Bracklyn Wind Farm Limited

Bracklyn Wind Farm

Co. Westmeath & Co. Meath

OUTLINE CONSTUCTION ENVIRONMENTAL MANAGEMENT PLAN (CEMP)

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Bracklyn Wind Farm Limited,
Greaghcrotta,
Tullyco,
Cootehill,
Co. Cavan.
Tel.: +353 (0) 49 555 5050

Jennings O'Donovan & Partners Limited,
Consulting Engineers,
Finisklin Business Park, Sligo.
Tel.: 071 9161416
Fax: 071 9161080
email: info@jodireland.com

JENNINGS O'DONOVAN & PARTNERS LIMITED
Project, Civil and Structural Consulting Engineers,
FINISKLIN BUSINESS PARK,
SLIGO,
IRELAND.

Telephone (071) 91 61416
Fax (071) 91 61080

Email info@jodireland.com
Web Site www.jodireland.com

DOCUMENT APPROVAL

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	Prepared by	**Reviewed**	**Approved by**
Document **Draft**	Name Jody Gormley	Name Sarah Moore	Name John McElvaney
Date 14h May 2021	Signature	Signature	Signature

Document **Final**	Name Jody Gormley	Name Sarah Moore	Name John McElvaney
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BRACKLYN WIND FARM, CO. WESTMEATH

CONSTRUCTION ENVIRONMENTAL MANAGEMENT PLAN

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1 INTRODUCTION

1.1 Background to Report

Jennings O'Donovan & Partners Limited (JOD), on behalf of Bracklyn Wind Farm Limited has prepared this outline Construction Environmental Management Plan (CEMP) for the proposed Bracklyn Wind Farm (the Development). This document has been prepared on a preliminary basis and will be further developed and expanded following the appointment of the Contractor for the main construction works. Some items of this outline CEMP can only be finalised with appropriate input from the Contractor who will actually carry out the construction works. This outline CEMP identifies for the incoming Contractor, the key environmental requirements that must be adhered to in order to deliver optimum environmental reassurance for the site.

1.2 Planning History

Retention permission was granted by Westmeath County Council on 14th October 2020 for an existing 80m meteorological mast at the site. There have been three other planning applications made in the site within the last 15 years, pertaining to the existing farm enterprise. These are as follows:

- A planning application for a pig rearing unit which was lodged on 14th August 2008, that was subsequently withdrawn.
- Retention permission granted by Westmeath County Council on 8th April 2009 for a 4550m^3 slurry storage tank and external sump at the site.
- Planning permission granted by Westmeath County Council on 22nd April 2009 for a pig rearing unit to accommodate 744 sows, facilities to rear weaners to 30kgs, staff facilities, installation of a proprietary wastewater treatment system, percolation area and the carrying out of all ancillary site development works.

1.3 Construction Environmental Management Plan (CEMP): Aims & Objectives

This outline Construction Environmental Management Plan (CEMP) has been developed in accordance with the Institute of Environmental Management and Assessment (IEMA) Practitioner "*Environmental Management Plans*", Best Practice Series, Volume 12, December 2008.

The principle objective of this outline CEMP is to avoid, minimise and control adverse environmental impacts associated with the development of Bracklyn windfarm. As such, the Contractors commit to safeguarding the environment through the identification, avoidance and mitigation of the potential negative environmental impacts associated with the development, construction, operation and decommissioning of Bracklyn Wind Farm.

This outline CEMP aims to define good practice as well as specific actions required to implement mitigation requirements as identified in the Environmental Impact Assessment Report (EIAR), the planning process and/or other licensing or consenting processes.

The outline CEMP will be developed further and / or amended where necessary, subsequent to planning consent, to take account of planning condition requirements and any information which may be made available from additional consultations, site surveys etc.

The CEMP will form part of the contract documents for the main Civil Construction works. The Civil Works Contractor will take account of the structure, content, methods and requirements contained within the various sections of this outline CEMP when further developing this document (to include environmental plans) as required by the Contract.

While this outline CEMP provides a benchmark for good practice, where avoidance or further minimisation of risks to the environment can be demonstrated through use of alternative methods or improvements to current practices, the Contractor will implement these wherever possible, subject to approval from environmental monitoring personnel.

1.4 CEMP Development & Implementation

The outline CEMP has been prepared to accompany a planning application for the proposed Bracklyn Windfarm. It is a live document on site and will be further amended where necessary, subsequent to planning consent. This outline CEMP may also be updated by the Contractor with site specific method statements and plans as required prior to each phase of the works. It is also effectively a document management system for recording information and data relating to environmental checks, reports, surveys, monitoring data and auditing. Upon completion of the construction works, the Contractor will submit a complete electronic copy of the final CEMP to the client for their records. This final CEMP will include electronic scans of all hard copy reports, data, field records and correspondence which are gathered over the course of the construction works.

While version numbers will remain fixed depending on the stage of the project, it is acknowledged that the CEMP is a continually evolving document which can be updated in part or whole, at any stage of the project. Hence, revision and document distribution records are included at the front of each CEMP document to enable individual documents to be updated at any time. A summary of the CEMP development process and the required input from the main parties involved in the planning and construction of the wind farm are indicated in Figure 1.1.

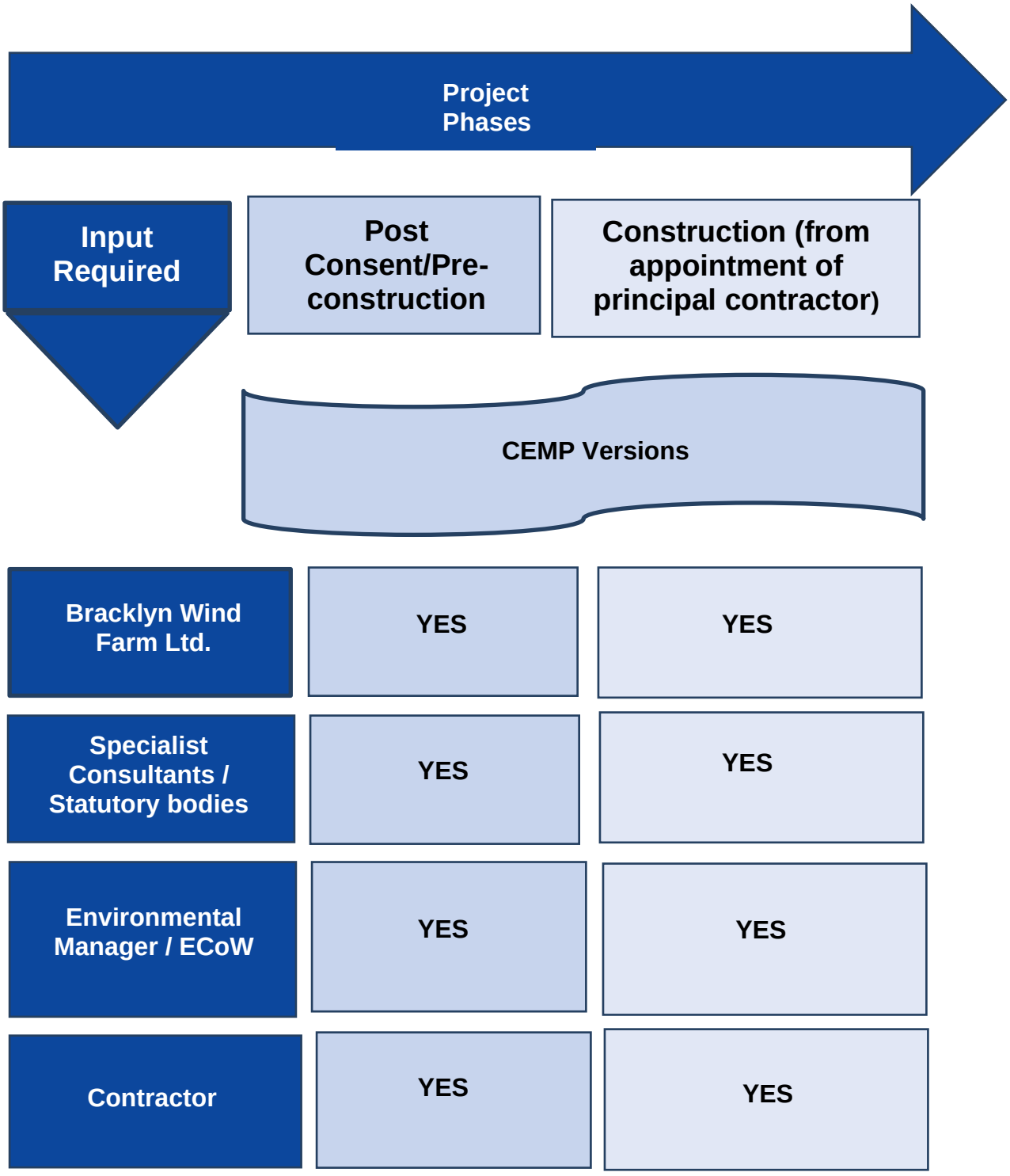


Figure 1.1 Summary of CEMP development process (CEMP Roles & Responsibilities)

This outline CEMP has been prepared by JOD on behalf of Bracklyn Wind Farm Limited for use by the appointed Contractor. The Contractor will be responsible for further development of the CEMP in line with planning condition requirements and other relevant licenses and consents. This may involve liaison with statutory bodies where appropriate.

Prior to commencement of construction works, the Contractor will identify a core Environmental Management Group, comprising of specific project personnel and an independent Ecological Clerk of Works (ECoW) and Environmental Manager. The Environmental Management Group will meet monthly to discuss the monthly environmental report and will advise site personnel on areas where improvements may be made on site. The group will draw on technical expertise from relevant specialists where required, including the Resident Engineer (R.E.), and will liaise with other relevant external bodies as required.

The Contractor will appoint an Environmental Manager (EM) who will be responsible for coordination and continued development of the CEMP and any other surveys, reports or method statements required. In conjunction with the ECoW, the EM will also review the Contractors method statements and environmental plans as required by the CEMP, carry out compliance auditing during the construction phase and coordinate the Environmental Management Group and required liaisons between Bracklyn Wind Farm Limited., the Contractor, the Planning Authority and other statutory authorities.

The Contractor will appoint an ECoW. The main roles and responsibilities of the ECoW relate to compliance monitoring with the CEMP and planning conditions and advice provision in relation to ecological matters. The ECoW will also assist the EM.

1.5 CEMP Structure

The CEMP is divided into discreet Sections which are designed to be filed as separate documents / folders if required. A copy of the CEMP documents / folder(s) will be kept in the site offices for the duration of the site works and will be made available for review at any time. The Contractor's EM will be responsible for the CEMP and will keep all sections updated throughout the construction phase.

Where the Contractor has standard documents within his own company / corporate Environmental Management Plans which cover a particular requirement of this CEMP, these will either be inserted or cross referenced within the relevant Section of this CEMP.

The CEMP Sections are listed in Table 1.2 as follows:

TABLE 1.2: CONSTRUCTION ENVIRONMENTAL MANAGEMENT PLAN (CEMP): Document Structure

Section	Title & Brief Description	Contractor Development Required
1	Introduction	No (Information purposes only)
2	Project Information Provides details on site location, scheme description and a summary of the environmental sensitivities at the site in Table 2.1 (as derived from the Appropriate Assessment Screenings and other information where available). Any documents prepared by or on behalf of Bracklyn Wind Farm Limited will be recorded in Table 2.3. which contains a record of all Scheme Amendments and a Register of Variations.	Yes Any documents prepared by the Contractor will be recorded in Table 2.3 and inserted in the CEMP where necessary. Any Scheme Amendments and / or Variations to the CEMP required during the works will be recorded by the Contractor in Tables 2.4 and 2.5.
3	Environmental Communications Plan Contains details on specific requirements relating to: • Contact details for Bracklyn Wind Farm Limited personnel, technical specialists, Contractor personnel, regulators, landowners, other stakeholders etc; • Meetings, reports and consultations; • Roles and responsibilities; and • General reporting procedures and tasks.	Yes The Contractor will: i) Insert contact information for regulatory authorities and other stakeholders (where not already provided) into Table 3.1 ii) Refer to Table 3.2 for details on requirements for meetings, reports and consultations iii) Insert information on Contractor appointments and responsibilities relating to environmental management and implementation of this CEMP into Table 3.3. iv) Refer to Figure 3.1 for a summary of the main communication lines.
4	Correspondence, Records, Reports This Section relates to document control and retention of records. The information at the start of Section 4 provides: • A list of all documents to be retained / filed within the CEMP. Table 4.1 provides a record of all Environmental Consents, Licenses and Permits issued for the project.	Yes The Contractor will complete Table 4.1. Throughout the duration of the Contract, the Contractor will insert / file all communication records, data, field records and reports associated with Environmental Management and implementation of this CEMP into this Section 4. This Section may be sub-divided into sub-folders for specific information relating to discrete areas of Environmental Management (such as waste management, pollution prevention, water quality monitoring, ecology etc). Alternatively, this information may be filed within the individual Technical Schedules in Section 5. The filing method selected by the Contractor will be made explicit at the start of Section 4.
5	Appendices	No.

TABLE 1.2: CONSTRUCTION ENVIRONMENTAL MANAGEMENT PLAN (CEMP): Document Structure		
Section	**Title & Brief Description**	**Contractor Development Required**
	Appendix A - Drawings	The Contractor is not required to develop the Appendices to this document. The Appendices are reference documents provided for information purposes.
6	Technical Schedules & Available Information Technical Schedules include the following: TS1 Environmental (Incident and Emergency) Response Plan (ERP) TS2 Surface Water Management Plan (SWMP) TS3 Water Quality Monitoring Plan (WQMP) TS4 Spoil Management Plan (SMP) TS5 Waste Management Plan (WMP)	Yes The Contractor is required to develop the Technical Schedules and/or include additional information or method statements as appropriate and where required by the Contract. The development of the Technical Schedules will generate more site specific documents which address particular environmental management procedures applicable for works in specified areas of the site. These Technical Schedules form the Contractor's Environmental Plans (for example, Waste Management Plan). Table 5.1 lists all Technical Schedules and provides information on Contractor responsibilities.

2 PROJECT INFORMATION

2.1 Site Location and Scheme Description

The Wind Farm and Grid Connection project is located within the townlands of Bracklin, Co. Westmeath and Coolronan, Co. Meath. The site is approximately 5.3 km north of Raharney village and approximately 4.7 km south of Delvin village, Co. Westmeath.

The proposed wind farm and electricity substation is located entirely within a single landholding; while ancillary elements of the overall development, including grid connection infrastructure and haul route upgrade works, are located on both private lands and within the public road network.

Current land use within the proposed wind farm site is predominately agricultural grassland, with small pockets of deciduous woodland and conifer tree plantations. The wind farm site is bordered by intact raised bog to the north, east and south, and with grassland to the west. Much of the grassland along the periphery of the proposed wind farm site is reclaimed cutover raised bog.

The proposed development comprises of 9 no. wind turbines (T1-T11, excluding T8 & T9) and all associated development works to accommodate their installation, operation, maintenance and the export of electrical power to the national grid. This will include a permanent meteorological mast 104m in height, site access tracks, foundations, hardstanding areas, underground cabling, single storey substation, accompanying equipment and compound area. Elevations for the turbine locations within the site range from 79m AOD at T6 and T7 to 93m AOD at T3. The Overall Site Layout Drawing No. BRK_PAS_LOC_002, Rev 0 is attached in Appendix A.

TABLE 2.1 Turbine Coordinates (Irish Transverse Mercator [ITM])

Turbine Base	Easting ITM	Northing ITM
T1	660970	759136
T2	660780	758679
T3	660893	758066
T4	661188	757707
T5	660780	757320
T6	661425	758849
T7	661617	758418
T10	662349	758514
T11	662153	758072

3 ENVIRONMENTAL CONTROLS

3.1 Use of CEMP

Prior to the commencement of construction works the contractor will draw up a detailed Construction Management Plan which will incorporate this outline CEMP. This outline CEMP is informed by mitigation measures set out in EIAR and associated documents and by the guidance documents and best practice measures listed below. This outline CEMP will be adhered to and further developed by the Contactor and will be overseen by the project representative/foreman.

The contractor will be required to supply a detailed Construction Management Plan for proposed activities on site which demonstrate how the environmental controls outlined in the following sections are to be achieved on site. This Construction Management Plan will be subject to review and will be agreed in advance of any works taking place on site. In some instance, with reference to works which may present a risk of sediment release, Inland Fisheries Ireland (IFI) will be consulted with respect to the development of the Construction Management Plan.

The following documents should contribute to the Construction Management Plan supplemented by specific additional measures proposed below:

- Forestry and Water Quality Guidelines-Forest Service (DMNR, 2000)
- Forestry and Freshwater Pearl Mussel Requirements- Site Assessment and Mitigation Measures (Forest Service, 2009);
- Forest Operations & Water Quality Guidelines (Coillte, 2009)
- Guidelines on Protection of Fisheries during Construction Work in and Adjacent to Water (IFI, 2016).

3.2 Human Beings and Community

3.2.1 Employment and Local Investment

During the 15-18 month construction phase of the proposed development, there would be economic effects resulting from expenditure on items such as site preparation, access roads, purchase and delivery of materials, plant, equipment and components.

Procurement of goods and services are likely to have a significant positive effect on the local economy.

3.2.2 Land Use

The proposed development site forms part of operational farm holdings and is owned by a number of private land owners.

The legal agreements include a suite of measures designed to minimise any likely land use effects including the clear identification of lands which may be subject to development, measures to ensure that disturbed lands are reinstated appropriately and returned to agricultural use insofar as possible, and provision for the use of proposed access tracks by landowners during the operational phase of the proposed development. Measures to facilitate the safe continuation of agricultural operations during the construction phase have been developed. This will include fencing and signage to be provided by the Contractor.

3.2.3 Tourism and Recreation Assets

The site shall be available for use as a recreational facility. Existing access tracks are, on occasion, used by local residents for walking/cycling and the upgrade of existing access tracks and construction of new tracks will improve the amenity value of the site. The Contractor shall manage public access during the construction period. This may involve fencing off areas of the site where mobile plant are active or where large components are being lifted or where other potential safety risks have been identified.

The Contractor will develop measures to ensure that local residents are informed of the construction work including the location and duration of temporary road closures and the identification of alternative routes during the construction works.

3.2.4 Accidents or Natural Disasters

As set out within **Chapter 6** and **Chapter 7** of the EIAR, the proposed development is not recognised to be a likely source of pollution during either the construction or operational phases, predominately due to the limited volume of hydrocarbons stored on site and the bunding arrangements to ensure that spillages do not occur. In the event of an accident on-site, mitigation measures set out in the above chapters will ensure that significant environmental effects do not occur.

There is limited likelihood for significant natural disasters to occur at the proposed development site. The potential natural disasters that may occur are therefore limited to flooding and fire. The risk of flooding is addressed in **Chapter 7** of the EIAR. Fluvial flooding of any significance is not anticipated for the wind farm site. However, there is potential for increased fluvial flood risk at the end mast locations on the grid connection. Within **Chapter 4** of the EIAR, it is considered that the risk of significant fire occurring, affecting the proposed development and causing it to have significant environmental effects is limited. One of the core mitigation by design features of the proposed development, maximising the distance to residential dwellings, further limits any likelihood of significant human health effects as a result of accidents or natural disasters.

The proposed development site is not regulated by, connected or proximate to any site regulated under the Control of Major Accident Hazards Involving Dangerous Substances Regulations (i.e. sites regulated in accordance with the SEVESO Directives) and so there is no likelihood for cumulative effects or interactions with any such site.

3.2.5 Community Benefit Funds and Community Investment

The operation of the proposed wind farm will bring about a number of financial benefits to the community. These include investment opportunities, community benefit funds, contributions to local resident energy costs, payment of business rates to Westmeath County Council and rental income accrued by involved landowners.

3.2.6 Noise

During the construction and operational phases of the proposed development, noise levels sufficient to cause noise induced hearing damage or sleep disturbance are not likely to occur. The full results of this assessment are presented in **Chapter 11** of the EIAR, Noise and Vibration. Controls on construction noise are outlined in Section 3.8 of this CEMP.

3.2.7 Lighting protection

Appropriate lightning protection measures are incorporated in modern wind turbines to ensure that lightning is conducted harmlessly past the sensitive parts of the nacelle and down into the earth.

Lightning protection is also incorporated into the design of the proposed electricity substation.

3.2.8 Ice Fall

In extremely cold climates or at high altitude, ice can potentially build up on blades or other parts of the turbines. Ice can potential fall off and cause injury although there is no experience of any such incident in Ireland. Most modern turbines are fitted with anti-vibration sensors, which will detect any imbalance caused by the icing of the blades. The sensors will cause the turbine to wait until the blades have been de-iced prior to beginning operation. All occupied/habitable properties in the vicinity of the proposed wind farm are located well in excess of 500m from a proposed turbine and therefore there is no likely impact in respect of ice throw.

The Contractor(s) shall manage employees and the public so as to avoid a defined zone around turbines during weather when ice could potentially form on blades.

3.2.9 Electromagnetic (EMF) Interference

The proposed grid connection electricity lines will comply with international guidelines for EMF. The cables will also comply with EU guidelines for human exposure to EMF. The proposed substation is located well away from any residence with no possible EMF impact. The substation when operational will also comply with EU guidelines relating to exposure to EMF.

3.2.10 Shadow Flicker

Shadow Flicker is assessed in detail in **Chapter 12** of the EIAR. There will be no significant residual shadow flicker impacts arising from the proposed development. Mitigation measures will ensure that any residual effects are within the acceptable limits.

3.3 Ecology

3.3.1 Approach

All mitigation measures have been developed in the context of national and international legislative guidance for the protection and management of flora, habitats of conservation importance, fauna and aquatic ecological interest. The description of mitigation measures is provided in terms of mitigation by avoidance, reduction and remediation.

An Operational Phase Environmental Management Plan will also be drawn up and implemented and will be agreed with the relevant statutory bodies. Monitoring of wildlife and efficacy of the mitigation measures will be undertaken during and post construction.

3.3.2 Statutory Protected Sites

Proposed mitigation measures, required to prevent adverse effects on downstream Natura 2000 sites during construction, are outlined in the Natura Impact Statement (NIS) for the proposed development. The mitigation measures included in the NIS relate to protection of water quality flowing into the River Boyne and River Blackwater SAC and SPA. Figure 3.1 (taken from Figure 5.2 of the EIAR) shows the location of Natura 2000 Sites within 15km of the proposed development.

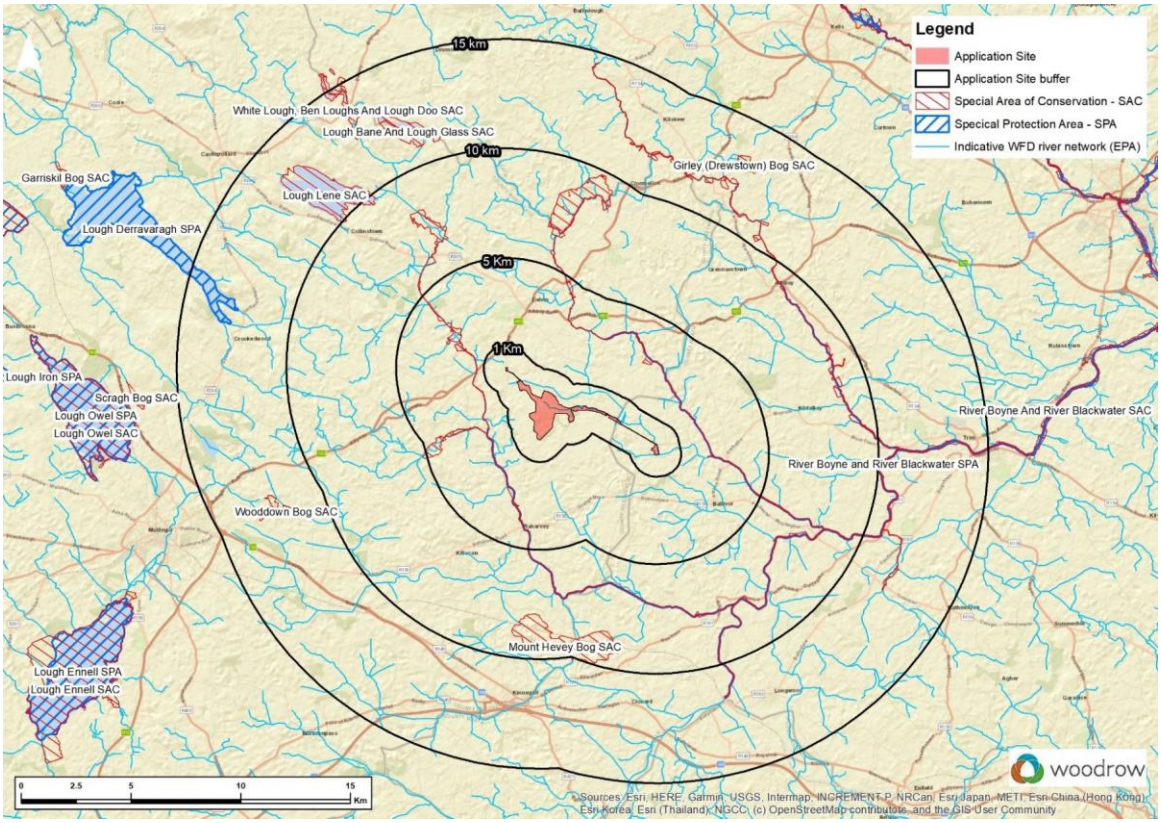


Figure 3.1 – Location of Natura 2000 Sites Within 15km of Proposed Development (Reproduced from Figure 5.2 of the EIAR)

The mitigation measures proposed are taken from **Chapter 7 of the EIAR** and are designed to avoid adverse effects on local watercourses and groundwater. If these measures are implemented in full, they will ensure avoidance of impacts on the Natura 2000 sites, and the Qualifying Interests (QIs), including river lamprey, Atlantic salmon, otter and kingfisher. Mitigation measures provided in the NIS include:-

- Avoidance of sensitive aquatic areas where possible by implementing a 50m construction buffer zone. Note: The majority of the proposed development (including all turbine locations) are located outside of areas that have been assessed to be hydrologically sensitive, apart from some sections of access track, the T7 hardstand, a section of the construction compound along, the north-western corner of the substation, sections of the grid connection route and locations of watercourse crossing.
- As described in **Chapter 3 of the EIAR**, specific mitigation measures, incorporated into the design of the development and through implementation of best practice methodologies will be employed where work inside buffer zones is proposed.
- Works for stream crossings will be carried out during the working window for instream works. This working window is defined by Inland Fisheries Ireland (IFI) as July to September to avoid vulnerable spawning salmonids/lamprey that may be present in downstream environments outside

of this window. Any works outside of this period would require a derogation under the Local Authorities (Works) Act, 1949;

- There will be no crossing of rivers or streams by machinery during the construction phase, other than by constructed access routes, and all machinery must remain within the works corridor and utilise designated access routes;
- There will be no direct dewatering to watercourses during the construction phase. All outflows from drainage associated with construction will be by diffuse overland drainage at appropriate locations and through settlement ponds;
- For locations where works will be undertaken within water protection buffer zones (i.e. within 50m of watercourses), double silt fences will be installed around the watercourse to prevent sediment/silt infiltration into the watercourse;
- Cement leachate, hydrocarbon oils and other toxic poisonous materials will require full containment and will not be permitted to discharge to any waters, and control measures to be place will include:-
    - Appropriate bunded storage area for storage of fuels/oils, with onsite storage of hydrocarbons to be kept to a minimum;
    - Mobile double skinned fuel bowser will be used for re-fuelling on-site;
    - No refuelling will be permitted at works locations within the 50m hydrological buffer;
    - Spill kits will be readily available to deal with any accidental spillage;
    - There is an outline emergency plan for the construction phase to deal with accidental spillages;
    - Ready-mixed concrete will be brought to site, with no batching of wet-cement products occurring on site;
    - Where possible pre-cast products will be installed, including all watercourse crossings;
    - Use of wet-cement products within the hydrological buffer will be avoided, insofar as possible;
    - Lined cement washout ponds will be used for chute cleaning, with minimal volumes of water being imported onto the site;
    - No discharge of cement contaminated waters to the construction phase drainage system or directly to any artificial drain or watercourse will be permitted; and
- Wastewater emanating on-site (sewage, waste-water from site office) will be taken off-site for disposal/treatment at controlled facilities. To this effect, welfare facilities for construction site workers will include self-contained port-a-loos with an integrated waste holding tank. No water will be sourced on the site, nor will any wastewater be discharged to the site.

Chapter 7 of the EIAR also provide details of the Sustainable Drainage Systems (SuDS) that will be implemented to manage surface water taking account of water quantity (flooding), water quality (pollution) and biodiversity (wildlife and plants). This SuDS will adopt the following elements:-

- Open constructed drains for development run-off collection and treatment;
- Infiltration interception drains for upslope 'clean' water collection and dispersion;
- Flow attenuation and filtration check dams to reduce velocities, with consideration given to gradient with drains to determine spacing requirements; and
- Settlements ponds and buffered outfalls to control and store development runoff to allow settlement prior to discharge at Greenfield runoff rates. No outflow will be permitted directly into natural watercourses.

The site drainage and attenuation system will be installed prior to the main construction activities, and includes excavation of drainage ditches and installation of settlement ponds and soakaways. The site-specific drainage scheme is required to attenuate, hydraulically (flow) and hydrochemically (pollutants), the projected increase in runoff of *c*. 20.4 m^3/day (worst-case scenario) that will arise from the creation of additional areas of hardstanding.

Chapter 7 of the EIAR also provides details of management of soil/peat deposition areas to avoid impacting on water quality including:-

- Both proposed spoil deposition areas are located outside the 50m stream buffer zone;
- Silt fences, straw bales and biodegradable matting will be used to control surface water runoff for deposition areas; and
- Deposition areas will be sealed with a digger bucket and vegetated as soon possible to reduce sediment entrainment in runoff

Other measures include:-

- In order to avoid run-off of silt-laden water impacting upon water quality within surface water features adjacent to the works corridor, reinstatement works including measures to re-vegetate disturbed areas through re-seeding and/or placement of saved turves will be undertaken immediately after construction works;
- During construction, turves will be stored separately from spoil (soil/rock). Separate storage of turves will ensure vegetation is not significantly damaged and that turves can be replaced as a top-mat to facilitate rapid re-instatement of the surface vegetation, thereby significantly reducing the likelihood of soil erosion and the likelihood of silt laden surface waters affecting water quality;
- To ensure control measures are implemented appropriately, an Ecological Clerk of Works (ECoW) and Environmental Manager will be employed for the duration of the construction works; and
- Monitoring of water quality during construction will be undertaken as outlined in Technical Schedule 3 – Water Quality Monitoring Plan.

3.3.3 Important Habitats

As described in Section 5.3.4 of the EIAR **S**emi-natural woodland habitats assessed as Local Importance (Higher Value) to Regional (County) Importance were identified during site surveys and the initial site layout was re-designed to avoid these areas. This iterative design process, described further at **Chapter 2 of the EIAR**, included the omission of 2 no. turbines and revising the configuration of ancillary infrastructure to avoid areas of bog and natural/semi-natural woodland. These design iterations also assessed the requirement for felling to implement bat feature buffers around several turbines, which have been designed to avoid impinging on natural/semi-natural woodland. There are 2 no. locations where the proposed bat feature buffers would extend into important woodland habitats, including Annex I bog woodland at T10 and oak-birch-holly woodland at T11. However, these areas of woodland will be retained and additional post-construction monitoring for bats will be undertaken at these locations to determine if the residual habitat feature draws bats towards the rotor swept area (see **Section 5.6.1.6 of the EIAR**).

Figure 3.2 (taken from Figure 5.1 of the EIAR) shows the location of wind farm infrastructure relative to Bracklin Wood and Lisclogher Bog.

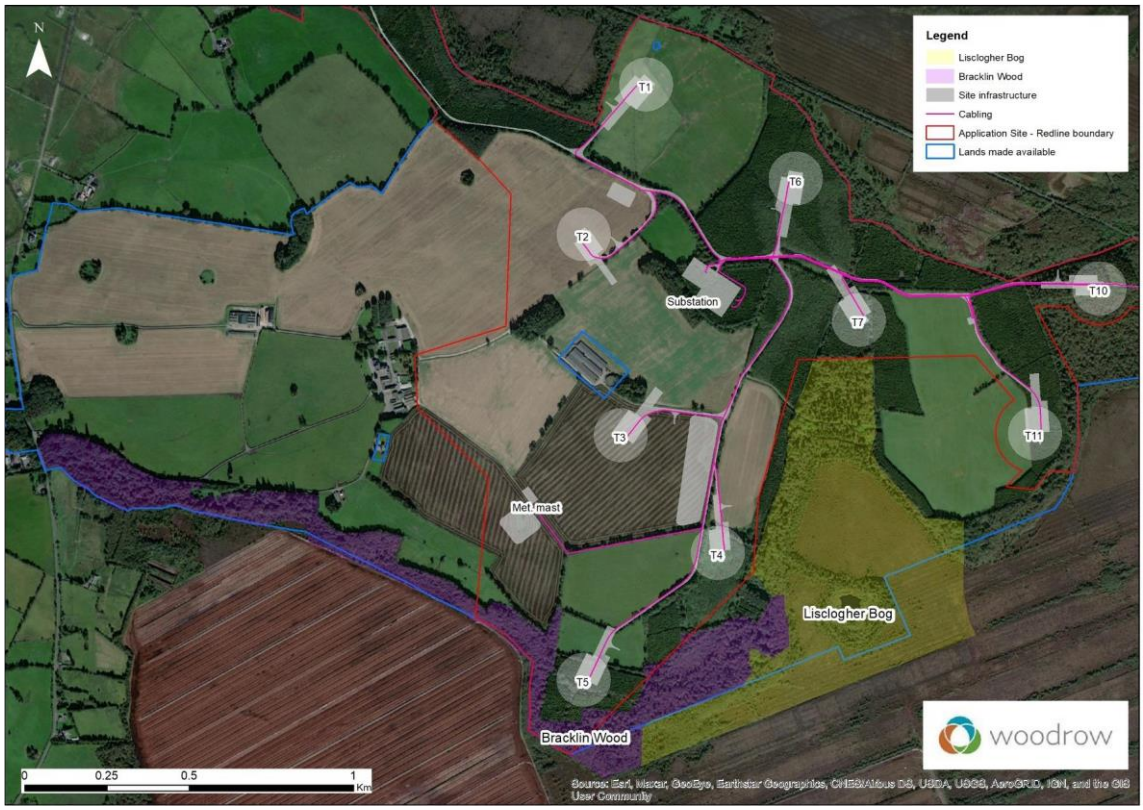


Figure 3.2 – Location of Wind Farm Infrastructure Relative to Bracklin Wood and Lisclogher Bog (Reproduced from Figure 5.1 of EIAR)

The proposed development was designed to utilise existing agricultural/forestry access tracks and the infrastructural footprint largely targets lower value habitats including tillage, improved grassland and commercial monocrop plantations. Likewise, areas where felling is required to implement bat feature buffers generally comprise commercial forestry and the lengths of treelines and hedgerows to be removed has been kept to a minimum. Similarly, the number of locations where access tracks are required to intersect hedgerows/treelines has been limited thus minimising the extent of hedgerow/treeline removal.

Habitat types are assessed in Section 5.3.4 of the EIAR. Table 3.1 below presents a summary of the habitat types within the proposed development site and which have potential EU Annex 1 Affiliations.

TABLE 3.1 – SUMMARY OF HABITAT TYPES (REPRODUCED FROM TABLE 5.17 OF THE EIAR)						
Code	**Fossitt (2000) habitat type**	**Potential EU Annex I Affiliations**	**Areas (ha) or Length (m)**			**Occurrence within construction corridor/operational footprint**
			Grid route	**Wind farm site**	**Total**	
BC1	Arable crops	No		82.98ha	82.98ha	T2 and T3 including access tracks, met mast, large deposition area, temporary site compound.
BL3	Buildings & artificial surfaces	No	0.25ha	4.08ha	4.33ha	Concrete and gravel roads through site (including the area of piggery). Houses and tracks along grid connection route (excluding the local metaled road along the grid route).
ED3	Recolonising bare ground	No	0.001ha		0.001ha	Adjacent to grid connection route
FW4	1st to 3rd order steams As shown by EPA mapping – indicative flow network classified as FW4 as most sections are highly channelised and therefore does not strictly fit criteria for FW2-Depositing/lowland river Drainage ditches	No	1,143m 471m	2,127m 10,232m	3,270m 10,703m	Main channel through the Site is the Bolandstown (1st/2nd order stream), which joins Carranstown (3rd order) stream where the grid connection route crosses into Co. Meath. Access tracks run adjacent to this channel, as do sections of grid connection route. There are 4 no. of cross points and the T7 hardstand extends across the channel. Site drained by extensive network of ditches all flowing into the main channel – access tracks and grid connection route cross or run next to drains, with felling areas around turbines and substation occurring areas with or next to drains.
FL8	Other artificial lakes & ponds	No		0.19ha	0.19ha	Ecologically poor, ephemeral scrape that will be used as a location for spoil deposition. Area of depression reported, with the maximum extent of the wet area much smaller at 0.06ha.
GA1	Improved grassland	No	25.658ha	45.236ha	70.89ha	T1, sections of access tracks to T5 and T11, grid connection route.
GA2/WS3	Amenity grassland & Ornamental-non-native shrubs	No	0.15ha		0.15ha	Gardens along grid connection route (not in proposed development site)
GS2	Dry meadow & grassy verges	No	0.87ha	0.78ha	1.65ha	Along roadside stretches grid of connection route and existing farm/forestry tracks

TABLE 3.1 – SUMMARY OF HABITAT TYPES (REPRODUCED FROM TABLE 5.17 OF THE EIAR)						
Code	**Fossitt (2000) habitat type**	**Potential EU Annex I Affiliations**	**Areas (ha) or Length (m)**			**Occurrence within construction corridor/operational footprint**
			Grid route	**Wind farm site**	**Total**	
PB4	Cutover bog	Possibly	0.48ha		0.48ha	Adjacent to grid of connection route
		[7150] Depression on peat substrate of the Rhynchosporion				
WD1	Mixed broadleaved woodland – older *growth/semi-natural*	No		4.72ha	4.72ha	Substation and ring fort at T3, also adjacent to access tracks in places and adjacent to grid connection route
WD1	Mixed broadleaved woodland - *plantation*	No		21.78ha	21.78ha	T4, turbine felling areas for T4, with small areas at T6, T7
WD4	Conifer plantation	No		57.68ha	57.68ha	T5, T6, T7, T11, access tracks to T1, T5, T6, T7, T10, T11, substation, turbine felling areas for T5, T6, T7, T10, T11
WN1	Oak-birch-holly woodland	Unlikely [91A0] Old sessile oak woods with Ilex & Blechnum in the British Isles	0.03ha	6.95ha	6.99ha	Felling area for T11 (unless avoided) and small area in felling area for T10, small sections on grid connection route
WN7	Bog woodland - *Non-Annex I*	No	1.32ha	3.89ha	5.21ha	Felling area at T10, start of grid connection route exiting wind farm site east of T10, with some areas adjacent along other sections of grid route.
WN7 – Annex 1	Bog woodland – *Annex 1*	Yes [91D0] *Bog woodland - small area south of T10		0.199ha	0.199ha	Small area within turbine felling area for T10, unless avoided
WS1	Scrub	No	0.05ha		0.05ha	Adjacent to grid of connection route (not in proposed development site)
WS5	Recently felled woodland	No		3.45ha	3.45	T10, within felling area for T10
WL2	Hedgerow	No	464m	601m	1,065m	Adjacent to T3 access track, grid connection route
WL2	Treeline	No	1,092m	6,810m	7,902m	Felling areas for T4, T5, T7, access tracks, adjacent to grid connection route.

Potential damage to sensitive habitats adjacent to proposed site infrastructure, has largely been avoided; as construction for the majority of the proposed site access tracks will involve upgrading existing forestry and farm tracks. Likewise, the majority of internal site cabling will be buried directly adjacent to or within the existing tracks. For sections of newly proposed access track, a 5m buffer from woodland and treelines has been implemented within which there will be no excavation work, tracking of heavy plant or storage of materials. Measures required to protect watercourses (e.g. erection of silt fence) will be permitted. If for unforeseen circumstances during the course of construction works any of these activities are required to occur within the buffer an appropriately qualified arboriculturist will undertake a pre-construction assessment to ensure impacts to vegetation are avoided. This 5m treeline/woodland buffer will be implemented along sections of access track running in improved grassland to T10/T11 and from T4 to T5.

To avoid widespread disturbance to habitats, access within the proposed development site will be restricted to the footprint of the proposed works corridor and no access between different parts of the proposed development will be permitted, except via the proposed works corridor. An ECoW will be employed throughout the construction phase to ensure that construction activities do not encroach, unnecessarily, into any important habitats.

3.3.4 Non-native and Invasive Species

The presence and distribution of non-native species within the proposed development site were identified and mapped during walkover surveys (see **Section 5.3.4.1 of the EIAR**). No Third Schedule invasive species were identified; however, best practice guidelines will be employed during construction to ensure that non-native species are not spread and, where feasible, are controlled. In particular, it is proposed to implement measures to control the presence of cherry laurel between turbines T10 and T11. Details of proposed measures to control cherry laurel are provided within the Habitat Management Plan at **Annex 5.6 to the EIAR**.

To avoid non-native species being introduced to the site, quarry material will be sourced from licensed quarries, and certification that materials do not contain invasive species will be required. A pre-construction walkover survey of the works corridor will confirm the presence of any invasive non-native species that may have escaped into the area since the baseline surveys were conducted.

3.3.5 Birds

From vantage point surveys, it was observed that the site had low densities of use by waterbird species.

Usage of the wind farm site by raptor species of higher conservation concern, including hen harrier, goshawk, merlin and peregrine was found to be very low, with no breeding or roosting sites located within the 2 km turbine buffer. A barn owl breeding site was located within 1.4km of the closest proposed turbine, with another possible site c. 3.5km to the north.

Apart from snipe, woodcock and a failed lapwing breeding attempt, no other notably sensitive breeding species, were recorded within or directly adjacent to the proposed works corridor. All snipe breeding activity was found to be beyond the zone of influence for construction activity and operational displacement effects.

A detailed list of species observed over a two-year period is presented in **Table 5.2.2 of the EIAR**.

As part of the iterative design process (embedded mitigation), areas of old growth woodland have been avoided and will be retained. These areas were identified as important for woodland birds, especially breeding woodcock as well as a range of Amber listed breeding passerines.

To avoid widespread disturbance to birds, access within the proposed development site will be restricted to the footprint of the proposed works corridor and no access between different parts of the site will be permitted except via the proposed works corridor. Measures proposed at **Section 5.5.1.1 of the EIAR** to protect water quality will avoid adverse effects on birds that rely on downstream aquatic habitats, such as grey wagtail and kingfisher.

To avoid direct and indirect disturbance to breeding birds, the following restrictions on timings of construction works will, where feasible, be applied:-

- Construction will be timed to commence outside the bird breeding season (March to August inclusive). This does not preclude construction continuing during the breeding season, but would allow sensitive bird species to choose nesting sites away from sources of potential disturbance;
- Where removal of suitable nesting habitat is required to facilitate the works, habitat clearance works will be undertaken prior to the 1st March in the construction year;
- Vegetation removal required for creation of bat feature buffers around turbines will be undertaken outside the bird breeding season;

- Once vegetation has been removed within the works corridor, these areas will be retained in a condition that limits suitability for nesting birds for the remainder of the construction phase. Any areas of potential cover, particularly cover for ground nesting species, will be rendered unsuitable by cutting vegetation or tracking over with an excavator;
- Should the clearance of vegetation suitable for nesting birds be required during the bird breeding season, the relevant vegetation will be surveyed in advance by the ECoW (with ornithological survey experience);
- Any construction works proposed during the breeding bird season will be preceded by a survey and will ensure the implementation of buffer zones (if nests/territories are identified) and measures required in order to avoid disturbance. Particular attention will be given to sensitive bird species (including breeding raptors and waders); and
- If works are scheduled to commence in February, a pre-construction visit will be required to monitor potential lapwing breeding sites in the tillage fields surrounding T2 and T3, as this species can be present on territories early in the season (late-February/early March).

3.3.6 Mammals (excluding bats)

The likelihood of effects on aquatic mammals, specifically otter foraging habitats, will be avoided through water quality protection measures as described at **Section 5.5.1.1 of the EIAR**.

The proposed development has been designed to minimise the impact on features which are important for mammals such as hedgerows and drains. Old growth woodland and treelines have been avoided insofar as possible. While commercial forestry will be removed, care has been taken to ensure that overall connectivity between existing woodland and linear features is retained throughout the construction and operational phases of the proposed development.

During the design phase of the proposed development, a badger main sett was located within the footprint of the proposed substation. The dimensions of the substation compound were altered to avoid directly affecting the sett and a set-back distance of 30m was imposed. Likewise, an outlier sett in an earth bank southwest of the T2 hardstand (see **Figure A5.8.1 at Annex 5.8 to the EIAR**) was avoided by re-aligning the access track to ensure a standoff of in excess of 30m was retained. There was also badger activity recorded at the southern end of the field, adjacent to the southern-most part of the spoil deposition area. An appropriate 30m standoff will be maintained from the spoil storage and the felling area for T4. Proposed excavation for cabling running along this tree line to the meteorological mast will be buffered by 30m from sett entrances.

It is acknowledged that the distribution of mammal resting places can change over time. Therefore, in order to avoid accidental disturbance during the construction phase, a pre-construction walkover survey of the proposed development site will be undertaken. If any mammal resting places are identified, then appropriate exclusion zone(s) will be implemented and construction activities will be timed to avoid sensitive periods for the species affected, i.e. the breeding season.

Likewise, inappropriately timed vegetation removal, required to implement bat feature buffers has the potential to directly affect the resting sites of borrowing and arboreal mammals. Although during baseline surveys, no mammal resting places were identified within the footprint of the proposed development or proposed felling areas, a pre-construction walkover survey will be undertaken prior to commencement of construction.

Pre-construction/felling surveys will cover all suitable habitat for protected mammals including within 50m of the works corridor for badgers and red squirrel, 100m for pine martin and 150m for otter. The aim of the surveys is to identify the resting sites of protect mammals and implement appropriate exclusion zone buffers, if required.

The following mitigation measures will be applied to avoid disturbance to badgers:-

During the breeding season (December to June inclusive), no construction works should be undertaken within 50m of active setts, nor blasting or pile driving within 150m of active setts.

Out of the breeding season (July to November, inclusive), the following restrictions will apply:

- No heavy machinery should be used within 30m of badger setts (unless carried out under licence);
- Lighter machinery (generally wheeled vehicles) should not be used within 20m of a sett entrance; and
- Light work, such as digging by hand or scrub clearance should not take place within 10m of sett entrances.

Disturbance to foraging mammals will be avoided by:-

- Construction works being largely limited to daylight hours thus allowing nocturnal animals like badgers and otters to forage through the night; and

- Minimising the risk of mammals becoming trapped if falling into excavations through the provision of egress points, e.g. placing escape planks or spoil runs.

3.3.7 Bats

The removal of vegetation is likely to impact on habitats utilised by roosting, foraging and commuting bats. **Annex 5.5 to the EIAR** provides a detailed discussion on, and assessment of, the likely effects on bats and proposed mitigation measures to avoid likely significant effects.

During the construction phase of the proposed development, mitigation largely focuses on avoidance of direct effects to roosting bats, with further consideration given to likely indirect effects on foraging/commuting habitats.

The iterative design process has, insofar as possible, avoided the removal of older growth treelines and woodland habitats likely to be utilised by roosting bats, as described at **Chapter 2 of the EIAR**.

While several trees/treelines were noted as supporting Potential Roost Features (PRFs) within the works corridor, no active roosts were identified during surveys. However, given that a period of time is likely to elapse prior to the commencement of construction, it is acknowledged that roosting bats could occupy PRFs, such as ivy clad trees with occasional holes/fissures. Therefore, pre-construction roost surveys will be undertaken to identify and protect any bats occupying roosts in vegetation earmarked for removal.

Any trees identified as supporting moderate to high PRFs within the works corridor will be targeted with further surveys, including emergence/re-entry surveys and/or roost inspections (using endoscopes and thermal imaging cameras). Surveys will determine occupancy, the type of roost (e.g. maternity, hibernation, mating, transitional), species using the roost and the level of occupancy. Surveys will be conducted by appropriately experienced ecologists.

For any occupied roost sites, where vegetation removal is proposed, these surveys will inform a derogation license application process (from the NPWS) to undertake appropriate mitigation actions, as required, to ensure the conservation of bats. Such actions could include measures to exclude bats from potential roost holes prior to vegetation removal and provision of alternative roost sites.

Trees requiring felling, and identified as having moderate-to-high PRF, where surveying proves inconclusive will be 'soft felled', as outlined in the NRA (2005) guidelines[1]. This procedure must be carried out in suitable weather conditions, at an appropriate time of year, and involves:-

- Removing the tree in sections, starting with the top branches and then working down the trunk trying to avoid cutting through cavities;
- Any sections with PRFs must be lowered with care and laid on the ground with potential entrances to roosts orientated upwards to allow bat to vacate the roost; and
- Sections must be left in situ for at least 24 hours in suitable weather conditions to allow any bats to disperse.

For any occupied roost sites where vegetation removal is not proposed, an exclusion zone will be implemented to prevent disturbance during times of occupancy as may be determined from **Table 5.28 of the EIAR**. The extent of the exclusion zone can be up to 30m for any notably disruptive works such as piling/rock breaking; however, this measure should be proportional to the disturbance levels emanating from the construction activity.

3.3.8 Marsh Fritillary

In Ireland the occurrence of this species is largely restricted to locations where the larval foodplant devil's-bit scabious (Succisa pratensis) occurs. The extent of devil's-bit scabious within the lands-made-available for the project was limited to a few very small patches and it was totally non- existent from areas occupied by the proposed development footprint based on lack of suitable habitat within the potential Zone of Influence, required and the proposed development site was assessed as unsuitable for this species.

3.3.9 Fisheries

The main drainage channel (modified stream) flowing through the proposed development site was found to be unsuitable for spawning salmon and lamprey. The proposed development site is at the

[1] NRA (2005). Guidelines for the Treatment of Bats prior to the Construction of National Road Schemes. Environmental Series on Construction Impacts, Transport Infrastructure Ireland - TII (formerly NRA), Dublin. Available at: https://www.tii.ie/tii-library/environment/construction-guidelines/Guidelines-for-the-Treatment-of-Bats-during-the-Construction-of-National-Road-Schemes.pdf

upper reaches of a tributary of the Stonyford River that is subject to periodic drainage maintenance works. Drainage has a negative effect on the occurrence of white-clawed crayfish; and therefore, it is considered unlikely that species occurs in this watercourse.

Salmon and lamprey spawning habitat and white-clawed crayfish are noted as occurring downstream of the proposed development. White-clawed crayfish have been recorded from the catchment of the Stonyford River. Salmon and river lamprey are listed as Qualifying Interests (QIs) of the River Boyne and River Blackwater SAC. The healthiest population of river lamprey are reported as occurring in the lower reaches of the Boyne River main channel downstream of Navan and the Stonyford tributary was considered to only support brook lamprey. Salmon run the River Boyne almost every month of the year and the Boyne is considered important for this species. In-stream improvement works on the Stonyford River have created spawning habitat for salmon.

Other native fish species recorded from the Stonyford River include brown trout and eels, and non-native species including stoneloach and minnow.

The mitigation measures required for protection of fisheries are there as included in **Section 3.3.2 of this CEMP** for the protection of the River Boyne and River Blackwater SAC and SPA.

3.3.10 Monitoring Measures

3.3.10.1 Pre-Construction Ecological Monitoring

In order to avoid accidental disturbance to the resting places of protected mammals including badgers, otters, red squirrels and pine martens; construction activities will be preceded by an ecological walkover survey of the proposed works corridor, including the grid connection route and bat feature buffers..

Likewise, as outlined in Section **5.5.1.6 of the EIAR**, in order to limit accidental disturbance to bat roosts during construction; prior to works commencing trees within the works corridor previously assessed as supporting moderate to high PRFs will be re-assessed. Initially this will involve a ground level visual assessment, which will be followed up by inspections under licence and re-entry/emergence surveys, as required.

As detailed in Section **5.5.1.4 of the EIAR**, construction works conducted during the bird breeding season will require pre-construction nesting bird surveys to avoid disturbance breeding birds. If nests are identified ongoing monitoring will be implemented to ensure protection measures (exclusion zone

buffers) are implemented and to determine when works can processed, once the breeding attempted is completed.

3.3.10.2 Water Quality Monitoring

In order to verify the efficacy of pollution prevention and mitigation measures during construction, water quality monitoring will be undertaken in accordance with the proposals enclosed in **Technical Schedule 3 – Water Quality Monitoring Plan**.

3.3.10.3 Monitoring of Annex I Bog Woodland

Given the presence of Annex 1 habitats within the vicinity of the proposed development, it is deemed to be prudent to undertake monitoring to ensure that construction activities do not adversely impact on the quantity or quality of this habitat.

Prior to construction, eight permanent quadrats (10x10m squares) will be set up within the area of Annex I bog woodland between T10 and T11 for long-term vegetation monitoring.

During the construction phase, surveys will be repeated to ensure that the habitat is not impacted by construction works, especially by any drainage in the vicinity of T10 and the access track leading to T11.

Post-construction surveys will be undertaken in Years 1, 2, 3, 5 and 10.

Surveys will be undertaken by a suitably qualified botanist and at the optimal time of year for surveying bog woodland.

3.3.10.4 Monitoring of Bat Feature Buffers

The aim for bat feature buffers around turbines is to ensure that habitats are as featureless as possible to discourage foraging bats, as well as potential prey species for kestrels. Initially this will require regular monitoring in Years 1, 2 & 3 to ensure vegetation clearance measures and ongoing management result in the desired habitat conditions. Once the optimal conditions have been created (after Year 3) the habitat will continue to be maintained in this manner.

3.3.10.5 Bird Monitoring

Ornithological monitoring surveys will commence at the commencement of construction and will continue, post-construction, in Years 1, 2, 3, 4, 5, 10 &15.

Surveys will be conducted, in accordance with SNH guidance2, by a suitably experienced ornithologist and will include the following:-

- Vantage point surveys;
- Wider area breeding raptors surveys;
- Breeding season surveys of 500m turbine buffer; and
- Fatality monitoring (to be conducted conjunction with bat fatality monitoring.

3.3.10.6 Bat Monitoring

A three-year post-construction monitoring programme is proposed for bats (SNH et al. 2019), with monitoring in Years 1, 2 & 3. Monitoring is designed to evaluate the success bat feature buffers at reducing bat activity levels in the vicinity of turbines.

Bat activity surveys will be undertaken in Years 1, 2 & 3.

Fatality monitoring will be undertaken in Years 1, 2 & 3.

3.4 Soils and Geology

3.4.1 Description

Based on the GSI bedrock mapping (www.gsi.ie), the majority of the proposed development is mapped to be underlain by Dinantian Pure Unbedded Limestones; while the far eastern portion of the proposed wind farm site and section of the proposed grid connection are mapped to be underlain by Dinantian Upper Impure Limestones.

The southwestern corner of the WF site is mapped to be underlain by Dinantian Lower Impure Limestones.

Based on the GSI/Teagasc soils mapping (www.gsi.ie); the central, southern and western areas of the proposed wind farm site are mainly underlain by deep, well- drained mineral soils (BminDW) with cutover bog mapped on the northern and eastern portion of the site. The proposed electricity substation is mapped as being underlain by cutover peat.

[2] Scottish Natural Heritage (2017). Recommended bird survey methods to inform impact assessment of onshore wind farms.

The soil type mapped along the proposed grid connection route is mainly cut peat with some peaty gleys towards the eastern side at the end mast location.

GSI subsoils mapping (www.gsi.ie) show that limestone tills are present in the central, southern and western areas of the proposed wind farm site and cutover bog mapped on the northern and eastern portion of the proposed wind farm site, including the location of the proposed electricity substation. Cutover bog is also mapped along the majority of the proposed grid connection route as well as the end mast locations. The subsoils at the haul route works areas are mapped as limestone tills.

Peat depths recorded (refer to **Annex 6.2** to the EIAR) from over 50 probes ranged from 0-2.5m with an average peat depth of 0.6m. 86% of the probes recorded peat depths of less than 1.0m with 95% of peat depth probes recorded peat depths of less than 2.0m. A number of localised readings recorded peat depths from 2.0 to 2.5m.

Probing undertaken along the access roads in agricultural areas demonstrate that peaty topsoil is typically present with some shallow pockets of peat between approximately 0.3 and 0.5m in depth. The peat is typically dry and very firm.

Trial pit and peat probe locations are illustrated on **Table 3.2** below.

TABLE 3.2 TRIAL PIT AND PEAT LOCATIONS		
Location	**Average Peat Depth (m)**	**Summary of Subsoil Lithology**
T1	0	Slightly sandy SILT over sandy, gravelly SILT
T2	0	Slightly sandy SILT over SILT/CLAY
T3	0	SILT/CLAY with cobbles
T4	0.25	Slightly gravelly SILT/CLAY over sandy, gravelly SILT/CLAY
T5	0.7	Gravelly, sandy SILT
T6	0.7	Sandy, gravelly SILT
T7	0.75	Sandy, gravelly SILT
T10	1.8	Lacustrine CLAY over sandy GRAVEL (fine)
T11	0	SILT/CLAY with cobbles and boulders
Meteorological Mast	0	SILT/CLAY with cobbles and boulders
Temporary Compound	0	Slightly sandy SILT over SILT/CLAY
Site Control Building	0	Slightly gravelly SILT/CLAY
Substation	1	Sandy gravelly SILT

A peat stability risk assessment was carried out for the main infrastructural elements at the proposed development site (refer to **Annex 6.2** to the EIAR). The findings of the peat stability risk assessment showed that the proposed development site has an acceptable margin of safety, is suitable for the proposed development and is considered to be at low risk of peat failure.

There are no known areas of soil contamination within the proposed development site or in its immediate environs. During the site walkovers and site investigations, no areas of contamination concern were identified.

3.4.2 Construction Phase Mitigation Measures

3.4.2.1 Peat, soil, subsoil and bedrock excavation

The excavation of peat, soil and subsoil will have a direct effect on the geological environment and no specific mitigation measures are proposed. The excavation of materials will be completed in accordance with best practice for the management and treatment of such materials.

3.4.2.2 Erosion of Exposed Peat, Soil and Subsoil at Excavation and Storage Areas

The following avoidance and design measures are proposed to reduce erosion effects at excavation and spoil storage areas:-

- Bog mats will be used, as necessary, to support construction plant and machinery on soft ground, thus reducing the likelihood of peat, soil and subsoil erosion and avoiding the formation of rutted areas. This will substantially reduce the likelihood for surface water ponding to occur;

- Excavated soil will be side cast and stored temporarily adjacent to excavation areas for use during reinstatement and landscaping. Where material is not required for reinstatement or landscaping, it shall be immediately transported to the spoil deposition areas;

- Silt fences, and all necessary surface water management measures (including upslope interceptor drains), will be installed around all temporary stockpiles to limit movement of entrained sediment in surface water runoff. All slopes will be sealed with the bucket of an excavator;

- In order to minimise runoff during the construction phase, works will not take place during periods of intense or prolonged rainfall (to prevent increased silt laden runoff). Drainage systems, as outlined in **Chapter 7** of the EIAR, will be implemented to limit runoff effects during the construction phase;

- At the designated spoil deposition areas, material will be placed in layers to ensure stability is maintained and works will be undertaken in accordance with best practice construction methodologies. Works at the spoil deposition areas will be monitored, on a weekly basis during the construction phase and monthly for a six-month period thereafter, by an appropriately qualified Geotechnical Engineer. In the event that any ground stability issues arise, the Engineer will have the power to cease works until such time as remedial works have been completed to his/her satisfaction;

- Permanently mounded soils and subsoils; for example, berms surrounding turbines and hardstands, berms located along access tracks and at the spoil deposition areas; will be seeded and grassed over at the earliest opportunity to prevent erosion;

- The electricity line (grid connection) trench will be reinstated to the required specification and in accordance with landowner requirements and will be reseeded or allowed to vegetate naturally

(on agricultural land) or topped with tarmacadam (or similar along public roads) at the earliest opportunity to prevent erosion; and

- Following the installation of the proposed end masts, excavated material will be reinstated, graded to match the surrounding ground profile and reseeded or allowed to vegetate naturally.

3.4.2.3 Contamination of Peat, Soils and Subsoils by leakages, spillages of hydrocarbons or other chemicals

The following measures are proposed to specifically prevent contamination of peat, soils and subsoils:-

- The volume of fuels or oils stored on site will be minimised. All fuel and oil will be stored in an appropriately bunded area within the temporary construction compound. Only an appropriate volume of fuel will be stored at any given time. The bunded area will be roofed to avoid the ingress of rainfall and will be fitted with a storm drainage system and an appropriate oil interceptor;

- All bunded areas will have 110% capacity of the volume to be stored;

- On site re-fuelling of machinery will be carried out using a mobile double skinned fuel bowser. The fuel bowser, a double-axel custom-built refuelling trailer will be re-filled at the temporary compound and will be towed around the site by a 4x4 jeep to where plant and machinery is located. The 4x4 jeep will also be fully stocked with fuel absorbent material and pads in the event of any accidental spillages. The fuel bowser will be parked on a level area in the construction compound when not in use and only designated trained and competent operatives will be authorised to refuel plant on site. Mobile measures such as drip trays and fuel absorbent mats will be used during all refuelling operations to avoid any accidental leakages;

- All plant and machinery used during construction will be regularly inspected for leaks and fitness for purpose;

- Spill kits will be available to deal with any minor accidental spillages within the temporary construction compound and during re-fuelling;

- All waste tar material arising from road cuttings (from trenching in public roads and haul route upgrade works) will be removed off-site and disposed of at a licensed waste facility. Due to the potential for contamination of soils and subsoils, it is not proposed to utilise this material for any reinstatement works; and

- An emergency plan for the construction phase to deal with accidental spillages is contained in **Technical Schedule 1 – Environmental Incident and Emergency Response Plan**. This emergency plan will be further developed by the contractor prior to the commencement of construction.

3.4.3 Monitoring Measures

There is no proposed monitoring programme for land and soils. However, during and post-construction, all excavated or raised areas (i.e. cut and fill) and reinstated/landscaped ground, including the spoil deposition areas, will be inspected for signs of erosion and instability. These inspections will be undertaken on a weekly basis during the construction phase and monthly, for a six-month period, post construction.

3.5 Water

3.5.1 Description

On a regional scale, the proposed development is located in the Boyne River surface water catchment within the Eastern River Basin District (ERBD) in Hydrometric Area 07.

On a more local scale, the majority of the wind farm site (including all of the proposed 9 no. turbine locations) and the grid connection (including end masts) is located in the Stonyford River (Boyne_SC050) surface water catchment.

The Stonyford River flows into the Boyne River approximately 17km downstream of the proposed site.

A small area on the far west of the proposed site is located in the River Deel surface water catchment (Deel[Raharney]_SC_010). The River Deel flows into the Boyne River approximately 18km downstream of the proposed site. There is no proposed infrastructure located in the River Deel surface water catchment.

In addition to numerous land drains, the majority of the wind farm and 110kV substation site is drained by 3 no. main streams which are headwater streams of the Stonyford River and River Deel.

Along the grid connection, there will be a requirement for 4 no. watercourse crossings. Of these 4 no. mapped crossings, 3 no. will be required within the wind farm site itself and the other 1 no. is an existing crossing along the public road.

3.5.2 Flood Risk

There are no areas on the historical 6" or 25" mapping in the area of the wind farm site or grid connection route that are identified as an area that is "Liable to Floods". No recurring flood incidents were identified near the proposed wind farm site from OPW's Flood Hazard Mapping. The closest mapped flood event is along the Stonyford River near Delvin village, ~3km to the north of the site.

Each of the watercourses that emerge in the area of the proposed wind farm site are small headwater streams and therefore fluvial flood of any significance is not anticipated.

No elements of the proposed wind farm infrastructure are located in a mapped PFRA flood zone.

The proposed 110kv substation is located centrally within the wind farms site and it is also located outside of a mapped PFRA flood zone.

The end masts at the Mullingar-Corduff 110kV overhead electrical transmission line are located in a PFRA mapped 100-year fluvial flood zone. Due to the overhead nature of the end mast and the small footprint area of the foundations, there will be no potential for increased fluvial risk at the end mast locations.

3.5.3 Surface Water Quality

Most recent data shows that the Stonyford River has a Moderate (Q3-4) to Good (Q4) Q-rating both upstream and downstream of the wind farm site and grid connection. The Deel River is reported to have a High Status (Q5) upstream of the WF site and reduces to Moderate (Q3-4) to Good (Q4) downstream of the WF site.

Surface Water Quality Monitoring was carried out at three locations (within and downstream of the wind farm site). Results were either "Good Status" or "High Status".

3.5.4 Hydrogeology

The limestones which underlie the proposed development are classified by the GSI (www.gsi.ie) as a Locally Important Aquifer (Bedrock which is Moderately Productive only in Local Zones) and a Poor Aquifer.

In terms of local Groundwater Bodies (GWBs), the proposed development is located in the Athboy GWB (IE_EA_G_001).

The bedrock aquifer at the proposed development site have a Low Importance.

Based on the trial pit investigation, the groundwater table in the areas of limestone tills are more than 2.5 – 3m below ground level. However, in areas of cutover bog, the underlying silts/clays were generally found to be saturated. Groundwater levels in areas of cutover bog will be between 1 and 1.5m below ground level.

The vulnerability rating of the aquifer beneath the proposed wind farm and substation site is mapped as "Low" to "High". The low vulnerability reflects the peat covered areas and the high vulnerability areas are typically mineral subsoils. The moderate vulnerability areas are in the transition zone between the peat and the mineral subsoils.

There are no mapped groundwater source protection areas for either public water supplies or group water schemes in the area of the proposed development (National Federation Group Water Schemes only).

No private dwelling houses were identified to be located immediately down-gradient (i.e. downslope; nearest dwelling located in excess of 700m from the location of a proposed wind turbine) of the proposed development (and in particular turbine locations) and, therefore, there is no likelihood to significant effects on groundwater supplies.

3.5.5 Changes in Site Runoff Volumes

As calculated in Section **7.3.14 of the EIAR**, the emplacement of the proposed development footprint could result in an average increase in surface water runoff of 20.4m3/d.

3.5.6 Mitigation

3.5.6.1 Approach

The overarching objective of the proposed mitigation measures is to ensure that all surface water runoff is comprehensively treated and attenuated such that no silt or sediment laden waters or deleterious material is discharged into the local drainage system. A preliminary/outline Surface Water Management Plan (SWMP), incorporating the surface water drainage design has been prepared, see Technical Schedule – Surface Water Management Plan, and incorporates the principles of Sustainable Drainage Systems (SuDS) through an arrangement of surface water drainage infrastructure. The SWMP has had regard to greenfield runoff rates and has been designed to mimic same and is sufficient to accommodate a 1-in-100 year rainfall event.

While the SuDS, overall, is an amalgamation of a suite of drainage infrastructure; the overall philosophy is straightforward. In summary:-

- All surface water runoff will be directed to specially constructed swales surrounding all areas of ground proposed to be disturbed (including the area for the temporary storage of material);
- The swales will direct runoff into settlement ponds/silt traps where silt/sediment will be allowed to settle; and
- Following the settlement of silt/sediment, clean water will be discharged indirectly to the local drainage network via buffered outfalls thus ensuring that no scouring occurs.

The suite of surface water drainage infrastructure will include interception drains, collector drains swales, sedimats, flow attenuation and filtration check dams, settlement ponds/silt traps, and buffered outfalls.

The design criteria implemented as part of the SuDS are as follows:-

- To minimise alterations to the ambient site hydrology and hydrogeology;
- To provide settlement and treatment controls as close to the site footprint as possible and to replicate, where possible, the existing hydrological environment of the site;
- To minimise sediment loads resulting from the development run-off during the construction phase;
- To preserve greenfield runoff rates and volumes;

- To strictly control all surface water runoff such that no silt or other pollutants shall enter watercourses and that no artificially elevated levels of downstream siltation or no plumes of silt arise when substratum is disturbed;

- To provide settlement ponds to encourage sedimentation and storm water runoff settlement;

- To reduce stormwater runoff velocities throughout the site to prevent scouring and encourage settlement of sediment locally;

- To manage erosion and allow for the effective revegetation of bare surfaces; and

- To manage and control water within the site and allow for the discharge of runoff from the site below the MAC of the relevant surface water regulation value.

It should be noted that the measures set out below refer to the overall mitigation framework within which the SWMP has been prepared; while further measures are also proposed.

3.5.6.2 Earthworks (Removal of Vegetation Cover, Excavations and Stock Piling) Resulting in Suspended Solids Entrainment in Surface Water

3.5.6.2.1 Mitigation by Avoidance

The key mitigation measure during the construction phase is the avoidance of sensitive aquatic areas where possible by using a 50m buffer. From the constraints map (**Annex 7.2 to EIAR**), it can be seen that apart from some sections of access track, the T7 hardstand, a section of the construction compound along, the north-western corner of the substation along with the watercourse crossing locations, the majority of the proposed development areas (including all turbine locations) are located outside of areas that have been assessed to be hydrologically sensitive.

As described in **Chapter 3 of the EIAR**, specific mitigation measures, incorporated into the design of the development and through implementation of best practice methodologies (discussed below) will be employed where work inside buffer zones is proposed.

The generally large setback distance from sensitive hydrological features means that sufficient space is provided for the installation of proposed drainage mitigation measures (discussed below) and to ensure their effective operation. The proposed buffer zone will ensure:-

- Avoidance of physical damage to watercourses, and associated release of sediment;
- Avoidance of excavations within close proximity to surface water courses;
- Avoidance of the entry of suspended sediment from earthworks into watercourses; and,
- Avoidance of the entry of suspended sediment from the construction phase drainage system into watercourses, achieved in part by ending drain discharge outside the buffer zone and allowing percolation across the vegetation of the buffer zone.

3.5.6.2.2 Mitigation by Prevention

The following section details the measures which will be put in place during the construction phase to ensure that surface water features are protected from the release of silt or sediment and to ensure that all surface water runoff is fully attenuated to avoid the discharge of dirty water.

- Source controls to limit the likelihood for 'dirty water' to occur:-
    - Interceptor drains, vee-drains, diversion drains, flume pipes, erosion and velocity control measures such as use of sand bags, oyster bags filled with clean washed gravel, filter fabrics, and other similar/equivalent or appropriate systems;
    - Small working areas, covering stockpiles, weathering off stockpiles, cessation of works in certain areas or other similar/equivalent or appropriate measures.
- In-Line controls to ensure appropriate management of silt laden water:-
    - Interceptor drains, vee-drains, oversized swales, erosion and velocity control measures such as check dams, sand bags, oyster bags, straw bales, flow limiters, weirs, baffles, silt bags, silt fences, sedimats, filter fabrics, and collection sumps, temporary sumps/attenuation lagoons, sediment traps, pumping systems, settlement ponds, temporary pumping chambers, or other similar/equivalent or appropriate systems.
- Treatment systems to fully attenuate silt laden waters prior to discharge:-

- Temporary sumps and attenuation ponds, temporary storage lagoons, sediment traps, and settlement ponds, and proprietary settlement systems such as Siltbuster, and/or other similar/equivalent or appropriate systems.

It should be noted for this site that an extensive network of land drains already exists, and these will be integrated and enhanced as required and used within the wind farm development drainage system. The integration of the existing land drainage network and the proposed wind farm network is common practice in wind energy developments and will also result in benefits to surrounding agricultural lands.

The main elements of interaction with existing drains will be as follows:-

- Apart from interceptor drains, which will convey clean runoff water to the downstream drainage system, there will be no direct discharge (without treatment for sediment reduction, and attenuation for flow management) of runoff from the proposed wind farm drainage into the existing site drainage network. This will reduce the likelihood for any increased risk of downstream flooding or sediment transport/erosion;

- Silt traps will be placed in the existing drains upstream of any streams where construction works is taking place, and these will be diverted into proposed interceptor drains, or culverted under/across the works area;

- During the operational phase of the wind farm, runoff from individual turbine hardstanding areas will be not discharged into the existing drain network but discharged locally at each turbine location through stilling ponds and buffered outfalls onto vegetated surfaces;

- Buffered outfalls which will be numerous over the site will promote percolation of drainage waters across vegetation and close to the point at which the additional runoff is generated, rather than direct discharge to the existing drains of the site;

- Drains running parallel to the existing roads that requiring widening will be upgraded. Velocity and silt control measures such as check dams, sand bags, oyster bags, straw bales, flow limiters, weirs, baffles and silt fences will be used during the upgrade works. Regular buffered outfalls will also be added to these drains to protect downstream surface waters.

3.5.6.2.3 Water Treatment Train

A final line of defence can be provided by a water treatment train such as a “Siltbuster”, if required. If the discharge water from construction areas fails to be of a high quality, then a filtration treatment

system (such as a 'Siltbuster' or similar equivalent treatment train (sequence of water treatment processes) will be used to filter and treat all surface discharge water collected in the dirty water drainage system. This water treatment train will apply for the entirety of the construction phase.

3.5.6.2.4 Silt Fences

Silt fences will be emplaced within drains down-gradient of all construction areas. Silt fences are effective at removing heavy settleable solids. This will act to prevent entry to watercourses of sand and gravel sized sediment, released from excavation of mineral sub-soils of glacial and glacio-fluvial origin, and entrained in surface water runoff. Inspection and maintenance of these structures during construction phase is critical to their functioning to stated purpose. They will remain in place throughout the entire construction phase. Double silt fences will be emplaced within drains down-gradient of all construction areas inside the hydrological buffer zones to provide an additional layer of protection in these areas.

3.5.6.2.5 Silt Bags

Silt bags will be used where small to medium volumes of water need to be pumped from excavations. As water is pumped through the bag, most of the sediment is retained by the geotextile fabric allowing filtered water to pass through. Silt bags will be used with natural vegetation filters or sedimats (sediment entrapment mats, consisting of coir or jute matting) placed at the silt bag location to provide further treatment of the water outfall from the silt bag. Sedimats will be secured to the ground surface using stakes/pegs. The sedimat will extend to the full width of the outfall to ensure all water passes through this additional treatment measure.

3.5.6.2.6 Management of Runoff from Soil Deposition Areas

It is proposed that excavated soil and peat will be used for reinstatement and landscaping throughout the site and any excess material will be placed in 2 no. deposition areas at the wind farm site, 1 no. soil deposition area and 1 no. peat deposition area.

Excavated peat from grid connection to be used as backfill and landscaping/reinstatement. Excavated soil from grid on public road (as well as road surfacing) to be removed to licenced facility.

Both proposed spoil deposition areas are located outside the 50m stream buffer zone (refer to **Annex 7.2 to the EIAR**).

The proposed deposition areas are natural depressions in the ground, or areas of lower-lying ground, and therefore there might be a requirement to de-water prior to infilling (please refer to Section **7.5.1.2 of the EIAR** for mitigation measures relating to dewatering).

During the initial placement of spoil in the deposition areas, silt fences, straw bales and biodegradable matting will be used to control surface water runoff. Drainage from overburden deposition areas will ultimately be routed to an oversized swale and a number of settlement ponds and a 'Siltbuster' with appropriate storage and settlement capacity, designed for a '1-in-100 year 6-hour return' period, before being discharged to the on-site drains.

Spoil deposition areas will be sealed with a digger bucket and vegetated as soon possible to reduce sediment entrainment in runoff. Once re-vegetated and stabilised, soil/peat deposition areas will no longer be a likely source of silt laden runoff. Settlement ponds will be left in place until the areas have stabilised.

3.5.6.2.7 Grid Connection Installation Works

Temporary silt fencing/silt trap arrangements will be placed within existing roadside/field drainage features along the grid connection to remove any suspended sediments from the works area. The trapped sediment will be removed and disposed at an appropriate licenced facility. The bare ground re-seeded/reinstated immediately and silt fencing temporally left in place if necessary.

3.5.6.2.8 Pre-emptive Site Drainage Management

The works programme for the initial construction stage of the development will also take account of weather forecasts, and predicted rainfall in particular. Large excavations and movements of soil/subsoil or vegetation stripping will be suspended or scaled back if prolonged or intense rain is forecast. The extent to which works will be scaled back or suspended will relate directly to the amount of rainfall forecast.

The following forecasting systems are available and will be used on a daily basis at the site to direct proposed construction activities:-

- General Forecasts: Available on a national, regional and county level from the Met Eireann website (www.met.ie/forecasts). These provide general information on weather patterns including rainfall, wind speed and direction but do not provide any quantitative rainfall estimates;

- Meteo Alarm: Alerts to the possible occurrence of severe weather for the next 2 days. Less useful than general forecasts as only available on a provincial scale;

- 3 hour Rainfall Maps: Forecast quantitative rainfall amounts for the next 3 hours but does not account for possible heavy localised events;

- Rainfall Radar Images: Images covering the entire country are freely available from the Met Eireann website (www.met.ie/latest/rainfall_radar.asp). The images are a composite of radar data from Shannon and Dublin airports and give a picture of current rainfall extent and intensity. Images show a quantitative measure of recent rainfall. A 3 hour record is given and is updated every 15 minutes. Radar images are not predictive; and,

- Consultancy Service: Met Eireann provide a 24 hour telephone consultancy service. The forecaster will provide interpretation of weather data and give the best available forecast for the area of interest.

Using the safe threshold rainfall values will allow work to be safely controlled (from a water quality perspective) in the event of an impending high rainfall intensity event.

Works will be suspended if forecasting suggests either of the following is likely to occur:-

- >10 mm/hr (i.e. high intensity local rainfall events);

- >25 mm in a 24-hour period (heavy frontal rainfall lasting most of the day); or,

- >half monthly average rainfall in any 7 days.

Prior to works being suspended the following control measures will be completed:-

- Secure all open excavations;

- Provide temporary or emergency drainage to prevent back-up of surface runoff; and,

- Avoid working during heavy rainfall and for up to 24-hours after heavy events to ensure drainage systems are not overloaded.

3.5.6.2.9 Timing of Site Construction Works

The construction of the site drainage system will be carried out, at the respective location, prior to other activities being commenced. The construction of the drainage system will only be carried out

during periods of low rainfall, and therefore minimum runoff rates. This will minimise the risk of entrainment of suspended sediment in surface water runoff, and transport via this pathway to surface watercourses. Construction of the drainage system during this period will also ensure that attenuation features associated with the drainage system will be in place and functional for all subsequent construction works.

3.5.6.3 Excavation Dewatering and Potential Impacts on Surface Water Quality

The management of excavation dewatering (pumping), particularly in relation to any accumulation of water in foundations or electricity line trenches, and subsequent treatment prior to discharge into the drainage network will be undertaken as follows:-

- Appropriate interceptor drainage, to prevent upslope surface runoff from entering excavations, will be put in place;
- The interceptor drainage will be discharged to the site constructed drainage system or onto natural vegetated surfaces and not directly to surface waters to ensure that Greenfield runoff rates are mimicked;
- If required, pumping of excavation inflows will prevent build up of water in the excavation;
- The pumped water volumes will be discharged via volume and sediment attenuation ponds adjacent to excavation areas, or via specialist treatment systems such as a Siltbuster unit;
- There will be no direct discharge to surface watercourses, and therefore no risk of hydraulic loading or contamination will occur;
- Daily monitoring of wind farm excavations by the Environmental Manager will occur during the construction phase. If high levels of seepage inflow occur, excavation work at this location will cease immediately and a geotechnical assessment undertaken; and,
- A mobile 'Siltbuster' or similar equivalent specialist treatment system will be available on-site for emergencies. Siltbusters are mobile silt traps that can remove fine particles from water using a proven technology and hydraulic design in a rugged unit. The mobile units are specifically designed for use on construction-sites. They will be used as final line of defence if needed.

3.5.6.4 Potential Release of Hydrocarbons during Construction and Storage

Mitigation measures proposed to avoid release of hydrocarbons at the site are as follows:-

- The volume of fuels or oils stored on site will be minimised. All fuel and oil will be stored in an appropriately bunded area within the temporary construction compound. Only an appropriate volume of fuel will be stored at any given time. The bunded area will be roofed to avoid the ingress of rainfall and will be fitted with a storm drainage system and an appropriate oil interceptor;

- All bunded areas will have 110% capacity of the volume to be stored;

- On site re-fuelling of machinery will be carried out using a mobile double skinned fuel bowser. The fuel bowser, a double-axel custom-built refuelling trailer will be re-filled at the temporary compound and will be towed around the site by a 4x4 jeep to where plant and machinery is located. No refuelling will be permitted at works locations within the 50m hydrological buffer. The 4x4 jeep will also be fully stocked with fuel absorbent material and pads in the event of any accidental spillages. The fuel bowser will be parked on a level area in the construction compound when not in use and only designated trained and competent operatives will be authorised to refuel plant on site. Mobile measures such as drip trays and fuel absorbent mats will be used during all refuelling operations to avoid any accidental leakages;

- All plant and machinery used during construction will be regularly inspected for leaks and fitness for purpose;

- Spill kits will be readily available to deal with any accidental spillage in;

- All waste tar material arising from road cuttings (from trenching or other works in public roads) will be removed off-site and taken to a licensed waste facility. Due to the potential for contamination of soils and subsoils, it is not proposed to utilise this material for any reinstatement works; and

- An outline emergency plan for the construction phase to deal with accidental spillages is contained within **Technical Schedule 1 – Environmental Incident and Emergency Response Plan**. This emergency plan will be further developed prior to the commencement of development, and will be agreed with the Planning Authority as part of the detailed CEMP.

3.5.6.5 Groundwater and Surface Water Contamination from Wastewater Disposal

Measures to avoid contamination of ground and surface waters by wastewaters will comprise:-

- Measures to avoid contamination of ground and surface waters by wastewaters will comprise:- The provision of self contained port-a-loos (chemical toilets) with an integrated waste holding tank will be installed at the site compound, maintained by the providing contractor, and removed from site on completion of the construction works;

- Water supply for the site office and other sanitation will be brought to site and removed after use to be discharged at a suitable off-site treatment location; and,

- No water will be sourced on the site, nor will any wastewater be discharged to the site

3.5.6.6 Release of Cement-Based Products

The following mitigation measures are proposed to ensure that the release of cement-based products is avoided:-

- No batching of wet-cement products will occur on site. Ready-mixed concrete will be brought to site as required and, where possible, emplacement of pre-cast products, will take utilised;

- All watercourse crossings will utilise pre-cast products and the use of wet-cement products within the hydrological buffer will be avoided insofar as possible;

- Where concrete is delivered on site, only the chute will be cleaned, using the smallest volume of water practicable. Chute cleaning will be undertaken at lined cement washout ponds with waters being tankered and stored in the temporary construction compound, removed off site and disposed of at an approved licensed facility. No discharge of cement contaminated waters to the construction phase drainage system or directly to any artificial drain or watercourse will be allowed;

- Weather forecasting will be used to ensure that prolonged or intense rainfall is not predicted during concrete pouring activities; and,

- The pour site will be kept free of standing water and plastic covers will be ready in case of sudden rainfall event.

3.5.6.7 Morphological Changes to Surface Water Courses & Drainage Patterns

The following mitigation measures are proposed:-

- Where possible, all proposed new stream crossings will be clear span bridges (bottomless culverts) and the stream beds will remain undisturbed. No in-stream excavation works at the crossing locations are proposed and therefore there will be no impact on the stream at the proposed crossing location;

- Where internal wind farm electrical cabling of grid connection cabling will pass above or below the existing culvert and will not directly interfere with the culvert;

- At the time of construction, all guidance/best practice requirements of the Office of Public Works (OPW) or Inland Fisheries Ireland will be incorporated into the design/construction of the proposed watercourse/culvert crossings;

- As a further precaution, in-stream construction work (should it be required for any reason) will only be carried out during the period permitted by Inland Fisheries Ireland for in-stream works according to the Eastern Regional Fisheries Board (2004) guidance document "Requirements for the Protection of Fisheries Habitat during Construction and Development Works at River Sites", i.e., May to September inclusive. This time period coincides with the period of lowest expected rainfall, and therefore minimum runoff rates. This will minimise the risk of entrainment of suspended sediment in surface water runoff, and transport via this pathway to surface watercourses (any deviation from this will be done in discussion with the IFI);

- During the near stream construction works (i.e. within the 50m buffer zone), double row silt fences will be emplaced immediately down-gradient of the construction area for the duration of the construction phase; and

- All new or revised watercourse crossings (watercourses mapped on OSI mapping) will require a Section 50 license application to the OPW in accordance with the Arterial Drainage Act 1945. The river/stream crossings will be designed in accordance with OPW guidelines/requirements on applying for a Section 50 consent.

The proposed Bracklyn Wind Farm will not alter the hydrology or water balance of the catchments/watercourses downstream of the proposed site, therefore the proposed development will not affect any proposed bog rehabilitation plans that might be carried out in the future on any adjoining

boglands. Any rehabilitation plans that are carried out will also have to be done in a manner that will not affect upstream drainage and therefore no effects on the proposed Bracklyn Wind Farm site are anticipated.

3.5.6.8 Potential Hydrological Impacts on Designated Sites

The proposed mitigation measures for protection of surface water quality, which will include buffer zones and robust drainage control measures (i.e. interceptor drains, swales, settlement ponds), will ensure that the quality of runoff from proposed development areas will be very high.

As stated in **Section 7.6.1.1 of the EIAR**, there could potentially be an "imperceptible, temporary impact" on local streams and rivers which, if occurs, would be extremely localised and of a very short duration (i.e. hours). Therefore, significant indirect hydrological or water quality effects on the downstream River Boyne and River Blackwater SAC will not occur.

3.6 Air and Climate

The greatest likelihood of effects on air quality during the construction phase is from construction dust emissions and the potential for nuisance dust. In order to minimise dust emissions during construction, a series of mitigation measures have been prepared in the form of an outline Dust Minimisation Plan (see **Annex 8.2 to EIAR**).

A detailed Dust Minimisation Plan will be formulated prior to the construction phase of the project Measures to be included within the Dust Minimisation Plan include:-

- Access tracks and public roads in the vicinity of the site shall be regularly cleaned to remove mud, aggregates and debris and maintained as appropriate. All road sweepers shall be water assisted;
- Any road that has the potential to give rise to fugitive dust shall be regularly watered, as appropriate, during dry and/or windy conditions;
- Vehicles delivering material with dust potential shall be enclosed or covered with tarpaulin at all times to restrict the escape of dust;
- Public roads in the vicinity of the site shall be regularly inspected for cleanliness and cleaned as necessary;

- In the event of dust nuisance occurring outside the site boundary, movement of materials will be immediately terminated and satisfactory procedures implemented to rectify the problem before the resumption of operations;

- If issues persist and the above measures are not satisfactorily controlling dust emissions, a wheel cleaning system with rumble grids to dislodge accumulated dust and mud prior to leaving the site should be installed; and

- During movement of materials both on and off-site, trucks will be stringently covered with tarpaulin at all times. Before entrance onto public roads, trucks will be adequately inspected to ensure no potential for dust emissions;

- Material handling systems and site stockpiling of materials will be designed and laid out to minimise exposure to wind. Water misting or sprays will be used as required if particularly dusty activities are necessary during dry or windy periods;

- The dust minimisation plan shall be reviewed at regular intervals during the construction phase to ensure the effectiveness of the procedures in place and to maintain the goal of minimisation of dust through the use of best practice and procedures.

- At all times, these procedures will be strictly monitored and assessed. In the event of dust nuisance occurring outside the site boundary, movements of materials likely to raise dust will be curtailed and satisfactory procedures implemented to rectify the problem before the resumption of construction operations.

3.7 Archaeology and Cultural Heritage

As part of the EIAR (Chapter 9), an Archaeological, Architectural and Cultural Heritage Assessment was prepared for the wind farm development. The assessment presents all known existing archaeological sites, provides a summary of potential impacts associated with the development of the proposed wind farm and also provides relative mitigation measures.

There are fourteen recorded monuments within 1km of the proposed development as described in **Section 10.4.2 of the EIAR**. The majority are ringforts although there is also a flat cemetry, an earthwork, a field system and two tower houses. There are six protected structures (three in Co. Meath and three in Co. Westmeath) within the landholding and fifty-four protected structures in Co. Meath

within 5km of the proposed development (**see 10.4.9 of the EIAR**). The following mitigation measures are proposed:

- A post-consent pre-construction archaeological geophysical survey shall be carried out in all areas of land take associated with the proposed turbine bases and crane hardstands. The geophysical survey will be carried out under licence to the Department of Housing, Local Government and Heritage;

- Post-consent pre-construction test trenching shall be carried out in all areas of land take associated with the proposed turbine bases and hardstands, as well as along the access roads leading to Turbine 3 and Turbine 11. Test trenching will be carried out under licence to the Department of Housing, Local Government and Heritage and the National Museum of Ireland. Provision will be made for the full excavation and recording of any archaeological features or deposits that may be exposed during test trenching. Test trenching will be cognisant of the results of the geophysical survey. Further recommendations, which may include preservation in situ or archaeological excavation, may be made on completion of the test trenching programme;

- Archaeological monitoring of all excavations associated with construction of the proposed wind farm shall be carried out. Monitoring will be carried out under licence to the Department of Housing, Local Government and Heritage and the National Museum of Ireland. Provision will be made for the full excavation and recording of any archaeological features or deposits that may be exposed during monitoring;

- Archaeological monitoring of all excavations associated with the proposed grid connection shall be carried out. Monitoring will be carried out under licence to the Department of Housing, Local Government and Heritage and the National Museum of Ireland. Provision will be made for the full excavation and recording of any archaeological features or deposits that may be exposed during monitoring; and

- Archaeological monitoring of all excavations associated with the proposed road upgrades shall be carried out. Monitoring will be carried out under licence to the Department of Housing, Local Government and Heritage and the National Museum of Ireland. Provision will be made for the full excavation and recording of any archaeological features or deposits that may be exposed during monitoring.

Given their proximity to existing heritage features, it is recommended that micrositing should not be considered in respect of Turbine 3 or Turbine T11 should it result in turbines being moved closer to the Recorded Monuments in these two areas.

The micrositing of other infrastructure, within the tolerances outlined in **Chapter 3 of the EIAR**, will not result in any adverse effect on archaeological, architectural or cultural heritage features.

3.8 Noise

Construction activities will be completed in accordance with the provisions, where relevant, of BS 5228-1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites – Noise which offers detailed guidance on the control of noise & vibration from demolition and construction activities. The relevant practices to be adopted during construction shall include:-

- Limiting the hours during which site activities likely to create high levels of noise or vibration are permitted;
- Establishing channels of communication between the contractor/developer, Local Authorities and residents;
- Appointing a site representative responsible for matters relating to noise and vibration;
- Monitoring typical levels of noise and vibration during critical periods and at sensitive locations; and
- Keeping site access tracks even to mitigate the potential for vibration from HGVs.

Furthermore, a variety of practicable noise control measures will be employed. These include:-

- Selection of plant with low inherent potential for generation of noise and/or vibration;
- Placing of noisy/vibratory plant as far away from sensitive properties as permitted by site constraints, and;
- Regular maintenance and servicing of plant items.

The following list of measures will be implemented, as relevant, to ensure compliance with the relevant construction noise criteria:

- No plant or machinery will be permitted to cause a public nuisance due to noise;
- The best means practicable, including proper maintenance of plant, will be employed to minimise the noise produced by on site operations.
- All vehicles and mechanical plant will be fitted with effective exhaust silencers and maintained in good working order for the duration of the contract;
- Compressors will be attenuated models fitted with properly lined and sealed acoustic covers which will be kept closed whenever the machines are in use and all ancillary pneumatic tools shall be fitted with suitable silencers;
- Machinery that is used intermittently will be shut down or throttled back to a minimum during periods when not in use;
- Any plant, such as generators or pumps, which may be required to operate outside of general construction hours will be surrounded by an acoustic enclosure or portable screen;
- During the course of the construction programme, supervision of the works will include ensuring compliance with the limits detailed in **Table 11.6 of the EIAR** using methods outlined in BS 5228-1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites – Noise;
- The hours of construction activity will be limited to avoid unsociable hours where possible. Construction operations, including the delivery of construction materials, shall generally be restricted to between 07:00hrs and 19:00hrs Monday to Friday and between 07:00hrs and 13:00hrs on Saturdays, with no operations on Sundays or public holidays. However, to ensure that optimal use is made of good weather periods, at occasional critical periods within the construction programme (i.e. concrete pours, turbine component deliveries and turbine erection) or in the event of an emergency; activities may be necessary outside out of these hours.

Based on assessment of the geological composition of the site undertaken to date, it is concluded that significant levels of rock are not present. In the unlikely event that rock is encountered, rock breaking

may be employed to utilise this rock in the construction of access tracks or hardstands. If rock breaking is required, the following measures will be implemented, where necessary, to mitigate noise emissions:-

- Fit suitably designed muffler or sound reduction equipment to the rock breaking tool to reduce noise without impairing machine efficiency;
- Ensure all air lines are sealed;
- Use a dampened bit to eliminate a 'ringing' sound;
- Erect an acoustic screen between compressors or generators and noise sensitive area. When possible, line of sight between top of machine and reception point will be obscured; and
- Enclose the breaker or rock drill in portable or fixed acoustic enclosure with suitable ventilation.

3.9 Vibration

The level of vibration from construction activities shall be limited to the values set out in **Table 11.7 of the EIAR**.

Given the substantial distances between locations where notable levels of vibration may take place (e.g. piling at turbine locations or extensive use of vibration rollers in access track construction) and the nearest NSLs, no likely significant effect will be experienced. Therefore, no specific mitigation measures are proposed in respect of these works.

The completion of upgrade works to the haul route (i.e. along the L1504 and L5508) and the transportation of construction materials will occur in close proximity to a number of residential properties along these roads. All dwellings located within 50m of proposed upgrade works and above-referenced local roads are assessed to be modern buildings of sound construction (see **Section 11.3.1.2** of the EIAR) and are not, therefore, assessed as likely to be susceptible to cosmetic or structural damage from the magnitude of vibration predicted to be generated by the proposed upgrade works and traffic movements.

However, and notwithstanding the above; prior to the commencement of development a visual inspection (with photographic record) of all structures (buildings) within 50m of the L1504 and L5508 will be undertaken by a suitably qualified engineer to identify any pre-existing evidence of structural

deterioration. A report on the visual inspection of each property will, on completion, be furnished to the respective property owners. During construction, it is also proposed to undertake occasional inspections to ensure the early identification of any adverse effects.

Following the completion of construction, a similar survey shall be completed and if a deterioration is identified and can be directly attributed to the construction of the proposed development, appropriate action will be immediately undertaken in agreement with the property owner and at the expense of the Applicant. The Planning Authority will also be advised of any necessary remedial work.

As further level of protection to those properties located immediately adjacent to the L5508 (identified as H17, H24 and H77) where it is proposed to increase the width of the existing road carriageway, the following additional mitigation measures are recommended:-

- Prior to the commencement of construction, a dilapidation survey of each property will be undertaken. This survey will form the basis of a report (to be furnished to the property owner) providing detailed description of the condition of the property;

- Crack 'tell-tales' will be installed on any existing cracks that are of concern. These 'tell-tales' will allow the cracks to be carefully monitored and will indicate whether any movement or opening of the cracks has occurred. The tell-tales will be inspected regularly during construction;

- A vibration monitor will be installed at each of the properties and will allow for actual vibration levels to be carefully monitored; ;

- A speed limit of 20 km/h will be put in place for all construction traffic using the L5508 within 100m of each of the above dwellings; and

- Following construction, a further dilapidation survey of the properties will be undertaken and furnished to the property owners. The results of this survey will be compared to that carried out prior to construction and can be used to determine if any damage has been caused to the properties.

With the above mitigation and monitoring measures in place, the likelihood of any damage to buildings, but in particular residential dwellings, will be minimised. Moreover, the regular monitoring of the proposed 'tell-tales' and vibration monitors will give an early indication of vibration levels and will ensure that a timely intervention can be made, and additional mitigation or remedial measures implemented, if adverse effects are assessed as likely to arise.

3.10 Traffic

The likely effects of the proposed development have been identified as being slight to moderate and temporary in nature and associated with short-term construction and decommissioning activities. Cumulative effects could, in the absence of mitigation, rise to 'significant' if the proposed development is constructed at the same time as the proposed Ballivor Wind Farm on adjacent lands. Likely effects during the operational phase have been assessed as being imperceptible and hence mitigation measures are not deemed to be necessary.

In order to avoid significant effects and reduce the predicted magnitude of effects to the greatest possible extent, a suite of mitigation measures are available which will further reduce any likely effects during the construction phase. The following mitigation measures will be implemented:-

- Traffic movements will be limited to 07:00-19:00 Monday to Friday and 07:00–13:00 on Saturdays with no movements on Sundays or public holidays. It may be occasionally necessary to undertake works outside of these hours to avail of favourable weather conditions or during extended concrete pours. Where construction activities are necessary outside of the normal working hours, local residents and the Planning Authority will receive prior notification;

- A wheel cleaning facility will be provided, as necessary, to prevent any debris being transferred from site to the adjacent public roads. All drivers will be required to ensure that their vehicle is free from dirt and stones prior to departure from the construction site. Where conditions exist for dust to become friable, techniques such as damping down of the affected areas will be employed and vehicles/loads will be covered to reduce dust emissions;

- A Traffic Management Plan shall be agreed as part of the Construction Environmental Management Plan (CEMP) with the Local Authority prior to the commencement of development. The Traffic Management Plan shall include inter alia confirmed details of construction material haul routes; confirmed details of vehicle specifications; a materials delivery programme; traffic management measures including details of 'Stop/Go' systems, signage, road closures and diversionary routes; and road reinstatement details;

- All works to the public road shall be undertaken in consultation with, and agreed in advance with, the Local Authority;

- All reasonable steps shall be taken to ensure that national and regional routes are used to transport all materials to the site, in so far as is possible;

- Prior to, and post, construction; pavement condition surveys and bridge surveys will be undertaken along all non-national access routes. Given the high-quality and well-maintained nature of motorways and national routes, it is not assessed as necessary to carry out surveys of these carriageways or structures along these routes. Following the completion of the pre-construction survey, any works which are assessed as necessary to facilitate the delivery of components and materials to the proposed development site shall be undertaken, while any deterioration of carriageways or structures identified in the post-construction survey shall be put right at the expense of the developer and to the satisfaction of the Planning Authority;

- Adequate signage shall be provided at entrances providing access, safety and warning information;

- Speed limit compliance; particularly along the L1504, L5508 and L80122; will be emphasised to all staff and contractors prior to the commencement of construction during site induction, and will be strictly enforced throughout the construction phase;

- Sufficient car parking spaces will be available at the contractor's temporary depot/storage area during the construction phase. No parking of cars by persons associated with the proposed development will be permitted on any part of the public road that is not closed to traffic. All staff will be instructed to ensure that private entrances remain unobscured (particularly along the grid connection route);

- Traffic restrictions shall be kept to minimum duration and extent;

- Appropriate traffic management; including maintenance of local access, pedestrian access (where safe to do so) and diversions; shall be implemented to facilitate continued public use of roads where temporary traffic restrictions have to be put in place. Precise details of these measures will be detailed in the Traffic Management Plan to be agreed with the Planning Authority prior to the commencement of development;

- The timing of oversized loads shall be agreed with the relevant local authorities and An Garda Síochána, and all relevant licenses and permits shall be obtained in advance;

- Maximum axle loadings for abnormal/oversized loads shall be strictly enforced in accordance with the Road Traffic (Construction and Use of Vehicles) Regulations 2003 (S.I. No. 5 of 2003);

- A designated contact point and coordinator will be put in place to manage all access arrangements and to interface with the public and the Local Authority;

- No hedgerows or potential breeding habitats to be removed during the summer breeding season; and

- The site shall be closed, and strictly secured, to the public during the construction phase.

The proposed turbine delivery and construction material haul routes will be monitored during construction to identify any damage which may have been caused by construction traffic. Where any damage has been caused by traffic associated with the proposed development, it shall be repaired by the appointed contractor as soon as possible.

3.11 Waste

The measures outlined in the **Spoil Management Plan (Technical Schedule 4), the Waste Management Plan (Technical Schedule 5)** and the measures outlined below will be employed and strictly observed during the construction phase:

- All waste arising during the construction phase will be managed and disposed of in a way that ensures the provisions of the Waste Management Act 1996 and associated amendments and regulations.
- Any material that is removed offsite for landfill disposal (e.g. road surfacing material) will be classified in accordance with Council Decision 2003 (2003/33/EC) in order to confirm that it is suitable for its proposed use or for landfill disposal. Excavated material, which requires offsite disposal, will be classified (where possible) prior to excavation, in order to minimise the amount of material stockpiling at the subject site. Excavated spoil material will be transported from the site using appropriately permitted waste contractors, i.e. hold permits from Westmeath County Council or other authorities permitted to issue permits for waste collection in County Westmeath.
- Surplus material, will be placed at either of the designated Spoil Deposition Areas, one of which is specifically for peat and one specifically for sub-soil.

3.12 Landscape & Shadow Flicker

Aside from construction stage mitigation measures to minimise land and vegetation disturbance and dust emissions, there are no specific mitigation measures to be implemented. The appropriate

management and reinstatement of excavations, in a timely manner, will ensure that any adverse effects caused, for example at site entrances or road upgrade locations, are minimised insofar as possible. Similarly, the progressive reinstatement and landscaping of the site will remediate any short term adverse effects on the local landscape.

The proposed development has embedded landscape and visual mitigation measures that will be implemented to make the development less intrusive and less eye catching on a localised level include:-

- The colour of turbines will be industry standard off-white/light grey semi-matt non-reflective finish;
- Transmission lines between individual turbines and the substation will be placed underground;
- Special care will be taken to preserve any features, insofar as possible, which contribute to the landscape character of the study area; and
- Counter rotation of blade sets will be avoided.

The likely shadow flicker effects have been minimised, and avoided where possible, through the iterative design process and assessment of project alternatives as described at **Chapter 2 of the EIAR**. However; while the proposed development strikes the best balance between the avoidance of likely significant effects and achieving the objectives of the project, shadow flicker effects remain, as discussed above.

Shadow flicker mitigation is available, and widely implemented, on wind farm developments where shadow flicker levels are proven to be in excess of the recommended limits. These mitigation measures effectively limit (curtail) the operation of turbines during the infrequent and rare periods when shadow flicker occurs. In short, if a particular turbine is creating shadow flicker effects at a particular receptor, then the operation of that turbine may be temporarily curtailed. This is usually achieved by turning off the turbines at predetermined times, as predicted by the shadow flicker model, when shadow flicker is proven to occur.

The wind turbines will each be fitted with shadow flicker curtailment software, inherent to their design, to facilitate their shut down as required. If the sun is shining, the software will turn off the turbine at the predetermined times when shadow flicker is predicted to occur based on the prediction model. This approach will be implemented, as necessary, to ensure that actual levels of shadow flicker do not exceed either of the relevant limits.

3.13 Infrastructure and Telecommunications

The proposed wind turbines will, as requested by the IAA and Department of Defence in their respective consultation responses, be fitted with aviation warning lighting in accordance with the specification to be agreed with the IAA and the Planning Authority.

At a maximum of thirty days following the installation of all proposed turbines, 'as-constructed details' will be provided to the IAA to allow for the updating of mapping charts, including:-

- The number of wind turbines;
- WGS-84 coordinates of each turbine;
- Ground elevation of each turbine (Malin Head OD);
- Blade tip elevation of each turbine (Malin Head OD);
- Height of Turbine;
- Contour maps at the requisite scale; and
- A note of which turbines have been fitted with obstacle warning lights.

In the event that the obstacle warning lights fail or if there are plans to withdraw them from use for a period of time, the IAA will be contacted, via AISOPs@iaa.ie, as a matter of urgency, to request that a NOTAM (Notice to Airmen) is issued concerning the absence of obstacle lights. The following information will be provided to the IAA:-

- Obstacle ID;
- Obstacle type;
- Obstacle Position;
- Elevation; and
- Colour of Light.

The Department of Defence shall also be notified in the event of a failure of the installed warning lights.

It should also be noted, however, that the proposed wind turbines will be fitted with an uninterruptable power supply (UPS) to ensure that the aviation warning lights remain operational even in the event of a power outage. This UPS is sufficient for a period of twelve hours; after which, the warning lights can be powered by a small generator should the power outage continue.

Extensive consultation with telecommunications providers has confirmed that significant adverse effects on existing telecommunication links are unlikely to arise from the operation of the proposed development. While the proposed development is assessed as unlikely to interfere with any microwave links, all operators will be kept informed of any changes to the layout (e.g. micrositing) should these occur to ensure that compliance with telecommunications constraints is maintained.

In their consultation response, 2rn recommended that a protocol agreement be entered into to ensure that any complaints received from the local public concerned are appropriately remediated. This is a standard protocol for such development proposals and has been agreed between the parties and is enclosed at **Annex 13.3 to the EIAR)**.

While assessed to be unlikely, if significant signal interference in any form is identified and is directly attributed to the proposed development, appropriate remedial measures will immediately be undertaken. A range of technical measures are available to mitigate any instances of interference including signal amplifiers, active deflectors and relay transmitters, repeater stations, booster units, realignment of domestic aerials, installation of higher quality aerials and the installation of suppression equipment. Remedial works will be promptly undertaken to ensure uninterrupted telecommunication, broadcasting and mobile phone service provision.

3.14 Construction Sequence

The Contractor's proposed sequence of works will have regard to the implementation of all environmental mitigation measures.

The outline construction sequence of the development is as follows:

- Install environmental protection/mitigation measures including buffer zones for any tree root protection, or badger setts or protected zones as outlined in ecological report on the distribution of protected flora or invasive species.
- Traffic management measures to be implemented in advance of commencement of haul route upgrade works. Works to be completed to ensure unimpeded access during the construction of the proposed development;
- Upgrade works to the L5508 will be commenced;
- Surface water protection measures to be installed;
- The construction of the site entrances, ensuring that requisite traffic visibility splays are provided;

- Establishment and continued management of spoil deposition areas;
- Progressive construction of internal on-site access tracks;
- Construction of the temporary construction compound for off-loading materials and equipment, and to accommodate temporary site offices;
- Construction of bunded areas for oil, fuel and lubricant storage tanks;
- As the internal access tracks progress to each turbine location, foundation excavations for the turbines will commence and foundations laid. The hardstanding areas will be constructed as track construction advances;
- Construction of site control building;
- Other temporary upgrade works along the turbine component haul route will be commenced;
- As on-site access tracks progress, internal wind farm cabling ducting and cabling will be installed;
- Installation of turbines will commence once the on-site access tracks, hardstands, foundations and drainage measures are in place and the road upgrade works are complete. It is anticipated that each turbine will take approximately 1 no. week to install. Three cranes will be used for this operation. As each turbine is completed, the electrical connections will be made;
- Decommissioning of the temporary meteorological mast and installation of the permanent meteorological mast will then take place; and
- Progressive site reinstatement, restoration and landscaping including re-profiling and of spoil deposition areas and peat storage areas, removal of temporary construction compound and turbine storage areas; erection of post-and-wire fencing around turbines, access tracks and at site entrances; and erection of gates and vegetation at site entrances.

The construction method for the proposed substation and grid connection will consist of the following general sequence:-

- The construction of the site entrances and access tracks;
- Site preparatory and groundworks associated with the substation compound footprint including control building;
- Construction of the control buildings;

- Construction of bases or plinths for electrical apparatus, including Electricity Storage System containers;
- Erection of palisade fencing around substation;
- Installation of internal and external electrical apparatus in control buildings and within compound area;
- Site preparatory and groundworks associated with the strain tower foundations,
- Erection of end masts;
- Installation of underground electricity line between substation and end masts;
- Commissioning and testing of electrical apparatus;
- Connection of underground electricity line to the 110kV Mullingar-Corduff electricity transmission line;
- Final commissioning of all electrical equipment and apparatus; and
- Progressive site reinstatement, restoration, landscaping and planting proposals including the installation of stockproof fencing and the erection of gates.

Once the turbines are installed and the substation and electrical system completed, the turbines will be tested and commissioned.

A detailed Construction Management Plan (CMP) for construction will be prepared by the Contractor in advance of all construction activities and will incorporate all mitigation measures recommended in this report. This report will be issued to the Contractor to ensure that all environmental mitigation measures required will be captured in the detailed CMP.

3.15 Outline Method Statements

This CEMP and its future versions/revisions will form part of the Contract for Bracklyn Wind Farm. It will therefore be updated and revised during the different stages of the development. The Contractor will address all of the mitigation measures and best practice construction methods detailed within the above consent in his design and in any detailed environmental plans as required by this CEMP or the Contract.

Please refer to the Schedule of Mitigation Measures (Annex 1.8 of the EIAR) which provides all mitigation measures proposed in the EIAR and associated documents.

Where any mitigation measures or construction methods described in other documents deviate in any way from those contained within this CEMP, the Contractor will abide by whichever is the most onerous and stringent in terms of environmental protection.

3.16 Scheme Amendments

Scheme Amendments will be recorded in Table 3.3. These amendments do not include changes to the scheme design which are completed in accordance with the existing planning consent; instead, this refers to changes in the design of the wind farm for which additional approvals and / or consents may be required from Westmeath County Council and/or Meath County Council. For example, amendments to track layouts or turbine locations outside of approved micrositing boundaries as per the current grant of planning permission.

The purpose of recording Scheme Amendments here is to provide a record of any changes in the design and siting of the wind farm infrastructure such that any associated environmental impacts and mitigation measures may be appropriately instigated through this CEMP.

TABLE 3.3 SCHEME AMENDMENTS

Reference	Date	Scheme Amendment Description	Environmental Sensitivities potentially Impacted by Scheme Amendment.

3.17 Register of Variations

Where any variations to the Technical Schedules and CEMP are required (either as a result of Scheme Amendments or through corrective actions or improvements noted and undertaken on site) these will be recorded in Table 3.4, Register of Variations. Furthermore, all changes to construction methods, design, mitigation and the implications of these changes and authorising personnel will be recorded in Table 3.4.

TABLE 3.4 REGISTER OF VARIATIONS			
No.	Variation Description	Authorising Personnel	Completion Date

4 COMMUNICATION PLAN

4.1 Introduction

Both the Contractor and the Client will appoint Project Managers to the project. These Project Managers will be the main points of contact between the two parties. The Contractors team will report directly to the Construction Project Manager, with all Client staff reporting directly to the Client Project Manager.

It is envisaged that main project communications will take the form of structured reporting arrangements and meetings.

All issues in relation to environmental management/monitoring will be reported to the Site EM/Resident Engineer. The Contractor's Environmental Manager (EM)/Resident Engineer (RE) shall report to the Contractor and Client on a regular basis.

4.2 Contact Sheets

Table 4.1 provides a list of Bracklyn Windfarm Ltd., Contractor and relevant third party contact details. This table should be updated and kept current by the Contractor for the duration of the Contract.

TABLE 4.1 CONTACT SHEETS

Company	Position	Name	Telephone
Bracklyn Windfarm Ltd.	Client Project Manager		
Contractor	Site Manager / EM		
Contractor	Contracts Manager		
Contractor	General Manager		
Contractor	Foreman		
Contractor	Ecological Clerk of Works (ECoW)		
Bracklyn Energy Ltd.	Construction Project Manager		

4.3 Meetings Reports and Consultations

Table 4.2 lists all meetings and consultations as required by the Contract. The table also provides details on the schedule/frequency, scope & objectives and attendees / responsibility for each meeting.

4.4 Roles & Responsibilities

Roles and responsibilities for environmental management, monitoring and reporting are detailed in Table 4.3. The Contractor's EM/Resident Engineer will be responsible for the delivery of all elements of the Environmental Management Plan. The Contractor's EM/ Resident Engineer will retain all responsibility for issuing, changing and monitoring the Environmental Management Plan.

4.5 Reporting Procedures

Figure 4.1 provides a diagrammatic outline of the general tasks and communication lines, based on the roles described in Tables 4.2 and 4.3 and tasks detailed in the Technical Schedules. The Contractor will update this information as part of the detailed CEMP.

Technical Schedule TS1, Environmental Incident and Emergency Response Plan, includes a figure illustrating the communications plan for reporting procedures for all potential environmental risks, hazards or incidents which may relate to ecology, water quality, dust, noise or archaeology.

Environmental reporting to statutory and non-statutory bodies, such as Westmeath County Council, Inland Fisheries Ireland, Department of Culture, Heritage and the Gaeltacht, will be managed by the relevant Contractor in accordance with an agreed reporting schedule.

TABLE 4.2 MEETINGS, REPORTS AND CONSULTATIONS			
Meeting/Report	**Schedule/Frequency**	**Scope & Objective**	**Attendees/Responsibilities**
A Record of all meetings, checks, permissions and licenses will be retained within Section 4 of this CEMP			
Site Inductions	All new site personnel and visitors		Contractor to organize and maintain records
Weekly environmental meetings	Weekly	To provide updates on environmental mitigation measures and performance and identify actions for improvement. The Contractor's EM is required to maintain a Pollution Prevention Measures Register (PPMR) in which mitigation measures put into place will be listed and checked weekly to assess the requirement for maintenance. The results of these checks will be discussed at the meeting and corrective actions agreed as required.	Attendance required: ECoW, Contractor's EM, Site Manager, and any other relevant personnel or statutory consultees where necessary.
Monthly Environmental Report & Monthly Environmental Management Group Meeting	Monthly	To provide a compiled record of weekly meeting minutes and environmental performance and monitoring results (e.g. air, noise or water quality monitoring as appropriate). To identify any areas / action for improvement.	To be prepared by EM. Report to be issued to the Contractor and Construction Project Manager before the end of each calendar month. Report to be discussed at the monthly meeting with recommendations for improvement passed to the Contractor in written format
Final Environmental Report	Upon completion of construction works	The final report will document the environmental and ecological effects of the construction period. The evidence for effects will be based on findings included in the minutes of weekly meetings and monthly meetings, together with other recording information maintained by the EM. The report will relate results to residual effects predicted in the EIS.	The Final Report will be prepared by the EM. The report will be made available to the Contractor, Construction Project Manager and Planning Authority, if required.

TABLE 4.2 MEETINGS, REPORTS AND CONSULTATIONS			
Meeting/Report	**Schedule/Frequency**	**Scope & Objective**	**Attendees/Responsibilities**
Environmental Checks and Monitoring of Mitigation Works	As required in advance of construction works regular checks should also be made at least every 14 days.	Environmental Checks are to be carried out in advance of construction works. This will comprise an on-site meeting / inspection to confirm the appropriate use of identified mitigation measures and highlight any further issues / measures which may be relevant prior to commencement of works in any area. As a minimum, Environmental Checks will be completed at each main piece of site infrastructure (turbine bases, construction compounds, sub-station, control room) prior to works commencing in that area. Advance checks will be undertaken no less than every 100m of constructed or upgraded access track. Environmental Checks will include: • Checks for visual evidence of contamination / sediment alongside watercourses, nearby working areas and in areas of surface water discharge. • Regular checks of all plant and equipment to identify any oil or fuel leaks to confirm the condition of the plant. • Inspection of drainage and erosion and sediment control measures. Additional checks should be made before, during (where safe to do so) and immediately following anticipated storm events or periods of continuous or heavy intermittent rainfall over one or more days. • Environmental checks will also encompass a review of – Waste management procedures – General site tidiness – Temporary materials storage (extracted materials stockpiles) and restoration works and – Peat stability	Environmental checks will be undertaken by the Contractor, supervised by the ECoW and EM where appropriate. The ECoW/EM may also undertake regular checks, either independently or in conjunction with the Contractor's checks as required. The Contractor and ECoW/EM will retain a record of all inspections / findings of Environmental Checks within Section 4 of this CEMP. All records will be made available for audit / review. All records will also be made available for discussion during regular meetings as scheduled herein.

TABLE 4.2 MEETINGS, REPORTS AND CONSULTATIONS			
Meeting/Report	**Schedule/Frequency**	**Scope & Objective**	**Attendees/Responsibilities**
		– Signs of any mammal activity on site – Buffer zones (if any) are being maintained – Monitoring of any new Third Schedule part 1or 2 species within the wind farm site	
Environmental Audit	At least once every month.		Environmental Audits may be carried out by the Contractor, or Bracklyn Windfarm Ltd. at any time during the works. Audit procedures and forms are included within Section 4 and TS1. These will be followed / completed by the Employer when undertaking environmental audits and may also be adopted by the Contractor, unless alternative procedures and forms are submitted and approved as part of the Contractor's detailed CEMP.
Liaison with regulator / statutory Consultees	As Required	Provide regular updates to relevant authority on environmental performance and maintain good working relationships with the regulatory bodies.	Contractor and ECoW/EM where required. Meetings will be initiated as required by Planning Condition, Technical Schedules or as agreed throughout the duration of the construction phase. The Contractor is responsible for obtaining all relevant permissions, consents, licenses and permits. Some permits may require application and implementation by an appropriately qualified person. In these instances, the Contractor will consult with the ECoW or other specialist Environmental Consultants where required.

TABLE 4.3 ROLES AND RESPONSIBILITIES	
Position	**Roles and Responsibilities**
Construction Project Manager	The Construction Project Manager will: Ensure that the Contractor has obtained the relevant approvals and licenses and consents from regulatory bodies and statutory consultees where required. Ensure that the Contractor has submitted all relevant documentation to the ECoW and Project EM, liaise with the Site Manager and the ECoW/EM and ensure that corrective actions and variations to the CEMP have been instigated.
Project Site Manager/Engineer	The Site Manager will provide liaison between the ECoW/EM and the Contractor where environmental sensitivities, instruction for environmental performance improvements or corrective actions are requested by the ECoW, EM or other appropriate person(s) as a result of environmental checks or audits conducted by these person(s). The Site Manager will ensure that all notifications of environmental sensitivities and incidents as well as other general observations on environmental performance are reported back to the Construction Project Manager. The Project Site Manager is responsible for review and further development of the CEMP.
ECoW: Ecological Clerk of Works	The ECoW will work with Bracklyn Windfarm Ltd. and the Contractor to ensure compliance with best practice and with all environmental mitigation and monitoring requirements as detailed within the ES, relevant planning conditions and CEMP. Where a particular ecological concern exists at the site, or specific habitat management activities are to be undertaken in conjunction with the main civils construction works, a Specialist Ecologist / Environmental Consultant may also be required unless the ECoW is suitably qualified to undertake the particular ecological responsibilities. The main roles of the ECoW are as follows: • Organise start-up meeting / Tool box talks with the Contractor to agree working methods, specifically including communications; weekly schedules; monitoring of data storage; and preparation of plans indicating location of key features including mitigation measures, monitoring points and sensitive habitats. • Maintain a weekly presence on site during the main construction works. • Organise a minimum of weekly meetings with the Site Manager and / or Foreman, to allow briefing on the programme of works on site and to provide on-site guidance during construction. Note: It is essential that the Contractor supplies information on proposed works and scheduling to the ECoW in advance in order to anticipate and address any issues, specifically including drainage, buffer /protection zones, silt mitigation measures, cabling, roads, turbine bases, met masts, compounds, landscaping, topsoil removal, storage and replacement, vegetation reinstatement and restoration works, planting, felling and habitat management. • Highlight the need for compliance with planning conditions. **Note: If failures occur and actions are taken which contravene legislation then the ECoW has the power to stop works in the affected area with immediate effect and the appropriate statutory agency and planning officer will be informed. These actions will only be taken where appropriate. Notification to stop works will be by verbal means, followed up with written confirmation recording the time and date of the instruction, personnel involved and reasons for the instruction. Upon recommencement of works, details of any corrective actions and / or remedial measures implemented will be recorded within Section 4.**

TABLE 4.3 ROLES AND RESPONSIBILITIES	
Position	**Roles and Responsibilities**
	• Give tool box talks as agreed with the site contractor to address key areas, including water pollution prevention, protected species management, and on-site biodiversity. • Monitor potential environmental impacts, including: − Use of and storage of oils and toxic chemicals on site, e.g. cement − Dewatering of excavations (including turbine bases) − Silt control − Water management, including working in or close to watercourses − Protection of ecological interests, e.g. protected species and habitats • Identify environmentally-sensitive areas and ecological hazards for demarcation by the Contractor • Produce written reports to the Contractor following site visits and meetings. This includes monthly reports and a final report.
Specialist Ecologist / Environmental Consultant	Where a Specialist Ecologist / Environmental Consultant is employed, this person(s) will: • Provide advice and maintain regular liaison with the Project Site Manager, Project Manager, ECoW, EM, and Contractor and / or other specialist Environmental Consultant as and when required. • Undertake specific monitoring activities and reporting as defined in agreed documentation prepared as part of the planning process.
Contractor Appointments	
Construction Manager	[The Contractor is required to specify roles and responsibilities for each individual below]
Site Agent	[To Be Confirmed]
Foreman	[To Be Confirmed]
EM	[To Be Confirmed]
Other Nominated Person(s)	[To Be Confirmed]

FIGURE 4.1 GENERAL COMMUNICATION PLAN

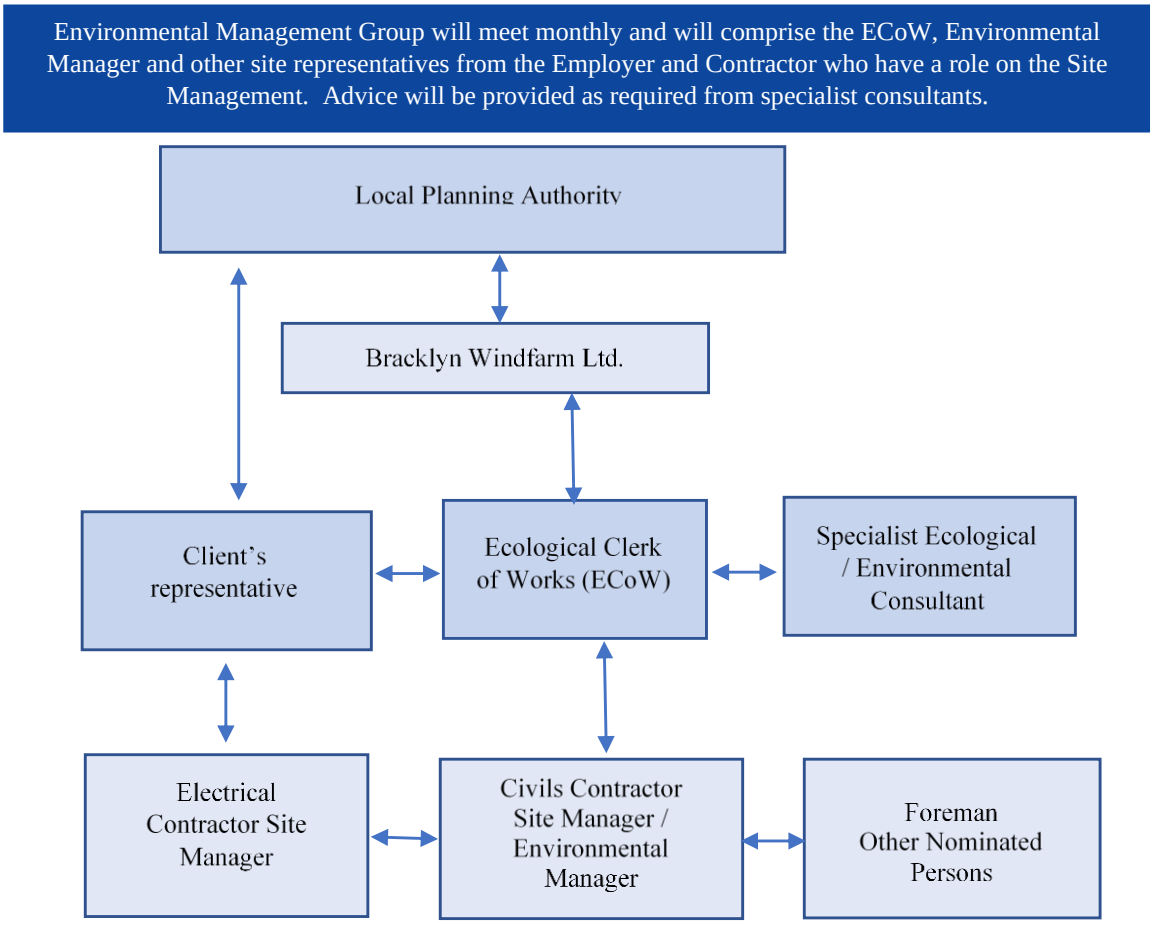


Figure 4.1 General Communication Plan

4.6 Training, Awareness and Competence

All site personnel will receive environmental awareness information as part of their initial site briefing. The detail of the information should be tailored to the scope of their work on site. This will ensure that personnel are familiar with the environmental aspects and impacts associated with their activities, the procedures in place to control these impacts and the consequences of departure from these procedures.

The CEMP will be posted on the main site notice board during the project. The environmental performance at the site will be on the agenda of the monthly project management meetings for the project. Elements of the CEMP will be discussed at these meetings including objectives and targets, the effectiveness of environmental procedures etc. Two-way communication will be encouraged by inviting all personnel to offer their comments on environmental performance at the site.

4.7 Emergency Preparedness and Response

An emergency preparedness and response procedure are required to prevent environmental pollution incidents. Suitable spill kits and absorbent material for dealing with oil spills will be maintained on site. In the event of pollution or potential risk of pollution, Westmeath County Council and Meath County Council will be informed immediately. In the case of water pollution, in addition to Westmeath County Council, Inland Fisheries Ireland will also be informed immediately. In the case of new developments in relation to badgers on site. the Department of Culture, Heritage and the Gaeltacht will be informed.

5 CORRESPONDENCE, RECORDS & REPORTS

5.1 Requirements

The Contractor will insert / file all communication records and reports associated with Environmental Management and implementation of this CEMP under this Section 5. As a guide, the following sub-sections of filed information will be required (at a minimum):

A) Meeting minutes and attendance record

B) Weekly Environmental Reports

C) Monthly Environmental Reports

D) Environmental Checks

E) Audit Reports

F) Ecology documentation and monitoring records

G) Pollution Prevention, including a Pollution Prevention Measures Register

H) Water Quality documentation and monitoring records

I) Archaeology documentation and monitoring records

J) Ground Risk, including a Geotechnical Risk Register

K) Waste Management documentation

L) Licensing and Consents: copies of all permissions, consents, licenses and permits and related correspondence. A summary record of all such documents shall also be provided as per Table 5.1 of this CEMP.

M) General Correspondence: all other relevant internal and external communication records relating to environmental management issues and implementation of the CEMP.

N) Training Records

O) Toolbox Talk Records

P) EM Reports

All of these documents and records will be made available for inspection in the site office. The documentation will be maintained and will be reviewed on a regular basis with revisions controlled in accordance with the site quality plan.

5.2 Environmental Audits

The Contractor's EM will consult and assist with the Client EM in evaluating compliance with applicable legislation by means of a monthly Environmental Audit.

A blank Environmental Audit Report form is included in TS1 Environmental Incident and Emergency Response Plan.

All completed audit report forms and records of corrective actions (and close outs) must be filed within this Section of the CEMP.

5.3 Environmental Consents, Licenses & Permits

The Contractor's EM (or otherwise nominated responsible person(s), in conjunction with the ECoW, will complete the summary record for all applicable permissions, consents, licenses and permits obtained for the site. This record will follow the format provided in Table 5.1.

TABLE 5.1 RECORD OF ENVIRONMENTAL CONSENTS, LICENSES AND PERMITS ISSUED		
Consents, Licenses & Permits	**Governing Legislation**	**Licensed Activity**
Pollution Control & Hydrology		
Section 50 consents for watercourse crossing (application in progress)	EU (Assessment and Management of Flood Risks) Regulations SI 122 of 2010 and Section 50 of The Arterial Drainage Act, 1945.	Construction, Replacement or Alteration of Bridges and Culverts.
Biodiversity		
Waste Management / Contaminated Land		
Noise / Vibration		
Archaeology		
Transport		
Other		

5.4 Environmental Monitoring and Measuring

All of the mitigation measures outlined in Section 3.0 will be monitored, where applicable. The Contractor will put in place a program of monitoring for dust, noise, vibration and water sampling in accordance with the requirements of this CEMP. A separate Ecological and Environmental Monitoring Proposals Document has been prepared and should be read in conjunction with this CEMP.

Copies of all records will be maintained in the site office and will be reviewed by the Contractor.

5.5 Non-Conformance, Corrective and Preventative Action

Non-Conformance Notices will be issued where there is a situation where limits associated with activities on the project are exceeded, or there is an internal/external complaint associated with environmental performance.

Non-Conformance is the situation where essential components of the Environmental Management Statement (EMS) are absent or dysfunctional, or where there is insufficient control of the activities and processes to the extent that the functionality of the EMS in terms of the policy, objectives and management programmes, is compromised.

Correction will be required in order to improve the identified non-conformance. The EMS and all its components must conform to the CEMP, objectives and targets and the requirements of the ISO 14001 management standard. In the event of non-conformance with any of the above, the following must be undertaken:

- Cause of the non-compliance;
- Develop a plan for correction of the non-compliance;
- Determine preventive measures and ensure they are effective;
- Verify the effectiveness of the correction of the non-compliance;
- Ensure that any procedures affected by the corrective action taken are revised accordingly.

Responsibility must be designated for the investigation, correction, mitigation and prevention of non-conformance.

6 TECHNICAL SCHEDULES & AVAILABLE INFORMATION

6.1 Technical Schedules

Various Technical Schedules have been prepared by Jennings O'Donovan and Partners Ltd. as listed in Table 6.1. These are intended to provide a benchmark for best practice and to define Bracklyn Windfarm Ltd.'s minimum requirements for environmental management and mitigation.

6.2 Contractor Requirements

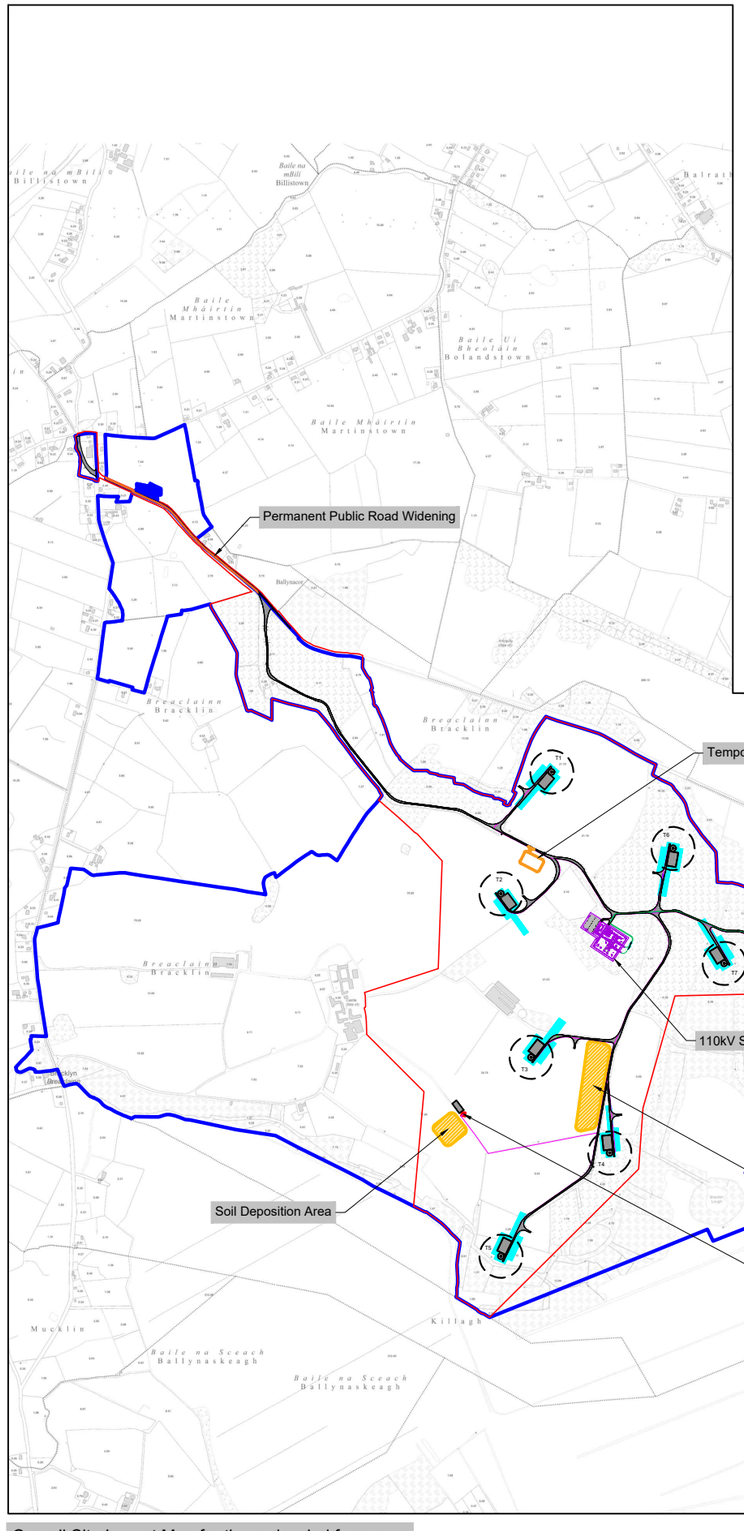
The Contractor is required to further develop the Technical Schedules into detailed site and works specific environmental plans, method statements and procedural documents. Table 6.1 provides a summary of the content of the Technical Schedules and the Contractor's obligations for their further development.

TABLE 6.1 LIST OF TECHNICAL SCHEDULES		
TS 1	Environmental Incident and Emergency Response Plan	The Contractor will prepare a detailed Environmental (Incident and Emergency) Response Plan. This will include procedures for dealing with containment of accidental chemical or fuel spills, potential overload of the drainage system by silt during unforeseen adverse weather conditions etc.
TS 2	Surface Water Management Plan	The SWMP has described how the site drainage system will operate to minimise modification and disruption to the existing site hydrology. This includes an outline of the proposed drainage maintenance and management regime post-construction. The contractor is obliged to implement the SWMP.
TS 3	Water Quality Monitoring Plan (WQMP)	The WQMP is to be agreed with Westmeath County Council and Meath County Council upon which, the contractor will be obliged to implement it.
TS 4	Spoil Management Plan (SMP)	The SMP has estimated the volume of spoil that will be generated during the construction phase, and it outlines the locations where the material can be re-used on site. The contractor is obliged to implement the SMP.
TS5	Waste Management Plan (WMP)	A WMP is intended to implement reduction and effective management of resources and waste during the early design stages of the wind farm construction, through to completion, such that legal compliance is met; project build costs are minimised; a framework for continuous improvement and best practice is implemented and maintained; and carbon emissions and other negative environmental impacts associated with the production and management of waste materials are

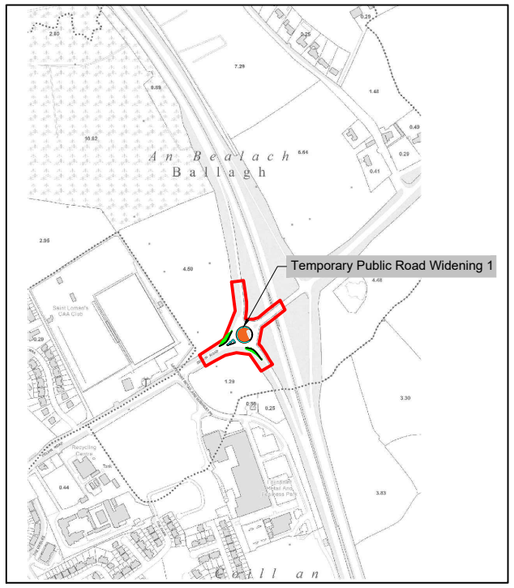
TABLE 6.1 LIST OF TECHNICAL SCHEDULES		
		minimised. The WMP provides an outline of the minimum requirements to be contained within the Contractor's detailed WMP. TS5 also provides an outline of the anticipated waste management procedures and routes that may apply during construction. In preparation of the detailed WMP, the Contractor will liaise the local authority and relevant bodies to determine requirements for, and obtain, licenses and consents associated with waste management and foul water discharge from the site where appropriate.

Appendix A

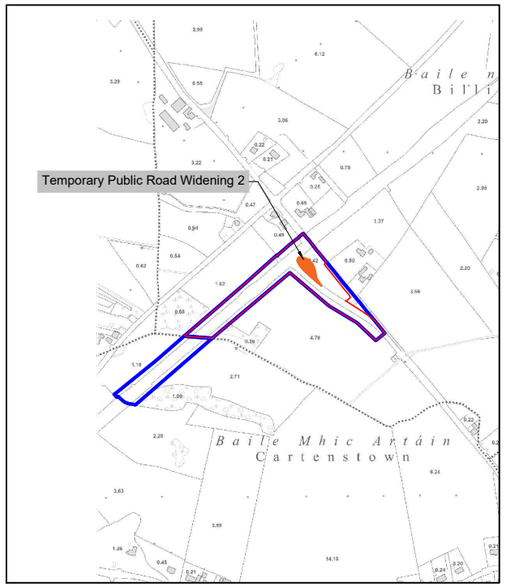
Drawings



Overall Site Layout Map for the main wind farm area
(Scale 1:23,000)



Overall Site Layout Map for Temporary Public Road Widening 1
(located approximately 15km south west of the main wind farm area)
(Scale 1:12,500)



Overall Site Layout Map for Temporary Public Road Widening 2
(located approximately 3km north west of the main wind farm area)
(Scale 1:12,500)

Legend:

- Ownership Boundary
- Application Boundary
- Wind Farm Access Tracks & Crane Hardstanding Areas
- Indicative Wind Farm Cable Routes
- 110kV Connection Cable Route
- Temporary Construction Compound
- Indicative Areas for be used for the storage and assembly of the turbine components prior to turbine erection. Area to be graded and leveled as required. Area to be reinstated after the wind farm has been constructed.
- Soil Deposition Areas
- Communications Chamber / Joint Bay / Link Box Chamber
- Registed Right of Way Areas

Date:	Rev:	Description:	Drawn By:

Prepared By:

Galetech Energy Services
Clondargan, Stradone
Co. Cavan, H12 NV06
info@galetechenergy.com
www.galetechenergy.com

Client: Bracklyn Wind Farm Limited

Job Title: Bracklyn Wind Farm

Drawing Title: Overall Site Layout Map

Drawing No.:	Revision No.:
BRK_PAS_LOC_002	Rev00
Scale:	**Date:**
(A3) 1:23,000, 1:12,500	27/07/2021

Drawn By:	Checked By:	Confirmed By:
J.B.	S.C.	D.O.

Bracklyn Wind Farm Limited

Bracklyn Wind Farm,

Co. Westmeath & Co. Meath

Construction Environmental Management Plan (CEMP)

TECHNICAL SCHEDULE 1

Environmental Incident and Emergency Communication Response Plan

September 2021

Bracklyn Wind Farm Limited,
Greaghcrotta,
Tullyco,
Cootehill,
Co. Cavan.
Tel.: +353 (0) 49 555 5050

Jennings O'Donovan & Partners Limited,
Consulting Engineers,
Finisklin Business Park,
Sligo, F91 RHH9
Tel.: 071 9161416
Fax: 071 9161080
email: info@jodireland.com

JENNINGS O'DONOVAN & PARTNERS LIMITED
Project, Civil and Structural Consulting Engineers,
FINISKLIN BUSINESS PARK,
SLIGO,
IRELAND.

Telephone (071) 9161416
Fax (071) 9161080

Email info@jodireland.com
Web Site www.jodireland.com

DOCUMENT APPROVAL

PROJECT	Bracklyn Wind Farm, Co. Westmeath & Co. Meath.	
CLIENT / JOB NO	Bracklyn Wind Farm Limited	6175
DOCUMENT TITLE/NO.	Emergency Incidient and Emergengy Communication Plan	

	Prepared by	**Reviewed**	**Approved by**
Document *Draft*	Name Jody Gormley	Name Sarah Moore	Name John McElvaney
Date 1st July 2021	Signature	Signature	Signature

Document *Final*	Name Jody Gormley	Name Sarah Moore	Name John McElvaney
Date 9th September 2021	Signature	Signature	Signature

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1 INTRODUCTION

1.1 Why have an Environmental (Incident & Emergency) Response Plan?

Many construction and industrial sites intrinsically have the potential to cause significant environmental harm which could threaten water supplies, public health and wildlife in the event of an environmental incident. The aim of this plan is to see that in the event of an emergency, quick action will limit any impacts on humans and the local environment.

This response plan forms part of the pre commencement requirement for the works and outlines conditions of work for staff, and for every contractor or sub-contractor at the site.

1.2 Outline of this Environmental (Incident & Emergency) Response Plan

The information contained in this plan is a live document which needs to be updated regularly and forms the Environmental Incident & Emergency Response Plan (ERP), part of the Outline/Preliminary[1] Construction Environmental Management Plan (CEMP) for the proposed Bracklyn Wind Farm and Grid Connection.

It contains details of:

- Who should be contacted in an emergency?
- Procedures to be followed in an emergency
- Staff responsibilities in an emergency

1.3 What is an Environmental Incident?

This plan should be instigated once there has been an emergency or environmental incident on site or elsewhere linked to the construction of the proposed Bracklyn Wind Farm and Grid Connection. Such an incident is a discharge to air, land or water that could cause environmental damage. Causes of environmental incidents on site include:

- Leaking plant or equipment
- Containment Failure
- Fire
- Land Slide
- Vandalism
- Overfilling of containment vessels

[1] The terms 'Preliminary' and 'Outline' are used interchangeably throughout this report.

- Flooding on site
- Leaking Portaloo
- Discharge of raw or partially treated effluent
- Wind-blown waste, litter or dust
- Fuel drips or spills during refuelling
- Leak from fuel or chemical containers
- Contaminated water or sediment/silt entering a water course or drain
- Failure of pumps and pipelines

Any of these incidents could affect drainage systems, surface waters, aquatic ecosystems, groundwater and soil. These incidents could also affect air quality by producing toxic fumes and airborne pollutants which may damage human health, wild and domestic animals and ecosystems.

1.4 Reference Documents

Current legislation has been taken into account into the production of this Plan and will be accounted for in the further development of the Contractor's Construction Management Plan.

This plan has been developed alongside other Management Plans that form part of the preliminary Construction Environmental Management Plan (CEMP) including a:

- Surface Water Management Plan (SWMP)
- Water Quality Management and Inspection Plan (WQMIP)
- Spoil Management Plan (SMP)
- Waste Management Plan (WMP)

2 GENERAL REQUIREMENTS OF AN ERP

As mentioned, environmental incidents may include flooding, spillages (oil and chemicals), contaminated run-off, riverbed disturbance, damage to underground services, damage to habitats, poor waste disposal and storage. This ERP provides:

- An outline of the construction works and references to relevant existing environmental plans
- Summarises local environmental sensitivities
- Identifies key mapping reference points for the site
- Identifies key staff and 24-hour contact details to be contacted in the event of an emergency

- Identifies key external bodies and emergency response numbers who should be contacted in the event of an emergency
- Details an Inventory of Chemical Products and Waste Inventory on Site*
- Details an Inventory of Pollution Prevention Equipment
- Provides details of staff trained in the use of spill kits and booms etc.
- Provides details of reporting requirements
- Provides detailed procedures to be followed in the event of an emergency and details staff responsible for re-positioning and moving of plant
- Provides a summary sheet for operatives outlining key actions in the event of an emergency. This will be available to all operatives on site.

***Because of the nature of wind farm construction operations and the nature of works on site, the potential pollutants will vary. Therefore sections 4 and 5 will be continually updated at the site office*.

3 CONSTRUCTION WORKS AT BRACKLYN WIND FARM.

Bracklyn Wind Farm Limited. intends to develop a 9 no. turbine Wind Farm project and Grid Connection on lands at Bracklin, Co. Westmeath and Coolronan, Co. Meath. The proposed Development is located in east Co. Westmeath and west Co. Meath, approximately 16 kilometres (km) east of Mullingar, approximately 4km south of Delvin and approximately 5km north of Raharney. The proposed Development at the Site will consist of the following:

- 9 no. wind turbines with a maximum tip height of 185 metres (m);
- All associated foundations and crane hardstanding areas;
- All associated underground electrical and communications cabling;
- Provision of new internal wind farm site access tracks and use of, and upgrades to, existing agricultural/forestry tracks, and associated site entrance from the L5508 local public road;
- 1 no. site control building;
- 1 no. free-standing meteorological mast of 104m in height;
- 1 no. temporary construction compound;
- Felling of up to 28 hectares (ha) of commercial forestry plantation to facilitate the construction of infrastructure;
- The storage of excavated material at 2 no. spoil deposition areas;
- Upgrade works to public roads along the turbine component haul route;

- A 110 kilovolt (kV) 'loop-in/loop-out' Air-Insulated Switchgear (AIS) electrical substation and all associated electrical equipment including an Electricity Storage System ;
- 6.3km of 110kV underground electricity lines, accompanied by 2.5km of associated access track and 3 no. site entrances to facilitate connection of the proposed electricity substation to the existing 110kV Mullingar-Corduff overhead electricity transmission line;
- Upgrade works to public roads along the turbine component haul route; and
- All associated and ancillary site development, excavation, construction, landscaping and reinstatement works, including provision of site drainage infrastructure and surface water protection measures.

4 INCIDENT & HAZARD REPORTING

A reporting system has been developed for reporting environmental incidents or hazards for the site. These reports will be logged so that they can be regularly revised and form part of the response plan procedural review.

The last page on this report has attached a blank environmental incident report that should be completed in the event of an accident/incident. This includes details of all non-compliance and corrective actions carried out as a result of any incidents.

5 WASTE DISPOSAL AFTER ENVIRONMENTAL INCIDENCES

If spill kits etc. are used in the event of a pollution incident, operatives need to carefully dispose of used equipment by carefully placing them in a sealed bag or container. They should then be removed from site by a licensed waste contractor as per the Waste Management Plan (WMP).

6 SITE INDUCTION AND TOOLBOX TALKS

It is imperative that all contractors, sub-contractors and staff on site are fully familiar with this ERP and it will be detailed regularly in Toolbox Talks. During these talks, they will also receive regular reminders of the importance of the local environment and of the necessary environmental controls that are in place on site where the windfarm is being developed.

7 MEASURES REQUIRED TO PREVENT SPILLAGES AND CONTAMINATION

7.1 Measures to Specifically Prevent Contamination from Leakages and Spillages

The following measures are proposed to specifically prevent contamination of surface water, ground water, peat, soils and subsoils by leakages, spillages of hydrocarbons or other chemicals:-

- The volume of fuels or oils stored on site will be minimised. All fuel and oil will be stored in an appropriately bunded area within the temporary construction compound. Only an appropriate volume of fuel will be stored at any given time. The bunded area will be roofed to avoid the ingress of rainfall and will be fitted with a storm drainage system and an appropriate oil interceptor;
- All bunded areas will have 110% capacity of the volume to be stored;
- On site re-fuelling of machinery will be carried out using a mobile double skinned fuel bowser. The fuel bowser, a double-axel custom-built refuelling trailer will be re-filled at the temporary compound and will be towed around the site by a 4x4 jeep to where plant and machinery is located. The 4x4 jeep will also be fully stocked with fuel absorbent material and pads in the event of any accidental spillages. The fuel bowser will be parked on a level area in the construction compound when not in use and only designated trained and competent operatives will be authorised to refuel plant on site. Mobile measures such as drip trays and fuel absorbent mats will be used during all refuelling operations to avoid any accidental leakages;
- All plant and machinery used during construction will be regularly inspected for leaks and fitness for purpose;
- Spill kits will be available to deal with any minor accidental spillages within the temporary construction compound and during re-fuelling;
- All waste tar material arising from road cuttings (from trenching in public roads and haul route upgrade works) will be removed off-site and disposed of at a licensed waste facility. Due to the potential for contamination of groundwater soils and subsoils, it is not proposed to utilise this material for any reinstatement works.
- Self contained port-a-loos (chemical toilets) with an integrated waste holding tank will be installed at the site compound, maintained by the providing contractor, and removed from site on completion of the construction works;

7.2 Leakages and Spillages During Wet Weather

The works programme for the initial construction stage of the development will take account of weather forecasts, and predicted rainfall in particular. Large excavations and movements of soil/subsoil or vegetation stripping will be suspended or scaled back if prolonged or intense rain is forecast. The extent to which works will be scaled back or suspended will relate directly to the amount of rainfall forecast.

The following forecasting systems are available and will be used on a daily basis at the site to direct proposed construction activities:-

- General Forecasts: Available on a national, regional and county level from the Met Eireann website (www.met.ie/forecasts). These provide general information on weather patterns including rainfall, wind speed and direction but do not provide any quantitative rainfall estimates;
- Meteo Alarm: Alerts to the possible occurrence of severe weather for the next 2 days. Less useful than general forecasts as only available on a provincial scale;
- 3 hour Rainfall Maps: Forecast quantitative rainfall amounts for the next 3 hours but does not account for possible heavy localised events;
- Rainfall Radar Images: Images covering the entire country are freely available from the Met Eireann website (www.met.ie/latest/rainfall_radar.asp). The images are a composite of radar data from Shannon and Dublin airports and give a picture of current rainfall extent and intensity. Images show a quantitative measure of recent rainfall. A 3 hour record is given and is updated every 15 minutes. Radar images are not predictive; and,
- Consultancy Service: Met Eireann provide a 24 hour telephone consultancy service. The forecaster will provide interpretation of weather data and give the best available forecast for the area of interest.

Using the safe threshold rainfall values will allow work to be safely controlled (from a water quality perspective) in the event of an impending high rainfall intensity event.

Works will be suspended if forecasting suggests either of the following is likely to occur:-

- >10 mm/hr (i.e. high intensity local rainfall events);
- >25 mm in a 24-hour period (heavy frontal rainfall lasting most of the day); or,
- >half monthly average rainfall in any 7 days.

Prior to works being suspended the following control measures will be completed:-

- Secure all open excavations;
- Provide temporary or emergency drainage to prevent back-up of surface runoff; and,
- Avoid working during heavy rainfall and for up to 24-hours after heavy events to ensure drainage systems are not overloaded.

8 SUMMARY SHEET FOR MACHINERY & PLANT OPERATORS

This summary sheet is for all site personnel. A laminated copy will be kept on all site vehicles/ machinery.

8.1 Procedures to be followed in the event of an incident:

The following procedures are intended as a guide in dealing with incidents. Health & Safety guidance should be followed at all times applying common sense and ensuring the health & safety of yourself and others:

1. Identify the source of the spillage and cut off source if possible, e.g. by closing valve, righting container, reinstating bund etc.
2. Work on site will cease and all operatives will assist in placing spill mats on the affected area. Site Manager/ Main Contact should be notified.
3. Identify where spillage may go. If spillage is near a watercourse (drainage/ditch/ river) divert spillage away from the watercourse through the use of absorbent materials from the spill kit.
4. If a watercourse is at risk of contamination from suspended solids from a slope failure, do as follows:

   a) Place straw bales wrapped in geotextile or sand/gravel bags with geotextile curtains **immediately** in the watercourse(s) at regular intervals downstream from the incident. These sand/straw bags and bales will be removed and replaced with stone filters once water quality is stabilised.

   b) Stone check dams faced with a layer of geotextile will be constructed at critical points along the watercourse.

   c) Small sumps will be formed intermittently between the check dams to reduce the amount of suspended solids contained in the water.
5. OIL SPILL IN WATERCOURSE. If spill has reached the watercourse, do as follows:

   a) Place flexible absorbent booms across watercourse, ahead of the contamination within a quiet stretch of water.

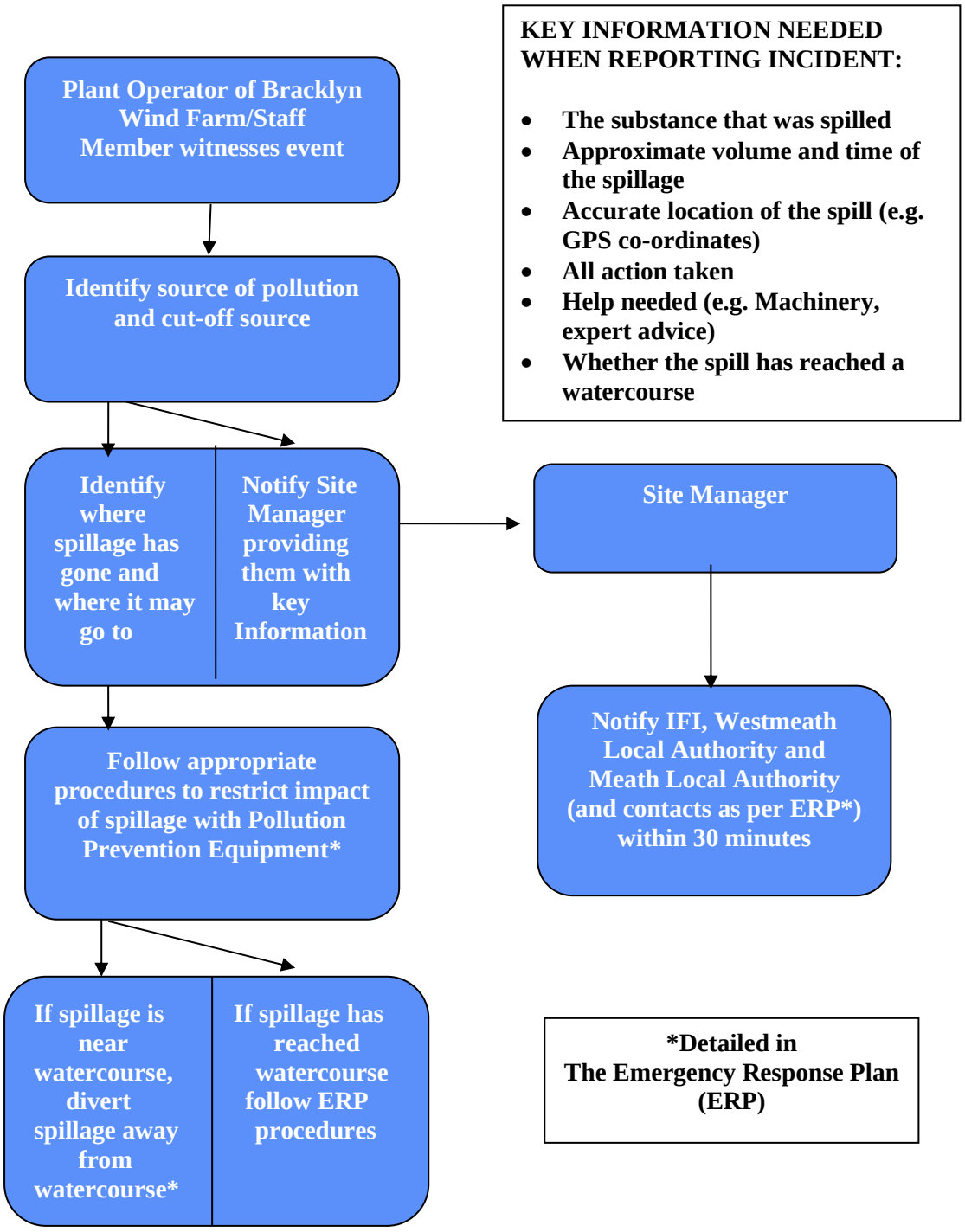
b) Place absorbent cushions in the water immediately upstream of these booms as well as downstream of the booms.

c) Remove and replace saturated absorbent material as required. Please ensure removed cushions are placed in sealed polythene bags/containers and disposed of by the principal waste contractor.

6. Notify all parties in the order listed overleaf. Notification should be made by one member of staff whilst remainder of staff present deal with the spill.
7. Dig up all contaminated ground as soon as possible/immediately. All contaminated materials should be placed in sealed polythene bags/containers and disposed of appropriately by an appropriate licensed waste contractor.
8. Complete required record of incident and response into reporting system

8.2 Communication Plan

A Communication Plan (to be followed in the event of a spillage) will be provided by the Contactor, in liaison with relevant stakeholders and will be included in the updated ERP prior to commencement of site development works. An outline Communication Plan is proposed below:



8.3 Environmental Response Plan for Bracklyn Wind Farm

INCIDENT RESPONSE PLAN FOR BRACKLYN WINDFARM ***Based on template provided in GPP 21 –Guidance for Pollution Prevention***	
Site Address: **Bracklyn Wind Farm** **Bracklin,** Co. Westmeath **Official Company Address:** Bracklyn Wind Farm Limited Greaghcrotta, Tullyco, Cootehill, Co. Cavan. Tel.: +353 (0) 49 555 5050 **KEY HOLDERS FOR SITE – NAME & CONTACT NUMBERS:**	**NGR:** E:261426, N:258584 **Map references:** OSI Discovery Sheet 42
Overview of the activities on site: **Include number of employees at different time of the day:** Daylight Hours: Dusk to Dawn: Weekend Dusk to Dawn: Bank Holidays:	
Description of surrounding area:	
Date & Version of the plan:	**Name & position of person responsible for compiling/approving the plan:**
Review Date	**Date of next exercise:**
Objectives of the plan: To limit any potential harmful impact to the local environment through swift and appropriate actions in the event of an emergency.	
List of external organisations consulted in the preparation of this plan with contact details	

Distribution list of who has received this plan and which version. *Please note that it is recommended that you review and revise this plan regularly:*

8.4 External and Internal Contacts

External Contacts		
Contact	**Office Hours**	**Out of Office**
Emergency Services (Fire/Police/Ambulance)	999 or 112	999 or 112
Local Garda Station	Delvin: 044-9664193 Killucan: 044-9374112	
Local Hospital. Midland Regional Hospital, Mullingar	044-934 0221	
Westmeath County Council, Áras an Chontae, Mount Street, Mullingar, Co. Westmeath. N91 FH4N	044-9332000	
Meath County Council, Buvinda House, Dublin Road Navan, Co. Meath. C15 Y291	046-9097065	
EPA Regional Office Athlone The Civic Centre, Church St. Athlone, Co. Westmeath	0906 475 722	1850 365 121
Inland Fisheries Ireland	01 8842600	1890 347 424 (24 hours a day)
Roads Service (Blocked/Flooded Roads)	0300 2000 100	0300 2000 100
ESB- Electricity Company	01 8529534	
Telecommunications – Eircom/Eir	1800475475	
Internal Contacts		
Names and position of staff authorised and trainers to activate and co-ordinate the plan. Staff to be contacted if need to move or evacuate the site		
Other Staff:		
Managing Director		

Site Manager		
Environmental Manager		
Health & Safety Manager		

8.5 Chemical Product & Waste Inventory

Chemical Product & Waste Inventory						
Trade name/ substance	**Solid/liquid/ gas or powder**	**UN number**	**Max amount**	**Location marked on site plan**	**Type of Containment**	**Relevant health & Environmental properties**

8.6 Pollution Prevention Equipment Inventory (On/Off-Site Resources)

Pollution Prevention Equipment Inventory (On/Off-Site Resources)			
Type	**Location**	**Amount**	**Staff contact**

For example:

- *Personal protective Equipment (PPE) available that should be worn*
- *absorbents*
- *drain mats/covers*
- *pipe blockers*
- *booms*
- *pumps*
- *sandbags*
- *Straw bales wrapped in geotextile*
- *silt fencing*
- *over drums*

IF ANY OF THIS EQUIPMENT REQUIRES SPECIALIST TRAINING – STATE WHO HAS BEEN TRAINED IN ITS USE AND DATE OF TRAINING (attach evidence where possible).

8.7 Site Environmental Incident Report Form

Site		Date	
Time		Weather:	
Report By:		Position:	
Bracklyn Wind Farm personnel present:		Position:	
Contractor Personnel Present:		Position:	

Description of Incident

Item Spilled	
Estimate of Volume of Spillage	

List of actions followed once incident was noted	**Time**	**Corrective Action By**	
		Action	**By**
Who first observed incident?			
First action			
Next Action			
Time Pollution Hotline was contacted			
Other			

Details of Clean-Up contractor or how contamination was removed from site:

Details of how this could be avoided in future:	
Details of review of internal procedures as result of this incident:	

DATE REPORT COMPLETED_____

Site:		**Date**:	
Time:		**Weather conditions:**	
Report by:		**Position**:	
Bracklyn Wind Farm personnel present:		**Position:**	
Contractor personnel present:		**Position:**	

Item	Questions	Yes	No	Corrective Action Required	
				Action	By
1. Miscellaneous					
1.01	Does the contractor carry out regular internal environment audits on the site? Are recommendations recorded and is corrective action monitored?				
1.02	Have any environment incidents occurred and have these been reported as per on site procedure?				
1.03	Does the site induction contain a section on environmental requirements, including spill procedures, and is this communicated effectively?				
2. Land					
2.01	Are areas of hard standing (excluding bunded and refuelling areas) appropriately drained?				
2.02	Have local roads been inspected and cleaned where necessary?				
2.03	Has all test pitting and soil stripping been monitored by an archaeologist?				
2.04	Have all site clearance works been checked by an ecologist prior to works?				

Item	Questions	Yes	No	Corrective Action Required	
				Action	By
3. Material and equipment					
3.01	Is there knowledge of the IFI |Guidelines on Protection of Fisheries During Construction Works in and Adjacent to Waters (2016) and OPW Environmental Guidance: Drainage Maintenance & Construction (2019)				
3.02	Are transformers/ generators located in secondary containment bunds?				
3.03	Are all bunds capable of containing 110% of the volume of the largest container?				
3.04	Is refuelling carried out in a designated refuelling bay?				
3.05	Does all site drainage on hard standing drain to an oil interceptor?				
3.06	Is the designated area for oil, fuel and chemical storage appropriately sited (i.e. on hard standing at least 10m from a watercourse)?				
3.07	Are there procedures in place to monitor bund integrity and mange bund rainwater levels? Are these followed and recorded?				
3.08	Is there awareness that oil or residue from contaminated water removed from bunds should be disposed of as special waste and not discharged to land or the water environment? (oil absorbent materials (pads etc.) should be used first)				
3.09	Are all drums and mobile plant (e.g. generators) placed on drip trays more than 10m from any watercourse?				
3.10	Is all plant maintained in a good state of leaks? Are there records of this?				
3.11	Are there adequate spill kits available and stored in close proximity to potential risks?				
3.12	Are all refuelling browsers double skinned, locked when not in use, and in a good state of repair?				

Item	Questions	Yes	No	Corrective Action Required	
				Action	By
3.13	Is there evidence of unmanaged/ unrecorded fuel / oil spillages on site?				
3.14	Are dry or wet wheel washing facilities fully operational and effective?				
3.15	If wet wheel washing facilities are required, are these closed systems with no discharge to the water environment?				
3.16	Are there laboratory certificates (accredited by the Irish National Accreditation Board) to confirm that imported material stone aggregate brought onto site is free from any contamination?				
4. Noise, Dust and Light					
4.01	Are there facilities to dampen stockpiles and site working areas/roads to suppress dust?				
4.02	Are vehicles carrying loose material sheeted at all times?				
4.03	Are construction works, or deliveries of materials to and from the development, audible at noise sensitive premises?				
4.04	Has all external construction lighting received the approval of the planning authority?				
5. Waste					
5.01	Is the site tidy and free from litter?				
5.02	Is there evidence of waste beyond the site boundary?				
5.03	Is waste segregated and kept securely in containers in clearly designated areas?				
5.04	Does all waste leaving the site have the appropriate duty of care paperwork?				
5.05	Is all waste leaving the site being taken to an appropriately licenced site?				
5.06	Does all special/ hazardous waste (e.g. oil contaminated soils, waste oil) have the appropriate Special Waste Consignment Note?				
5.07	Is material re-used/recycled on site where possible?				
5.08	Are waste management practices in line with the site waste management plan?				
5.09	Are relevant Waste Management Exemptions in place for use of waste on site (e.g. use of waste concrete to create foundation sub-base)?				

Item	Questions	Yes	No	Corrective Action Required	
				Action	By
5.10	Is there any evidence of burning on site?				
5.11	Is there any evidence of unlicensed burial of waste?				
6. Water					
6.01	Do all discharges to land or watercourses have appropriate authorisation from Local Authorities /IFI?				
6.02	Does all watercourse engineering (bank protection, crossing etc.) have the appropriate authorization from Local Authorities / IFI?				
6.03	Do any abstractions from a watercourse or groundwater body have the appropriate authorization from Local Authority / IFI?				
6.04	Has confirmation for the SUDS design for access roads been gained from Local Authority / IFI?				
6.05	Are cut-off ditches installed on the uphill side of the working area to avoid contaminated surface water run-off?				
6.06	Have field drain been diverted where necessary?				
6.07	Is adequate treatment (e.g. settlement tank/lagoons/discharge to land) provided to prevent silt contaminated water entering watercourses and groundwater?				
6.08	Has vegetation removal/ clearance of the site been minimised to avoid unnecessary areas of bare ground?				
6.09	Have buffer-strips been left between working area and watercourses?				
6.10	Is plant operating in the watercourse?				
6.11	Have all culverts been installed at the base of stockpiles situated within close proximity to watercourses?				
6.12	Have silt fences been installed at the base of stockpiles situated within close proximity to watercourses?				
6.13	Are there adequate controls on site construction roads to minimize sediment runoff into watercourses (in particular, are there adequate flow attenuation measures within surface drain)?				
6.14	Are there any sign of decaying straw bales in water courses? (this could lead to organic pollution of the water course)				
6.15	Are silt traps regularly maintained?				

Item	Questions	Yes	No	Corrective Action Required	
				Action	By
6.16	Has ease of maintenance been considered in the design of permanent drainage features?				
6.17	Is there evidence of contamination of any watercourse (e.g. with oil, sediment, concrete, waste) in the vicinity of the works?				
6.18	Is monitoring of potential impacts on watercourses carried out on a regular basis and fully recorded?				
6.19	Are dewatering operations being carried out in such a way to minimise sediment contamination?				
6.20	Is drainage and run off in concrete batching areas adequate?				
6.21	Are adequate pollution prevention measures considered and put in place during concrete pours?				
7. Landscape					
7.01	Have earthworks been designed to promote successful re- instatement of vegetation?				
7.02	Are reinstatement and restoration works being implemented in a timely manner as per the requirements of the Contract?				
8. Ecology					
8.01	Have storage sites (soil, plant etc.) been sited on areas of lower quality habitat where possible?				
8.02	Is the ECoW a member of the institute of Ecology and /or Environmental management as required by planning conditions?				
8.03	Have buffer zones been constructed and maintained around designated protected species exclusion areas (e.g. red squirrel dreys, water vole habitats, otter holts, badger setts etc.)?				
8.04	Have toolbox talks on the subject of ecology and environmental responsibilities on site been delivered? Have attendance record been maintained for these?				

Item	Questions	Yes	No	Corrective Action Required	
				Action	By
9. Documentation Check					
9.01	Start-up meeting record				
9.02	Full contacts list in Section 3, Table 3.0 of CEMP				
9.03	Induction records				
9.04	Pollution Prevention Measures Register				
9.05	Geotechnical Risk Register				
9.06	Weekly meeting minutes				
9.07	Records of environmental checks and routine monitoring of mitigation measures				
9.10	Water Quality Monitoring Results				
9.11	Safety and Environmental Awareness Reports (SEARs). Filed and entered on database?				
9.12	Safety and Environmental Audit Reports for the site. (If yes, insert date of last audit)				
9.13	Contractor's Environmental Plans (or Construction Method Statements):				

Bracklyn Wind Farm Ltd.

Bracklyn Wind Farm,

Co. Westmeath

Construction Environmental Management Plan (CEMP)

TECHNICAL SCHEDULE 2

Surface Water Management Plan

September 2021

Bracklyn Wind Farm Ltd,
Greaghcrotta,
Tullyco,
Cootehill,
Co. Cavan.
Tel.: +353 (0) 49 555 5050 (c/o Galetech Energy Services)

Jennings O'Donovan & Partners Limited,
Consulting Engineers,
Finisklin Business Park,
Sligo, F91 RHH9
Tel.: 071 9161416
Fax: 071 9161080
email: info@jodireland.com

JENNINGS O'DONOVAN & PARTNERS LIMITED
Project, Civil and Structural Consulting Engineers,
FINISKLIN BUSINESS PARK,
SLIGO,
IRELAND.

Telephone (071) 9161416
Fax (071) 9161080

Email info@jodireland.com
Web Site www.jodireland.com

DOCUMENT APPROVAL

PROJECT	Bracklyn Wind Farm, Co. Westmeath.	
CLIENT / JOB NO	Galetech Energy Developments Ltd & Bracklyn Wind Farm Ltd	6175
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	Prepared by	**Reviewed**	**Approved by**
Document *Draft*	Name Jody Gormley	Name Sarah Moore	Name John McElvaney
Date 15th May 2021	Signature	Signature	Signature

Document *Final*	Name Jody Gormley	Name Sarah Moore	Name John McElvaney
Date 30th September 2021	Signature	Signature	Signature

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APPENDIX C – Settlement Pond Calculations

1 INTRODUCTION

1.1 Overview

This outline Surface Water Management Plan (SWMP) for the Development describes the site drainage that has been designed for the site using the following principles:

- Ecologically Sensitive Processes
- Sustainable Drainage Systems (SuDS)

This is a live document and where there is a requirement for variation on the ground to provide more ecologically sensitive drainage then the SWMP will be updated to reflect this. The SWMP will be updated by the appointed Contractor and changes to the document will be agreed with the Project Hydrologist and Ecological Clerk of Works (EcoW) before drainage works commence. The SWMP aims to:

- Describe environmental sensitives of the site and the buffer zones
- Describe how the system will operate to minimise modification and disruption to the existing site hydrology
- Outline the proposed maintenance regime
- Outline the proposed drainage management post-construction

2 BASELINE ENVIRONMENT

2.1 Site Description

The proposed Development is located in east Co. Westmeath, approximately 16km east of Mullingar, 4km south of Delvin and 5km north of Raharney. The site is located in the townland of Bracklin, on a lowland area containing a mosaic of improved and semi-improved agricultural fields. The Site consists mainly of improved and semi-improved agricultural fields with cutover bog and conifer plantations of varying age and class throughout the area. The area surrounding the Site has very little variation in elevation and is typical of an Irish midland landscape.

2.2 Topography

The topography at and in the immediate area surrounding the Site is relatively undulating. Local topography is broadly flat with gradual inclines of <3 degrees gradient. The site extends from approximately 76m AOD to approximately 99m AOD throughout the site, with topography generally sloping gradually towards the east.

2.3 Hydrology and Geology

The majority of surface water associated with the project site drains into the Cartenstown Stream and the directly connected Bolandstown Stream which is central to the Site. The Bolandstown stream eventually discharges into the Cartenstown Stream, which then discharges into the Stonyford River, which is part of the Stonyford_040 river sub basin, within the Boyne sub catchment and catchment.

A small area towards the northeastern corner of the Site, near the two “End Masts” in Coolronan, Co. Meath, is drained directly by a segment of the Stonyford River which is within the Stonyford_030 river sub basin and thus, also within the Boyne subcatchment and catchment. Another small area towards the northwest corner of the project site is drained by the Claddagh stream, within the Deel (Raharney)_010 river sub basin and sub catchment, which is part of the Boyne catchment. The final area along the eastern boundary of the site is drained by the Greenan Stream, also contained within the Deel (Raharney)_010 river sub basin and sub catchment and thus, the Boyne catchment.

The site is relatively flat and well drained. The general geology of the site consists of either peat or mineral topsoil (less than 0.2m) on sandy, gravelly silt with limestone bedrock underneath.

3 ENVIRONMNETAL CONSTRAITNS AND MITIGATION MEASURES

There are a number of construction phase mitigation measures that must be adhered to during the installation of the drainage system. The relevant EIAR chapters where mitigation measures can be found are shown in Table 3.1.

Table 3.1 Location of relevant mitigation measures

Element	Location of Mitigation Measures
Biodiversity	EIAR Chapter 5
Land and Soils	EIAR Chapter 6
Water	EIAR Chapter 7

4 DRAINAGE SYSTEM OVERVIEW

4.1 SuDS Drainage Design Criteria

The design criteria for the SuDS design are as follows:

- To minimise alterations to the ambient site hydrology and hydrogeology
- To provide settlement and treatment controls as close to the site footprint as possible and to replicate where possible the existing hydrological environment of the site
- To minimise sediment loads resulting from the development run-off during the construction phase
- To preserve Greenfield runoff rates and volumes
- To provide appropriate retention times
- To provide settlement ponds to encourage sedimentation and storm water runoff settlement
- To reduce stormwater runoff velocities throughout the site to prevent scouring and encourage settlement of sediment locally
- To manage the problems of erosion and allow for the effective revegetation of bare surfaces
- To control water within the site and allow for the discharge of runoff from the site within the limits prescribed in the Salmonid Regulations.

4.2 Purpose of a SuDS Drainage Design

There is increased potential for water pollution, in particular sedimentation to local surface water features due to the excavation and generation of spoil and emplacement of stone materials during the construction stage of the project. The purpose of incorporating a SuDS design 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.
- To regulate the rate of surface water run-off downslope to prevent scouring and to encourage settlement of sediment locally.

- To minimise the quantity of sediment laden stormwater and resulting settlement pond sizes by separating "clean" water from the "dirty" development runoff.

4.3 SuDS Design Philosophy

The overarching objective of the SuDS design is to ensure that all surface water runoff is comprehensively attenuated such that no silt or sediment laden waters or deleterious material is discharged into the local drainage system. While the SuDS, overall, is an amalgamation of a suite of drainage infrastructure; the overall philosophy is straightforward. In summary:-

- All surface water runoff will be directed to specially constructed swales surrounding all areas of ground proposed to be disturbed
- The swales will direct runoff into settlement ponds/silt traps where silt/sediment will be allowed to settle; and
- Following the settlement of silt/sediment, clean water will be discharged indirectly to the local drainage network via buffered outfalls thus ensuring that no scouring/erosion occurs.

The approach to treatment and attenuation of storm water is as follows:

- Additional drainage measures will only be added as necessary. The dimensions of these features will avoid intercepting large volumes of water.
- Storm water runoff from the proposed roads will be managed will crossfall downslope to mimic the natural drainage patterns of the site.
- Swale vegetation used will be appropriate to the local area and will be approved by the Ecological Clerk of Works.
- Temporary erosion protection together with silt fences may be required until the vegetation becomes established (coir matting or similar).
- Roads will be constructed from aggregate and will not be surfaced with bitumen materials, thus allowing for permeation, and helping to reduce runoff volumes. Therefore, a reduced runoff coefficient of 75% is applicable.
- An additional 20% will be included to take account for climate change. This will increase the total coefficient to 90%.
- Stormwater runoff within the swale will be treated through the provision of check dams, within a range depending on local slope of swale.
- The stone used for the construction of the check dams will be washed graded stone with a size range between approximately 5mm and 40mm.
- Discharging directly back into the surrounding area will assist in maintaining the hydrological characteristics of the site.

- Vegetation will be reinstated on slopes as early as possible.
- Stream crossings will be completed using bottomless culverts.
- Under track drainage will be provided with drainage pipes at existing surface water features. The under-track drainage will provide a means for flows to pass and maintain the natural flow throughout the site.
- A sump may be required for trench dewatering's, water will subsequently be pumped into settlement ponds and allowed to settle. The general location of the small sump will ensure that they pose minimal health and safety risk to site personnel.
- All drains will be kept as shallow as possible so that they do not pose any health and safety risk to plant or personnel. Maximum depth of standing water will be limited to 0.3m within the drains.
- The settlement ponds will be designed to cater for infilling and rehabilitation post construction phase of the project.
- The level of silt runoff during construction will be monitored and if it is excessive in any area this can be managed by the provision of additional silt attenuation features such as silt fences or silt traps. If the suspended solids levels remain high, water can be pumped from settlement ponds into tankers and transferred off site to a suitable water treatment facility subject to agreement with the Local Authority.
- Field drains will be piped directly under the track through appropriately sized drainage pipes.
- 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 surface water feature.

4.3.1 Design Philosophy

The SuDS design must be managed and monitored, at all times and particularly after storm or heavy rainfall and during construction phase environmental auditing. The design rationale is that of an integrated approach where each element is assessed for its potential contribution to sediment suspension and the appropriate mitigation measures integrated into the layout design. The design principles are as follows:

Minimise → Intercept → Treat → Disperse → Dilute

4.3.2 Minimise

The main principle of this SuDS design is to minimise the volume of 'dirty' water requiring treatment through means of informed, integrated and sustainable drainage design. It achieves this by keeping 'clean' water clean by interception and separation, and by collecting the 'dirty' water and treating it by

removing the suspended sediments. The resultant outflow is dispersed across vegetation and will become diluted through contact with the clean water runoff in the buffer areas before entering site/ roadside drains.

4.3.3 Intercept

The key sediment control measure is the separation of construction runoff from the clean water runoff that arises in the undisturbed areas of the site and surrounding lands. This significantly reduces the volume and velocity of dirty water that the sediment and erosion control measures need to deal with. To achieve separation, clean water infiltration interception drains are positioned on the upslope and dirty water drains positioned along the verge, with site surfaces sloped towards dirty water drains. The remainder of this clean water will be regularly piped under both the site roads and dirty water drains to avoid contamination. Piping the clean water regularly under the site roads allows the clean water to follow the course it would have taken before construction thus mimicking the existing surface water sheet flow pattern of the site.

4.3.4 Treat, Disperse and Dilute

The clean water infiltration interceptor drains are positioned upslope of the development footprint, to prevent any mixing of the clean and 'dirty' water. The infiltration interceptor drains redirect the clean water away from the site infrastructure, as best suits the natural topography of each sector. The clean water outflow is then discharged into either, an existing drainage network or dispersed through an area of vegetation where it can percolate into the ground naturally. These 'dirty water' drains collect all incident rainwater that falls on the development infrastructure and drain into the settlement ponds. The treated effluent is then dispersed across vegetation (through buffered outfalls) to further filter the discharge. Dispersal in this manner has the effect of allowing the smaller particle sizes to be taken up by the vegetation.

5 DETAILED DESIGN CONSIDERATIONS

5.1 Overview

This SuDS adopts a design for the drainage of the site. The following elements in series are proposed:

- Open Constructed drains for development run-off collection and treatment;
- Infiltration Interception Drains for upslope "clean" water collection and dispersion;
- Filtration Check Dams to reduce velocities along sections of road which run perpendicular to contours;
- Settlements Ponds and Buffered Outfalls to control and store development runoff to encourage settlement prior to discharge at Greenfield runoff rates;

5.2 Infiltration Interception Drains

Drainage management will ensure that natural runoff is not permitted to mix with construction runoff from sources such as excavation dewatering or track runoff. Design will ensure that infiltration interceptor drains be installed upslope of development, to intercept and divert clean surface water runoff, prior to it coming in contact with areas of excavation. Design will ensure that natural runoff infiltration interceptor drains are installed ahead of main earthworks wherever practical.

This is intended to reduce the flow of natural runoff onto any exposed areas of peat/soil, thereby reducing the amount of potential silt laden runoff requiring treatment. Installed drainage will allow provision for natural runoff water, upslope of the development, to collect in infiltration interceptor drain and directed away from the development. In certain areas it will be required to pass through under track clean water culverts, separate to drainage provided for track runoff, and be discharged downstream of site development.

Temporary silt / pollution prevention and scour protection measures will be provided in artificial natural runoff drainage installed in order to mitigate potential for scouring and transport of sediment from newly excavated channels which will be formed as part of the construction runoff drainage provisions.

Frequency of outflow points are designed to avoid collection and interception of large catchments creating significant point flows, with associated risks due to scour and hydraulic capacity.

5.3 Linear Track Drainage

Where linear track drains are utilised, it is proposed that stone filled check dams will be installed at a regular frequency, in order to reduce flow velocities and improve conditions for the settlement of solids in transit. Check dams will be constructed from 5-40mm crushed rock and will constitute the majority of the check dams. It is intended that these dams will be relatively simple to construct but will provide treatment of construction runoff at source. There will be outflow points (spillways) from the drains to the settlement ponds. No outflow will be permitted directly into natural watercourses.

5.4 Flow Attenuation & Filtration Check Dams

The proposed Bracklyn Wind Farm includes areas where infrastructure and accompanying drains cross generally flat/gently undulating gradients. In such situations, appropriate flow attenuation measures will be installed.

The roads within the Development will be constructed with an appropriate surface cross slope, so that all storm water flow will be directed towards the constructed drains located along road verges. The width and depth of constructed drains will be minimised as far as practical in order to reduce ground disturbance, excavation footprint (and hence volume of excavated materials) and also disruption of local hydrology as far as possible.

Permanent check dams (flow barriers or dams constructed across the drainage channel) will be installed at regular intervals within the dirty water cut off drains in order to reduce erosion and allow for greater flow control. These check dams are required in order to reduce the velocity of water and therefore allow settlement of coarser sediment particles as well as silt at low flow conditions. Reduction in flow velocity will also prevent scouring of the drainage channel itself.
Settlement build up will be monitored and cleaned during the construction stage when necessary. The number and location of check dams will be dependent on the slope, flow and volume of water, although the following general rules will be applied:

- The maximum spacing between check dams should be such that the toe of the upstream dam is at the same elevation as the top of the downstream dam.
- The centre of the check dam should be at least 0.2m lower than the outside edges.
- Side slopes should be 1:2 or less.
- A Terram membrane barrier or similar non-woven geotextile membrane will be placed around check dam.
- Check dams will be keyed at least 0.1m into the drainage channel bottom in order to prevent the dam washing out.
- Check dams will be maintained and monitored on a regular basis. Sediment will be removed before it reaches one half the original dam height.

Worked examples:

- The depth of a check dam is 0.3m high: => 0.3m x (1 in 100 gradient) = 30m spacing;
  => also; 0.3m x (1 in 50 gradient) = 15m spacing.
- For a 0.5m high check dam: => 0.5m x (1 in 50 gradient) = 25m spacing.

See Table 5.1 for recommended spacing, relative to the gradient of swale, for a 0.3m high check dam.

Table 5.1 Check Dam Spacing for typical 0.3m high check dam

Max Spacing (m)	Gradient
3m	10% (1 in 10)
4m	8% (1 in 12)
5m	6% (1 in 17)
6m	5% (1 in 20)
8m	4% (1 in 25)
10m	3% (1 In 33)
15m	2% (1 In 50)
20m	1.5% (1 in 67)
30m	1% (1 in 100)

Note: Table 5.1 spacing only applies to check dams with a 0.3m height. The spacing between check dam increases as the check dam height increases.

5.5 Settlement Ponds

Runoff from the windfarm road surface will be settled and attenuated to mimic natural runoff patterns. To capture runoff generated within the development footprint it is proposed to use constructed drains. Accumulations of runoff will then be transferred to settlement ponds. All drains will be kept as shallow as possible so that they pose no health and safety risk to plant or personnel. Settlement ponds are to be securely fenced to prevent easy access. The ponds are utilised to attenuate and to aid the removal of suspended solids from site runoff water. Settlement ponds will be emplaced at 65 locations along the drainage footprint.

Calculation parameters for the determination of storage requirements have been undertaken and are as follows:

- A 1 in 100-year rainfall return design (Source: Met Eireann - Please refer to Appendix A).
- An initial outlet overflow rate is applied of 4.0 l/s/ha (litres per second) which approximates to Greenfield run-off rates for the site. (Source: HR Wallingford – Please refer to Appendix B).
- The rational method is subsequently applied to calculate the flow volumes into each settlement pond over these respective periods. The Rational Method is expressed by the formula, where V is the volume of water generated in the settlement pond, C is the run-off co-efficient, A is the area of the hardstanding / catchment, I is the rainfall depth and t is the duration of rainfall occurrence.
- A runoff coefficient of 0.9 (75% runoff + 20% for Climate Change) is conservatively applied to all footprint areas.

- For attenuation, a 1 in 100-year rainfall, 6-hour return period is used as outlined in Section 7.3.1.4 of the EIAR.

5.6 Settlement/Attenuation Pond Sizing

Table 5.2 identifies settlement ponds designed to treat and attenuate each development catchment area. A set of robust dimensions for each settlement pond design, to treat each individual catchment area, are shown above. Results in Table 5.2 are based on calculations found in Appendix C.

Allowing an average water depth of 0.75m to account for side slopes, the following are the volumes of each pond.

Type A 22m^3

Type B 34m^3

Type C 46m^3

Type D 68m^3

Type E 91m^3

Type F 112m^3

Table 5.1 Settlement/Attenuation Pond Sizing

Pond Ref.	Ref.	Chainage	Development Area (m^2)	Volume Required (m3)	Pond Type	Volume Provided (m3)
M1	Access from Public Road	0-200	1125	44.06	C	46
M2	Access from Public Road	200-501	1354.5	58.94	D	68
M3	Main Roadway	0-100	450	19.58	A	22
M4	Main Roadway	100-275	787.5	34.27	C	46
M5	Main Roadway	275-450	787.5	34.27	C	46
M6	Main Roadway	450-480	135	5.87	A	22
M7	Main Roadway	480-520	180	7.83	A	22
M8	Main Roadway	520-540	90	3.92	A	22
M9	Main Roadway	540-560	90	3.92	A	22
M10	Main Roadway	560-730	765	33.29	B	34
M11	Main Roadway	900-1050	675	29.37	B	34
M12	Main Roadway	1090-1175	832.5	36.22	C	46
M13	Main Roadway	1175-1260	382.5	16.64	A	22
M14	Main Roadway	1260-1330	315	13.71	A	22

Pond Ref.	Ref.	Chainage	Development Area (m^2)	Volume Required (m3)	Pond Type	Volume Provided (m3)
M15	Main Roadway	1330-1400	315	13.71	A	22
M16	Main Roadway	1400-1550	1350	58.74	D	68
M17	Main Roadway	1650-1775	562.5	24.48	B	34
M18	Main Roadway	1775-1800	112.5	4.90	A	22
M19	Main Roadway	1800-1825	112.5	4.90	A	22
M20	Main Roadway	1825-1900	337.5	14.69	A	22
M21	Main Roadway	1900-1950	225	9.79	A	22
M22	Main Roadway	1950-2200	1125	48.95	D	68
T1.1	T1	0-25	112.5	4.90	A	22
T1.2	T1	25-50	112.5	4.90	A	22
T1.3	T1	730-900	765	33.29	B	34
T1.4	T1	60-335	1237.5	53.85	D	68
T1.5	T1	335-611	1237.5	53.85	D	68
T2.1	T2	0-180	810	35.24	C	46
T2.2	T2	350-435	1260	54.82	D	68
T2.3	T2	300	787.5	34.27	C	46
T2.4	T2	180-355	810	35.24	C	46
T3.1	T3	0-205	922.5	40.14	C	46
T3.2	T3	205-410	922.5	40.14	C	46
T3.3	T3	420-485	292.5	12.73	A	22
T3.4	T3	485-550	292.5	12.73	A	22
T3.5	T3	225	585	25.45	A	22
T3.6	T3	250-367	720	31.33	B	34
T3.7	T3	0-250	1080	46.99	D	68
T3.8	T3	367	720	31.33	B	34
T3.9	T3	575-775	945	41.12	C	46
T4.1	T4	750-800	225	9.79	A	22
T4.2	T4	800	225	9.79	A	22
T4.3	T4	800-993	1012.5	44.06	C	46
T4.4	T4	875	1012.5	44.06	C	46
T5.1	T5	570-650 (different roads)	1350	58.74	D	68
T5.2	T5	650-700	225	9.79	A	22
T5.3	T5	700-780	360	15.66	A	22
T5.4	T5	780-857	1575	58.74	D	68
T5.5	T5	100-375	1215	52.87	D	68
T6.1	T6	0-65	292.5	12.73	A	22
T6.2	T6	65-258	990	43.08	C	46
T6.3	T6	150-258	720	31.33	B	34

Pond Ref.	Ref.	Chainage	Development Area (m^2)	Volume Required (m3)	Pond Type	Volume Provided (m3)
T7.1	T7	1775	450	19.58	A	22
T7.2	T7	1775	450	19.58	A	22
T7.3	T7	1775	450	19.58	A	22
T10.1	T10	2210-2285	337.5	14.69	A	22
T10.2	T10	2285-2370	337.5	14.69	A	22
T10.3	T10	2375-2500	675	29.37	B	34
T10.4	T10	2375-2500	675	29.37	B	34
T10.5	T10	2500-2614	675	29.37	B	34
T10.6	T10	2500-2614	675	29.37	B	34
T11.1	T11	0-250	1125	48.95	D	68
T11.2	T11	260-425	742.5	32.31	B	34
T11.3	T11	425-515	1237.5	53.85	D	68
T11.4	T11	400-515	675	29.37	B	34

6 MAINTAINENCE AND MONITORING

Surface water runoff control infrastructure will be checked and maintained on a regular basis and settlement ponds and check dams will be maintained (desludged/settle solids removed) on a regular basis, particularly during the construction phase of the Development. It is important to minimise the agitation of solids during these works, otherwise it will likely lead to an acute significant loading of suspended solids in the drainage network.

Site water runoff quality will be monitored during the decommissioning, construction, and operational phases of the Development. A relatively high frequency of monitoring (e.g. daily) is required during the decommissioning and construction phase. Similarly, the early stages of the operational phase will require a relatively high frequency of monitoring, however the frequency of monitoring can gradually reduce thereafter – presuming there are no issues with the quality of discharging water at that point in time.

It is recommended that a handheld turbidity meter is available to accurately measure the quality of water discharging from the Site. The meter should be maintained and calibrated frequently. It is recommended that quality thresholds are established for the purposes of escalating water quality issues as/if they arise. Laboratory testing will be carried out in accordance with the requirements of Technical Schedule 3, Water Quality Monitoring Plan and will supplement and verify the on-site results.

7 POST CONSTRUCTION DRAINAGE MANAGEMENT

Following the completion of construction, a full review of construction stage temporary drainage will be undertaken by the appointed contractor (in conjunction with the Project hydrologist/Site Engineer and the Project ECoW), with a view to removing any drainage infrastructure that is no longer required during the Development's operational phase.

Appendix A – Bracklyn Rainfall Data

Met Eireann
Return Period Rainfall Depths for sliding Durations
Irish Grid: Easting: 261024, Northing: 259113,

	Interval		Years											
DURATION	6months,	1year,	2,	3,	4,	5,	10,	20,	30,	50,	75,	100,	150,	200,	250,	500,
5 mins	2.5,	3.5,	4.0,	4.8,	5.3,	5.8,	7.1,	8.7,	9.7,	11.1,	12.4,	13.3,	14.9,	16.0,	17.0,	N/A ,
10 mins	3.5,	4.8,	5.6,	6.7,	7.4,	8.0,	9.9,	12.1,	13.5,	15.5,	17.2,	18.6,	20.7,	22.3,	23.7,	N/A ,
15 mins	4.1,	5.7,	6.6,	7.9,	8.8,	9.4,	11.7,	14.2,	15.9,	18.2,	20.3,	21.9,	24.3,	26.3,	27.9,	N/A ,
30 mins	5.4,	7.4,	8.5,	10.1,	11.2,	12.1,	14.8,	17.9,	19.9,	22.7,	25.1,	27.0,	30.0,	32.2,	34.1,	N/A ,
1 hours	7.1,	9.7,	11.1,	13.1,	14.4,	15.4,	18.8,	22.5,	24.9,	28.2,	31.2,	33.4,	36.9,	39.6,	41.8,	N/A ,
2 hours	9.4,	12.6,	14.3,	16.8,	18.5,	19.7,	23.8,	28.3,	31.2,	35.2,	38.7,	41.3,	45.4,	48.6,	51.1,	N/A ,
3 hours	11.1,	14.8,	16.7,	19.5,	21.4,	22.8,	27.3,	32.3,	35.5,	40.0,	43.8,	46.8,	51.3,	54.7,	57.6,	N/A ,
4 hours	12.4,	16.5,	18.6,	21.7,	23.7,	25.2,	30.2,	35.5,	39.0,	43.8,	47.9,	51.1,	55.9,	59.6,	62.6,	N/A ,
6 hours	14.6,	19.3,	21.6,	25.1,	27.4,	29.1,	34.6,	40.6,	44.5,	49.8,	54.4,	57.9,	63.2,	67.2,	70.5,	N/A ,
9 hours	17.2,	22.5,	25.2,	29.1,	31.7,	33.6,	39.8,	46.5,	50.8,	56.6,	61.7,	65.5,	71.3,	75.8,	79.4,	N/A ,
12 hours	19.3,	25.1,	28.1,	32.3,	35.1,	37.2,	43.9,	51.1,	55.7,	62.0,	67.4,	71.5,	77.8,	82.5,	86.3,	N/A ,
18 hours	22.7,	29.3,	32.7,	37.5,	40.6,	43.0,	50.4,	58.5,	63.6,	70.5,	76.5,	81.0,	87.8,	93.0,	97.2,	N/A ,
24 hours	25.5,	32.8,	36.4,	41.6,	45.0,	47.6,	55.6,	64.3,	69.8,	77.2,	83.6,	88.5,	95.7,	101.2,	105.7,	120.9,
2 days	30.9,	38.9,	42.9,	48.5,	52.2,	54.9,	63.5,	72.5,	78.2,	85.9,	92.4,	97.4,	104.7,	110.3,	114.8,	130.0,
3 days	35.7,	44.4,	48.7,	54.8,	58.7,	61.6,	70.7,	80.3,	86.3,	94.3,	101.2,	106.3,	113.9,	119.7,	124.3,	139.9,
4 days	40.0,	49.4,	54.1,	60.6,	64.7,	67.8,	77.5,	87.6,	93.8,	102.3,	109.4,	114.8,	122.7,	128.7,	133.5,	149.6,
6 days	48.1,	58.7,	63.9,	71.2,	75.8,	79.3,	89.9,	100.9,	107.8,	116.9,	124.6,	130.4,	138.9,	145.3,	150.5,	167.6,
8 days	55.6,	67.3,	73.0,	81.0,	86.0,	89.8,	101.3,	113.2,	120.6,	130.4,	138.7,	144.8,	153.9,	160.7,	166.2,	184.3,
10 days	62.6,	75.4,	81.6,	90.2,	95.6,	99.7,	112.1,	124.8,	132.7,	143.1,	151.9,	158.4,	168.0,	175.2,	180.9,	200.0,
12 days	69.5,	83.2,	89.9,	99.0,	104.8,	109.2,	122.3,	135.9,	144.2,	155.2,	164.4,	171.3,	181.4,	189.0,	195.0,	215.0,
16 days	82.6,	98.1,	105.6,	115.9,	122.4,	127.2,	141.8,	156.8,	166.0,	178.1,	188.2,	195.7,	206.8,	215.0,	221.6,	243.2,
20 days	95.2,	112.4,	120.7,	132.0,	139.1,	144.4,	160.4,	176.7,	186.7,	199.8,	210.7,	218.8,	230.7,	239.6,	246.6,	269.9,
25 days	110.5,	129.7,	138.9,	151.4,	159.3,	165.1,	182.7,	200.5,	211.4,	225.7,	237.6,	246.4,	259.3,	268.8,	276.5,	301.5,

NOTES:
N/A Data not available
These values are derived from a Depth Duration Frequency (DDF) Model
For details refer to:
'Fitzgerald D. L. (2007), Estimates of Point Rainfall Frequencies, Technical Note No. 61, Met Eireann, Dublin',
Available for download at www.met.ie/climate/dataproducts/Estimation-of-Point-Rainfall-Frequencies_TN61.pdf

Appendix B – Greenfield Runoff Rate Estimation for Bracklyn Wind Farm

HR Wallingford
Working with water

Greenfield runoff rate estimation for sites

www.uksuds.com | Greenfield runoff tool

Calculated by:	Darren Gilsenan
Site name:	Bracklyn WF
Site location:	Bracklyn WestMeath

This is an estimation of the greenfield runoff rates that are used to meet normal best practice criteria in line with Environment Agency guidance "Rainfall runoff management for developments", SC030219 (2013) , the SuDS Manual C753 (Ciria, 2015) and the non-statutory standards for SuDS (Defra, 2015). This information on greenfield runoff rates may be
the basis for setting consents for the drainage of surface water runoff from sites.

Site Details

Latitude:	53.57591° N
Longitude:	7.07482° W
Reference:	2825952786
Date:	May 26 2021 14:17

Runoff estimation approach IH124

Site characteristics

Total site area (ha): 270

Methodology

Q_{BAR} estimation method:	Calculate from SPR and SAAR
SPR estimation method:	Calculate from SOIL type

Soil characteristics

	Default	Edited
SOIL type:	2	2
HOST class:	N/A	N/A
SPR/SPRHOST:	0.3	0.3

Hydrological characteristics

	Default	Edited
SAAR (mm):	960	960
Hydrological region:	13	13
Growth curve factor 1 year:	0.85	0.85
Growth curve factor 30 years:	1.65	1.65
Growth curve factor 100 years:	1.95	1.95
Growth curve factor 200 years:	2.15	2.15

Notes

(1) Is Q_{BAR} < 2.0 l/s/ha?

When Q_{BAR} is < 2.0 l/s/ha then limiting discharge rates are set at 2.0 l/s/ha.

(2) Are flow rates < 5.0 l/s?

Where flow rates are less than 5.0 l/s consent for discharge is usually set at 5.0 l/s if blockage from vegetation and other materials is possible. Lower consent flow rates may be set where the blockage risk is addressed by using appropriate drainage elements.

(3) Is SPR/SPRHOST ≤ 0.3?

Where groundwater levels are low enough the use of soakaways to avoid discharge offsite would normally be preferred for disposal of surface water runoff.

Greenfield runoff rates

	Default	Edited
Q_{BAR} (l/s):	591.49	591.49
1 in 1 year (l/s):	502.77	502.77
1 in 30 years (l/s):	975.96	975.96
1 in 100 year (l/s):	1153.41	1153.41
1 in 200 years (l/s):	1271.71	1271.71

Appendix C – Settlement Pond Calculations

Pond Ref.	Ref. Geometric Drawings	Chainage	Development Area (m^2)	Volume Required (m^3)	Pond Type	Volume Provided (m^3)
M1	Access from Public Road	0-200	1125	44.06	C	46
M2	Access from Public Road	200-501	1354.5	58.94	D	68
M3	Main Roadway	0-100	450	19.58	A	22
M4	Main Roadway	100-275	787.5	34.27	C	46
M5	Main Roadway	275-450	787.5	34.27	C	46
M6	Main Roadway	450-480	135	5.87	A	22
M7	Main Roadway	480-520	180	7.83	A	22
M8	Main Roadway	520-540	90	3.92	A	22
M9	Main Roadway	540-560	90	3.92	A	22
M10	Main Roadway	560-730	765	33.29	B	34
M11	Main Roadway	900-1050	675	29.37	B	34
M12	Main Roadway	1090-1175	832.5	36.22	C	46
M13	Main Roadway	1175-1260	382.5	16.64	A	22
M14	Main Roadway	1260-1330	315	13.71	A	22
M15	Main Roadway	1330-1400	315	13.71	A	22
M16	Main Roadway	1400-1550	1350	58.74	D	68
M17	Main Roadway	1650-1775	562.5	24.48	B	34
M18	Main Roadway	1775-1800	112.5	4.90	A	22
M19	Main Roadway	1800-1825	112.5	4.90	A	22
M20	Main Roadway	1825-1900	337.5	14.69	A	22
M21	Main Roadway	1900-1950	225	9.79	A	22
M22	Main Roadway	1950-2200	1125	48.95	D	68
T1.1	T1	0-25	112.5	4.90	A	22
T1.2	T1	25-50	112.5	4.90	A	22
T1.3	T1	730-900	765	33.29	B	34
T1.4	T1	60-335	1237.5	53.85	D	68
T1.5	T1	335-611	1237.5	53.85	D	68
T2.1	T2	0-180	810	35.24	C	46
T2.2	T2	350-435	1260	54.82	D	68
T2.3	T2	300	787.5	34.27	C	46
T2.4	T2	180-355	810	35.24	C	46
T3.1	T3	0-205	922.5	40.14	C	46
T3.2	T3	205-410	922.5	40.14	C	46
T3.3	T3	420-485	292.5	12.73	A	22
T3.4	T3	485-550	292.5	12.73	A	22
T3.5	T3	225	585	25.45	A	22
T3.6	T3	250-367	720	31.33	B	34
T3.7	T3	0-250	1080	46.99	D	68
T3.8	T3	367	720	31.33	B	34
T3.9	T3	575-775	945	41.12	C	46
T4.1	T4	750-800	225	9.79	A	22
T4.2	T4	800	225	9.79	A	22
T4.3	T4	800-993	1012.5	44.06	C	46
T4.4	T4	875	1012.5	44.06	C	46
T5.1	T5	570-650 (different road's)	1350	58.74	D	68
T5.2	T5	650-700	225	9.79	A	22
T5.3	T5	700-780	360	15.66	A	22
T5.4	T5	780-857	1575	58.74	D	68
T5.5	T5	100-375	1215	52.87	D	68
T6.1	T6	0-65	292.5	12.73	A	22
T6.2	T6	65-258	990	43.08	C	46
T6.3	T6	150-258	720	31.33	B	34
T7.1	T7	1775	450	19.58	A	22
T7.2	T7	1775	450	19.58	A	22
T7.3	T7	1775	450	19.58	A	22
T10.1	T10	2210-2285	337.5	14.69	A	22
T10.2	T10	2285-2370	337.5	14.69	A	22
T10.3	T10	2375-2500	675	29.37	B	34
T10.4	T10	2375-2500	675	29.37	B	34
T10.5	T10	2500-2614	675	29.37	B	34
T10.6	T10	2500-2614	675	29.37	B	34
T11.1	T11	0-250	1125	48.95	D	68
T11.2	T11	260-425	742.5	32.31	B	34
T11.3	T11	425-515	1237.5	53.85	D	68
T11.4	T11	400-515	675	29.37	B	34

Settlement Pond M1 0.225 0.0045 treated water discharge rate (l/s)
Pond Location: Chainage 0-200 4.0 l/s/ha

1 in 100 year return	Rainfall (mm)		C	A (km^2)	(m^3/s)	Volume (m^3)	Discharge (m^3)	Residual Volume (m^3)	Comments
M100 5min	13.3	0.278	0.9	0.001013	0.040	12.1	0.122	12.01	
M100 10min	18.6	0.278	0.9	0.001013	0.028	17.0	0.243	16.72	
M100 15min	21.9	0.278	0.9	0.001013	0.022	20.0	0.365	19.61	
M100 30min	27	0.278	0.9	0.001013	0.014	24.6	0.729	23.89	
M100 60min	33.4	0.278	0.9	0.001013	0.008	30.5	1.458	29.00	
M100 2hr	41.3	0.278	0.9	0.001013	0.005	37.7	2.916	34.75	
M100 4hr	51.1	0.278	0.9	0.001013	0.003	46.6	5.832	40.77	
M100 6hr	57.9	0.278	0.9	0.001013	0.002	52.8	8.748	44.06	TypeC
M100 12hr	71.5	0.278	0.9	0.001013	0.002	65.2	17.496	47.71	
M100 24hr	81	0.278	0.9	0.001013	0.001	73.9	34.992	38.88	
M100 48hr	88.5	0.278	0.9	0.001013	0.000	80.7	69.984	10.73	

Settlement Pond M2 0.301 0.0045 treated water discharge rate (l/s)
Pond Location: Chainage 200-501 4.0 l/s/ha

1 in 100 year return	Rainfall (mm)		C	A (km^2)	(m^3/s)	Volume (m^3)	Discharge (m^3)	Residual Volume (m^3)	Comments
M100 5min	13.3	0.278	0.9	0.001355	0.054	16.2	0.163	16.06	
M100 10min	18.6	0.278	0.9	0.001355	0.038	22.7	0.325	22.37	
M100 15min	21.9	0.278	0.9	0.001355	0.030	26.7	0.488	26.23	
M100 30min	27	0.278	0.9	0.001355	0.018	32.9	0.975	31.97	
M100 60min	33.4	0.278	0.9	0.001355	0.011	40.7	1.950	38.80	
M100 2hr	41.3	0.278	0.9	0.001355	0.007	50.4	3.901	46.49	
M100 4hr	51.1	0.278	0.9	0.001355	0.004	62.3	7.802	54.54	
M100 6hr	57.9	0.278	0.9	0.001355	0.003	70.6	11.703	58.94	Type D
M100 12hr	71.5	0.278	0.9	0.001355	0.002	87.2	23.406	63.83	
M100 24hr	81	0.278	0.9	0.001355	0.001	98.8	46.812	52.01	
M100 48hr	88.5	0.278	0.9	0.001355	0.001	108.0	93.623	14.35	

Settlement Pond M3 0.1 0.0045 treated water discharge rate (l/s)
Pond Location: Chainage 0-100 4.0 l/s/ha

1 in 100 year return	Rainfall (mm)		C	A (km^2)	(m^3/s)	Volume (m^3)	Discharge (m^3)	Residual Volume (m^3)	Comments
M100 5min	13.3	0.278	0.9	0.000450	0.018	5.4	0.054	5.34	
M100 10min	18.6	0.278	0.9	0.000450	0.013	7.5	0.108	7.43	
M100 15min	21.9	0.278	0.9	0.000450	0.010	8.9	0.162	8.71	
M100 30min	27	0.278	0.9	0.000450	0.006	10.9	0.324	10.62	
M100 60min	33.4	0.278	0.9	0.000450	0.004	13.5	0.648	12.89	
M100 2hr	41.3	0.278	0.9	0.000450	0.002	16.7	1.296	15.44	
M100 4hr	51.1	0.278	0.9	0.000450	0.001	20.7	2.592	18.12	
M100 6hr	57.9	0.278	0.9	0.000450	0.001	23.5	3.888	19.58	Type A
M100 12hr	71.5	0.278	0.9	0.000450	0.001	29.0	7.776	21.20	
M100 24hr	81	0.278	0.9	0.000450	0.000	32.8	15.552	17.28	
M100 48hr	88.5	0.278	0.9	0.000450	0.000	35.9	31.104	4.77	

Settlement Pond M4 0.175 0.0045 treated water discharge rate (l/s)
Pond Location: Chainage 100-275 4.0 l/s/ha

1 in 100 year return	Rainfall (mm)		C	A (km^2)	(m^3/s)	Volume (m^3)	Discharge (m^3)	Residual Volume (m^3)	Comments
M100 5min	13.3	0.278	0.9	0.000788	0.031	9.4	0.095	9.34	
M100 10min	18.6	0.278	0.9	0.000788	0.022	13.2	0.189	13.00	
M100 15min	21.9	0.278	0.9	0.000788	0.017	15.5	0.284	15.25	
M100 30min	27	0.278	0.9	0.000788	0.011	19.2	0.567	18.58	
M100 60min	33.4	0.278	0.9	0.000788	0.007	23.7	1.134	22.56	
M100 2hr	41.3	0.278	0.9	0.000788	0.004	29.3	2.268	27.03	
M100 4hr	51.1	0.278	0.9	0.000788	0.003	36.2	4.536	31.71	
M100 6hr	57.9	0.278	0.9	0.000788	0.002	41.1	6.804	34.27	TypeC
M100 12hr	71.5	0.278	0.9	0.000788	0.001	50.7	13.608	37.11	
M100 24hr	81	0.278	0.9	0.000788	0.001	57.5	27.216	30.24	
M100 48hr	88.5	0.278	0.9	0.000788	0.000	62.8	54.432	8.34	

Settlement Pond M5 0.175 0.0045 treated water discharge rate (l/s)
Pond Location: Chainage 275-450 4.0 l/s/ha

1 in 100 year return	Rainfall (mm)		C	A (km^2)	(m^3/s)	Volume (m^3)	Discharge (m^3)	Residual Volume (m^3)	Comments
M100 5min	13.3	0.278	0.9	0.000788	0.031	9.4	0.095	9.34	
M100 10min	18.6	0.278	0.9	0.000788	0.022	13.2	0.189	13.00	
M100 15min	21.9	0.278	0.9	0.000788	0.017	15.5	0.284	15.25	
M100 30min	27	0.278	0.9	0.000788	0.011	19.2	0.567	18.58	
M100 60min	33.4	0.278	0.9	0.000788	0.007	23.7	1.134	22.56	
M100 2hr	41.3	0.278	0.9	0.000788	0.004	29.3	2.268	27.03	
M100 4hr	51.1	0.278	0.9	0.000788	0.003	36.2	4.536	31.71	
M100 6hr	57.9	0.278	0.9	0.000788	0.002	41.1	6.804	34.27	TypeC
M100 12hr	71.5	0.278	0.9	0.000788	0.001	50.7	13.608	37.11	
M100 24hr	81	0.278	0.9	0.000788	0.001	57.5	27.216	30.24	
M100 48hr	88.5	0.278	0.9	0.000788	0.000	62.8	54.432	8.34	

Settlement Pond M6 0.03 0.0045 treated water discharge rate (l/s)
Pond Location: Chainage 450-480 4.0 l/s/ha

1 in 100 year return	Rainfall (mm)		C	A (km^2)	(m^3/s)	Volume (m^3)	Discharge (m^3)	Residual Volume (m^3)	Comments
M100 5min	13.3	0.278	0.9	0.000135	0.005	1.6	0.016	1.60	
M100 10min	18.6	0.278	0.9	0.000135	0.004	2.3	0.032	2.23	
M100 15min	21.9	0.278	0.9	0.000135	0.003	2.7	0.049	2.61	
M100 30min	27	0.278	0.9	0.000135	0.002	3.3	0.097	3.19	
M100 60min	33.4	0.278	0.9	0.000135	0.001	4.1	0.194	3.87	
M100 2hr	41.3	0.278	0.9	0.000135	0.001	5.0	0.389	4.63	
M100 4hr	51.1	0.278	0.9	0.000135	0.000	6.2	0.778	5.44	
M100 6hr	57.9	0.278	0.9	0.000135	0.000	7.0	1.166	5.87	Type A
M100 12hr	71.5	0.278	0.9	0.000135	0.000	8.7	2.333	6.36	
M100 24hr	81	0.278	0.9	0.000135	0.000	9.8	4.666	5.18	
M100 48hr	88.5	0.278	0.9	0.000135	0.000	10.8	9.331	1.43	

Settlement Pond M7 0.04 0.0045 treated water discharge rate (l/s)
Pond Location: Chainage 480-520 4.0 l/s/ha

1 in 100 year return	Rainfall (mm)		C	A (km^2)	(m^3/s)	Volume (m^3)	Discharge (m^3)	Residual Volume (m^3)	Comments
M100 5min	13.3	0.278	0.9	0.000180	0.007	2.2	0.022	2.13	
M100 10min	18.6	0.278	0.9	0.000180	0.005	3.0	0.043	2.97	
M100 15min	21.9	0.278	0.9	0.000180	0.004	3.6	0.065	3.49	
M100 30min	27	0.278	0.9	0.000180	0.002	4.4	0.130	4.25	
M100 60min	33.4	0.278	0.9	0.000180	0.002	5.4	0.259	5.16	
M100 2hr	41.3	0.278	0.9	0.000180	0.001	6.7	0.518	6.18	
M100 4hr	51.1	0.278	0.9	0.000180	0.001	8.3	1.037	7.25	
M100 6hr	57.9	0.278	0.9	0.000180	0.000	9.4	1.555	7.83	Type A
M100 12hr	71.5	0.278	0.9	0.000180	0.000	11.6	3.110	8.48	
M100 24hr	81	0.278	0.9	0.000180	0.000	13.1	6.221	6.91	
M100 48hr	88.5	0.278	0.9	0.000180	0.000	14.3	12.442	1.91	

Settlement Pond M8 0.02 0.0045 treated water discharge rate (l/s)
Pond Location: Chainage 520-540 4.0 l/s/ha

1 in 100 year return	Rainfall (mm)		C	A (km^2)	(m^3/s)	Volume (m^3)	Discharge (m^3)	Residual Volume (m^3)	Comments
M100 5min	13.3	0.278	0.9	0.000090	0.004	1.1	0.011	1.07	
M100 10min	18.6	0.278	0.9	0.000090	0.003	1.5	0.022	1.49	
M100 15min	21.9	0.278	0.9	0.000090	0.002	1.8	0.032	1.74	
M100 30min	27	0.278	0.9	0.000090	0.001	2.2	0.065	2.12	
M100 60min	33.4	0.278	0.9	0.000090	0.001	2.7	0.130	2.58	
M100 2hr	41.3	0.278	0.9	0.000090	0.000	3.3	0.259	3.09	
M100 4hr	51.1	0.278	0.9	0.000090	0.000	4.1	0.518	3.62	
M100 6hr	57.9	0.278	0.9	0.000090	0.000	4.7	0.778	3.92	Type A
M100 12hr	71.5	0.278	0.9	0.000090	0.000	5.8	1.555	4.24	
M100 24hr	81	0.278	0.9	0.000090	0.000	6.6	3.110	3.46	
M100 48hr	88.5	0.278	0.9	0.000090	0.000	7.2	6.221	0.95	

Settlement Pond M9 0.02 0.0045 treated water discharge rate (l/s)
Pond Location: Chainage 540-560 4.0 l/s/ha

1 in 100 year return	Rainfall (mm)		C	A (km^2)	(m^3/s)	Volume (m^3)	Discharge (m^3)	Residual Volume (m^3)	Comments
M100 5min	13.3	0.278	0.9	0.000090	0.004	1.1	0.011	1.07	
M100 10min	18.6	0.278	0.9	0.000090	0.003	1.5	0.022	1.49	
M100 15min	21.9	0.278	0.9	0.000090	0.002	1.8	0.032	1.74	
M100 30min	27	0.278	0.9	0.000090	0.001	2.2	0.065	2.12	
M100 60min	33.4	0.278	0.9	0.000090	0.001	2.7	0.130	2.58	
M100 2hr	41.3	0.278	0.9	0.000090	0.000	3.3	0.259	3.09	
M100 4hr	51.1	0.278	0.9	0.000090	0.000	4.1	0.518	3.62	
M100 6hr	57.9	0.278	0.9	0.000090	0.000	4.7	0.778	3.92	Type A
M100 12hr	71.5	0.278	0.9	0.000090	0.000	5.8	1.555	4.24	
M100 24hr	81	0.278	0.9	0.000090	0.000	6.6	3.110	3.46	
M100 48hr	88.5	0.278	0.9	0.000090	0.000	7.2	6.221	0.95	

Settlement Pond M10 0.17 0.0045 treated water discharge rate (l/s)
Pond Location: Chainage 560-730 4.0 l/s/ha

1 in 100 year return	Rainfall (mm)		C	A (km^2)	(m^3/s)	Volume (m^3)	Discharge (m^3)	Residual Volume (m^3)	Comments
M100 5min	13.3	0.278	0.9	0.000765	0.031	9.2	0.092	9.07	
M100 10min	18.6	0.278	0.9	0.000765	0.021	12.8	0.184	12.63	
M100 15min	21.9	0.278	0.9	0.000765	0.017	15.1	0.275	14.81	
M100 30min	27	0.278	0.9	0.000765	0.010	18.6	0.551	18.05	
M100 60min	33.4	0.278	0.9	0.000765	0.006	23.0	1.102	21.91	
M100 2hr	41.3	0.278	0.9	0.000765	0.004	28.5	2.203	26.25	
M100 4hr	51.1	0.278	0.9	0.000765	0.002	35.2	4.406	30.80	
M100 6hr	57.9	0.278	0.9	0.000765	0.002	39.9	6.610	33.29	Type B
M100 12hr	71.5	0.278	0.9	0.000765	0.001	49.3	13.219	36.05	
M100 24hr	81	0.278	0.9	0.000765	0.001	55.8	26.438	29.37	
M100 48hr	88.5	0.278	0.9	0.000765	0.000	61.0	52.877	8.10	

Settlement Pond	M11	0.15	0.0045				treated water discharge rate (l/s)		
Pond Location: Chainage 900-1050							4.0	l/s/ha	
1 in 100 year return	Rainfall (mm)		C	A (km²)	(m³/s)	Volume (m³)	Discharge (m³)	Residual Volume (m³)	
M100 5min	13.3	0.278	0.9	0.000675	0.027	8.1	0.081	8.01	
M100 10min	18.6	0.278	0.9	0.000675	0.019	11.3	0.162	11.15	
M100 15min	21.9	0.278	0.9	0.000675	0.015	13.3	0.243	13.07	
M100 30min	27	0.278	0.9	0.000675	0.009	16.4	0.486	15.93	
M100 60min	33.4	0.278	0.9	0.000675	0.006	20.3	0.972	19.33	
M100 2hr	41.3	0.278	0.9	0.000675	0.003	25.1	1.944	23.17	
M100 4hr	51.1	0.278	0.9	0.000675	0.002	31.1	3.888	27.18	
M100 6hr	57.9	0.278	0.9	0.000675	0.002	35.2	5.832	29.37	
M100 12hr	71.5	0.278	0.9	0.000675	0.001	43.5	11.664	31.81	
M100 24hr	81	0.278	0.9	0.000675	0.001	49.2	23.328	25.92	
M100 48hr	88.5	0.278	0.9	0.000675	0.000	53.8	46.656	7.15	

Settlement Pond	M12	0.185	0.0045				treated water discharge rate (l/s)		
Pond Location: Chainage 1090-1175							4.0	l/s/ha	
1 in 100 year return	Rainfall (mm)		C	A (km²)	(m³/s)	Volume (m³)	Discharge (m³)	Residual Volume (m³)	
M100 5min	13.3	0.278	0.9	0.000833	0.033	10.0	0.100	9.87	
M100 10min	18.6	0.278	0.9	0.000833	0.023	13.9	0.200	13.75	
M100 15min	21.9	0.278	0.9	0.000833	0.018	16.4	0.300	16.12	
M100 30min	27	0.278	0.9	0.000833	0.011	20.2	0.599	19.65	
M100 60min	33.4	0.278	0.9	0.000833	0.007	25.0	1.199	23.85	
M100 2hr	41.3	0.278	0.9	0.000833	0.004	31.0	2.398	28.57	
M100 4hr	51.1	0.278	0.9	0.000833	0.003	38.3	4.795	33.52	
M100 6hr	57.9	0.278	0.9	0.000833	0.002	43.4	7.193	36.22	
M100 12hr	71.5	0.278	0.9	0.000833	0.001	53.6	14.386	39.23	
M100 24hr	81	0.278	0.9	0.000833	0.001	60.7	28.771	31.97	
M100 48hr	88.5	0.278	0.9	0.000833	0.000	66.4	57.542	8.82	

Settlement Pond	M13	0.085	0.0045				treated water discharge rate (l/s)		
Pond Location: Chainage 1175-1260							4.0	l/s/ha	
1 in 100 year return	Rainfall (mm)		C	A (km²)	(m³/s)	Volume (m³)	Discharge (m³)	Residual Volume (m³)	
M100 5min	13.3	0.278	0.9	0.000383	0.015	4.6	0.046	4.54	
M100 10min	18.6	0.278	0.9	0.000383	0.011	6.4	0.092	6.32	
M100 15min	21.9	0.278	0.9	0.000383	0.008	7.5	0.138	7.41	
M100 30min	27	0.278	0.9	0.000383	0.005	9.3	0.275	9.03	
M100 60min	33.4	0.278	0.9	0.000383	0.003	11.5	0.551	10.96	
M100 2hr	41.3	0.278	0.9	0.000383	0.002	14.2	1.102	13.13	
M100 4hr	51.1	0.278	0.9	0.000383	0.001	17.6	2.203	15.40	
M100 6hr	57.9	0.278	0.9	0.000383	0.001	19.9	3.305	16.64	
M100 12hr	71.5	0.278	0.9	0.000383	0.001	24.6	6.610	18.02	
M100 24hr	81	0.278	0.9	0.000383	0.000	27.9	13.219	14.69	
M100 48hr	88.5	0.278	0.9	0.000383	0.000	30.5	26.438	4.05	

Settlement Pond	M14	0.07	0.0045				treated water discharge rate (l/s)		
Pond Location: Chainage 1260-1330							4.0	l/s/ha	
1 in 100 year return	Rainfall (mm)		C	A (km²)	(m³/s)	Volume (m³)	Discharge (m³)	Residual Volume (m³)	
M100 5min	13.3	0.278	0.9	0.000315	0.013	3.8	0.038	3.74	
M100 10min	18.6	0.278	0.9	0.000315	0.009	5.3	0.076	5.20	
M100 15min	21.9	0.278	0.9	0.000315	0.007	6.2	0.113	6.10	
M100 30min	27	0.278	0.9	0.000315	0.004	7.7	0.227	7.43	
M100 60min	33.4	0.278	0.9	0.000315	0.003	9.5	0.454	9.02	
M100 2hr	41.3	0.278	0.9	0.000315	0.002	11.7	0.907	10.81	
M100 4hr	51.1	0.278	0.9	0.000315	0.001	14.5	1.814	12.68	
M100 6hr	57.9	0.278	0.9	0.000315	0.001	16.4	2.722	13.71	
M100 12hr	71.5	0.278	0.9	0.000315	0.000	20.3	5.443	14.84	
M100 24hr	81	0.278	0.9	0.000315	0.000	23.0	10.886	12.10	
M100 48hr	88.5	0.278	0.9	0.000315	0.000	25.1	21.773	3.34	

Settlement Pond	M15	0.07	0.0045				treated water discharge rate (l/s)		
Pond Location: Chainage 1330-1400							4.0	l/s/ha	
1 in 100 year return	Rainfall (mm)		C	A (km²)	(m³/s)	Volume (m³)	Discharge (m³)	Residual Volume (m³)	
M100 5min	13.3	0.278	0.9	0.000315	0.013	3.8	0.038	3.74	
M100 10min	18.6	0.278	0.9	0.000315	0.009	5.3	0.076	5.20	
M100 15min	21.9	0.278	0.9	0.000315	0.007	6.2	0.113	6.10	
M100 30min	27	0.278	0.9	0.000315	0.004	7.7	0.227	7.43	
M100 60min	33.4	0.278	0.9	0.000315	0.003	9.5	0.454	9.02	
M100 2hr	41.3	0.278	0.9	0.000315	0.002	11.7	0.907	10.81	
M100 4hr	51.1	0.278	0.9	0.000315	0.001	14.5	1.814	12.68	
M100 6hr	57.9	0.278	0.9	0.000315	0.001	16.4	2.722	13.71	
M100 12hr	71.5	0.278	0.9	0.000315	0.000	20.3	5.443	14.84	
M100 24hr	81	0.278	0.9	0.000315	0.000	23.0	10.886	12.10	
M100 48hr	88.5	0.278	0.9	0.000315	0.000	25.1	21.773	3.34	

Settlement Pond	M16	0.3	0.0045				treated water discharge rate (l/s)			
Pond Location: Chainage 1400-1550							4.0	l/s/ha		
1 in 100 year return	Rainfall (mm)		C	A (km²)	(m³/s)	Volume (m³)	Discharge (m³)	Residual Volume (m³)	Comments	
M100 5min	13.3	0.278	0.9	0.001350	0.054	16.2	0.162	16.01		
M100 10min	18.6	0.278	0.9	0.001350	0.038	22.6	0.324	22.29		
M100 15min	21.9	0.278	0.9	0.001350	0.030	26.6	0.486	26.14		
M100 30min	27	0.278	0.9	0.001350	0.018	32.8	0.972	31.86		
M100 60min	33.4	0.278	0.9	0.001350	0.011	40.6	1.944	38.67		
M100 2hr	41.3	0.278	0.9	0.001350	0.007	50.2	3.888	46.33		
M100 4hr	51.1	0.278	0.9	0.001350	0.004	62.1	7.776	54.36		
M100 6hr	57.9	0.278	0.9	0.001350	0.003	70.4	11.664	58.74	Type D	
M100 12hr	71.5	0.278	0.9	0.001350	0.002	86.9	23.328	63.61		
M100 24hr	81	0.278	0.9	0.001350	0.001	98.5	46.656	51.84		
M100 48hr	88.5	0.278	0.9	0.001350	0.001	107.6	93.312	14.30		

Settlement Pond	M17	0.125	0.0045				treated water discharge rate (l/s)			
Pond Location: Chainage 1650-1775							4.0	l/s/ha		
1 in 100 year return	Rainfall (mm)		C	A (km²)	(m³/s)	Volume (m³)	Discharge (m³)	Residual Volume (m³)	Comments	
M100 5min	13.3	0.278	0.9	0.000563	0.022	6.7	0.068	6.67		
M100 10min	18.6	0.278	0.9	0.000563	0.016	9.4	0.135	9.29		
M100 15min	21.9	0.278	0.9	0.000563	0.012	11.1	0.203	10.89		
M100 30min	27	0.278	0.9	0.000563	0.008	13.7	0.405	13.27		
M100 60min	33.4	0.278	0.9	0.000563	0.005	16.9	0.810	16.11		
M100 2hr	41.3	0.278	0.9	0.000563	0.003	20.9	1.620	19.30		
M100 4hr	51.1	0.278	0.9	0.000563	0.002	25.9	3.240	22.65		
M100 6hr	57.9	0.278	0.9	0.000563	0.001	29.3	4.860	24.48	Type B	
M100 12hr	71.5	0.278	0.9	0.000563	0.001	36.2	9.720	26.51		
M100 24hr	81	0.278	0.9	0.000563	0.000	41.0	19.440	21.60		
M100 48hr	88.5	0.278	0.9	0.000563	0.000	44.8	38.880	5.96		

Settlement Pond	M18	0.025	0.0045				treated water discharge rate (l/s)			
Pond Location: Chainage 1775-1800							4.0	l/s/ha		
1 in 100 year return	Rainfall (mm)		C	A (km²)	(m³/s)	Volume (m³)	Discharge (m³)	Residual Volume (m³)	Comments	
M100 5min	13.3	0.278	0.9	0.000113	0.004	1.3	0.014	1.33		
M100 10min	18.6	0.278	0.9	0.000113	0.003	1.9	0.027	1.86		
M100 15min	21.9	0.278	0.9	0.000113	0.002	2.2	0.041	2.18		
M100 30min	27	0.278	0.9	0.000113	0.002	2.7	0.081	2.65		
M100 60min	33.4	0.278	0.9	0.000113	0.001	3.4	0.162	3.22		
M100 2hr	41.3	0.278	0.9	0.000113	0.001	4.2	0.324	3.86		
M100 4hr	51.1	0.278	0.9	0.000113	0.000	5.2	0.648	4.53		
M100 6hr	57.9	0.278	0.9	0.000113	0.000	5.9	0.972	4.90	Type A	
M100 12hr	71.5	0.278	0.9	0.000113	0.000	7.2	1.944	5.30		
M100 24hr	81	0.278	0.9	0.000113	0.000	8.2	3.888	4.32		
M100 48hr	88.5	0.278	0.9	0.000113	0.000	9.0	7.776	1.19		

Settlement Pond	M19	0.025	0.0045				treated water discharge rate (l/s)			
Pond Location: Chainage 1800-1825							4.0	l/s/ha		
1 in 100 year return	Rainfall (mm)		C	A (km²)	(m³/s)	Volume (m³)	Discharge (m³)	Residual Volume (m³)	Comments	
M100 5min	13.3	0.278	0.9	0.000113	0.004	1.3	0.014	1.33		
M100 10min	18.6	0.278	0.9	0.000113	0.003	1.9	0.027	1.86		
M100 15min	21.9	0.278	0.9	0.000113	0.002	2.2	0.041	2.18		
M100 30min	27	0.278	0.9	0.000113	0.002	2.7	0.081	2.65		
M100 60min	33.4	0.278	0.9	0.000113	0.001	3.4	0.162	3.22		
M100 2hr	41.3	0.278	0.9	0.000113	0.001	4.2	0.324	3.86		
M100 4hr	51.1	0.278	0.9	0.000113	0.000	5.2	0.648	4.53		
M100 6hr	57.9	0.278	0.9	0.000113	0.000	5.9	0.972	4.90	Type A	
M100 12hr	71.5	0.278	0.9	0.000113	0.000	7.2	1.944	5.30		
M100 24hr	81	0.278	0.9	0.000113	0.000	8.2	3.888	4.32		
M100 48hr	88.5	0.278	0.9	0.000113	0.000	9.0	7.776	1.19		

Settlement Pond	M20	0.075	0.0045				treated water discharge rate (l/s)			
Pond Location: Chainage 1825-1900							4.0	l/s/ha		
1 in 100 year return	Rainfall (mm)		C	A (km²)	(m³/s)	Volume (m³)	Discharge (m³)	Residual Volume (m³)	Comments	
M100 5min	13.3	0.278	0.9	0.000338	0.013	4.0	0.041	4.00		
M100 10min	18.6	0.278	0.9	0.000338	0.009	5.7	0.081	5.57		
M100 15min	21.9	0.278	0.9	0.000338	0.007	6.7	0.122	6.54		
M100 30min	27	0.278	0.9	0.000338	0.005	8.2	0.243	7.96		
M100 60min	33.4	0.278	0.9	0.000338	0.003	10.2	0.486	9.67		
M100 2hr	41.3	0.278	0.9	0.000338	0.002	12.6	0.972	11.58		
M100 4hr	51.1	0.278	0.9	0.000338	0.001	15.5	1.944	13.59		
M100 6hr	57.9	0.278	0.9	0.000338	0.001	17.6	2.916	14.69	Type A	
M100 12hr	71.5	0.278	0.9	0.000338	0.001	21.7	5.832	15.90		
M100 24hr	81	0.278	0.9	0.000338	0.000	24.6	11.664	12.96		
M100 48hr	88.5	0.278	0.9	0.000338	0.000	26.9	23.328	3.58		

Settlement Pond	M21	0.05	0.0045				treated water discharge rate (l/s)			
Pond Location: Chainage 1900-1950							4.0	l/s/ha		
1 in 100 year return	Rainfall (mm)		C	A (km²)	(m³/s)	Volume (m³)	Discharge (m³)	Residual Volume (m³)	Comments	
M100 5min	13.3	0.278	0.9	0.000225	0.009	2.7	0.027	2.67		
M100 10min	18.6	0.278	0.9	0.000225	0.006	3.8	0.054	3.72		
M100 15min	21.9	0.278	0.9	0.000225	0.005	4.4	0.081	4.36		
M100 30min	27	0.278	0.9	0.000225	0.003	5.5	0.162	5.31		
M100 60min	33.4	0.278	0.9	0.000225	0.002	6.8	0.324	6.44		
M100 2hr	41.3	0.278	0.9	0.000225	0.001	8.4	0.648	7.72		
M100 4hr	51.1	0.278	0.9	0.000225	0.001	10.4	1.296	9.06		
M100 6hr	57.9	0.278	0.9	0.000225	0.001	11.7	1.944	9.79	Type A	
M100 12hr	71.5	0.278	0.9	0.000225	0.000	14.5	3.888	10.60		
M100 24hr	81	0.278	0.9	0.000225	0.000	16.4	7.776	8.64		
M100 48hr	88.5	0.278	0.9	0.000225	0.000	17.9	15.552	2.38		

Settlement Pond	M22	0.25	0.0045				treated water discharge rate (l/s)			
Pond Location: Chainage 1950-2200							4.0	l/s/ha		
1 in 100 year return	Rainfall (mm)		C	A (km²)	(m³/s)	Volume (m³)	Discharge (m³)	Residual Volume (m³)	Comments	
M100 5min	13.3	0.278	0.9	0.001125	0.045	13.5	0.135	13.34		
M100 10min	18.6	0.278	0.9	0.001125	0.031	18.8	0.270	18.58		
M100 15min	21.9	0.278	0.9	0.001125	0.025	22.2	0.405	21.79		
M100 30min	27	0.278	0.9	0.001125	0.015	27.4	0.810	26.55		
M100 60min	33.4	0.278	0.9	0.001125	0.009	33.8	1.620	32.22		
M100 2hr	41.3	0.278	0.9	0.001125	0.006	41.8	3.240	38.61		
M100 4hr	51.1	0.278	0.9	0.001125	0.004	51.8	6.480	45.30		
M100 6hr	57.9	0.278	0.9	0.001125	0.003	58.7	9.720	48.95	Type D	
M100 12hr	71.5	0.278	0.9	0.001125	0.002	72.5	19.440	53.01		
M100 24hr	81	0.278	0.9	0.001125	0.001	82.1	38.880	43.20		
M100 48hr	88.5	0.278	0.9	0.001125	0.001	89.7	77.760	11.92		

Settlement Pond	T1.1	0.025	0.0045	treated water discharge rate (l/s)					
Pond Location: Chainage 0-25							4.0	l/s/ha	
1 in 10 year return	Rainfall (mm)		C	A (km²)	(m³/s)	Volume (m³)	Discharge (m³)	Residual Volume (m³)	Comments
M100 5min	13.3	0.278	0.9	0.000113	0.004	1.3	0.014	1.33	
M100 10min	18.6	0.278	0.9	0.000113	0.003	1.9	0.027	1.86	
M100 15min	21.9	0.278	0.9	0.000113	0.002	2.2	0.041	2.18	
M100 30min	27	0.278	0.9	0.000113	0.002	2.7	0.081	2.65	
M100 60min	33.4	0.278	0.9	0.000113	0.001	3.4	0.162	3.22	
M100 2hr	41.3	0.278	0.9	0.000113	0.001	4.2	0.324	3.86	
M100 4hr	51.1	0.278	0.9	0.000113	0.000	5.2	0.648	4.53	
M100 6hr	57.9	0.278	0.9	0.000113	0.000	5.9	0.972	4.90	Type A
M100 12hr	71.5	0.278	0.9	0.000113	0.000	7.2	1.944	5.30	
M100 24hr	81	0.278	0.9	0.000113	0.000	8.2	3.888	4.32	
M100 48hr	88.5	0.278	0.9	0.000113	0.000	9.0	7.776	1.19	

Settlement Pond	T1.2	0.025	0.0045	treated water discharge rate (l/s)					
Pond Location: Chainage 25-50							4.0	l/s/ha	
1 in 10 year return	Rainfall (mm)		C	A (km²)	(m³/s)	Volume (m³)	Discharge (m³)	Residual Volume (m³)	Comments
M100 5min	13.3	0.278	0.9	0.000113	0.004	1.3	0.014	1.33	
M100 10min	18.6	0.278	0.9	0.000113	0.003	1.9	0.027	1.86	
M100 15min	21.9	0.278	0.9	0.000113	0.002	2.2	0.041	2.18	
M100 30min	27	0.278	0.9	0.000113	0.002	2.7	0.081	2.65	
M100 60min	33.4	0.278	0.9	0.000113	0.001	3.4	0.162	3.22	
M100 2hr	41.3	0.278	0.9	0.000113	0.001	4.2	0.324	3.86	
M100 4hr	51.1	0.278	0.9	0.000113	0.000	5.2	0.648	4.53	
M100 6hr	57.9	0.278	0.9	0.000113	0.000	5.9	0.972	4.90	Type A
M100 12hr	71.5	0.278	0.9	0.000113	0.000	7.2	1.944	5.30	
M100 24hr	81	0.278	0.9	0.000113	0.000	8.2	3.888	4.32	
M100 48hr	88.5	0.278	0.9	0.000113	0.000	9.0	7.776	1.19	

Settlement Pond	T1.3	0.17	0.0045	treated water discharge rate (l/s)					
Pond Location: Chainage 730-900							4.0	l/s/ha	
1 in 10 year return	Rainfall (mm)		C	A (km²)	(m³/s)	Volume (m³)	Discharge (m³)	Residual Volume (m³)	Comments
M100 5min	13.3	0.278	0.9	0.000765	0.031	9.2	0.092	9.07	
M100 10min	18.6	0.278	0.9	0.000765	0.021	12.8	0.184	12.63	
M100 15min	21.9	0.278	0.9	0.000765	0.017	15.1	0.275	14.81	
M100 30min	27	0.278	0.9	0.000765	0.010	18.6	0.551	18.05	
M100 60min	33.4	0.278	0.9	0.000765	0.006	23.0	1.102	21.91	
M100 2hr	41.3	0.278	0.9	0.000765	0.004	28.5	2.203	26.25	
M100 4hr	51.1	0.278	0.9	0.000765	0.002	35.2	4.406	30.80	
M100 6hr	57.9	0.278	0.9	0.000765	0.002	39.9	6.610	33.29	Type B
M100 12hr	71.5	0.278	0.9	0.000765	0.001	49.3	13.219	36.05	
M100 24hr	81	0.278	0.9	0.000765	0.001	55.8	26.438	29.37	
M100 48hr	88.5	0.278	0.9	0.000765	0.000	61.0	52.877	8.10	

Settlement Pond	T1.4	0.275	0.0045	treated water discharge rate (l/s)					
Pond Location: Chainage 60-335							4.0	l/s/ha	
1 in 10 year return	Rainfall (mm)		C	A (km²)	(m³/s)	Volume (m³)	Discharge (m³)	Residual Volume (m³)	Comments
M100 5min	13.3	0.278	0.9	0.001238	0.049	14.8	0.149	14.68	
M100 10min	18.6	0.278	0.9	0.001238	0.035	20.7	0.297	20.44	
M100 15min	21.9	0.278	0.9	0.001238	0.027	24.4	0.446	23.97	
M100 30min	27	0.278	0.9	0.001238	0.017	30.1	0.891	29.20	
M100 60min	33.4	0.278	0.9	0.001238	0.010	37.2	1.782	35.45	
M100 2hr	41.3	0.278	0.9	0.001238	0.006	46.0	3.564	42.47	
M100 4hr	51.1	0.278	0.9	0.001238	0.004	57.0	7.128	49.83	
M100 6hr	57.9	0.278	0.9	0.001238	0.003	64.5	10.692	53.85	Type D
M100 12hr	71.5	0.278	0.9	0.001238	0.002	79.7	21.384	58.31	
M100 24hr	81	0.278	0.9	0.001238	0.001	90.3	42.768	47.52	
M100 48hr	88.5	0.278	0.9	0.001238	0.001	98.6	85.536	13.11	

Settlement Pond	T1.5	0.275	0.0045	treated water discharge rate (l/s)					
Pond Location: Chainage 335-611							4.0	l/s/ha	
1 in 10 year return	Rainfall (mm)		C	A (km²)	(m³/s)	Volume (m³)	Discharge (m³)	Residual Volume (m³)	Comments
M100 5min	13.3	0.278	0.9	0.001238	0.049	14.8	0.149	14.68	
M100 10min	18.6	0.278	0.9	0.001238	0.035	20.7	0.297	20.44	
M100 15min	21.9	0.278	0.9	0.001238	0.027	24.4	0.446	23.97	
M100 30min	27	0.278	0.9	0.001238	0.017	30.1	0.891	29.20	
M100 60min	33.4	0.278	0.9	0.001238	0.010	37.2	1.782	35.45	
M100 2hr	41.3	0.278	0.9	0.001238	0.006	46.0	3.564	42.47	
M100 4hr	51.1	0.278	0.9	0.001238	0.004	57.0	7.128	49.83	
M100 6hr	57.9	0.278	0.9	0.001238	0.003	64.5	10.692	53.85	Type B
M100 12hr	71.5	0.278	0.9	0.001238	0.002	79.7	21.384	58.31	
M100 24hr	81	0.278	0.9	0.001238	0.001	90.3	42.768	47.52	
M100 48hr	88.5	0.278	0.9	0.001238	0.001	98.6	85.536	13.11	

Settlement Pond	T2.1	0.18	0.0045	treated water discharge rate (l/s)					
Pond Location: Chainage 0-355							4.0	l/s/ha	
1 in 10 year return	Rainfall (mm)		C	A (km²)	(m³/s)	Volume (m³)	Discharge (m³)	Residual Volume (m³)	Comments
M100 5min	13.3	0.278	0.9	0.000810	0.032	9.7	0.097	9.61	
M100 10min	18.6	0.278	0.9	0.000810	0.023	13.6	0.194	13.38	
M100 15min	21.9	0.278	0.9	0.000810	0.018	16.0	0.292	15.69	
M100 30min	27	0.278	0.9	0.000810	0.011	19.7	0.583	19.12	
M100 60min	33.4	0.278	0.9	0.000810	0.007	24.4	1.166	23.20	
M100 2hr	41.3	0.278	0.9	0.000810	0.004	30.1	2.333	27.80	
M100 4hr	51.1	0.278	0.9	0.000810	0.003	37.3	4.666	32.62	
M100 6hr	57.9	0.278	0.9	0.000810	0.002	42.2	6.998	35.24	Type C
M100 12hr	71.5	0.278	0.9	0.000810	0.001	52.2	13.997	38.17	
M100 24hr	81	0.278	0.9	0.000810	0.001	59.1	27.994	31.10	
M100 48hr	88.5	0.278	0.9	0.000810	0.000	64.6	55.987	8.58	

Settlement Pond	T2.2	0.28	0.0045	treated water discharge rate (l/s)					
Pond Location: Chainage 350-435							4.0	l/s/ha	
1 in 10 year return	Rainfall (mm)		C	A (km²)	(m³/s)	Volume (m³)	Discharge (m³)	Residual Volume (m³)	Comments
M100 5min	13.3	0.278	0.9	0.001260	0.050	15.1	0.151	14.94	
M100 10min	18.6	0.278	0.9	0.001260	0.035	21.1	0.302	20.81	
M100 15min	21.9	0.278	0.9	0.001260	0.028	24.9	0.454	24.40	
M100 30min	27	0.278	0.9	0.001260	0.017	30.6	0.907	29.74	
M100 60min	33.4	0.278	0.9	0.001260	0.011	37.9	1.814	36.09	
M100 2hr	41.3	0.278	0.9	0.001260	0.007	46.9	3.629	43.24	
M100 4hr	51.1	0.278	0.9	0.001260	0.004	58.0	7.258	50.74	
M100 6hr	57.9	0.278	0.9	0.001260	0.003	65.7	10.886	54.82	Type D
M100 12hr	71.5	0.278	0.9	0.001260	0.002	81.1	21.773	59.37	
M100 24hr	81	0.278	0.9	0.001260	0.001	91.9	43.546	48.38	
M100 48hr	88.5	0.278	0.9	0.001260	0.001	100.4	87.091	13.35	

Settlement Pond	T2.3	0.175	0.0045	treated water discharge rate (l/s)					
Pond Location: Chainage 300							4.0	l/s/ha	
1 in 10 year return	Rainfall (mm)		C	A (km²)	(m³/s)	Volume (m³)	Discharge (m³)	Residual Volume (m³)	Comments
M100 5min	13.3	0.278	0.9	0.000788	0.031	9.4	0.095	9.34	
M100 10min	18.6	0.278	0.9	0.000788	0.022	13.2	0.189	13.00	
M100 15min	21.9	0.278	0.9	0.000788	0.017	15.5	0.284	15.25	
M100 30min	27	0.278	0.9	0.000788	0.011	19.2	0.567	18.58	
M100 60min	33.4	0.278	0.9	0.000788	0.007	23.7	1.134	22.56	
M100 2hr	41.3	0.278	0.9	0.000788	0.004	29.3	2.268	27.03	
M100 4hr	51.1	0.278	0.9	0.000788	0.003	36.2	4.536	31.71	
M100 6hr	57.9	0.278	0.9	0.000788	0.002	41.1	6.804	34.27	Type C
M100 12hr	71.5	0.278	0.9	0.000788	0.001	50.7	13.608	37.11	
M100 24hr	81	0.278	0.9	0.000788	0.001	57.5	27.216	30.24	
M100 48hr	88.5	0.278	0.9	0.000788	0.000	62.8	54.432	8.34	

Settlement Pond	T2.4	0.18	0.0045	treated water discharge rate (l/s)					
Pond Location: Chainage 0-355							4.0	l/s/ha	
1 in 10 year return	Rainfall (mm)		C	A (km²)	(m³/s)	Volume (m³)	Discharge (m³)	Residual Volume (m³)	Comments
M100 5min	13.3	0.278	0.9	0.000810	0.032	9.7	0.097	9.61	
M100 10min	18.6	0.278	0.9	0.000810	0.023	13.6	0.194	13.38	
M100 15min	21.9	0.278	0.9	0.000810	0.018	16.0	0.292	15.69	
M100 30min	27	0.278	0.9	0.000810	0.011	19.7	0.583	19.12	
M100 60min	33.4	0.278	0.9	0.000810	0.007	24.4	1.166	23.20	
M100 2hr	41.3	0.278	0.9	0.000810	0.004	30.1	2.333	27.80	
M100 4hr	51.1	0.278	0.9	0.000810	0.003	37.3	4.666	32.62	
M100 6hr	57.9	0.278	0.9	0.000810	0.002	42.2	6.998	35.24	Type C
M100 12hr	71.5	0.278	0.9	0.000810	0.001	52.2	13.997	38.17	
M100 24hr	81	0.278	0.9	0.000810	0.001	59.1	27.994	31.10	
M100 48hr	88.5	0.278	0.9	0.000810	0.000	64.6	55.987	8.58	

Settlement Pond	T3.1	0.205	0.0045	treated water discharge rate (l/s)					
Pond Location: Chainage 0-205							4.0	l/s/ha	
1 in 10 year return	Rainfall (mm)		C	A (km²)	(m³/s)	Volume (m³)	Discharge (m³)	Residual Volume (m³)	Comments
M100 5min	13.3	0.278	0.9	0.000923	0.037	11.1	0.111	10.94	
M100 10min	18.6	0.278	0.9	0.000923	0.026	15.5	0.221	15.23	
M100 15min	21.9	0.278	0.9	0.000923	0.020	18.2	0.332	17.86	
M100 30min	27	0.278	0.9	0.000923	0.012	22.4	0.664	21.77	
M100 60min	33.4	0.278	0.9	0.000923	0.008	27.8	1.328	26.42	
M100 2hr	41.3	0.278	0.9	0.000923	0.005	34.3	2.657	31.66	
M100 4hr	51.1	0.278	0.9	0.000923	0.003	42.5	5.314	37.15	
M100 6hr	57.9	0.278	0.9	0.000923	0.002	48.1	7.970	40.14	Type C
M100 12hr	71.5	0.278	0.9	0.000923	0.001	59.4	15.941	43.47	
M100 24hr	81	0.278	0.9	0.000923	0.001	67.3	31.882	35.42	
M100 48hr	88.5	0.278	0.9	0.000923	0.000	73.5	63.763	9.77	

Settlement Pond	T3.2	0.205	0.0045	treated water discharge rate (l/s)					
Pond Location: Chainage 205-410							4.0	l/s/ha	
1 in 10 year return	Rainfall (mm)		C	A (km²)	(m³/s)	Volume (m³)	Discharge (m³)	Residual Volume (m³)	Comments
M100 5min	13.3	0.278	0.9	0.000923	0.037	11.1	0.111	10.94	
M100 10min	18.6	0.278	0.9	0.000923	0.026	15.5	0.221	15.23	
M100 15min	21.9	0.278	0.9	0.000923	0.020	18.2	0.332	17.86	
M100 30min	27	0.278	0.9	0.000923	0.012	22.4	0.664	21.77	
M100 60min	33.4	0.278	0.9	0.000923	0.008	27.8	1.328	26.42	
M100 2hr	41.3	0.278	0.9	0.000923	0.005	34.3	2.657	31.66	
M100 4hr	51.1	0.278	0.9	0.000923	0.003	42.5	5.314	37.15	
M100 6hr	57.9	0.278	0.9	0.000923	0.002	48.1	7.970	40.14	Type C
M100 12hr	71.5	0.278	0.9	0.000923	0.001	59.4	15.941	43.47	
M100 24hr	81	0.278	0.9	0.000923	0.001	67.3	31.882	35.42	
M100 48hr	88.5	0.278	0.9	0.000923	0.000	73.5	63.763	9.77	

Settlement Pond	T3.3	0.065	0.0045	treated water discharge rate (l/s)					
Pond Location: Chainage 420-485							4.0	l/s/ha	
1 in 10 year return	Rainfall (mm)		C	A (km²)	(m³/s)	Volume (m³)	Discharge (m³)	Residual Volume (m³)	Comments
M100 5min	13.3	0.278	0.9	0.000293	0.012	3.5	0.035	3.47	
M100 10min	18.6	0.278	0.9	0.000293	0.008	4.9	0.070	4.83	
M100 15min	21.9	0.278	0.9	0.000293	0.006	5.8	0.105	5.66	
M100 30min	27	0.278	0.9	0.000293	0.004	7.1	0.211	6.90	
M100 60min	33.4	0.278	0.9	0.000293	0.002	8.8	0.421	8.38	
M100 2hr	41.3	0.278	0.9	0.000293	0.002	10.9	0.842	10.04	
M100 4hr	51.1	0.278	0.9	0.000293	0.001	13.5	1.685	11.78	
M100 6hr	57.9	0.278	0.9	0.000293	0.001	15.3	2.527	12.73	Type A
M100 12hr	71.5	0.278	0.9	0.000293	0.000	18.8	5.054	13.78	
M100 24hr	81	0.278	0.9	0.000293	0.000	21.3	10.109	11.23	
M100 48hr	88.5	0.278	0.9	0.000293	0.000	23.3	20.218	3.10	

Settlement Pond	T3.4	0.065	0.0045	treated water discharge rate (l/s)					
Pond Location: Chainage 485-550							4.0	l/s/ha	
1 in 10 year return	Rainfall (mm)		C	A (km²)	(m³/s)	Volume (m³)	Discharge (m³)	Residual Volume (m³)	Comments
M100 5min	13.3	0.278	0.9	0.000293	0.012	3.5	0.035	3.47	
M100 10min	18.6	0.278	0.9	0.000293	0.008	4.9	0.070	4.83	
M100 15min	21.9	0.278	0.9	0.000293	0.006	5.8	0.105	5.66	
M100 30min	27	0.278	0.9	0.000293	0.004	7.1	0.211	6.90	
M100 60min	33.4	0.278	0.9	0.000293	0.002	8.8	0.421	8.38	
M100 2hr	41.3	0.278	0.9	0.000293	0.002	10.9	0.842	10.04	
M100 4hr	51.1	0.278	0.9	0.000293	0.001	13.5	1.685	11.78	
M100 6hr	57.9	0.278	0.9	0.000293	0.001	15.3	2.527	12.73	Type A
M100 12hr	71.5	0.278	0.9	0.000293	0.000	18.8	5.054	13.78	
M100 24hr	81	0.278	0.9	0.000293	0.000	21.3	10.109	11.23	
M100 48hr	88.5	0.278	0.9	0.000293	0.000	23.3	20.218	3.10	

Settlement Pond	T3.5	0.13	0.0045	treated water discharge rate (l/s)					
Pond Location: Chainage 225							4.0	l/s/ha	
1 in 10 year return	Rainfall (mm)		C	A (km²)	(m³/s)	Volume (m³)	Discharge (m³)	Residual Volume (m³)	Comments
M100 5min	13.3	0.278	0.9	0.000585	0.023	7.0	0.070	6.94	
M100 10min	18.6	0.278	0.9	0.000585	0.016	9.8	0.140	9.66	
M100 15min	21.9	0.278	0.9	0.000585	0.013	11.5	0.211	11.33	
M100 30min	27	0.278	0.9	0.000585	0.008	14.2	0.421	13.81	
M100 60min	33.4	0.278	0.9	0.000585	0.005	17.6	0.842	16.76	
M100 2hr	41.3	0.278	0.9	0.000585	0.003	21.8	1.685	20.08	
M100 4hr	51.1	0.278	0.9	0.000585	0.002	26.9	3.370	23.56	
M100 6hr	57.9	0.278	0.9	0.000585	0.001	30.5	5.054	25.45	Type A
M100 12hr	71.5	0.278	0.9	0.000585	0.001	37.7	10.109	27.57	
M100 24hr	81	0.278	0.9	0.000585	0.000	42.7	20.218	22.46	
M100 48hr	88.5	0.278	0.9	0.000585	0.000	46.6	40.435	6.20	

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Settlement Pond	T3.6	0.16	0.0045			treated water discharge rate (l/s)			
Pond Location: Chainage 250-367						4.0	l/s/ha		
1 in 10 year return	Rainfall (mm)		C	A (km²)	(m³/s)	Volume (m³)	Discharge (m³)	Residual Volume (m³)	Comments
M100 5min	13.3	0.278	0.9	0.000720	0.029	8.6	0.086	8.54	
M100 10min	18.6	0.278	0.9	0.000720	0.020	12.1	0.173	11.89	
M100 15min	21.9	0.278	0.9	0.000720	0.16	14.2	0.259	13.94	
M100 30min	27	0.278	0.9	0.000720	0.10	17.5	0.518	16.99	
M100 60min	33.4	0.278	0.9	0.000720	0.006	21.7	1.037	20.62	
M100 2hr	41.3	0.278	0.9	0.000720	0.004	26.8	2.074	24.71	
M100 4hr	51.1	0.278	0.9	0.000720	0.002	33.1	4.147	28.99	
M100 6hr	57.9	0.278	0.9	0.000720	0.002	37.5	6.221	31.33	Type B
M100 12hr	71.5	0.278	0.9	0.000720	0.001	46.4	12.442	33.93	
M100 24hr	81	0.278	0.9	0.000720	0.001	52.5	24.883	27.65	
M100 48hr	88.5	0.278	0.9	0.000720	0.000	57.4	49.766	7.63	

Settlement Pond	T3.7	0.24	0.0045			treated water discharge rate (l/s)			
Pond Location: Chainage 0-250						4.0	l/s/ha		
1 in 10 year return	Rainfall (mm)		C	A (km²)	(m³/s)	Volume (m³)	Discharge (m³)	Residual Volume (m³)	Comments
M100 5min	13.3	0.278	0.9	0.001080	0.043	12.9	0.130	12.81	
M100 10min	18.6	0.278	0.9	0.001080	0.030	18.1	0.259	17.83	
M100 15min	21.9	0.278	0.9	0.001080	0.024	21.3	0.389	20.92	
M100 30min	27	0.278	0.9	0.001080	0.015	26.3	0.778	25.49	
M100 60min	33.4	0.278	0.9	0.001080	0.009	32.5	1.555	30.94	
M100 2hr	41.3	0.278	0.9	0.001080	0.006	40.2	3.110	37.07	
M100 4hr	51.1	0.278	0.9	0.001080	0.003	49.7	6.221	43.49	
M100 6hr	57.9	0.278	0.9	0.001080	0.003	56.3	9.331	46.99	Type D
M100 12hr	71.5	0.278	0.9	0.001080	0.002	69.6	18.662	50.89	
M100 24hr	81	0.278	0.9	0.001080	0.001	78.8	37.325	41.47	
M100 48hr	88.5	0.278	0.9	0.001080	0.000	86.1	74.650	11.44	

Settlement Pond	T3.8	0.16	0.0045			treated water discharge rate (l/s)			
Pond Location: Chainage 250-367						4.0	l/s/ha		
1 in 10 year return	Rainfall (mm)		C	A (km²)	(m³/s)	Volume (m³)	Discharge (m³)	Residual Volume (m³)	Comments
M100 5min	13.3	0.278	0.9	0.000720	0.029	8.6	0.086	8.54	
M100 10min	18.6	0.278	0.9	0.000720	0.020	12.1	0.173	11.89	
M100 15min	21.9	0.278	0.9	0.000720	0.16	14.2	0.259	13.94	
M100 30min	27	0.278	0.9	0.000720	0.10	17.5	0.518	16.99	
M100 60min	33.4	0.278	0.9	0.000720	0.006	21.7	1.037	20.62	
M100 2hr	41.3	0.278	0.9	0.000720	0.004	26.8	2.074	24.71	
M100 4hr	51.1	0.278	0.9	0.000720	0.002	33.1	4.147	28.99	
M100 6hr	57.9	0.278	0.9	0.000720	0.002	37.5	6.221	31.33	Type B
M100 12hr	71.5	0.278	0.9	0.000720	0.001	46.4	12.442	33.93	
M100 24hr	81	0.278	0.9	0.000720	0.001	52.5	24.883	27.65	
M100 48hr	88.5	0.278	0.9	0.000720	0.000	57.4	49.766	7.63	

Settlement Pond	T3.9	0.21	0.0045			treated water discharge rate (l/s)			
Pond Location: Chainage 0-250						4.0	l/s/ha		
1 in 10 year return	Rainfall (mm)		C	A (km²)	(m³/s)	Volume (m³)	Discharge (m³)	Residual Volume (m³)	Comments
M100 5min	13.3	0.278	0.9	0.000945	0.038	11.3	0.113	11.21	
M100 10min	18.6	0.278	0.9	0.000945	0.026	15.8	0.227	15.61	
M100 15min	21.9	0.278	0.9	0.000945	0.021	18.6	0.340	18.30	
M100 30min	27	0.278	0.9	0.000945	0.013	23.0	0.680	22.30	
M100 60min	33.4	0.278	0.9	0.000945	0.008	28.4	1.361	27.07	
M100 2hr	41.3	0.278	0.9	0.000945	0.005	35.2	2.722	32.43	
M100 4hr	51.1	0.278	0.9	0.000945	0.003	43.5	5.443	38.05	
M100 6hr	57.9	0.278	0.9	0.000945	0.002	49.3	8.165	41.12	Type C
M100 12hr	71.5	0.278	0.9	0.000945	0.001	60.9	16.330	44.53	
M100 24hr	81	0.278	0.9	0.000945	0.001	68.9	32.659	36.29	
M100 48hr	88.5	0.278	0.9	0.000945	0.000	75.3	65.318	10.01	

Settlement Pond	T4.1	0.05	0.0045			treated water discharge rate (l/s)			
Pond Location: Chainage 750-800						4.0	l/s/ha		
1 in 10 year return	Rainfall (mm)		C	A (km²)	(m³/s)	Volume (m³)	Discharge (m³)	Residual Volume (m³)	Comments
M100 5min	13.3	0.278	0.9	0.000225	0.009	2.7	0.027	2.67	
M100 10min	18.6	0.278	0.9	0.000225	0.006	3.8	0.054	3.72	
M100 15min	21.9	0.278	0.9	0.000225	0.005	4.4	0.081	4.36	
M100 30min	27	0.278	0.9	0.000225	0.003	5.5	0.162	5.31	
M100 60min	33.4	0.278	0.9	0.000225	0.002	6.8	0.324	6.44	
M100 2hr	41.3	0.278	0.9	0.000225	0.001	8.4	0.648	7.72	
M100 4hr	51.1	0.278	0.9	0.000225	0.001	10.4	1.296	9.06	
M100 6hr	57.9	0.278	0.9	0.000225	0.001	11.7	1.944	9.79	Type A
M100 12hr	71.5	0.278	0.9	0.000225	0.000	14.5	3.888	10.60	
M100 24hr	81	0.278	0.9	0.000225	0.000	16.4	7.776	8.64	
M100 48hr	88.5	0.278	0.9	0.000225	0.000	17.9	15.552	2.38	

Settlement Pond	T4.2	0.05	0.0045			treated water discharge rate (l/s)			
Pond Location: Chainage 800						4.0	l/s/ha		
1 in 10 year return	Rainfall (mm)		C	A (km²)	(m³/s)	Volume (m³)	Discharge (m³)	Residual Volume (m³)	Comments
M100 5min	13.3	0.278	0.9	0.000225	0.009	2.7	0.027	2.67	
M100 10min	18.6	0.278	0.9	0.000225	0.006	3.8	0.054	3.72	
M100 15min	21.9	0.278	0.9	0.000225	0.005	4.4	0.081	4.36	
M100 30min	27	0.278	0.9	0.000225	0.003	5.5	0.162	5.31	
M100 60min	33.4	0.278	0.9	0.000225	0.002	6.8	0.324	6.44	
M100 2hr	41.3	0.278	0.9	0.000225	0.001	8.4	0.648	7.72	
M100 4hr	51.1	0.278	0.9	0.000225	0.001	10.4	1.296	9.06	
M100 6hr	57.9	0.278	0.9	0.000225	0.001	11.7	1.944	9.79	Type A
M100 12hr	71.5	0.278	0.9	0.000225	0.000	14.5	3.888	10.60	
M100 24hr	81	0.278	0.9	0.000225	0.000	16.4	7.776	8.64	
M100 48hr	88.5	0.278	0.9	0.000225	0.000	17.9	15.552	2.38	

Settlement Pond	T4.3	0.225	0.0045			treated water discharge rate (l/s)			
Pond Location: Chainage 800-993						4.0	l/s/ha		
1 in 10 year return	Rainfall (mm)		C	A (km²)	(m³/s)	Volume (m³)	Discharge (m³)	Residual Volume (m³)	Comments
M100 5min	13.3	0.278	0.9	0.001013	0.040	12.1	0.122	12.01	
M100 10min	18.6	0.278	0.9	0.001013	0.028	17.0	0.243	16.72	
M100 15min	21.9	0.278	0.9	0.001013	0.022	20.0	0.365	19.61	
M100 30min	27	0.278	0.9	0.001013	0.014	24.6	0.729	23.89	
M100 60min	33.4	0.278	0.9	0.001013	0.008	30.5	1.458	29.00	
M100 2hr	41.3	0.278	0.9	0.001013	0.005	37.7	2.916	34.75	
M100 4hr	51.1	0.278	0.9	0.001013	0.003	46.8	5.832	40.77	
M100 6hr	57.9	0.278	0.9	0.001013	0.002	52.8	8.748	44.06	Type C
M100 12hr	71.5	0.278	0.9	0.001013	0.002	65.2	17.496	47.71	
M100 24hr	81	0.278	0.9	0.001013	0.001	73.9	34.992	38.88	
M100 48hr	88.5	0.278	0.9	0.001013	0.000	80.7	69.984	10.73	

Settlement Pond	T4.4	0.225	0.0045			treated water discharge rate (l/s)			
Pond Location: Chainage 800-993						4.0	l/s/ha		
1 in 10 year return	Rainfall (mm)		C	A (km²)	(m³/s)	Volume (m³)	Discharge (m³)	Residual Volume (m³)	Comments
M100 5min	13.3	0.278	0.9	0.001013	0.040	12.1	0.122	12.01	
M100 10min	18.6	0.278	0.9	0.001013	0.028	17.0	0.243	16.72	
M100 15min	21.9	0.278	0.9	0.001013	0.022	20.0	0.365	19.61	
M100 30min	27	0.278	0.9	0.001013	0.014	24.6	0.729	23.89	
M100 60min	33.4	0.278	0.9	0.001013	0.008	30.5	1.458	29.00	
M100 2hr	41.3	0.278	0.9	0.001013	0.005	37.7	2.916	34.75	
M100 4hr	51.1	0.278	0.9	0.001013	0.003	46.8	5.832	40.77	
M100 6hr	57.9	0.278	0.9	0.001013	0.002	52.8	8.748	44.06	Type C
M100 12hr	71.5	0.278	0.9	0.001013	0.002	65.2	17.496	47.71	
M100 24hr	81	0.278	0.9	0.001013	0.001	73.9	34.992	38.88	
M100 48hr	88.5	0.278	0.9	0.001013	0.000	80.7	69.984	10.73	

Settlement Pond	T5.1	0.3	0.0045			treated water discharge rate (l/s)			
Pond Location: Chainage 570-650						4.0	l/s/ha		
1 in 10 year return	Rainfall (mm)		C	A (km²)	(m³/s)	Volume (m³)	Discharge (m³)	Residual Volume (m³)	Comments
M100 5min	13.3	0.278	0.9	0.001350	0.054	16.2	0.162	16.01	
M100 10min	18.6	0.278	0.9	0.001350	0.038	22.6	0.324	22.29	
M100 15min	21.9	0.278	0.9	0.001350	0.030	26.6	0.486	26.14	
M100 30min	27	0.278	0.9	0.001350	0.018	32.8	0.972	31.86	
M100 60min	33.4	0.278	0.9	0.001350	0.011	40.6	1.944	38.67	
M100 2hr	41.3	0.278	0.9	0.001350	0.007	50.2	3.888	46.33	
M100 4hr	51.1	0.278	0.9	0.001350	0.004	62.1	7.776	54.36	
M100 6hr	57.9	0.278	0.9	0.001350	0.003	70.4	11.664	58.74	Type D
M100 12hr	71.5	0.278	0.9	0.001350	0.002	86.9	23.328	63.61	
M100 24hr	81	0.278	0.9	0.001350	0.001	98.5	46.656	51.84	
M100 48hr	88.5	0.278	0.9	0.001350	0.001	107.6	93.312	14.30	

Settlement Pond	T5.2	0.05	0.0045			treated water discharge rate (l/s)			
Pond Location: Chainage 650-700						4.0	l/s/ha		
1 in 10 year return	Rainfall (mm)		C	A (km²)	(m³/s)	Volume (m³)	Discharge (m³)	Residual Volume (m³)	Comments
M100 5min	13.3	0.278	0.9	0.000225	0.009	2.7	0.027	2.67	
M100 10min	18.6	0.278	0.9	0.000225	0.006	3.8	0.054	3.72	
M100 15min	21.9	0.278	0.9	0.000225	0.005	4.4	0.081	4.36	
M100 30min	27	0.278	0.9	0.000225	0.003	5.5	0.162	5.31	
M100 60min	33.4	0.278	0.9	0.000225	0.002	6.8	0.324	6.44	
M100 2hr	41.3	0.278	0.9	0.000225	0.001	8.4	0.648	7.72	
M100 4hr	51.1	0.278	0.9	0.000225	0.001	10.4	1.296	9.06	
M100 6hr	57.9	0.278	0.9	0.000225	0.001	11.7	1.944	9.79	Type A
M100 12hr	71.5	0.278	0.9	0.000225	0.000	14.5	3.888	10.60	
M100 24hr	81	0.278	0.9	0.000225	0.000	16.4	7.776	8.64	
M100 48hr	88.5	0.278	0.9	0.000225	0.000	17.9	15.552	2.38	

Settlement Pond	T5.3	0.08	0.0045			treated water discharge rate (l/s)			
Pond Location: Chainage 700-780						4.0	l/s/ha		
1 in 10 year return	Rainfall (mm)		C	A (km²)	(m³/s)	Volume (m³)	Discharge (m³)	Residual Volume (m³)	Comments
M100 5min	13.3	0.278	0.9	0.000360	0.014	4.3	0.043	4.27	
M100 10min	18.6	0.278	0.9	0.000360	0.010	6.0	0.086	5.94	
M100 15min	21.9	0.278	0.9	0.000360	0.008	7.1	0.130	6.97	
M100 30min	27	0.278	0.9	0.000360	0.005	8.8	0.259	8.50	
M100 60min	33.4	0.278	0.9	0.000360	0.003	10.8	0.518	10.31	
M100 2hr	41.3	0.278	0.9	0.000360	0.002	13.4	1.037	12.36	
M100 4hr	51.1	0.278	0.9	0.000360	0.001	16.6	2.074	14.50	
M100 6hr	57.9	0.278	0.9	0.000360	0.001	18.8	3.110	15.66	Type A
M100 12hr	71.5	0.278	0.9	0.000360	0.001	23.2	6.221	16.96	
M100 24hr	81	0.278	0.9	0.000360	0.000	26.3	12.442	13.82	
M100 48hr	88.5	0.278	0.9	0.000360	0.000	28.7	24.883	3.81	

Settlement Pond	T5.4	0.3	0.0045			treated water discharge rate (l/s)			
Pond Location: Chainage 780-857						4.0	l/s/ha		
1 in 10 year return	Rainfall (mm)		C	A (km²)	(m³/s)	Volume (m³)	Discharge (m³)	Residual Volume (m³)	Comments
M100 5min	13.3	0.278	0.9	0.001350	0.054	16.2	0.162	16.01	
M100 10min	18.6	0.278	0.9	0.001350	0.038	22.6	0.324	22.29	
M100 15min	21.9	0.278	0.9	0.001350	0.030	26.6	0.486	26.14	
M100 30min	27	0.278	0.9	0.001350	0.018	32.8	0.972	31.86	
M100 60min	33.4	0.278	0.9	0.001350	0.011	40.6	1.944	38.67	
M100 2hr	41.3	0.278	0.9	0.001350	0.007	50.2	3.888	46.33	
M100 4hr	51.1	0.278	0.9	0.001350	0.004	62.1	7.776	54.36	
M100 6hr	57.9	0.278	0.9	0.001350	0.003	70.4	11.664	58.74	Type D
M100 12hr	71.5	0.278	0.9	0.001350	0.002	86.9	23.328	63.61	
M100 24hr	81	0.278	0.9	0.001350	0.001	98.5	46.656	51.84	
M100 48hr	88.5	0.278	0.9	0.001350	0.001	107.6	93.312	14.30	

Settlement Pond	T5.5	0.27	0.0045			treated water discharge rate (l/s)			
Pond Location: Chainage 570-650						4.0	l/s/ha		
1 in 10 year return	Rainfall (mm)		C	A (km²)	(m³/s)	Volume (m³)	Discharge (m³)	Residual Volume (m³)	Comments
M100 5min	13.3	0.278	0.9	0.001215	0.049	14.6	0.146	14.41	
M100 10min	18.6	0.278	0.9	0.001215	0.034	20.4	0.292	20.06	
M100 15min	21.9	0.278	0.9	0.001215	0.027	24.0	0.437	23.53	
M100 30min	27	0.278	0.9	0.001215	0.016	29.5	0.875	28.67	
M100 60min	33.4	0.278	0.9	0.001215	0.010	36.6	1.750	34.80	
M100 2hr	41.3	0.278	0.9	0.001215	0.006	45.2	3.499	41.70	
M100 4hr	51.1	0.278	0.9	0.001215	0.004	55.9	6.998	48.92	
M100 6hr	57.9	0.278	0.9	0.001215	0.003	63.4	10.498	52.87	Type D
M100 12hr	71.5	0.278	0.9	0.001215	0.002	78.2	20.995	57.25	
M100 24hr	81	0.278	0.9	0.001215	0.001	88.6	41.990	46.65	
M100 48hr	88.5	0.278	0.9	0.001215	0.001	96.9	83.981	12.87	

Settlement Pond		T6.1	0.065	0.0045	treated water discharge rate (l/s)				
Pond Location: Chainage 0-65								4.0	l/s/ha
1 in 10 year return	Rainfall (mm)		C	A (km²)	(m³/s)	Volume (m³)	Discharge (m³)	Residual Volume (m³)	Comments
M100 5min	13.3	0.278	0.9	0.000293	0.012	3.5	0.035	3.47	
M100 10min	18.6	0.278	0.9	0.000293	0.008	4.9	0.070	4.83	
M100 15min	21.9	0.278	0.9	0.000293	0.006	5.8	0.105	5.66	
M100 30min	27	0.278	0.9	0.000293	0.004	7.1	0.211	6.90	
M100 60min	33.4	0.278	0.9	0.000293	0.002	8.8	0.421	8.38	
M100 2hr	41.3	0.278	0.9	0.000293	0.002	10.9	0.842	10.04	
M100 4hr	51.1	0.278	0.9	0.000293	0.001	13.5	1.685	11.78	
M100 6hr	57.9	0.278	0.9	0.000293	0.001	15.3	2.527	12.73	Type A
M100 12hr	71.5	0.278	0.9	0.000293	0.000	18.8	5.054	13.78	
M100 24hr	81	0.278	0.9	0.000293	0.000	21.3	10.109	11.23	
M100 48hr	88.5	0.278	0.9	0.000293	0.000	23.3	20.218	3.10	

Settlement Pond		T6.2	0.22	0.0045	treated water discharge rate (l/s)				
Pond Location: Chainage 65-258								4.0	l/s/ha
1 in 10 year return	Rainfall (mm)		C	A (km²)	(m³/s)	Volume (m³)	Discharge (m³)	Residual Volume (m³)	Comments
M100 5min	13.3	0.278	0.9	0.000990	0.040	11.9	0.119	11.74	
M100 10min	18.6	0.278	0.9	0.000990	0.028	16.6	0.238	16.35	
M100 15min	21.9	0.278	0.9	0.000990	0.022	19.5	0.356	19.17	
M100 30min	27	0.278	0.9	0.000990	0.013	24.1	0.713	23.36	
M100 60min	33.4	0.278	0.9	0.000990	0.008	29.8	1.426	28.36	
M100 2hr	41.3	0.278	0.9	0.000990	0.005	36.8	2.851	33.98	
M100 4hr	51.1	0.278	0.9	0.000990	0.003	45.6	5.702	39.86	
M100 6hr	57.9	0.278	0.9	0.000990	0.002	51.6	8.554	43.08	Type C
M100 12hr	71.5	0.278	0.9	0.000990	0.001	63.8	17.107	46.65	
M100 24hr	81	0.278	0.9	0.000990	0.001	72.2	34.214	38.01	
M100 48hr	88.5	0.278	0.9	0.000990	0.000	78.9	68.429	10.49	

Settlement Pond		T6.3	0.16	0.0045	treated water discharge rate (l/s)				
Pond Location: Chainage 150-258								4.0	l/s/ha
1 in 10 year return	Rainfall (mm)		C	A (km²)	(m³/s)	Volume (m³)	Discharge (m³)	Residual Volume (m³)	Comments
M100 5min	13.3	0.278	0.9	0.000720	0.029	8.6	0.086	8.54	
M100 10min	18.6	0.278	0.9	0.000720	0.020	12.1	0.173	11.89	
M100 15min	21.9	0.278	0.9	0.000720	0.016	14.2	0.259	13.94	
M100 30min	27	0.278	0.9	0.000720	0.010	17.5	0.518	16.99	
M100 60min	33.4	0.278	0.9	0.000720	0.006	21.7	1.037	20.62	
M100 2hr	41.3	0.278	0.9	0.000720	0.004	26.8	2.074	24.71	
M100 4hr	51.1	0.278	0.9	0.000720	0.002	33.1	4.147	28.99	
M100 6hr	57.9	0.278	0.9	0.000720	0.002	37.5	6.221	31.33	Type B
M100 12hr	71.5	0.278	0.9	0.000720	0.001	46.4	12.442	33.93	
M100 24hr	81	0.278	0.9	0.000720	0.001	52.5	24.883	27.65	
M100 48hr	88.5	0.278	0.9	0.000720	0.000	57.4	49.766	7.63	

Settlement Pond		T7.1	0.1	0.0045	treated water discharge rate (l/s)				
Pond Location: Chainage 1775								4.0	l/s/ha
1 in 10 year return	Rainfall (mm)		C	A (km²)	(m³/s)	Volume (m³)	Discharge (m³)	Residual Volume (m³)	Comments
M100 5min	13.3	0.278	0.9	0.000450	0.018	5.4	0.054	5.34	
M100 10min	18.6	0.278	0.9	0.000450	0.013	7.5	0.108	7.43	
M100 15min	21.9	0.278	0.9	0.000450	0.010	8.9	0.162	8.71	
M100 30min	27	0.278	0.9	0.000450	0.006	10.9	0.324	10.62	
M100 60min	33.4	0.278	0.9	0.000450	0.004	13.5	0.648	12.89	
M100 2hr	41.3	0.278	0.9	0.000450	0.002	16.7	1.296	15.44	
M100 4hr	51.1	0.278	0.9	0.000450	0.001	20.7	2.592	18.12	
M100 6hr	57.9	0.278	0.9	0.000450	0.001	23.5	3.888	19.58	Type A
M100 12hr	71.5	0.278	0.9	0.000450	0.001	29.0	7.776	21.20	
M100 24hr	81	0.278	0.9	0.000450	0.000	32.8	15.552	17.28	
M100 48hr	88.5	0.278	0.9	0.000450	0.000	35.9	31.104	4.77	

Settlement Pond		T7.2	0.1	0.0045	treated water discharge rate (l/s)				
Pond Location: Chainage 1775								4.0	l/s/ha
1 in 10 year return	Rainfall (mm)		C	A (km²)	(m³/s)	Volume (m³)	Discharge (m³)	Residual Volume (m³)	Comments
M100 5min	13.3	0.278	0.9	0.000450	0.018	5.4	0.054	5.34	
M100 10min	18.6	0.278	0.9	0.000450	0.013	7.5	0.108	7.43	
M100 15min	21.9	0.278	0.9	0.000450	0.010	8.9	0.162	8.71	
M100 30min	27	0.278	0.9	0.000450	0.006	10.9	0.324	10.62	
M100 60min	33.4	0.278	0.9	0.000450	0.004	13.5	0.648	12.89	
M100 2hr	41.3	0.278	0.9	0.000450	0.002	16.7	1.296	15.44	
M100 4hr	51.1	0.278	0.9	0.000450	0.001	20.7	2.592	18.12	
M100 6hr	57.9	0.278	0.9	0.000450	0.001	23.5	3.888	19.58	Type A
M100 12hr	71.5	0.278	0.9	0.000450	0.001	29.0	7.776	21.20	
M100 24hr	81	0.278	0.9	0.000450	0.000	32.8	15.552	17.28	
M100 48hr	88.5	0.278	0.9	0.000450	0.000	35.9	31.104	4.77	

Settlement Pond		T7.3	0.1	0.0045	treated water discharge rate (l/s)				
Pond Location: Chainage 1775								4.0	l/s/ha
1 in 10 year return	Rainfall (mm)		C	A (km²)	(m³/s)	Volume (m³)	Discharge (m³)	Residual Volume (m³)	Comments
M100 5min	13.3	0.278	0.9	0.000450	0.018	5.4	0.054	5.34	
M100 10min	18.6	0.278	0.9	0.000450	0.013	7.5	0.108	7.43	
M100 15min	21.9	0.278	0.9	0.000450	0.010	8.9	0.162	8.71	
M100 30min	27	0.278	0.9	0.000450	0.006	10.9	0.324	10.62	
M100 60min	33.4	0.278	0.9	0.000450	0.004	13.5	0.648	12.89	
M100 2hr	41.3	0.278	0.9	0.000450	0.002	16.7	1.296	15.44	
M100 4hr	51.1	0.278	0.9	0.000450	0.001	20.7	2.592	18.12	
M100 6hr	57.9	0.278	0.9	0.000450	0.001	23.5	3.888	19.58	Type A
M100 12hr	71.5	0.278	0.9	0.000450	0.001	29.0	7.776	21.20	
M100 24hr	81	0.278	0.9	0.000450	0.000	32.8	15.552	17.28	
M100 48hr	88.5	0.278	0.9	0.000450	0.000	35.9	31.104	4.77	

Settlement Pond		T10.1	0.075	0.0045	treated water discharge rate (l/s)				
Pond Location: Chainage 2210-2285								4.0	l/s/ha
1 in 10 year return	Rainfall (mm)		C	A (km²)	(m³/s)	Volume (m³)	Discharge (m³)	Residual Volume (m³)	Comments
M100 5min	13.3	0.278	0.9	0.000338	0.013	4.0	0.041	4.00	
M100 10min	18.6	0.278	0.9	0.000338	0.009	5.7	0.081	5.57	
M100 15min	21.9	0.278	0.9	0.000338	0.007	6.7	0.122	6.54	
M100 30min	27	0.278	0.9	0.000338	0.005	8.2	0.243	7.96	
M100 60min	33.4	0.278	0.9	0.000338	0.003	10.2	0.486	9.67	
M100 2hr	41.3	0.278	0.9	0.000338	0.002	12.6	0.972	11.58	
M100 4hr	51.1	0.278	0.9	0.000338	0.001	15.5	1.944	13.59	
M100 6hr	57.9	0.278	0.9	0.000338	0.001	17.6	2.916	14.69	Type A
M100 12hr	71.5	0.278	0.9	0.000338	0.001	21.7	5.832	15.90	
M100 24hr	81	0.278	0.9	0.000338	0.000	24.6	11.664	12.96	
M100 48hr	88.5	0.278	0.9	0.000338	0.000	26.9	23.328	3.58	

Settlement Pond		T10.2	0.075	0.0045	treated water discharge rate (l/s)				
Pond Location: Chainage 2285-2370								4.0	l/s/ha
1 in 10 year return	Rainfall (mm)		C	A (km²)	(m³/s)	Volume (m³)	Discharge (m³)	Residual Volume (m³)	Comments
M100 5min	13.3	0.278	0.9	0.000338	0.013	4.0	0.041	4.00	
M100 10min	18.6	0.278	0.9	0.000338	0.009	5.7	0.081	5.57	
M100 15min	21.9	0.278	0.9	0.000338	0.007	6.7	0.122	6.54	
M100 30min	27	0.278	0.9	0.000338	0.005	8.2	0.243	7.96	
M100 60min	33.4	0.278	0.9	0.000338	0.003	10.2	0.486	9.67	
M100 2hr	41.3	0.278	0.9	0.000338	0.002	12.6	0.972	11.58	
M100 4hr	51.1	0.278	0.9	0.000338	0.001	15.5	1.944	13.59	
M100 6hr	57.9	0.278	0.9	0.000338	0.001	17.6	2.916	14.69	Type A
M100 12hr	71.5	0.278	0.9	0.000338	0.001	21.7	5.832	15.90	
M100 24hr	81	0.278	0.9	0.000338	0.000	24.6	11.664	12.96	
M100 48hr	88.5	0.278	0.9	0.000338	0.000	26.9	23.328	3.58	

Settlement Pond		T10.3	0.15	0.0045	treated water discharge rate (l/s)				
Pond Location: Chainage 2375-2500								4.0	l/s/ha
1 in 10 year return	Rainfall (mm)		C	A (km²)	(m³/s)	Volume (m³)	Discharge (m³)	Residual Volume (m³)	Comments
M100 5min	13.3	0.278	0.9	0.000675	0.027	8.1	0.081	8.01	
M100 10min	18.6	0.278	0.9	0.000675	0.019	11.3	0.162	11.15	
M100 15min	21.9	0.278	0.9	0.000675	0.015	13.3	0.243	13.07	
M100 30min	27	0.278	0.9	0.000675	0.009	16.4	0.486	15.93	
M100 60min	33.4	0.278	0.9	0.000675	0.006	20.3	0.972	19.33	
M100 2hr	41.3	0.278	0.9	0.000675	0.003	25.1	1.944	23.17	
M100 4hr	51.1	0.278	0.9	0.000675	0.002	31.1	3.888	27.18	
M100 6hr	57.9	0.278	0.9	0.000675	0.002	35.2	5.832	29.37	Type B
M100 12hr	71.5	0.278	0.9	0.000675	0.001	43.5	11.664	31.81	
M100 24hr	81	0.278	0.9	0.000675	0.001	49.2	23.328	25.92	
M100 48hr	88.5	0.278	0.9	0.000675	0.000	53.8	46.656	7.15	

Settlement Pond		T10.4	0.15	0.0045	treated water discharge rate (l/s)				
Pond Location: Chainage 2375-2500								4.0	l/s/ha
1 in 10 year return	Rainfall (mm)		C	A (km²)	(m³/s)	Volume (m³)	Discharge (m³)	Residual Volume (m³)	Comments
M100 5min	13.3	0.278	0.9	0.000675	0.027	8.1	0.081	8.01	
M100 10min	18.6	0.278	0.9	0.000675	0.019	11.3	0.162	11.15	
M100 15min	21.9	0.278	0.9	0.000675	0.015	13.3	0.243	13.07	
M100 30min	27	0.278	0.9	0.000675	0.009	16.4	0.486	15.93	
M100 60min	33.4	0.278	0.9	0.000675	0.006	20.3	0.972	19.33	
M100 2hr	41.3	0.278	0.9	0.000675	0.003	25.1	1.944	23.17	
M100 4hr	51.1	0.278	0.9	0.000675	0.002	31.1	3.888	27.18	
M100 6hr	57.9	0.278	0.9	0.000675	0.002	35.2	5.832	29.37	Type B
M100 12hr	71.5	0.278	0.9	0.000675	0.001	43.5	11.664	31.81	
M100 24hr	81	0.278	0.9	0.000675	0.001	49.2	23.328	25.92	
M100 48hr	88.5	0.278	0.9	0.000675	0.000	53.8	46.656	7.15	

Settlement Pond		T10.5	0.15	0.0045	treated water discharge rate (l/s)				
Pond Location: Chainage 2500-2614								4.0	l/s/ha
1 in 10 year return	Rainfall (mm)		C	A (km²)	(m³/s)	Volume (m³)	Discharge (m³)	Residual Volume (m³)	Comments
M100 5min	13.3	0.278	0.9	0.000675	0.027	8.1	0.081	8.01	
M100 10min	18.6	0.278	0.9	0.000675	0.019	11.3	0.162	11.15	
M100 15min	21.9	0.278	0.9	0.000675	0.015	13.3	0.243	13.07	
M100 30min	27	0.278	0.9	0.000675	0.009	16.4	0.486	15.93	
M100 60min	33.4	0.278	0.9	0.000675	0.006	20.3	0.972	19.33	
M100 2hr	41.3	0.278	0.9	0.000675	0.003	25.1	1.944	23.17	
M100 4hr	51.1	0.278	0.9	0.000675	0.002	31.1	3.888	27.18	
M100 6hr	57.9	0.278	0.9	0.000675	0.002	35.2	5.832	29.37	Type B
M100 12hr	71.5	0.278	0.9	0.000675	0.001	43.5	11.664	31.81	
M100 24hr	81	0.278	0.9	0.000675	0.001	49.2	23.328	25.92	
M100 48hr	88.5	0.278	0.9	0.000675	0.000	53.8	46.656	7.15	

Settlement Pond		T10.6	0.15	0.0045			treated water discharge rate (l/s)	
Pond Location: Chainage 2500-2614							4.0	l/s/ha
1 in 10 year return	Rainfall (mm)		C	A (km²)	(m³/s)	Volume (m³)	Discharge (m³)	Residual Volume (m³)	Comments
M100 5min	13.3	0.278	0.9	0.000675	0.027	8.1	0.081	8.01	
M100 10min	18.6	0.278	0.9	0.000675	0.019	11.3	0.162	11.15	
M100 15min	21.9	0.278	0.9	0.000675	0.015	13.3	0.243	13.07	
M100 30min	27	0.278	0.9	0.000675	0.009	16.4	0.486	15.93	
M100 60min	33.4	0.278	0.9	0.000675	0.006	20.3	0.972	19.33	
M100 2hr	41.3	0.278	0.9	0.000675	0.003	25.1	1.944	23.17	
M100 4hr	51.1	0.278	0.9	0.000675	0.002	31.1	3.888	27.18	
M100 6hr	57.9	0.278	0.9	0.000675	0.002	35.2	5.832	29.37	Type B
M100 12hr	71.5	0.278	0.9	0.000675	0.001	43.5	11.664	31.81	
M100 24hr	81	0.278	0.9	0.000675	0.001	49.2	23.328	25.92	
M100 48hr	88.5	0.278	0.9	0.000675	0.000	53.8	46.656	7.15	

Settlement Pond		T11.1	0.25	0.0045				treated water discharge rate (l/s)	
Pond Location: Chainage 0-250								4.0	l/s/ha
1 in 10 year return	Rainfall (mm)		C	A (km²)	(m³/s)	Volume (m³)	Discharge (m³)	Residual Volume (m³)	Comments
M100 5min	13.3	0.278	0.9	0.001125	0.045	13.5	0.135	13.34	
M100 10min	18.6	0.278	0.9	0.001125	0.031	18.8	0.270	18.58	
M100 15min	21.9	0.278	0.9	0.001125	0.025	22.2	0.405	21.79	
M100 30min	27	0.278	0.9	0.001125	0.015	27.4	0.810	26.55	
M100 60min	33.4	0.278	0.9	0.001125	0.009	33.8	1.620	32.22	
M100 2hr	41.3	0.278	0.9	0.001125	0.006	41.8	3.240	38.61	
M100 4hr	51.1	0.278	0.9	0.001125	0.004	51.8	6.480	45.30	
M100 6hr	57.9	0.278	0.9	0.001125	0.003	58.7	9.720	48.95	Type D
M100 12hr	71.5	0.278	0.9	0.001125	0.002	72.5	19.440	53.01	
M100 24hr	81	0.278	0.9	0.001125	0.001	82.1	38.880	43.20	
M100 48hr	88.5	0.278	0.9	0.001125	0.001	89.7	77.760	11.92	

Settlement Pond		T11.2	0.165	0.0045				treated water discharge rate (l/s)	
Pond Location: Chainage 260-425								4.0	l/s/ha
1 in 10 year return	Rainfall (mm)		C	A (km²)	(m³/s)	Volume (m³)	Discharge (m³)	Residual Volume (m³)	Comments
M100 5min	13.3	0.278	0.9	0.000743	0.030	8.9	0.089	8.81	
M100 10min	18.6	0.278	0.9	0.000743	0.021	12.4	0.178	12.26	
M100 15min	21.9	0.278	0.9	0.000743	0.016	14.6	0.267	14.38	
M100 30min	27	0.278	0.9	0.000743	0.010	18.1	0.535	17.52	
M100 60min	33.4	0.278	0.9	0.000743	0.006	22.3	1.069	21.27	
M100 2hr	41.3	0.278	0.9	0.000743	0.004	27.6	2.138	25.48	
M100 4hr	51.1	0.278	0.9	0.000743	0.002	34.2	4.277	29.90	
M100 6hr	57.9	0.278	0.9	0.000743	0.002	38.7	6.415	32.31	Type B
M100 12hr	71.5	0.278	0.9	0.000743	0.001	47.8	12.830	34.99	
M100 24hr	81	0.278	0.9	0.000743	0.001	54.2	25.661	28.51	
M100 48hr	88.5	0.278	0.9	0.000743	0.000	59.2	51.322	7.87	

Settlement Pond		T11.3	0.275	0.0045				treated water discharge rate (l/s)	
Pond Location: Chainage 425-515								4.0	l/s/ha
1 in 10 year return	Rainfall (mm)		C	A (km²)	(m³/s)	Volume (m³)	Discharge (m³)	Residual Volume (m³)	Comments
M100 5min	13.3	0.278	0.9	0.001238	0.049	14.8	0.149	14.68	
M100 10min	18.6	0.278	0.9	0.001238	0.035	20.7	0.297	20.44	
M100 15min	21.9	0.278	0.9	0.001238	0.027	24.4	0.446	23.97	
M100 30min	27	0.278	0.9	0.001238	0.017	30.1	0.891	29.20	
M100 60min	33.4	0.278	0.9	0.001238	0.010	37.2	1.782	35.45	
M100 2hr	41.3	0.278	0.9	0.001238	0.006	46.0	3.564	42.47	
M100 4hr	51.1	0.278	0.9	0.001238	0.004	57.0	7.128	49.83	
M100 6hr	57.9	0.278	0.9	0.001238	0.003	64.5	10.692	53.85	Type D
M100 12hr	71.5	0.278	0.9	0.001238	0.002	79.7	21.384	58.31	
M100 24hr	81	0.278	0.9	0.001238	0.001	90.3	42.768	47.52	
M100 48hr	88.5	0.278	0.9	0.001238	0.001	98.6	85.536	13.11	

Settlement Pond		T11.4	0.15	0.0045				treated water discharge rate (l/s)	
Pond Location: Chainage 400-515								4.0	l/s/ha
1 in 10 year return	Rainfall (mm)		C	A (km²)	(m³/s)	Volume (m³)	Discharge (m³)	Residual Volume (m³)	Comments
M100 5min	13.3	0.278	0.9	0.000675	0.027	8.1	0.081000	8.01	
M100 10min	18.6	0.278	0.9	0.000675	0.019	11.3	0.162000	11.15	
M100 15min	21.9	0.278	0.9	0.000675	0.015	13.3	0.243000	13.07	
M100 30min	27	0.278	0.9	0.000675	0.009	16.4	0.486000	15.93	
M100 60min	33.4	0.278	0.9	0.000675	0.006	20.3	0.972000	19.33	
M100 2hr	41.3	0.278	0.9	0.000675	0.003	25.1	1.944000	23.17	
M100 4hr	51.1	0.278	0.9	0.000675	0.002	31.1	3.888000	27.18	
M100 6hr	57.9	0.278	0.9	0.000675	0.002	35.2	5.832000	29.37	Type B
M100 12hr	71.5	0.278	0.9	0.000675	0.001	43.5	11.664000	31.81	
M100 24hr	81	0.278	0.9	0.000675	0.001	49.2	23.328000	25.92	
M100 48hr	88.5	0.278	0.9	0.000675	0.000	53.8	46.656000	7.15	

Bracklyn Wind Farm Limited

Bracklyn Wind Farm

Co. Westmeath & Co. Meath

Construction Environmental Management Plan (CEMP)

TECHNICAL SCHEDULE 3

Water Quality Monitoring Plan

September 2021

Bracklyn Wind Farm Limited,
Greaghcrotta,
Tullyco,
Cootehill,
Co. Cavan.
Tel.: +353 (0) 49 555 5050

Jennings O'Donovan & Partners Limited,
Consulting Engineers,
Finisklin Business Park, Sligo.
Tel.: 071 9161416
Fax: 071 9161080
email: info@jodireland.com

JENNINGS O'DONOVAN & PARTNERS LIMITED
Project, Civil and Structural Consulting Engineers,
FINISKLIN BUSINESS PARK,
SLIGO,
IRELAND.

Telephone (071) 91 61416
Fax (071) 91 61080

Email info@jodireland.com
Web Site www.jodireland.com

DOCUMENT APPROVAL

PROJECT	Bracklyn Wind Farm, Co. Westmeath & Co. Meath	
CLIENT / JOB NO	Bracklyn Wind Farm Limited	6175
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	Prepared by	**Reviewed**	**Approved by**
Document **Draft**	Name Jody Gormley	Name Sarah Moore	Name John McElvaney
Date 14h May 2021	Signature	Signature	Signature

Document **Final**	Name Jody Gormley	Name Sarah Moore	Name John McElvaney
Date 9th September 2021	Signature	Signature	Signature

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1. INTRODUCTION

1.1 Scope and Requirements

1.1.1 The Contractor is solely responsible for pollution prevention for the duration of the contract and until such time as permanent measures, such as permanent drainage and silt mitigation controls, are deemed to be adequate.

1.1.2 In order to verify the efficacy of pollution prevention and mitigation works during construction, Water Quality Monitoring is required to be undertaken by a suitably qualified independent Environmental Manager (EM), prior to, during and post completion of construction works. This will include all watercourses within the catchment of the construction area. The monitoring will comprise visual, hydrochemistry and grab sample monitoring.

1.1.3 The details of the monitoring contained within this Water Quality Management Plan (WQMP) will be reviewed by the Westmeath County Council and Meath County Council prior to commencement of construction. The approved plan will be coordinated and implemented on site by the Environmental Manager. The CEMP, SWMP and the measures detailed in this WQMP are part of the main pre commencement requirements for the works associated with the construction of Bracklyn Wind Farm.

1.2 Reference Documentation

1.2.1 Construction works have the potential to cause pollution of the water environment. All construction works on site, and specifically construction works to be undertaken within and in the vicinity of any watercourses, will be completed in compliance with current legislation and best practice as detailed within the Construction Environment Management Plan (CEMP).

1.2.2 The following reports (along with any further surveys conducted) will be used to inform the scope of the construction phase WQMP.

- Environmental Impact Assessment Report (EIAR) (Galetech Energy Services September 2021)
- CEMP including Management Plans (Jennings O' Donovan September 2021)

2. RESPONSIBILITIES

2.1 General

2.1.1 Responsibility for the water quality monitoring programme, and coordination thereof, will lie with the independent EM appointed at the start of the programme.

2.1.2 Prior to works commencing, an EM will be retained by Bracklyn Wind Farm Limited with a responsibility to implement this WQMP. Among other requirements, the WQMP requires a full baseline survey to be undertaken prior to the commencement of construction and requires the contractor to provide a 'schedule of work' to the water quality specialist at the beginning of each week.

2.1.3 The EM will prepare and deliver site induction and training to all construction personnel, in liaison with the Site Engineer and EM/Ecological Clerk of Works (ECoW).

2.1.4 As outlined in Table 4.3 of the CEMP, the EM will:

- Undertake specific monitoring activities and reporting as defined in agreed documentation prepared as part of the planning process fulfilling the requirements of the WQMP, including:
- Daily visual inspection of:
    - Access tracks for signs of ground damage or solids escape to nearby watercourses in vicinity of construction works
    - The ground between the structure under construction and the nearest downslope watercourse for signs of solids escape or ground damage
    - Surface water features in vicinity of construction works
    - Any pollution control measures at structures and along access tracks (e.g. silt fences, drain or stream crossings etc.) for evidence of contaminated run-off or mitigation failure.
- Attendance at the critical work phases including: access track construction, foundation excavation, watercourse crossings, concrete pouring and back-filling.
- Collection and analysis of water samples at seven (7) monitoring locations along the instream works at the Development Site, before, during (if potential pollution is visually identified) and after construction works at that location. These water monitoring locations will be upstream and downstream of the instream works at the Development Site (ML 1-7) as outlined (Appendix A of this report).

- EPA Q Value Biological Monitoring at the 7 no. monitoring locations (as outlined in Appendix A of this report) before and after construction works.

2.1.5 Collection and analysis of water samples at the monitoring locations (i.e. upstream & downstream of construction work location) before, during and after construction works. It is proposed that 1 round of sampling will be undertaken prior to the commencement of development and will be used as a baseline by which all subsequent samples will be compared. Monthly sampling will then be completed for the duration of the construction phase while 1 no. round of sampling will be completed following the completion of construction and reinstatement activities.

2.2 Hydrochemistry Monitoring

2.2.1 Field Monitoring

Field monitoring of water quality parameters and collection of samples will be undertaken by the EM who will be appropriately qualified on the required monitoring methods and the use, calibration and maintenance of all monitoring equipment used (Scope outlined in Section 3). Monitoring will be undertaken at the 7 monitoring locations outlined in Table 1 below.

Table 1 List of Proposed Monitoring Location Coordinates

Monitoring Location	ITM Easting (m)	ITM Northing (m)
1	659679	759760
2	659873	759821
3	662465	758673
4	664462	757912
5	666062	756607
6	666185	756455
7	668734	756301

2.2.2 Laboratory Analysis

Laboratory analysis of water samples will also be undertaken as part of the monitoring programme by an independent and appropriately certified laboratory to be appointed by the EM.

2.2.3 Coordination of the laboratory sampling and analytical programme will be undertaken by the EM. Samples will be dispatched for analysis under chain of custody procedures. Laboratory analytical results will be sent directly to the EM.

2.2.4 Interpretation and reporting of both the field and laboratory data will be the responsibility of the EM.

2.3 Reporting

2.3.1 Monthly Water Quality Reporting

Results of water quality monitoring shall assist in determining requirements for improvements in drainage and pollution prevention measures implemented on site. A monthly report on water quality will be prepared by the EM.

2.3.2 It will be the responsibility of the EM to present the ongoing results of water quality and weather monitoring at site meetings and with outside bodies. This shall be done at weekly meetings and reported within the overall Monthly Environmental Report to be prepared by the EM.

2.3.3 The monthly reports on water quality will consider all visual, field monitoring and results of laboratory analysis received that month. Reports will describe how the results compare with baseline data as well as previous monthly reports on water quality. The reports will also describe whether any deterioration or improvement in water quality has been observed and whether any effects are attributable to construction activities and what remedial measures or corrective actions have been implemented.

2.3.4 Monthly reports on water quality will be provided to the Client Project Manager and will be made available to the Planning Authority, as may be necessary.

2.3.6 Final Report on Water Quality

Upon completion of all post-construction monitoring, the EM will prepare a final report on water quality. This final report will cover the overall performance against baseline data, details on any impacts attributed to construction works and recommendations for remedial works if required.

2.3.7 The final report will be provided to Westmeath County Council, Meath County Council and Inland Fisheries Ireland.

2.4 Contingency Sampling & Emergency Response

2.4.1 In the event that a pollution incident arises from the construction works, such as that resulting from a spill or accidental release of chemicals, oils and fuels or concrete effluent, threatens to enter, or has entered a watercourse, additional sampling and analysis of surface water samples will be undertaken to determine the level of impact to the surface water receptor and remedial

requirements, where necessary.

2.4.2 Where a pollution incident has occurred as a result of construction works, the EM will consult with Westmeath County Council and Meath County Council to determine sampling requirements and any additional survey requirements where potentially significant impacts are identified. Where it is demonstrated that the pollution occurred as a result of non-compliance with the CEMP, the costs of any additional sampling or survey requirements shall be borne by the Contractor.

3. WATER QUALITY MONITORING: OUTLINE SCOPE

3.1 General

3.1.1 The full scope of monitoring and precise monitoring locations require agreement with the County Council prior to commencement of construction works.

3.1.2 Water Quality Monitoring locations will be identified through grid reference, photographic record and indicated on a plan. For repeat sampling locations, each location will also be marked on the ground (stake/post) to ensure that the correct location is sampled each time.

3.1.3 Sample locations shall be labelled consistently for the duration of the monitoring period. Where any additional locations are sampled during the works, the location (grid reference) of the sampling point will be recorded and a photograph will be taken at time of sampling.

3.1.4 'Control' sample locations may also be included in the scope of any monitoring.

3.2 Hydrochemistry Monitoring

3.2.1 The monitoring programme will include:

- At least one baseline monitoring visit.
- Daily visual observation in areas of high construction activity or during high rainfall periods to identify any evidence of siltation, oil or silt. Visual inspections will include details of the color of the water at the time of inspection.
- Weekly visual inspections and monthly field hydrochemistry monitoring.
- One round of post construction monitoring.

3.1.5 The agreed suite of grab sample determinants may include the following:

Parameters for hydrochemistry analysis

- pH
- Temperature
- Total Suspended Solids (TSS)
- Dissolved Organic Carbon (DOC)
- Conductivity
- Dissolved Oxygen (DO)
- Total Oxidized Nitrogen (TON)
- Ammoniacal Nitrogen

- Ammonia
- Potassium
- Phosphate
- Biological Oxygen Demand (BOD)
- Chemical Oxygen Demand (COD)
- Total Petroleum Hydrocarbons (TPH) (*Only during construction phase)

Appendix A: Water Quality Monitoring Locations

Bracklyn Wind Farm Limited.

Bracklyn Wind Farm,

Co. Westmeath

Construction Environmental Management Plan (CEMP)

TECHNICAL SCHEDULE 4

Spoil Management Plan

September 2021

Bracklyn Wind Farm Ltd,
Greaghcrotta,
Tullyco,
Cootehill,
Co. Cavan.
Tel.: +353 (0) 49 555 5050 (c/o
Galetech Energy Services)

Jennings O'Donovan & Partners Limited,
Consulting Engineers,
Finisklin Business Park,
Sligo, F91 RHH9
Tel.: 071 9161416
Fax: 071 9161080
email: info@jodireland.com

JENNINGS O'DONOVAN & PARTNERS LIMITED
Project, Civil and Structural Consulting Engineers,
FINISKLIN BUSINESS PARK,
SLIGO,
IRELAND.

Telephone (071) 91 61416
Fax (071) 91 61080

Email info@jodireland.com
Web Site www.jodireland.com

DOCUMENT APPROVAL

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	Prepared by	**Reviewed**	**Approved by**
Document **Draft**	Name Jody Gormley	Name Sarah Moore	Name John McElvaney
Date 29th April 2021	Signature	Signature	Signature

Document **Final**	Name Jody Gormley	Name Sarah Moore	Name David Kiely
Date 17th September 2021	Signature	Signature	Signature

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Appendix F – Spoil Management Layout

1 INTRODUCTION

1.1 General

Bracklyn Wind Farm Limited. intends to develop a 9 no. turbine Wind Farm project and Grid Connection on lands at Bracklin, Co. Westmeath and Coolronan, Co. Meath. The proposed Development is located in east Co. Westmeath and west Co. Meath, approximately 16km east of Mullingar, 4km south of Delvin and 5km north of Raharney. Jennings O'Donovan & Partners Limited (JOD) has been engaged by Bracklyn Wind Farm Limited. to develop an outline Construction Environmental Management Plan (CEMP) for the project, including preparation of the following technical schedules:

- Environmental Incident and Emergency Communication Response Plan (Technical Schedule 1)
- Surface Water Management Plan (Technical Schedule 2)
- Water Quality Monitoring Plan (Technical Schedule 3)
- Spoil Management Plan (Technical Schedule 4)
- Waste Management Plan (Technical Schedule 5)

The proposed Development at the Site will consist of the following:

- 9 no. wind turbines with a maximum tip height of up to 185 metres (m);
- All associated foundations and crane hardstanding areas;
- All associated underground electrical and communications cabling;
- Provision of new internal wind farm site access tracks and use of, and upgrades to, existing agricultural/forestry tracks, and associated site entrance from the L5508 local public road;
- 1 no. site control building;
- 1 no. free-standing meteorological mast of up to 104m in height;
- 1 no. temporary construction compound;
- Felling of up to 28 hectares (ha) of commercial forestry plantation to facilitate the construction of infrastructure;
- The storage of excavated material at 2 no. spoil deposition areas;
- Upgrade works to public roads along the turbine component haul route;
- A 110 kilovolt (kV) 'loop-in/loop-out' Air-Insulated Switchgear (AIS) electrical substation and all associated electrical equipment including an Electricity Storage System ;
- Approximately 6.34km of 110kV underground electricity lines, accompanied by approximately 2.5km of associated access track and 2 no. site entrances to facilitate connection of the proposed electricity substation to the existing 110kV Mullingar-Corduff overhead electricity transmission line;
- Upgrade works to public roads along the turbine component haul route; and

- All associated and ancillary site development, excavation, construction, landscaping and reinstatement works, including provision of site drainage infrastructure and surface water protection measures.

The Spoil Management Plan (SMP) provides an assessment of the issue of handling surplus excavated material at the proposed wind farm site. The measures outlined in the plan will be monitored on site by the appointed Environmental Manager (EM) and will be discussed with the Contractor before works commence on site. This plan should be read in conjunction with the CEMP and Appendices.

1.2 Site Description

The area around the site comprises mainly of flat grassland under agricultural use with peat bog adjacent to the northern and southern boundary of the proposed site. The wider landscape supports conifer plantations of varying age and class.

The site is located in the townland of Bracklin, Co. Westmeath and Coolronan, Co. Meath, on a lowland area of predominately improved and semi-improved agricultural fields with cutover bog and other conifer plantations of varying age and class throughout the area.

1.3 Site Investigations

A geotechnical site investigation study was carried out by Hydro Environmental Services Ltd. in June 2020 which consisted of the excavation of ten trial pits. Ground conditions generally comprised topsoil overlying sandy, gravelly silts. Some areas of dry fibrous peat were found in the centre of the site and towards the northern/southern boundaries. Topsoil depths were up to 0.20m. Bedrock was only encountered at one trial pit (Max. depth 4.2m below ground) during this site investigation, namely TP-T2, at a depth of 1.30m below the ground surface. This data was used to inform this report on subsoil and bedrock conditions at the site.

An additional site investigation (which included peat depth probing) was carried out as part of a Geotechnical and Peat Stability report conducted by Fehily Timoney and Company (FT) in September 2020[1]. During this site investigation, peat depths were recorded between 0 to 2.5m from over 50 probes across the site, with 95% of probes recording peat depths less than 2.0m and 86% less than 1.0m. The greatest peat depths were of 2.0 to 2.5m around the location of the proposed wind turbine T10. A summary of the peat depths recorded at the location of each proposed turbine is provided in Table 1.1. This data was used to inform this report on peat depths throughout the site

[1] Fehily Timoney & Company Ltd. (2021) *Geotechnical and Peat Stability Assessment – Bracklyn Wind Farm*, Cork, Ireland

Table 1.1 Natural Peat Depths for Bracklyn Wind Farm

Turbine no./Waypoint	Depth of in-situ Peat (m)
T1	No peat encountered
T2	No peat encountered
T3	No peat encountered
T4	0.25
T5	0.7
T6	0.7
T7	0.75
T10	1.8
T11	No peat encountered
Substation	No peat encountered
Met Mast	No peat encountered

As set out in Section 6.3.3.3 of the EIAR, there are no known areas of soil contamination within the proposed development site or in its immediate environs.

1.4 General Aims and Principals of the Spoil Management Plan

The purpose of this SMP is to see that the spoil is managed safely and reused without environmental risk as a result of the proposed development, and to see that good site management practices are carried out.

Any reinstatement and reprofiling proposals will consider and mitigate against all identified significant risks to environmental receptors.

Reinstatement of all excavated materials will occur as close to the site of excavation as possible. Excavated material horizons will be replaced in sequence and depths similar to those recorded prior to excavation or similar to the surrounding undisturbed ground at the point of reinstatement. Topsoil and surface vegetation excavated during the construction of the wind farm infrastructure will be temporarily stored and used to finish reinstated surfaces.

Reinstatement and reprofiling of, and around, infrastructure will be carried out during the construction phase. Early reinstatement and reprofiling is required to so as to promote vegetation and habitat reinstatement as early as possible. This will reduce temporary storage/stockpiling of soils.

Reprofiling and landscaping will allow for sympathetic restoration of the ground surface and ground profile to reduce the visual impact of new infrastructure, facilitate vegetation regrowth and reduce scour and erosion of bare surfaces prior to vegetation establishment. Reinstatement will be undertaken

as work progresses. This work will be completed only by experienced personnel under guidance from the appointed Ecological Clerk of Works (ECoW) and EM, and he/she will conduct regular inspections of the work to ensure it is completed in an appropriate manner.

All areas subjected to reinstatement will be fenced with stock-proof fencing to prevent livestock disturbance until vegetation has become established.

Excavated material can be disposed of in several ways:

- Excavated rock can be entirely recycled into the formation of new wind farm infrastructure, predominantly for site access tracks and crane hardstands.
- Excavated sub-soil material will be used as fill material where suitable (e.g. back filling around and on top of turbine foundations)
- Excavated peat material will be used for landscaping purposes at the 9 no turbine locations.
- Additional peat material will be placed to a depth of 1m in areas clear-felled around T5, T6, T7, T10 and T11.
- Excess till and subsoil material excavated during the construction of the proposed development will be placed in a designated deposition area located between the proposed turbines T3 and T4.
- Excess peat material excavated during the construction of the proposed development will be placed in a designated deposition area to the south west of the proposed permanent Meteorological Mast.
- Excavated topsoil will be used to vegetate edges of site access tracks and hardstands, to finish off reinstated areas of hardstands and to provide low berms along site access tracks.

1.5 Management of Excavated Material

Any surplus materials excavated during the construction phase shall, in the first instance, be stored on site in an environmentally safe manner that will not result in the pollution of waters or the smothering of ecologically sensitive habitats until it is required for re-use. It is proposed that any temporary onsite stockpiles of soil, rock and other excavated material shall be removed and utilised in the site reinstatement programme to infill any excavated areas which would then be mounded and capped with sod prior to the completion of works.

The proposed site is relatively flat, with a maximum gradient of 3 degrees recorded onsite [1]. As such, there will be no storage of excavated peat or soil on slopes (>5 degrees gradient) during the construction of the Development. Furthermore, separate peat and soil deposition areas have been selected based on gradient, geotechnical data and ground stability assessment, habitat type, and the adequacy of the ground to support the surcharge material. The Civil Works Contractor will be responsible for providing that the removal and storage of excavated material is undertaken in

accordance with the requirements of this management plan. The temporary storage area and the vegetative material will be inspected regularly from an ecological perspective by the ECoW.

It is proposed to develop 2 no. spoil deposition areas (see location map in Appendix F to this Technical Schedule) where excess peat, soil and subsoil which cannot be utilised for reinstatement or is unsuitable for landscaping purposes on site, will be stored permanently. The locations of the deposition areas have been selected due to the absence of any environmental constraints, separation distance to watercourses and the presence of natural depressions in ground levels. Spoil will be transported to these locations where it will be placed in layers in accordance with best-practice methods, including supervision of the works by a geotechnical engineer or appropriately competent person. Appropriate drainage management measures will be implemented to ensure that the deposited spoil does not become waterlogged. It is proposed that the smaller (western) deposition area will be used to store peat material while the larger (eastern) area will accommodate soil and subsoil. Facilitating the storage of peat in this way will negate the requirement for transportation off-site to an approved waste disposal facility and reduce the number of vehicle movements associated with the proposed development at the construction phase.

Following the completion of construction, the deposition areas will be graded to match the profile of surrounding land, capped with soil, and will be reseeded. In addition, excess spoil will be used, where possible, to form a thin (≤ 1m) layer over areas which have been recently felled. The material will be allowed to vegetate naturally and will provide for an increased proliferation of local habitats and species, thus representing a localised environmental gain.

Works at the spoil deposition areas will be monitored, on a weekly basis during the construction phase and monthly for a six month period thereafter, by an appropriately qualified geotechnical engineer.

It should be noted that tarmac cuttings arising from trenching works along the public road, or upgrade works to the L5508, will not be re-used or stored on site due to the possibility of soil contamination but will be removed and disposed of at a licensed waste handling facility.

1.6 Reinstatement

Reinstatement works can commence at an early stage of the construction works. Such reinstatement can occur following the completion of individual sections of work such as the completion of, say, a turbine foundation or hardstand. Reinstatement would include grading of any slopes left by the construction works, followed by the careful placement of topsoil which had been previously excavated from this area and temporarily stored on site. Natural revegetation is the preferred method of recovery.

2 ESTIMATED EXCAVATION QUANTITIES

The Site Investigations carried out by Hydro Environmental Services Ltd. show that the typical soil conditions on the site consist of Glacial Tills overlying Limestone Bedrock.

2.1 Access Track Construction

The minimum access track width required for delivery of turbine components is 4.5m. However, typically, access tracks with a running width of 5.0m wide are provided but will be wider at localised areas such as junctions and corners/bends. Table 2.1 below tabulates the volumes of topsoil and sub-soil to be excavated for site access tracks.

Table 2.1 Estimated Excavation for Access Track Construction

Access track Section	Access track Type	Length (m)	Width (m)	Relevant Turbine/Way point	Peat Depth (m)	Soft Till Depth (m)	Depth to firm Sub-soil (m)	Volume of Peat to be excavated (m^3)	Volume of Soft Till to be excavated (m^3)
Entrance to T1 Spur	Excavated	1,344	7.8	T1	-	0.4	0.4	-	4,193
T1 Spur	Excavated	121	7.8	T1	-	0.4	0.4	-	378
T1 Spur to T2 Spur	Excavated	232	7.8	T1/T2	-	0.4	0.4	-	724
Existing T2 Spur (to be Widened by 2m)	Excavated	301	2.0	T2	-	0.4	0.4	-	241
T2 Spur to T6 Spur	Excavated	493	8.6	T2/T6	0.35	0.45	0.8	1,484	1,908
Existing T6 Spur (to be Widened by 2m)	Floated	68	2.0	T6	0.7	2.3	N/A	-	-
Existing T6 Spur to T3 Spur (to be Widened by 2.5m)	Excavated	558	2.5	T3/T7	0.4	0.4	0.8	558	558
Existing T3 Spur (to be Widened by 2.5m)	Excavated	241	2.5	T3	-	0.2	0.2	-	121
T3 Spur to T4 Spur	Excavated	147	7.4	T3	-	0.2	0.2	-	218
T4 Spur	Excavated	96	7.4	T3/T4	0.15	0.45	0.6	107	320
T4 Spur to T5	Excavated	646	8.2	T4/T5	0.5	0.5	1.0	2649	2649
Existing T6 Spur to T7 (to be Widened by 2m)	Floated	192	2.0	T6/T7	0.7	2.8	N/A	-	-
T7 to T11 Spur	Floated	420	5.0	T7	0.7	2.8	N/A	-	-
T11 Spur to T10	Floated	197	5.0	T10	1.8	-	N/A	-	-
T11 Spur	Excavated	372	7.4	T11	-	0.3	0.3	-	826
Totals		**5,428**						**4,798**	**12,136**

2.2 Wind Turbine Foundations

The depth of excavation required for each wind turbine foundation will vary. The diameter of the Gravity wind turbine foundations (T1-7 & T11) will be 22m. The diameter of the Piled wind turbine foundation (T10) will be 19m. Each foundation will be approximately 3m deep. Table 2.2 provides a breakdown of the approximate total excavation volume for the wind turbine foundations.

Table 2.2 Estimated Excavation for WTG Foundations

Turbine No.	Foundation Type	Area of Excavation (m^2)	Depth of Excavation (m)	Total Excavation (m^3)	Material at Formation	Total Peat (m^3)	Total Soil (m^3)	Total Rock (m^3)
T1	Gravity	452 m^2	5.0	2,260m^3	Grey, firm, sandy, very gravelly SILT with cobbles and boulders (non-cohesive)	-	2,260	0
T2	Gravity	452m^2	3.0	1,356m^3	Bedrock	-	588	768
T3	Gravity	452m^2	3.0	1,356m^3	Reddish brown, very firm SILT/CLAY with cobbles	-	1,356	-
T4	Gravity	452m^2	3.0	1,356m^3	Orange brown, firm, slightly gravelly SILT/CLAY	113	1,243	-
T5	Gravity	452m^2	5.0	2,260m^3	Very firm CLAY	316	1,944	0
T6	Gravity	452m^2	5.0	2,260m^3	Very firm CLAY	316	1,944	0
T7	Gravity	452m^2	5.0	2,260m^3	Very firm CLAY	339	1,921	0
T10	Piled	314m^2	3.0	942m^3	Grey, sandy, GRAVEL(Fine). High volume groundwater seepage	565	377	0
T11	Gravity	452m^2	3.0	1,356m^3	Light brown, very firm SILT/CLAY with cobbles and boulders	0	1,356	0
			Totals	**15,406m^3**		**1,649**	**12,989**	**768**

2.3 Hardstands

The depth of excavation required for each crane hardstand will vary. The crane hardstanding area will be 55m x 35m while the hub assembly area will be 15 x 12m, the temporary nacelle and hub storage area will be 24m^2, giving a total area of 2,129m^2. Table 2.3 provide a breakdown of the approximate total excavation volumes for the crane hardstands.

Table 2.3 Estimated Excavation from Crane Hardstands

Hardstand No.	Type	Area (m^2)	Depth to Formation (m)	Total Excavation (m^3)	Material at Final Depth	Total Peat (m^3)	Total Soil (m^3)	Total Rock (m^3)	Relevant Turbine/ Waypoint
T1	Excavated	2,129	0.6	1,277	Grey, firm, sandy, very gravelly SILT with cobbles and boulders (non-cohesive)	-	1,277	-	T1
T2	Excavated	2,129	0.4	852	Greyish brown, very firm SILT/CLAY with angular cobbles	-	852	-	T2
T3	Excavated	2,129	0.3	639	Reddish brown, very firm SILT/CLAY with cobbles	-	639	-	T3
T4	Excavated	2,129	0.4	852	Orange brown, very firm, slightly sandy, slightly gravelly SILT/CLAY	533	319	-	T4
T5	Excavated	2,129	3.0	6,387	Firm SILT/CLAY	1,490	4,897	-	T5
T6	Excavated	2,129	3.5	7,452	Soft (very wet) sandy, gravelly SILT with cobbles. Moderate ground water seepage	1,490	5,962	-	T6
T7	Excavated	2,129	2.0	4,258	Grey soft, sandy gravelly SILT with cobbles and boulders. Minor groundwater seepage	1,597	2,661	-	T7
T10	Excavated	2,129	3.5	7,452	Grey, sandy, GRAVEL(Fine). High volume groundwater seepage	3,833	3,619	-	T10
T11	Excavated	2,129	0.3	639	Light brown, very firm SILT/CLAY with cobbles and boulders	-	639	-	T11
			Totals	**29,808**		**8,943**	**20,865**	**0**	

2.4 Grid Connection

The grid connection from Bracklyn Wind Farm, in Bracklin, Co. Westmeath to the 2 no. 110kV 'End Masts' in Coolronan, Co. Meath runs over a c. 6.34km route, of which 4.42km is in private lands and approximately 1.92km of the route is located on the public road network. Of the 4.42km in private lands, approximately 1.56km is located underneath internal site access tracks while the balance of approximately 2.86km is an agricultural land. The grid connection is a "looped" type between the existing 110kV overhead line and the proposed 110kV site substation which means that there will be a twin trench with the ducts within each being a minimum of 2m apart.

Joint bays will be required at 650/750m intervals. In all, 14 No. are required (7 No. on each of the twin connections). The joint bay detail which is to EirGrid's Specification is shown in Appendix A to this Technical Schedule.

The joint bays are 2.53m wide (2.1 + 2 x 0.215) externally and 2.265m deep externally (0.25 +1.8 + 0.215) (see Appendix A). Allowing for concrete blinding, localised soft spots, a drainage sump, an overall average depth of 2.35m is assumed. A communications chamber 1.52m x 1.1m x 1.1m deep will be constructed adjacent to each joint bay.

The trench detail underneath the site access tracks is shown on Drawing No. BRK001PAS_EIAR_GA-0.07 (see also Appendix B to this Technical Schedule).

The trench detail for the off-road section in agricultural land is shown on Drawing No. BRK001PAS_EIAR_GA-0.08 (see also Appendix C to this Technical Schedule).

The trench detail for the section in public roads is shown on Drawing No. BRK001PAS_EIAR_GA-0.09 (see also Appendix D to this Technical Schedule).

The trench section located in agricultural lands accounts for 2.86km of the 6.34km grid connection route. There will be six (length 6.0m each) joint bays (overall length 36m) located along the trench section in agricultural lands, subject to the detailed design process. The remaining trench section (2,850m) located in agricultural lands will be at the standard depth (1. 315m) and width (0.6m) for 'Open Country' Works (Appendix B), subject to the detailed design process. Table 2.4 below shows the total approximate volume of material that will be excavated from agricultural lands to accommodate this cable route. On agricultural lands, topsoil and subsoil can be reused in the reinstatement process as per the typical trench specifications (Appendix B). Reinstatement of material on agricultural lands will be carried out on a trench section length of 5,684m and to a depth of 0.675m.

Table 2.4 below shows the total approximate volume of material that will be used in the reinstatement of excavated areas along the cable route on agricultural lands.

Table 2.4 Material to be Excavated on Agricultural lands

	Length (m)	Depth (m)	Width (m)	Total
Joint bay to be excavated (Agricultural lands)	36	2.35	2.53	214
C2 Comms Chambers				11
Trench on agricultural lands (Minus Joint bay)	(2,860 x 2) – 36 = 5,684	1.315	0.6	4,485
Total excavated material on agricultural lands				4,710 (4,485 +214+11)
Total amount of soil that can be reused as backfill (Trench)	(2,860 x 2) – 36 = 5,684	0.675	0.6	2,302
Total amount of spoil from agricultural land excavation that can be reused for landscaping works	2,408 (4,710 – 2,302)			

The trench section located underneath site access tracks accounts for 1.56km of the 6.34km Grid Connection route. There will be four (length 6.0m each) joint bays (overall length 24m) along the trench section located underneath these site access tracks, subject to the detailed design process. This trench section (1.56km) will be the standard width (0.6m) and will be excavated to a depth of 1.015m below the site access track (Appendix C), subject to the detailed design process.

Table 2.5 below shows the total approximate volume of material that will be excavated underneath the construction of the site access tracks to accommodate this cable route. Within site access tracks, topsoil and subsoil can be reused in the reinstatement process as per the typical trench specifications for a 'Trench layout through Access Road Section' Works (Appendix C). Reinstatement of material will be carried out on a trench section length of 3,096m and to a depth of 0.375m below site access tracks. Table 2.5 below shows the total approximate volume of material that will be used in the reinstatement of excavated areas along the cable route underneath site access tracks.

Table 2.5 Material to be Excavated Underneath Site Access Tracks

	Material Type	Length (m)	Depth (m)	Width (m)	Total Excavated (m^3)
Joint Bays	**Soil under Joint Bays (4 in total)**	24	2.35	2.53	143
C2 Comms Chambers		8			
Underground Electricity Transmission Line	**Soil under site access tracks (Minus 4 joint bays)**	(1,560 x 2) - 24 = 3,096	1.015	0.6	1,886
Total material excavated underneath site access tracks		2,037 (143 + 8 + 1886)			
Total amount of spoil that can be reused as backfill (Trench)		697 (3,096 x 0.375 x 0.6)			
Total amount of spoil from excavation underneath site access tracks		1,340 (2,037 - 697)			

The public road network accounts for 1.92km of the 6.34km two-way Grid Connection. Table 2.6 below shows the total approximate volume of material that will be excavated and removed from the public road to accommodate the cable route. There will be six(length 6.0m each) joint bays (overall length 36m each) located on the public road. These joint bays will have similar dimensions to those on private lands above (Appendix A), subject to the detailed design process. The remaining trench section (3,804m) will be excavated to the standard depth (1.315m) and width (0.6m) for 'Permanent reinstatement of longitudinal opening in roadway' Works (Appendix D), subject to the detailed design process. However, the top 100mm (road surfacing) will be excavated 200mm wider than the trenches at either side. Thus, the width of road surfacing to be removed will be 1.0m for each trench. All Road surfacing and sub-base material which is excavated from the public road will be removed from site and disposed of at a licenced waste facility. Table 2.6 below shows the total volume of spoil that will created and removed as part of the development to a licenced waste facility.

Table 2.6 Material to be Excavated Within Public Roads

	Material Type	Length (m)	Depth (m)	Width (m)	Total Excavated (m^3)
Joint Bays	**Road Sub-base under Joint Bays (6 in total)**	36	2.25	2.53	205
	Road surfacing	36	0.1	2.53	9
C2 Comms Chambers	**Road Sub-base**				**12**
Underground Electricity Transmission Line	**Road Sub-base (Minus 6 joint bays)**	1,920 x 2-36 = 3,804	1.215	0.6	2,773
	Road surfacing	1,920 x 2 – 36 = 3,804	0.1	1.0	381
Total amount of sub-base from public road excavation		2,990 (2,773 + 205 +12)			
Total amount of road surfacing from public road excavation		390 (381 + 9)			

Total amount of spoil from public road excavation	3,380 (2,990 + 390)

2.5 Grid Connection Access Track

The proposed grid connection route crosses private lands for c. 4,320m. A new access track, measuring 2,563m in length, will be constructed adjacent to the underground line in these private lands to provide access for future repair and maintenance works. This includes a small section from T10 to the road, then the entire stretch of grid route located on the private lands opposite, and the section running from the end masts up to the road. This new access track will be excavated to a standard depth (0.5m) and width (3.0m), giving an approximate excavation volume of 3,845m^3. It is envisaged that this excavated spoil will consist entirely of Peat based on the EPA Soil Maps[2] of the proposed route for this access track.

2.6 Electrical Sub-Station

The 110kV 'Loop in/Loop out' Electrical Sub-Station is located onsite, in the townland of Bracklin. Co. Westmeath. The hardstanding area for the 110kV 'Loop in/Loop out' Electrical Sub-Station will have a width of 94.75m over 89m and a width of 56m for 71m giving a total area of 12,409m^2. For an approximate excavation depth of 0.32m, the approximate excavation volume is 3,971m^3. Based on the SI data taken near this location for T2/T6 (Table 1.1), it is considered that this excavated material will consist entirely of peat. For the two buildings within the sub-station, the foundations and trenches will be deeper and will generate an additional 564m^3 of peat so as to give a total excavation volume of 4,535m^3.

2.7 Site Cabling

Site cabling between the turbines and the site control building will be per the typical service trench detail shown on Drawing No. BRK001PAS_EIAR_GA-0.06 and in Appendix E to this Technical Schedule. The cables will run alongside the site tracks and will cross cracks at junctions. Assuming a worst case scenario in which all cables are ducted, using 125mm ducts, then the depth of stone dust bed and surround will be 275mm. Apart from large, sharp stones, all other excavated material will be re-used. The total length of site cabling is estimated at 5,655m with a trench width of 0.5m. The volume of spoil is estimated at 778m3 (5655 x 0.5 x 0.275). Using similar proportions of peat to subsoil as for the access tracks, the volume of peat is estimated at 230m^3 while the volume of subsoil is estimated at 548m^3.

2.8 Site Control Building

A site control building will be required to allow the underground electrical cabling circuits from each wind turbine to converge for onward to the 110kV electricity substation. This site control building will be located adjacent west to the T11 spur access track, just south of the junction with the T10 access track. The foundation for this site control building will have an above-ground footprint of 95m^2 with an excavation depth of approx. 1.0m, giving an approximate excavation volume of 95m^3. Peat depth at this location is 0.2m (Table 2.1). As such, it is envisaged that this excavated spoil will consist of 19m^3 of peat and 76m^3 of soil.

2.9 Lattice Type End Masts

Two lattice type End Masts will be required for the proposed grid connection to break into the existing Mullingar-Corduff overhead electricity line in the townland of Coolronan, Co. Meath. These masts will have a permanent above-ground footprint of 76m^2, with concrete foundations below ground to a depth of 3m, giving an approximate excavation volume of 228m^3. It is envisaged that this excavated spoil will consist entirely of Peat based on the EPA Soil Maps of the area[2].

2.10 Temporary Site Compound

A temporary site compound will be located along the main arterial access track to the site during the construction phase of the proposed development. This temporary compound will occupy an approximate area of 4,000m^2 and will be excavated to a depth of 0.3m (for crushed stone to be laid down temporarily), giving an approximate excavation volume of 1,200m^3. Based on the SI data taken near this location for T1/T2 (Table 1.1), it is presumed that this excavated material will consist entirely of soil.

2.11 Permanent Meteorological Mast

The hardstanding area for the meteorological mast will be 45m x 20m. The excavation depth for the hardstanding area will be 0.3m, giving an approximate excavation volume of 270m^3. The foundation footprint for the meteorological mast will be 10 x 10m. Excavation depth for the foundation will be 2.1m giving an approximate excavation volume of 210m^3. Therefore, the total excavation volume for the meteorological mast is approximately 480m^3. The permanent meteorological mast is located 300m south west of T3. Peat was not encountered in the trial pit (TP-MM) at this location. As such, it is envisaged that the excavated spoil will consist entirely of soil.

2.12 Road Widening Works

To facilitate delivery of turbine components to the proposed development, road widening works are required for 1.325km along the L5508, between the site entrance and the junction of the L5508/L1504. The excavation depth for this road widening is likely to be 0.6m on average with a width of 1.25m,

giving an approximate excavation volume of 1,000m^3, of which it is estimated approximately 500m^3 will be peat and approximately 500m^3 will be soil.

In addition to the works mentioned above, an approximate area of 1,870m^2 will be excavated at the junction between the N52/L1504 to facilitate delivery of turbine components to the proposed development. The excavation depth for these widening works is likely to be approximately 0.6m, giving an approximate excavation volume of 1,120m^3. It is envisaged that this excavated spoil will consist entirely of peat based on the EPA maps for the area[2].

2.13 Total Estimated Excavation Volume Summary

As detailed in Sections 2.1 to 2.12, the total estimated excavation volume is approximately 85,556m^3, of which approximately 32,614m^3 is peat, approximately 48,794m^3 is clay/mineral soil, approximately 768m^3 is rock, approximately 390m^3 is road surfacing and approximately 2,990m^3 is Road sub-base material. These quantities are detailed in Table 2.7.

Table 2.7 Summary of Estimated Excavation Quantities

Section		Total (m^3)	Peat (m^3)	Soil (m^3)	Rock (m^3)	Road Surfacing (m^3)	Road Sub-Base (m^3)
Site Access Track Construction		16,934	4,798	12,136	-	-	-
Foundation Excavation		15,406	1,649	12,989	768	-	-
Hardstand Excavation		29,808	8,943	20,865	-	-	-
Grid Connection	Public Roads	3,380	-	-	-	390	2,990
	Agricultural Lands	4,710	4,710	-	-	-	-
	Site Access Tracks	2,037	2,037				-
Grid Connection Access Track		3,845	3,845	-	-	-	-
Electrical Substation & 2 no. Control Buildings		4,535	4,535	-	-	-	-
1 no. Site Control Building		95	19	76	-	-	-
Site Cabling		778	230	548			
2 no. Lattice Type End Masts		228	228	-	-	-	-
Temporary Site Compound		1,200	-	1,200	-	-	-
Meteorological Mast		480	-	480	-	-	-
	L5508	1,000	500	500	-	-	-

Section		Total (m^3)	Peat (m^3)	Soil (m^3)	Rock (m^3)	Road Surfacing (m^3)	Road Sub-Base (m^3)
Road Widening Works	N52/L1504	1,120	1,120	-	-	-	-
Total Excavation Volume		**85,556**	**32,614**	**48,794**	**768**	**390**	**2,990**
Total Volume (incl. 20% Bulking Factor)*		**102,668**	**39,137**	**58,553**	**922**	**468**	**3,588**

***A factor of 20% (bulking factor of 15% and contingency factor of 5%) has been applied to the excavated spoil volumes to allow for expected increase in volume upon excavation and to allow for a variation in ground conditions across the site.**

3 RE-USE OF EXCAVATED MATERIAL

3.1 Access Track Edges

It is proposed that low, shaped and vegetated berms be provided at site access track edges (both sides). The total length of site access tracks is 5,428m which would give a possible length of berms of 10,856m. However, when junctions, turning areas and buffers to streams are discounted, the approximate length available is 8,142m. The total volume of soil to be excavated for site access tracks (including the bulking factor) is estimated at 14,563m^3. Thus, each berm should have a cross-sectional area of 1.8m^2. Berms 1.0m high, 0.6m wide at top and 3.0m wide at bottom would provide a cross-sectional area of approximately 1.8m^2 which could be used as an indicative design. The sub-soil would be used for the core of each berm and each berm would be finished in topsoil and allowed to vegetate. If necessary, these berms can be redesigned with greater dimensions to provide additional storage for soil material excavated during construction of the proposed development.

3.2 Hardstand Edges

It is proposed that additional vegetated embankments will be constructed along the hardstand edges to provide further storage capacity for excavated soil (see Appendix F). The available perimeter around each of the 9 no. hardstands is approx. 90m which would give a possible embankment length of 810m. Embankments 2m high, 12m wide at the bottom and 8m wide at the top would provide a cross-sectional area of 20m^2 which could be used as an indicative design. The sub-soil would be used for the core of each embankment and each embankment would be finished in topsoil and allowed to vegetate. This would give a total volume of 16,200m^3 for storage of soil excavated from the hardstands.

3.3 Hardstand Construction

All excavated rock (922m^3) will be used in hardstand construction.

3.4 Turbine Foundation Ballast

Approximately 3,400m^3 of excavated soil will be used as backfill/ballast to the top of the 9 no. turbine foundations.

3.5 Soil Deposition Area

A designated soil deposition area is proposed within the site between T3 and T4 (see Appendix E). The total volume for deposition at this location is 22,859m^3. The balance of soil excavated for turbines and hardstands will be placed along the hardstand edges and turbine edges.

3.6 Peat Deposition Area

A designated peat deposition area is proposed within the Site to the south west of the permanent meteorological mast (see Appendix E). It is envisaged that approximately 10,971m^3 of excavated peat will be deposited at this location.

3.7 Landscaping

Approximately 1,000m^3 of excavated peat will be used for landscaping purposes at the 9 no. turbine locations. Furthermore, approximately 3,845m^3 of peat will be excavated during construction of the new access track adjacent to the grid connection in private lands. It is envisaged that upon construction of the access track that this spoil will be used for landscaping works on the lands either side.

3.8 Reinstatement of Clear-felled Areas

It is proposed that a portion of excavated peat will be used in the reinstatement of 28 ha of conifer plantation that is to be clear-felled around T5, T6, T7, T10, T11 and the 110KV 'Loop-in/Loop-out' sub-station (See Appendix E). Excavated peat will be placed at a depth of up to 1m in these locations. It is envisaged that approximately 10,466m^3 of excavated peat will be deposited at this location.

3.9 Reinstatement of Compound

The 5,442m^3 of excavated peat from the 110kV 'Loop-in/Loop-out' sub-station will be side cast and temporarily stored adjacent to the works at this location. On completion of the project, this peat will be used for reinstatement works around the sub-station's compound area.

3.10 Summary of Re-Use of Excavated Material

The road surfacing and sub-base material from the excavation of the grid connection along public roads will be removed from site and disposed of at a licensed waste facility. All other excavated material will either be re-used or stored within a designated deposition areas on site. Table 3.1 provides a summary of the re-use methods.

Table 3.1 – Summary of Spoil Management Arrangements

Excavated Material	Volume	Volume (Incl. 20% Bulking Factor)	Re-Use
Excavated Topsoil & Subsoil for Access Tracks	12,136m^3	14,563m^3	Re-Use in access track berms
Excavated Peat for Access Tracks	4,798m^3	5,758m^3	2,879m^3 deposited at peat deposition area 2,879m^3 re-used for reinstatement of the clear-felled area
Excavated Soil from Foundations	12,989m^3	15,587m^3	3,400m^3 as backfill to foundations 12,187m^3 deposited at designated soil deposition area
Excavated Peat from Foundations	1,649m^3	1,979m^3	1000m^3 used for landscaping around turbine foundations. 490m^3 deposited at designated peat deposition area 489m^3 re-used for reinstatement of the clear-felled area
Excavated Rock from Foundations	768m^3	922m^3	Re-Use fully for hardstand construction
Excavated Soil from Hardstands	20,865m^3	25,038m^3	16,200m^3 re-used in Embankments around hardstands 8,838m^3 deposited at designated soil deposition area
Excavated Peat from Hardstands	8,943m^3	10,732m^3	5,366m^3 deposited at designated peat deposition area 5,366m^3 re-used for reinstatement of the clear-felled area
Excavated Soil from Site Control Building	76m^3	91m^3	Re-Used fully for landscaping around site control building.
Excavated Peat from Site Control Building	19m^3	23m^3	Re-Used fully for landscaping around site control building.
Excavated Peat from the 110kV Sub-Station	4,535m^3	5,442m^3	Re-Used fully for reinstatement around the substation compound.
Excavated Soil from Permanent Meteorological Mast	480m^3	576m^3	576m^3 deposited at designated soil deposition area

Excavated Material	Volume	Volume (Incl. 20% Bulking Factor)	Re-Use
Excavated Peat from Grid Connection in agricultural lands	4,710m^3	5,652m^3	2,302m^3 as backfill along grid connection trench. 3,350m^3 used for landscaping/reinstatement along private lands.
Excavated Peat from Grid Connection under site access tracks	2,037m^3	2,444m^3	697m^3 as backfill along grid connection trench. 988m^3 deposited at designated peat deposition area 759m^3 re-used for reinstatement of the clear-felled area
Excavated Sub-base from Grid Connection along public roads	2,990m^3	3,588m^3	Remove off-site and dispose at a licensed waste facility.
Road surfacing from Grid Connection along public roads	390m^3	468m^3	Remove off-site and dispose at a licensed waste facility.
Excavated Peat from Grid Connection Access Track	3,845m^3	4,614m^3	Re-Used fully for landscaping along access road.
Excavated Peat from Site Cabling	230m^3	276m^3	276m^3 to peat deposition area
Excavated Soil from Site Cabling	548m^3	658m^3	658m^3 to spoil deposition area
Excavated Soil from L5508 Road Widening	500m^3	600m^3	600m^3 deposited at the designated soil deposition area.
Excavated Peat from L5508 Road Widening	500m^3	600m^3	300m^3 deposited at designated peat deposition area 300m^3 re-used for reinstatement of the clear-felled area
Excavated Peat from N52/L1504 Road Widening	1,120m^3	1,344m^3	672m^3 deposited at designated peat deposition area 672m^3 re-used for reinstatement of the clear-felled area
Excavated Peat from the 2-no. Lattice Type End Masts in Coolronan, Co. Meath	228m^3	274m^3	Re-Used fully for landscaping around the 2-no. Lattice Type End Masts in Coolronan, Co. Meath

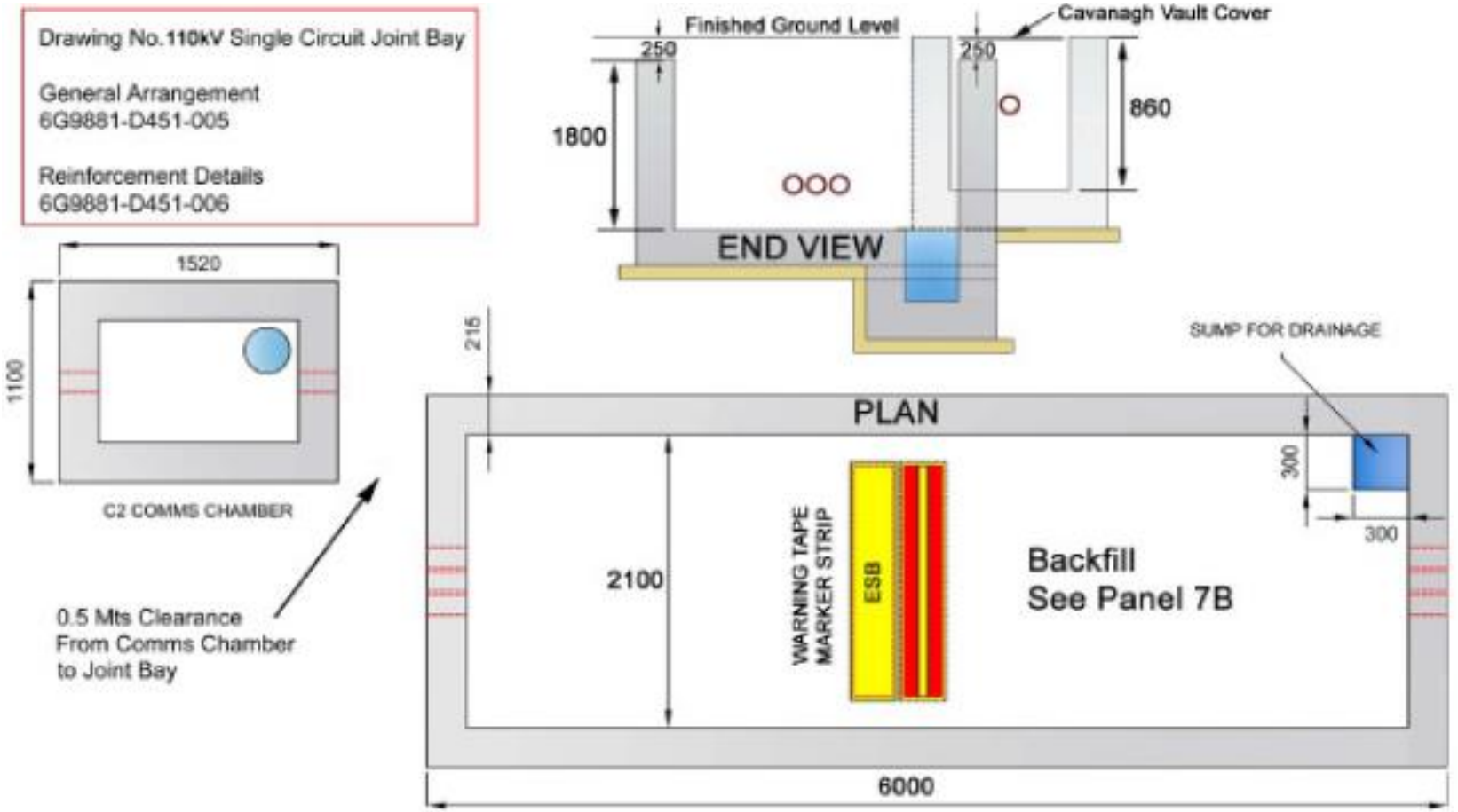
Excavated Material	Volume	Volume (Incl. 20% Bulking Factor)	Re-Use
Excavated soil from the Temporary Site Compound	1,200m^3	1,440m^3	Re-Used fully for reinstatement of the Temporary Site Compound area upon completion of the construction phase of the Development
Total	**85,556m^3**	**102,668m^3**	

4 RECOMMENDATION

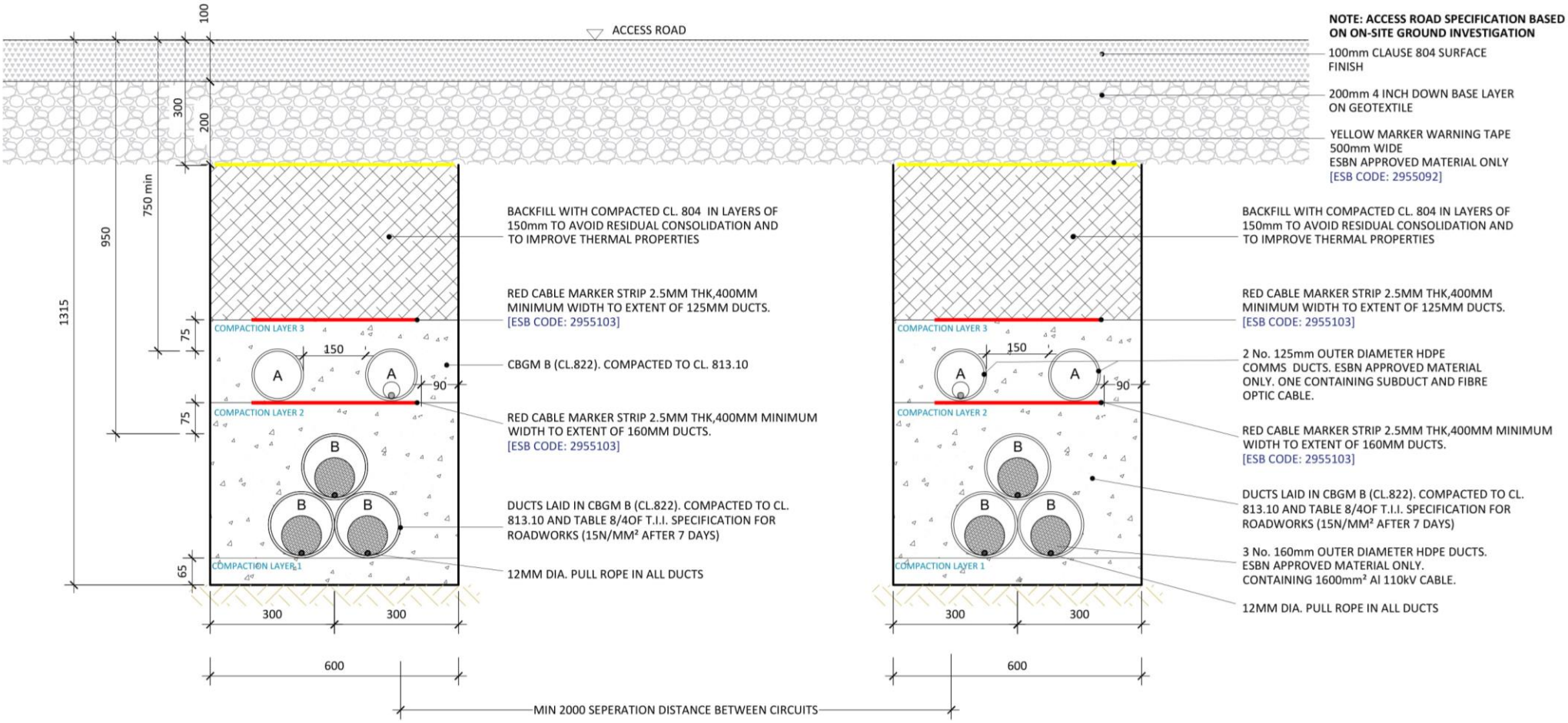
Based on the available information, Jennings O'Donovan make the following recommendations:

- The estimated potential total volume of excavated material (including the 20% Bulking Factor) is approximately 102,668m^3.
- Approximately 64,783m^3 of excavated material can be reused for works on site.
- Approximately 4,056m^3 of excavated material from trenches in public roads will have to be removed off-site and disposed at a licenced waste facility.
- Approximately 10,971m^3 of excavated peat material will be deposited in the designated peat deposition area, south west of the proposed meteorological mast.
- The remaining balance of 22,859m^3 of excavated soil material will be deposited in the designated soil deposition area, between T3 and T4.

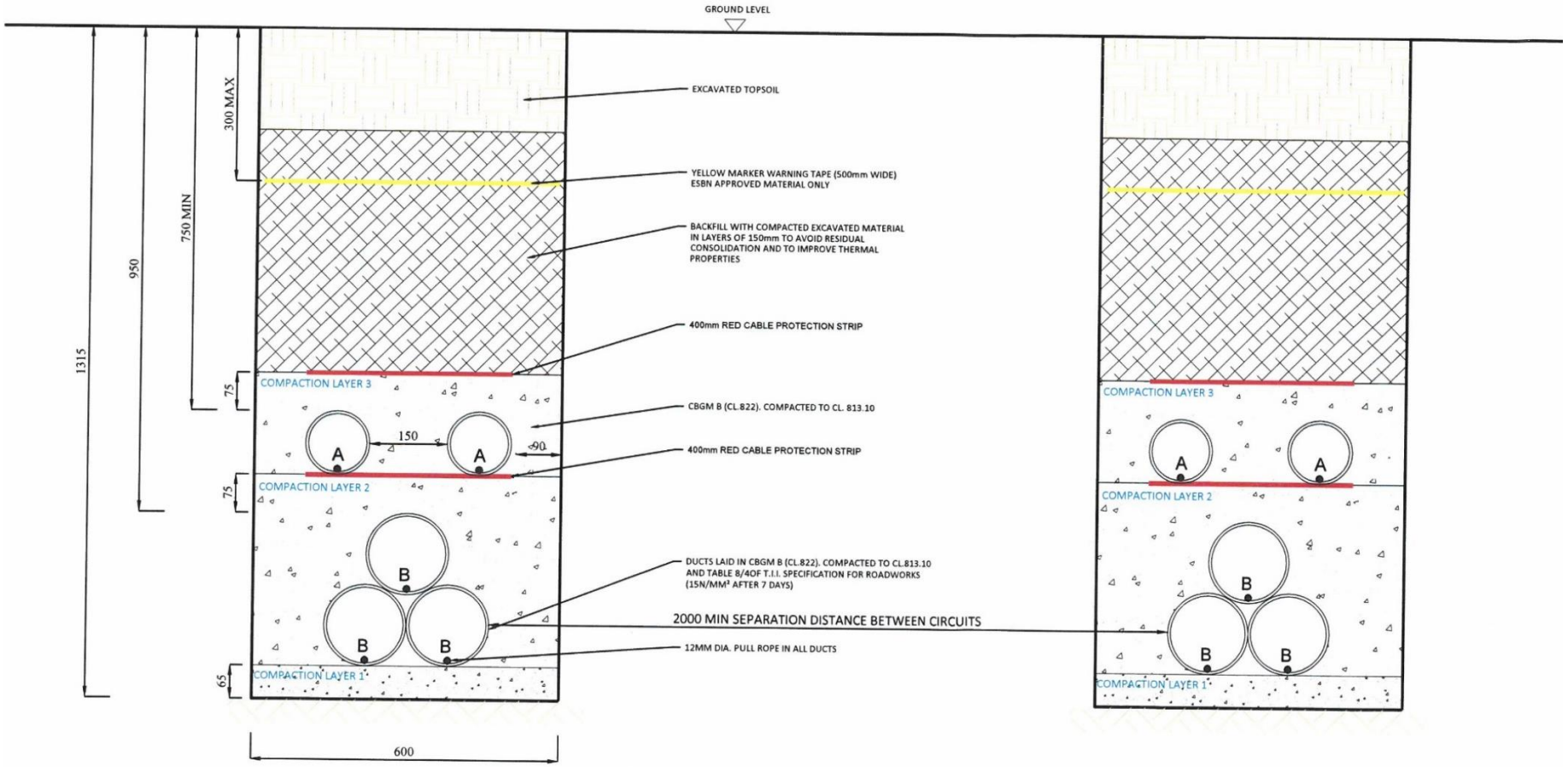
APPENDIX A - TYPICAL JOINT BAY DETAILS



APPENDIX B - 2 WAY SINGLE TRENCH LAYOUT THROUGH ACCESS TRACK SECTION



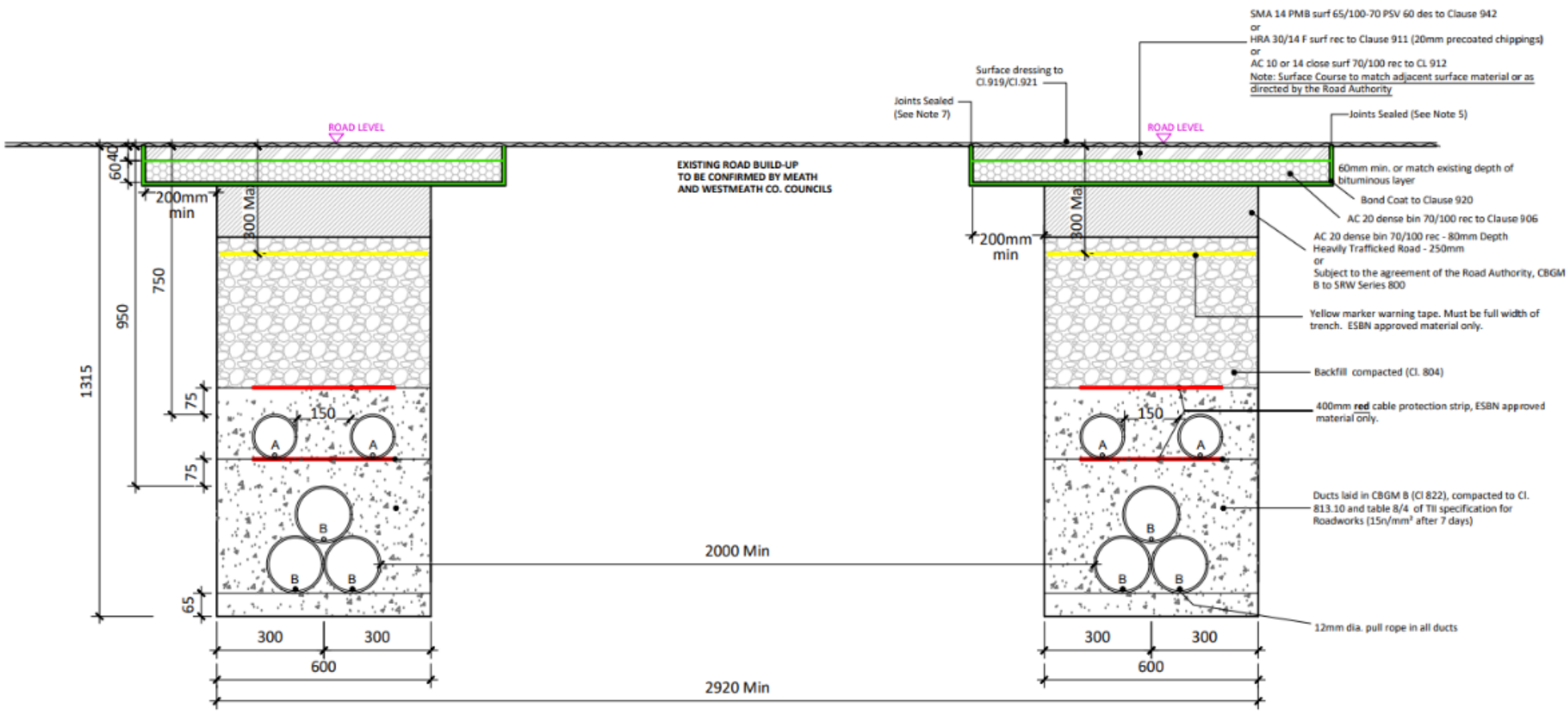
APPENDIX C – TYPICAL TRENCH SECTION THROUGH OFF ROAD SECTION IN AGRICULTURAL LAND



A = 125mm: Outer Diameter HDPE ESB Approved Duct, SDR=17.6
B= 160mm : Outer Diameter HDPE ESB Approved Duct, SDR= 21

TYPICAL DOUBLE TRENCH LAYOUT THROUGH OFF ROAD SECTION
SCALE 1:10

APPENDIX D - TYPICAL SECTION THROUGH PERMANENT REINSTATEMENT OF LONGITUDINAL OPENING IN ROADWAY

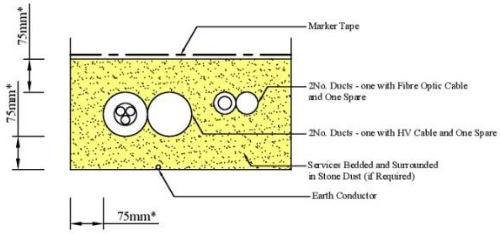


A = 125mm: Outer Diameter HDPE ESB Approved Duct, SDR=17.6

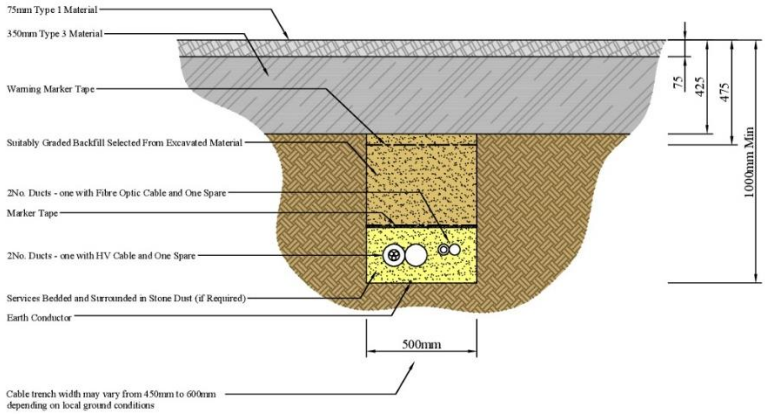
B= 160mm : Outer Diameter HDPE ESB Approved Duct, SDR= 21

APPENDIX E – TYPICAL SERVICE TRENCH DETAIL (SITE CABLING)

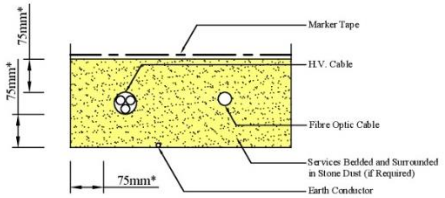
Typical Service Trench Crossing Track
Scale 1:20



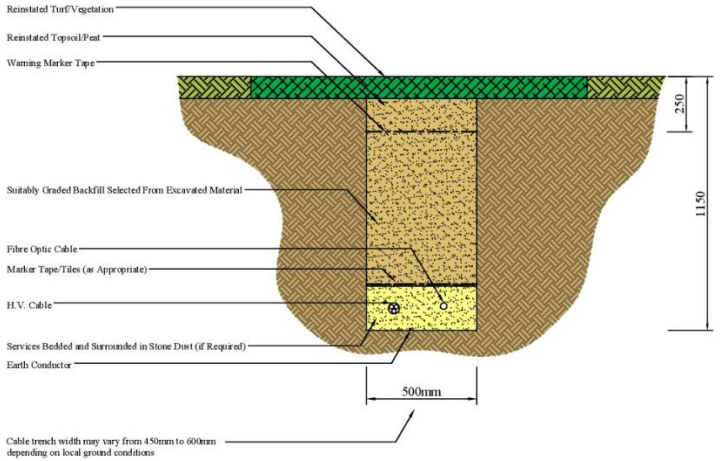
Enlarged Services Detail
Scale 1:10



Typical Service Trench Detail
Scale 1:20



Enlarged Services Detail
Scale 1:10



APPENDIX F – SPOIL MANAGEMENT LAYOUT