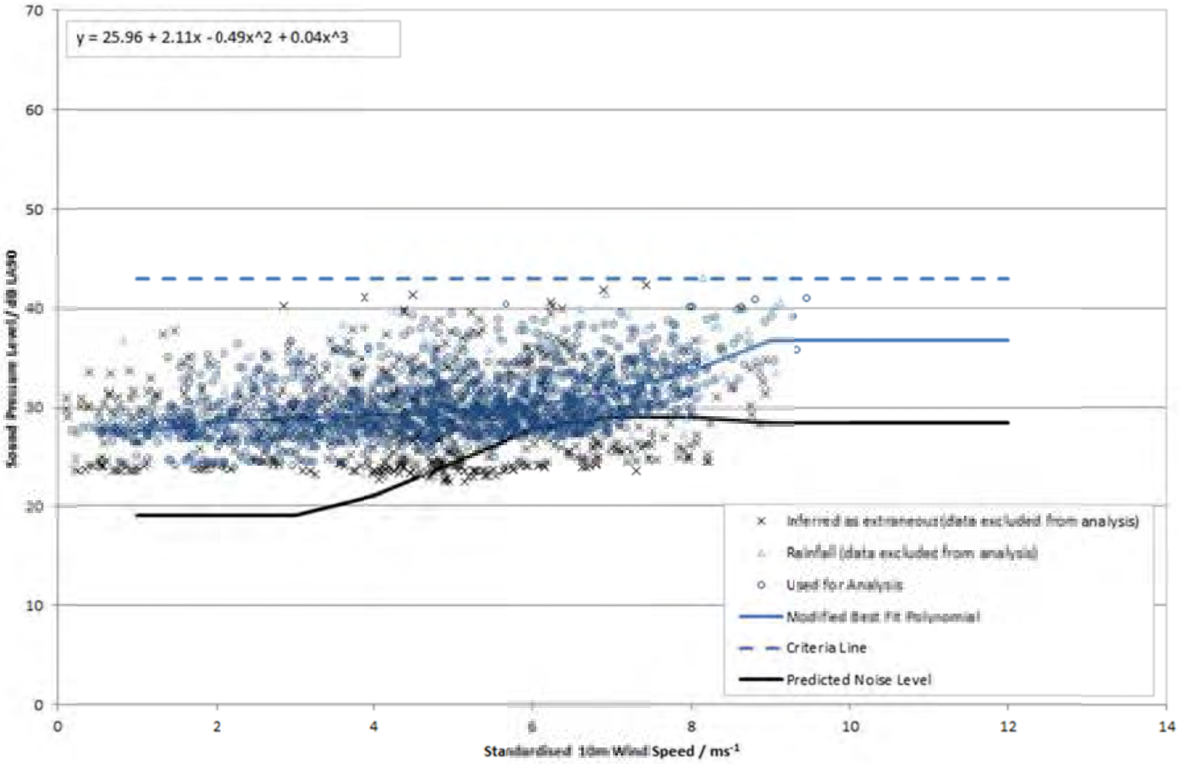


Chart 10.8: Downwind Predicted Noise Levels, Noise Limits and Background Noise Levels during Night-Time Periods at H40

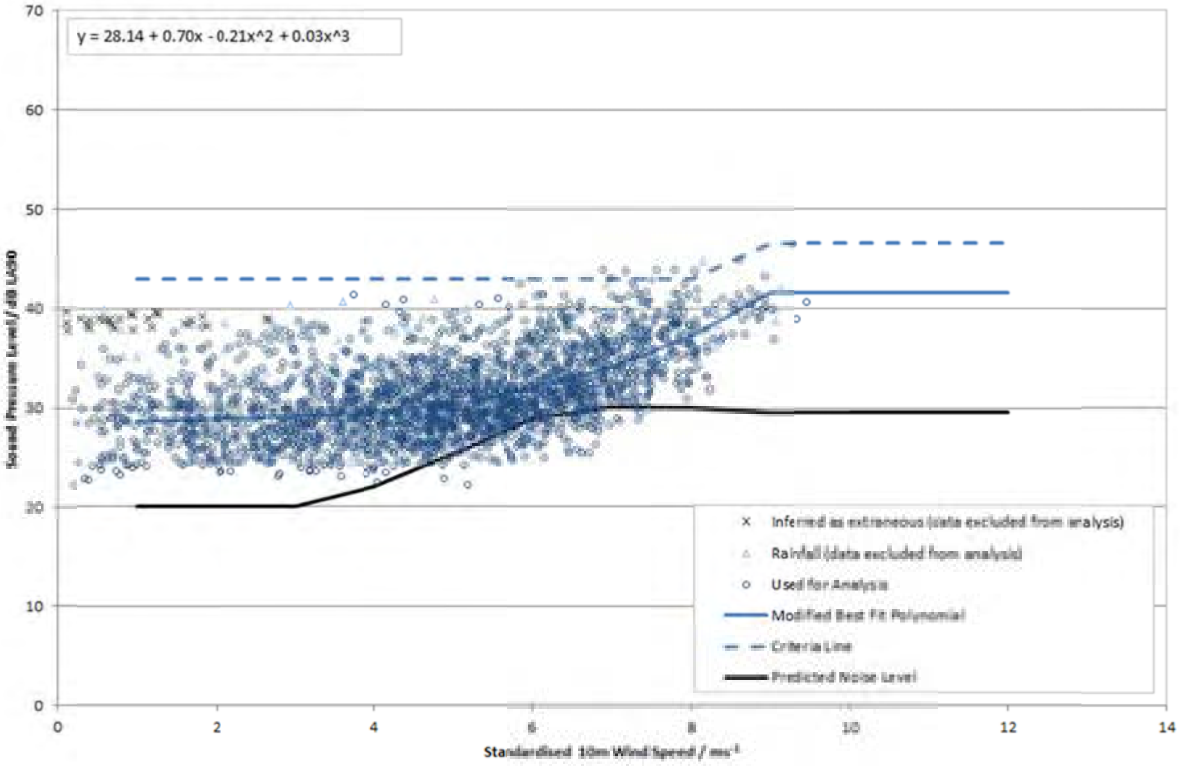


Chart 10.9: Cumulative Predicted Noise Levels and Noise Limits at H41

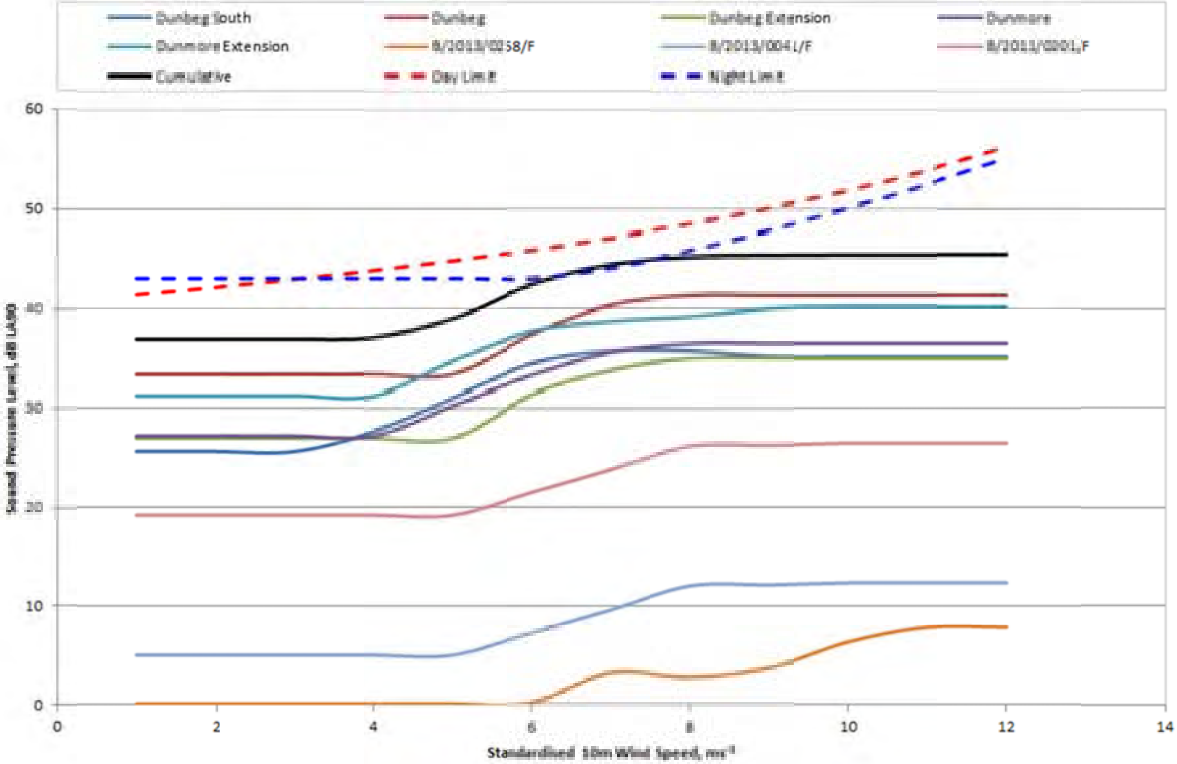
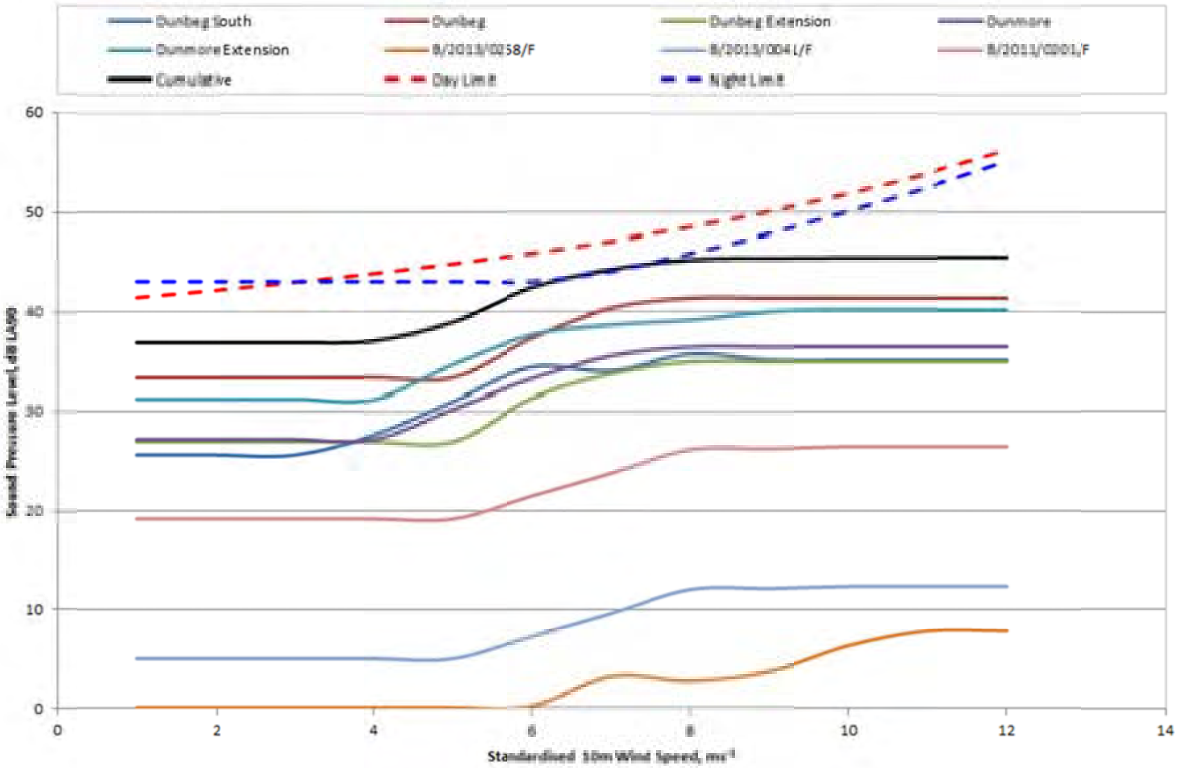


Chart 10.10: Cumulative Predicted Noise Levels and Noise Limits at H41 with Mitigation



Technical Appendix 10.8: Suggested Planning Conditions: Noise

10.246 If the wind farm was successful in its application for planning permission any resulting decision notice would likely contain appropriately worded noise conditions, written so as to be in accordance with Planning Policy PPS 1[67].

10.247 Such conditions would provide a degree of protection to nearby residents in the event that noise from the wind farm causes disturbance. To that end, presented below are a set of relevant, precise and enforceable conditions that RES suggest may be considered as appropriate. The form of condition wording suggested has been adopted at sites such as Freasdail[68], Minnygap[69], Roos[70], Solwaybank[71] and Wryde Croft[72]. Any final conditions attached to the proposal would be according to the discretion of the decision maker.

10.248 The proposed noise limits are derived by subtracting the predicted noise levels due to those existing, consented and proposed projects other than the Development considered in this assessment from the total ETSU-R-97 limit deemed appropriate in the cumulative assessment. This produces noise limits applicable to the Development alone such that the cumulative noise limit is met in combination with the other schemes considered in this assessment.

10.249 The use of downwind predicted noise levels for each of the schemes considered implies that the limits remaining for the Development are conservative in that a greater amount of the total limit would potentially be available when the property in question is located crosswind or upwind of the schemes whose predicted noise levels are being subtracted from the total ETSU-R-97 limit.

[67] Department for the Environment, Northern Ireland "PPS 1: General Principles", March 1998

[68] Directorate for Planning and Environmental Appeals, Appeal Decision Notice, Appeal Reference PPA-130-2036, Decision Date: 15 April 2014

[69] Directorate for Planning and Environmental Appeals, Appeal Decision Notice, Appeal Reference PPA-170-2055, Decision Date: 19 June 2014

[70] The Planning Inspectorate, Appeal Decision, Appeal Reference: APP/E2001/A/09/2113076, Decision Date: 21 June 2010

[71] Directorate for Planning and Environmental Appeals, Appeal Decision Notice, Appeal Reference PPA-170-2091, Decision Date: 23 September 2014

[72] The Planning Inspectorate, Appeal Decisions for Appeal References: APP/J0540/A/08/2083801 and APP/J0540/A/08/2090541, Decision Date: 1 April 2010

1. The level of noise immissions from the combined effects of the wind turbines (including the application of any tonal penalty) when calculated in accordance with the attached Guidance Notes, shall not exceed the values set out in the attached Table A or Table B (as appropriate). Noise limits for dwellings which lawfully exist or have planning permission for construction at the date of this consent but are not listed in the Tables attached shall be those of the physically closest location listed in the Tables unless otherwise agreed with the Local Planning Authority. The coordinate locations to be used in determining the location of each of the dwellings listed in Tables A and B shall be those listed in Table C.

2. Within 21 days from the receipt of a written request from the Local Planning Authority and following a complaint to the Local Planning Authority from the occupant of a dwelling which lawfully exists or has planning permission at the date of this consent, the wind farm operator shall, at the wind farm operators expense, employ an independent consultant approved by the Local Planning Authority to assess the level of noise immissions from the wind farm at the complainant's property following the procedures described in the attached Guidance Notes.

3. The wind farm operator shall provide to the Local Planning Authority the independent consultant's assessment and conclusions regarding the said noise complaint, including all calculations, audio recordings and the raw data upon which those assessments and conclusions are based. Such information shall be provided within 2 months of the date of the written request of the Local Planning Authority, with an additional 3 weeks allowed should further investigation pursuant to Guidance Note 4 be required, unless otherwise extended in writing by the Local Planning Authority.

4. Wind speed, wind direction and power generation data shall be continuously logged and provided to the Local Planning Authority at its request and in accordance with the attached Guidance Notes within 14 days of such request. Such data shall be retained for a period of not less than 24 months.

5. No development shall commence until there has been submitted to the Local Planning Authority details of a nominated representative for the development to act as a point of contact for local residents (in connection with conditions 1 - 4) together with the arrangements for notifying and approving any subsequent change in the nominated representative. The nominated representative shall have responsibility for liaison with the Local Planning Authority in connection with any noise complaints made during the construction, operation and decommissioning of the wind farm.

SCHEDULE OF NOISE GUIDANCE NOTES

These notes form part of conditions 1-5. They further explain these conditions and specify the methods to be deployed in the assessment of complaints about noise immissions from the wind farm.

Reference to ETSU-R-97 refers to the publication entitled "The Assessment and Rating of Noise from Wind Farm" (1997) published by the Energy Technology Support unit (ETSU) for the Department of Trade and Industry (DTI).

NOTE 1

a) Values of the $L_{A90,10min}$ noise statistic shall be measured at the complainant's property using a sound level meter of EN 60651/BS EN 60804 Type 1, or EN 61672 Class 1 quality (or the replacement thereof) set to measure using a fast time weighted response as specified in BS EN 60651/BS EN 60804 or BS EN 61672-1 (or the equivalent UK adopted standard in force at the time of the measurements). This shall be calibrated in accordance with the procedure specified in BS 4142: 1997 (or the replacement thereof). These measurements shall be made in such a way that the requirements of Note 3 shall also be satisfied.

b) The microphone should be mounted at 1.2 - 1.5 m above ground level, fitted with a two layer windshield (or suitable alternative approved in writing from the Local Planning Authority), and placed outside the complainant's dwelling. Measurements should be made in "free-field" conditions. To achieve this, the microphone should be placed at least 3.5m away from the building facade or any reflecting surface except the ground at a location agreed with the Local Planning Authority.

c) The $L_{A90,10min}$ measurements shall be synchronised with measurements of the 10-minute arithmetic mean wind speed and with operational data, including power generation information for each wind turbine, from the turbine control systems of the wind farm.

d) The wind farm operator shall continuously log arithmetic mean wind speed and arithmetic mean wind direction data in 10 minute periods on the wind farm site to enable compliance with the conditions to be evaluated. The mean wind speed at hub height shall be 'standardised' to a reference height of 10 metres as described in ETSU-R-97 at page 120 using a reference roughness length of 0.05 metres. It is this standardised 10m height wind speed data which is correlated with the noise measurements of Note 2(a) in the manner described in Note 2(c).

NOTE 2

a) The noise measurements shall be made so as to provide not less than 20 valid data points as defined in Note 2 paragraph (b). Such measurements shall provide valid data points for the range of wind speeds, wind directions, times of day and power generation requested by the Local Planning Authority. In specifying such conditions the Local Planning Authority shall have regard to those conditions which were most likely to have prevailed during times when the complainant alleges there was disturbance due to noise.

b) Valid data points are those that remain after all periods during rainfall have been excluded. Rainfall shall be assessed by use of a rain gauge that shall log the occurrence of rainfall in each 10minute period concurrent with the measurement periods set out in Note 1(c) and is situated in the vicinity of the sound level meter.

c) A least squares, "best fit" curve of a maximum 2nd order polynomial or otherwise as may be agreed with the local planning authority shall be fitted between the standardised mean wind speed (as defined in Note 1 paragraph (d)) plotted against the measured $L_{A90,10min}$ noise levels. The noise level at each integer speed shall be derived from this best-fit curve.

NOTE 3

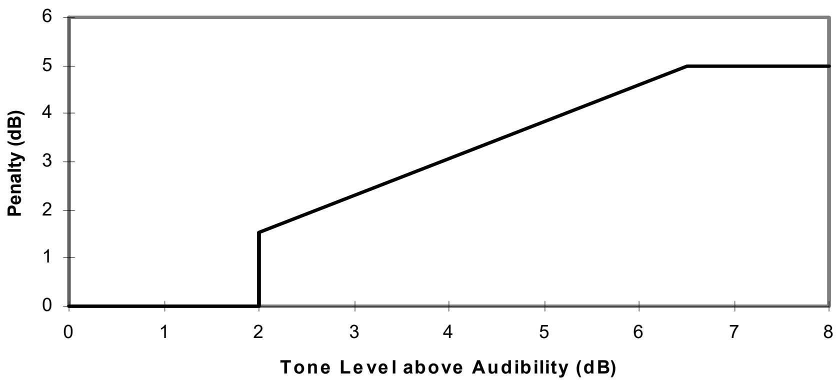
Where, in the opinion of the Local Planning Authority, noise immissions at the location or locations where assessment measurements are being undertaken contain a tonal component, the following rating procedure shall be used.

a) For each 10-minute interval for which $L_{A90,10min}$ data have been obtained as provided for in Notes 1 and 2, a tonal assessment shall be performed on noise immissions during 2-minutes of each 10-minute period. The 2-minute periods shall be regularly spaced at 10-minute intervals provided that uninterrupted clean data are available. Where clean data are not available, the first available uninterrupted clean 2 minute period out of the affected overall 10 minute period shall be selected. Any such deviations from standard procedure, as described in Section 2.1 on pages 104-109 of ETSU-R-97, shall be reported.

b) For each of the 2-minute samples the margin above or below the audibility criterion of the tone level difference, ΔL_{tm} (Delta L_{tm}), shall be calculated by comparison with the audibility criterion, given in Section 2.1 on pages 104-109 of ETSU-R-97.

c) The arithmetic average margin above audibility shall be calculated for each wind speed bin where data is available, each bin being 1 metre per second wide and centred on integer wind speeds. For samples for which the tones were below the audibility criterion or no tone was identified, a value of zero audibility shall be substituted.

d) The tonal penalty shall be derived from the margin above audibility of the tone according to the figure below. The rating level at each wind speed shall be calculated as the arithmetic sum of the wind farm noise level, as determined from the best-fit curve described in Note 2, and the penalty for tonal noise.



NOTE 4

If the wind farm noise level (including the application of any tonal penalty as per Note 3) is above the limit set out in the conditions, measurements of the influence of background noise shall be made to determine whether or not there is a breach of condition. This may be achieved by repeating the steps in Notes 1 & 2 with the wind farm switched off in order to determine the background noise, L_3, at the assessed wind speed. The wind farm noise at this wind speed, L_1, is then calculated as follows, where L_2 is the measured wind farm noise level at the assessed wind speed with turbines running but without the addition of any tonal penalty:

$$L_1 = 10\log\left[10^{L_2/10} - 10^{L_3/10}\right]$$

The wind farm noise level is re-calculated by adding the tonal penalty (if any) to the wind farm noise.

TABLE OF NOISE LIMITS RELATING TO CONDITION 1

Table A: The $L_{A90,10min}$ dB Wind Farm Noise Level Between 23:00 and 07:00 hours:

House ID	Standardised 10m Wind Speed, ms^{-1}											
	1	2	3	4	5	6	7	8	9	10	11	12
H6	42.8	42.8	42.8	42.8	42.7	42.2	41.7	41.3	43.2	43.1	43.1	43.1
H7	42.8	42.8	42.8	42.8	42.8	42.5	42.1	41.9	43.6	43.5	43.5	43.5
H8	42.8	42.8	42.8	42.8	42.8	42.5	42.2	42.0	43.6	43.6	43.6	43.6
H9	42.9	42.9	42.9	42.9	42.8	42.7	42.4	42.2	43.8	43.8	43.8	43.8
H10	42.9	42.9	42.9	42.9	42.9	42.7	42.5	42.4	43.9	43.9	43.9	43.9
H11	42.9	42.9	42.9	42.9	42.9	42.8	42.7	42.6	44.1	44.1	44.1	44.1
H12	42.9	42.9	42.9	42.9	42.9	42.8	42.7	42.6	44.1	44.1	44.1	44.1
H13	42.9	42.9	42.9	42.9	42.9	42.8	42.7	42.6	44.1	44.1	44.1	44.1
H14	42.9	42.9	42.9	42.9	42.9	42.8	42.7	42.6	44.1	44.1	44.1	44.1
H15	43.0	43.0	43.0	43.0	42.9	42.8	42.7	42.7	44.2	44.2	44.2	44.2
H16	43.0	43.0	43.0	43.0	42.9	42.8	42.8	42.7	44.2	44.2	44.2	44.2
H17	43.0	43.0	43.0	43.0	42.9	42.9	42.8	42.7	44.2	44.2	44.2	44.2
H18	43.0	43.0	43.0	43.0	42.9	42.9	42.8	42.7	44.2	44.2	44.2	44.2
H19	43.0	43.0	43.0	43.0	42.9	42.9	42.8	42.8	42.7	42.7	42.7	42.7
H21	43.0	43.0	43.0	43.0	43.0	42.9	42.9	42.8	42.8	42.8	42.8	42.8
H22	43.0	43.0	43.0	43.0	43.0	42.9	42.8	42.8	42.8	42.8	42.7	42.7
H23	43.0	43.0	43.0	43.0	43.0	42.9	42.8	42.8	42.8	42.8	42.7	42.7
H24	43.0	43.0	43.0	43.0	42.9	42.9	42.8	42.8	42.8	42.7	42.7	42.7
H25	43.0	43.0	43.0	43.0	42.9	42.9	42.8	42.8	42.8	42.7	42.7	42.7
H26	43.0	43.0	43.0	43.0	42.9	42.9	42.8	42.7	42.7	42.7	42.7	42.7
H27	43.0	43.0	43.0	43.0	42.9	42.9	42.8	42.7	42.7	42.7	42.7	42.7
H28	43.0	43.0	43.0	43.0	42.9	42.9	42.8	42.7	42.7	42.7	42.7	42.7
H29	42.9	42.9	42.9	42.9	42.9	42.9	42.8	42.7	46.5	46.4	46.4	46.4
H30	42.9	42.9	42.9	42.9	42.9	42.9	42.8	42.7	46.5	46.4	46.4	46.4
H31	42.9	42.9	42.9	42.9	42.9	42.9	42.8	42.7	46.5	46.4	46.4	46.4
H32	42.9	42.9	42.9	42.9	42.9	42.9	42.8	42.7	46.5	46.4	46.4	46.4
H33	42.9	42.9	42.9	42.9	42.9	42.9	42.8	42.7	46.5	46.4	46.4	46.4
H34	42.9	42.9	42.9	42.9	42.9	42.9	42.8	42.7	46.5	46.4	46.4	46.4
H35	42.9	42.9	42.9	42.9	42.9	42.9	42.8	42.7	46.5	46.5	46.4	46.4
H36	42.9	42.9	42.9	42.9	42.9	42.9	42.8	42.7	46.5	46.5	46.4	46.4
H37	42.9	42.9	42.9	42.9	42.9	42.9	42.8	42.7	46.5	46.5	46.5	46.5
H38	42.9	42.9	42.9	42.9	42.9	42.9	42.8	42.7	46.5	46.5	46.5	46.5
H39	43.0	43.0	43.0	43.0	42.9	42.9	42.8	42.7	46.5	46.5	46.5	46.5
H40	42.9	42.9	42.9	42.9	42.9	42.9	42.8	42.7	46.5	46.4	46.4	46.4
H41	41.9	41.9	41.9	41.9	41.2	37.2	34.1	39.5	44.7	48.4	51.6	54.6

Table B: $L_{A90,10min}$ dB Wind Farm Noise Level at all other times:

House ID	Standardised 10m Wind Speed, ms^{-1}											
	1	2	3	4	5	6	7	8	9	10	11	12
H6	38.4	38.6	39.1	39.7	40.5	41.1	42.3	44.4	46.8	49.7	49.7	49.7
H7	38.6	38.8	39.2	39.9	40.6	41.5	42.7	44.7	47.0	49.8	49.8	49.8
H8	38.6	38.8	39.3	39.9	40.7	41.5	42.8	44.7	47.0	49.8	49.8	49.8
H9	38.7	38.9	39.4	40.0	40.7	41.7	43.0	44.9	47.1	49.8	49.8	49.8
H10	38.8	39.0	39.4	40.0	40.8	41.7	43.1	45.0	47.2	49.9	49.9	49.9
H11	38.9	39.1	39.5	40.1	40.9	41.9	43.2	45.1	47.3	49.9	49.9	49.9
H12	38.8	39.1	39.5	40.1	40.9	41.8	43.2	45.1	47.2	49.9	49.9	49.9
H13	38.9	39.1	39.5	40.1	40.9	41.9	43.2	45.1	47.3	49.9	49.9	49.9
H14	38.9	39.1	39.5	40.1	40.9	41.9	43.2	45.1	47.3	49.9	49.9	49.9
H15	38.9	39.1	39.5	40.1	40.9	41.9	43.3	45.1	47.3	49.9	49.9	49.9
H16	38.9	39.1	39.5	40.1	40.9	41.9	43.3	45.1	47.3	49.9	49.9	49.9
H17	38.9	39.1	39.5	40.1	40.9	41.9	43.3	45.1	47.3	49.9	49.9	49.9
H18	38.9	39.1	39.5	40.1	40.9	41.9	43.3	45.1	47.3	49.9	49.9	49.9
H19	36.0	36.8	37.7	38.6	39.7	40.9	42.5	44.3	46.5	49.0	49.0	49.0
H21	36.1	36.8	37.7	38.6	39.7	41.0	42.6	44.4	46.5	49.1	49.1	49.1
H22	36.0	36.8	37.7	38.6	39.7	40.9	42.5	44.3	46.5	49.0	49.0	49.0
H23	36.0	36.8	37.7	38.6	39.7	40.9	42.5	44.3	46.5	49.0	49.0	49.0
H24	36.0	36.7	37.7	38.6	39.7	40.9	42.5	44.3	46.5	49.0	49.0	49.0
H25	36.0	36.7	37.7	38.6	39.7	40.9	42.5	44.3	46.5	49.0	49.0	49.0
H26	36.0	36.7	37.6	38.6	39.7	40.9	42.5	44.3	46.5	49.0	49.0	49.0
H27	36.0	36.7	37.6	38.6	39.7	40.9	42.5	44.3	46.5	49.0	49.0	49.0
H28	36.0	36.7	37.6	38.6	39.7	40.9	42.5	44.3	46.5	49.0	49.0	49.0
H29	39.2	39.2	39.6	40.6	41.9	43.5	45.4	47.5	49.7	52.2	52.2	52.2
H30	39.2	39.2	39.6	40.6	41.9	43.5	45.4	47.5	49.7	52.2	52.2	52.2
H31	39.2	39.2	39.6	40.6	41.9	43.5	45.4	47.5	49.7	52.2	52.2	52.2
H32	39.2	39.2	39.6	40.6	41.9	43.5	45.4	47.5	49.7	52.2	52.2	52.2
H33	39.2	39.2	39.6	40.6	41.9	43.5	45.4	47.5	49.7	52.2	52.2	52.2
H34	39.2	39.2	39.6	40.6	41.9	43.5	45.4	47.5	49.7	52.2	52.2	52.2
H35	39.2	39.2	39.6	40.6	41.9	43.5	45.4	47.5	49.7	52.2	52.2	52.2
H36	39.2	39.2	39.6	40.6	41.9	43.5	45.4	47.5	49.7	52.2	52.2	52.2
H37	39.2	39.2	39.6	40.6	41.9	43.5	45.4	47.5	49.7	52.2	52.2	52.2
H38	39.2	39.2	39.6	40.6	41.9	43.5	45.4	47.5	49.7	52.2	52.2	52.2
H39	39.2	39.2	39.6	40.6	41.9	43.5	45.4	47.5	49.7	52.2	52.2	52.2
H40	39.2	39.2	39.6	40.6	41.9	43.5	45.4	47.5	49.7	52.2	52.2	52.2
H41	39.7	40.7	41.8	42.9	43.7	43.8	44.3	46.1	48.5	50.9	53.3	55.8

TABLE OF COORDINATE LOCATIONS OF PROPERTIES

Note to Table C: The geographical co-ordinates references are provided for the purpose of identifying the general location of dwellings to which a given set of noise limits applies

Table C: Coordinate locations of the properties listed in Tables A & B:

House ID	X	Y
H6	273008	426728
H7	272472	426376
H8	272444	426346
H9	272232	426087
H10	272050	425810
H11	271738	425476
H12	271705	425389
H13	271625	425273
H14	271608	425251
H15	271755	424863
H16	271796	424809
H17	271778	424682
H18	271807	424666
H19	271855	424613
H21	271750	424052
H22	271921	423842
H23	271951	423759
H24	272280	423403
H25	272406	423257
H26	272854	423282
H27	272909	423356
H28	273010	423273
H29	273975	423247
H30	273989	423241
H31	273981	423277
H32	274145	423178
H33	274414	423279
H34	274449	423291
H35	274862	423484
H36	274901	423478
H37	274972	423478
H38	274987	423479
H39	275513	423379
H40	273923	422996
H41	273812	427187

11

Traffic & Transport

Appendix 11: Traffic & Transport

Appendix 11.1 AIL Delivery Analysis

KEY

SITE (TAKEN FROM RES DRAWING 03219D2501-03)

PROPOSED DELIVERY ROUTE

OVERVIEW
SHEET 1 OF 6

ISSUE	DRAWN	CHKD	APPD	DATE	REVISION NOTES
02	AS	GM	SM	20-12-2017	SITE ENTRANCE UPDATED
01	CT	SM	SM	13-07-2017	FIRST ISSUE

LAYOUT DWG N/A

T-LAYOUT NO. N/A

DRAWING NUMBER
03219D2401-02

COORDS IRISH NATIONAL GRID

PURPOSE PRELIMINARY

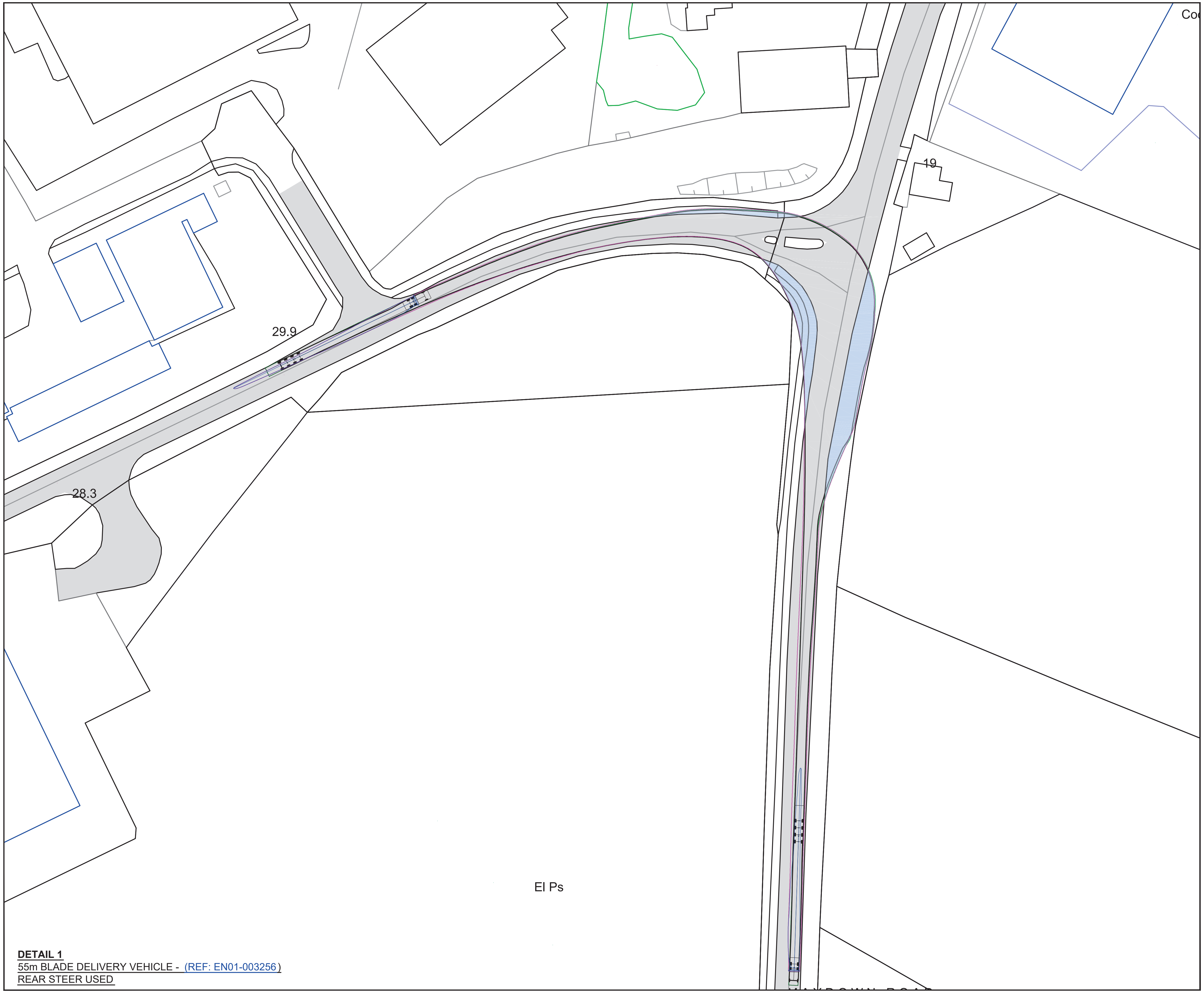
SCALE 1:150,000

ORIGINAL PLOT SIZE A3

PROJECT TITLE
DUNBEG SOUTH
WIND FARM

DRAWING TITLE
DELIVERY ANALYSIS -
55m BLADE VEHICLE

BEAUFORT COURT, EGG FARM LANE,
KINGS LANGLEY, HERTS WD4 8LR.
TEL +44 (0) 1923 299200
FAX +44 (0) 1923 299299



DETAIL 1
55m BLADE DELIVERY VEHICLE - (REF: EN01-003256)
REAR STEER USED

KEY
- EXISTING ROAD/TRACK SURFACE
- OVERRUN / OVERSAIL WIDENING (HIGHWAY)
- OVERRUN / OVERSAIL WIDENING (HARDSHOULDER)
- ILLUMINATED BOLLARD
- STREET LIGHT
- STREET SIGN

VEHICLE PATH
- WHEEL EXTENTS (BLACK)
- BODY EXTENTS (GREEN)
- DELIVERY VEHICLE (BLACK)
- LOAD (BLUE)
- LOAD EXTENTS (MAGENTA)

NOTES

1. AREAS OF OVERRUN AND OVERSAIL CONSIDER THE COMBINED AREA FOR ALL ASSESSED VEHICLES.
2. VEHICLE DIMENSIONS BASED ON TYPICAL DELIVERY VEHICLES AND SHOULD BE CONFIRMED PRIOR TO DELIVERY.
3. LAND TAKE IS APPROXIMATE AND INCLUDES OVERRUN, OVERSAIL AND TEMPORARY WORKS.
4. ALL RELEVANT AUTHORITIES TO BE CONSULTED ON RELOCATION / REMOVAL OF STREET FURNITURE.

DETAIL 1
SHEET 2 OF 6

ISSUE	DRAWN	CHKD	APPD	DATE	REVISION NOTES
02	AS	GM	SM	20-12-2017	SITE ENTRANCE UPDATED
01	CT	SM	SM	13-07-2017	FIRST ISSUE

LAYOUT DWG N/A
T-LAYOUT NO. N/A

DRAWING NUMBER
03219D2401-02

COORDS IRISH NATIONAL GRID

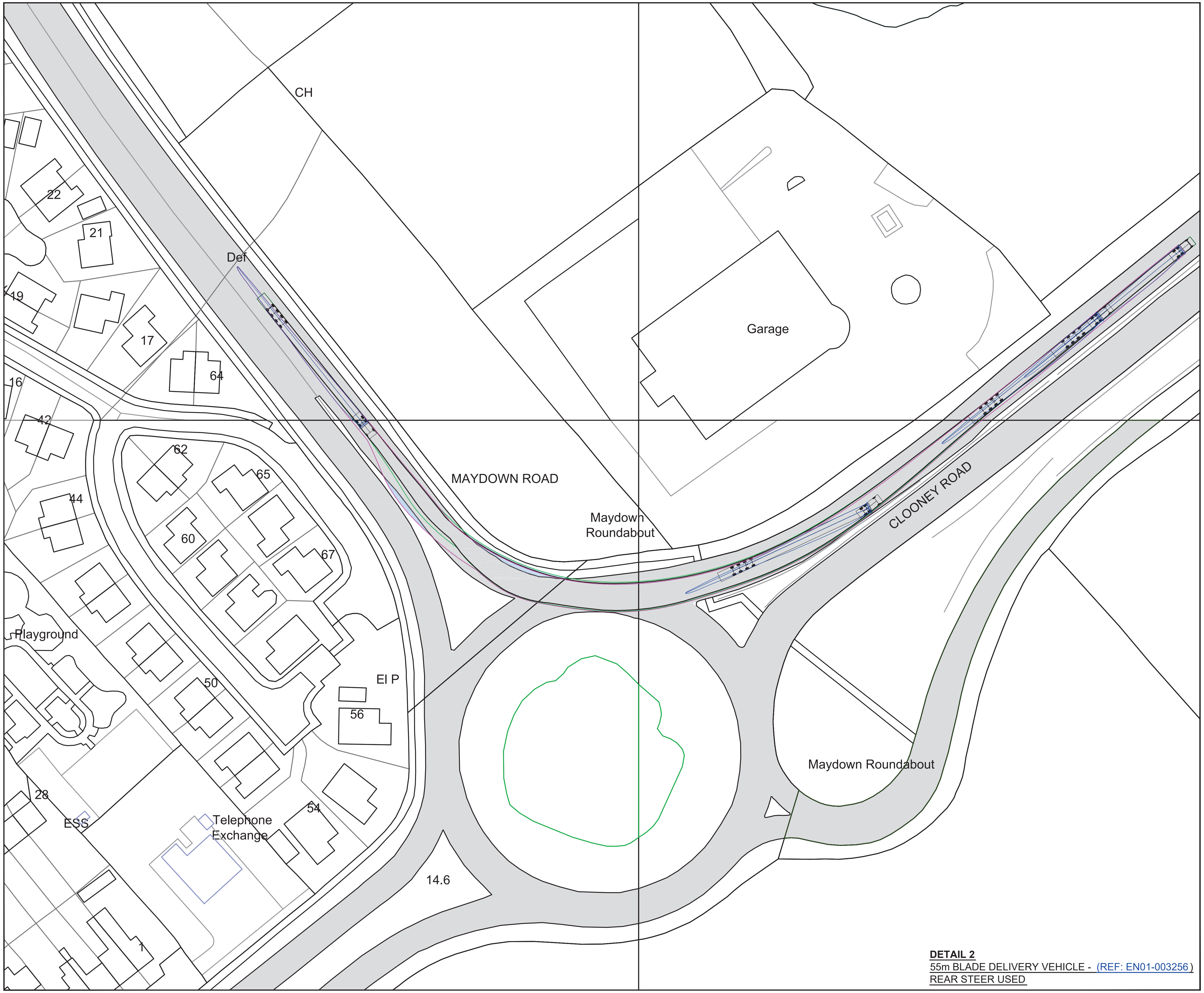
PURPOSE PRELIMINARY

SCALE 1:1000
ORIGINAL PLOT SIZE A3

PROJECT TITLE
DUNBEG SOUTH
WIND FARM

DRAWING TITLE
DELIVERY ANALYSIS -
55m BLADE VEHICLE

BEAUFORT COURT, EGG FARM LANE, KINGS LANGLEY, HERTS WD4 8LR.
TEL +44 (0) 1923 299200
FAX +44 (0) 1923 299299



DETAIL 2
55m BLADE DELIVERY VEHICLE - (REF: EN01-003256)
REAR STEER USED

KEY

- EXISTING ROAD/TRACK SURFACE
- OVERRUN / OVERSAIL WIDENING (HIGHWAY)
- OVERRUN / OVERSAIL WIDENING (HARDSHOULDER)
- ILLUMINATED BOLLARD
- STREET LIGHT
- STREET SIGN

VEHICLE PATH

- WHEEL EXTENTS (BLACK)
- BODY EXTENTS (GREEN)
- DELIVERY VEHICLE (BLACK)
- LOAD (BLUE)
- LOAD EXTENTS (MAGENTA)

NOTES

1. AREAS OF OVERRUN AND OVERSAIL CONSIDER THE COMBINED AREA FOR ALL ASSESSED VEHICLES.
2. VEHICLE DIMENSIONS BASED ON TYPICAL DELIVERY VEHICLES AND SHOULD BE CONFIRMED PRIOR TO DELIVERY.
3. LAND TAKE IS APPROXIMATE AND INCLUDES OVERRUN, OVERSAIL AND TEMPORARY WORKS.
4. ALL RELEVANT AUTHORITIES TO BE CONSULTED ON RELOCATION / REMOVAL OF STREET FURNITURE.

N

DETAIL 2
SHEET 3 OF 6

ISSUE	DRAWN	CHKD	APPD	DATE	REVISION NOTES
02	AS	GM	SM	20-12-2017	SITE ENTRANCE UPDATED
01	CT	SM	SM	13-07-2017	FIRST ISSUE

LAYOUT DWG N/A
T-LAYOUT NO. N/A

DRAWING NUMBER
03219D2401-02

COORDS BRITISH NATIONAL GRID

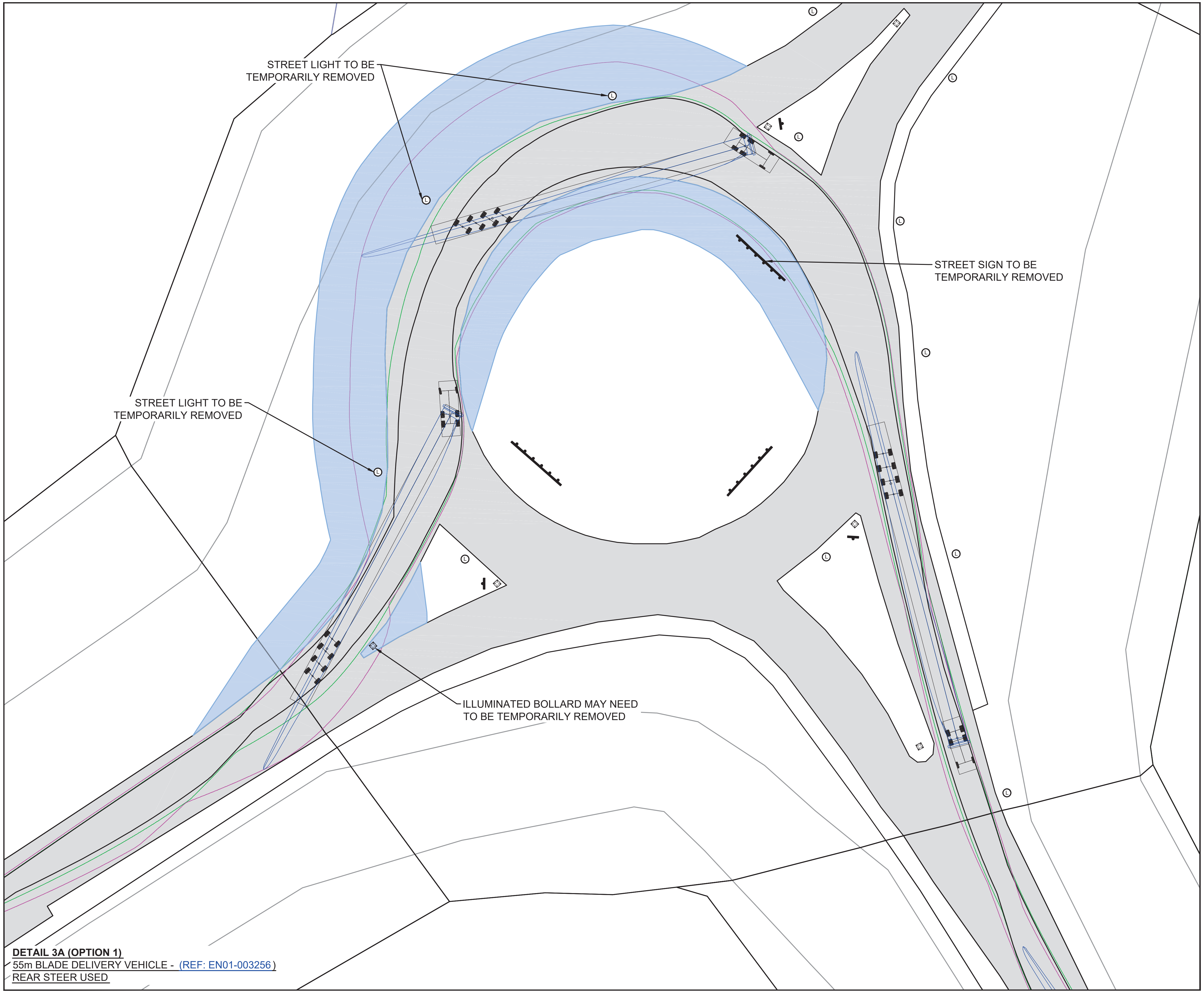
PURPOSE PRELIMINARY

SCALE 1:1000
ORIGINAL PLOT SIZE A3

PROJECT TITLE
DUNBEG SOUTH
WIND FARM

DRAWING TITLE
DELIVERY ANALYSIS -
55m BLADE VEHICLE

BEAUFORT COURT, EGG FARM LANE,
KINGS LANGLEY, HERTS WD4 8LR.
TEL +44 (0) 1923 299200
FAX +44 (0) 1923 299299

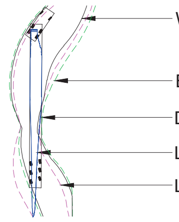


DETAIL 3A (OPTION 1)
55m BLADE DELIVERY VEHICLE - (REF: EN01-003256)
REAR STEER USED

KEY

- EXISTING ROAD/TRACK SURFACE
- OVERRUN / OVERSAIL WIDENING (HIGHWAY)
- OVERRUN / OVERSAIL WIDENING (HARDSHOULDER)
- ILLUMINATED BOLLARD
- STREET LIGHT
- STREET SIGN

VEHICLE PATH



NOTES

1. AREAS OF OVERRUN AND OVERSAIL CONSIDER THE COMBINED AREA FOR ALL ASSESSED VEHICLES.
2. VEHICLE DIMENSIONS BASED ON TYPICAL DELIVERY VEHICLES AND SHOULD BE CONFIRMED PRIOR TO DELIVERY.
3. LAND TAKE IS APPROXIMATE AND INCLUDES OVERRUN, OVERSAIL AND TEMPORARY WORKS.
4. ALL RELEVANT AUTHORITIES TO BE CONSULTED ON RELOCATION / REMOVAL OF STREET FURNITURE.

DETAIL 3A (OPTION 1)
SHEET 4 OF 6

ISSUE	DRAWN	CHKD	APPD	DATE	REVISION NOTES
02	AS	GM	SM	20-12-2017	SITE ENTRANCE UPDATED
01	CT	SM	SM	13-07-2017	FIRST ISSUE

LAYOUT DWG N/A
T-LAYOUT NO. N/A

DRAWING NUMBER
03219D2401-02

COORDS BRITISH NATIONAL GRID

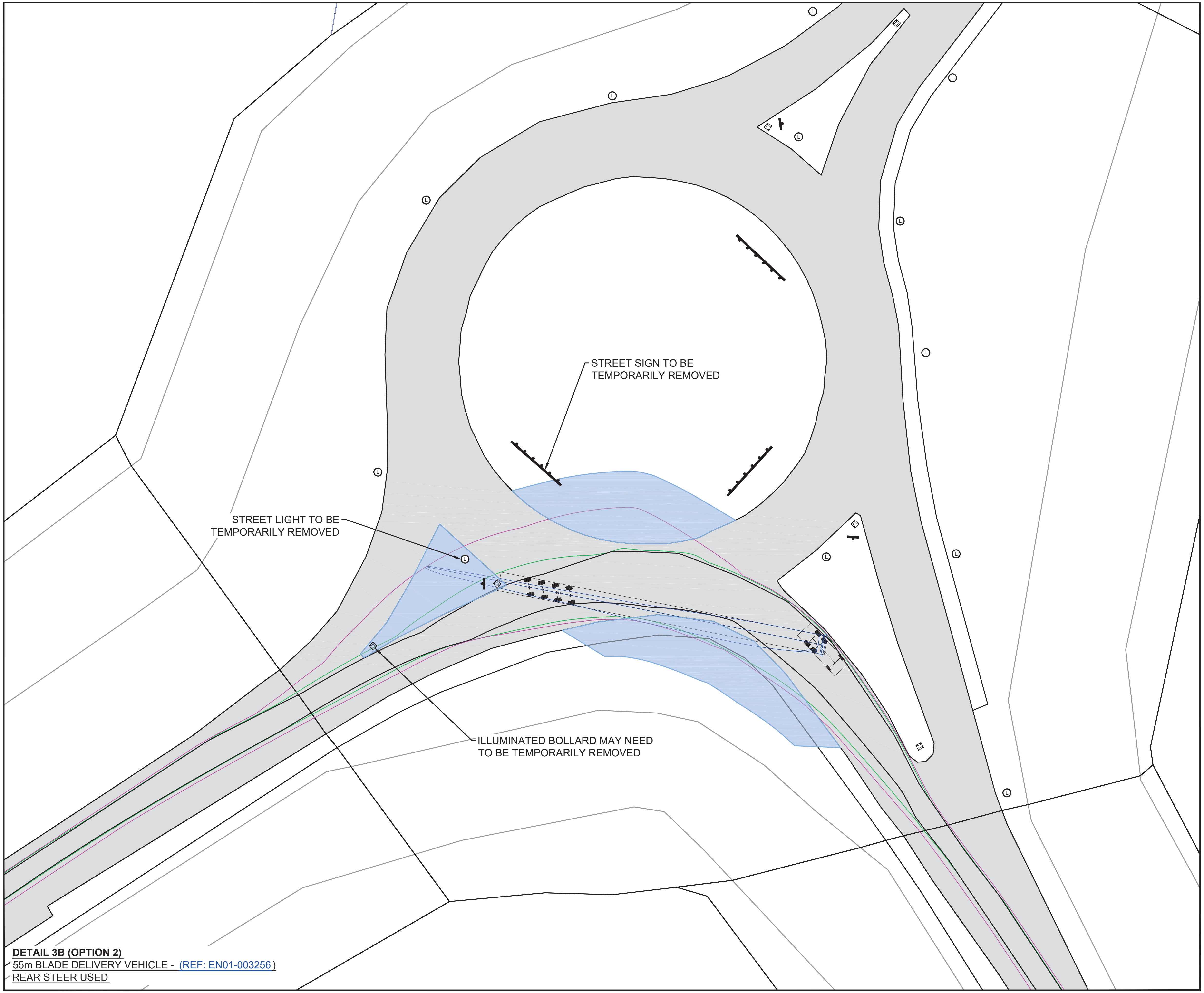
PURPOSE PRELIMINARY

SCALE 1:500
ORIGINAL PLOT SIZE A3

PROJECT TITLE
DUNBEG SOUTH
WIND FARM

DRAWING TITLE
DELIVERY ANALYSIS -
55m BLADE VEHICLE

BEAUFORT COURT, EGG FARM LANE,
KINGS LANGLEY, HERTS WD4 8LR.
TEL +44 (0) 1923 299200
FAX +44 (0) 1923 299299



DETAIL 3B (OPTION 2)
55m BLADE DELIVERY VEHICLE - (REF: EN01-003256)
REAR STEER USED

KEY

- EXISTING ROAD/TRACK SURFACE
- OVERRUN / OVERSAIL WIDENING (HIGHWAY)
- OVERRUN / OVERSAIL WIDENING (HARDSHOULDER)
- ILLUMINATED BOLLARD
- STREET LIGHT
- STREET SIGN

VEHICLE PATH

- WHEEL EXTENTS (BLACK)
- BODY EXTENTS (GREEN)
- DELIVERY VEHICLE (BLACK)
- LOAD (BLUE)
- LOAD EXTENTS (MAGENTA)

NOTES

1. AREAS OF OVERRUN AND OVERSAIL CONSIDER THE COMBINED AREA FOR ALL ASSESSED VEHICLES.
2. VEHICLE DIMENSIONS BASED ON TYPICAL DELIVERY VEHICLES AND SHOULD BE CONFIRMED PRIOR TO DELIVERY.
3. LAND TAKE IS APPROXIMATE AND INCLUDES OVERRUN, OVERSAIL AND TEMPORARY WORKS.
4. ALL RELEVANT AUTHORITIES TO BE CONSULTED ON RELOCATION / REMOVAL OF STREET FURNITURE.

DETAIL 3B (OPTION 2)
SHEET 5 OF 6

ISSUE	DRAWN	CHKD	APPD	DATE	REVISION NOTES
02	AS	GM	SM	20-12-2017	SITE ENTRANCE UPDATED
01	CT	SM	SM	13-07-2017	FIRST ISSUE

LAYOUT DWG N/A
T-LAYOUT NO. N/A

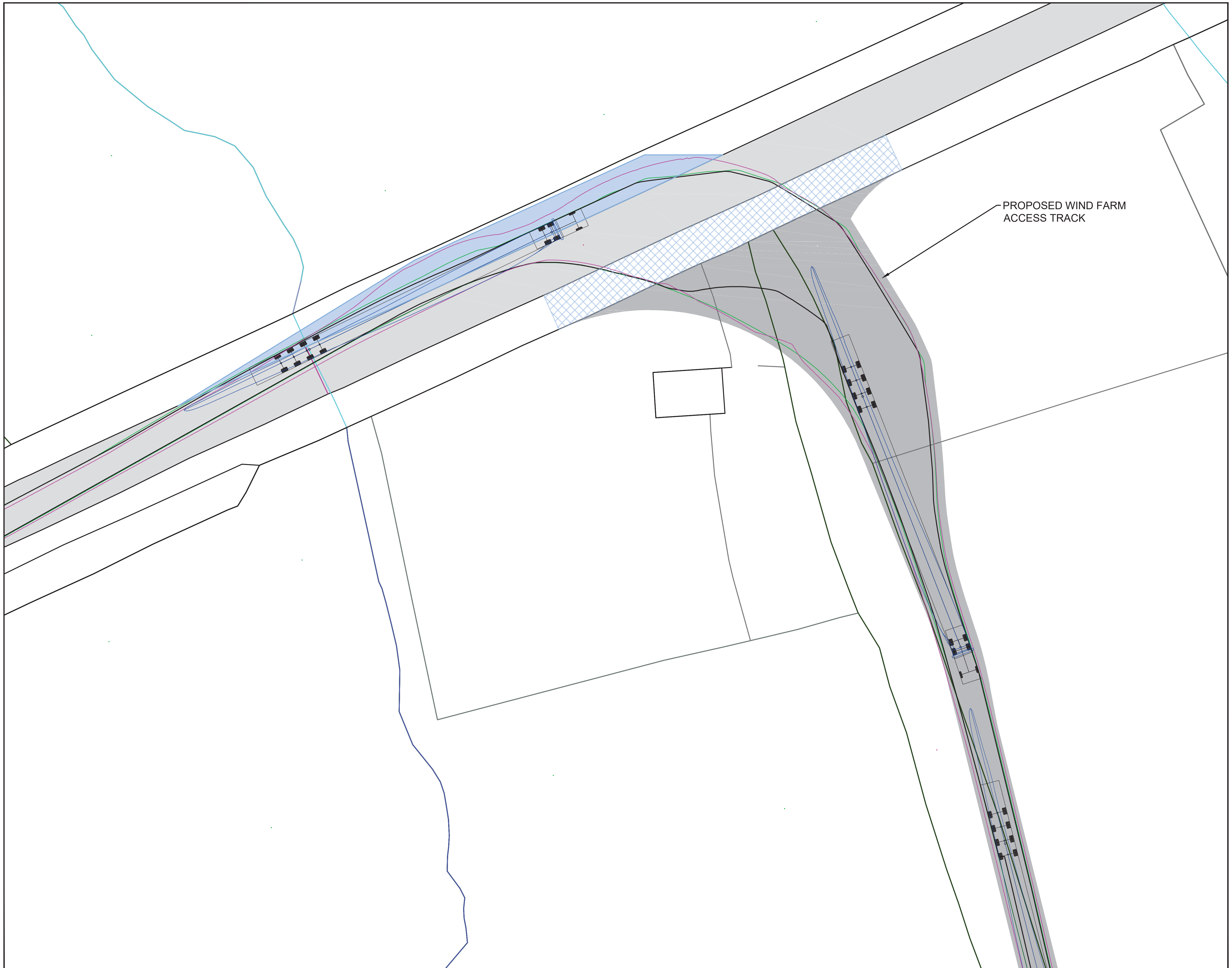
DRAWING NUMBER
03219D2401-02

COORDS BRITISH NATIONAL GRID
PURPOSE PRELIMINARY
SCALE 1:500
ORIGINAL PLOT SIZE A3

PROJECT TITLE
DUNBEG SOUTH WIND FARM

DRAWING TITLE
DELIVERY ANALYSIS - 55m BLADE VEHICLE

BEAUFORT COURT, EGG FARM LANE,
KINGS LANGLEY, HERTS WD4 8LR.
TEL +44 (0) 1923 299200
FAX +44 (0) 1923 299299



DETAIL 4
55m BLADE DELIVERY VEHICLE - (REF: EN01-003256)
REAR STEER USED

KEY

- EXISTING ROAD/TRACK SURFACE
- OVERRUN / OVERSAIL WIDENING (HIGHWAY)
- OVERRUN / OVERSAIL WIDENING (HARDSHOULDER)
- ILLUMINATED BOLLARD
- STREET LIGHT
- STREET SIGN

VEHICLE PATH

- WHEEL EXTENTS (BLACK)
- BODY EXTENTS (GREEN)
- DELIVERY VEHICLE (BLACK)
- LOAD (BLUE)
- LOAD EXTENTS (MAGENTA)

NOTES

1. AREAS OF OVERRUN AND OVERSAIL CONSIDER THE COMBINED AREA FOR ALL ASSESSED VEHICLES.
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4. ALL RELEVANT AUTHORITIES TO BE CONSULTED ON RELOCATION / REMOVAL OF STREET FURNITURE.

N

DETAIL 4
SHEET 6 OF 6

ISSUE	DRAWN	CHKD	APPD	DATE	REVISION NOTES
02	AS	GM	SM	20-12-2017	SITE ENTRANCE UPDATED
01	CT	SM	SM	13-07-2017	FIRST ISSUE

LAYOUT DWG N/A
T-LAYOUT NO. N/A

DRAWING NUMBER
03219D2401-02

COORDS BRITISH NATIONAL GRID

PURPOSE PRELIMINARY

SCALE 1:500
ORIGINAL PLOT SIZE A3

PROJECT TITLE
DUNBEG SOUTH
WIND FARM

DRAWING TITLE
DELIVERY ANALYSIS -
55m BLADE VEHICLE

BEAUFORT COURT, EGG FARM LANE,
KINGS LANGLEY, HERTS WD4 8LR.
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