McCloy Consulting

Surface Water Management Plan

Cummeennabuddoge Wind Farm

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APPENDICES

1 INTRODUCTION

1.1 Terms of Reference

FuturEnergy Ireland via its lead consultant has appointed McCloy Consulting Ltd to prepare a Surface Water Management Plan (SWMP) to support a planning application for the proposed Cummeennabuddoge Wind Farm.

The purpose of this SWMP assessment is to provide further details of proposed mitigation measures specifically in relation to management of surface water from the proposed development where there is initially a perceived risk of deterioration in the Water Framework Directive (WFD) ecological status of any affected waterbody (refer to section 1.3 for further information), which would similarly be reflected as a significant adverse impact in Environmental Impact Assessment terms.

This appendix is intended to supplement the Environmental Impact Assessment Report (EIAR) specifically **Chapter 11: Hydrology, Water Quality and Flood Risk**) submitted in support of the planning application for the proposal.

1.2 Statement of Authority

McCloy Consulting is an independent environmental consultancy specialising in the water environment, with specialist knowledge of hydrological assessments, sustainable drainage systems (SuDS), drainage, river modelling, and flood risk assessment.

McCloy Consulting has ongoing involvement in numerous water environment studies and Sustainable Drainage Systems (SuDS) projects across the UK and Ireland and has developed expertise in surface water management for wind farms. The company has successfully designed numerous SuDS/surface water management solutions for wind farms in accordance with current best practice guidance. The primary personnel responsible for preparing this SWMP / WFD assessment are:

- Iain Muir MSc CEnv MIEnvSc – Senior Consultant and Chartered Environmentalist experienced in Environmental Impact Assessment (EIA) specialising in the water environment, undertaking hydrology, water quality and flood risk assessments for major infrastructure projects; and
- Kyle Somerville BEng (Hons) CEng MIEI – Director and Chartered Engineer specialising in hydrology and surface water management for wind farm developments and has overseen outline and detailed design of surface water management for more than thirty onshore wind farm developments in the UK and Ireland.

1.3 Water Framework Directive

The European Water Framework Directive (2000/60/EC) was given legal effect in Ireland by the European Communities (Water Policy) Regulations 2003 (S.I. No. 722 of 2003). It applies to rivers, lakes, groundwater, and transitional coastal waters.

A requirement of the WFD is to attain good ecological water status and that deterioration in the status of water is prevented. The Environmental Impact Assessment Directive (85/337/EEC) requires likely significant environmental impacts to be identified, assessed, and mitigated. An impact that would compromise achievement of a WFD objectives or result in the deterioration in the status of waters would be considered a significant impact.

Any new development must ensure that this fundamental requirement of the Directive is not compromised. **Chapter 11: Hydrology, Water Quality and Flood Risk** of the EIAR outlines mitigation measures specifically in relation to management of surface water (detailed further in this SWMP) to prevent deterioration of water quality and quantity. The EIA chapter concludes that overall residual effects of the Cummeennabuddoge Wind Farm on the water environment are 'not significant', therefore, WFD objectives are deemed to have been satisfied.

2 MITIGATING MEASURES

2.1 Approach

To mitigate the potential degradation of surface water quality and morphology because of construction activities associated with the development, mitigation measures are to be implemented during all stages of the construction process.

2.2 Introduction

The construction phase of all projects is a period within which there is increased potential for pollution, in particular silt pollution to local watercourses. Effects may continue but to a lesser extent in the operational phase. Potential pollution increases in the decommissioning phase due to similar but lesser-scale earthworks as the construction phase. The focus of this document is to provide sufficient detail to ensure that water pollution will not occur because of construction, operational and decommissioning activities at the site and to minimise the risk of any such occurrence.

EIAR Chapter 11 has identified downstream receptors of significance from a drainage perspective especially watercourses with fisheries potential and should be referred to for a detailed appraisal of the site hydrology.

The main objectives of the following sections are to demonstrate that sufficient measures have been put in place to protect those identified receptors and to ensure that drainage is constructed to relevant guidance and standards, particularly as follows:

- To propose appropriate, robust and buildable SuDS techniques for the prevention of erosion and the removal of silts and pollutants from construction and operation phase runoff.
- To ensure that permanent drainage at the development is designed to a sufficient hydraulic capacity to contain a pre-determined return period rainfall event.
- To give consideration of the control and monitoring proposals for the dewatering and drainage of excavations and borrow pits.

The drainage design adopts a SuDS approach, using temporary SuDS for the drainage of the temporary works during the construction phase.

Where construction activities near watercourses and water bodies are essential, steps have been undertaken to identify sufficient mitigation measures for the protection of the watercourses against pollution and have been presented on drawings accompanying this report within **Annex A** and **Annex B**. Surface water management and pollution prevention during all elements of construction has been given due consideration within this design statement and within the scope of the associated surface water management plan design.

This report gives both specific and general details on the drainage method for temporary works, permanent site drainage and pollution prevention measures for surface water management.

2.3 Additional References

This document refers to and should be read in conjunction with the Cummeennabuddoge Wind Farm EIAR, in particular:

- Chapter 8: Biodiversity; and
- Chapter 10: Soils, Geology and Hydrogeology.

Chapters are contained in **Volume 2** and Technical Appendices are included within **Volume 4** of the EIAR. In addition, the following accompanying drawings included within **Annex A** and **Annex B** of this Technical Appendix:

- SWMP_01 – 30 Preliminary SuDS General Arrangement (Planning Stage Drainage Layout); and
- SWMP_20 - 26 Preliminary SuDS Details (Planning Stage Drainage Details).

3 SITE DRAINAGE INFORMATION

3.1 Site Area

The core of the Proposed Development lies within existing commercial forestry, located on land at Clydaghroe and Cummeenabuddoge, Clonkeen, predominantly within County Kerry, although most of the grid connection infrastructure is proposed within County Cork. The nearest settlements are Ballyvourney and Millstreet (both in County Cork) located approximately 5 km south and 7 km north-east of the site, respectively. The Site is approximately centred on Grid Reference 519914, 583144.

The assessment area considered within the **EIAR Chapter 11** and this assessment (the 'Site Boundary') occupies an area of approximately 709 ha.

3.2 Topography

The topography of the Site typically slopes down from the southern boundary (maximum approximately 520 m OD) to the northern boundary (at approximately 300 m OD) with the Lackabaun and Mullaghanish mountain peaks located to the south of the site.

Most of the central section of the Site is located between 300-400 m OD, and the watercourses crossing the site have created a ridge and shallow valley system. Lower elevations are observed in the west of the site where the access track join from the N22, which is at approximately 270 m OD. The tracks within 1.5km of the N22 are steep, climbing from an elevation of 270 m OD to approximately 380 m OD (refer to EIAR Figure 1-1a).

3.3 Site Hydrology

Site hydrology is fully described in the **EIAR Chapter 11** that this Plan is intended to support.

Environmental Protection Agency (EPA) WFD dataset boundaries indicate that most of the Site lies within the Flesk [Kerry]_SC_010 WFD river sub-catchment (SC) (part of the larger Laune-Maine-Dingle Bay catchment), flowing westward from the Proposed Development and ultimately discharging to Lough Leane at Killarney approximately 24 km downstream from the Proposed Development site boundary.

Most of the grid connection route (approximately 2.8 km) is located within the Foherish_SC_010 river sub-catchment (part of the larger Lee, Cork Harbour and Youghal Bay catchment), flowing south-east then south from the Proposed Development site.

A small section of the grid connection route (approximately 475 m) is located within the Blackwater [Munster]_SC_040 river sub-catchment (part of the Blackwater (Munster) catchment), flowing north-east then north from the Proposed Development site.

For the purposes of WFD classification and assessment, the Flesk [Kerry]_SC_010 WFD, Foherish_SC_010, and Blackwater [Munster]_SC_040 river sub-catchments are further delineated into river 'sub-basins' (refer to EIAR Figure 11-1). The Proposed Development is located within the river sub-basins outlined in Table 11-8 of EIAR Chapter 11.

4 SUDS DESIGN APPROACH

4.1 Relevant Guidance and Legislative Requirements

All drainage relating to Cummeennabuddoge Wind Farm will be constructed using best practice and in conformance with the requirements of the relevant regulatory authorities. The key legislation and guidance which will be adhered to are defined in the **EIAR Chapter 11** and are not repeated here.

To meet the design criteria and objectives detailed previously in this report and regulatory authority requirements, the following over-arching design philosophy and principles have been developed to inform the detailed design.

4.2 Controlling Runoff

The following is proposed:

- Track and hardstanding runoff will flow laterally to trackside ditches or swales constructed to the edge of the hardstanding footprint;
- Tracks and hardstanding areas will be constructed from unbound aggregate and are not surfaced, thus encouraging infiltration and helping to reduce runoff volumes. This has been allowed for within the design philosophy through the utilisation of a reduced runoff coefficient of 60 %, and a heavy silt loading assumed as defined by D'Arcy et al (2000), for industrial and engineering land uses;
- Piped under track drainage is provided with associated sumps and check dams. The under-track drainage will provide a means for flows to pass from a swale on the uphill side to the downhill side of the slope without impediment;
- In cases where the tracks must run significantly downhill, transverse drains ('grips') will be constructed where appropriate in the surface of the tracks to divert any runoff flowing down the track into the adjacent drainage ditch/across open ground;
- Rate and volume of runoff is attenuated using check dams located in trackside swales and ponds located at significant new hardstanding areas. Attenuation features will also reduce flow velocities preventing scour and allow settlement of silts prior to discharge; and
- It is not proposed to use other methods such as filter drains or hard permeable surfacing due to the lack of infiltration capacity in prevalent soil types.

4.3 Water Quality and Treatment

The following is proposed:

- Clean / dirty water separation is maintained on site. Clean water will be prevented from entering excavations and dirty water drainage swales through use of clean water diversion / cut-off ditches;
- A treatment train is implemented with a minimum of two stages of treatment for polluted runoff from the site during the construction phase;
- All treatment settlement features (check dam backwaters and ponds) are designed to offer sufficient retention time to settle out the silt grain sizes anticipated;
- Silt laden runoff within trackside swales will be treated through the provision of small check dams at specified centres along the swales (to be specified as part of detailed design). Note that steeper swale sections will require a greater frequency of check dams;
- Appropriate site management measures will be taken to ensure that runoff from the construction site is not contaminated by fuel or lubricant spillages. There will be no discharge of trade effluent, sewage effluent or contaminated drainage into any watercourse system or ditch. Any dewatering from excavations will be via surface silt traps, check dams and settlement ponds to ensure sediment does not enter surrounding watercourses; and
- Areas stripped of vegetation shall be kept to a minimum. Stripped vegetation will be reinstated on slopes as early as possible.

4.4 Preserving Hydrology / Amenity & Biodiversity

- The proposed drainage design ensures natural streams are to be bridged on their original alignment with no in-stream works.

- Runoff from new hardstanding areas will be collected and attenuated before discharge to receiving drainage networks.

4.5 Summary

The proposed SuDS design provides a surface water management train that will seek to mitigate potentially adverse impacts on the hydrology of the Proposed Development.

Application of the above design philosophy in the detailed design and construction of site-specific elements is considered in the following sections of this report.

5 DRAINAGE DESIGN

5.1 Preamble

The following key considerations have been identified in the planning-stage design of hydrology and drainage (including foul) for the site to preserve water quality, downstream hydrology and preserve stream morphology sufficiently that there is certainty that the measures can be implemented effectively and to ensure that the assessment of residual effects can be predicted with certainty. The measures at planning stage will provide a framework within which any future detailed design stage will match or better. Key concerns addressed by the planning-stage design are as follows:

- Identification of watercourse crossings and drainage paths across the site.
- Sizing and definition of hydraulic capacity requirements for watercourse crossings.
- Requirement for fish passes / consideration of migratory fish.
- Definition of Buffer Zones.
- Separation of 'clean' and 'dirty' water.
- Detailed design of permanent track and hardstanding drainage (attenuation and treatment);
- Treatment of runoff from borrow pits.
- Treatment of runoff from spoil storage repositories.

The SuDS design has been prepared for purposes of the planning application. The design as presented in the planning application is conservative in its approach and is sufficiently detailed to allow a robust appraisal of the scheme in EIA terms, including consideration of the scheme earthworks footprint.

Preliminary drainage layout is shown on accompanying drainage management drawings **SWMP_01 to 30** within **Annex A.**

5.2 Watercourses and Watercourse Crossings

5.2.1 Identification of Watercourse Crossings

Watercourses significant for purposes of environmental design have been identified within the **EIAR Chapter 11** hydrology assessment undertaken for the project. Sensitive water features on the site comprise natural watercourses and main flowing forestry drains.

To allow the built footprint of the proposed development the following is required:

- 7 no. crossings of major watercourses;
- 1 no. crossings of minor watercourses.

Additional consideration will be given to management of drainage crossings at post-planning design refinement stage, including any other minor drainage crossings required to accommodate other existing drainage (forestry ditches and drains as encountered alongside existing roads, tracks etc).

Works to watercourse crossings will be subject to authorisation by the Office of Public Works (OPW) under Section 50 of the Arterial Drainage Act 1945.

5.2.2 Design of Watercourse Crossings

A sufficiently detailed hydraulic design sufficient to allow assessment of environmental effects has been prepared as part of this assessment. Final design of watercourse crossings will be undertaken at detailed design stage, post planning consent, which determine the detailed structural form which is dictated by ground conditions.

The following guidance has been adhered to in the preliminary design and will be similarly applied in the detailed design of watercourse crossings:

- Hydrological assessments made using appropriate methods to determine the design flow. Culverts are designed to convey the 1% AEP flood, including climate change (MRFS scenario), with free inlet conditions.
- SNIFFER WFD documents.

- CIRIA Culvert design and operation guide (C689); and
- Fisheries considerations shall incorporate guidance stated in 'Guidelines on Protection of Fisheries During Construction Works in and Adjacent to Waters' as published by Inland Fisheries Ireland (2016).

Eight (8) watercourse crossings have been identified and hydraulic criteria have been designed. All watercourse crossings are clear spans (i.e. bridges or bottomless culverts) to ensure there is no in-stream work that would have a potentially adverse effect on water quality. Use of clear spans ensures that the stream bed and bank remains undisturbed / intact and negate the need for in-channel works to preserve fish habitat and will avoid introducing structures that would inhibit fish passage.

Bridge abutments or bottomless culvert (i.e. inverted "U") footings are sited outside the stream bed and set back sufficiently from the bank that there is no risk of reduced quality runoff in the footing excavation draining discharging uncontrolled to the watercourse.

Minimum spans and heights are established in the watercourse crossing schedule at a **Watercourse Crossing Schedule** at **Annex D** to this report, including supporting calculations. The watercourse crossing schedule informs detailed plans included in the civil engineering package, where spans are determined to to accommodate meanders or the need to accommodate scour protection to the abutment sited outside the river channel. The structural form does not affect the outcome of related environmental assessments where all work is outside the watercourse.

Additional mitigation will be implemented to prevent pollution of the watercourse during the construction of the watercourse crossing to reduce residual risk, comprising the temporary installation of silt fences adjacent to the stream channel or similarly effective measures. Silt fence arrangements are shown on drawing **SWMP_20** included in **Annex B.**

A clear span / bottomless culvert crossing detail is shown on drawing **SWMP_25** included in **Annex B.** Site specific watercourse crossing details are included in the civil engineer drawings submitted with the planning application.

5.3 Water Feature Buffer Zones

Buffer zones to water features have been established within the Site Boundary in **Chapter 11: Hydrology, Water Quality and Flood Risk** for the project and are shown on accompanying drainage management drawings **SWMP_01 - 30** within **Annex A.**

Proposed infrastructure is designed to lie out with stated hydrological buffer zones.

Buffers shall be imposed during the construction phase to limit the types of construction activities permissible in proximity to water. Where the local site environment requires additional protection (e.g., steep slopes or lack of vegetation between construction corridor and watercourse) then stringent additional mitigation measures (such as bank-top silt fence barriers) are introduced. Buffer areas will act as riparian zones allowing filtration and settlement, minimising sediment transport, attenuating flows and maximising infiltration.

All turbines and infrastructure are outside the recommended buffers (other than unavoidable watercourse crossings) as described in **Chapter 3**: **Design Evolution and Consideration of Alternatives**.

5.4 Temporary Drainage

5.4.1 Clean / Polluted Water Separation

Drainage management ensures that clean water is not permitted to mix with contaminated water from sources such as excavation dewatering or track runoff, where "clean water" should be interpreted as natural surface runoff unaffected by construction / earthworks runoff.

Design ensures that upslope cut off ditches are to be installed to intercept and divert clean upslope surface water runoff flowing overland prior to it meeting areas of significant excavation. Design and construction sequencing ensures that clean water cut off ditches are installed ahead of main earthworks wherever practical. This is intended to reduce the flow of clean water onto any exposed areas of rock and soil, thereby reducing the amount of potential silt laden runoff requiring treatment.

Installed drainage allows provision for clean water intercepted in cut-off ditches to pass through and under track structures separate to drainage provided for track runoff.

Temporary silt / pollution prevention and scour protection measures (such as check dams) is provided in artificial clean water drainage installed to mitigate potential for scouring and transport of sediment from newly excavated channels.

Diversion drainage is to be dispersed over vegetated ground. Diversions are designed to avoid collection and interception of large catchments creating significant point flows, with associated risks due to scour and hydraulic capacity.

Clean water drainage is shown on SWMP drawings included at Annex A and cutoff arrangements and culvert arrangements to pass clean water through / around works is shown at **SWMP_26** in **Annex B.**

5.4.2 Borrow Pit Drainage

Borrow pits represent a significant potential source of reduced quality runoff due to dust from blasting and rock breaking, potential for encountering shallow groundwater in excavations, accumulation of rainwater in excavations and trafficking by heavy plant causing sludge.

Temporary drainage will be installed prior to opening of borrow pits. The approach to drainage ensures that clean runoff flowing toward or over the borrow pit is diverted either in cutoff drainage and bunds formed from cutoff ditch excavation to the top of the cut slope, prior to commencement of clearing of overburden.

Settlement features are planned at the low point or adjacent to borrow pits, and internal drainage (or pumping) of accumulated water on the borrow pit floor shall discharge to settlement features. Settlement features treat runoff to an acceptable standard before discharging overland or discharging into proposed trackside drainage.

The critical water quality event is likely to be a high intensity “first flush” rainfall event and as such a 1-hour design rainfall intensity is adopted, including allowance for climate change. Given the likely duration of main construction work and operation of temporary drainage, a 2-year return period storm is adopted.

Supporting calculations for borrow pit drainage are in **Annex C** and drainage arrangements are shown on SWMP drawings **in Annex A.**

5.5 Permanent / Operational Phase Track Drainage

Surface water drainage design meets the requirements of the Kerry County Council Development Plan 2015-2021 (which remains extant presently) and to the standards of Kerry County Council Water Services Department, insofar as those standards may apply to a development of this nature. While the application site and Proposed Development extends into County Cork, the development in that area is limited to a grid cable route which has no permanent drainage associated with it.

The drainage design is intended to demonstrate how water quantity and quality are dealt with as well as making provision for biodiversity where practicable.

Permanent surface water drainage design therefore adopts SuDS principles and ensures that runoff from new impermeable surfaces (tracks and ancillary infrastructure) shall be reduced to the pre-development greenfield rate. The design principles adopted in the Drainage Plan are as follows:

- The drainage system caters for protection for up to a 1 in 100 / 1% AEP rainfall event including allowance for climate change., common to the standard of protection for flooding from surface water drainage afforded by GDSDS as best practice.
- GDSDS standards direct that all runoff up to the design standard shall be limited to Qbar where Long Term Storage (i.e., loss of water by infiltration) cannot be accommodated. Given likely seasonal saturation of shallow peat soils, the design adopts the more onerous Qbar approach.
- Runoff from access tracks is collected via open swales. Run-off is attenuated with the use of check dams to reduce the peak rate of run-off and to encourage infiltration of surface water.
- Combine settlement/attenuation features (basins) are provided to main outlets.

- Discharged run-off is encouraged to discharge overland, rather than accumulate concentrated peak flows to discharge to watercourses. Point discharges are to be set back outside the banks of watercourses so that no in-channel works are proposed.

Permanent drainage shall in effect be installed as enabling work and its function shall be in place during the construction and earthworks / track construction phase.

Measures incorporated in the preliminary design are further expanded in the following sections.

5.5.1 Trackside Drainage

The cross fall on the track is aligned to divert "dirty" surface water (i.e., contaminated surface water from track surface)into trackside swales by lateral surface flow or via track surface grips.

The swale and track shoulder will be vegetated as soon as possible after construction, to reduce potential for runoff from exposed aggregates and clays and promote removal of suspended solids within runoff by filtration in vegetation. Any vegetation used will be appropriate to the local area. Temporary erosion protection will be implemented wherever required until the vegetation becomes established (coir matting or similar).

All swales are kept as shallow as possible so that they pose no health and safety risk to plant or personnel.

Drainage swales are designed to allow hydraulic conveyance of runoff appropriate to the protection of the surrounding land use, with additional consideration of effect of a 100-yr (flood protection) event (i.e., exceedance event

Under-track piped drainage crossings are provided to allow up-slope swales to drain to the down slope side. Crossings will be provided at regular intervals to allow for redundancy due to potential blockage, and at all localised low points. Outlets from crossing pipes generally coincide with swale breakouts.

Dirty water under track crossings and breakouts are maintained separately from clean water crossings (see Section 5.4.1).

There are regular outflow points ("breakouts") from the swales throughout the SuDS system to eliminate the potential for the generation of large flows at single outflow points. This assists the drainage network in maintaining the hydrological response displayed by the natural catchment. Breakouts allow for the release of runoff over intact vegetated ground, thereby reducing flows to the end-of-line settlement and attenuation / settlement feature. Breakout discharges are directed away from watercourses and across intact vegetation to increase the drainage path and buffer zone between the point of discharge and watercourses.

Trackside swale arrangements are shown on **SWMP_01 to 30** within **Annex A** and track drainage details are shown on **SWMP_21 and SWMP_22** in **Annex B.**

Installation of grips will prevent extensive rutting of the track structure and aids drainage of the track surface, which in turn reduces potential for trafficking of the surface to cut the track and generate silt. Drainage grips will generally comprise a steel channel section installed flush to the track surface, with concrete haunching as may be required in areas of heavy trafficking.

5.5.2 Runoff Attenuation

Runoff from will be attenuated to mimic natural runoff patterns at all stages of the development including during the construction phase. Flow rates from tracks is reduced through use of attenuating check dams within swales installed adjacent to all hardstanding areas, providing immediate attenuation "at source", with pass-forward flow rate reduced by filtration and temporary detention.

Frequent breakouts from swales to discharge accumulated runoff overland at regular frequencies will further encourage attenuation of runoff peaks by dispersing runoff over vegetation where losses would be expected by vegetative retention, transpiration, and infiltration.

End-of-run attenuation utilises ponds or basins. Basins have a permanent attenuation function up to GDSDS standards for the permanent works.

Outlets are controlled by orifices or vortex controls (hydrobrakes or similar) to manage runoff to Qbar or the lowest practicable flowrate at small sub catchments bearing in mind the need to prevent blockages.

Supporting calculations are in **Annex C** and attenuation basins are scheduled and shown on SWMP drawings **in Annex A.** An attenuation basin detail is included on **SWMP_24** in **Annex B.**

The following schedule summarizes surface water attenuation provision, to be read in conjunction with the drainage catchment map overleaf. A higher resolution map is included at **Annex C.**

Table 5-1 – Attenuation Basin Schedule

Sub Catchment ID	Subcatchment Area sq. m	Minimum Volume cu. m	Nominal Depth m	Nominal Width m	Nominal Length m	Discharge Rate lps (Qbar)	Notes
1	5679	97	1	8	12	9.0	
2	4991	85	1	5	17	7.9	
3	8836	151	1.5	8	15	14.1	Dimensions increased to suit water quality requirements
4	2093	36	1	5	7	3.3	
5	2264	39	1	5	8	3.6	
6	6087	104	1	8	13	9.7	
7	8125	139	1	8	17	12.9	
8	21892	375	1.5	10	30	34.8	Dimensions increased to suit water quality requirements
9	13665	234	1.5	10	18	21.8	Dimensions increased to suit water quality requirements
10	16333	280	1.5	10	22	26.0	Dimensions increased to suit water quality requirements
11	13082	224	1.5	10	18	20.8	Dimensions increased to suit water quality requirements
12	2323	40	1	5	8	3.7	
13	14944	256	1.5	10	20	23.8	Dimensions increased to suit water quality requirements
14	1738	30	1	5	6	2.8	

Sub Catchment ID	Subcatchment Area sq. m	Minimum Volume cu. m	Nominal Depth m	Nominal Width m	Nominal Length m	Discharge Rate lps (Qbar)	Notes
15	11958	205	1.5	10	16	19.0	Dimensions increased to suit water quality requirements
16	13841	237	1.5	10	19	22.0	Dimensions increased to suit water quality requirements
17	2863	49	1	5	10	4.6	
18	436	7	1	5	5	2.0	Rate adjusted to suit minimum allowed for blockage mitigation
19	798	14	1	5	5	2.0	Rate adjusted to suit minimum allowed for blockage mitigation
20	13415	230	1.5	10	18	21.4	Dimensions increased to suit water quality requirements
21	10570	181	1.5	8	18	16.8	Dimensions increased to suit water quality requirements
22	13756	236	1.5	10	19	21.9	Dimensions increased to suit water quality requirements
23	7373	126	1	8	16	11.7	
24	13105	224	1.5	10	18	20.9	Dimensions increased to suit water quality requirements
25	11376	195	1.5	8	19	18.1	Dimensions increased to suit water quality requirements

Sub Catchment ID	Subcatchment Area sq. m	Minimum Volume cu. m	Nominal Depth m	Nominal Width m	Nominal Length m	Discharge Rate lps (Qbar)	Notes
26	14632	251	1.5	10	20	23.3	Dimensions increased to suit water quality requirements
27	1731	30	1	5	6	2.8	
28	5706	98	1	8	12	9.1	
29	16421	281	1.5	10	22	26.1	Dimensions increased to suit water quality requirements
30	12092	207	1.5	10	16	19.2	Dimensions increased to suit water quality requirements
31	12460	213	1.5	10	17	19.8	Dimensions increased to suit water quality requirements
32	762	13	1	5	5	2.0	Rate adjusted to suit minimum allowed for blockage mitigation
33	12575	215	1.5	10	17	20.0	Dimensions increased to suit water quality requirements
34	16432	281	1.5	10	22	26.2	Dimensions increased to suit water quality requirements
35	1044	18	1	5	5	2.0	Rate adjusted to suit minimum allowed for blockage mitigation
36	2617	45	1	5	9	4.2	
37	1074	18	1	5	5	2.0	Rate adjusted to suit minimum allowed for blockage mitigation

Sub Catchment ID	Subcatchment Area sq. m	Minimum Volume cu. m	Nominal Depth m	Nominal Width m	Nominal Length m	Discharge Rate lps (Qbar)	Notes
38	431	7	1	5	5	2.0	Rate adjusted to suit minimum allowed for blockage mitigation
39	1950	33	1	5	7	3.1	
40	14941	256	1.5	10	20	23.8	Dimensions increased to suit water quality requirements
Total	336411	5761.35				562.2	

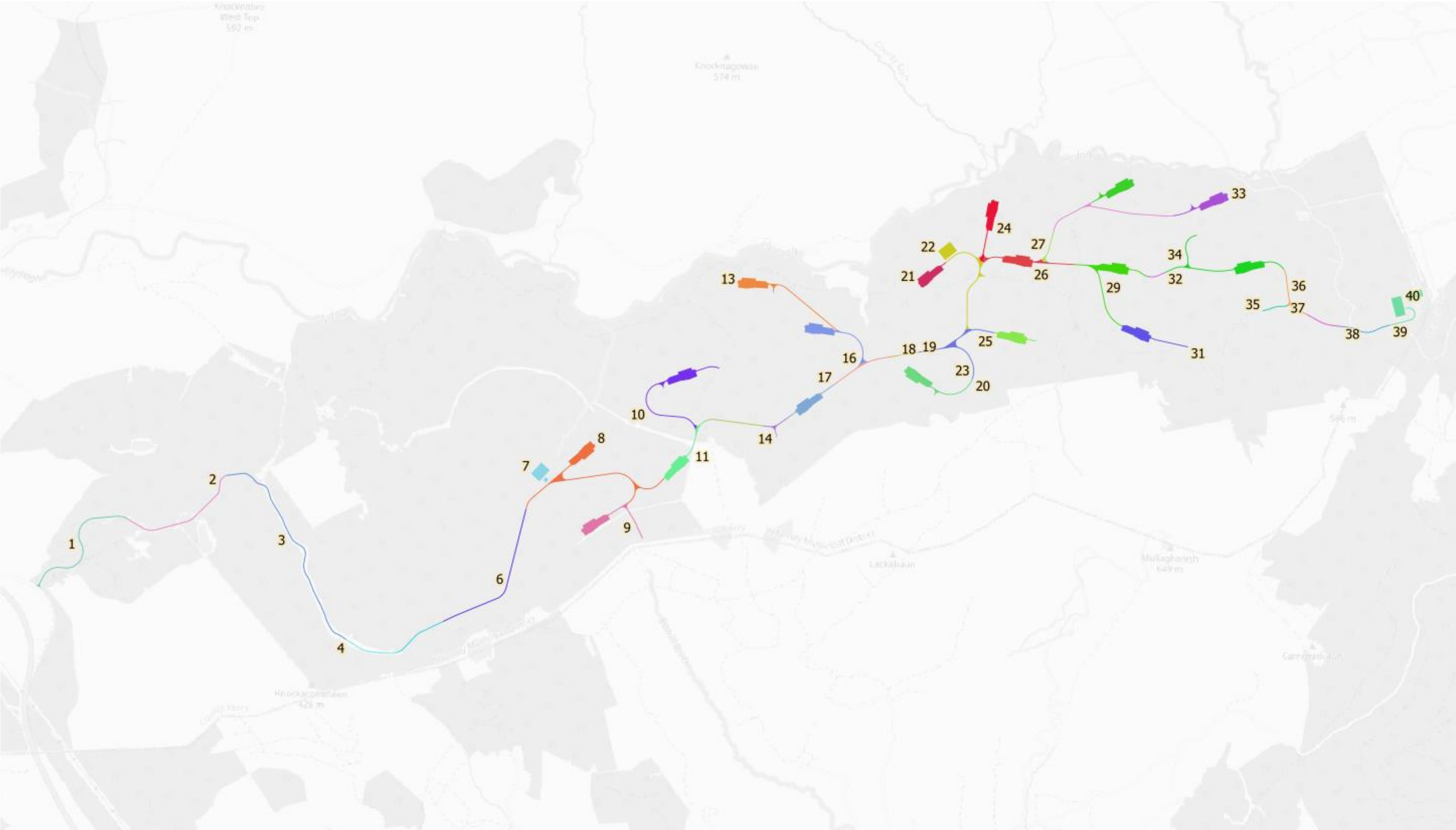

Figure 5-1 – Subcatchment Distribution

5.5.3 Drainage Grips

Drainage grips may be installed on the track surface where deemed a requirement to direct runoff into trackside drainage or to downslope settlement / filtration features. Positioning of grips will be determined at detailed design stage and on an observational basis during construction, however in general the need for grips will be greatest in areas on steep longitudinal track gradient.

5.6 Management of Suspended Solids

5.6.1 Check Dams

Initial treatment is provided "at source" by check dams installed within trackside swales at regular frequencies, to reduce flow velocities and improve conditions for the settlement of solids in transit.

Check dams shall be of stone formation however compacted clay check dams may be used should suitable stone be unavailable locally.

Where stone is used, the aggregate used to form check dams will be a small 'clean' graded stone. On steeper slopes the check dams will be anchored using larger stone placed on the downhill side of the check dam to prevent washing away of the smaller graded stone.

The check dams will serve dual functions, by both removing and settling out silts and reducing flow velocities, therefore mitigating against the effects of erosion within the swale and improving the design life of end of line settlement and attenuation features.

The frequency of installed check dams may be reduced post-construction phase, due to reduced silt loading anticipated following completion of construction activities and reduced site traffic.

Swale & check dam arrangements are shown on track drainage drawings **SWMP_21** and **SWMP_22** in **Annex B.**

5.6.2 Settlement Basins

All locations where significant accumulations of dirty water discharge in the vicinity of watercourses will pass through one or a sequence of settlement lagoons in order that suspended solid concentrations released can demonstrably be shown to have no detrimental effect to downstream water quality.

Permanent attenuation basins will have a combined settlement/attenuation function for the construction phase. In fulfilling that function the forebay and main lagoon are likely to be sacrificial and require active maintenance. There may be a requirement to re-form the main lagoon after main earthworks have concluded and sediment-laden runoff has stabilised. The work to reform the basin would comprise removal and disposal of accumulated silt and detritus, cleaning of inlets and outlets, and reforming of basin side slopes and re-establishment of any scour protection and vegetation.

Elsewhere standalone settlement basins are proposed for dewatering of planned significant excavations which are intended to be temporary for the construction phase and would be backfilled as part of reinstatement works. Washout pits to be located local to large excavations (i.e. turbine bases) are designed to accommodate the anticipated volume of contaminated water to be removed from the excavation, either through unavoidable surface water runoff or accumulation of shallow groundwater. Washout pits are sized to accommodate the volume for a period until such times as the water has been clarified, with the water subsequently pumped out and into the site drainage system.

Basin performance is estimated to allow 96% sediment removal under design conditions. Clay range particles where settlement is not possible can be further removed by overland discharges.

For permanent drainage, water quality protection and treatment of runoff is per the indices guidance in the CIRIA SuDS manual. The proposed development is taken as being a land use with heavy pollution risk where chemicals and fuel oils are to be delivered, handled, stored. Table 26.2 of the SuDS Manual defines the pollution hazard as High, with Pollution indices as follows:

- Total Suspended Solids 0.8
- Metals 0.8

- Hydrocarbons 0.9
- provision of permanent swales with check dams and a detention basin in sequence will have a Pollution Mitigation Index per Table 26.3 of the SuDS manual as follows:

Pollutant	Source Hazard Index	Swale Mitigation	Detention basin Mitigation	Total Mitigation Index	Sufficient?
TSS	0.8	0.5	0.5	1.0	Yes
Metals	0.8	0.6	0.5	1.1	Yes
Hydrocarbons	0.9	0.6	0.5	1.1	Yes

Attenuation / settlement basin arrangements and standalone settlement basin arrangements are shown on drawing **SWMP_24 and SWMP_23** included in **Annex B.** Supporting calculations for settlement basins are in **Annex C** and drainage arrangements are shown on SWMP drawings **in Annex A.**

5.6.3 Vegetative Filtration

Wherever possible, runoff from swales, ponds, or other pumped discharges will be dispersed over undisturbed intact vegetation, nominally over agreed riparian watercourse buffer zones, to allow vegetative filtration of runoff prior to water entering receiving watercourses.

5.7 Spoil Management

Management of spoil, including temporary and permanent spoil generated from excavations has been designed and submitted in support of the planning application. Site spoil management and drainage design ensures the following in terms of drainage for temporary spoil management areas:

- There will be no depositing of material within the watercourse buffer zones;
- Spoil shall be placed in such a manner to ensure no ponding of surface water on top of spoil heaps. Temporary spoil will be graded to ensure that all direct precipitation will run directly off the surface;
- Temporary spoil deposition areas ensure that natural flow paths (drainage channels) are not altered or blocked by deposited spoil; and
- Downgradient measures will be provided from spoil repositories in areas where runoff accumulates in order to treat reduced quality runoff to an appropriate standard per Section 5.6.2.

For purposes of the for-planning surface water management plan, treatment of runoff from spoil repositories comprises filtration through boundary stone bunds, silt fences, and vegetative filtration and infiltration across intact riparian zones outside of watercourse pollution prevention buffers; or collection into the site drainage network where it will be conveyed in track drainage swales and settlement features.

5.8 Foul Drainage

To prevent the requirement for a discharge of treated effluent of poor quality to a watercourse or percolation to groundwater that may cause nutrient enrichment of habitats, foul water from temporary compounds and the permanent substation will drain to temporary or permanent chemical facilities.

There will be no treated foul water discharge from the facilities. Emptying of chemical facilities (by tanker or similar) will be undertaken by a licensed haulier and waste will be disposed of at a suitable licensed waste disposal facility.

6 CONSTRUCTION PHASE – TEMPORARY DRAINAGE & POLLUTION PREVENTION

Specific requirements to be imposed on any Contractor involved in the construction of the scheme will be further detailed in a detailed Construction Environmental Management Plan (CEMP) which will include Construction Method Statements, which can be subject to be approval by the relevant local authority prior to construction.

All site personnel will be made aware of their environmental responsibilities at the site induction prior to being allowed to work on site, and through the production of a Method Statement, outlining Environmental Requirements for Sub-Contractors, which will include environmental emergency response procedures to deal with spillages, should they occur.

This section of the report outlines the steps which will be undertaken during the construction phase of the project to ensure compliance with relevant best practice guidance stated in **EIA Chapter 11**. Site visits by the SuDS Engineer will be agreed in advance and will be undertaken at various stages of the construction process to ensure that the proposed SuDS scheme is being constructed in line with the design.

Essential mitigation measures relevant to controlling erosion and runoff from construction of the SuDS are described in best practice guidance stated in **EIA Chapter 11.**

The measures proposed for the Construction Phase shall be similarly implemented for the Decommissioning Phase.

6.1 Planning and Phasing of Drainage Works

6.1.1 Site-Wide Requirements

Temporary pollution prevention measures will be employed prior to and during forestry felling and temporary or permanent drainage and surface water management features (SuDS) will be constructed prior to earthworks (including preliminary or enabling works) proceeding to construct any linear works (tracks / hardstanding areas / cable routes), turbine bases, and other infrastructure. Drainage will be provided to temporary works and reinstated to suit the final footprint of the completed development.

Forestry / felling works shall be subject to separate felling licencing which includes ensuring mitigation of risk to watercourses due to felling and associated plant movements. The nature of felling works shall depend on the maturity of trees at the time of felling and considered separately in **EIA Appendix 4-2 – Forestry Management Plan**.

Temporary drainage measures in advance of earthworks will include:

- Temporary silt fences erected in areas where risk of pollution to watercourses has been identified e.g., watercourse crossing locations and areas where development (such as felling) unavoidably lie within watercourse buffer zones;
- Upslope cut-off drainage channels approximately parallel to the proposed track alignment installed in advance of any excavated cuttings for the track or turbine hardstanding areas. This will prevent washout by surface flows of exposed clays in excavations and fine sediments in track makeup, and increase efficiency of silt removal in future trackside drainage swales;
- Minor drains, other flow paths and cut-off drain outlet locations will be identified and charted, to ensure that piped crossings can be installed in advance of or adjacent to the track construction;
- Settlement ponds will be constructed in advance of commencing excavations for foundations and at any other locations identified as required at detailed design stage; and
- Trackside drainage swales will be installed in parallel with track construction. Note that this may require that drainage swales are reformed on an ongoing basis as temporary track alignments are modified to their eventual finished design level.

In addition, spoil management is to be planned in advance of earthworks and on an ongoing basis, to allow planning of drainage required in advance of spoil being deposited.

Suitable prevention measures will always be in place to prevent the conveyance of silts to receiving watercourses.

6.1.2 Timing of Works

Works on the site likely to cause a high risk to surface water will be programmed to avoid unfavourable prevailing ground conditions and high volumes or extended periods of seasonal rainfall.

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 peat/subsoil or vegetation stripping will be suspended or scaled back if heavy rain is forecast. The extent to which works will be scaled back or suspended will be proportionate to the 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;
- MeteoAlarm: 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;
- 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 threshold rainfall values will allow the control of in the event of forecasting 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 shall be completed:

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

Contractors will avoid working during heavy rainfall and for up to 24 hours after heavy events to ensure drainage systems are not overloaded.

Planning of work in conjunction with weather forecasting shall similarly be informed and directed by the stringent water quality monitoring strategy to be adopted which will similarly inform the cessation or limiting of work in response to real time monitoring of key water quality parameters in the Clydagh River – refer to **EIA Appendix 11-3: Water Quality Monitoring & Response Plan.**

6.2 Forestry Felling

Tree felling to facilitate the Proposed Development will not be undertaken simultaneously with construction groundworks. Keyhole felling to facilitate construction works will take place prior to groundworks commencing.

Water protection measures will reduce the risk of suspended solids and nutrient release in surface watercourses. The water protection measures to be adopted during felling operations are set out as follows:

- Machine combinations (i.e. hand-held or mechanical) will be chosen which are most suitable for ground conditions at the time of felling, and which will minimise soil disturbance;
- Trees will be cut manually inside the discrete areas where felling is proposed within hydrological buffers (pollution prevention areas) and using machinery to extract whole trees only;
- Checking and maintenance of existing access roads and culverts will be on-going through any felling operation. The felling plan ensures that no tracking of vehicle through watercourses will occur, as vehicles will use road infrastructure and existing watercourse crossing points.
- Forestry ditches which drain from the proposed area to be felled towards existing surface watercourses will be blocked, and temporary check dams will be constructed in the forestry ditch.. Drains and sediment traps will be installed during ground preparation.

- Sediment traps will be sited in forestry ditches downstream of felling areas. Machine access will be maintained to enable the accumulated sediment to be excavated. Sediment will be carefully disposed of in the peat disposal areas.
- Double silt fencing will be installed at the downslope edge of felling areas which are located inside hydrological buffers (pollution prevention areas). Felling activities proximal to watercourses / within hydrological pollution prevention buffers will be supervised and monitored by the Ecological Clerk of Works (ECow);
- Drains and silt traps will be maintained throughout all felling works, ensuring that they are clear of sediment build-up and are not severely eroded. Correct drain alignment, spacing and depth will ensure that erosion and sediment build-up are minimized and controlled;
- Brash mats will be used to support vehicles on soft ground, reducing peat and mineral soils erosion and avoiding the formation of rutted areas, in which surface water ponding can occur. Brash mat renewal shall take place when they become heavily used and worn. Provision shall be made for brash mats along all off-track harvester routes, to protect the soil from compaction and rutting. Where there is risk of severe erosion occurring, extraction shall be suspended during periods of significant rainfall per **Section 6.1.2 Timing of Works**;
- Timber will be stacked in dry areas, and outside hydrological buffers (pollution prevention areas).
- Refuelling or maintenance of machinery will not occur hydrological buffers (pollution prevention areas. Mobile bowser, drip kits, qualified personnel will be used where refuelling is required. A permit to refuel system will be adopted at the site.

Before the commencement of any felling works, an Environmental Consultant (as required by **EIA Appendix 11-3: Water Quality Monitoring & Response Plan**) shall be appointed to oversee the keyhole and extraction works. The Consultant shall be experienced and competent, as proposed in the planning application. They will:

- Attend the site for the setup period when drainage protection works are being installed, and be present on site during the remainder of the forestry keyhole felling works.
- Prior to the commencement of works, review and agree the positioning by the Operator of the required Aquatic Buffer Zones (ABZs), silt traps, silt fencing (see below), water crossings and onsite storage facilities for fuel, oil and chemicals (see further below).
- Be responsible for preparing and delivering the Environmental Tool Box Talk (TBT) to all relevant parties involved in site operations, prior to the commencement of the works.
- Conduct the monitoring required by the Water Quality Monitoring Plan and implement control measures (interventions, cessations of work)
- Prepare and maintain a Water Protection Measure Register. This document is to be updated weekly by the Consultant.

6.3 Specific Construction Phase Measures

6.3.1 Working in the Vicinity of Water / Buffer Zones

Construction buffer zones to drainage features will be set as stated within **Chapter 11: Hydrology, Water Quality and Flood Risk** and are shown on the accompanying Drainage Management Drawings within **Annex A.**

The following procedures apply to the general construction activities in the vicinity of watercourses (i.e., within buffer zones):

- Due cognisance will be given to the prevailing ground conditions and season when programming the execution of the works, to seek to undertake the works in a period with low potential to cause introduction of silt laden runoff to on-site water features. This includes avoiding work per the triggers noted at Section 6.1.2.
- Works will be planned so that trackside drains do not discharge directly into watercourses, but rather through a buffer area of adequate width or via a constructed settlement feature such as pond or sequence of silt fences;
- Cement and concrete will be kept out with buffer zone to avoid contamination of watercourses;
- Runoff from excavations will not be pumped directly to watercourses. Where dewatering of excavations is required, water shall be pumped to the head of a treatment train (swale, basin, or detention pond) to receive full treatment prior to re-entry to the natural drainage system; and

- SuDS treatment techniques will be utilised to remove silts from runoff prior to the discharge of flows over open vegetated areas.

If a specific short-term risk to water quality is identified on site, specific localised measures will be implemented including:

- Placing temporary filtration silt fences within drainage channels where siltation is observed; and
- Installing temporary constructed settlement features such as sumps or settlement ponds / lagoons where required.

6.3.2 Watercourse Crossings

Residual risk to watercourses specific to the construction stage will be fully addressed in the Contractor's construction method statement and, in addition to those points outlined in Section 5.2.2, will include the following:

All watercourse crossings are clear span structures and require no in-channel work to facilitate their construction. Access to both banks shall either be by use of existing forestry tracks, or by use of a temporary bridging structure. Any temporary bridging structure shall be of a temporary bridging platform / baily bridge that themseves that can be erected without in-channel works. Temporary culverts or any other proposal causing disturbance of the stream bed or bank to allow far-bank access will not be permitted.

The timing of works to construct footings and install watercourse crossing shall be cognisant of the overarching restrictions relating to timing of works and weather conditions (see Section 6.1.2, timing of works), and water quality conditions based on the ongoing water quality monitoring planned for the duration of the construction phase (refer to **EIA Appendix 11-3: Water Quality Monitoring & Response Plan)**. Work associated with installation of watercourse crossings will be treated as potentially high risk and a precautious approach will be adopted in all instances in conjunction with the Environmental Consultant, when evaluating the suitability of conditions to commence and undertake works.

- Geotextile silt fences shall be installed adjacent to the drain bank upstream and downstream of the culvert location to filter contaminated runoff that may be caused by plant movement associated with the culvert installation. A sequence (minimum 2 no.) in-channel geotextile check dams will be installed within the drain channel downstream of the culvert location and downstream of the pump-return;
- Footings will be installed set back from the stream bank sufficiently that the bank remains intact. Ground conditions around banks should be expected to be permeable and ingress by shallow groundwater should be expected. Dewatering of excavations shall be pumped upslope away from the work and away from the watercourse to a dedicated settlement feature or similar (such as a silt sock and sedimat, or containerised solution such as a siltbuster).
- Any wet concrete work to pour footings will be strictly controlled and control measures will be put in place to prevent spillage from concrete chutes or pumps. Dewatering during or after concrete pours will be pumped out and detained or removed from site.
- The structure comprising pre-cast concrete or similar (e.g. flexi-arch) shall be installed and backfilled with suitable aggregate. Scour protection shall be formed at the culvert inlet and outlet using dry formed components (precast elements / lean-mix concrete-filled sandbags or similar). All scour protection shall lie outside the river channel and set back from the banks.
- The track formation shall be formed over the new structure. Silt fences set back from the stream bank will be sited to suit the footprint of the toe of the embankment.
- Geotextile or equivalent splashguards shall be erected to the track embankment over the culvert or clear span crossing prior to trafficking. Any temporary bridging structure will be removed on commissioning of the new structure suitable for receiving works traffic.

6.3.3 Turbine Bases and Crane Pads

Excavated turbine foundations are likely to result in large volumes of displaced excavated material as spoil, as well as concrete operations. Specific measures are, therefore, required to manage potential for silt laden runoff from spoil, silt laden runoff from pumped dewatering, and cementitious contamination in pumped dewatering from turbine bases.

Concrete will not be allowed to enter watercourses under any circumstances, and drainage from excavations in which concrete is being poured will not be discharged directly into existing watercourses without appropriate treatment. Delivery trucks, tools and equipment will be cleaned at designated washout areas located conveniently and within a controlled area of the construction compound. Runoff from wash-out areas will be appropriately stored within bunded containers and removed off-site by an appropriate waste disposal company. In addition, the following drainage measures will apply:

- Installation of cut-off drains around the working areas to intercept clean surface runoff and divert it around and away from the works;
- Minimising the stockpiling of materials and locating essential stockpiles outside any watercourse buffer zone;
- Polluted (silt laden) water collected in the base of any excavation would be gathered in a sump and pumped at a low flow rate into either the mini-settlement pond or track swale for treatment. Dewatering of excavations direct to watercourses will not be permitted; and
- The foundation working areas will be re-vegetated as soon as possible after construction.

6.3.4 Cable Trenches

The following shall apply to the construction of all cable trenches at the site:

- To minimise impacts from disturbance, cables will be laid in small trenches along the side of access tracks, as far as possible;
- Due cognisance will be given to the prevailing ground conditions and season when programming the execution of the works, to seek to undertake the works in a period with low potential to cause introduction of silt laden runoff from excavations;
- Excavation of cable trenches will be carried out over short distances, with frequent backfilling of trenches, to minimise opportunity for the ingress of water into open trenches;
- Temporary silt traps will be provided in longer trench runs and on steeper slopes; and
- Where constructed trackside swales are disturbed by cable installation, swale slopes will be correctly reinstated post infilling of the cable trench.

6.3.5 Dewatering

To control dewatering activities and to ensure that all dewatering allows for pollution prevention measures, a permit-to-work system will be implemented by the Contractor, particularly to ensure pumped dewatering from excavations is controlled. A permit will be required to be issued to a competent person prior to allowing any specific dewatering to commence.

6.3.6 Excavated Track Drainage

All track runoff (polluted water) would be directed to flow to track-side drainage channels as per Section 5.5, to be installed as tracks are constructed.

Due to anticipated low rates of infiltration and high ground water tables, as is common in predominately peat conditions, it is likely across most of the site that flows will not percolate through the base of the swale and will therefore be discharged from the swale via frequent spillways created through the embankments on the downhill sides of the access tracks.

Drainage swales and track shoulders will be re-vegetated as soon as feasible after completion of the track and drainage across the site. Installation details for excavated tracks is shown on drawing **SWMP_21** in **Annex B.**

7 MAINTENANCE

7.1 Construction Phase

The following is intended to inform the detailed drainage / SuDS maintenance manual for the construction phase.

It is envisaged that an engineer specialising in surface water management and SuDS would be required to undertake regular site inspections during the construction phase of the wind farm, to validate that any detailed SuDS design and associated requirements to ensure construction methods are adhered to on site, and in order to identify areas where additional or enhanced mitigation is required.

In addition to the regular site inspections carried out by the Engineer, the following construction inspections will be undertaken during the construction phase of the project. The list is not exhaustive and will be added to as per the requirements of the site.

7.1.1 Swales / Check Dams

- All check dams and settlement basins to be checked weekly in dry weather and daily during periods of heavy rainfall via a walkover survey during the construction phase. Excess trapped silt to be removed and disposed of / re-used as may be agreed with relevant authorities;
- Where check dams have become fully blocked with silt, they will be replaced. Procedure for replacement of the check dam as follows:
    - silt deposits to be removed from the upstream side of check dams;
    - removed silt to be buried or re-used by spreading in an area of the site where surface runoff will not convey silt deposits back to a watercourse;
    - where there are regular incidents of check dam blockage further check dams to be installed (every 15-20 m intervals) within the swales;
- Monitor side slopes of swales and basins and reinstate any areas of slope slippage by battering back or otherwise as may be appropriate.
- Should there be noticeable effects of erosion along the swales or at discharge points, suitable erosion protection measures such as placement of large stones or erosion protection textiles will be installed at the area affected; and
- Any temporarily stored or stockpiled material will be placed in a manner to ensure stability and set back sufficiently far such that in the case of unforeseen collapse, spoil would not cause infilling of swales.

7.1.2 Settlement & Attenuation Basins

- Basin inlets to be cleared of debris;
- Silt in aggregate forebays to be removed by excavator and disposed of. Any aggregate removed to be replaced with clean stone; and
- Any flow control device (orifice, weir or similar) to be checked and cleared of any debris.

7.1.3 Drainage Pipes

- Piped drainage (clean water / dirty water) to be monitored at inlets. Silt to be removed by hand or by excavator and disposed of.
- Pipe deflection to be monitored. Ineffective gradients to be identified and pipes excavated and replaced to ensure drainage function.

7.2 Operational Phase

A post-construction phase maintenance manual will be produced upon production of as built drainage survey for the site. This maintenance manual will contain recommendations identified above, augmented with further drainage findings collected during the construction phase which are deemed to assist in provision of long-term drainage management for the site.

8 SUMMARY AND CONCLUSION

8.1 Assessment of Post-Construction WFD Status

As noted at the outset of this document (**section 1.3**), a requirement of the WFD is to attain good ecological water status and that deterioration in the status of water is prevented.

Chapter 11: Hydrology, Water Quality and Flood Risk of the EIAR outlines mitigation measures specifically in relation to management of surface water (detailed further in this SWMP) to prevent deterioration of water quality and quantity. As the EIA chapter concludes that overall residual effects of the Cummeennabuddoge Wind Farm on the water environment are 'not significant' through the construction, operational and decommissioning phases, and WFD objectives are deemed to have been satisfied.

8.2 Conclusion

Following incorporation of site-wide general binding mitigation control measures, compliance with relevant best practice guidance stated in **EIA Chapter 11,** and site specific mitigation, no adverse effect is anticipated to the Water Framework Directive classifications of the waterbodies hydrologically connected to the Cummeennabuddoge Wind Farm as a result of the Proposed Development.

Annex A

Drainage Management - General Arrangement

M01944-02_SWMP_100	KEYPLAN
M01944-02_SWMP_01	LAYOUT SHEET 1
M01944-02_SWMP_02	LAYOUT SHEET 2
M01944-02_SWMP_03	LAYOUT SHEET 3
M01944-02_SWMP_04	LAYOUT SHEET 4
M01944-02_SWMP_05	LAYOUT SHEET 5
M01944-02_SWMP_06	LAYOUT SHEET 6
M01944-02_SWMP_07	LAYOUT SHEET 7
M01944-02_SWMP_08	LAYOUT SHEET 8
M01944-02_SWMP_09	LAYOUT SHEET 9
M01944-02_SWMP_10	LAYOUT SHEET 10
M01944-02_SWMP_11	LAYOUT SHEET 11
M01944-02_SWMP_12	LAYOUT SHEET 12
M01944-02_SWMP_13	LAYOUT SHEET 13
M01944-02_SWMP_14	LAYOUT SHEET 14
M01944-02_SWMP_15	LAYOUT SHEET 15
M01944-02_SWMP_16	LAYOUT SHEET 16
M01944-02_SWMP_17	LAYOUT SHEET 17
M01944-02_SWMP_18	LAYOUT SHEET 18
M01944-02_SWMP_19	LAYOUT SHEET 19
M01944-02_SWMP_20	LAYOUT SHEET 20
M01944-02_SWMP_21	LAYOUT SHEET 21
M01944-02_SWMP_22	LAYOUT SHEET 22
M01944-02_SWMP_23	LAYOUT SHEET 23
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M01944-02_SWMP_25	LAYOUT SHEET 25
M01944-02_SWMP_26	LAYOUT SHEET 26
M01944-02_SWMP_27	LAYOUT SHEET 27
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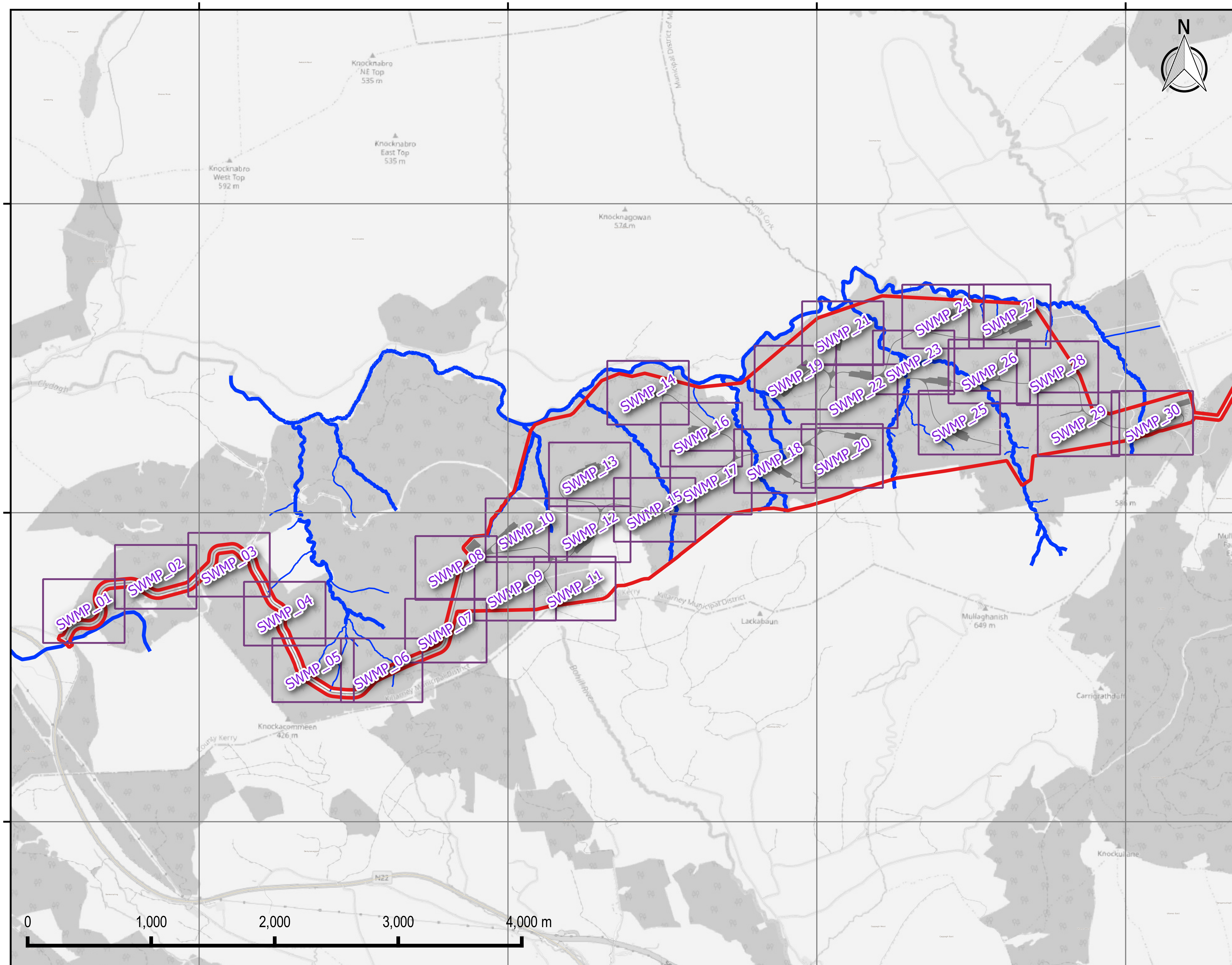
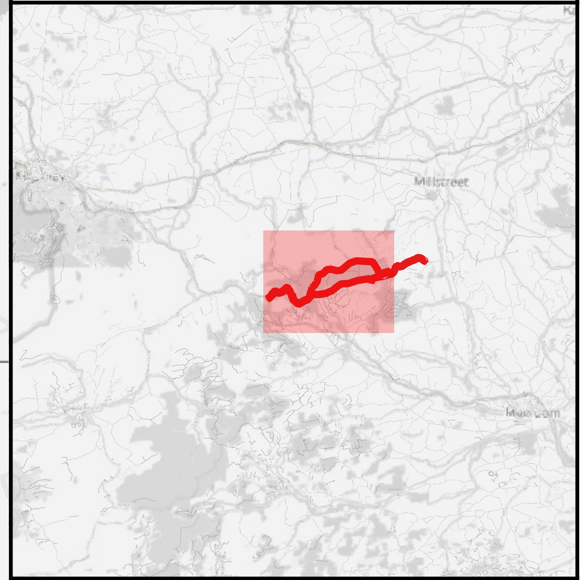
M01944-02_SWMP_29	LAYOUT SHEET 29
M01944-02_SWMP_30	LAYOUT SHEET 30



LOCATION CONTEXT



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DESCRIPTION			
CUMMEENABUDDOGE WIND FARM' - SWMP KEYPLAN			
PROJECT / FIGURE NO.			
M01944-02_SWMP_100			
DRAWN BY	SCALE	REVISION	DATE
KS	1:30,000@A3	00	14/11/2023

FuturEnergy Ireland

NOTES

GENERAL

1.DRAWINGS ARE INTENDED TO INFORM THE PLANNING APPLICATION. DRAWINGS ARE NOT INTENDED FOR CONSTRUCTION AND SHOULD NOT BE USED AS SUCH. FOR AVOIDANCE OF DOUBT, SURFACE WATER MANAGEMENT DESIGN IS INTENDED TO BE FURTHER DEVELOPED POST-CONSENT OF THE PLANNING APPLICATION INCLUDING MICROSITING.

2.ALL LOCATIONS OF SUDS FEATURES IDENTIFIED ARE APPROXIMATE AND ARE LIMITED BY THE LEVEL OF INFORMATION AVAILABLE. DETAILED SITING OF SUDS FEATURES SHALL BE UNDERTAKEN ON AN OBSERVATIONAL BASIS DEPENDANT ON LOCAL TOPOGRAPHY AND CHANGES IN ROAD ALIGNMENT DESIGN.

3.ADDITIONAL TEMPORARY DRAINAGE / MITIGATION WILL BE PROVIDED DURING THE CONSTRUCTION PHASE ON AN OBSERVATIONAL BASIS.

4.BACKGROUND MAPPING REPRODUCED © OPENSTREETMAP CONTRIBUTORS

5.ALL DRAINAGE MANAGEMENT FEATURES SHOWN SHOULD BE READ IN CONJUNCTION WITH RELEVANT DETAIL DRAWINGS.

POLLUTION PREVENTION

6.ALL WORK (INCLUDING FORESTRY FELLING) IN HYDROLOGICAL BUFFERS (POLLUTION PREVENTION ZONES) SHALL BE TREATED AS HIGH RISK AND SHALL BE SUBJECT TO PLANNING IN CONJUNCTION WITH THE ENVIRONMENTAL CONSULTANT. ALL WORKS TO BE PLANNED TO SUIT WEATHER FORECASTS AND ONGOING WATER QUALITY MONITORING PER THE SWMP AND WQMP.

7.ALL SETTLEMENT FEATURES ARE SUBJECT TO MICROSITING DESIGN.

8.DRAINAGE MANAGEMENT FEATURES INCLUDING ATTENUATION AND SETTLEMENT FEATURES AND DRAINAGE CROSSINGS TO BE INSTALLED PRIOR TO OR IN PARALLEL WITH TRACK CONSTRUCTION.

9.INTERIM MEASURES TO BE EMPLOYED IN ALL INSTANCES WHERE WORK CARRIED OUT TO CONSTRUCT THE ACCESS ROAD IS LIKELY TO CAUSE ADVERSE ENVIRONMENTAL IMPACTS THROUGH INCREASED SILT LOADINGS BEING GENERATED DURING THE CONSTRUCTION PHASE.

10.SUITABLE TEMPORARY PREVENTION MEASURES SHOULD BE IN PLACE AT ALL TIMES TO PREVENT THE CONVEYANCE OF SILTS TO RECEIVING WATERCOURSES.

11.OIL FUEL SHOULD BE STORED WITHIN CONTAINMENT AREA IN THE SITE COMPOUND. CEMENT SHOULD BE MIXED WITHIN COMPOUND. TOOLS SHOULD BE WASHED IN THE SAME AREA AND WATER RECYCLED (IN THE CEMENT MIX).

TRACK / INFRASTRUCTURE DRAINAGE

12.TEMPORARY UPSLOPE CUTOFF / DIVERSION DRAINAGE TO BE INSTALLED IN ADVANCE OF MAIN EARTHWORKS IN AREAS INDICATED IN ORDER TO MINIMISE SURFACE WATER INGRESS TO EXCAVATIONS

13.SETTLEMENT/ATTENUATION PONDS ARE RETAINED FOLLOWING COMPLETION OF CONSTRUCTION ACTIVITIES. BASINS TO BE MAINTAINED (CLEARING OF SILT AND DEBRIS) AND REINSTATED TO A FINAL PROFILE TO SUIT OPERATIONAL STAGE REUQIREMENTS.

14.BATTERS OF SWALES TO HAVE DIMENSIONS AS PER SEPARATELY ISSUED DETAIL DRAWING. SWALE TO BE RE-VEGETATED WITH LOCAL SPECIES.

15.SLOPES OF SWALES TO BE VEGETATED OR PROTECTED FROM EROSION UNTIL VEGETATION HAS BEEN ESTABLISHED. STRIPPED VEGETATIVE LAYER FROM EXCAVATIONS TO BE STORED LOCALLY AND USED TO LINE SLOPES AND BASE OF SWALE. VEGETATIVE LAYER TO BE PLACED INTO SWALE AFTER CONSTRUCTION OF THE SWALE.

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17.SPACING AND FREQUENCY OF CHECK DAMS WILL BE DEPENDANT UPON LONGITUDINAL GRADIENT OF SWALE.

WATERCOURSE & TRACK DRAINAGE CROSSINGS

18.ALL WATERCOURSE CROSSINGS TO BE CLEAR SPAN. CONSTRUCTION PLANING AND SEQUENCING TO BE PER THE REQUIREMENTS STATED IN THE SWMP WITH REGARDS TO AVOIDING WORK IN WATERCOURSES, INCLUDING TEMPORARY WORK FOR ACCESS.

19.THE MINIMUM PIPE DIAMETER FOR ANY TRACK DRAINAGE CROSSING SHALL BE 450MM. ALL HDPE PIPES SHALL BE TWINWALL TYPE, BBA HAPAS APPROVED.

MAINTENANCE

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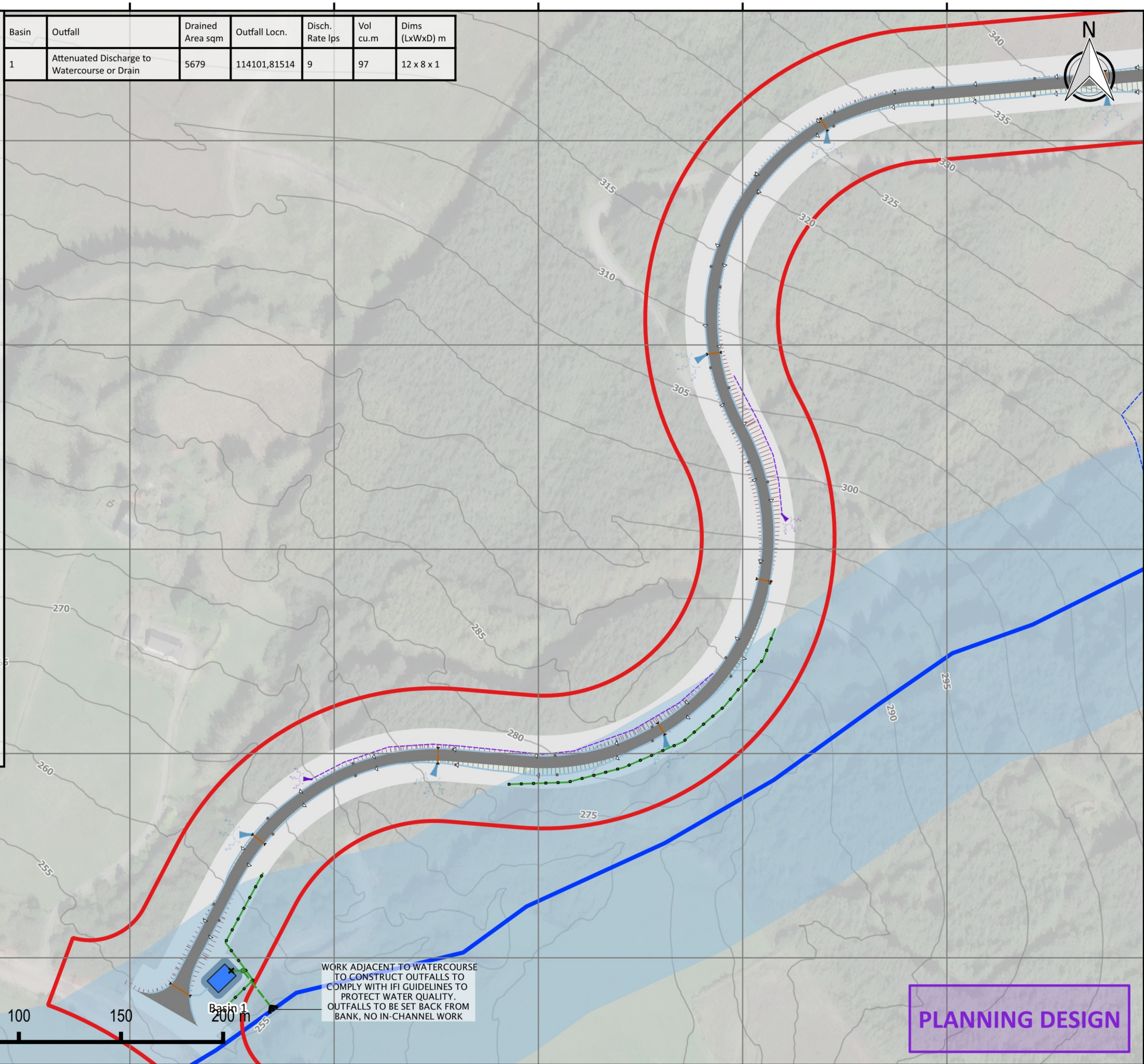
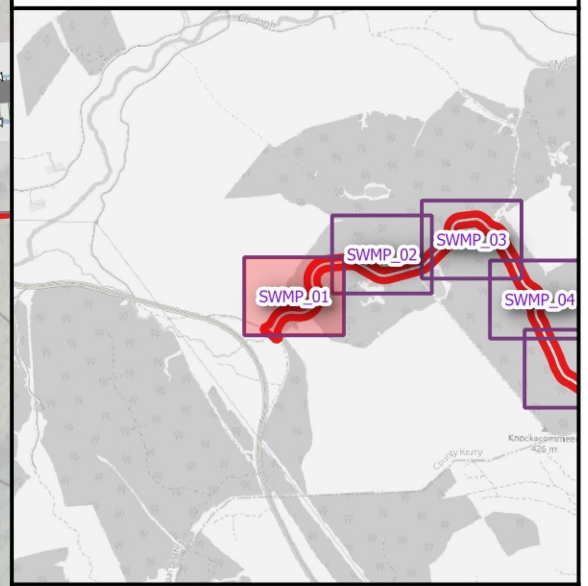
21.BUILD UP OF SILT LEVELS AT CHECK DAMS TO BE REMOVED AND DISPOSED OF APPROPRIATELY. SILT LEVELS AT CHECK DAMS TO BE VISUALLY INSPECTED AS PART OF AN ONGOING MAINTENANCE PROGRAMME DURING THE CONSTRUCTION PHASE. WHERE CHECK DAMS BECOME CLOGGED WITH SILT OR VEGETATION, STONE CHECK DAM TO BE REMOVED AND REPLACED SUBSEQUENT TO THE REMOVAL OF SILT

Basin	Outfall	Drained Area sqm	Outfall Locn.	Disch. Rate lps	Vol cu.m	Dims (LxWxD) m
1	Attenuated Discharge to Watercourse or Drain	5679	114101,81514	9	97	12 x 8 x 1



KEY PLAN



LEGEND

The Development
- Planning Application Boundary
- Wind Farm Infrastructure
- Indicates Cut
- Indicates Fill
- Spoil Repository
- Borrowpit

Existing Hydrology
- Major Watercourse
- Minor Watercourse
- Other minor / ephemeral (implied from LiDAR)
- Hydrological buffers (10m/60m)

Track Drainage Features
- Trackside Drain & Checkdam
- Clean Cutoff Drain
- Clean Drainage Pipe
- Dirty Track Drainage Pipe
- Watercourse Crossings
- Flow Control & Outfall to Watercourse
- Flow Control & Discharge by level spreader
- Track Drainage Breakout
- Attenuation + Settlement Basin
- Borrowpit Grips
- Borrowpit Settlement Lagoon
- Dewatering / Settlement Basin
- Indicative pumped dewatering
- Temporary Silt Fence
- Temporary Berm

POLLUTION PREVENTION GUIDANCE NOTES:

1.Suitable SUDS prevention measures should be in place at all times to prevent the conveyance of sediment to receiving watercourses.

2.Temporary or permanent SuDS features should be installed BEFORE or adjacent to construction of new access road and hardstanding.

3.Clean water cutoff ditch and crossing should be planned and installed BEFORE construction. Clean water management must consider spoil deposition on the site.

4.Direct discharge of untreated road drainage to watercourses shall not be permitted.

5.Buffer zones are to be maintained around all relevant watercourses as indicated on this drawing. No excavated material is to be stored within the buffer zone. All work in buffers to be treated as high risk requiriing pollution prevention and subject to Environmental Consultant supervision.

6.DO NOT pump water direct to watercourses.

7.DO NOT strip vegetation from existing ditches unless absolutely necessary.

8.If water pollution is identified the following steps should be adhered to:

STOP - Work in the immediate area should be stopped and the source of the pollution identified

CONTAIN - The source of the pollution should be bunded using a suitable method. Natural watercourses should be temporarily diverted around the source of pollution.

NOTIFY - The local authority and Client/Developer should be notified immediately to ensure that measures can be implemented downstream to protect fisheries and other sensitive areas.

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DESCRIPTION

CUMMEENABUDDOGE WIND FARM - DRAINAGE LAYOUT SHEET 1

PROJECT / FIGURE NO.

M01944-02_SWMP_01

DRAWN BY	SCALE	REVISION	DATE
DKS	1:2000	2	21/06/2024

FuturEnergy Ireland

NOTES

GENERAL

1.DRAWINGS ARE INTENDED TO INFORM THE PLANNING APPLICATION. DRAWINGS ARE NOT INTENDED FOR CONSTRUCTION AND SHOULD NOT BE USED AS SUCH. FOR AVOIDANCE OF DOUBT, SURFACE WATER MANAGEMENT DESIGN IS INTENDED TO BE FURTHER DEVELOPED POST-CONSENT OF THE PLANNING APPLICATION INCLUDING MICROSITING.

2.ALL LOCATIONS OF SUDS FEATURES IDENTIFIED ARE APPROXIMATE AND ARE LIMITED BY THE LEVEL OF INFORMATION AVAILABLE. DETAILED SITING OF SUDS FEATURES SHALL BE UNDERTAKEN ON AN OBSERVATIONAL BASIS DEPENDANT ON LOCAL TOPOGRAPHY AND CHANGES IN ROAD ALIGNMENT DESIGN.

3.ADDITIONAL TEMPORARY DRAINAGE / MITIGATION WILL BE PROVIDED DURING THE CONSTRUCTION PHASE ON AN OBSERVATIONAL BASIS.

4.BACKGROUND MAPPING REPRODUCED © OPENSTREETMAP CONTRIBUTORS

5.ALL DRAINAGE MANAGEMENT FEATURES SHOWN SHOULD BE READ IN CONJUNCTION WITH RELEVANT DETAIL DRAWINGS.

POLLUTION PREVENTION

6.ALL WORK (INCLUDING FORESTRY FELLING) IN HYDROLOGICAL BUFFERS (POLLUTION PREVENTION ZONES) SHALL BE TREATED AS HIGH RISK AND SHALL BE SUBJECT TO PLANNING IN CONJUNCTION WITH THE ENVIRONMENTAL CONSULTANT. ALL WORKS TO BE PLANNED TO SUIT WEATHER FORECASTS AND ONGOING WATER QUALITY MONITORING PER THE SWMP AND WQMP.

7.ALL SETTLEMENT FEATURES ARE SUBJECT TO MICROSITING DESIGN.

8.DRAINAGE MANAGEMENT FEATURES INCLUDING ATTENUATION AND SETTLEMENT FEATURES AND DRAINAGE CROSSINGS TO BE INSTALLED PRIOR TO OR IN PARALLEL WITH TRACK CONSTRUCTION.

9.INTERIM MEASURES TO BE EMPLOYED IN ALL INSTANCES WHERE WORK CARRIED OUT TO CONSTRUCT THE ACCESS ROAD IS LIKELY TO CAUSE ADVERSE ENVIRONMENTAL IMPACTS THROUGH INCREASED SILT LOADINGS BEING GENERATED DURING THE CONSTRUCTION PHASE.

10.SUITABLE TEMPORARY PREVENTION MEASURES SHOULD BE IN PLACE AT ALL TIMES TO PREVENT THE CONVEYANCE OF SILTS TO RECEIVING WATERCOURSES.

11.OIL FUEL SHOULD BE STORED WITHIN CONTAINMENT AREA IN THE SITE COMPOUND. CEMENT SHOULD BE MIXED WITHIN COMPOUND. TOOLS SHOULD BE WASHED IN THE SAME AREA AND WATER RECYCLED (IN THE CEMENT MIX).

TRACK / INFRASTRUCTURE DRAINAGE

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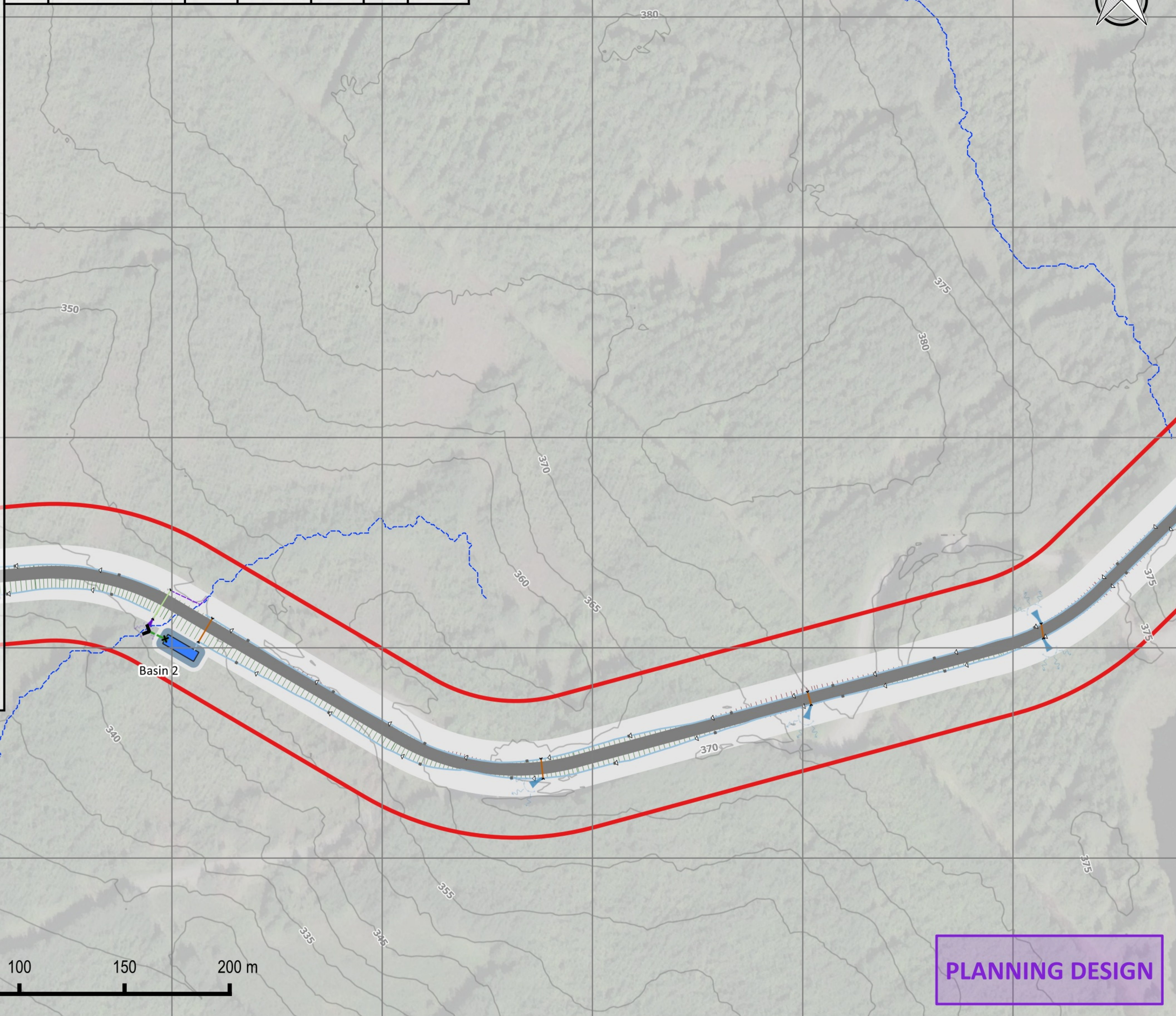
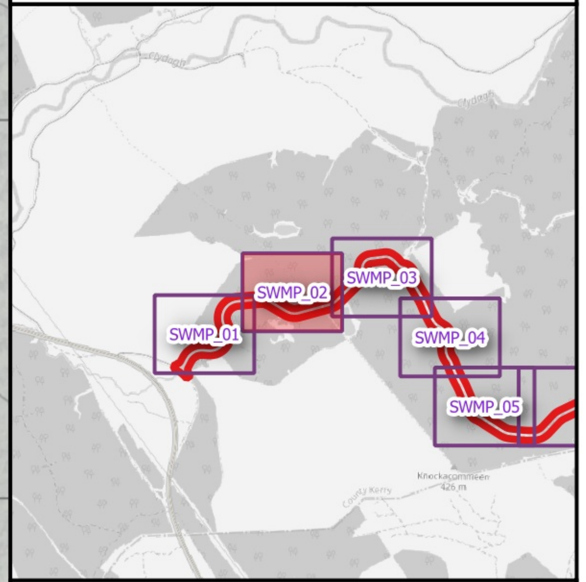
Basin	Outfall	Drained Area sqm	Outfall Locn.	Disch. Rate lps	Vol cu.m	Dims (LxWxD) m
2	Attenuated Discharge to Watercourse or Drain	4991	114619,81948	7.9	85	17 x 5 x 1



KEY PLAN



LEGEND

The Development
- Planning Application Boundary
- Wind Farm Infrastructure
- Indicates Cut
- Indicates Fill
- Spoil Repository
- Borrowpit

Existing Hydrology
- Major Watercourse
- Minor Watercourse
- Other minor / ephemeral (implied from LiDAR)
- Hydrological buffers (10m/60m)

Track Drainage Features
- Trackside Drain & Checkdam
- Clean Cutoff Drain
- Clean Drainage Pipe
- Dirty Track Drainage Pipe
- Watercourse Crossings
- Flow Control & Outfall to Watercourse
- Flow Control & Discharge by level spreader
- Track Drainage Breakout
- Attenuation + Settlement Basin
- Borrowpit Grips
- Borrowpit Settlement Lagoon
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POLLUTION PREVENTION GUIDANCE NOTES:

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5.Buffer zones are to be maintained around all relevant watercourses as indicated on this drawing. No excavated material is to be stored within the buffer zone. All work in buffers to be treated as high risk requiriing pollution prevention and subject to Environmental Consultant supervision.

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DESCRIPTION
CUMMEENABUDDOGE WIND FARM - DRAINAGE LAYOUT SHEET 2

PROJECT / FIGURE NO.
M01944-02_SWMP_02

DRAWN BY	SCALE	REVISION	DATE
DKS	1:2000	2	21/06/2024

FuturEnergy Ireland

NOTES
GENERAL
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Basin	Outfall	Drained Area sqm	Outfall Locn.	Disch. Rate lps	Vol cu.m	Dims (LxWxD) m
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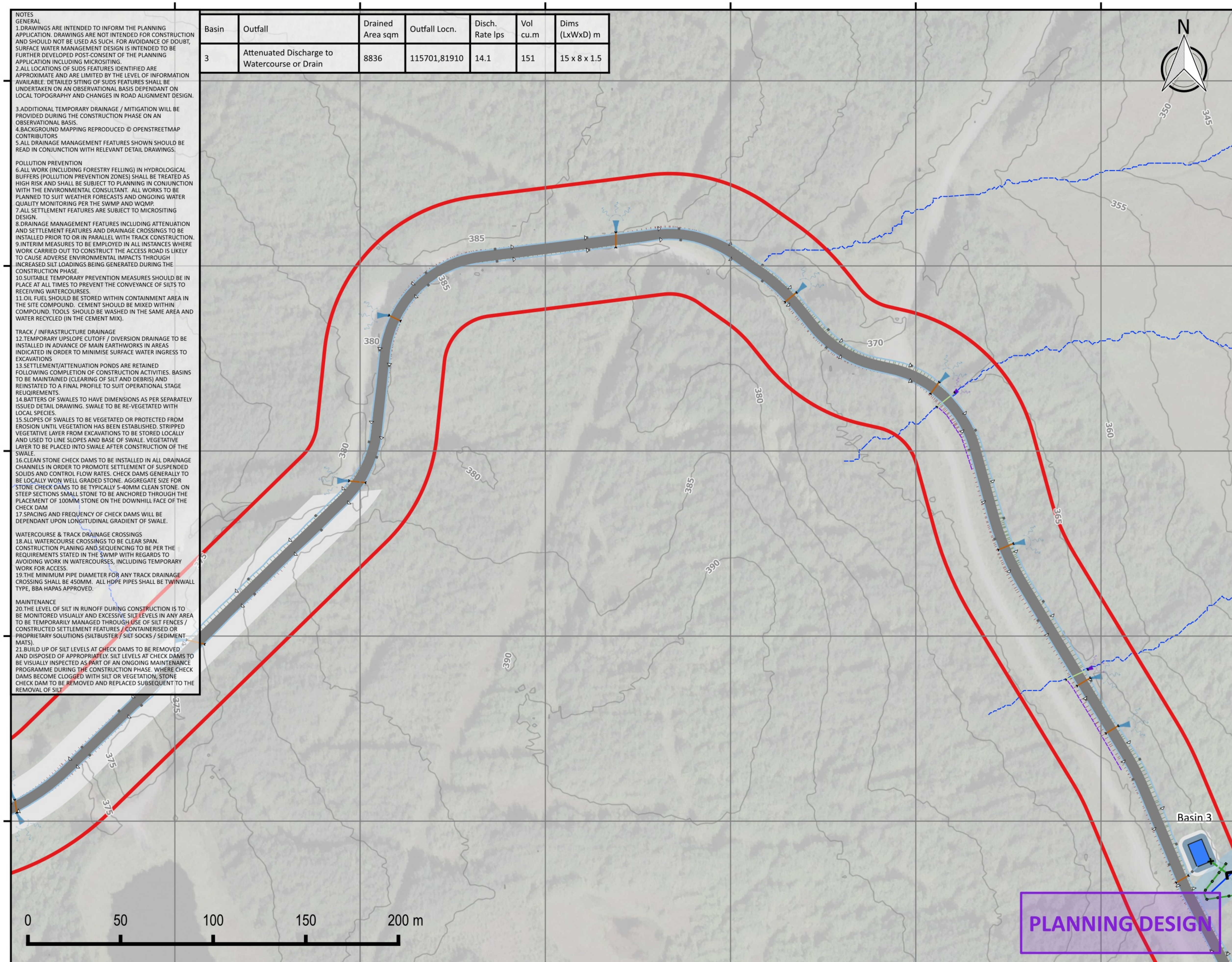
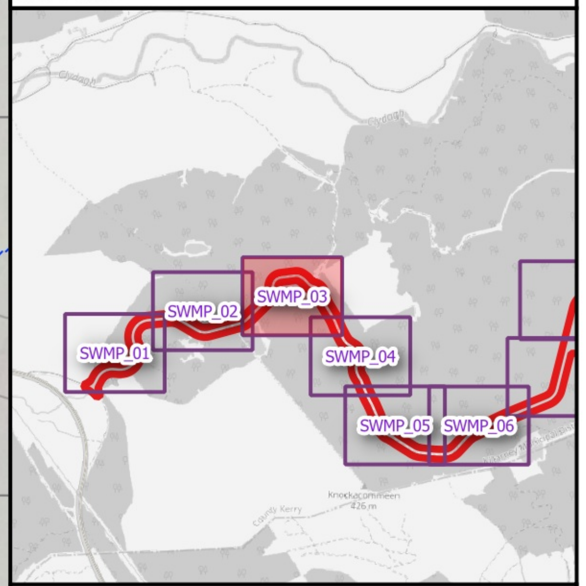


KEY PLAN



LEGEND

The Development
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- Indicates Cut
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DESCRIPTION
CUMMEENABUDDOGE WIND FARM - DRAINAGE LAYOUT SHEET 3

PROJECT / FIGURE NO.
M01944-02_SWMP_03

DRAWN BY	SCALE	REVISION	DATE
DKS	1:2000	2	21/06/2024

FuturEnergy Ireland

NOTES

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18.ALL WATERCOURSE CROSSINGS TO BE CLEAR SPAN. CONSTRUCTION PLANING AND SEQUENCING TO BE PER THE REQUIREMENTS STATED IN THE SWMP WITH REGARDS TO AVOIDING WORK IN WATERCOURSES, INCLUDING TEMPORARY WORK FOR ACCESS.

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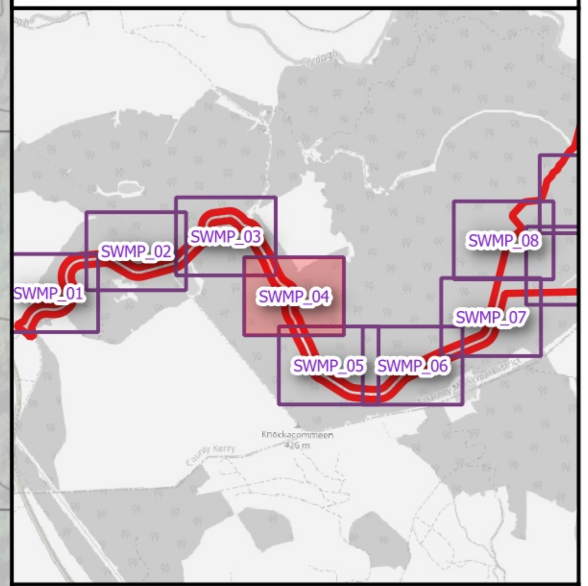
20.THE LEVEL OF SILT IN RUNOFF DURING CONSTRUCTION IS TO BE MONITORED VISUALLY AND EXCESSIVE SILT LEVELS IN ANY AREA TO BE TEMPORARILY MANAGED THROUGH USE OF SILT FENCES / CONSTRUCTED SETTLEMENT FEATURES / CONTAINERISED OR PROPRIETARY SOLUTIONS (SILTBUSTER / SILT SOCKS / SEDIMENT MATS).

21.BUILD UP OF SILT LEVELS AT CHECK DAMS TO BE REMOVED AND DISPOSED OF APPROPRIATELY. SILT LEVELS AT CHECK DAMS TO BE VISUALLY INSPECTED AS PART OF AN ONGOING MAINTENANCE PROGRAMME DURING THE CONSTRUCTION PHASE. WHERE CHECK DAMS BECOME CLOGGED WITH SILT OR VEGETATION, STONE CHECK DAM TO BE REMOVED AND REPLACED SUBSEQUENT TO THE REMOVAL OF SILT

Basin	Outfall	Drained Area sqm	Outfall Locn.	Disch. Rate lps	Vol cu.m	Dims (LxWxD) m
3	Attenuated Discharge to Watercourse or Drain	8836	115701,81910	14.1	151	15 x 8 x 1.5

KEY PLAN



LEGEND

The Development
- Planning Application Boundary
- Wind Farm Infrastructure
- Indicates Cut
- Indicates Fill
- Spoil Repository
- Borrowpit

Existing Hydrology
- Major Watercourse
- Minor Watercourse
- Other minor / ephemeral (implied from LiDAR)
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Track Drainage Features
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- Clean Drainage Pipe
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POLLUTION PREVENTION GUIDANCE NOTES:

1.Suitable SUDS prevention measures should be in place at all times to prevent the conveyance of sediment to receiving watercourses.

2.Temporary or permanent SuDS features should be installed BEFORE or adjacent to construction of new access road and hardstanding.

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4.Direct discharge of untreated road drainage to watercourses shall not be permitted.

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STOP - Work in the immediate area should be stopped and the source of the pollution identified

CONTAIN - The source of the pollution should be bunded using a suitable method. Natural watercourses should be temporarily diverted around the source of pollution.

NOTIFY - The local authority and Client/Developer should be notified immediately to ensure that measures can be implemented downstream to protect fisheries and other sensitive areas.

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DESCRIPTION			
CUMMEENABUDDOGE WIND FARM - DRAINAGE LAYOUT SHEET 4			
PROJECT / FIGURE NO.			
M01944-02_SWMP_04			
DRAWN BY	SCALE	REVISION	DATE
DKS	1:2000	2	21/06/2024

FuturEnergy Ireland

NOTES

GENERAL

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3.ADDITIONAL TEMPORARY DRAINAGE / MITIGATION WILL BE PROVIDED DURING THE CONSTRUCTION PHASE ON AN OBSERVATIONAL BASIS.

4.BACKGROUND MAPPING REPRODUCED © OPENSTREETMAP CONTRIBUTORS

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6.ALL WORK (INCLUDING FORESTRY FELLING) IN HYDROLOGICAL BUFFERS (POLLUTION PREVENTION ZONES) SHALL BE TREATED AS HIGH RISK AND SHALL BE SUBJECT TO PLANNING IN CONJUNCTION WITH THE ENVIRONMENTAL CONSULTANT. ALL WORKS TO BE PLANNED TO SUIT WEATHER FORECASTS AND ONGOING WATER QUALITY MONITORING PER THE SWMP AND WQMP.

7.ALL SETTLEMENT FEATURES ARE SUBJECT TO MICROSITING DESIGN.

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10.SUITABLE TEMPORARY PREVENTION MEASURES SHOULD BE IN PLACE AT ALL TIMES TO PREVENT THE CONVEYANCE OF SILTS TO RECEIVING WATERCOURSES.

11.OIL FUEL SHOULD BE STORED WITHIN CONTAINMENT AREA IN THE SITE COMPOUND. CEMENT SHOULD BE MIXED WITHIN COMPOUND. TOOLS SHOULD BE WASHED IN THE SAME AREA AND WATER RECYCLED (IN THE CEMENT MIX).

TRACK / INFRASTRUCTURE DRAINAGE

12.TEMPORARY UPSLOPE CUTOFF / DIVERSION DRAINAGE TO BE INSTALLED IN ADVANCE OF MAIN EARTHWORKS IN AREAS INDICATED IN ORDER TO MINIMISE SURFACE WATER INGRESS TO EXCAVATIONS

13.SETTLEMENT/ATTENUATION PONDS ARE RETAINED FOLLOWING COMPLETION OF CONSTRUCTION ACTIVITIES. BASINS TO BE MAINTAINED (CLEARING OF SILT AND DEBRIS) AND REINSTATED TO A FINAL PROFILE TO SUIT OPERATIONAL STAGE REUQIREMENTS.

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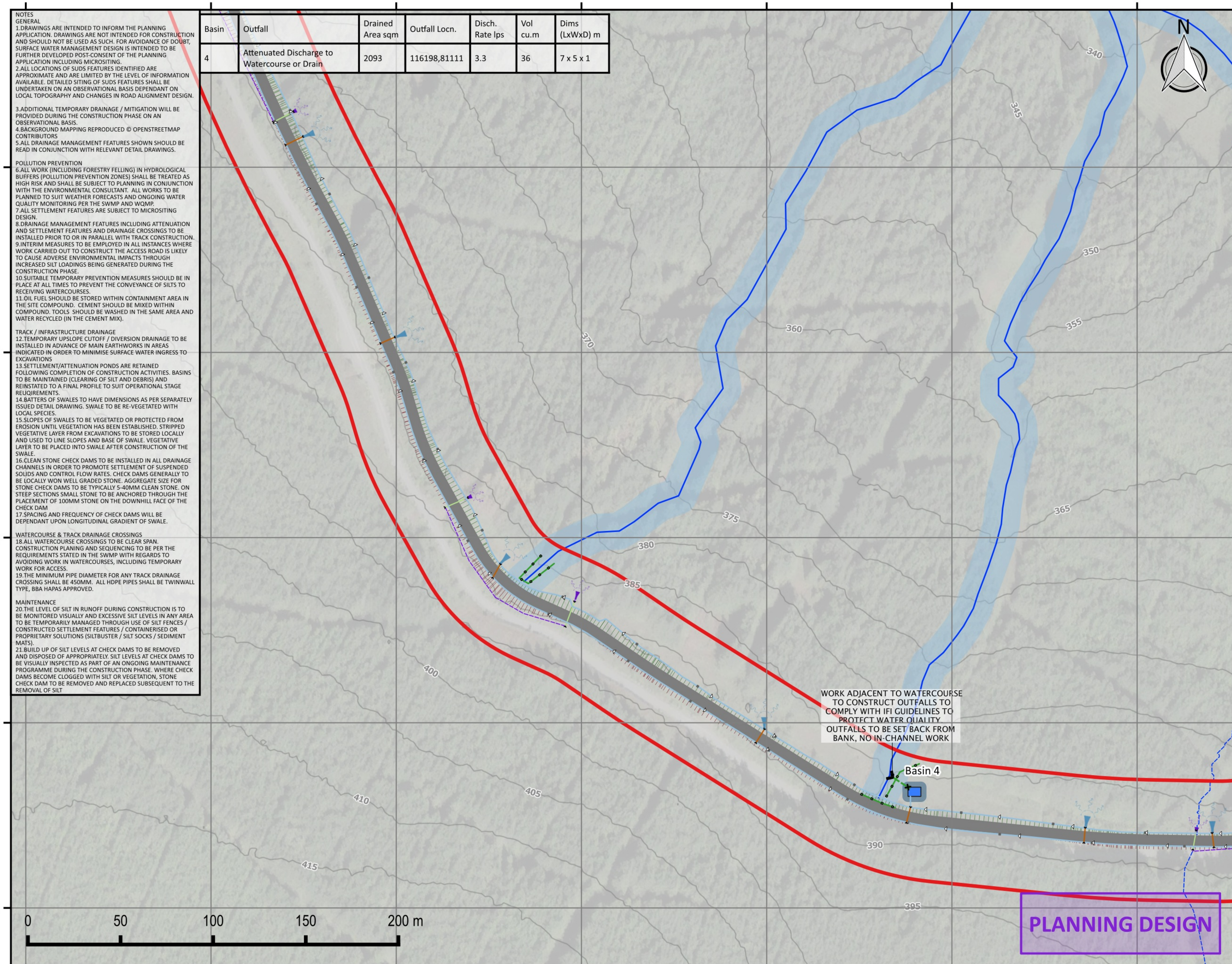
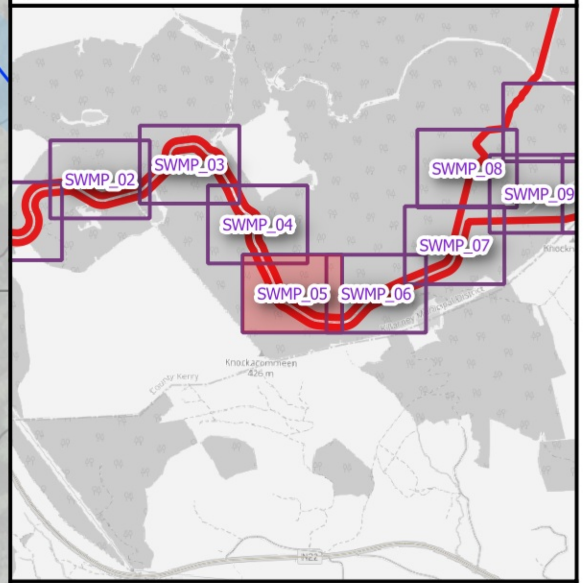
Basin	Outfall	Drained Area sqm	Outfall Locn.	Disch. Rate lps	Vol cu.m	Dims (LxWxD) m
4	Attenuated Discharge to Watercourse or Drain	2093	116198,81111	3.3	36	7 x 5 x 1



KEY PLAN



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DESCRIPTION			
CUMMEENABUDDOGE WIND FARM - DRAINAGE LAYOUT SHEET 5			
PROJECT / FIGURE NO.			
M01944-02_SWMP_05			
DRAWN BY	SCALE	REVISION	DATE
DKS	1:2000	2	21/06/2024

FuturEnergy Ireland

NOTES

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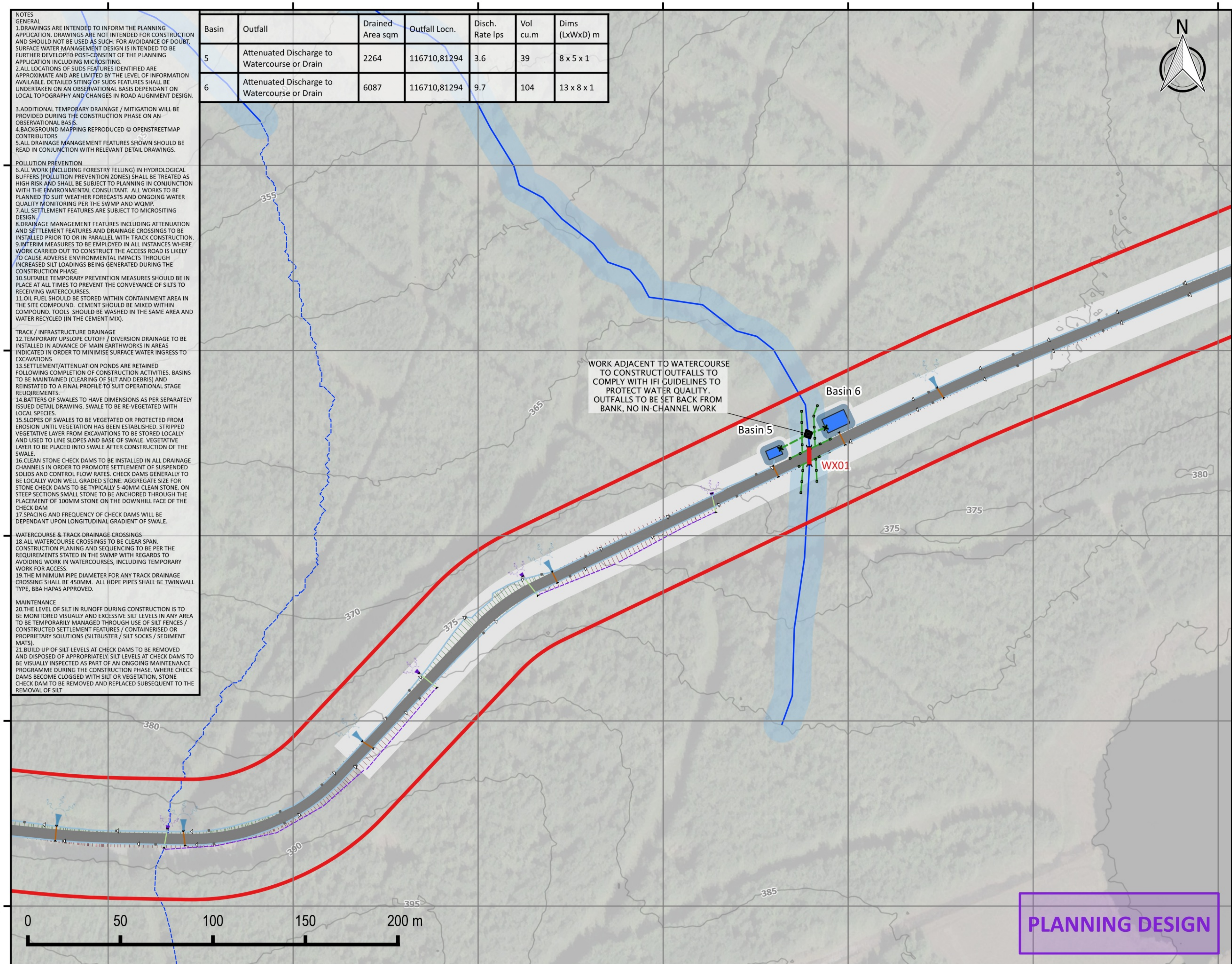
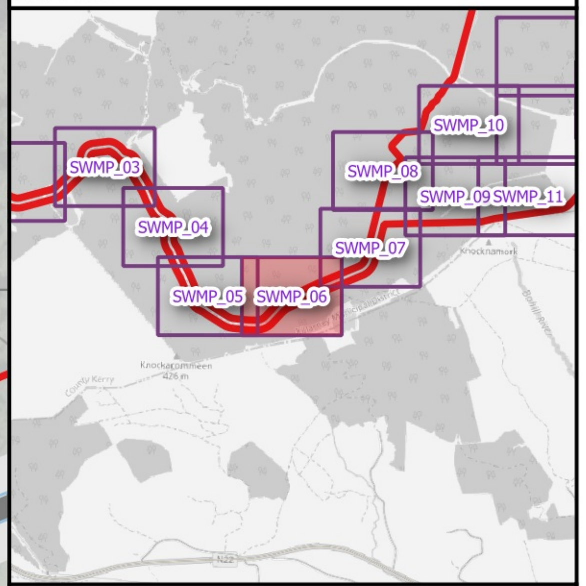
Basin	Outfall	Drained Area sqm	Outfall Locn.	Disch. Rate lps	Vol cu.m	Dims (LxWxD) m
5	Attenuated Discharge to Watercourse or Drain	2264	116710,81294	3.6	39	8 x 5 x 1
6	Attenuated Discharge to Watercourse or Drain	6087	116710,81294	9.7	104	13 x 8 x 1



KEY PLAN



LEGEND

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- Borrowpit Settlement Lagoon
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- Indicative pumped dewatering
- Temporary Silt Fence
- Temporary Berm

WX REF	DESCRIPTION
WX01	MIN. 2.5 M x 0.7 M (SPAN x HEIGHT) CLEAR SPAN BRIDGE OR BOTTOMLESS CULVERT

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DESCRIPTION			
CUMMEENABUDDOGE WIND FARM - DRAINAGE LAYOUT SHEET 6			
PROJECT / FIGURE NO.			
M01944-02_SWMP_06			
DRAWN BY	SCALE	REVISION	DATE
DKS	1:2000	2	21/06/2024

FuturEnergy Ireland

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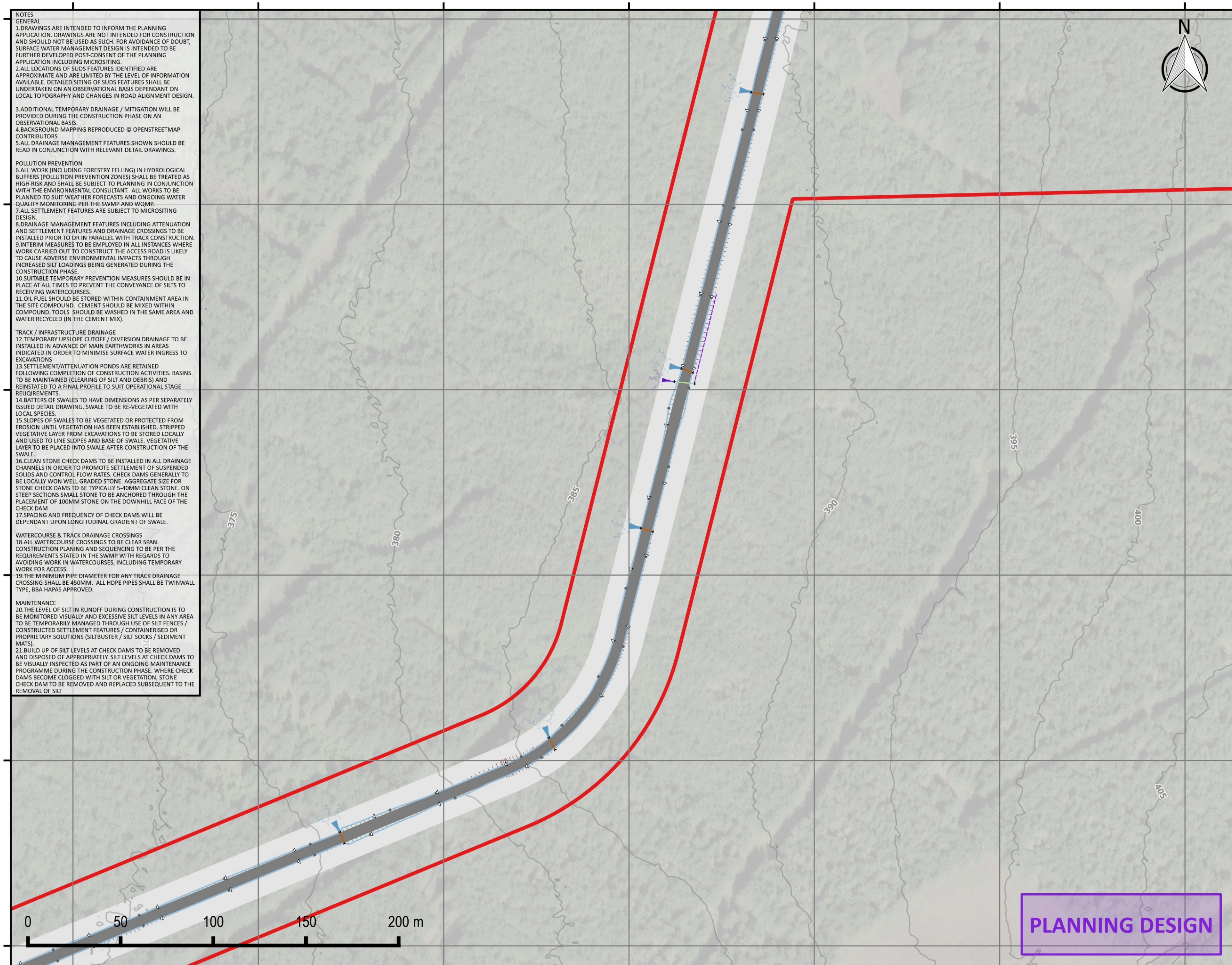

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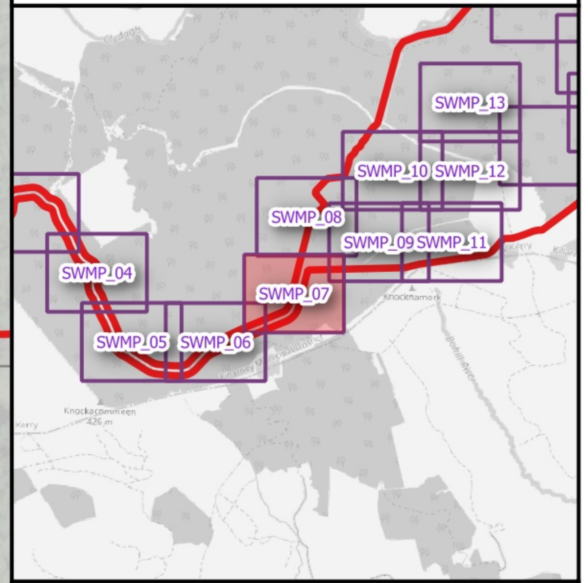

LEGEND

The Development
- Planning Application Boundary
- Wind Farm Infrastructure
- Indicates Cut
- Indicates Fill
- Spoil Repository
- Borrowpit

Existing Hydrology
- Major Watercourse
- Minor Watercourse
- Other minor / ephemeral (implied from LiDAR)
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POLLUTION PREVENTION GUIDANCE NOTES:

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DESCRIPTION			
CUMMEENABUDDOGE WIND FARM - DRAINAGE LAYOUT SHEET 7			
PROJECT / FIGURE NO.			
M01944-02_SWMP_07			
DRAWN BY	SCALE	REVISION	DATE
DKS	1:2000	2	21/06/2024

FuturEnergy Ireland

NOTES

GENERAL

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6.ALL WORK (INCLUDING FORESTRY FELLING) IN HYDROLOGICAL BUFFERS (POLLUTION PREVENTION ZONES) SHALL BE TREATED AS HIGH RISK AND SHALL BE SUBJECT TO PLANNING IN CONJUNCTION WITH THE ENVIRONMENTAL CONSULTANT. ALL WORKS TO BE PLANNED TO SUIT WEATHER FORECASTS AND ONGOING WATER QUALITY MONITORING PER THE SWMP AND WQMP.
7.ALL SETTLEMENT FEATURES ARE SUBJECT TO MICROSITING DESIGN.
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11.OIL FUEL SHOULD BE STORED WITHIN CONTAINMENT AREA IN THE SITE COMPOUND. CEMENT SHOULD BE MIXED WITHIN COMPOUND. TOOLS SHOULD BE WASHED IN THE SAME AREA AND WATER RECYCLED (IN THE CEMENT MIX).

TRACK / INFRASTRUCTURE DRAINAGE

12.TEMPORARY UPSLOPE CUTOFF / DIVERSION DRAINAGE TO BE INSTALLED IN ADVANCE OF MAIN EARTHWORKS IN AREAS INDICATED IN ORDER TO MINIMISE SURFACE WATER INGRESS TO EXCAVATIONS
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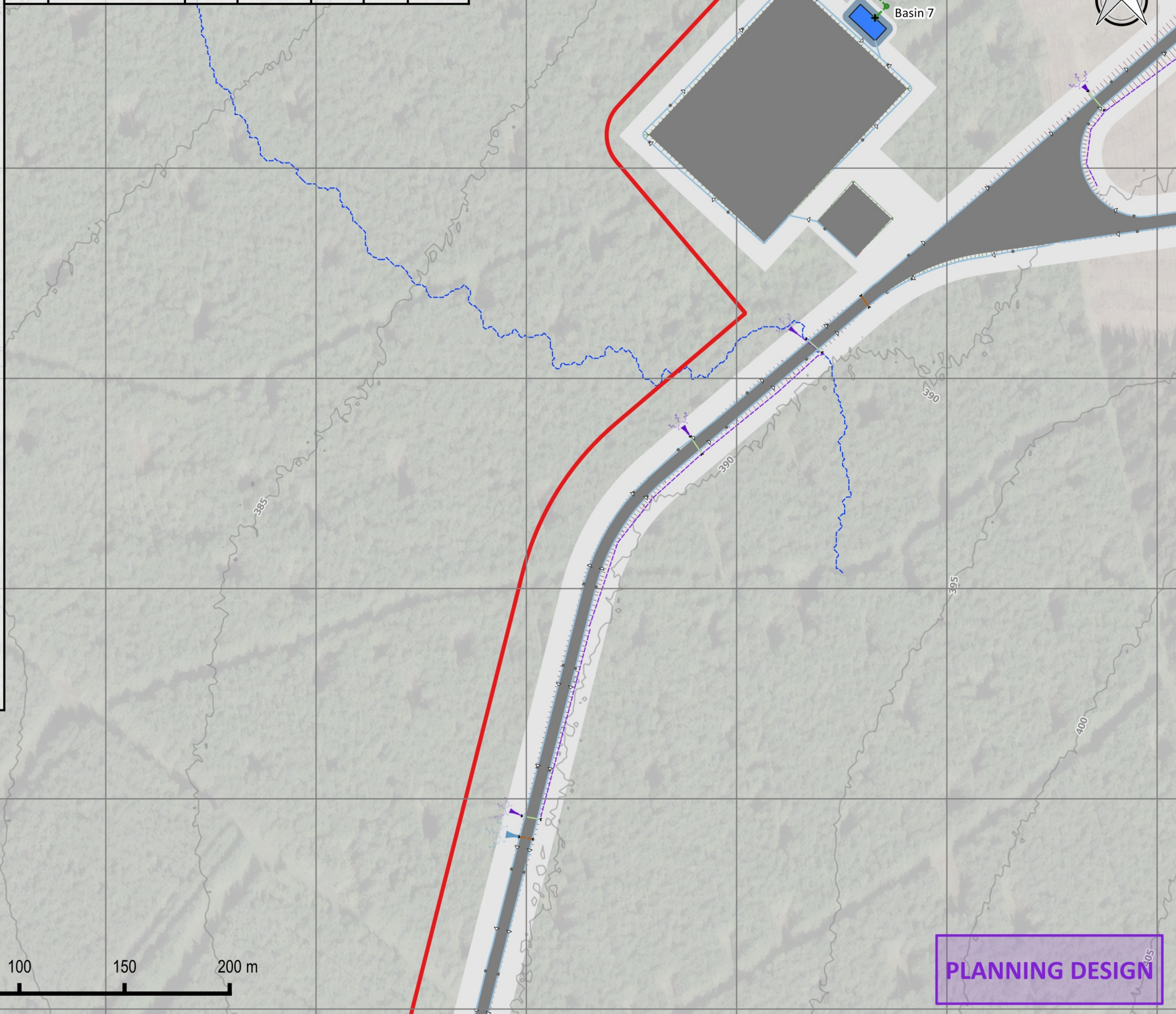
Basin	Outfall	Drained Area sqm	Outfall Locn.	Disch. Rate lps	Vol cu.m	Dims (LxWxD) m
7	Attenuated Discharge overland by Level Spreader	8125		12.9	139	17 x 8 x 1



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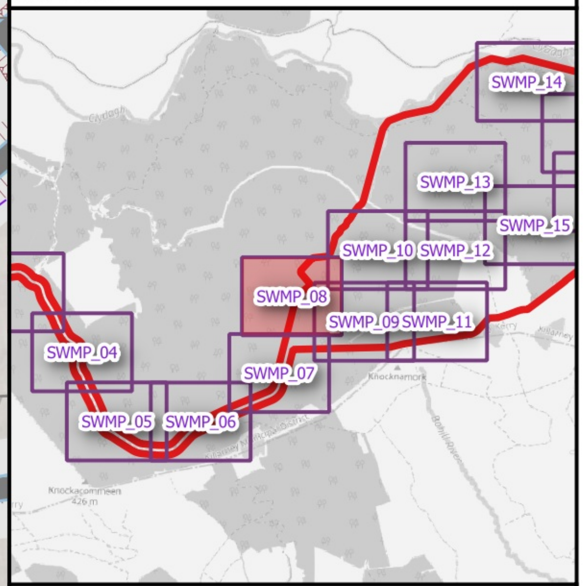

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DESCRIPTION			
CUMMEENABUDDOGE WIND FARM - DRAINAGE LAYOUT SHEET 8			
PROJECT / FIGURE NO.			
M01944-02_SWMP_08			
DRAWN BY	SCALE	REVISION	DATE
DKS	1:2000	2	21/06/2024

Ireland
FuturEnergy

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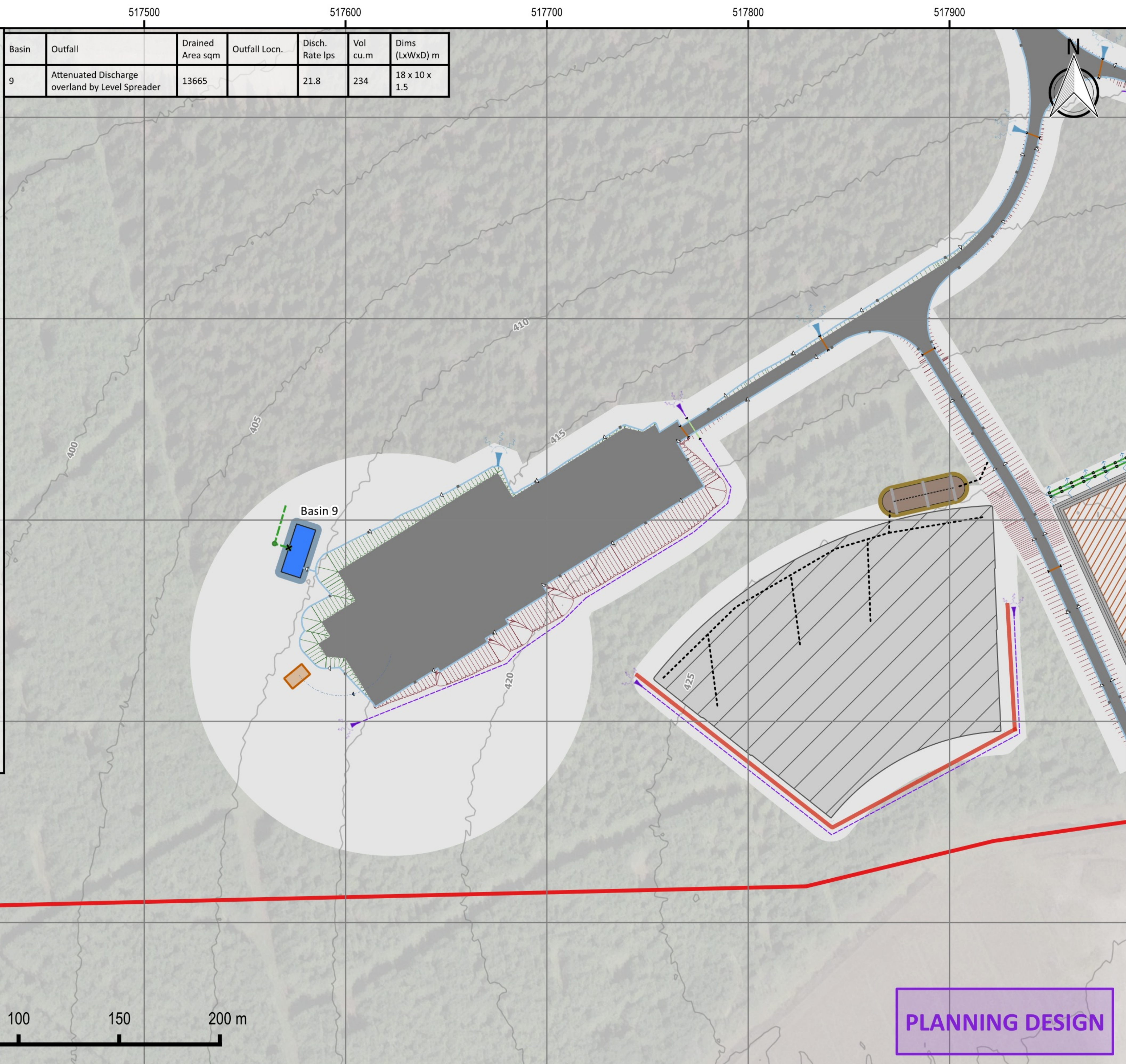
9	Attenuated Discharge overland by Level Spreader	13665		21.8	234	18 x 10 x 1.5



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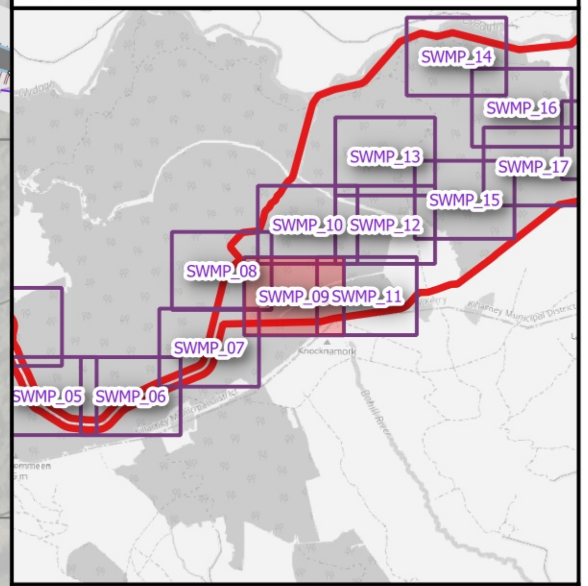

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- Indicates Cut
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DESCRIPTION			
CUMMEENABUDDOGE WIND FARM - DRAINAGE LAYOUT SHEET 9			
PROJECT / FIGURE NO.			
M01944-02_SWMP_09			
DRAWN BY	SCALE	REVISION	DATE
DKS	1:2000	2	21/06/2024

FuturEnergy Ireland

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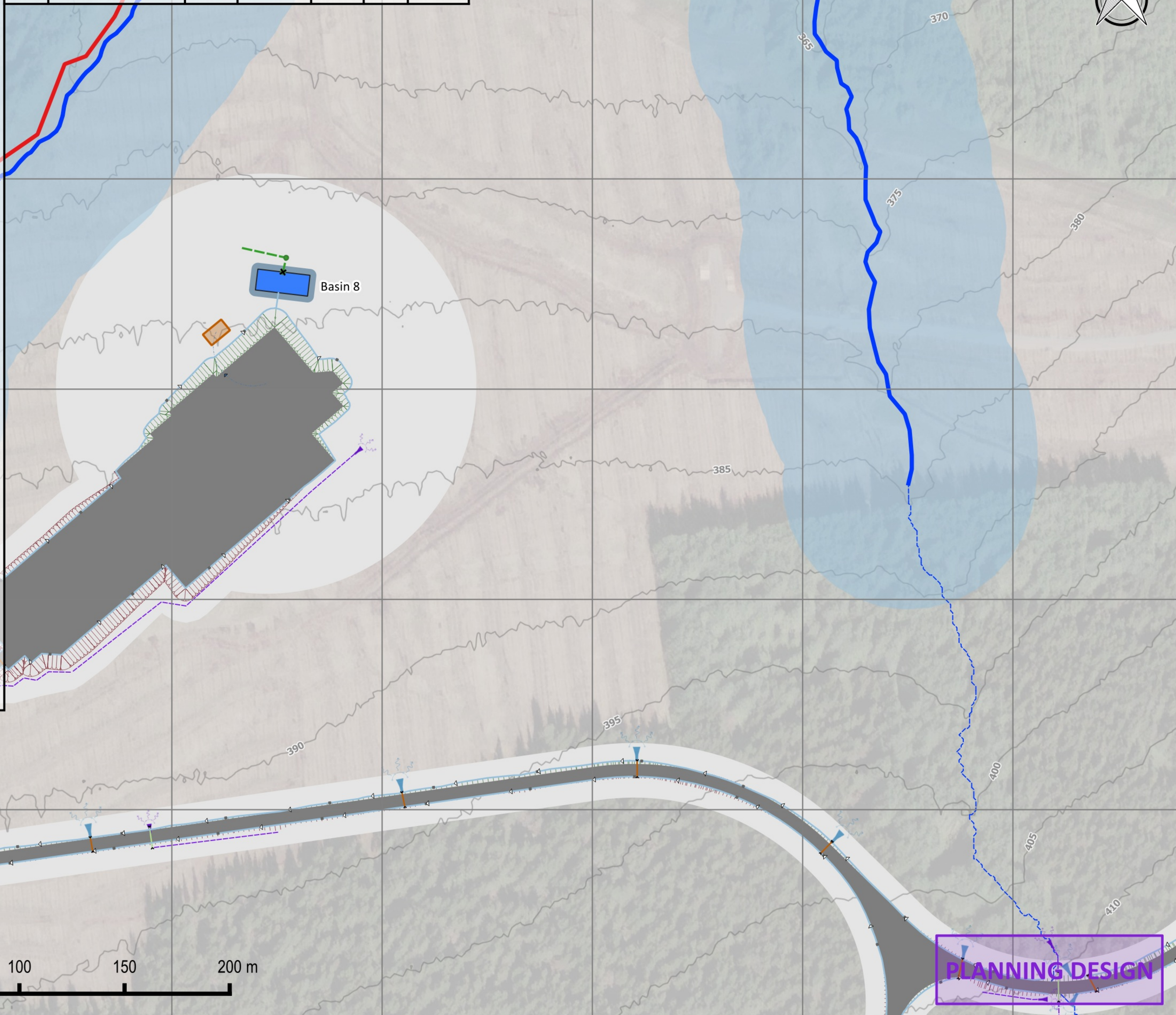

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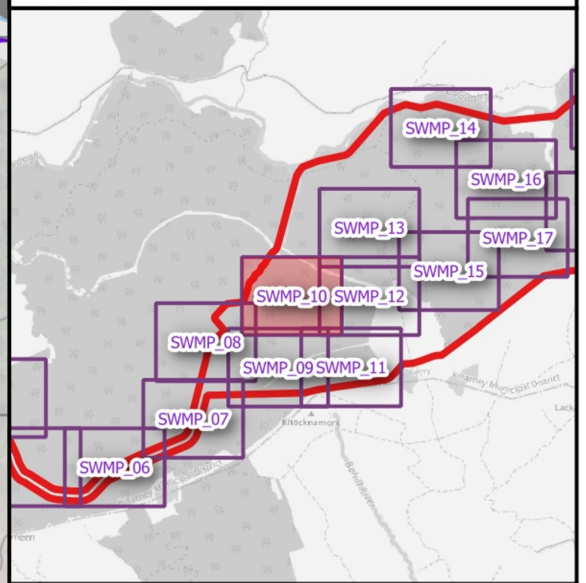

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DESCRIPTION			
CUMMEENABUDDOGE WIND FARM - DRAINAGE LAYOUT SHEET 10			
PROJECT / FIGURE NO.			
M01944-02_SWMP_10			
DRAWN BY	SCALE	REVISION	DATE
DKS	1:2000	2	21/06/2024

FuturEnergy Ireland

NOTES

GENERAL

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2.ALL LOCATIONS OF SUDS FEATURES IDENTIFIED ARE APPROXIMATE AND ARE LIMITED BY THE LEVEL OF INFORMATION AVAILABLE. DETAILED SITING OF SUDS FEATURES SHALL BE UNDERTAKEN ON AN OBSERVATIONAL BASIS DEPENDANT ON LOCAL TOPOGRAPHY AND CHANGES IN ROAD ALIGNMENT DESIGN.

3.ADDITIONAL TEMPORARY DRAINAGE / MITIGATION WILL BE PROVIDED DURING THE CONSTRUCTION PHASE ON AN OBSERVATIONAL BASIS.
4.BACKGROUND MAPPING REPRODUCED © OPENSTREETMAP CONTRIBUTORS
5.ALL DRAINAGE MANAGEMENT FEATURES SHOWN SHOULD BE READ IN CONJUNCTION WITH RELEVANT DETAIL DRAWINGS.

POLLUTION PREVENTION

6.ALL WORK (INCLUDING FORESTRY FELLING) IN HYDROLOGICAL BUFFERS (POLLUTION PREVENTION ZONES) SHALL BE TREATED AS HIGH RISK AND SHALL BE SUBJECT TO PLANNING IN CONJUNCTION WITH THE ENVIRONMENTAL CONSULTANT. ALL WORKS TO BE PLANNED TO SUIT WEATHER FORECASTS AND ONGOING WATER QUALITY MONITORING PER THE SWMP AND WQMP.
7.ALL SETTLEMENT FEATURES ARE SUBJECT TO MICROSITING DESIGN.
8.DRAINAGE MANAGEMENT FEATURES INCLUDING ATTENUATION AND SETTLEMENT FEATURES AND DRAINAGE CROSSINGS TO BE INSTALLED PRIOR TO OR IN PARALLEL WITH TRACK CONSTRUCTION.
9.INTERIM MEASURES TO BE EMPLOYED IN ALL INSTANCES WHERE WORK CARRIED OUT TO CONSTRUCT THE ACCESS ROAD IS LIKELY TO CAUSE ADVERSE ENVIRONMENTAL IMPACTS THROUGH INCREASED SILT LOADINGS BEING GENERATED DURING THE CONSTRUCTION PHASE.
10.SUITABLE TEMPORARY PREVENTION MEASURES SHOULD BE IN PLACE AT ALL TIMES TO PREVENT THE CONVEYANCE OF SILTS TO RECEIVING WATERCOURSES.
11.OIL FUEL SHOULD BE STORED WITHIN CONTAINMENT AREA IN THE SITE COMPOUND. CEMENT SHOULD BE MIXED WITHIN COMPOUND. TOOLS SHOULD BE WASHED IN THE SAME AREA AND WATER RECYCLED (IN THE CEMENT MIX).

TRACK / INFRASTRUCTURE DRAINAGE

12.TEMPORARY UPSLOPE CUTOFF / DIVERSION DRAINAGE TO BE INSTALLED IN ADVANCE OF MAIN EARTHWORKS IN AREAS INDICATED IN ORDER TO MINIMISE SURFACE WATER INGRESS TO EXCAVATIONS
13.SETTLEMENT/ATTENUATION PONDS ARE RETAINED FOLLOWING COMPLETION OF CONSTRUCTION ACTIVITIES. BASINS TO BE MAINTAINED (CLEARING OF SILT AND DEBRIS) AND REINSTATED TO A FINAL PROFILE TO SUIT OPERATIONAL STAGE REUQIREMENTS.
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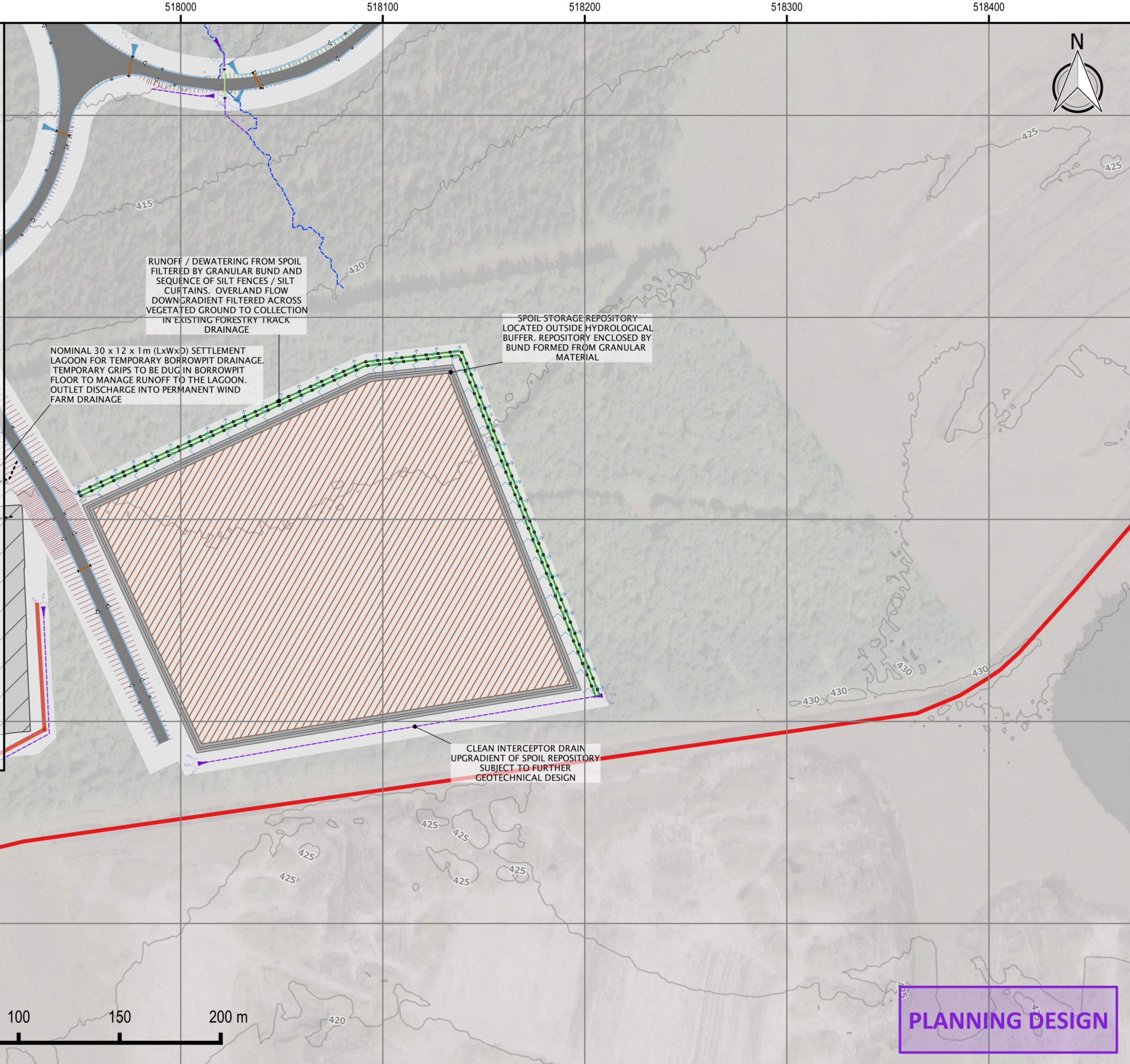
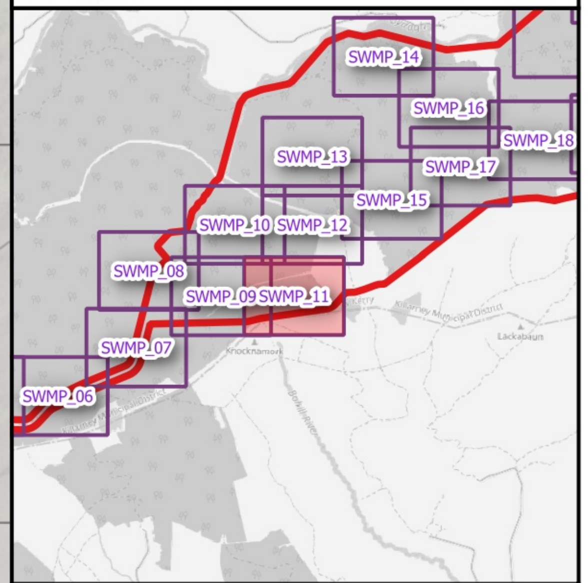


KEY PLAN



LEGEND

The Development
- Planning Application Boundary
- Wind Farm Infrastructure
- Indicates Cut
- Indicates Fill
- Spoil Repository
- Borrowpit

Existing Hydrology
- Major Watercourse
- Minor Watercourse
- Other minor / ephemeral (implied from LiDAR)
- Hydrological buffers (10m/60m)

Track Drainage Features
- Trackside Drain & Checkdam
- Clean Cutoff Drain
- Clean Drainage Pipe
- Dirty Track Drainage Pipe
- Watercourse Crossings
- Flow Control & Outfall to Watercourse
- Flow Control & Discharge by level spreader
- Track Drainage Breakout
- Attenuation + Settlement Basin
- Borrowpit Grips
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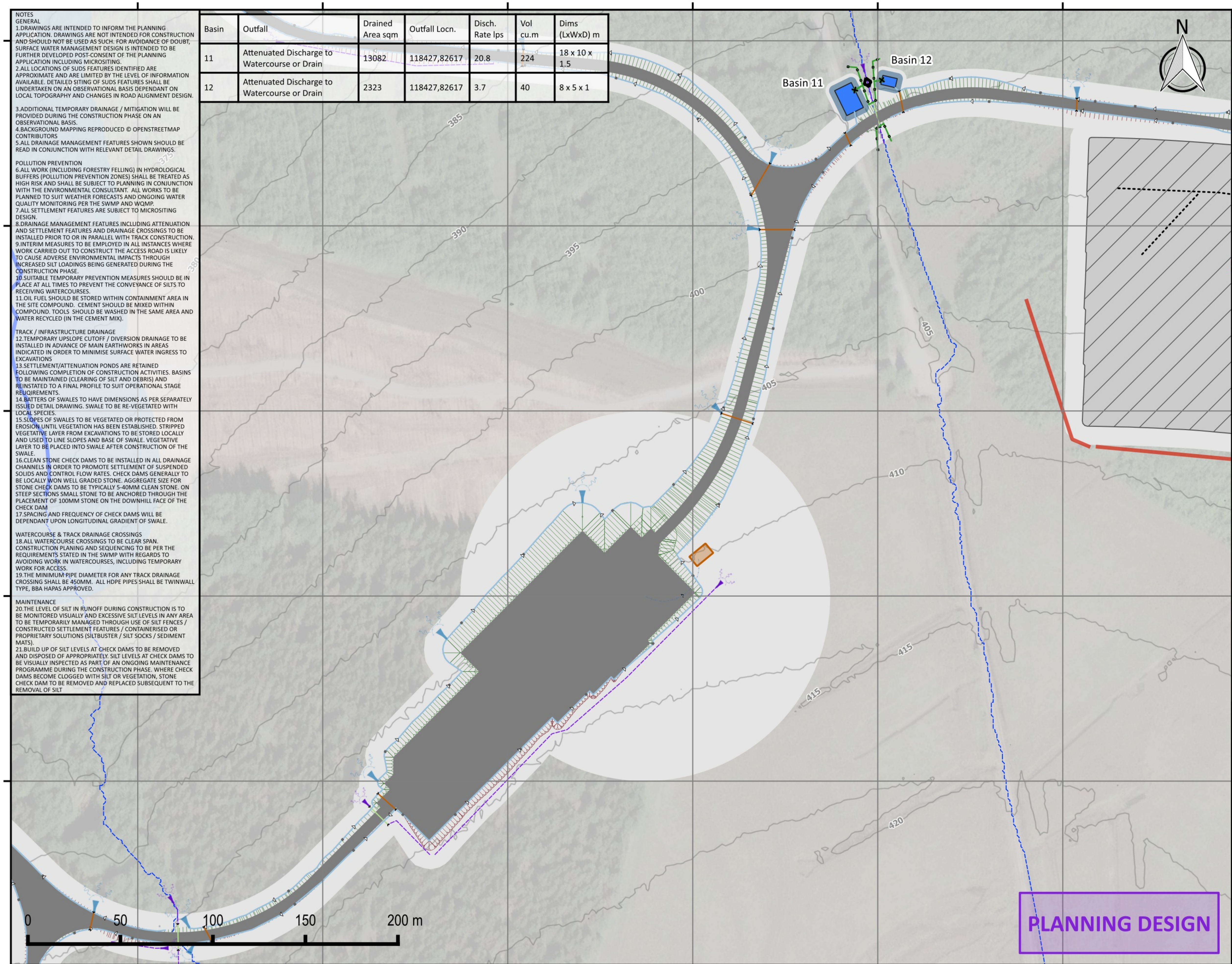
DESCRIPTION			
CUMMEENABUDDOGE WIND FARM - DRAINAGE LAYOUT SHEET 11			
PROJECT / FIGURE NO.			
M01944-02_SWMP_11			
DRAWN BY	SCALE	REVISION	DATE
DKS	1:2000	2	21/06/2024

FuturEnergy Ireland



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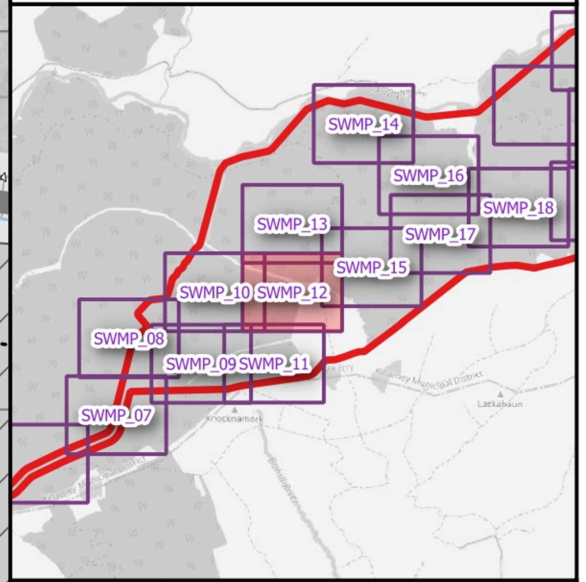
KEY PLAN



LEGEND

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- Indicates Cut
- Indicates Fill
- Spoil Repository
- Borrowpit

Existing Hydrology
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DESCRIPTION			
CUMMEENABUDDOGE WIND FARM - DRAINAGE LAYOUT SHEET 12			
PROJECT / FIGURE NO.			
M01944-02_SWMP_12			
DRAWN BY	SCALE	REVISION	DATE
DKS	1:2000	2	21/06/2024

FuturEnergy Ireland

NOTES

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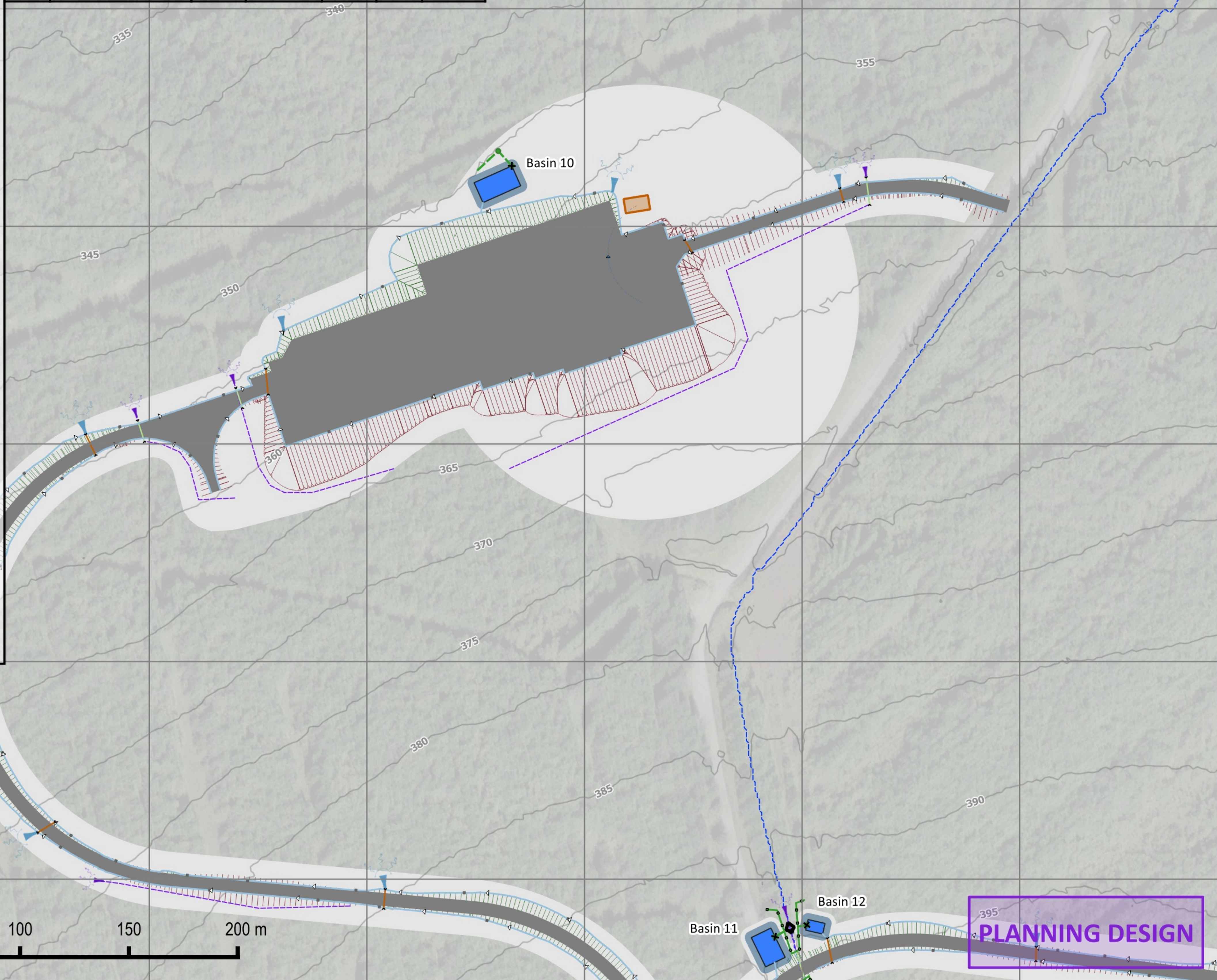
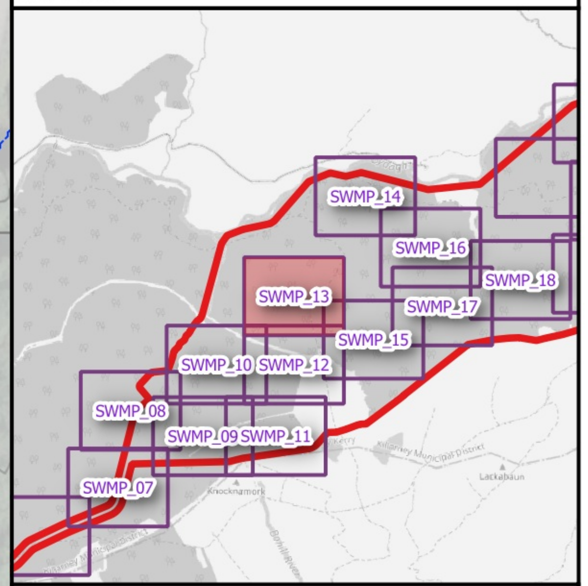


KEY PLAN



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DESCRIPTION
CUMMEENABUDDOGE WIND FARM - DRAINAGE LAYOUT SHEET 13

PROJECT / FIGURE NO.
M01944-02_SWMP_13

DRAWN BY	SCALE	REVISION	DATE
DKS	1:2000	2	21/06/2024

FuturEnergy Ireland

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POLLUTION PREVENTION

6.ALL WORK (INCLUDING FORESTRY FELLING) IN HYDROLOGICAL BUFFERS (POLLUTION PREVENTION ZONES) SHALL BE TREATED AS HIGH RISK AND SHALL BE SUBJECT TO PLANNING IN CONJUNCTION WITH THE ENVIRONMENTAL CONSULTANT. ALL WORKS TO BE PLANNED TO SUIT WEATHER FORECASTS AND ONGOING WATER QUALITY MONITORING PER THE SWMP AND WQMP.
7.ALL SETTLEMENT FEATURES ARE SUBJECT TO MICROSITING DESIGN.
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9.INTERIM MEASURES TO BE EMPLOYED IN ALL INSTANCES WHERE WORK CARRIED OUT TO CONSTRUCT THE ACCESS ROAD IS LIKELY TO CAUSE ADVERSE ENVIRONMENTAL IMPACTS THROUGH INCREASED SILT LOADINGS BEING GENERATED DURING THE CONSTRUCTION PHASE.
10.SUITABLE TEMPORARY PREVENTION MEASURES SHOULD BE IN PLACE AT ALL TIMES TO PREVENT THE CONVEYANCE OF SILTS TO RECEIVING WATERCOURSES.
11.OIL FUEL SHOULD BE STORED WITHIN CONTAINMENT AREA IN THE SITE COMPOUND. CEMENT SHOULD BE MIXED WITHIN COMPOUND. TOOLS SHOULD BE WASHED IN THE SAME AREA AND WATER RECYCLED (IN THE CEMENT MIX).

TRACK / INFRASTRUCTURE DRAINAGE

12.TEMPORARY UPSLOPE CUTOFF / DIVERSION DRAINAGE TO BE INSTALLED IN ADVANCE OF MAIN EARTHWORKS IN AREAS INDICATED IN ORDER TO MINIMISE SURFACE WATER INGRESS TO EXCAVATIONS
13.SETTLEMENT/ATTENUATION PONDS ARE RETAINED FOLLOWING COMPLETION OF CONSTRUCTION ACTIVITIES. BASINS TO BE MAINTAINED (CLEARING OF SILT AND DEBRIS) AND REINSTATED TO A FINAL PROFILE TO SUIT OPERATIONAL STAGE REUQIREMENTS.
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WATERCOURSE & TRACK DRAINAGE CROSSINGS

18.ALL WATERCOURSE CROSSINGS TO BE CLEAR SPAN. CONSTRUCTION PLANING AND SEQUENCING TO BE PER THE REQUIREMENTS STATED IN THE SWMP WITH REGARDS TO AVOIDING WORK IN WATERCOURSES, INCLUDING TEMPORARY WORK FOR ACCESS.
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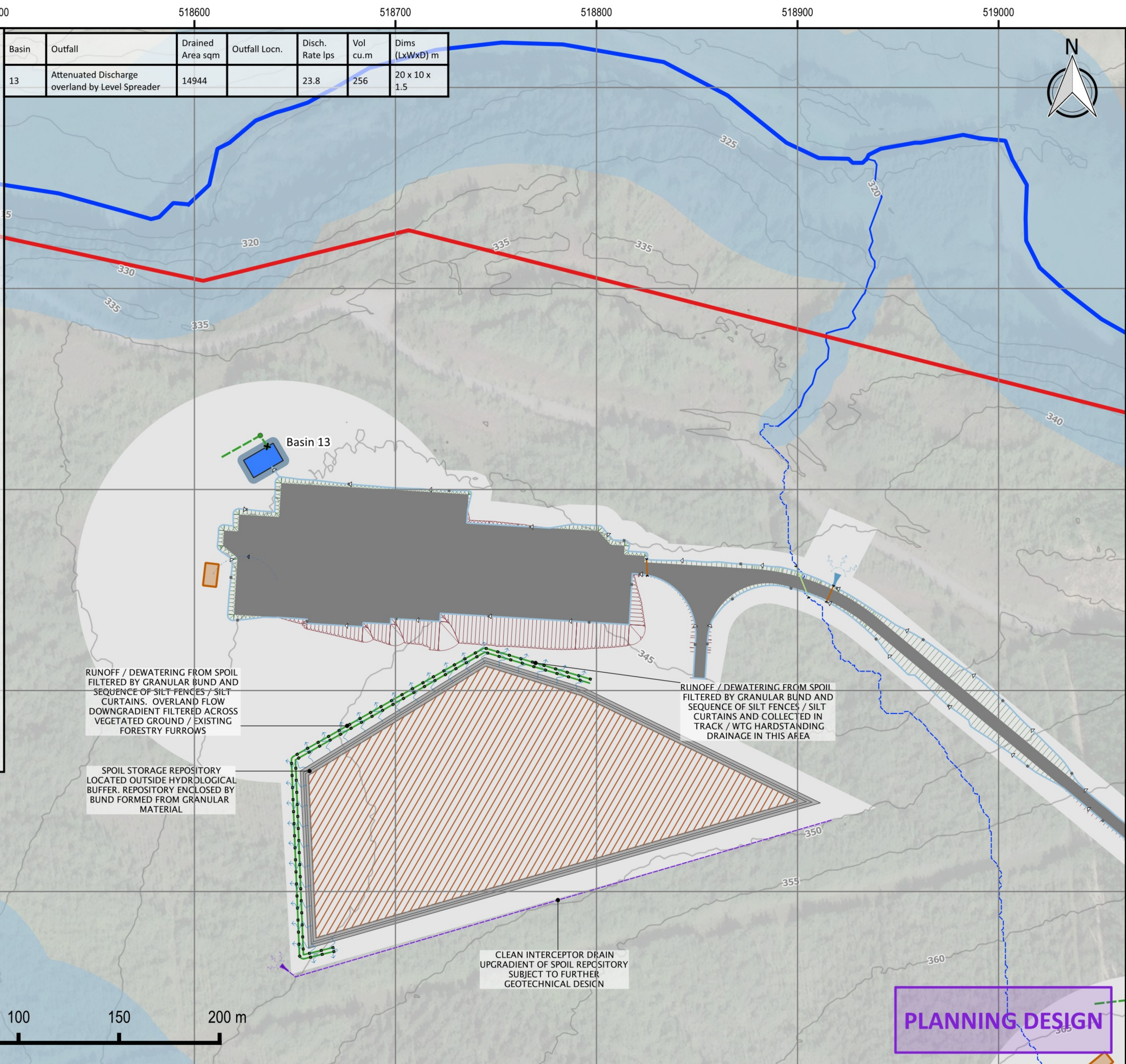
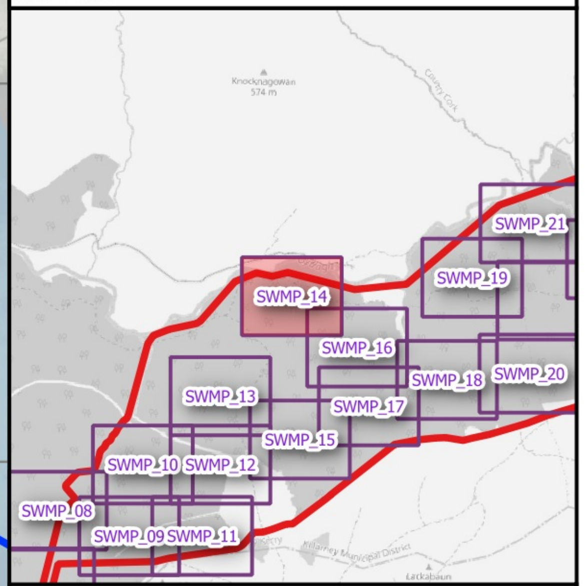
Basin	Outfall	Drained Area sqm	Outfall Locn.	Disch. Rate lps	Vol cu.m	Dims (LxWxD) m
13	Attenuated Discharge overland by Level Spreader	14944		23.8	256	20 x 10 x 1.5



KEY PLAN



LEGEND

The Development
- Planning Application Boundary
- Wind Farm Infrastructure
- Indicates Cut
- Indicates Fill
- Spoil Repository
- Borrowpit

Existing Hydrology
- Major Watercourse
- Minor Watercourse
- Other minor / ephemeral (implied from LiDAR)
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Track Drainage Features
- Trackside Drain & Checkdam
- Clean Cutoff Drain
- Clean Drainage Pipe
- Dirty Track Drainage Pipe
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- Flow Control & Outfall to Watercourse
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- Borrowpit Settlement Lagoon
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1.Suitable SUDS prevention measures should be in place at all times to prevent the conveyance of sediment to receiving watercourses.

2.Temporary or permanent SuDS features should be installed BEFORE or adjacent to construction of new access road and hardstanding.

3.Clean water cutoff ditch and crossing should be planned and installed BEFORE construction. Clean water management must consider spoil deposition on the site.

4.Direct discharge of untreated road drainage to watercourses shall not be permitted.

5.Buffer zones are to be maintained around all relevant watercourses as indicated on this drawing. No excavated material is to be stored within the buffer zone. All work in buffers to be treated as high risk requiriing pollution prevention and subject to Environmental Consultant supervision.

6.DO NOT pump water direct to watercourses.

7.DO NOT strip vegetation from existing ditches unless absolutely necessary.

8.If water pollution is identified the following steps should be adhered to:

STOP - Work in the immediate area should be stopped and the source of the pollution identified

CONTAIN - The source of the pollution should be bunded using a suitable method. Natural watercourses should be temporarily diverted around the source of pollution.

NOTIFY - The local authority and Client/Developer should be notified immediately to ensure that measures can be implemented downstream to protect fisheries and other sensitive areas.

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DESCRIPTION			
CUMMEENABUDDOGE WIND FARM - DRAINAGE LAYOUT SHEET 14			
PROJECT / FIGURE NO.			
M01944-02_SWMP_14			
DRAWN BY	SCALE	REVISION	DATE
DKS	1:2000	2	21/06/2024

FuturEnergy Ireland

NOTES

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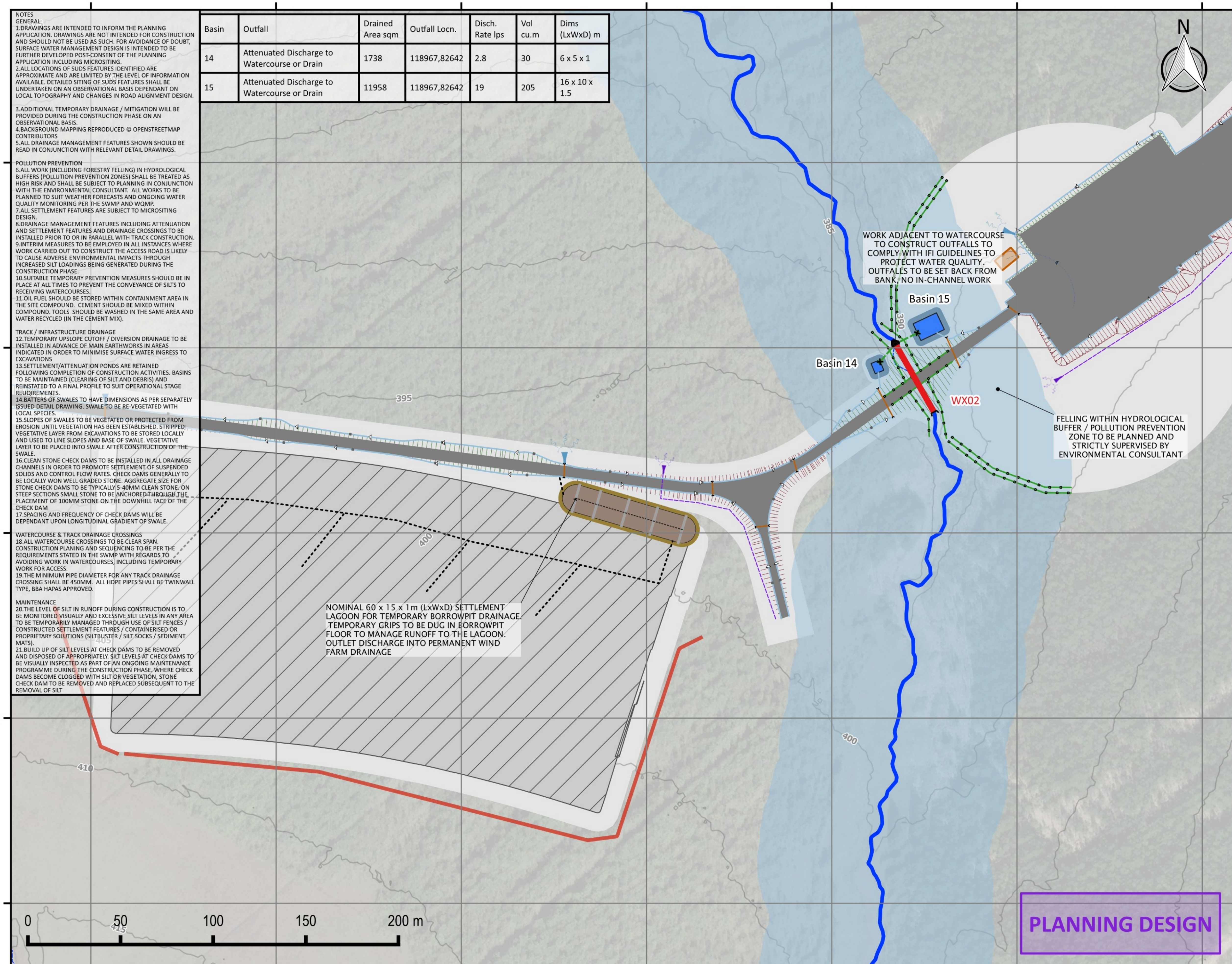
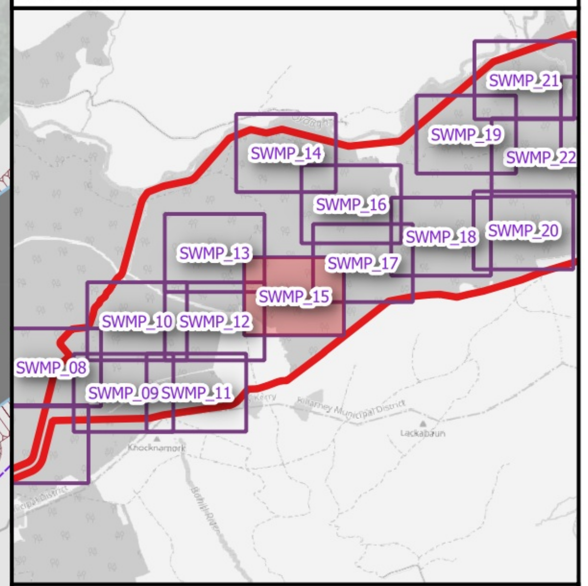
Basin	Outfall	Drained Area sqm	Outfall Locn.	Disch. Rate lps	Vol cu.m	Dims (LxWxD) m
14	Attenuated Discharge to Watercourse or Drain	1738	118967,82642	2.8	30	6 x 5 x 1
15	Attenuated Discharge to Watercourse or Drain	11958	118967,82642	19	205	16 x 10 x 1.5



KEY PLAN



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WX REF	DESCRIPTION
WX02	NEW MIN. 2.5 M x 1.1 M (SPAN x HEIGHT) CLEAR SPAN BRIDGE OR BOTTOMLESS CULVERT

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DESCRIPTION			
CUMMEENABUDDOGE WIND FARM - DRAINAGE LAYOUT SHEET 15			
PROJECT / FIGURE NO.			
M01944-02_SWMP_15			
DRAWN BY	SCALE	REVISION	DATE
DKS	1:2000	2	21/06/2024

FuturEnergy Ireland

NOTES

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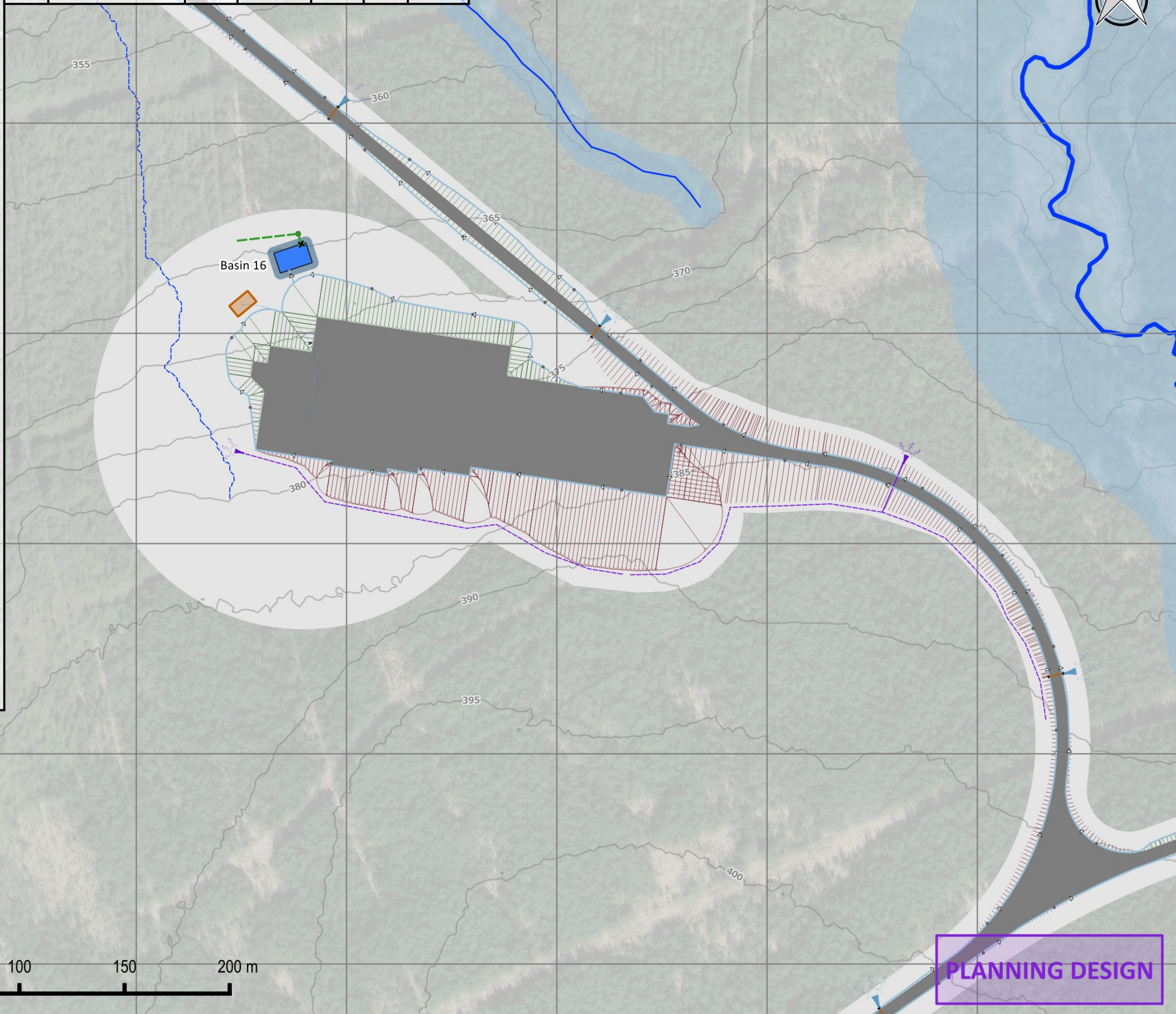
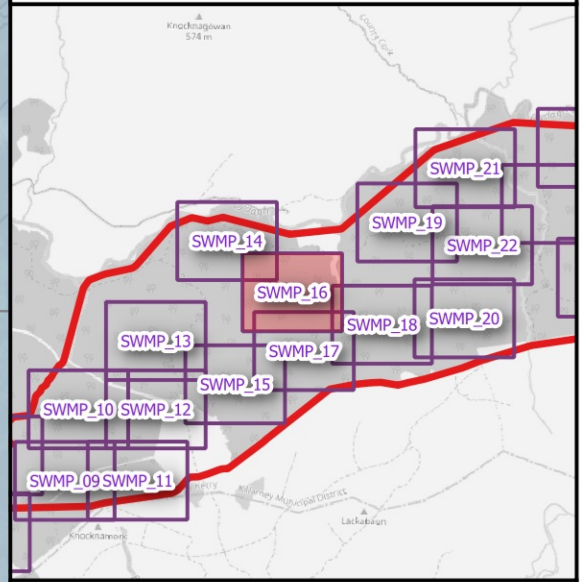


KEY PLAN



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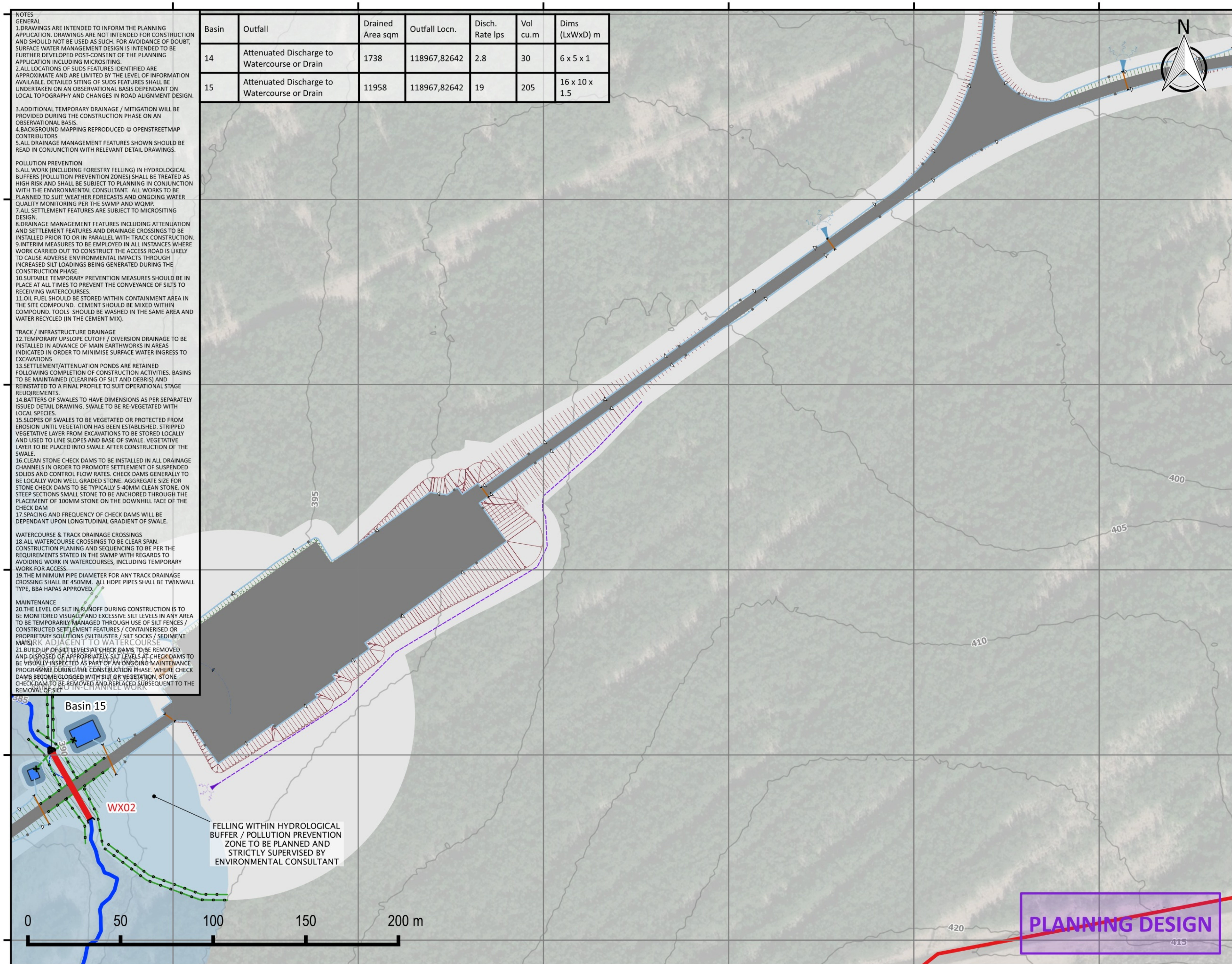
DESCRIPTION			
CUMMEENABUDDOGE WIND FARM - DRAINAGE LAYOUT SHEET 16			
PROJECT / FIGURE NO.			
M01944-02_SWMP_16			
DRAWN BY	SCALE	REVISION	DATE
DKS	1:2000	2	21/06/2024

FuturEnergy Ireland



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POLLUTION PREVENTION

6.ALL WORK (INCLUDING FORESTRY FELLING) IN HYDROLOGICAL BUFFERS (POLLUTION PREVENTION ZONES) SHALL BE TREATED AS HIGH RISK AND SHALL BE SUBJECT TO PLANNING IN CONJUNCTION WITH THE ENVIRONMENTAL CONSULTANT. ALL WORKS TO BE PLANNED TO SUIT WEATHER FORECASTS AND ONGOING WATER QUALITY MONITORING PER THE SWMP AND WQMP.

7.ALL SETTLEMENT FEATURES ARE SUBJECT TO MICROSITING DESIGN.

8.DRAINAGE MANAGEMENT FEATURES INCLUDING ATTENUATION AND SETTLEMENT FEATURES AND DRAINAGE CROSSINGS TO BE INSTALLED PRIOR TO OR IN PARALLEL WITH TRACK CONSTRUCTION.

9.INTERIM MEASURES TO BE EMPLOYED IN ALL INSTANCES WHERE WORK CARRIED OUT TO CONSTRUCT THE ACCESS ROAD IS LIKELY TO CAUSE ADVERSE ENVIRONMENTAL IMPACTS THROUGH INCREASED SILT LOADINGS BEING GENERATED DURING THE CONSTRUCTION PHASE.

10.SUITABLE TEMPORARY PREVENTION MEASURES SHOULD BE IN PLACE AT ALL TIMES TO PREVENT THE CONVEYANCE OF SILTS TO RECEIVING WATERCOURSES.

11.OIL FUEL SHOULD BE STORED WITHIN CONTAINMENT AREA IN THE SITE COMPOUND. CEMENT SHOULD BE MIXED WITHIN COMPOUND. TOOLS SHOULD BE WASHED IN THE SAME AREA AND WATER RECYCLED (IN THE CEMENT MIX).

TRACK / INFRASTRUCTURE DRAINAGE

12.TEMPORARY UPSLOPE CUTOFF / DIVERSION DRAINAGE TO BE INSTALLED IN ADVANCE OF MAIN EARTHWORKS IN AREAS INDICATED IN ORDER TO MINIMISE SURFACE WATER INGRESS TO EXCAVATIONS

13.SETTLEMENT/ATTENUATION PONDS ARE RETAINED FOLLOWING COMPLETION OF CONSTRUCTION ACTIVITIES. BASINS TO BE MAINTAINED (CLEARING OF SILT AND DEBRIS) AND REINSTATED TO A FINAL PROFILE TO SUIT OPERATIONAL STAGE REUQIREMENTS.

14.BATTERS OF SWALES TO HAVE DIMENSIONS AS PER SEPARATELY ISSUED DETAIL DRAWING. SWALE TO BE RE-VEGETATED WITH LOCAL SPECIES.

15.SLOPES OF SWALES TO BE VEGETATED OR PROTECTED FROM EROSION UNTIL VEGETATION HAS BEEN ESTABLISHED. STRIPPED VEGETATIVE LAYER FROM EXCAVATIONS TO BE STORED LOCALLY AND USED TO LINE SLOPES AND BASE OF SWALE. VEGETATIVE LAYER TO BE PLACED INTO SWALE AFTER CONSTRUCTION OF THE SWALE.

16.CLEAN STONE CHECK DAMS TO BE INSTALLED IN ALL DRAINAGE CHANNELS IN ORDER TO PROMOTE SETTLEMENT OF SUSPENDED SOLIDS AND CONTROL FLOW RATES. CHECK DAMS GENERALLY TO BE LOCALLY WON WELL GRADED STONE. AGGREGATE SIZE FOR STONE CHECK DAMS TO BE TYPICALLY 5-40MM CLEAN STONE. ON STEEP SECTIONS SMALL STONE TO BE ANCHORED THROUGH THE PLACEMENT OF 100MM STONE ON THE DOWNHILL FACE OF THE CHECK DAM

17.SPACING AND FREQUENCY OF CHECK DAMS WILL BE DEPENDANT UPON LONGITUDINAL GRADIENT OF SWALE.

WATERCOURSE & TRACK DRAINAGE CROSSINGS

18.ALL WATERCOURSE CROSSINGS TO BE CLEAR SPAN. CONSTRUCTION PLANING AND SEQUENCING TO BE PER THE REQUIREMENTS STATED IN THE SWMP WITH REGARDS TO AVOIDING WORK IN WATERCOURSES, INCLUDING TEMPORARY WORK FOR ACCESS.

19.THE MINIMUM PIPE DIAMETER FOR ANY TRACK DRAINAGE CROSSING SHALL BE 450MM. ALL HDPE PIPES SHALL BE TWINWALL TYPE, BBA HAPAS APPROVED.

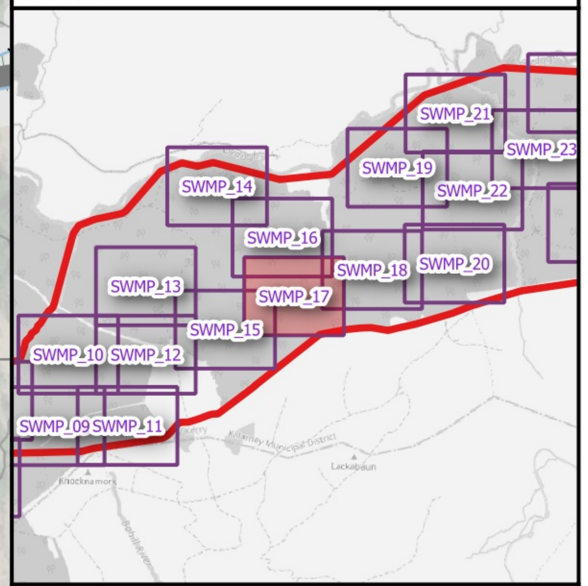
MAINTENANCE

20.THE LEVEL OF SILT IN RUNOFF DURING CONSTRUCTION IS TO BE MONITORED VISUALLY AND EXCESSIVE SILT LEVELS IN ANY AREA TO BE TEMPORARILY MANAGED THROUGH USE OF SILT FENCES / CONSTRUCTED SETTLEMENT FEATURES / CONTAINERISED OR PROPRIETARY SOLUTIONS (SILTBUSTER / SILT SOCKS / SEDIMENT MATS).

21.BUILD UP OF SILT LEVELS AT CHECK DAMS TO BE REMOVED AND DISPOSED OF APPROPRIATELY. SILT LEVELS AT CHECK DAMS TO BE VISUALLY INSPECTED AS PART OF AN ONGOING MAINTENANCE PROGRAMME DURING THE CONSTRUCTION PHASE. WHERE CHECK DAMS BECOME CLOGGED WITH SILT OR VEGETATION, STONE CHECK DAM TO BE REMOVED AND REPLACED SUBSEQUENT TO THE REMOVAL OF SILT

Basin	Outfall	Drained Area sqm	Outfall Locn.	Disch. Rate lps	Vol cu.m	Dims (LxWxD) m
14	Attenuated Discharge to Watercourse or Drain	1738	118967,82642	2.8	30	6 x 5 x 1
15	Attenuated Discharge to Watercourse or Drain	11958	118967,82642	19	205	16 x 10 x 1.5

KEY PLAN



LEGEND

The Development
- Planning Application Boundary
- Wind Farm Infrastructure
- Indicates Cut
- Indicates Fill
- Spoil Repository
- Borrowpit

Existing Hydrology
- Major Watercourse
- Minor Watercourse
- Other minor / ephemeral (implied from LiDAR)
- Hydrological buffers (10m/60m)

Track Drainage Features
- Trackside Drain & Checkdam
- Clean Cutoff Drain
- Clean Drainage Pipe
- Dirty Track Drainage Pipe
- Watercourse Crossings
- Flow Control & Outfall to Watercourse
- Flow Control & Discharge by level spreader
- Track Drainage Breakout
- Attenuation + Settlement Basin
- Borrowpit Grips
- Borrowpit Settlement Lagoon
- Dewatering / Settlement Basin
- Indicative pumped dewatering
- Temporary Silt Fence
- Temporary Berm

WX REF	DESCRIPTION
WX02	NEW MIN. 2.5 M x 1.1 M (SPAN x HEIGHT) CLEAR SPAN BRIDGE OR BOTTOMLESS CULVERT

POLLUTION PREVENTION GUIDANCE NOTES:

1.Suitable SUDS prevention measures should be in place at all times to prevent the conveyance of sediment to receiving watercourses.

2.Temporary or permanent SuDS features should be installed BEFORE or adjacent to construction of new access road and hardstanding.

3.Clean water cutoff ditch and crossing should be planned and installed BEFORE construction. Clean water management must consider spoil deposition on the site.

4.Direct discharge of untreated road drainage to watercourses shall not be permitted.

5.Buffer zones are to be maintained around all relevant watercourses as indicated on this drawing. No excavated material is to be stored within the buffer zone. All work in buffers to be treated as high risk requiriing pollution prevention and subject to Environmental Consultant supervision.

6.DO NOT pump water direct to watercourses.

7.DO NOT strip vegetation from existing ditches unless absolutely necessary.

8.If water pollution is identified the following steps should be adhered to:

STOP - Work in the immediate area should be stopped and the source of the pollution identified

CONTAIN - The source of the pollution should be bunded using a suitable method. Natural watercourses should be temporarily diverted around the source of pollution.

NOTIFY - The local authority and Client/Developer should be notified immediately to ensure that measures can be implemented downstream to protect fisheries and other sensitive areas.

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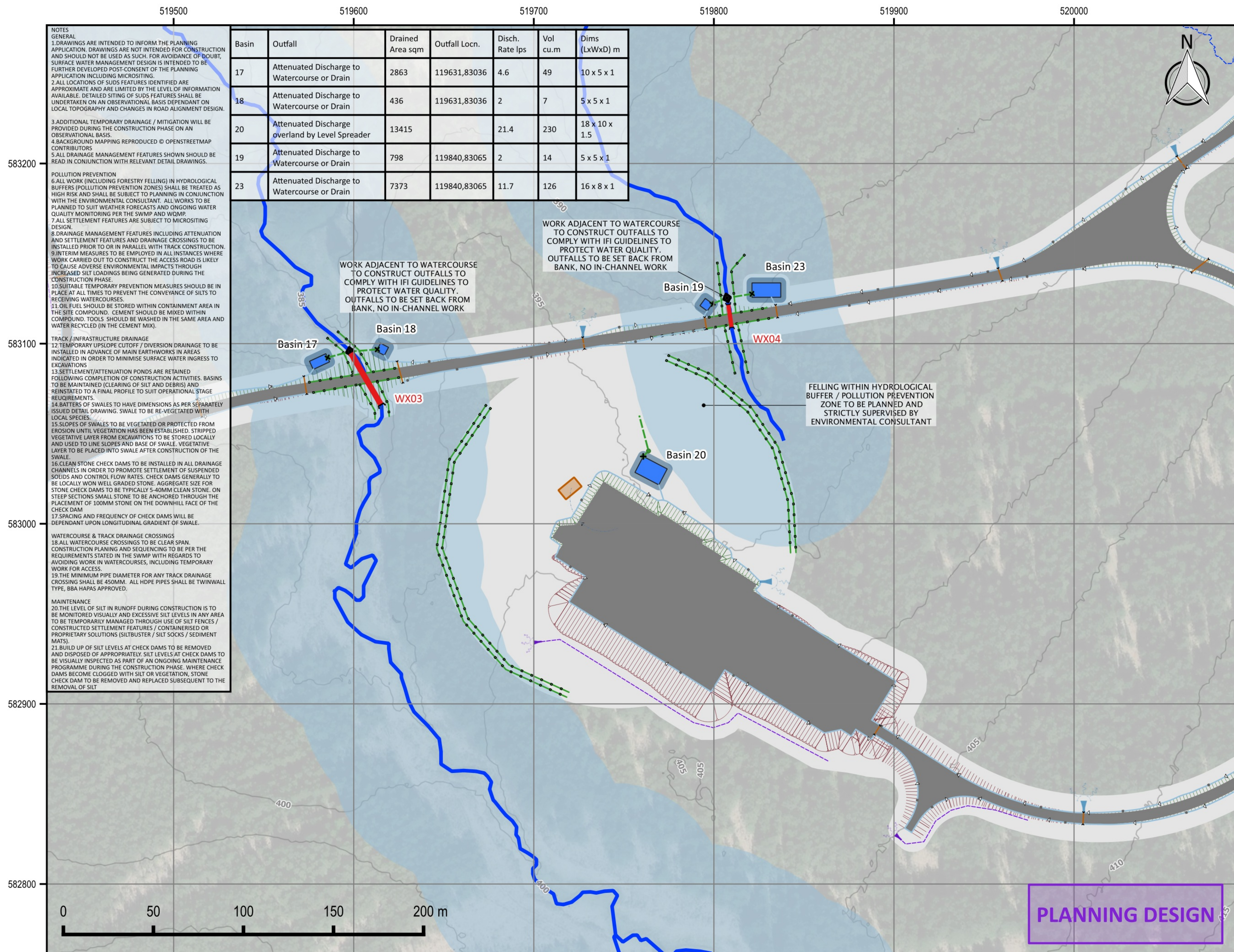
DESCRIPTION			
CUMMEENABUDDOGE WIND FARM - DRAINAGE LAYOUT SHEET 17			
PROJECT / FIGURE NO.			
M01944-02_SWMP_17			
DRAWN BY	SCALE	REVISION	DATE
DKS	1:2000	2	21/06/2024

FuturEnergy Ireland



NOTES

GENERAL

1.DRAWINGS ARE INTENDED TO INFORM THE PLANNING APPLICATION. DRAWINGS ARE NOT INTENDED FOR CONSTRUCTION AND SHOULD NOT BE USED AS SUCH. FOR AVOIDANCE OF DOUBT, SURFACE WATER MANAGEMENT DESIGN IS INTENDED TO BE FURTHER DEVELOPED POST-CONSENT OF THE PLANNING APPLICATION INCLUDING MICROSITING.
2.ALL LOCATIONS OF SUDS FEATURES IDENTIFIED ARE APPROXIMATE AND ARE LIMITED BY THE LEVEL OF INFORMATION AVAILABLE. DETAILED SITING OF SUDS FEATURES SHALL BE UNDERTAKEN ON AN OBSERVATIONAL BASIS DEPENDANT ON LOCAL TOPOGRAPHY AND CHANGES IN ROAD ALIGNMENT DESIGN.

3.ADDITIONAL TEMPORARY DRAINAGE / MITIGATION WILL BE PROVIDED DURING THE CONSTRUCTION PHASE ON AN OBSERVATIONAL BASIS.
4.BACKGROUND MAPPING REPRODUCED © OPENSTREETMAP CONTRIBUTORS
5.ALL DRAINAGE MANAGEMENT FEATURES SHOWN SHOULD BE READ IN CONJUNCTION WITH RELEVANT DETAIL DRAWINGS.

POLLUTION PREVENTION

6.ALL WORK (INCLUDING FORESTRY FELLING) IN HYDROLOGICAL BUFFERS (POLLUTION PREVENTION ZONES) SHALL BE TREATED AS HIGH RISK AND SHALL BE SUBJECT TO PLANNING IN CONJUNCTION WITH THE ENVIRONMENTAL CONSULTANT. ALL WORKS TO BE PLANNED TO SUIT WEATHER FORECASTS AND ONGOING WATER QUALITY MONITORING PER THE SWMP AND WQMP.
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9.INTERIM MEASURES TO BE EMPLOYED IN ALL INSTANCES WHERE WORK CARRIED OUT TO CONSTRUCT THE ACCESS ROAD IS LIKELY TO CAUSE ADVERSE ENVIRONMENTAL IMPACTS THROUGH INCREASED SILT LOADINGS BEING GENERATED DURING THE CONSTRUCTION PHASE.
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11.OIL FUEL SHOULD BE STORED WITHIN CONTAINMENT AREA IN THE SITE COMPOUND. CEMENT SHOULD BE MIXED WITHIN COMPOUND. TOOLS SHOULD BE WASHED IN THE SAME AREA AND WATER RECYCLED (IN THE CEMENT MIX).

TRACK / INFRASTRUCTURE DRAINAGE

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17.SPACING AND FREQUENCY OF CHECK DAMS WILL BE DEPENDANT UPON LONGITUDINAL GRADIENT OF SWALE.

WATERCOURSE & TRACK DRAINAGE CROSSINGS

18.ALL WATERCOURSE CROSSINGS TO BE CLEAR SPAN. CONSTRUCTION PLANING AND SEQUENCING TO BE PER THE REQUIREMENTS STATED IN THE SWMP WITH REGARDS TO AVOIDING WORK IN WATERCOURSES, INCLUDING TEMPORARY WORK FOR ACCESS.
19.THE MINIMUM PIPE DIAMETER FOR ANY TRACK DRAINAGE CROSSING SHALL BE 450MM. ALL HDPE PIPES SHALL BE TWINWALL TYPE, BBA HAPAS APPROVED.

MAINTENANCE

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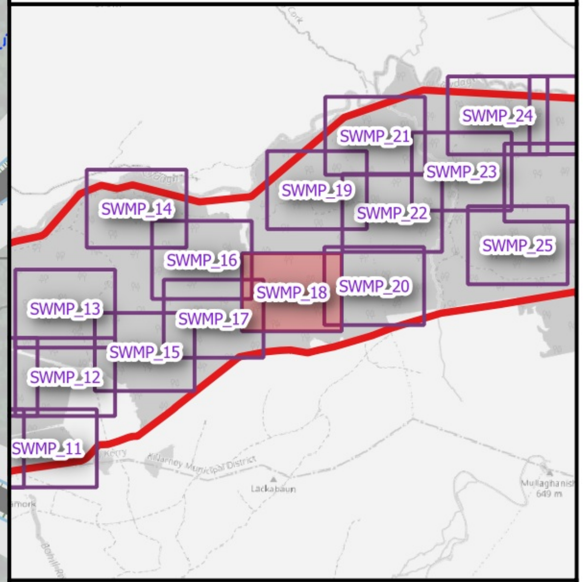
Basin	Outfall	Drained Area sqm	Outfall Locn.	Disch. Rate lps	Vol cu.m	Dims (LxWxD) m
17	Attenuated Discharge to Watercourse or Drain	2863	119631,83036	4.6	49	10 x 5 x 1
18	Attenuated Discharge to Watercourse or Drain	436	119631,83036	2	7	5 x 5 x 1
20	Attenuated Discharge overland by Level Spreader	13415		21.4	230	18 x 10 x 1.5
19	Attenuated Discharge to Watercourse or Drain	798	119840,83065	2	14	5 x 5 x 1
23	Attenuated Discharge to Watercourse or Drain	7373	119840,83065	11.7	126	16 x 8 x 1

KEY PLAN



LEGEND

The Development
- Planning Application Boundary
- Wind Farm Infrastructure
- Indicates Cut
- Indicates Fill
- Spoil Repository
- Borrowpit

Existing Hydrology
- Major Watercourse
- Minor Watercourse
- Other minor / ephemeral (implied from LiDAR)
- Hydrological buffers (10m/60m)

Track Drainage Features
- Trackside Drain & Checkdam
- Clean Cutoff Drain
- Clean Drainage Pipe
- Dirty Track Drainage Pipe
- Watercourse Crossings
- Flow Control & Outfall to Watercourse
- Flow Control & Discharge by level spreader
- Track Drainage Breakout
- Attenuation + Settlement Basin
- Borrowpit Grips
- Borrowpit Settlement Lagoon
- Dewatering / Settlement Basin
- Indicative pumped dewatering
- Temporary Silt Fence
- Temporary Berm

WX REF	DESCRIPTION
WX03	NEW MIN. 2.8 M x 1.2 M (SPAN x HEIGHT) CLEAR SPAN BRIDGE OR BOTTOMLESS CULVERT
WX04	NEW MIN. 2.5 M x 0.7 M (SPAN x HEIGHT) CLEAR SPAN BRIDGE OR BOTTOMLESS CULVERT

POLLUTION PREVENTION GUIDANCE NOTES:

1.Suitable SUDS prevention measures should be in place at all times to prevent the conveyance of sediment to receiving watercourses.

2.Temporary or permanent SuDS features should be installed BEFORE or adjacent to construction of new access road and hardstanding.

3.Clean water cutoff ditch and crossing should be planned and installed BEFORE construction. Clean water management must consider spoil deposition on the site.

4.Direct discharge of untreated road drainage to watercourses shall not be permitted.

5.Buffer zones are to be maintained around all relevant watercourses as indicated on this drawing. No excavated material is to be stored within the buffer zone. All work in buffers to be treated as high risk requiriing pollution prevention and subject to Environmental Consultant supervision.

6.DO NOT pump water direct to watercourses.

7.DO NOT strip vegetation from existing ditches unless absolutely necessary.

8.If water pollution is identified the following steps should be adhered to:

STOP - Work in the immediate area should be stopped and the source of the pollution identified

CONTAIN - The source of the pollution should be bunded using a suitable method. Natural watercourses should be temporarily diverted around the source of pollution.

NOTIFY - The local authority and Client/Developer should be notified immediately to ensure that measures can be implemented downstream to protect fisheries and other sensitive areas.

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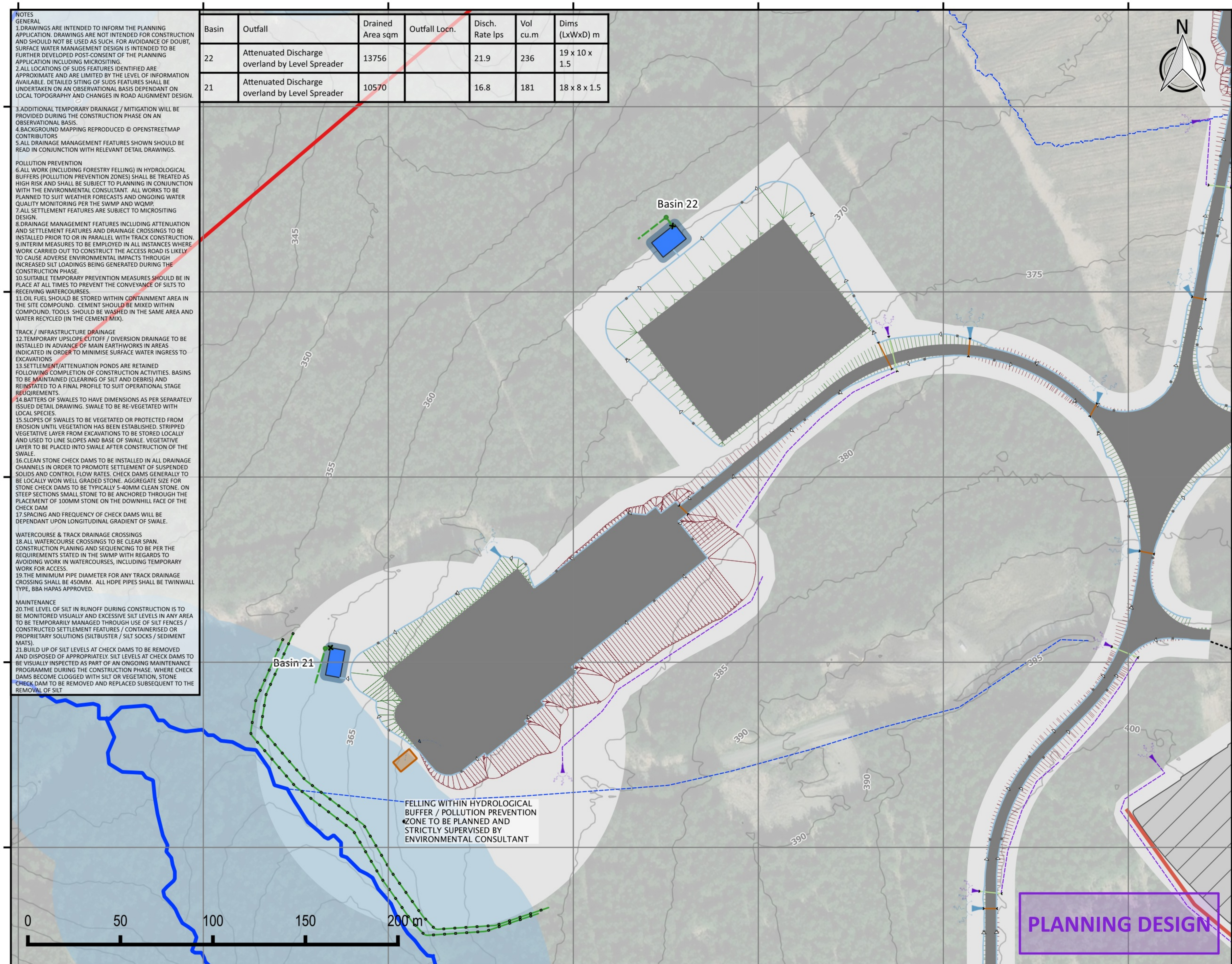
DESCRIPTION
CUMMEENABUDDOGE WIND FARM - DRAINAGE LAYOUT SHEET 18

PROJECT / FIGURE NO.
M01944-02_SWMP_18

DRAWN BY	SCALE	REVISION	DATE
DKS	1:2000	2	21/06/2024

FuturEnergy Ireland



NOTES

GENERAL

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4.BACKGROUND MAPPING REPRODUCED © OPENSTREETMAP CONTRIBUTORS

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MAINTENANCE

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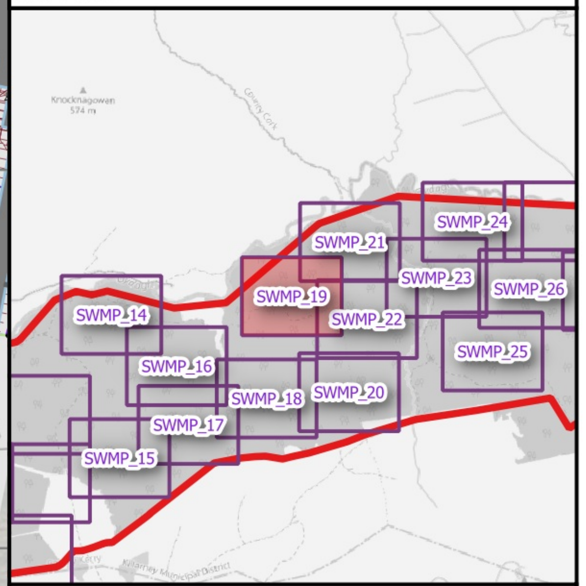
Basin	Outfall	Drained Area sqm	Outfall Locn.	Disch. Rate lps	Vol cu.m	Dims (LxWxD) m
22	Attenuated Discharge overland by Level Spreader	13756		21.9	236	19 x 10 x 1.5
21	Attenuated Discharge overland by Level Spreader	10570		16.8	181	18 x 8 x 1.5

KEY PLAN



LEGEND

The Development
- Planning Application Boundary
- Wind Farm Infrastructure
- Indicates Cut
- Indicates Fill
- Spoil Repository
- Borrowpit

Existing Hydrology
- Major Watercourse
- Minor Watercourse
- Other minor / ephemeral (implied from LiDAR)
- Hydrological buffers (10m/60m)

Track Drainage Features
- Trackside Drain & Checkdam
- Clean Cutoff Drain
- Clean Drainage Pipe
- Dirty Track Drainage Pipe
- Watercourse Crossings
- Flow Control & Outfall to Watercourse
- Flow Control & Discharge by level spreader
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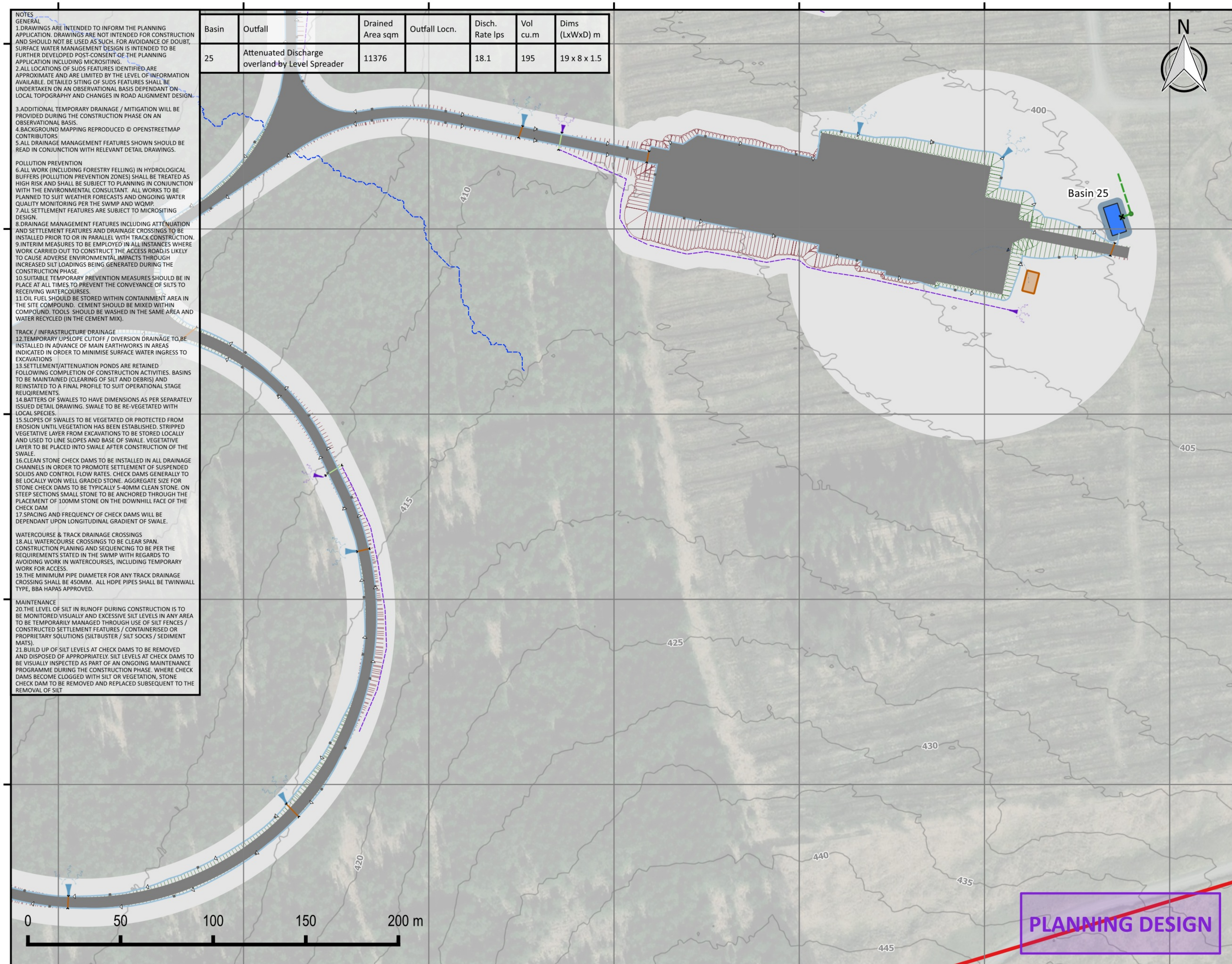
DESCRIPTION			
CUMMEENABUDDOGE WIND FARM - DRAINAGE LAYOUT SHEET 19			
PROJECT / FIGURE NO.			
M01944-02_SWMP_19			
DRAWN BY	SCALE	REVISION	DATE
DKS	1:2000	2	21/06/2024

FuturEnergy Ireland

Basin	Outfall	Drained Area sqm	Outfall Locn.	Disch. Rate lps	Vol cu.m	Dims (LxWxD) m
25	Attenuated Discharge overland by Level Spreader	11376		18.1	195	19 x 8 x 1.5



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POLLUTION PREVENTION

6.ALL WORK (INCLUDING FORESTRY FELLING) IN HYDROLOGICAL BUFFERS (POLLUTION PREVENTION ZONES) SHALL BE TREATED AS HIGH RISK AND SHALL BE SUBJECT TO PLANNING IN CONJUNCTION WITH THE ENVIRONMENTAL CONSULTANT. ALL WORKS TO BE PLANNED TO SUIT WEATHER FORECASTS AND ONGOING WATER QUALITY MONITORING PER THE SWMP AND WQMP.
7.ALL SETTLEMENT FEATURES ARE SUBJECT TO MICROSITING DESIGN.
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TRACK / INFRASTRUCTURE DRAINAGE

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19.THE MINIMUM PIPE DIAMETER FOR ANY TRACK DRAINAGE CROSSING SHALL BE 450MM. ALL HDPE PIPES SHALL BE TWINWALL TYPE, BBA HAPAS APPROVED.

MAINTENANCE

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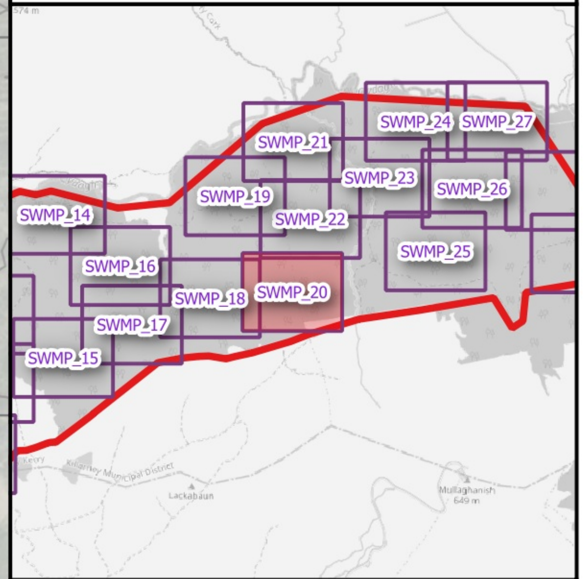
KEY PLAN



LEGEND

The Development
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- Wind Farm Infrastructure
- Indicates Cut
- Indicates Fill
- Spoil Repository
- Borrowpit

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CONTAIN - The source of the pollution should be bunded using a suitable method. Natural watercourses should be temporarily diverted around the source of pollution.

NOTIFY - The local authority and Client/Developer should be notified immediately to ensure that measures can be implemented downstream to protect fisheries and other sensitive areas.

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DESCRIPTION			
CUMMEENABUDDOGE WIND FARM - DRAINAGE LAYOUT SHEET 20			
PROJECT / FIGURE NO.			
M01944-02_SWMP_20			
DRAWN BY	SCALE	REVISION	DATE
DKS	1:2000	2	21/06/2024

FuturEnergy Ireland

Basin	Outfall	Drained Area sqm	Outfall Locn.	Disch. Rate lps	Vol cu.m	Dims (LxWxD) m
24	Attenuated Discharge overland by Level Spreader	13105		20.9	224	18 x 10 x 1.5

NOTES

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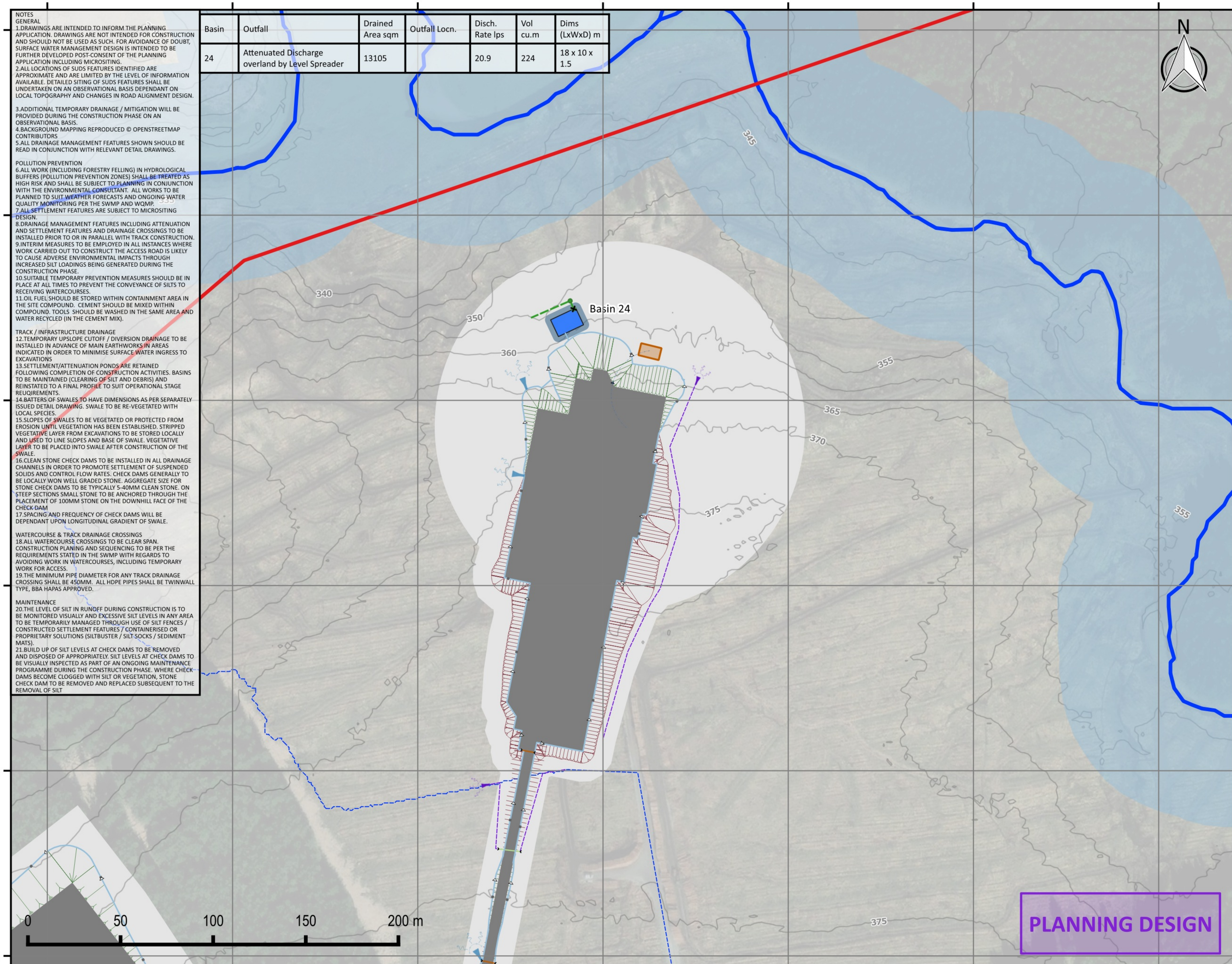
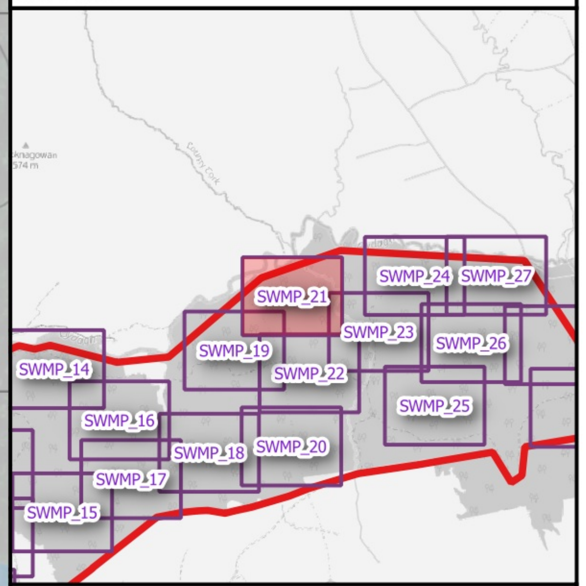


KEY PLAN



LEGEND

The Development
- Planning Application Boundary
- Wind Farm Infrastructure
- Indicates Cut
- Indicates Fill
- Spoil Repository
- Borrowpit

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- Minor Watercourse
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DESCRIPTION			
CUMMEENABUDDOGE WIND FARM - DRAINAGE LAYOUT SHEET 21			
PROJECT / FIGURE NO.			
M01944-02_SWMP_21			
DRAWN BY	SCALE	REVISION	DATE
DKS	1:2000	2	21/06/2024

FuturEnergy Ireland

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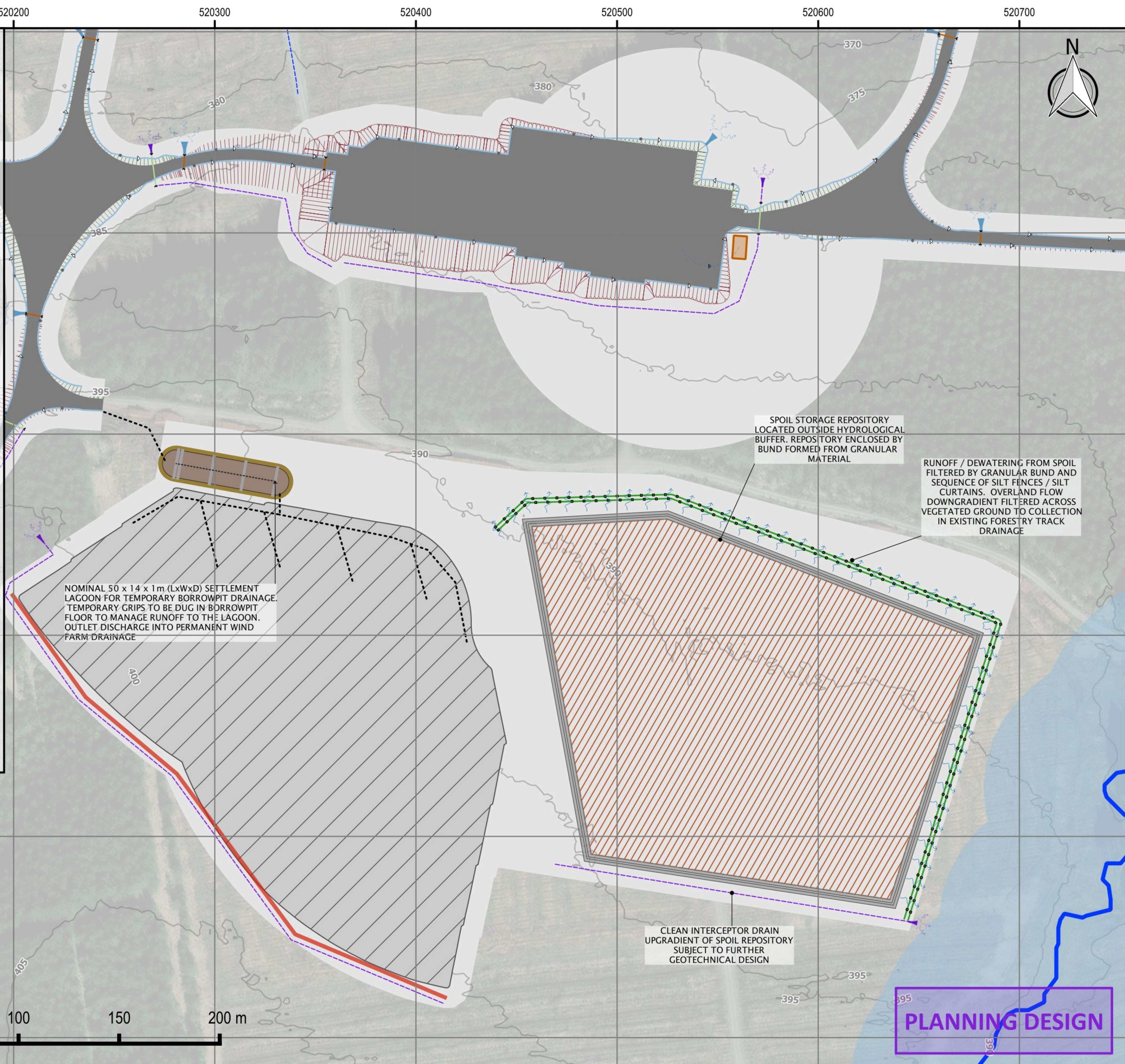
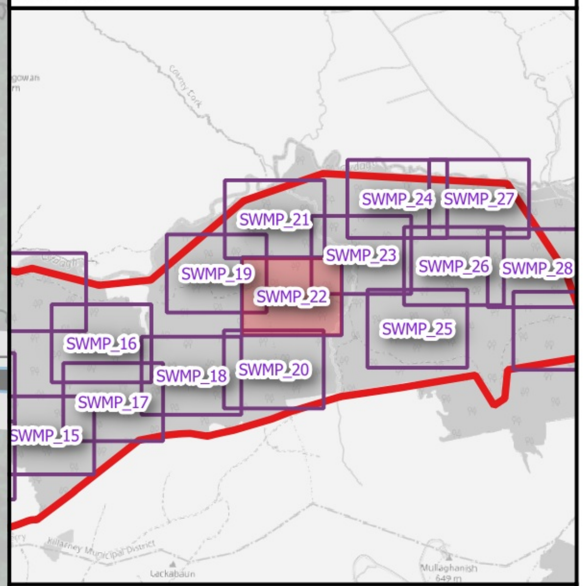


KEY PLAN



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DESCRIPTION			
CUMMEENABUDDOGE WIND FARM - DRAINAGE LAYOUT SHEET 22			
PROJECT / FIGURE NO.			
M01944-02_SWMP_22			
DRAWN BY	SCALE	REVISION	DATE
DKS	1:2000	2	21/06/2024

FuturEnergy Ireland

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16.CLEAN STONE CHECK DAMS TO BE INSTALLED IN ALL DRAINAGE CHANNELS IN ORDER TO PROMOTE SETTLEMENT OF SUSPENDED SOLIDS AND CONTROL FLOW RATES. CHECK DAMS GENERALLY TO BE LOCALLY WON WELL GRADED STONE. AGGREGATE SIZE FOR STONE CHECK DAMS TO BE TYPICALLY 5-40MM CLEAN STONE. ON STEEP SECTIONS SMALL STONE TO BE ANCHORED THROUGH THE PLACEMENT OF 100MM STONE ON THE DOWNHILL FACE OF THE CHECK DAM

17.SPACING AND FREQUENCY OF CHECK DAMS WILL BE DEPENDANT UPON LONGITUDINAL GRADIENT OF SWALE.

WATERCOURSE & TRACK DRAINAGE CROSSINGS

18.ALL WATERCOURSE CROSSINGS TO BE CLEAR SPAN. CONSTRUCTION PLANING AND SEQUENCING TO BE PER THE REQUIREMENTS STATED IN THE SWMP WITH REGARDS TO AVOIDING WORK IN WATERCOURSES, INCLUDING TEMPORARY WORK FOR ACCESS.

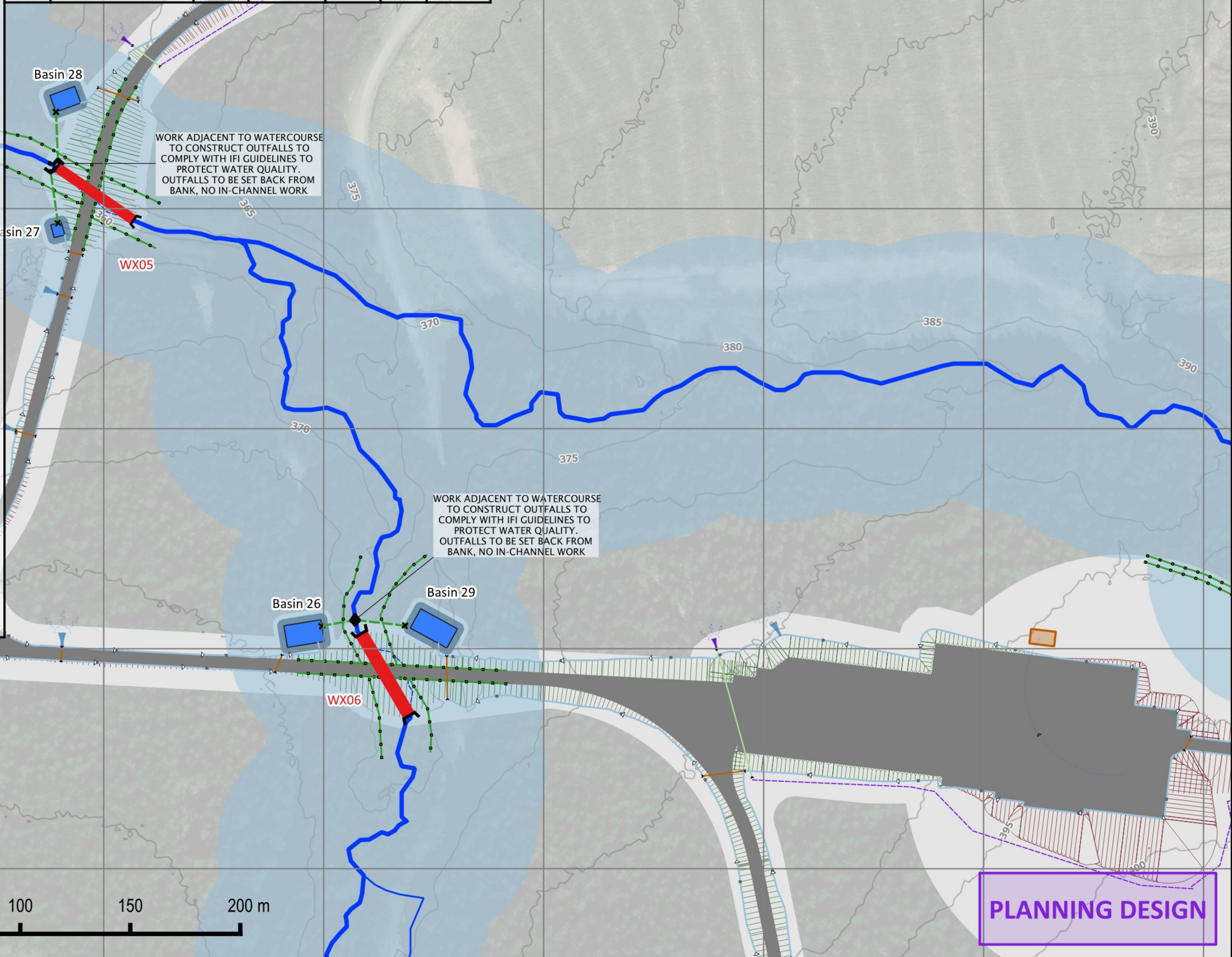
19.THE MINIMUM PIPE DIAMETER FOR ANY TRACK DRAINAGE CROSSING SHALL BE 450MM. ALL HDPE PIPES SHALL BE TWINWALL TYPE, BBA HAPAS APPROVED.

MAINTENANCE

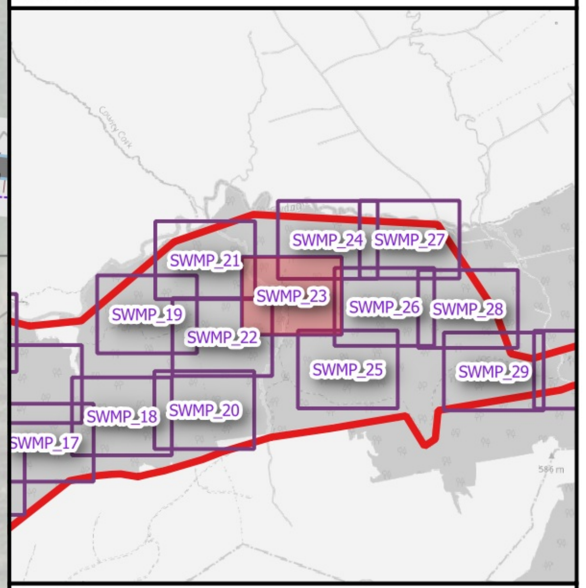
20.THE LEVEL OF SILT IN RUNOFF DURING CONSTRUCTION IS TO BE MONITORED VISUALLY AND EXCESSIVE SILT LEVELS IN ANY AREA TO BE TEMPORARILY MANAGED THROUGH USE OF SILT FENCES / CONSTRUCTED SETTLEMENT FEATURES / CONTAINERISED OR PROPRIETARY SOLUTIONS (SILTBUSTER / SILT SOCKS / SEDIMENT MATS).

21.BUILD UP OF SILT LEVELS AT CHECK DAMS TO BE REMOVED AND DISPOSED OF APPROPRIATELY. SILT LEVELS AT CHECK DAMS TO BE VISUALLY INSPECTED AS PART OF AN ONGOING MAINTENANCE PROGRAMME DURING THE CONSTRUCTION PHASE. WHERE CHECK DAMS BECOME CLOGGED WITH SILT OR VEGETATION, STONE CHECK DAM TO BE REMOVED AND REPLACED SUBSEQUENT TO THE REMOVAL OF SILT

Basin	Outfall	Drained Area sqm	Outfall Locn.	Disch. Rate lps	Vol cu.m	Dims (LxWxD) m
26	Attenuated Discharge to Watercourse or Drain	14632	120847,83653	23.3	251	20 x 10 x 1.5
29	Attenuated Discharge to Watercourse or Drain	16421	120847,83653	26.1	281	22 x 10 x 1.5
27	Attenuated Discharge to Watercourse or Drain	1731	120709,83858	2.8	30	6 x 5 x 1
28	Attenuated Discharge to Watercourse or Drain	5706	120712,83861	9.1	98	12 x 8 x 1



KEY PLAN



LEGEND

The Development
- Planning Application Boundary
- Wind Farm Infrastructure
- Indicates Cut
- Indicates Fill
- Spoil Repository
- Borrowpit

Existing Hydrology
- Major Watercourse
- Minor Watercourse
- Other minor / ephemeral (implied from LiDAR)
- Hydrological buffers (10m/60m)

Track Drainage Features
- Trackside Drain & Checkdam
- Clean Cutoff Drain
- Clean Drainage Pipe
- Dirty Track Drainage Pipe
- Watercourse Crossings
- Flow Control & Outfall to Watercourse
- Flow Control & Discharge by level spreader
- Track Drainage Breakout
- Attenuation + Settlement Basin
- Borrowpit Grips
- Borrowpit Settlement Lagoon
- Dewatering / Settlement Basin
- Indicative pumped dewatering
- Temporary Silt Fence
- Temporary Berm

WX REF	DESCRIPTION
WX05	NEW MIN. 8.0 M x 1.2 M (SPAN x HEIGHT) CLEAR SPAN BRIDGE OR BOTTOMLESS CULVERT
WX06	NEW MIN. 4.0 M x 1.2 M (SPAN x HEIGHT) CLEAR SPAN BRIDGE OR BOTTOMLESS CULVERT

POLLUTION PREVENTION GUIDANCE NOTES:

1.Suitable SUDS prevention measures should be in place at all times to prevent the conveyance of sediment to receiving watercourses.

2.Temporary or permanent SuDS features should be installed BEFORE or adjacent to construction of new access road and hardstanding.

3.Clean water cutoff ditch and crossing should be planned and installed BEFORE construction. Clean water management must consider spoil deposition on the site.

4.Direct discharge of untreated road drainage to watercourses shall not be permitted.

5.Buffer zones are to be maintained around all relevant watercourses as indicated on this drawing. No excavated material is to be stored within the buffer zone. All work in buffers to be treated as high risk requiriing pollution prevention and subject to Environmental Consultant supervision.

6.DO NOT pump water direct to watercourses.

7.DO NOT strip vegetation from existing ditches unless absolutely necessary.

8.If water pollution is identified the following steps should be adhered to:

STOP - Work in the immediate area should be stopped and the source of the pollution identified

CONTAIN - The source of the pollution should be bunded using a suitable method. Natural watercourses should be temporarily diverted around the source of pollution.

NOTIFY - The local authority and Client/Developer should be notified immediately to ensure that measures can be implemented downstream to protect fisheries and other sensitive areas.

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DESCRIPTION
CUMMEENABUDDOGE WIND FARM - DRAINAGE LAYOUT SHEET 23

PROJECT / FIGURE NO.
M01944-02_SWMP_23

DRAWN BY	SCALE	REVISION	DATE
DKS	1:2000	2	21/06/2024

FuturEnergy Ireland

NOTES
GENERAL
1.DRAWINGS ARE INTENDED TO INFORM THE PLANNING APPLICATION. DRAWINGS ARE NOT INTENDED FOR CONSTRUCTION AND SHOULD NOT BE USED AS SUCH. FOR AVOIDANCE OF DOUBT, SURFACE WATER MANAGEMENT DESIGN IS INTENDED TO BE FURTHER DEVELOPED POST-CONSENT OF THE PLANNING APPLICATION INCLUDING MICROSITING.
2.ALL LOCATIONS OF SUDS FEATURES IDENTIFIED ARE APPROXIMATE AND ARE LIMITED BY THE LEVEL OF INFORMATION AVAILABLE. DETAILED SITING OF SUDS FEATURES SHALL BE UNDERTAKEN ON AN OBSERVATIONAL BASIS DEPENDANT ON LOCAL TOPOGRAPHY AND CHANGES IN ROAD ALIGNMENT DESIGN.
3.ADDITIONAL TEMPORARY DRAINAGE / MITIGATION WILL BE PROVIDED DURING THE CONSTRUCTION PHASE ON AN OBSERVATIONAL BASIS.
4.BACKGROUND MAPPING REPRODUCED © OPENSTREETMAP CONTRIBUTORS
5.ALL DRAINAGE MANAGEMENT FEATURES SHOWN SHOULD BE READ IN CONJUNCTION WITH RELEVANT DETAIL DRAWINGS.

POLLUTION PREVENTION
6.ALL WORK (INCLUDING FORESTRY FELLING) IN HYDROLOGICAL BUFFERS (POLLUTION PREVENTION ZONES) SHALL BE TREATED AS HIGH RISK AND SHALL BE SUBJECT TO PLANNING IN CONJUNCTION WITH THE ENVIRONMENTAL CONSULTANT. ALL WORKS TO BE PLANNED TO SUIT WEATHER FORECASTS AND ONGOING WATER QUALITY MONITORING PER THE SWMP AND WQMP.
7.ALL SETTLEMENT FEATURES ARE SUBJECT TO MICROSITING DESIGN.
8.DRAINAGE MANAGEMENT FEATURES INCLUDING ATTENUATION AND SETTLEMENT FEATURES AND DRAINAGE CROSSINGS TO BE INSTALLED PRIOR TO OR IN PARALLEL WITH TRACK CONSTRUCTION.
9.INTERIM MEASURES TO BE EMPLOYED IN ALL INSTANCES WHERE WORK CARRIED OUT TO CONSTRUCT THE ACCESS ROAD IS LIKELY TO CAUSE ADVERSE ENVIRONMENTAL IMPACTS THROUGH INCREASED SILT LOADINGS BEING GENERATED DURING THE CONSTRUCTION PHASE.
10.SUITABLE TEMPORARY PREVENTION MEASURES SHOULD BE IN PLACE AT ALL TIMES TO PREVENT THE CONVEYANCE OF SILTS TO RECEIVING WATERCOURSES.
11.OIL FUEL SHOULD BE STORED WITHIN CONTAINMENT AREA IN THE SITE COMPOUND. CEMENT SHOULD BE MIXED WITHIN COMPOUND. TOOLS SHOULD BE WASHED IN THE SAME AREA AND WATER RECYCLED (IN THE CEMENT MIX).

TRACK / INFRASTRUCTURE DRAINAGE
12.TEMPORARY UPSLOPE CUTOFF / DIVERSION DRAINAGE TO BE INSTALLED IN ADVANCE OF MAIN EARTHWORKS IN AREAS INDICATED IN ORDER TO MINIMISE SURFACE WATER INGRESS TO EXCAVATIONS
13.SETTLEMENT/ATTENUATION PONDS ARE RETAINED FOLLOWING COMPLETION OF CONSTRUCTION ACTIVITIES. BASINS TO BE MAINTAINED (CLEARING OF SILT AND DEBRIS) AND REINSTATED TO A FINAL PROFILE TO SUIT OPERATIONAL STAGE REUQIREMENTS.
14.BATTERS OF SWALES TO HAVE DIMENSIONS AS PER SEPARATELY ISSUED DETAIL DRAWING. SWALE TO BE RE-VEGETATED WITH LOCAL SPECIES.
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17.SPACING AND FREQUENCY OF CHECK DAMS WILL BE DEPENDANT UPON LONGITUDINAL GRADIENT OF SWALE.

WATERCOURSE & TRACK DRAINAGE CROSSINGS
18.ALL WATERCOURSE CROSSINGS TO BE CLEAR SPAN. CONSTRUCTION PLANING AND SEQUENCING TO BE PER THE REQUIREMENTS STATED IN THE SWMP WITH REGARDS TO AVOIDING WORK IN WATERCOURSES, INCLUDING TEMPORARY WORK FOR ACCESS.
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MAINTENANCE
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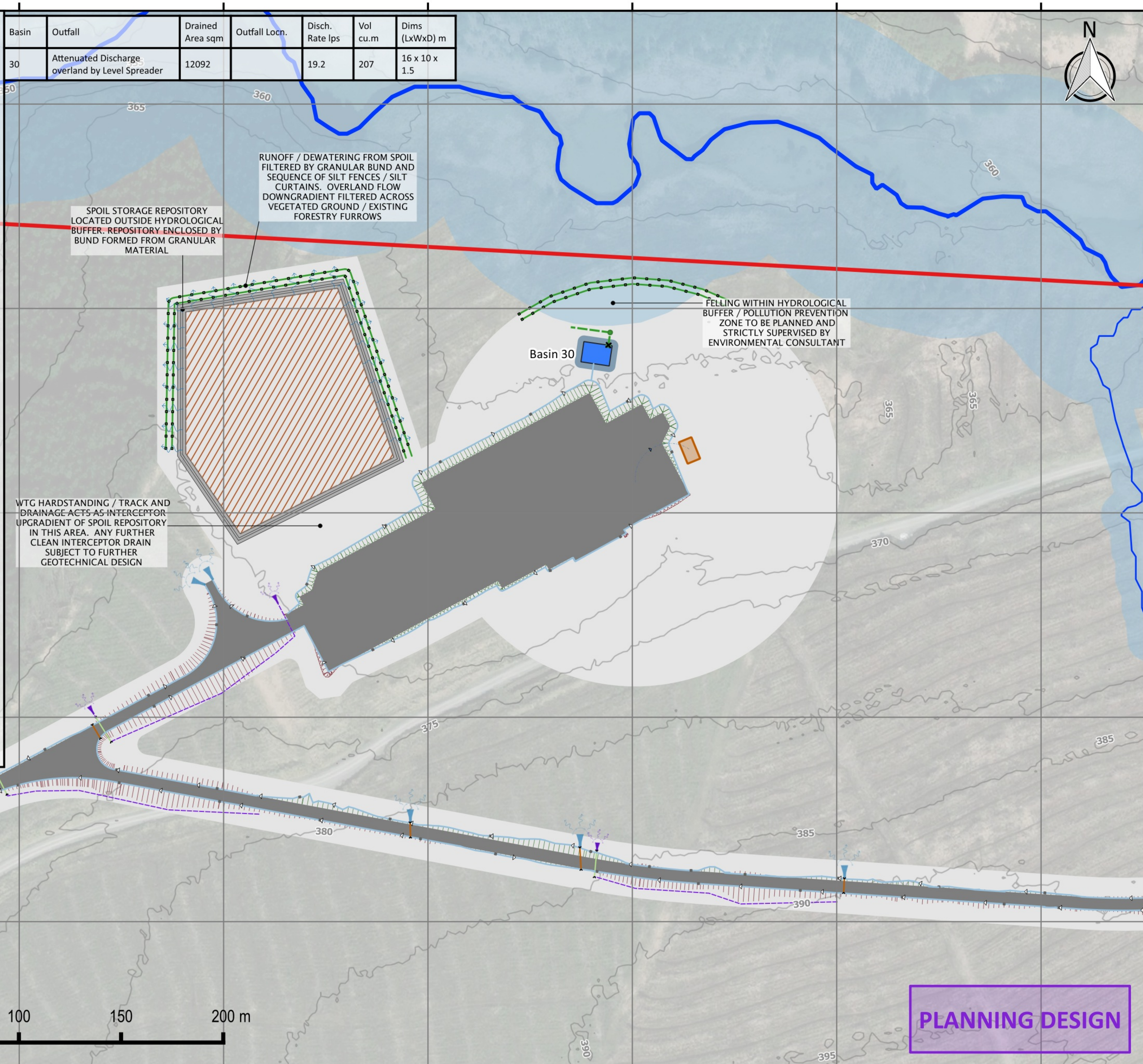
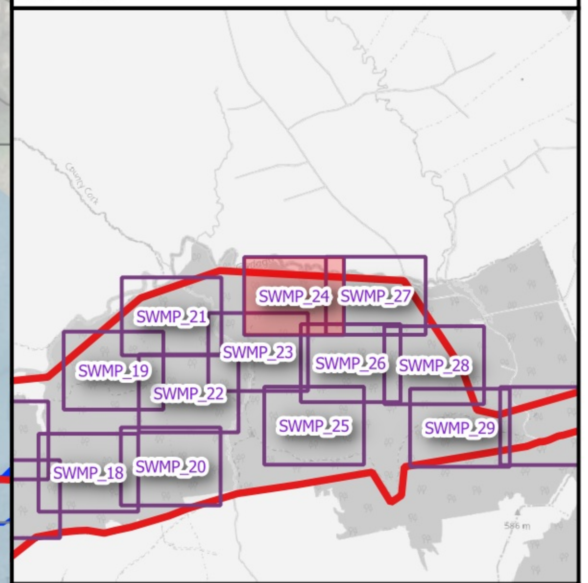
Basin	Outfall	Drained Area sqm	Outfall Locn.	Disch. Rate lps	Vol cu.m	Dims (LxWxD) m
30	Attenuated Discharge overland by Level Spreader	12092		19.2	207	16 x 10 x 1.5



KEY PLAN



LEGEND

The Development
- Planning Application Boundary
- Wind Farm Infrastructure
- Indicates Cut
- Indicates Fill
- Spoil Repository
- Borrowpit

Existing Hydrology
- Major Watercourse
- Minor Watercourse
- Other minor / ephemeral (implied from LiDAR)
- Hydrological buffers (10m/60m)

Track Drainage Features
- Trackside Drain & Checkdam
- Clean Cutoff Drain
- Clean Drainage Pipe
- Dirty Track Drainage Pipe
- Watercourse Crossings
- Flow Control & Outfall to Watercourse
- Flow Control & Discharge by level spreader
- Track Drainage Breakout
- Attenuation + Settlement Basin
- Borrowpit Grips
- Borrowpit Settlement Lagoon
- Dewatering / Settlement Basin
- Indicative pumped dewatering
- Temporary Silt Fence
- Temporary Berm

POLLUTION PREVENTION GUIDANCE NOTES:

1.Suitable SUDS prevention measures should be in place at all times to prevent the conveyance of sediment to receiving watercourses.

2.Temporary or permanent SuDS features should be installed BEFORE or adjacent to construction of new access road and hardstanding.

3.Clean water cutoff ditch and crossing should be planned and installed BEFORE construction. Clean water management must consider spoil deposition on the site.

4.Direct discharge of untreated road drainage to watercourses shall not be permitted.

5.Buffer zones are to be maintained around all relevant watercourses as indicated on this drawing. No excavated material is to be stored within the buffer zone. All work in buffers to be treated as high risk requiriing pollution prevention and subject to Environmental Consultant supervision.

6.DO NOT pump water direct to watercourses.

7.DO NOT strip vegetation from existing ditches unless absolutely necessary.

8.If water pollution is identified the following steps should be adhered to:

STOP - Work in the immediate area should be stopped and the source of the pollution identified

CONTAIN - The source of the pollution should be bunded using a suitable method. Natural watercourses should be temporarily diverted around the source of pollution.

NOTIFY - The local authority and Client/Developer should be notified immediately to ensure that measures can be implemented downstream to protect fisheries and other sensitive areas.

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DESCRIPTION
CUMMEENABUDDOGE WIND FARM - DRAINAGE LAYOUT SHEET 24

PROJECT / FIGURE NO.
M01944-02_SWMP_24

DRAWN BY	SCALE	REVISION	DATE
DKS	1:2000	2	21/06/2024

FuturEnergy Ireland

NOTES

GENERAL

1.DRAWINGS ARE INTENDED TO INFORM THE PLANNING APPLICATION. DRAWINGS ARE NOT INTENDED FOR CONSTRUCTION AND SHOULD NOT BE USED AS SUCH. FOR AVOIDANCE OF DOUBT, SURFACE WATER MANAGEMENT DESIGN IS INTENDED TO BE FURTHER DEVELOPED POST-CONSENT OF THE PLANNING APPLICATION INCLUDING MICROSITING.
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3.ADDITIONAL TEMPORARY DRAINAGE / MITIGATION WILL BE PROVIDED DURING THE CONSTRUCTION PHASE ON AN OBSERVATIONAL BASIS.
4.BACKGROUND MAPPING REPRODUCED © OPENSTREETMAP CONTRIBUTORS
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POLLUTION PREVENTION

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TRACK / INFRASTRUCTURE DRAINAGE

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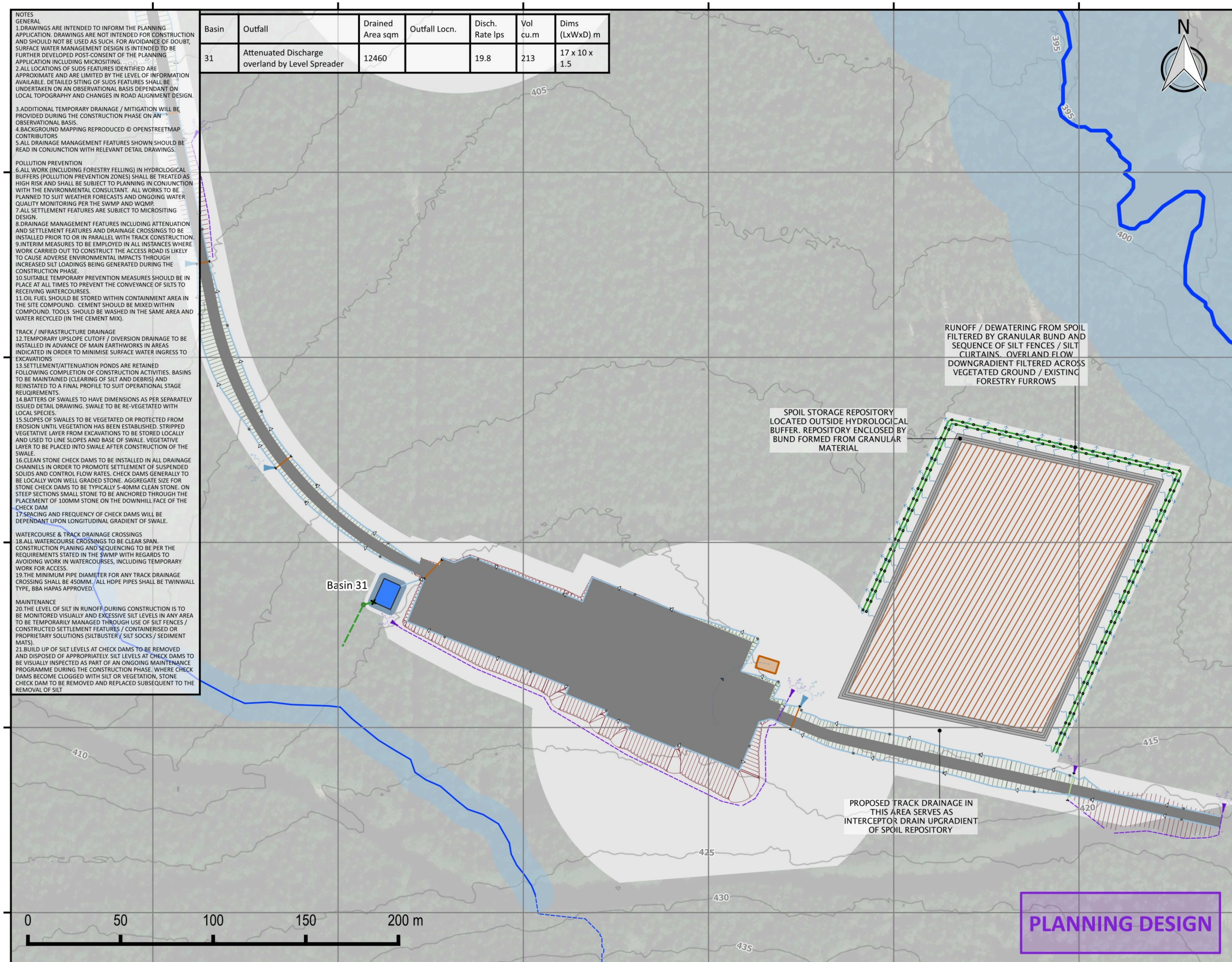
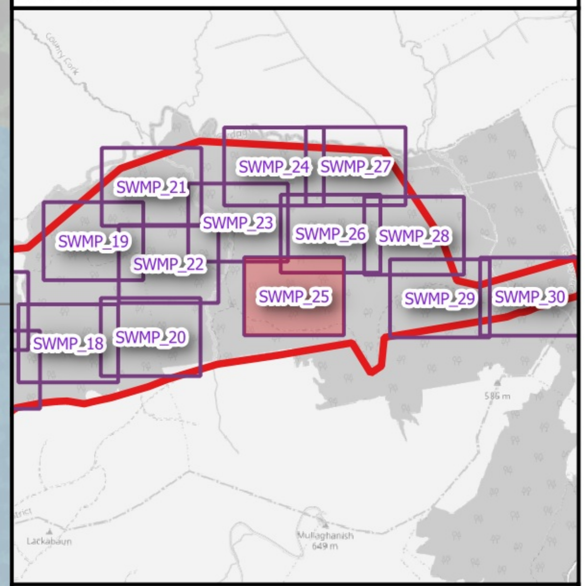
Basin	Outfall	Drained Area sqm	Outfall Locn.	Disch. Rate lps	Vol cu.m	Dims (LxWxD) m
31	Attenuated Discharge overland by Level Spreader	12460		19.8	213	17 x 10 x 1.5



KEY PLAN



LEGEND

The Development
- Planning Application Boundary
- Wind Farm Infrastructure
- Indicates Cut
- Indicates Fill
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- Borrowpit

Existing Hydrology
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POLLUTION PREVENTION GUIDANCE NOTES:

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DESCRIPTION
CUMMEENABUDDOGE WIND FARM - DRAINAGE LAYOUT SHEET 25

PROJECT / FIGURE NO.
M01944-02_SWMP_25

DRAWN BY	SCALE	REVISION	DATE
DKS	1:2000	2	21/06/2024

FuturEnergy Ireland

NOTES

GENERAL

1.DRAWINGS ARE INTENDED TO INFORM THE PLANNING APPLICATION. DRAWINGS ARE NOT INTENDED FOR CONSTRUCTION AND SHOULD NOT BE USED AS SUCH. FOR AVOIDANCE OF DOUBT, SURFACE WATER MANAGEMENT DESIGN IS INTENDED TO BE FURTHER DEVELOPED POST-CONSENT OF THE PLANNING APPLICATION INCLUDING MICROSITING.
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WATERCOURSE & TRACK DRAINAGE CROSSINGS

18.ALL WATERCOURSE CROSSINGS TO BE CLEAR SPAN. CONSTRUCTION PLANING AND SEQUENCING TO BE PER THE REQUIREMENTS STATED IN THE SWMP WITH REGARDS TO AVOIDING WORK IN WATERCOURSES, INCLUDING TEMPORARY WORK FOR ACCESS.
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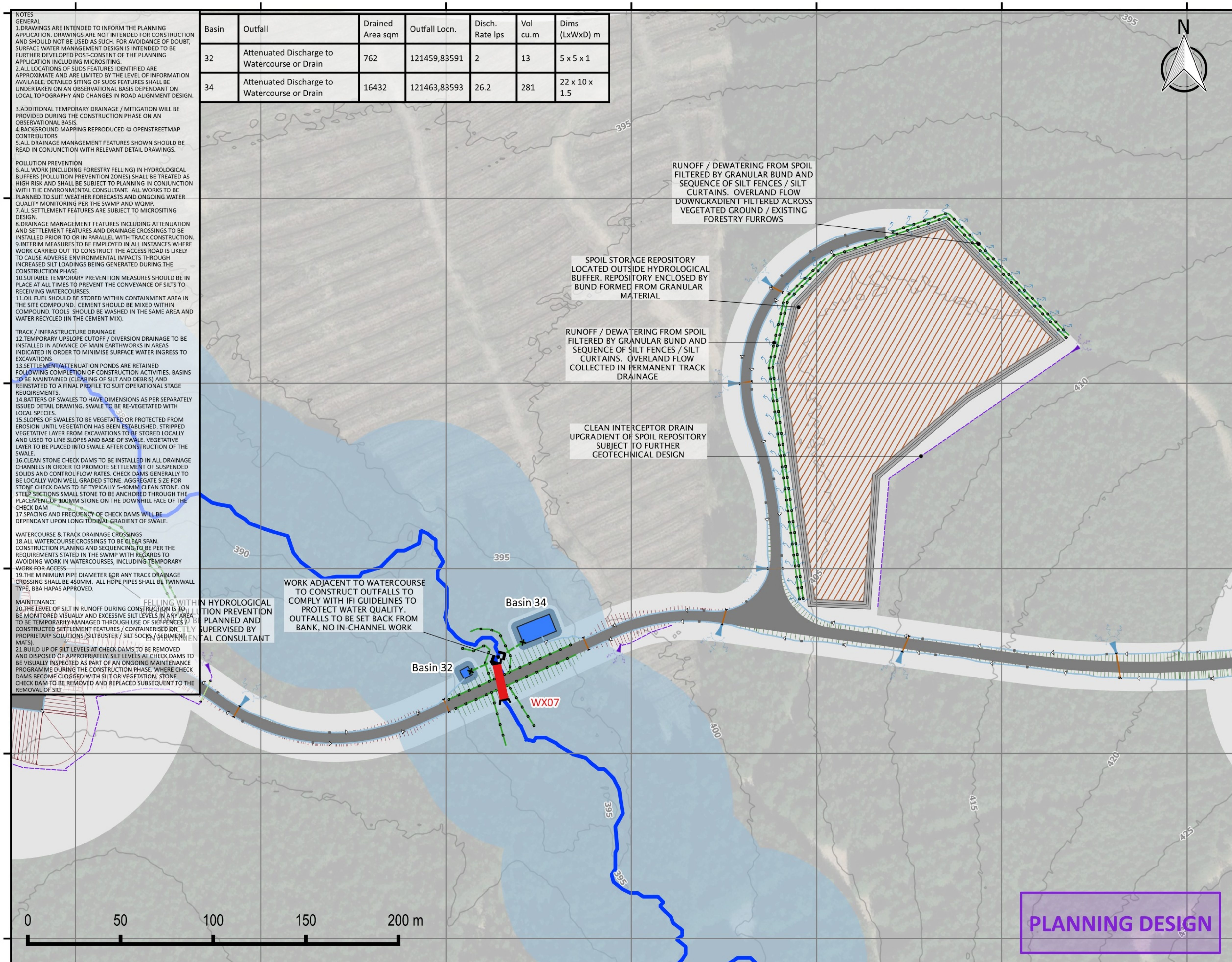
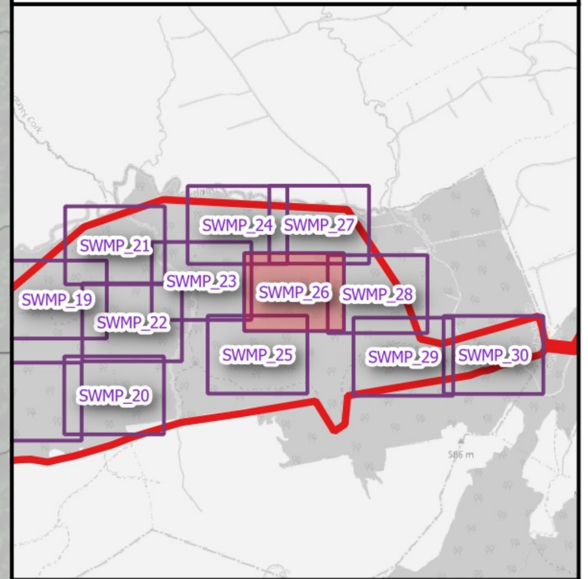
Basin	Outfall	Drained Area sqm	Outfall Locn.	Disch. Rate lps	Vol cu.m	Dims (LxWxD) m
32	Attenuated Discharge to Watercourse or Drain	762	121459,83591	2	13	5 x 5 x 1
34	Attenuated Discharge to Watercourse or Drain	16432	121463,83593	26.2	281	22 x 10 x 1.5



KEY PLAN



LEGEND

The Development
- Planning Application Boundary
- Wind Farm Infrastructure
- Indicates Cut
- Indicates Fill
- Spoil Repository
- Borrowpit

Existing Hydrology
- Major Watercourse
- Minor Watercourse
- Other minor / ephemeral (implied from LiDAR)
- Hydrological buffers (10m/60m)

Track Drainage Features
- Trackside Drain & Checkdam
- Clean Cutoff Drain
- Clean Drainage Pipe
- Dirty Track Drainage Pipe
- Watercourse Crossings
- Flow Control & Outfall to Watercourse
- Flow Control & Discharge by level spreader
- Track Drainage Breakout
- Attenuation + Settlement Basin
- Borrowpit Grips
- Borrowpit Settlement Lagoon
- Dewatering / Settlement Basin
- Indicative pumped dewatering
- Temporary Silt Fence
- Temporary Berm

WX REF	DESCRIPTION
WX07	NEW MIN. 5.0 M x 1.1 M (SPAN x HEIGHT) CLEAR SPAN BRIDGE OR BOTTOMLESS CULVERT

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1.Suitable SUDS prevention measures should be in place at all times to prevent the conveyance of sediment to receiving watercourses.

2.Temporary or permanent SuDS features should be installed BEFORE or adjacent to construction of new access road and hardstanding.

3.Clean water cutoff ditch and crossing should be planned and installed BEFORE construction. Clean water management must consider spoil deposition on the site.

4.Direct discharge of untreated road drainage to watercourses shall not be permitted.

5.Buffer zones are to be maintained around all relevant watercourses as indicated on this drawing. No excavated material is to be stored within the buffer zone. All work in buffers to be treated as high risk requiriing pollution prevention and subject to Environmental Consultant supervision.

6.DO NOT pump water direct to watercourses.

7.DO NOT strip vegetation from existing ditches unless absolutely necessary.

8.If water pollution is identified the following steps should be adhered to:

STOP - Work in the immediate area should be stopped and the source of the pollution identified

CONTAIN - The source of the pollution should be bunded using a suitable method. Natural watercourses should be temporarily diverted around the source of pollution.

NOTIFY - The local authority and Client/Developer should be notified immediately to ensure that measures can be implemented downstream to protect fisheries and other sensitive areas.

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DESCRIPTION			
CUMMEENABUDDOGE WIND FARM - DRAINAGE LAYOUT SHEET 26			
PROJECT / FIGURE NO.			
M01944-02_SWMP_26			
DRAWN BY	**SCALE**	**REVISION**	**DATE**
DKS	1:2000	2	21/06/2024

FuturEnergy Ireland

NOTES

GENERAL

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7.ALL SETTLEMENT FEATURES ARE SUBJECT TO MICROSITING DESIGN.
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9.INTERIM MEASURES TO BE EMPLOYED IN ALL INSTANCES WHERE WORK CARRIED OUT TO CONSTRUCT THE ACCESS ROAD IS LIKELY TO CAUSE ADVERSE ENVIRONMENTAL IMPACTS THROUGH INCREASED SILT LOADINGS BEING GENERATED DURING THE CONSTRUCTION PHASE.
10.SUITABLE TEMPORARY PREVENTION MEASURES SHOULD BE IN PLACE AT ALL TIMES TO PREVENT THE CONVEYANCE OF SILTS TO RECEIVING WATERCOURSES.
11.OIL FUEL SHOULD BE STORED WITHIN CONTAINMENT AREA IN THE SITE COMPOUND. CEMENT SHOULD BE MIXED WITHIN COMPOUND. TOOLS SHOULD BE WASHED IN THE SAME AREA AND WATER RECYCLED (IN THE CEMENT MIX).

TRACK / INFRASTRUCTURE DRAINAGE

12.TEMPORARY UPSLOPE CUTOFF / DIVERSION DRAINAGE TO BE INSTALLED IN ADVANCE OF MAIN EARTHWORKS IN AREAS INDICATED IN ORDER TO MINIMISE SURFACE WATER INGRESS TO EXCAVATIONS
13.SETTLEMENT/ATTENUATION PONDS ARE RETAINED FOLLOWING COMPLETION OF CONSTRUCTION ACTIVITIES. BASINS TO BE MAINTAINED (CLEARING OF SILT AND DEBRIS) AND REINSTATED TO A FINAL PROFILE TO SUIT OPERATIONAL STAGE REUQIREMENTS.
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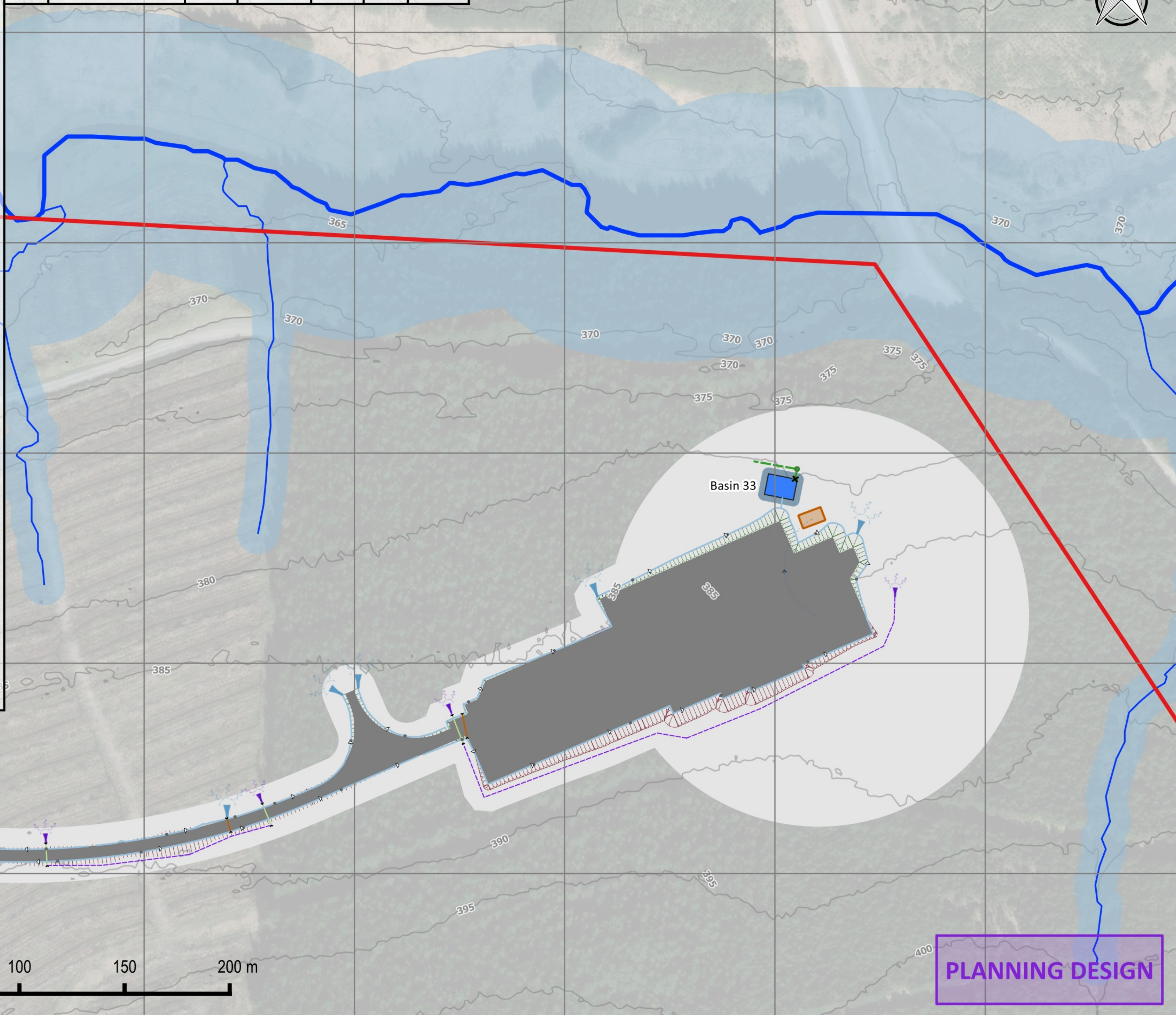
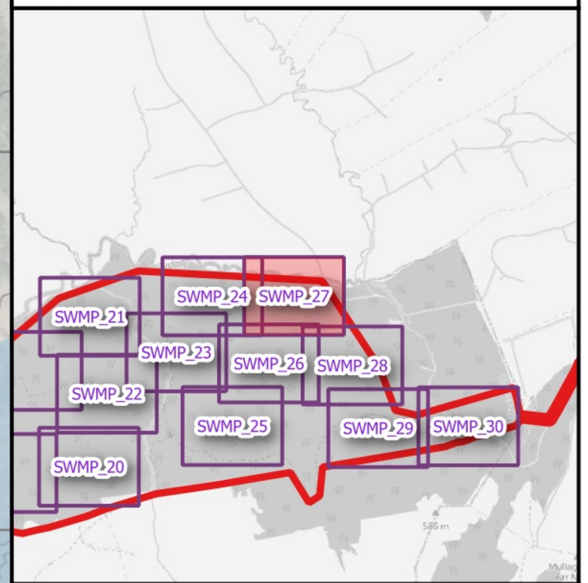
Basin	Outfall	Drained Area sqm	Outfall Locn.	Disch. Rate lps	Vol cu.m	Dims (LxWxD) m
33	Attenuated Discharge overland by Level Spreader	12575		20	215	17 x 10 x 1.5



KEY PLAN



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- Indicates Cut
- Indicates Fill
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DESCRIPTION			
CUMMEENABUDDOGE WIND FARM - DRAINAGE LAYOUT SHEET 27			
PROJECT / FIGURE NO.			
M01944-02_SWMP_27			
DRAWN BY	SCALE	REVISION	DATE
DKS	1:2000	2	21/06/2024

FuturEnergy Ireland

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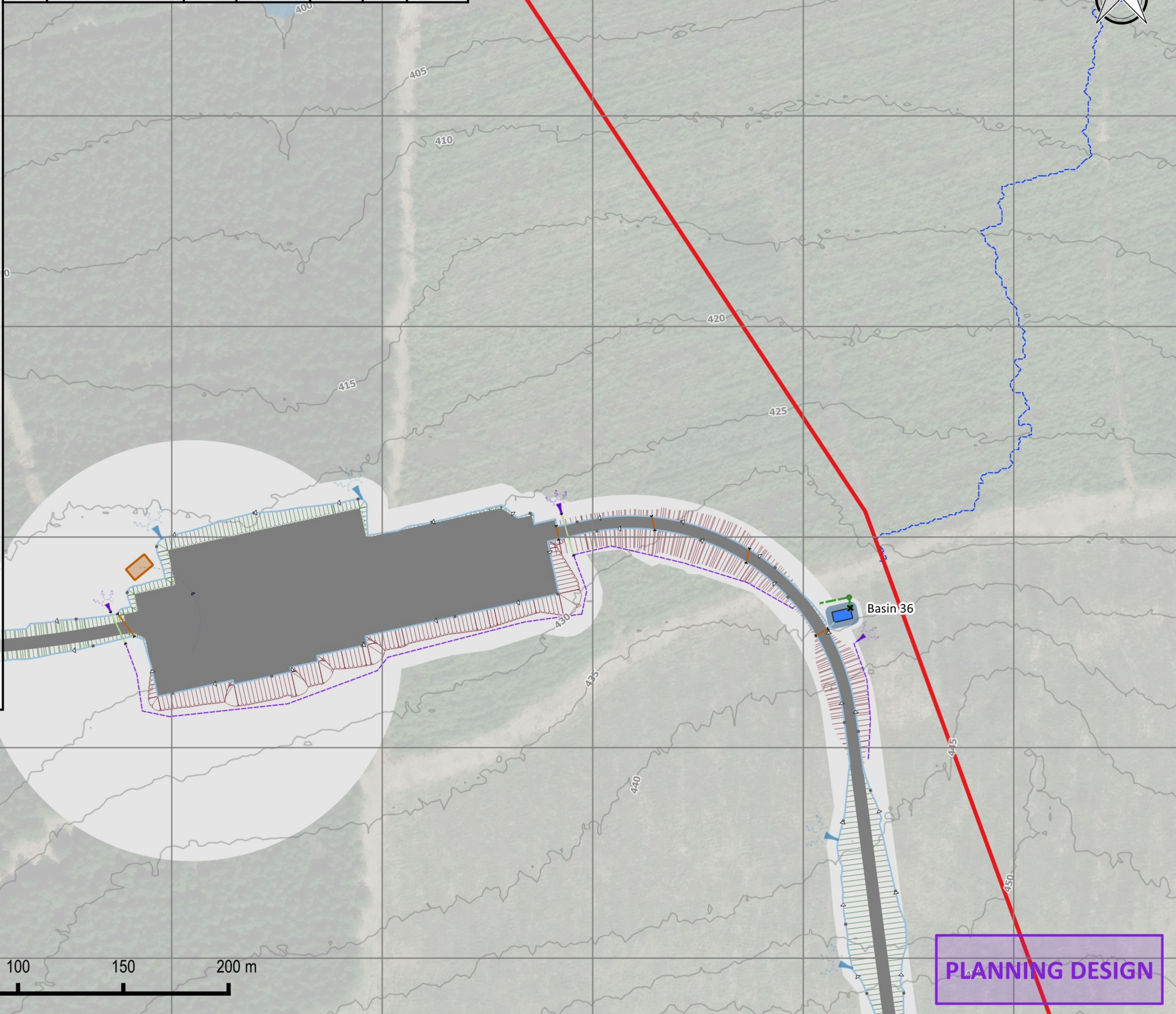
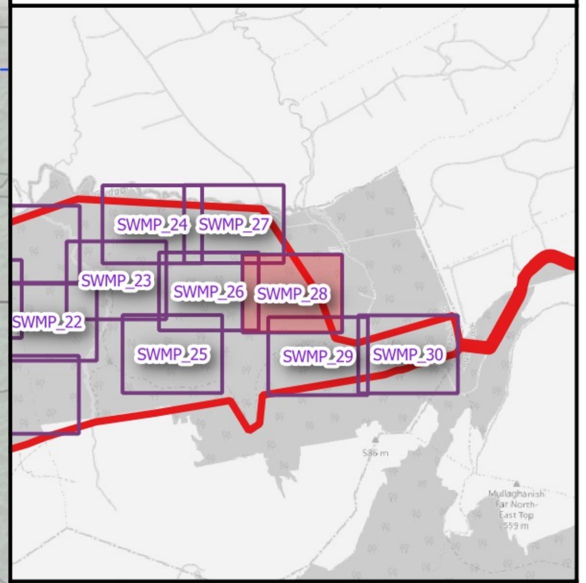


KEY PLAN



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DESCRIPTION			
CUMMEENABUDDOGE WIND FARM - DRAINAGE LAYOUT SHEET 28			
PROJECT / FIGURE NO.			
M01944-02_SWMP_28			
DRAWN BY	SCALE	REVISION	DATE
DKS	1:2000	2	21/06/2024

FuturEnergy Ireland

NOTES

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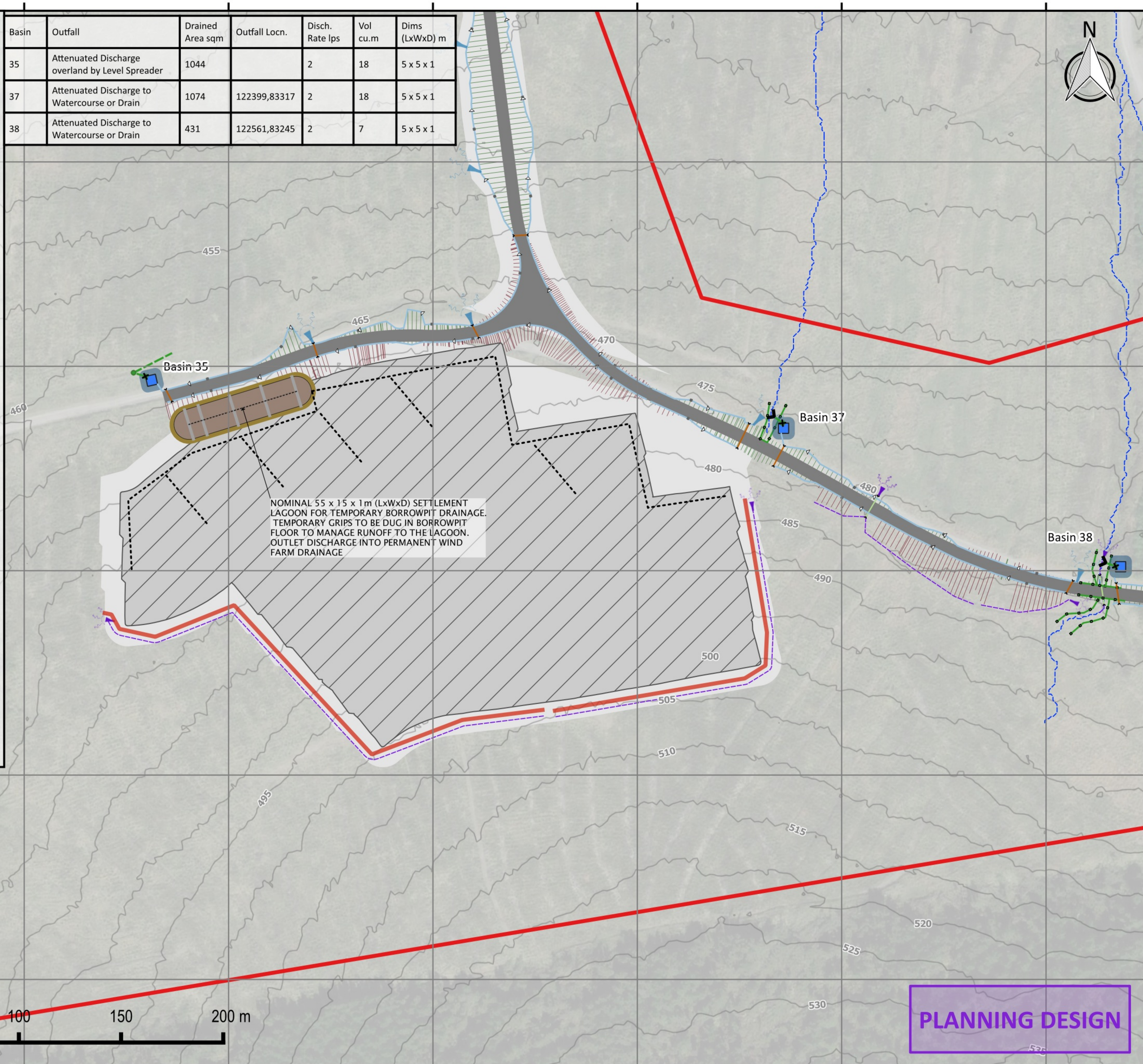
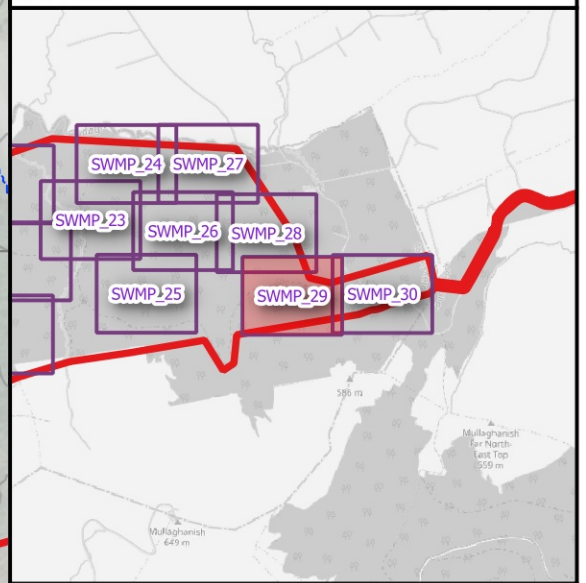
Basin	Outfall	Drained Area sqm	Outfall Locn.	Disch. Rate lps	Vol cu.m	Dims (LxWxD) m
35	Attenuated Discharge overland by Level Spreader	1044		2	18	5 x 5 x 1
37	Attenuated Discharge to Watercourse or Drain	1074	122399,83317	2	18	5 x 5 x 1
38	Attenuated Discharge to Watercourse or Drain	431	122561,83245	2	7	5 x 5 x 1



KEY PLAN



LEGEND

The Development
- Planning Application Boundary
- Wind Farm Infrastructure
- Indicates Cut
- Indicates Fill
- Spoil Repository
- Borrowpit

Existing Hydrology
- Major Watercourse
- Minor Watercourse
- Other minor / ephemeral (implied from LiDAR)
- Hydrological buffers (10m/60m)

Track Drainage Features
- Trackside Drain & Checkdam
- Clean Cutoff Drain
- Clean Drainage Pipe
- Dirty Track Drainage Pipe
- Watercourse Crossings
- Flow Control & Outfall to Watercourse
- Flow Control & Discharge by level spreader
- Track Drainage Breakout
- Attenuation + Settlement Basin
- Borrowpit Grips
- Borrowpit Settlement Lagoon
- Dewatering / Settlement Basin
- Indicative pumped dewatering
- Temporary Silt Fence
- Temporary Berm

POLLUTION PREVENTION GUIDANCE NOTES:

1.Suitable SUDS prevention measures should be in place at all times to prevent the conveyance of sediment to receiving watercourses.

2.Temporary or permanent SuDS features should be installed BEFORE or adjacent to construction of new access road and hardstanding.

3.Clean water cutoff ditch and crossing should be planned and installed BEFORE construction. Clean water management must consider spoil deposition on the site.

4.Direct discharge of untreated road drainage to watercourses shall not be permitted.

5.Buffer zones are to be maintained around all relevant watercourses as indicated on this drawing. No excavated material is to be stored within the buffer zone. All work in buffers to be treated as high risk requiriing pollution prevention and subject to Environmental Consultant supervision.

6.DO NOT pump water direct to watercourses.

7.DO NOT strip vegetation from existing ditches unless absolutely necessary.

8.If water pollution is identified the following steps should be adhered to:

STOP - Work in the immediate area should be stopped and the source of the pollution identified

CONTAIN - The source of the pollution should be bunded using a suitable method. Natural watercourses should be temporarily diverted around the source of pollution.

NOTIFY - The local authority and Client/Developer should be notified immediately to ensure that measures can be implemented downstream to protect fisheries and other sensitive areas.

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DESCRIPTION
CUMMEENABUDDOGE WIND FARM - DRAINAGE LAYOUT SHEET 29

PROJECT / FIGURE NO.
M01944-02_SWMP_29

DRAWN BY	SCALE	REVISION	DATE
DKS	1:2000	2	21/06/2024

FuturEnergy Ireland

NOTES

GENERAL

1.DRAWINGS ARE INTENDED TO INFORM THE PLANNING APPLICATION. DRAWINGS ARE NOT INTENDED FOR CONSTRUCTION AND SHOULD NOT BE USED AS SUCH. FOR AVOIDANCE OF DOUBT, SURFACE WATER MANAGEMENT DESIGN IS INTENDED TO BE FURTHER DEVELOPED POST-CONSENT OF THE PLANNING APPLICATION INCLUDING MICROSITING.

2.ALL LOCATIONS OF SUDS FEATURES IDENTIFIED ARE APPROXIMATE AND ARE LIMITED BY THE LEVEL OF INFORMATION AVAILABLE. DETAILED SITING OF SUDS FEATURES SHALL BE UNDERTAKEN ON AN OBSERVATIONAL BASIS DEPENDANT ON LOCAL TOPOGRAPHY AND CHANGES IN ROAD ALIGNMENT DESIGN.

3.ADDITIONAL TEMPORARY DRAINAGE / MITIGATION WILL BE PROVIDED DURING THE CONSTRUCTION PHASE ON AN OBSERVATIONAL BASIS.

4.BACKGROUND MAPPING REPRODUCED © OPENSTREETMAP CONTRIBUTORS

5.ALL DRAINAGE MANAGEMENT FEATURES SHOWN SHOULD BE READ IN CONJUNCTION WITH RELEVANT DETAIL DRAWINGS.

POLLUTION PREVENTION

6.ALL WORK (INCLUDING FORESTRY FELLING) IN HYDROLOGICAL BUFFERS (POLLUTION PREVENTION ZONES) SHALL BE TREATED AS HIGH RISK AND SHALL BE SUBJECT TO PLANNING IN CONJUNCTION WITH THE ENVIRONMENTAL CONSULTANT. ALL WORKS TO BE PLANNED TO SUIT WEATHER FORECASTS AND ONGOING WATER QUALITY MONITORING PER THE SWMP AND WQMP.

7.ALL SETTLEMENT FEATURES ARE SUBJECT TO MICROSITING DESIGN.

8.DRAINAGE MANAGEMENT FEATURES INCLUDING ATTENUATION AND SETTLEMENT FEATURES AND DRAINAGE CROSSINGS TO BE INSTALLED PRIOR TO OR IN PARALLEL WITH TRACK CONSTRUCTION.

9.INTERIM MEASURES TO BE EMPLOYED IN ALL INSTANCES WHERE WORK CARRIED OUT TO CONSTRUCT THE ACCESS ROAD IS LIKELY TO CAUSE ADVERSE ENVIRONMENTAL IMPACTS THROUGH INCREASED SILT LOADINGS BEING GENERATED DURING THE CONSTRUCTION PHASE.

10.SUITABLE TEMPORARY PREVENTION MEASURES SHOULD BE IN PLACE AT ALL TIMES TO PREVENT THE CONVEYANCE OF SILTS TO RECEIVING WATERCOURSES.

11.OIL FUEL SHOULD BE STORED WITHIN CONTAINMENT AREA IN THE SITE COMPOUND. CEMENT SHOULD BE MIXED WITHIN COMPOUND. TOOLS SHOULD BE WASHED IN THE SAME AREA AND WATER RECYCLED (IN THE CEMENT MIX).

TRACK / INFRASTRUCTURE DRAINAGE

12.TEMPORARY UPSLOPE CUTOFF / DIVERSION DRAINAGE TO BE INSTALLED IN ADVANCE OF MAIN EARTHWORKS IN AREAS INDICATED IN ORDER TO MINIMISE SURFACE WATER INGRESS TO EXCAVATIONS

13.SETTLEMENT/ATTENUATION PONDS ARE RETAINED FOLLOWING COMPLETION OF CONSTRUCTION ACTIVITIES. BASINS TO BE MAINTAINED (CLEARING OF SILT AND DEBRIS) AND REINSTATED TO A FINAL PROFILE TO SUIT OPERATIONAL STAGE REUQIREMENTS.

14.BATTERS OF SWALES TO HAVE DIMENSIONS AS PER SEPARATELY ISSUED DETAIL DRAWING. SWALE TO BE RE-VEGETATED WITH LOCAL SPECIES.

15.SLOPES OF SWALES TO BE VEGETATED OR PROTECTED FROM EROSION UNTIL VEGETATION HAS BEEN ESTABLISHED. STRIPPED VEGETATIVE LAYER FROM EXCAVATIONS TO BE STORED LOCALLY AND USED TO LINE SLOPES AND BASE OF SWALE. VEGETATIVE LAYER TO BE PLACED INTO SWALE AFTER CONSTRUCTION OF THE SWALE.

16.CLEAN STONE CHECK DAMS TO BE INSTALLED IN ALL DRAINAGE CHANNELS IN ORDER TO PROMOTE SETTLEMENT OF SUSPENDED SOLIDS AND CONTROL FLOW RATES. CHECK DAMS GENERALLY TO BE LOCALLY WON WELL GRADED STONE. AGGREGATE SIZE FOR STONE CHECK DAMS TO BE TYPICALLY 5-40MM CLEAN STONE. ON STEEP SECTIONS SMALL STONE TO BE ANCHORED THROUGH THE PLACEMENT OF 100MM STONE ON THE DOWNHILL FACE OF THE CHECK DAM

17.SPACING AND FREQUENCY OF CHECK DAMS WILL BE DEPENDANT UPON LONGITUDINAL GRADIENT OF SWALE.

WATERCOURSE & TRACK DRAINAGE CROSSINGS

18.ALL WATERCOURSE CROSSINGS TO BE CLEAR SPAN. CONSTRUCTION PLANING AND SEQUENCING TO BE PER THE REQUIREMENTS STATED IN THE SWMP WITH REGARDS TO AVOIDING WORK IN WATERCOURSES, INCLUDING TEMPORARY WORK FOR ACCESS.

19.THE MINIMUM PIPE DIAMETER FOR ANY TRACK DRAINAGE CROSSING SHALL BE 450MM. ALL HDPE PIPES SHALL BE TWINWALL TYPE, BBA HAPAS APPROVED.

MAINTENANCE

20.THE LEVEL OF SILT IN RUNOFF DURING CONSTRUCTION IS TO BE MONITORED VISUALLY AND EXCESSIVE SILT LEVELS IN ANY AREA TO BE TEMPORARILY MANAGED THROUGH USE OF SILT FENCES / CONSTRUCTED SETTLEMENT FEATURES / CONTAINERISED OR PROPRIETARY SOLUTIONS (SILTBUSTER / SILT SOCKS / SEDIMENT MATS).

21.BUILD UP OF SILT LEVELS AT CHECK DAMS TO BE REMOVED AND DISPOSED OF APPROPRIATELY. SILT LEVELS AT CHECK DAMS TO BE VISUALLY INSPECTED AS PART OF AN ONGOING MAINTENANCE PROGRAMME DURING THE CONSTRUCTION PHASE. WHERE CHECK DAMS BECOME CLOGGED WITH SILT OR VEGETATION, STONE CHECK DAM TO BE REMOVED AND REPLACED SUBSEQUENT TO THE REMOVAL OF SILT

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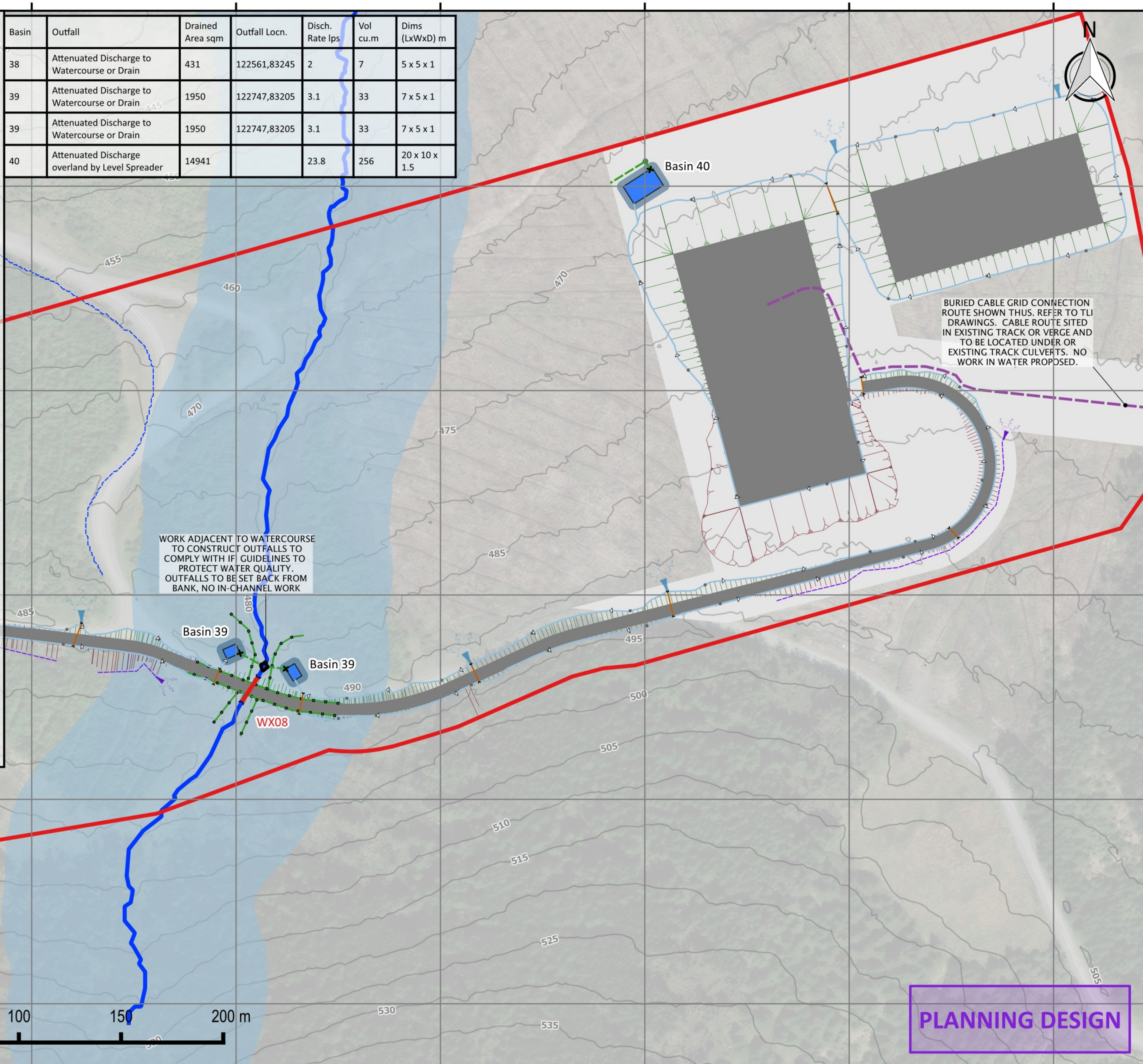
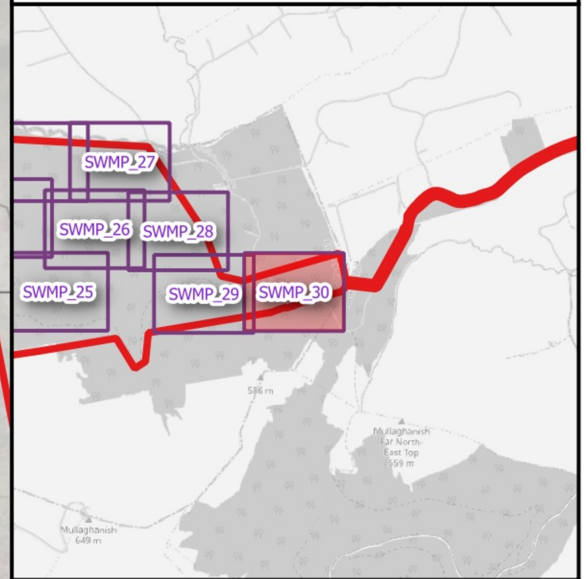
38	Attenuated Discharge to Watercourse or Drain	431	122561,83245	2	7	5 x 5 x 1
39	Attenuated Discharge to Watercourse or Drain	1950	122747,83205	3.1	33	7 x 5 x 1
39	Attenuated Discharge to Watercourse or Drain	1950	122747,83205	3.1	33	7 x 5 x 1
40	Attenuated Discharge overland by Level Spreader	14941		23.8	256	20 x 10 x 1.5



KEY PLAN



LEGEND

The Development
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- Indicates Fill
- Spoil Repository
- Borrowpit

Existing Hydrology
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Track Drainage Features
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- Clean Drainage Pipe
- Dirty Track Drainage Pipe
- Watercourse Crossings
- Flow Control & Outfall to Watercourse
- Flow Control & Discharge by level spreader
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- Attenuation + Settlement Basin
- Borrowpit Grips
- Borrowpit Settlement Lagoon
- Dewatering / Settlement Basin
- Indicative pumped dewatering
- Temporary Silt Fence
- Temporary Berm

WX REF	DESCRIPTION
WX08	NEW MIN. 2.5 M x 0.6 M (SPAN x HEIGHT) CLEAR SPAN BRIDGE OR BOTTOMLESS CULVERT

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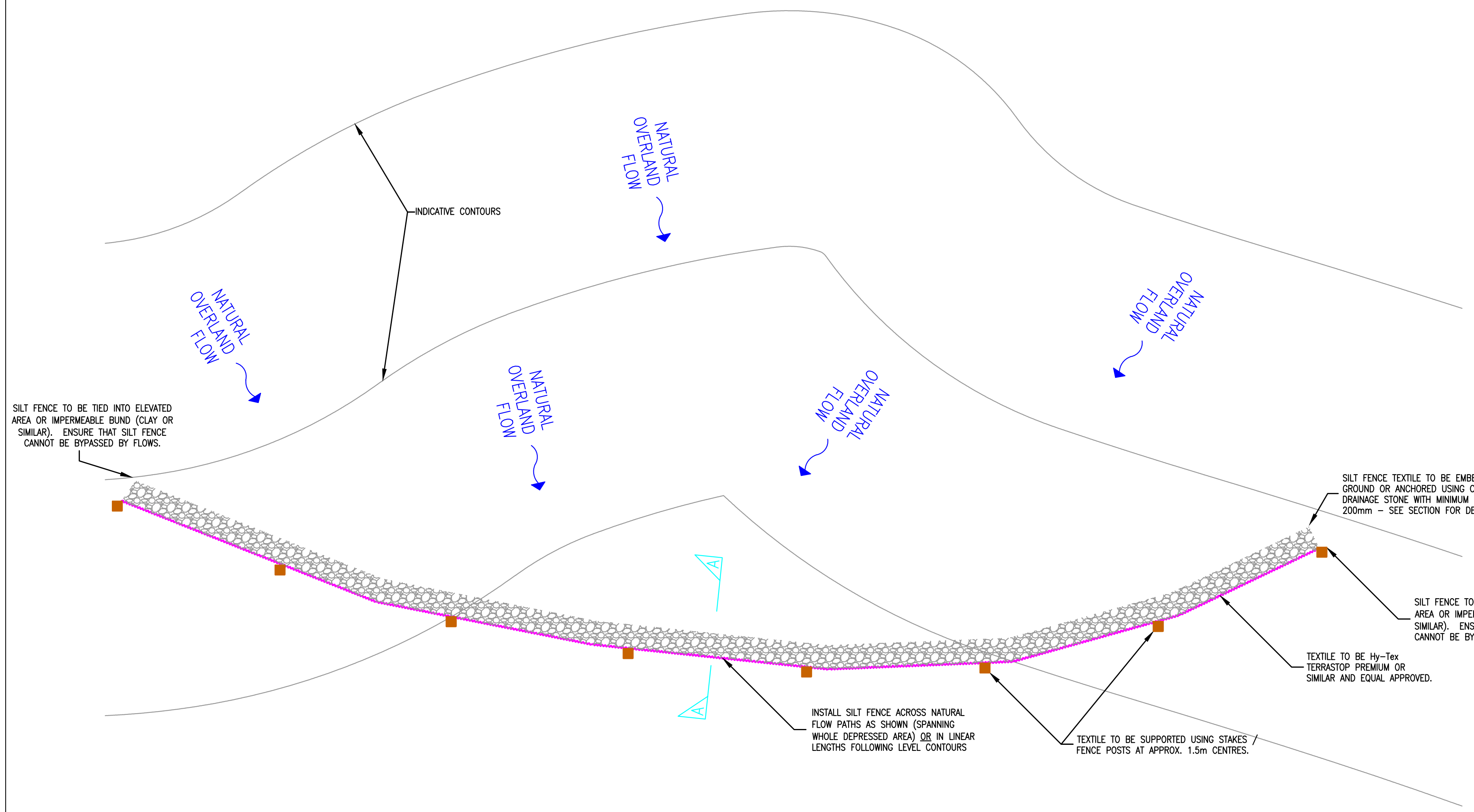
DESCRIPTION			
CUMMEENABUDDOGE WIND FARM - DRAINAGE LAYOUT SHEET 30			
PROJECT / FIGURE NO.			
M01944-02_SWMP_30			
DRAWN BY	SCALE	REVISION	DATE
DKS	1:2000	2	21/06/2024

FuturEnergy Ireland

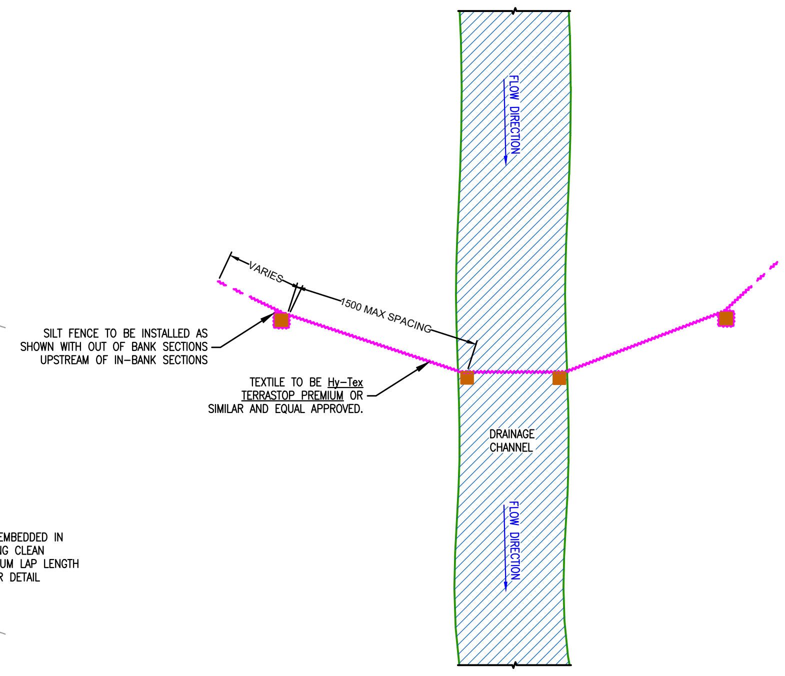
Annex B

Drainage Management – Drainage Feature Details

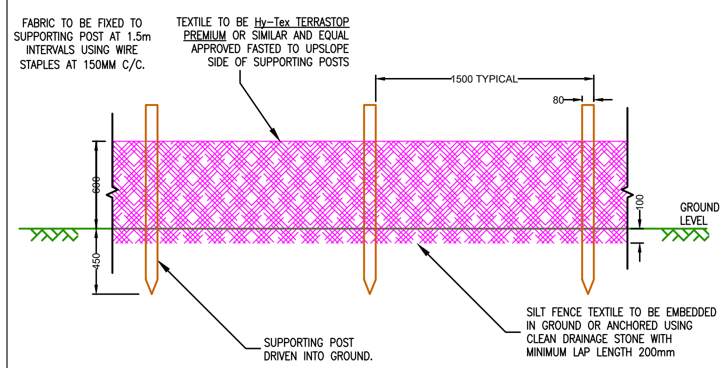
M01944-02_SWMP_200	Detail – Silt Fence
M01944-02_SWMP_201	Detail - Drainage at Excavated (Cut) Track
M01944-02_SWMP_203	Detail - Settlement Basin Arrangement
M01944-02_SWMP_204	Detail – Attenuation / Settlement Basin Arrangement
M01944-02_SWMP_206	Detail – Level Spreader, Breakout
M01944-02_SWMP_207	Detail – Clean Cutoff Drainage



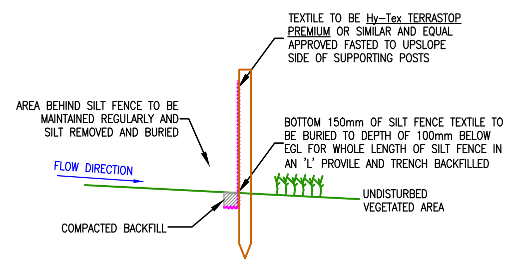
TYPICAL OVERLAND SILT FENCE PLAN
SCALE 1:25



TYPICAL CHANNEL SILT FENCE PLAN
SCALE 1:25



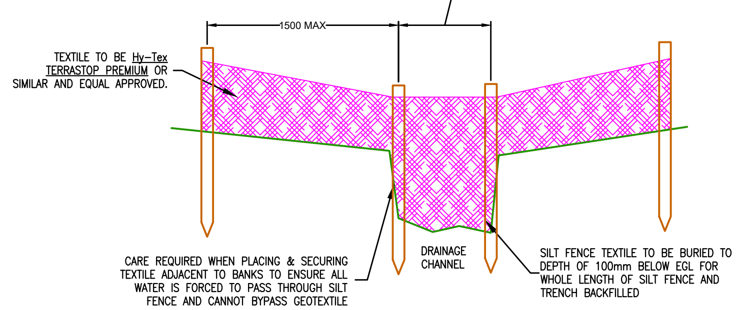
ELEVATION
SCALE 1:25



SECTION A–A
BURIED TYPE OPTION
SCALE 1:25

EXAMPLE OF CHANNEL SILT FENCE INSTALLATION
NTS

NOTE – IN–CHANNEL SILT FENCE BARRIERS ARE SUITABLE ONLY FOR PEAT / FORESTRY DRAINS AND ARE NOT FOR INSTALLATION IN WATERCOURSES



TYPICAL CHANNEL SILT FENCE ELEVATION
SCALE 1:25

ISSUE	DRN	APP	DATE	NOTES / DESCRIPTION
2	KS	KS	21.06.2024	STATUS UPDATED
1	DL	KS	08.02.2024	FOR PLANNING

STATUS: PLANNING

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Carnmoney Road North
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Co. Antrim, BT36 5QA

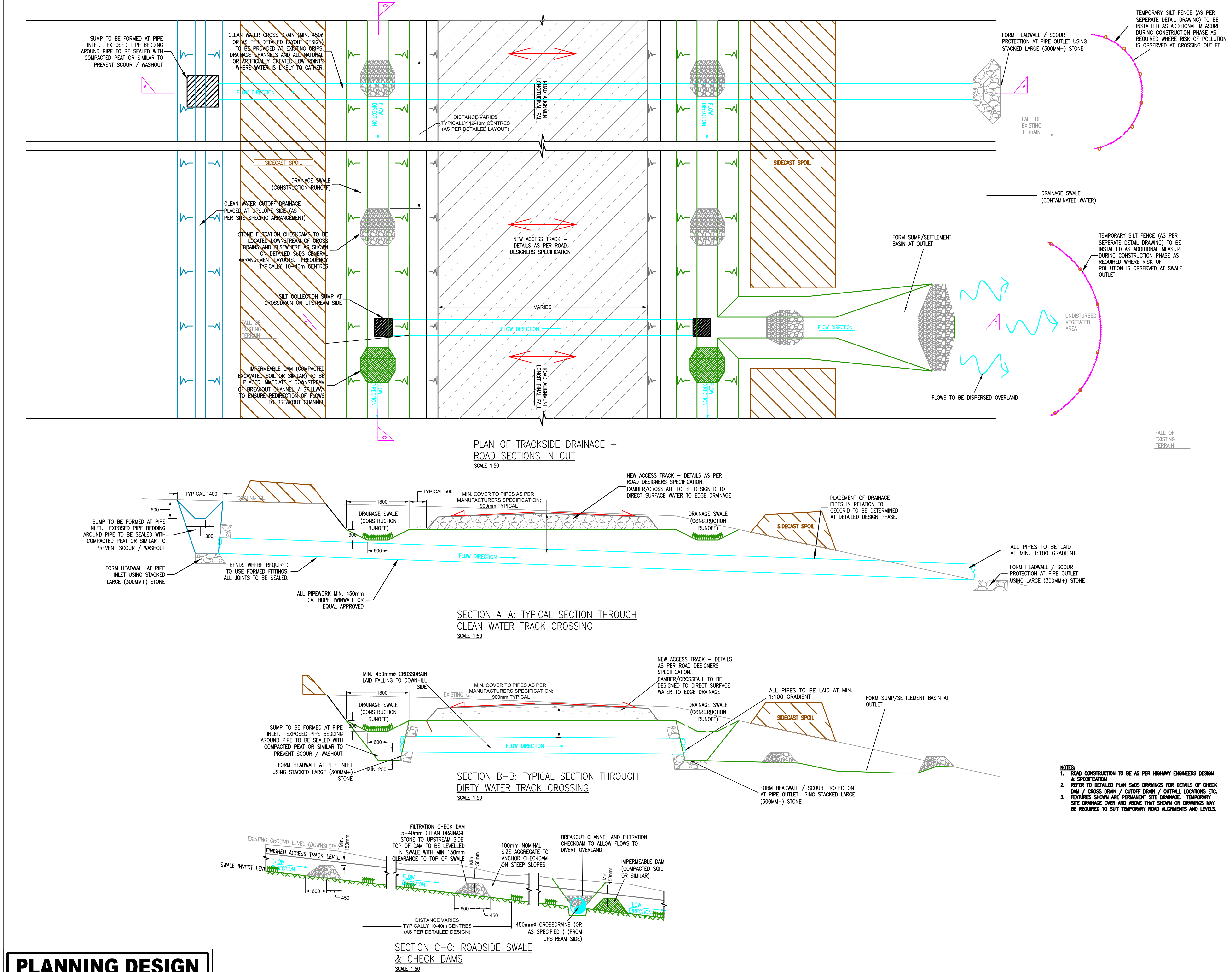
PROJECT: CUMMEENABUDDOGE WIND FARM

CLIENT: FuturEnergy Ireland

DRAWING TITLE: SURFACE WATER MANAGEMENT SILT FENCE

SCALE	ORIGINAL SIZE	
AS SHOWN@A1	A1	
DRAWN	CHECKED	DATE
KS	PDD	14/11/2023
PROJECT No.	DRAWING No.	ISSUE NO.
M01944–02	DWG_200	2

PLANNING DESIGN



NOTES:

1. ROAD CONSTRUCTION TO BE AS PER HIGHWAY ENGINEERS DESIGN & SPECIFICATION
2. REFER TO DETAILED PLAN SuDS DRAWINGS FOR DETAILS OF CHECK DAM / CROSS DRAIN / CUTOFF DRAIN / OUTFALL LOCATIONS ETC.
3. FEATURES SHOWN ARE PERMANENT SITE DRAINAGE. TEMPORARY SITE DRAINAGE OVER AND ABOVE THAT SHOWN ON DRAWINGS MAY BE REQUIRED TO SUIT TEMPORARY ROAD ALIGNMENTS AND LEVELS.

ISSUE	DRN	APP	DATE	NOTES / DESCRIPTION
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1	DL	KS	08.02.2024	FOR PLANNING

STATUS: PLANNING

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Mossley Mill, Lower Ground (West), Carnmoney Road North, Newtownabbey, Co. Antrim, BT36 5QA

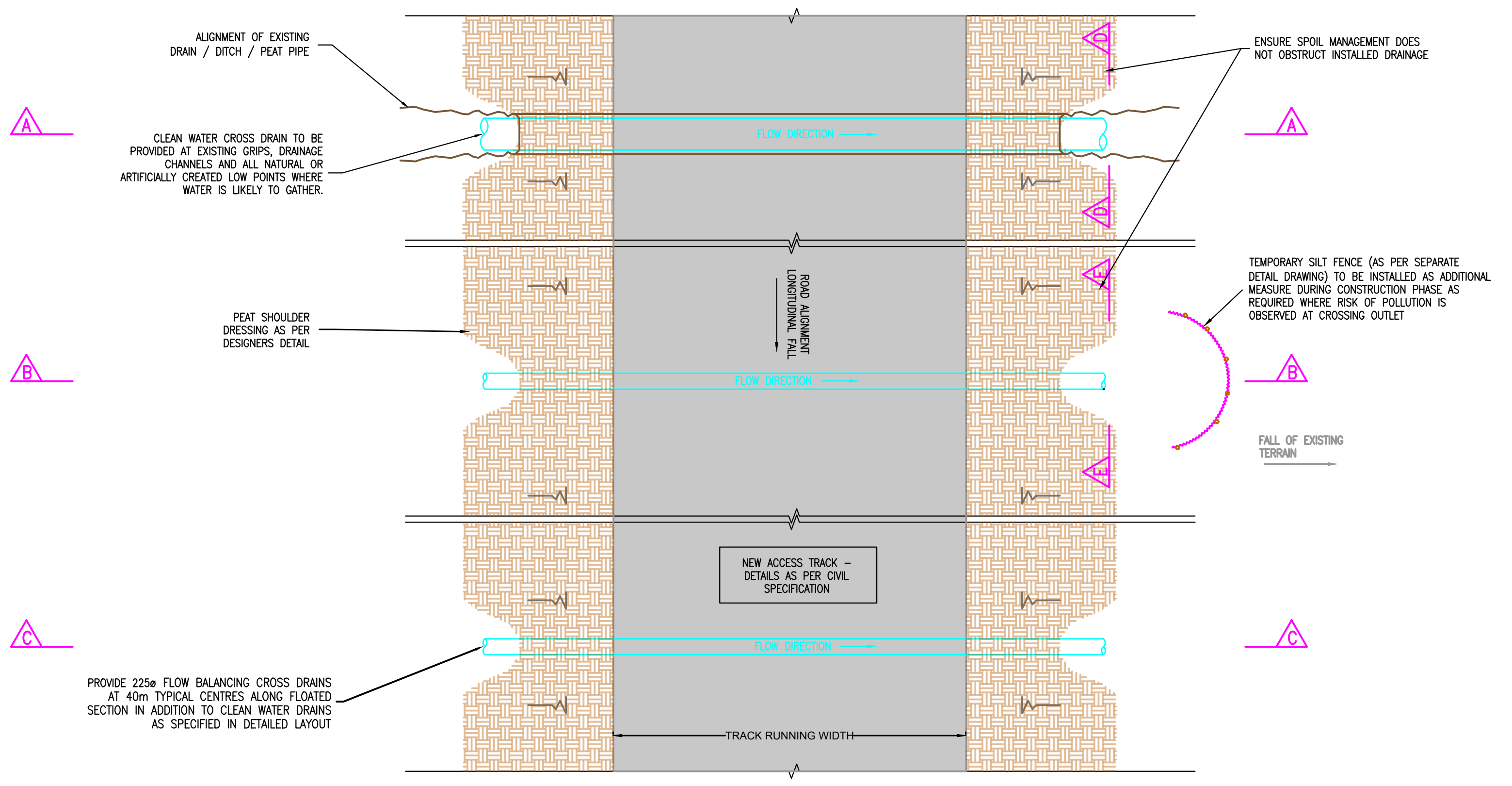
PROJECT: CUMMEENABUDDOGE WIND FARM

CLIENT: FuturEnergy Ireland

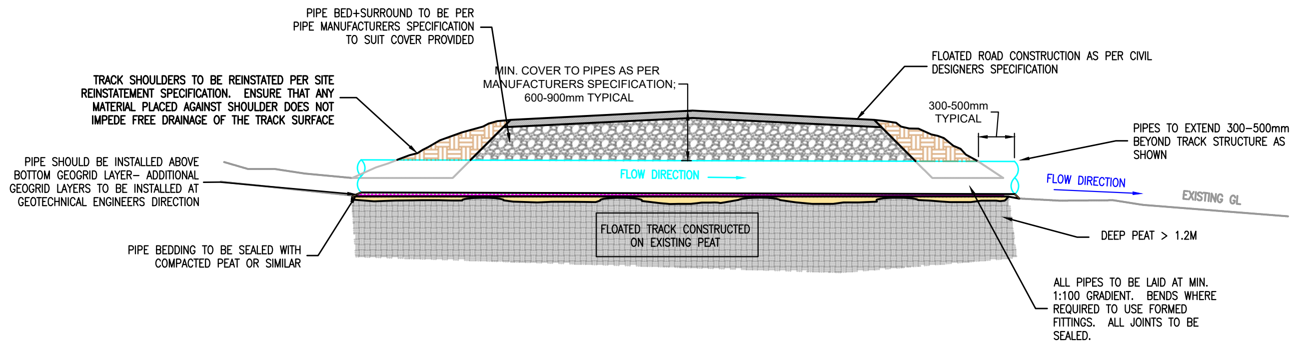
DRAWING TITLE: SURFACE WATER MANAGEMENT CUT TRACK DRAINAGE

SCALE	ORIGINAL SIZE	
AS SHOWN@A1	A1	
DRAWN	CHECKED	DATE
KS	PDD	14/11/2023
PROJECT No.	DRAWING No.	ISSUE NO.
M01944-02	DWG_201	2

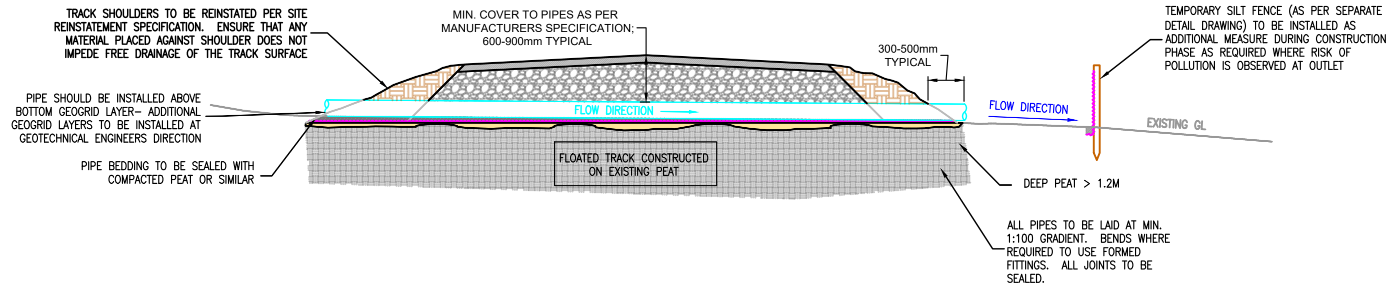
PLANNING DESIGN



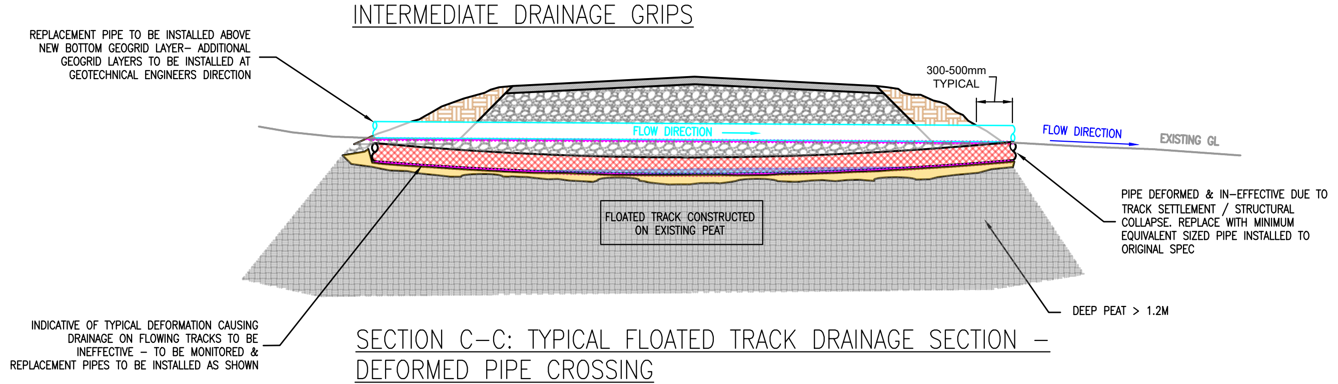
PLAN



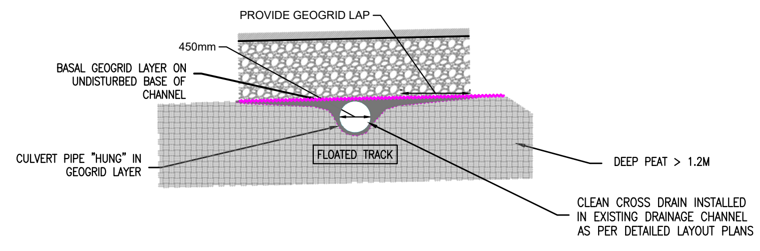
SECTION A–A: TYPICAL FLOATED TRACK DRAINAGE SECTION – CLEAN WATER CROSS DRAIN



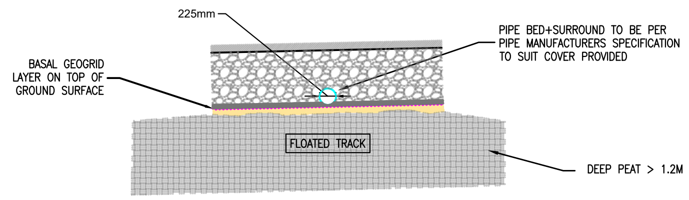
SECTION B–B: TYPICAL FLOATED TRACK DRAINAGE SECTION – INTERMEDIATE DRAINAGE GRIPS



SECTION C–C: TYPICAL FLOATED TRACK DRAINAGE SECTION – DEFORMED PIPE CROSSING



SECTION D–D: TYPICAL FLOATED TRACK DRAINAGE– CLEAN WATER CROSS DRAIN ELEVATION



SECTION E–E: TYPICAL FLOATED TRACK DRAINAGE– INTERMEDIATE DRAINAGE GRIP ELEVATION

TRACK DRAINAGE – FLOATING TRACK SECTIONS

TRACK DRAINAGE NOTES

1. ROAD CONSTRUCTION TO BE AS PER CIVIL WORKS DESIGN & SPECIFICATION. (BY OTHERS)
2. REFER TO DETAILED LAYOUT PLAN SuDS DRAWINGS FOR DETAILS OF CHECK DAM / CROSS DRAIN / CUTOFF DRAIN / OUTFALL LOCATIONS ETC. MICRO–SITING OF DRAINAGE ELEMENTS TO BE DETERMINED ON SITE IN CONJUNCTION WITH DESIGNER TO SUIT SPECIFIC CONDITIONS ENCOUNTERED.
3. FEATURES SHOWN ARE TO SUIT PERMANENT INFRASTRUCTURE. TEMPORARY SITE DRAINAGE OVER AND ABOVE THAT SHOWN ON DRAWINGS MAY BE REQUIRED TO SUIT TEMPORARY ROAD ALIGNMENTS AND LEVELS.
4. ALL EXCAVATED SLOPES TO BE BATTERED BACK TO A SAFE ANGLE OF REPOSE.
5. SPOIL SCREENING MOUNDS SHOWN INDICATIVE – REFER TO DETAILED SPOIL MANAGEMENT PLAN FOR THE DEVELOPMENT IN ALL INSTANCES FOR DETAILS OF PLACEMENT, BERM DIMENSIONS, AND COVERINGS.

ISSUE	DRN	APP	DATE	NOTES / DESCRIPTION
2	KS	KS	21.06.2024	STATUS UPDATED
1	DL	KS	08.02.2024	FOR PLANNING

STATUS: PLANNING

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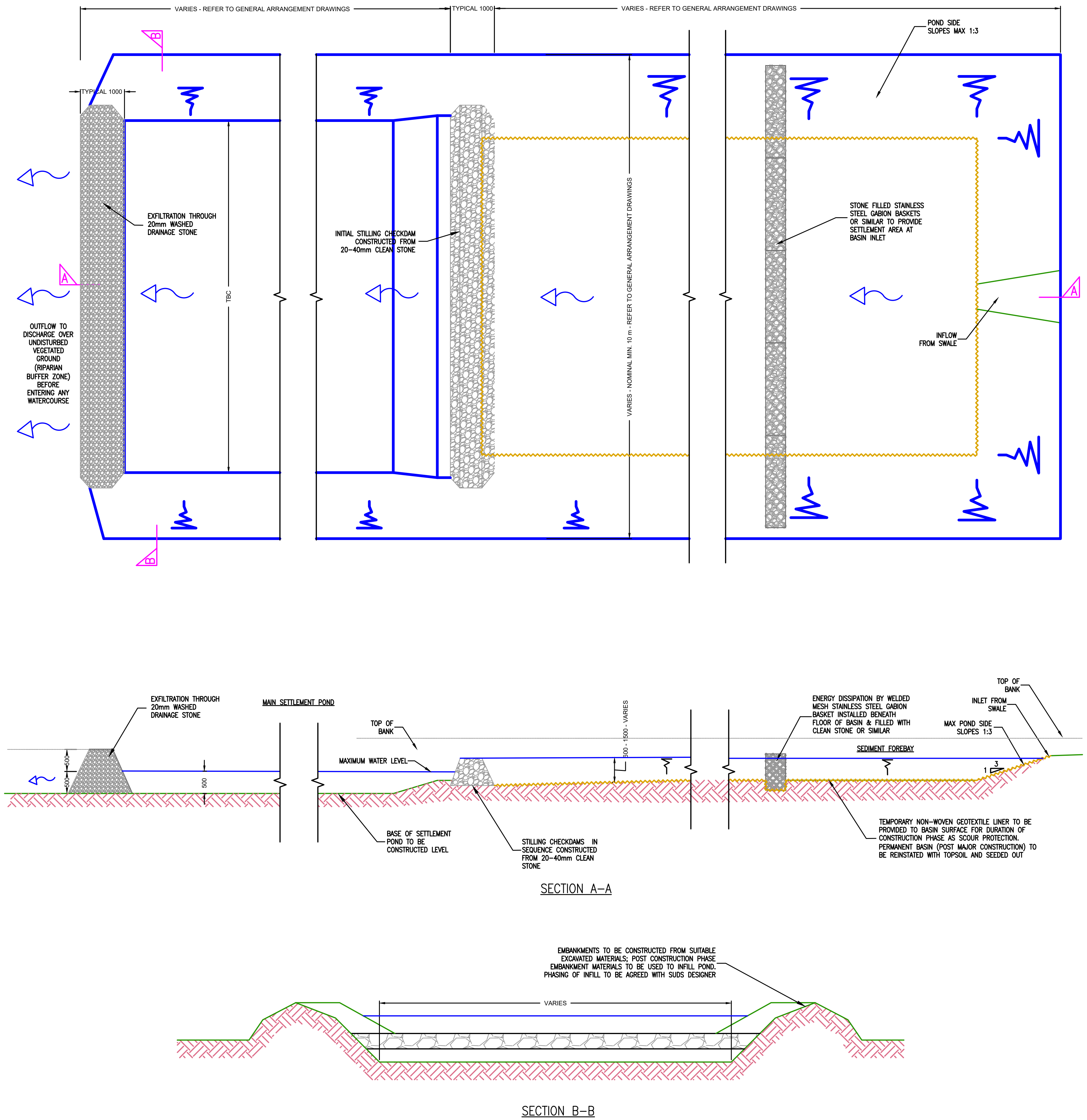
Mossley Mill, Lower Ground (West)
Carnmoney Road North
Newtownabbey
Co. Antrim, BT36 5QA

PROJECT: CUMMEENABUDDOGE WIND FARM

CLIENT: FuturEnergy Ireland

DRAWING TITLE: SURFACE WATER MANAGEMENT FLOATING TRACK DRAINAGE

SCALE	ORIGINAL SIZE	
AS SHOWN@A1	A1	
DRAWN	**CHECKED**	**DATE**
KS	PDD	14/11/2023
PROJECT No.	**DRAWING No.**	**ISSUE NO.**
M01944–02	DWG_202	2



PLANNING DESIGN

ISSUE	DRN	APP	DATE	NOTES / DESCRIPTION
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PROJECT: CUMMEENABUDDOGE WIND FARM

CLIENT: FuturEnergy Ireland

DRAWING TITLE: SURFACE WATER MANAGEMENT SETTLEMENT BASIN (BORROW PITS ETC)

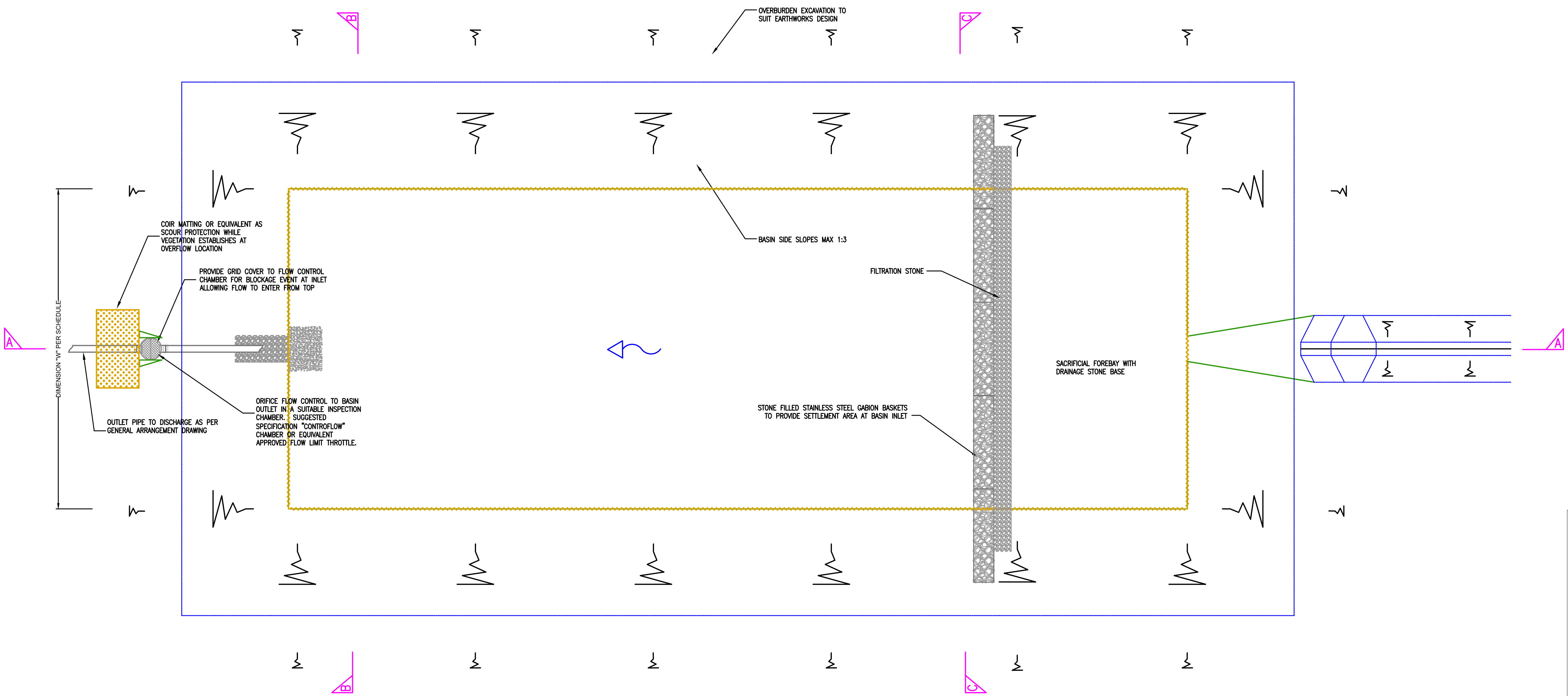
SCALE	ORIGINAL SIZE
AS SHOWN@A1	A1

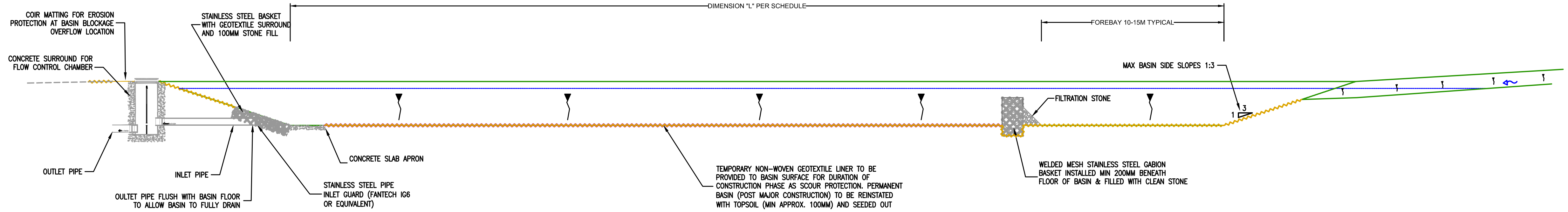
DRAWN	CHECKED	DATE
KS	PDD	14/11/2023

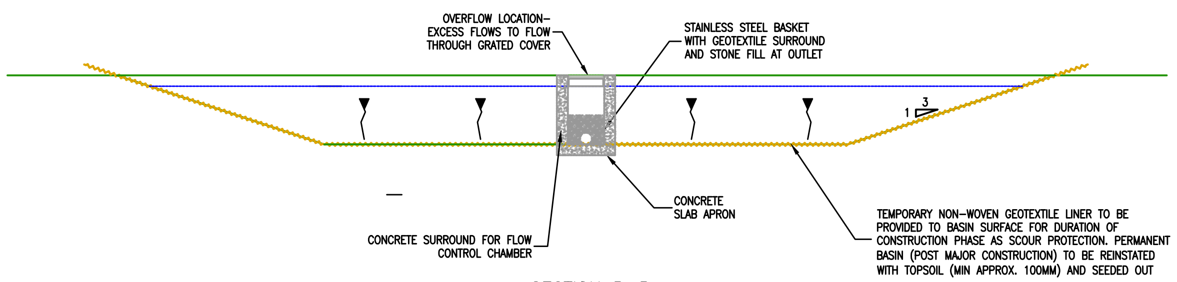
PROJECT No.	DRAWING No.	ISSUE NO.
M01944-02	DWG_203	2

DETENTION BASIN PLAN

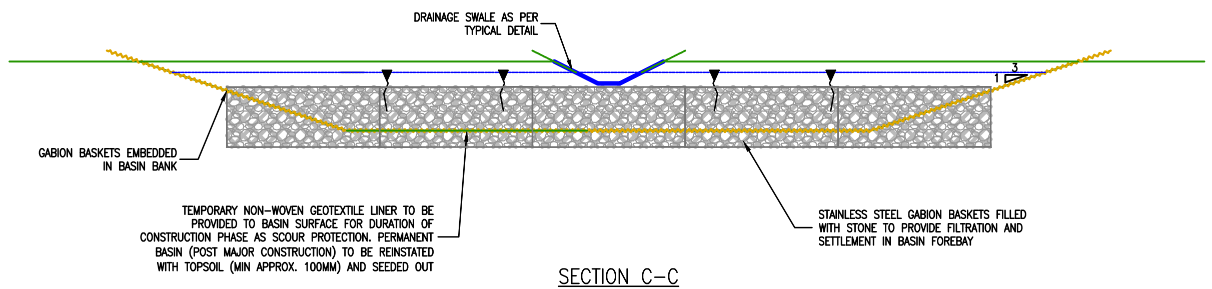
SCALE 1:50







SECTION B–B



SECTION C–C

TRACK DRAINAGE NOTES

1. ROAD CONSTRUCTION TO BE AS PER CIVIL WORKS DESIGN & SPECIFICATION. (BY OTHERS)
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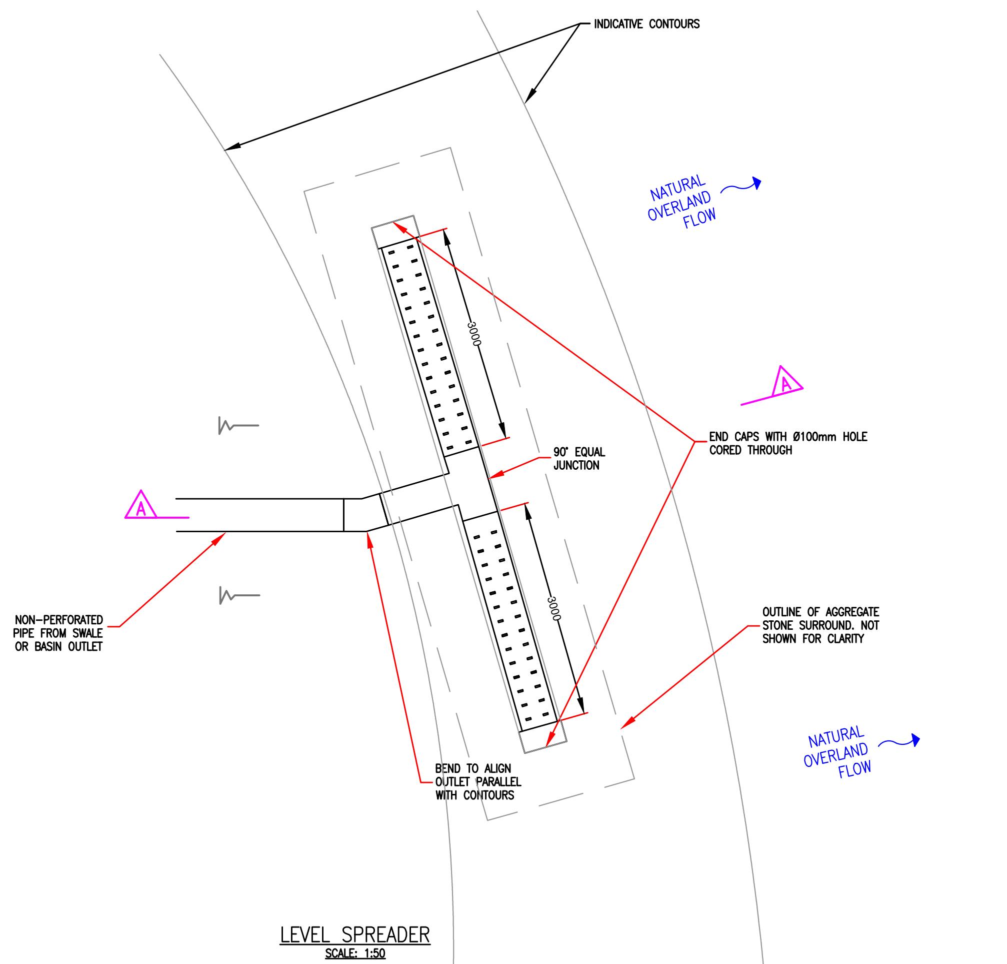
Co. Antrim, BT36 5QA

PROJECT: CUMMEENABUDDOGE WIND FARM

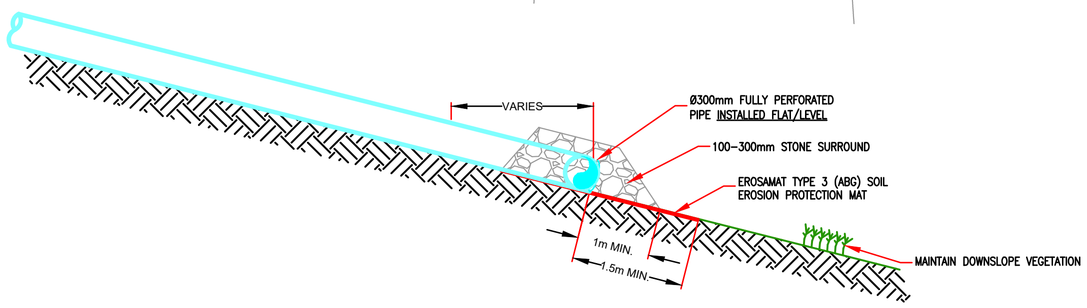
CLIENT: FuturEnergy Ireland

DRAWING TITLE: SURFACE WATER MANAGEMENT ATTENUATION BASIN DETAILS

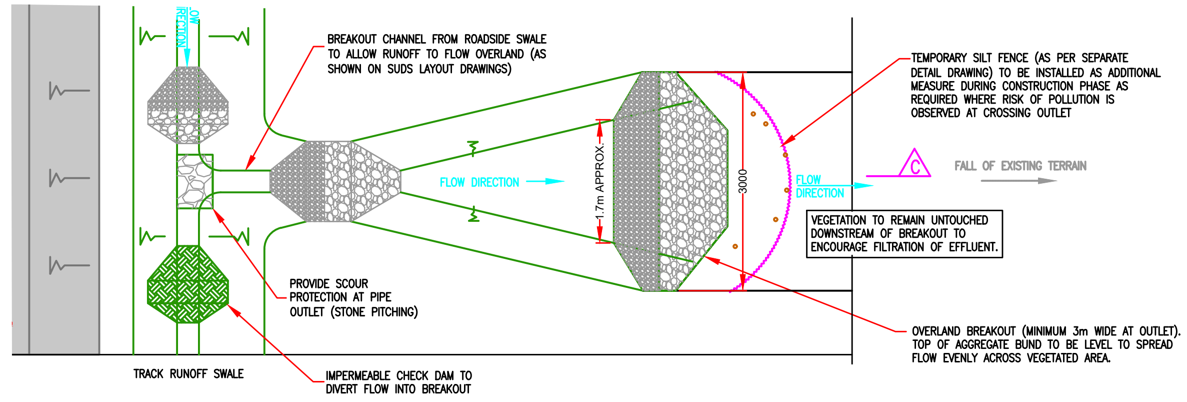
SCALE	ORIGINAL SIZE	
AS SHOWN@A1	A1	
DRAWN	CHECKED	DATE
KS	PDD	14/11/2023
PROJECT No.	DRAWING No.	ISSUE NO.
M01944-02	DWG_204	2

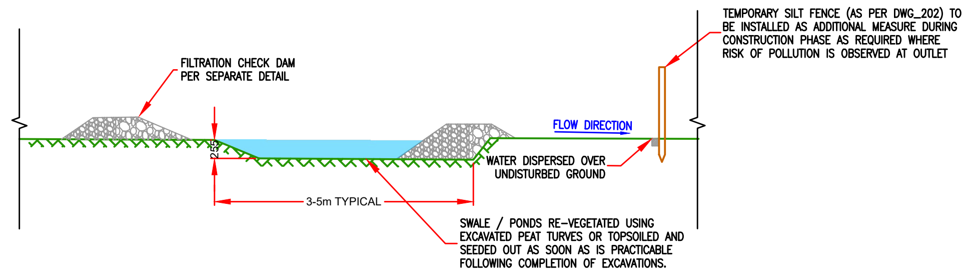


LEVEL SPREADER
SCALE: 1:50

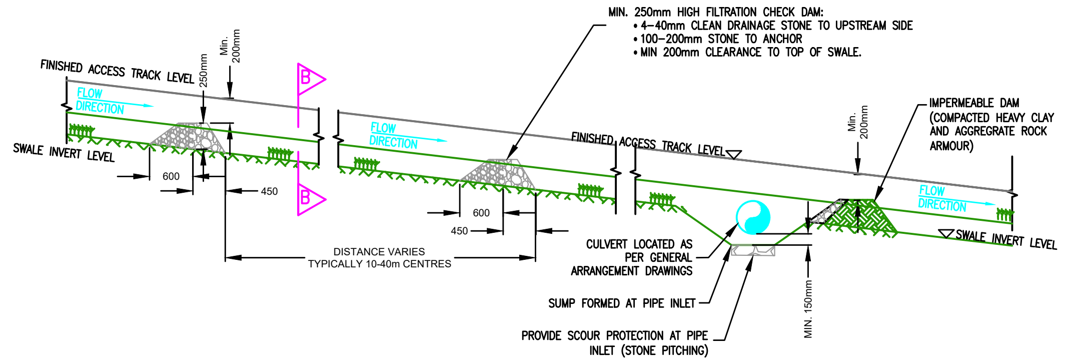


LEVEL SPREADER SECTION A-A
SCALE: 1:50

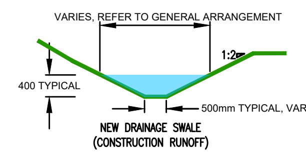




TYPICAL BREAKOUT – PLAN AND SECTION



TYPICAL TRACKSIDE SWALE & CHECK DAMS
SCALE 1:50



TYPICAL TRACKSIDE SWALE SECTION
SCALE 1:50

CHECK-DAM SPACINGS (MAXIMUM)	
CHANNEL GRADIENT	SPACING (m)
<1%	80
1-2.5%	40
2.5-5%	20
>5%	10

NOTE: DURING CONSTRUCTION PHASE THE LEVEL OF SUSPENDED SOLIDS IN TRACK RUN-OFF IS LIKELY TO NECESSITATE THE INCREASED FREQUENCY OF TEMPORARY CHECK DAMS FOR INCREASED SETTLEMENT POTENTIAL

TRACK DRAINAGE NOTES

1. ROAD CONSTRUCTION TO BE AS PER CIVIL WORKS DESIGN & SPECIFICATION. (BY OTHERS)
2. REFER TO LAYOUT PLAN DRAWINGS FOR DETAILS OF CHECK DAM / CROSS DRAIN / CUTOFF DRAIN / OUTFALL LOCATIONS ETC. MICRO-SITING OF DRAINAGE ELEMENTS TO BE DETERMINED ON SITE IN CONJUNCTION WITH DESIGNER TO SUIT SPECIFIC CONDITIONS ENCOUNTERED.
3. FEATURES SHOWN ARE TO SUIT PERMANENT INFRASTRUCTURE. TEMPORARY SITE DRAINAGE OVER AND ABOVE THAT SHOWN ON DRAWINGS MAY BE REQUIRED TO SUIT TEMPORARY ROAD ALIGNMENTS AND LEVELS.
4. ALL EXCAVATED SLOPES TO BE BATTERED BACK TO A SAFE ANGLE OF REPOSE.

ISSUE	DRN	APP	DATE	NOTES / DESCRIPTION
2	KS	KS	21.06.2024	STATUS UPDATED
1	DL	KS	08.02.2024	FOR PLANNING

STATUS: PLANNING

McCloy Consulting
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Mossley Mill, Lower Ground (West)
Carnmoney Road North
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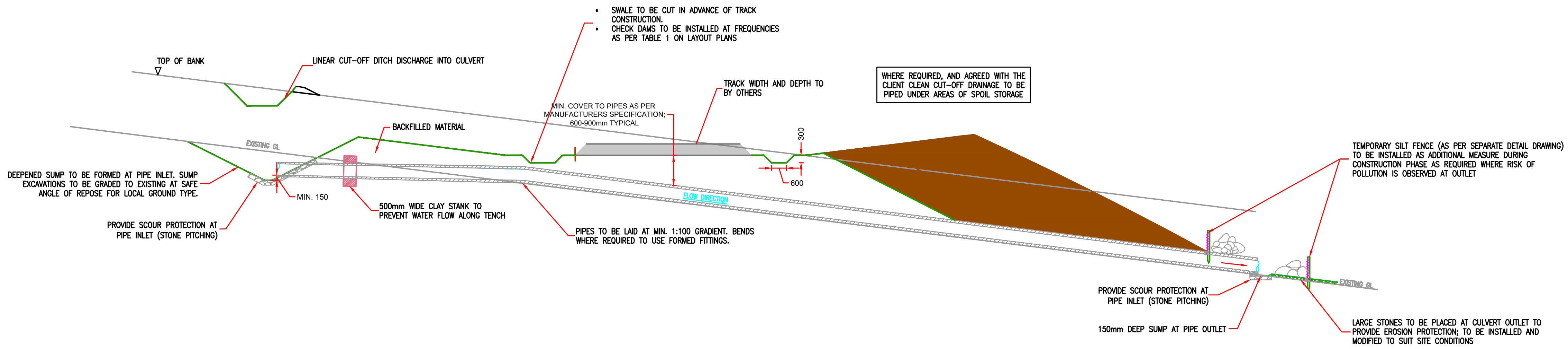
Co. Antrim, BT36 5QA

PROJECT: CUMMEENABUDDOGE WIND FARM

CLIENT: FuturEnergy Ireland

DRAWING TITLE: SURFACE WATER MANAGEMENT TYPICAL DRAINAGE DETAILS LEVEL SPREADER, CHECK DAMS

SCALE	ORIGINAL SIZE	
AS SHOWN@A1	A1	
DRAWN	CHECKED	DATE
KS	PDD	14/11/2023
PROJECT No.	DRAWING No.	ISSUE NO.
M01944-02	DWG_206	2



TYPICAL UPSLOPE CUT-OFF DITCH CULVERT & OUTLET

SCALE - 1:100

NOTES

1. SUDS SYSTEM TO BE CONSTRUCTED PRIOR TO, OR AT THE SAME TIME AS THE ACCESS ROAD & HARDSTANDINGS. INTERIM MEASURES SUCH AS THE PLACEMENT OF SILT FENCES TO BE USED AROUND WATERCOURSES AND RETAINED IN PLACE UNTIL SUDS ARE ESTABLISHED AND PROVIDING SUFFICIENT SILT REMOVAL.
2. LEVEL OF SEDIMENT AND DEBRIS TO BE MONITORED ON SILT FENCING AND REMOVED AND DEPOSITED IN A SUITABLE AREA, A MINIMUM OF 50m FROM A WATERCOURSE OR WATERBODY.
3. ALTERNATIVE FORMS OF SEDIMENT CONTROL MAY BE SUITABLE AND USED BUT MUST BE MONITORED ON AN OBSERVATIONAL BASIS AND IF DEEMED UNSUITABLE HY–TEX SILT FENCES MAY BE UTILISED.
4. IN AREAS WHERE THERE ARE HIGH SILT LOADINGS OF RUN–OFF SILT NETTING MAY BE USED IN SERIES WITH A MINIMUM GAP OF 1m BETWEEN ROWS TO PROVIDE ADDITIONAL TREATMENT.

ISSUE	DRN	APP	DATE	NOTES / DESCRIPTION
2	KS	KS	21.06.2024	STATUS UPDATED
1	DL	KS	08.02.2024	FOR PLANNING

STATUS: PLANNING

McCloy Consulting

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Mossley Mill, Lower Ground (West)
Carnmoney Road North
Newtownabbey
Co. Antrim, BT36 5QA

PROJECT: CUMMEENABUDDOGE WIND FARM

CLIENT: FuturEnergy Ireland

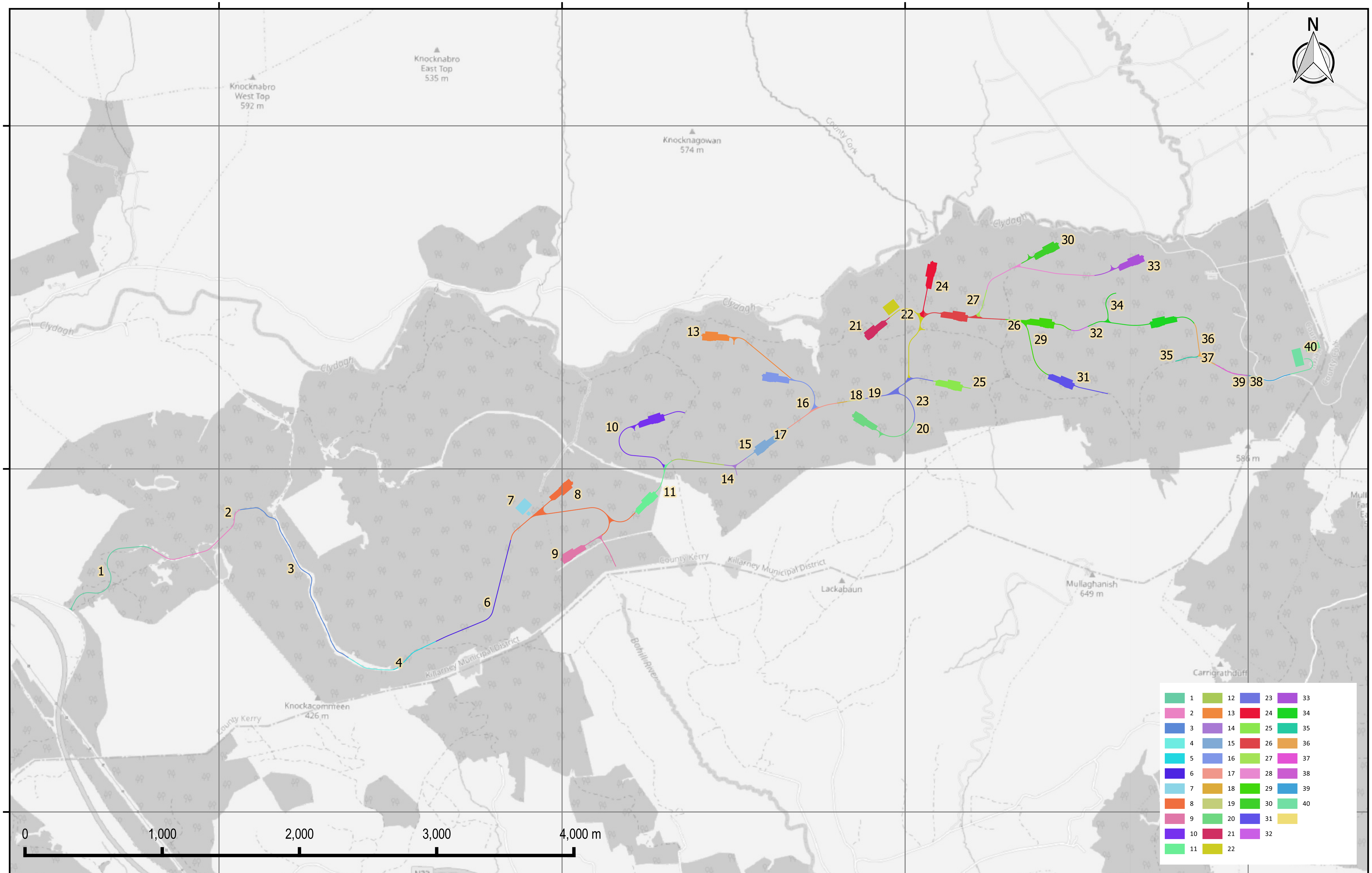
DRAWING TITLE: SURFACE WATER MANAGEMENT CLEAN CUTOFF DRAINAGE

SCALE	ORIGINAL SIZE	
AS SHOWN@A1	A1	
DRAWN	CHECKED	DATE
KS	PDD	14/11/2023
PROJECT No.	DRAWING No.	ISSUE NO.
M01944-02	DWG_207	2

Annex C

Supporting Calculations

C1
Tracks & Hard standings – Qbar / Attenuation / Settlement calculations



DESCRIPTION

CUMMEENABUDDOGE WIND FARM - SWMP SUBCATCHMENTS

PROJECT / FIGURE NO.

M01944-02_SWMP_101

DRAWN BY	SCALE	REVISION	DATE
KS	1:30,000@A3	00	14/11/2023

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FuturEnergy Ireland

Greenfield runoff rate estimation for sites

www.uksuds.com | Greenfield runoff tool

Calculated by:	Kyle Somerville
Site name:	Cummeenabuddoge Wind Farm
Site location:	Clydaghroe

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:	51.99388° N
Longitude:	9.16652° W
Reference:	1065293711
Date:	Nov 03 2023 15:59

Runoff estimation approach

IH124

Site characteristics

Total site area (ha): 33.64

Methodology

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

Soil characteristics

	Default	Edited
SOIL type:	5	5
HOST class:	N/A	N/A
SPR/SPRHOST:	0.53	0.53

Hydrological characteristics

	Default	Edited
SAAR (mm):	1553	1553
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):	535.48	535.48
1 in 1 year (l/s):	455.16	455.16
1 in 30 years (l/s):	883.54	883.54
1 in 100 year (l/s):	1044.18	1044.18
1 in 200 years (l/s):	1151.28	1151.28

Project	Cummeenaboddoge WF
Ref	M01944-02
Date	07/11/2023

McCloy Consulting

Purpose
To determine settlement pond parameters (minimum hydraulic retention time) to allow primary treatment of water quality for suspended solids in temporary construction phase runoff.

Approach
Design assumes:
- This calculation set considers the temporary construction phase as the worst case scenario. The calculation approach adopted assumes loss of 25% of runoff at source (overland breakouts etc)
- Settlement sizing for a drained area equivalent to the track surface.
- Settlement within permanent attenuation lagoon with outflow dictated by QBar to suit GDSDS standards
- Outflows and flowing layers are determined based on typical parameters for comparable detailed design. Level of design is preliminary / proof of concept.

Determination of Inflow Characteristics

Water quality design event adopted as a 2-year rainfall event; assumes 1hr duration for peak intensity + 20% climate change

Inflow to Pond calculated using Rational method
Q=CiA

Rainfall Intensity (i)	17.04	mm/hr	*Assuming 1hr event for peak inflow flow rate*
Runoff Coefficient (C)	60	%	*Runoff from unbound surfaces*

Characterisation of Influent

Median Concentration of TSS	2000	mg/l	per Construction Site Erosion and Sediment Controls - Planning Design & Performance, Pitt *et al*, 2007
Kinematic Viscosity of Water (n)	0.0000015	m^2/s	
Gravitational Constant (g)	9.81	m/s^2	
Particle Density (p_p)	2.76	kg/m^3	**Settlement Velocity for Silts** *based on Stokes Law*
Water Density (p_s)	1	kg/m^3	

$$V = \frac{d^2 g(\rho_p - \rho_s)}{18\eta}$$

Of Which (based on conservative particle size distribution bearing in mind observed ground conditions / prevalence of peat soils with some areas of clay till substrate

	Particle Size		% passing	%-age by mass	Median Concentration	Settling Velocity (based on Stokes Law)	Hydraulic Retention Time (HRT) (Time to Fully Settle) (based on 0.6m depth)
	mm	m	%	%	mg/l	m/s	hrs
	150um	0.00015	100	14	280	0.014388	0.0
	63um	0.000063	86	72	1440	0.002538043	0.1
	20um	0.00002	14	10	200	0.000255787	0.7
Clay Range	6um	0.000006	4	3	60	2.30208E-05	7.2
	2um	0.000002	1	1	20	2.55787E-06	65.2

CRM Stormflow Stormwater Management Software

Client:	FuturEnergy Ireland c/o GDG
Project:	Cummeennabuddoge WF
Location:	Killarney
Catchment:	Cumulative Hardstanding Area
Purpose	To estimate the attenuation volume to limit runoff from the site to Qbar

Catchment Details:

Buildings	0	m^2	x 95 %
Dense surfacing	252300	m^2	x 60 %
Effective Area	151380	m^2	

Storage Details:

Volume Vmax	3840	Cu.m
Porosity	100	%
Area Increase	0	%

Rainfall Details - FSR Method:

Return Period	100	years
Climate Change Factor	20	%
r value	0.23	
M5-60	16	mm

	mm	mm/h	storage (m^3)
5 min	8.2	117.9	1327.271
10 min	12.9	93.1	2028.186
15 min	16.4	78.6	2494.255
30 min	23.4	56.2	3291.774
45 min	28.1	44.9	3650.024
60 min	31.5	37.8	3794.295
2 hours	41.0	24.6	3586.949
6 hours	60.1	12.0	0.000
24 hours	95.5	4.8	0.000

Outflow Details:

Infiltration rate	0	m/hr
Attenuation Control	Fixed Outflow	
Control Diameter	-	mm
Discharge rate	535.5	l/s

Results:

Outcome:	Pass
Critical Storm Duration	1.27 hrs
Hmax	0.998 m
Time to half empty	59.6 min

Calculation Summary

Purpose: To summarise calculations to determine basin size for attenuation and treatment for the preliminary design

Inputs

Qbar for site	535.48	lps
%runoff from unbound surfaces for effective area:	60%	
%-losses allowed for by breakouts etc	25%	
Initial Estimate - Total Volume Required	3840	cumecs
%-Uplift applied to cumulative volume requirement to allow for unrealistic efficiency of fixed outflow	55%	

Catchment ID	AREA	Atten. Vol (pro-rata, area) - cu.m	Depth	Width	Length	Qbar Rate (lps)	Section Area sq m	Velocity m/s	Residence (hrs)	Updated Length	Notes	Finalised Dimensions LxWxD (m)
1	5679	100	1	8	13	9.0	4.8	0.0041	0.85	13		13x8x1
2	4991	88	1	5	18	7.9	3	0.0058	0.85	18		18x5x1
3	8836	156	1.5	8	13	14.1	4.8	0.0064	0.57	15	Dimensions increased to suit water quality requirements	15x8x1.5
4	2093	37	1	5	7	3.3	3	0.0024	0.85	7		7x5x1
5	2264	40	1	5	8	3.6	3	0.0026	0.85	8		8x5x1
6	6087	108	1	8	13	9.7	4.8	0.0044	0.85	13		13x8x1
7	8125	144	1	8	18	12.9	4.8	0.0059	0.85	18		18x8x1
8	21892	387	1.5	10	26	34.8	6	0.0126	0.57	30	Dimensions increased to suit water quality requirements	30x10x1.5
9	13665	242	1.5	10	16	21.8	6	0.0079	0.57	18	Dimensions increased to suit water quality requirements	18x10x1.5
10	16333	289	1.5	10	19	26.0	6	0.0094	0.57	22	Dimensions increased to suit water quality requirements	22x10x1.5
11	13082	231	1.5	10	15	20.8	6	0.0076	0.57	18	Dimensions increased to suit water quality requirements	18x10x1.5
12	2323	41	1	5	8	3.7	3	0.0027	0.85	8		8x5x1
13	14944	264	1.5	10	18	23.8	6	0.0086	0.57	20	Dimensions increased to suit water quality requirements	20x10x1.5
14	1738	31	1	5	6	2.8	3	0.0020	0.85	6		6x5x1
15	11958	212	1.5	10	14	19.0	6	0.0069	0.57	16	Dimensions increased to suit water quality requirements	16x10x1.5
16	13841	245	1.5	10	16	22.0	6	0.0080	0.57	19	Dimensions increased to suit water quality requirements	19x10x1.5
17	2863	51	1	5	10	4.6	3	0.0033	0.85	10		10x5x1
18	436	8	1	5	5	2.0	3	0.0005	2.76	5	Rate adjusted to suit minimum allowed for blockage mitigation	5x5x1
19	798	14	1	5	5	2.0	3	0.0009	1.51	5	Rate adjusted to suit minimum allowed for blockage mitigation	5x5x1
20	13415	237	1.5	10	16	21.4	6	0.0077	0.57	18	Dimensions increased to suit water quality requirements	18x10x1.5
21	10570	187	1.5	8	16	16.8	4.8	0.0076	0.57	18	Dimensions increased to suit water quality requirements	18x8x1.5
22	13756	243	1.5	10	16	21.9	6	0.0079	0.57	19	Dimensions increased to suit water quality requirements	19x10x1.5
23	7373	130	1	8	16	11.7	4.8	0.0053	0.85	16		16x8x1
24	13105	232	1.5	10	15	20.9	6	0.0076	0.57	18	Dimensions increased to suit water quality requirements	18x10x1.5
25	11376	201	1.5	10	13	18.1	6	0.0066	0.57	15	Dimensions increased to suit water quality requirements	15x10x1.5
26	14632	259	1.5	10	17	23.3	6	0.0084	0.57	20	Dimensions increased to suit water quality requirements	20x10x1.5
27	1731	31	1	5	6	2.8	3	0.0020	0.85	6		6x5x1
28	5706	101	1	8	13	9.1	4.8	0.0041	0.85	13		13x8x1
29	16421	291	1.5	10	19	26.1	6	0.0095	0.57	22	Dimensions increased to suit water quality requirements	22x10x1.5
30	12092	214	1.5	10	14	19.2	6	0.0070	0.57	16	Dimensions increased to suit water quality requirements	16x10x1.5
31	12460	220	1.5	10	15	19.8	6	0.0072	0.57	17	Dimensions increased to suit water quality requirements	17x10x1.5
32	762	13	1	5	5	2.0	3	0.0009	1.58	5	Rate adjusted to suit minimum allowed for blockage mitigation	5x5x1
33	12575	222	1.5	10	15	20.0	6	0.0073	0.57	17	Dimensions increased to suit water quality requirements	17x10x1.5
34	16432	291	1.5	10	19	26.2	6	0.0095	0.57	22	Dimensions increased to suit water quality requirements	22x10x1.5
35	1044	18	1	5	5	2.0	3	0.0012	1.15	5	Rate adjusted to suit minimum allowed for blockage mitigation	5x5x1
36	2617	46	1	5	9	4.2	3	0.0030	0.85	9		9x5x1
37	1074	19	1	5	5	2.0	3	0.0012	1.12	5	Rate adjusted to suit minimum allowed for blockage mitigation	5x5x1
38	431	8	1	5	5	2.0	3	0.0005	2.79	5	Rate adjusted to suit minimum allowed for blockage mitigation	5x5x1
39	1950	35	1	5	7	3.1	3	0.0023	0.85	7		7x5x1
40	14941	264	1.5	10	18	23.8	6	0.0086	0.57	20	Dimensions increased to suit water quality requirements	20x10x1.5

C2
Borrow pit Settlement

Project	Cummeenaboddoge WF - Borrowpit #1	
Ref	M01944-02	
Date	13/11/2023	

Purpose

To determine an appropriate size of settlement pond to allow treatment of water quality for suspended solids in temporary construction phase runoff.

Approach

Design assumes:
- This calculation set considers the temporary construction phase as the worst case scenario. The calculation approach adopted excludes the effect of any treatment of runoff "at source"
- Settlement sizing for a drained area equivalent to the whole borrowpit area.
- Settlement within permanent attenuation lagoon with no limit to outflow rate. 2 year rainfall design standard applied. Approach is conservative where in reality forebay / intermediate dams will reduce velocities and cause an attenuating effect.

Determination of Inflow Characteristics

Water quality design event adopted as a 2-year rainfall event; assumes 1hr duration for peak intensity + 20% climate change

Inflow to Pond calculated using Rational method
Q=CiA

Rainfall Intensity (i)	17.04	mm/hr	*Assuming 1hr event for peak inflow flow rate*
Runoff Coefficient (C)	0.45		based on WRAP / SOIL parameter (designing for temporary / undeveloped scenario - permanent drainage to cater for finalised surfaces)
Adjusted Runoff Coefficient	0.54		allowing +20% for compaction during construction
Drained Works Area	1.63	Ha	
Design Inflow (Q)	42	lps	
or	0.042	m3/sec	
Design Outflow	42	lps	No reduction applied
or	0.042	m3/sec	

Characterisation of Influent

Maximum Concentration of TSS	2800	mg/l	per Construction Site Erosion and Sediment Controls - Planning Design & Performance, Pitt *et al*, 2007
Kinematic Viscosity of Water (n)	0.0000015	m^2/s	
Gravitational Constant (g)	9.81	m/s^2	
Particle Density (p_p)	2.76	kg/m^3	
Water Density (p_s)	1	kg/m^3	

Settlement Velocity for Silts
based on Stokes Law

$$V = \frac{d^2 g(\rho_p - \rho_s)}{18\eta}$$

Of Which (based on conservative particle size distribution bearing in mind observed ground conditions / prevalence of peat soils with some areas of clay till substrate

	Particle Size		% passing	%-age by mass	Concentration	Settling Velocity (based on Stokes Law)	Hydraulic Retention Time (HRT) (Time to Fully Settle) (based on 0.6m depth)
	mm	m	%	%	mg/l	m/s	hrs
	150um	0.00015	100	14	392	0.014388	0.0
	63um	0.000063	86	72	2016	0.002538043	0.1
	20um	0.00002	14	10	280	0.000255787	0.7
Clay Range	6um	0.000006	4	3	84	2.30208E-05	7.2
	2um	0.000002	1	1	28	2.55787E-06	65.2

Project	Cummeenaboddoge WF - Borrowpit #1	
Ref	M01944-02	
Date	13/11/2023	

McCloy Consulting

Determination of Outflow Characteristics

As a conservative measure, the effect of filtration via drainage stone media is excluded and the design assumes an unlimited overflow rate dictated by the inflow rate.

Determination of Initial Settlement Pond Characteristics for Water Quality Treatment

Surface Overflow Rate is dictated by the flow rate divided by the total surface area of the sedimentation feature, and is equivalent to the Terminal Settlement Velocity

Assuming a lagoon with base dimensions:		
Length	30	m
Breadth	12	m
Total Depth	1	m
Of which flowing layer is say	0.3	m
Volume	452	m3
Side Slope (1 in)	2	n/a
Area	360	m2
Therefore Surface Overflow Rate	0.0001	m/s
Average Flow velocity across lagoon	0.0116	m/s

Retention time in the lagoon is equivalent to the length of travel (lagoon length) relative to the outflow rate.
Retention time: 0.72 hrs

Initial settlement pond effluent is therefore characterised as follows:

	Particle Size	HRT	Residence sufficient for full settlement?	Residual Concentration	
	um	hrs		mg/l	
	150	0.01	OK	0	
	63	0.07	OK	0	
	20	0.65	OK	0	
Clay Range	6	7.24	NO	67	
	2	65.16	NO	27	
			Concentration in Outflow	95	mg/l
			Equivalent to	97%	removal

Design Notes and Summary

Install a lagoon with **base (invert)** dimensions: 30x12x0.3m deep
Installation to include forebay (clean drainage stone); intermediate dams (clean drainage stone). Treat clay range with flocculent dosing to suit observed conditions.

Calc	Checked	Date	Revision	Notes	
KS	KS	14/06/2022	Original	N/A	

R:_Projects\M01944 Gavin and Doherty Geosolutions UK Ltd\02 Clydaghroe\08 GIS\Data\SWMP Geopackages\Linked Calculations\Borrow Pit Calcs\[CALCBP1 - Settle

Project	Cummeenaboddoge WF - Borrowpit #2	
Ref	M01944-02	
Date	13/11/2023	

McCloy Consulting

Purpose

To determine an appropriate size of settlement pond to allow treatment of water quality for suspended solids in temporary construction phase runoff.

Approach

Design assumes:
- This calculation set considers the temporary construction phase as the worst case scenario. The calculation approach adopted excludes the effect of any treatment of runoff "at source"
- Settlement sizing for a drained area equivalent to the whole borrowpit area.
- Settlement within permanent attenuation lagoon with no limit to outflow rate. 2 year rainfall design standard applied. Approach is conservative where in reality forebay / intermediate dams will reduce velocities and cause an attenuating effect.

Determination of Inflow Characteristics

Water quality design event adopted as a 2-year rainfall event; assumes 1hr duration for peak intensity + 20% climate change

Inflow to Pond calculated using Rational method
Q=CiA

Rainfall Intensity (i)	17.04	mm/hr	*Assuming 1hr event for peak inflow flow rate*
Runoff Coefficient (C)	0.45		based on WRAP / SOIL parameter (designing for temporary / undeveloped scenario - permanent drainage to cater for finalised surfaces)
Adjusted Runoff Coefficient	0.54		allowing +20% for compaction during construction
Drained Works Area	4.51	Ha	
Design Inflow (Q)	115	lps	
or	0.115	m3/sec	
Design Outflow	115	lps	No reduction applied
or	0.115	m3/sec	

Characterisation of Influent

Maximum Concentration of TSS	2800	mg/l	per Construction Site Erosion and Sediment Controls - Planning Design & Performance, Pitt *et al*, 2007
Kinematic Viscosity of Water (n)	0.0000015	m^2/s	
Gravitational Constant (g)	9.81	m/s^2	
Particle Density (p_p)	2.76	kg/m^3	
Water Density (p_s)	1	kg/m^3	

Settlement Velocity for Silts
based on Stokes Law

$$V = \frac{d^2 g(\rho_p - \rho_s)}{18\eta}$$

Of Which (based on conservative particle size distribution bearing in mind observed ground conditions / prevalence of peat soils with some areas of clay till substrate

	Particle Size		% passing	%-age by mass	Concentration	Settling Velocity (based on Stokes Law)	Hydraulic Retention Time (HRT) (Time to Fully Settle) (based on 0.6m depth)
	mm	m	%	%	mg/l	m/s	hrs
	150um	0.00015	100	14	392	0.014388	0.0
	63um	0.000063	86	72	2016	0.002538043	0.1
	20um	0.00002	14	10	280	0.000255787	0.7
Clay Range	6um	0.000006	4	3	84	2.30208E-05	7.2
	2um	0.000002	1	1	28	2.55787E-06	65.2

Project	Cummeenaboddoge WF - Borrowpit #2	
Ref	M01944-02	
Date	13/11/2023	McCloy Consulting

Determination of Outflow Characteristics

As a conservative measure, the effect of filtration via drainage stone media is excluded and the design assumes an unlimited overflow rate dictated by the inflow rate.

Determination of Initial Settlement Pond Characteristics for Water Quality Treatment

Surface Overflow Rate is dictated by the flow rate divided by the total surface area of the sedimentation feature, and is equivalent to the Terminal Settlement Velocity

Assuming a lagoon with base dimensions:

Length	60	m
Breadth	15	m
Total Depth	1	m
Of which flowing layer is say	0.3	m
Volume	1058	m3
Side Slope (1 in)	2	n/a
Area	900	m2
Therefore Surface Overflow Rate	0.0001	m/s
Average Flow velocity across lagoon	0.0256	m/s

Retention time in the lagoon is equivalent to the length of travel (lagoon length) relative to the outflow rate.

Retention time: 0.65 hrs

Initial settlement pond effluent is therefore characterised as follows:

	Particle Size	HRT	Residence sufficient for full settlement?	Residual Concentration	
	um	hrs		mg/l	
	150	0.01	OK	0	
	63	0.07	OK	0	
	20	0.65	OK	0	
Clay Range	6	7.24	NO	69	
	2	65.16	NO	27	
			Concentration in Outflow	96	mg/l
			Equivalent to	97%	removal

Design Notes and Summary

Install a lagoon with **base (invert)** dimensions: 60x15x0.3m deep

Installation to include forebay (clean drainage stone); intermediate dams (clean drainage stone). Treat clay range with flocculent dosing to suit observed conditions.

Calc	Checked	Date	Revision	Notes	
KS	KS	13/11/2023	Original	N/A	

R:_Projects\M01944 Gavin and Doherty Geosolutions UK Ltd\02 Clydaghroe\08 GIS\Data\SWMP Geopackages\Linked Calculations\Borrow Pit Calcs\[CALCBP2 - Settle

Project	Cummeenaboddoge WF - Borrowpit #3
Ref	M01944-02
Date	13/11/2023

McCloy Consulting

Purpose

To determine an appropriate size of settlement pond to allow treatment of water quality for suspended solids in temporary construction phase runoff.

Approach

Design assumes:
- This calculation set considers the temporary construction phase as the worst case scenario. The calculation approach adopted excludes the effect of any treatment of runoff "at source"
- Settlement sizing for a drained area equivalent to the whole borrowpit area.
- Settlement within permanent attenuation lagoon with no limit to outflow rate. 2 year rainfall design standard applied. Approach is conservative where in reality forebay / intermediate dams will reduce velocities and cause an attenuating effect.

Determination of Inflow Characteristics

Water quality design event adopted as a 2-year rainfall event; assumes 1hr duration for peak intensity + 20% climate change

Inflow to Pond calculated using Rational method
Q=CiA

Rainfall Intensity (i)	17.04	mm/hr	*Assuming 1hr event for peak inflow flow rate*
Runoff Coefficient (C)	0.45		based on WRAP / SOIL parameter (designing for temporary / undeveloped scenario - permanent drainage to cater for finalised surfaces)
Adjusted Runoff Coefficient	0.54		allowing +20% for compaction during construction
Drained Works Area	3.58	Ha	
Design Inflow (Q)	92	lps	
or	0.092	m3/sec	
Design Outflow	92	lps	No reduction applied
or	0.092	m3/sec	

Characterisation of Influent

Maximum Concentration of TSS	2800	mg/l	per Construction Site Erosion and Sediment Controls - Planning Design & Performance, Pitt *et al*, 2007
Kinematic Viscosity of Water (n)	0.0000015	m^2/s	
Gravitational Constant (g)	9.81	m/s^2	
Particle Density (p_p)	2.76	kg/m^3	
Water Density (p_s)	1	kg/m^3	

Settlement Velocity for Silts
based on Stokes Law

$$V = \frac{d^2 g(\rho_p - \rho_s)}{18\eta}$$

Of Which (based on conservative particle size distribution bearing in mind observed ground conditions / prevalence of peat soils with some areas of clay till substrate

	Particle Size		% passing	%-age by mass	Concentration	Settling Velocity (based on Stokes Law)	Hydraulic Retention Time (HRT) (Time to Fully Settle) (based on 0.6m depth)
	mm	m	%	%	mg/l	m/s	hrs
	150um	0.00015	100	14	392	0.014388	0.0
	63um	0.000063	86	72	2016	0.002538043	0.1
	20um	0.00002	14	10	280	0.000255787	0.7
Clay Range	6um	0.000006	4	3	84	2.30208E-05	7.2
	2um	0.000002	1	1	28	2.55787E-06	65.2

Determination of Outflow Characteristics

As a conservative measure, the effect of filtration via drainage stone media is excluded and the design assumes an unlimited overflow rate dictated by the inflow rate.

Determination of Initial Settlement Pond Characteristics for Water Quality Treatment

Surface Overflow Rate is dictated by the flow rate divided by the total surface area of the sedimentation feature, and is equivalent to the Terminal Settlement Velocity

Assuming a lagoon with base dimensions:

Length	50	m
Breadth	15	m
Total Depth	1	m
Of which flowing layer is say	0.3	m
Volume	888	m3
Side Slope (1 in)	2	n/a
Area	750	m2
Therefore Surface Overflow Rate	0.0001	m/s
Average Flow velocity across lagoon	0.0204	m/s

Retention time in the lagoon is equivalent to the length of travel (lagoon length) relative to the outflow rate.
Retention time: 0.68 hrs

Initial settlement pond effluent is therefore characterised as follows:

	Particle Size	HRT	Residence sufficient for full settlement?	Residual Concentration	
	um	hrs		mg/l	
	150	0.01	OK	0	
	63	0.07	OK	0	
	20	0.65	OK	0	
Clay Range	6	7.24	NO	68	
	2	65.16	NO	27	
		Concentration in Outflow		96	mg/l
			Equivalent to	97%	removal

Design Notes and Summary

Install a lagoon with **base (invert**) dimensions: 50x15x0.3m deep
Installation to include forebay (clean drainage stone); intermediate dams (clean drainage stone). Treat clay range with flocculent dosing to suit observed conditions.

Calc	Checked	Date	Revision	Notes	
KS	KS	13/11/2023	Original	N/A	

R:_Projects\M01944 Gavin and Doherty Geosolutions UK Ltd\02 Clydaghroe\08 GIS\Data\SWMP Geopackages\Linked Calculations\Borrow Pit Calcs\[CALCBP3 - Settle

Project	Cummeenaboddoge WF - Borrowpit #4
Ref	M01944-02
Date	13/11/2023

McCloy Consulting

Purpose

To determine an appropriate size of settlement pond to allow treatment of water quality for suspended solids in temporary construction phase runoff.

Approach

Design assumes:
- This calculation set considers the temporary construction phase as the worst case scenario. The calculation approach adopted excludes the effect of any treatment of runoff "at source"
- Settlement sizing for a drained area equivalent to the whole borrowpit area.
- Settlement within permanent attenuation lagoon with no limit to outflow rate. 2 year rainfall design standard applied. Approach is conservative where in reality forebay / intermediate dams will reduce velocities and cause an attenuating effect.

Determination of Inflow Characteristics

Water quality design event adopted as a 2-year rainfall event; assumes 1hr duration for peak intensity + 20% climate change

Inflow to Pond calculated using Rational method
Q=CiA

Rainfall Intensity (i)	17.04	mm/hr	*Assuming 1hr event for peak inflow flow rate*
Runoff Coefficient (C)	0.45		based on WRAP / SOIL parameter (designing for temporary / undeveloped scenario - permanent drainage to cater for finalised surfaces)
Adjusted Runoff Coefficient	0.54		allowing +20% for compaction during construction
Drained Works Area	3.886	Ha	
Design Inflow (Q)	99	lps	
or	0.099	m3/sec	
Design Outflow	99	lps	No reduction applied
or	0.099	m3/sec	

Characterisation of Influent

Maximum Concentration of TSS	2800	mg/l	per Construction Site Erosion and Sediment Controls - Planning Design & Performance, Pitt *et al*, 2007
Kinematic Viscosity of Water (n)	0.0000015	m^2/s	
Gravitational Constant (g)	9.81	m/s^2	
Particle Density (p_p)	2.76	kg/m^3	
Water Density (p_s)	1	kg/m^3	

Settlement Velocity for Silts
based on Stokes Law

$$V = \frac{d^2 g(\rho_p - \rho_s)}{18\eta}$$

Of Which (based on conservative particle size distribution bearing in mind observed ground conditions / prevalence of peat soils with some areas of clay till substrate

	Particle Size		% passing	%-age by mass	Concentration	Settling Velocity (based on Stokes Law)	Hydraulic Retention Time (HRT) (Time to Fully Settle) (based on 0.6m depth)
	mm	m	%	%	mg/l	m/s	hrs
	150um	0.00015	100	14	392	0.014388	0.0
	63um	0.000063	86	72	2016	0.002538043	0.1
	20um	0.00002	14	10	280	0.000255787	0.7
Clay Range	6um	0.000006	4	3	84	2.30208E-05	7.2
	2um	0.000002	1	1	28	2.55787E-06	65.2

Project	Cummeenaboddoge WF - Borrowpit #4
Ref	M01944-02
Date	13/11/2023

McCloy Consulting

Determination of Outflow Characteristics

As a conservative measure, the effect of filtration via drainage stone media is excluded and the design assumes an unlimited overflow rate dictated by the inflow rate.

Determination of Initial Settlement Pond Characteristics for Water Quality Treatment

Surface Overflow Rate is dictated by the flow rate divided by the total surface area of the sedimentation feature, and is equivalent to the Terminal Settlement Velocity

Assuming a lagoon with base dimensions:

Length	55	m
Breadth	15	m
Total Depth	1	m
Of which flowing layer is say	0.3	m
Volume	973	m3
Side Slope (1 in)	2	n/a
Area	825	m2
Therefore Surface Overflow Rate	0.0001	m/s
Average Flow velocity across lagoon	0.0221	m/s

Retention time in the lagoon is equivalent to the length of travel (lagoon length) relative to the outflow rate.
Retention time: 0.69 hrs

Initial settlement pond effluent is therefore characterised as follows:

	Particle Size	HRT	Residence sufficient for full settlement?	Residual Concentration	
	um	hrs		mg/l	
	150	0.01	OK	0	
	63	0.07	OK	0	
	20	0.65	OK	0	
Clay Range	6	7.24	NO	68	
	2	65.16	NO	27	
			Concentration in Outflow	95	mg/l
			Equivalent to	97%	removal

Design Notes and Summary

Install a lagoon with **base (invert**) dimensions: 55x15x0.3m deep
Installation to include forebay (clean drainage stone); intermediate dams (clean drainage stone). Treat clay range with flocculent dosing to suit observed conditions.

Calc	Checked	Date	Revision	Notes	
KS	KS	13/11/2023	Original	N/A	

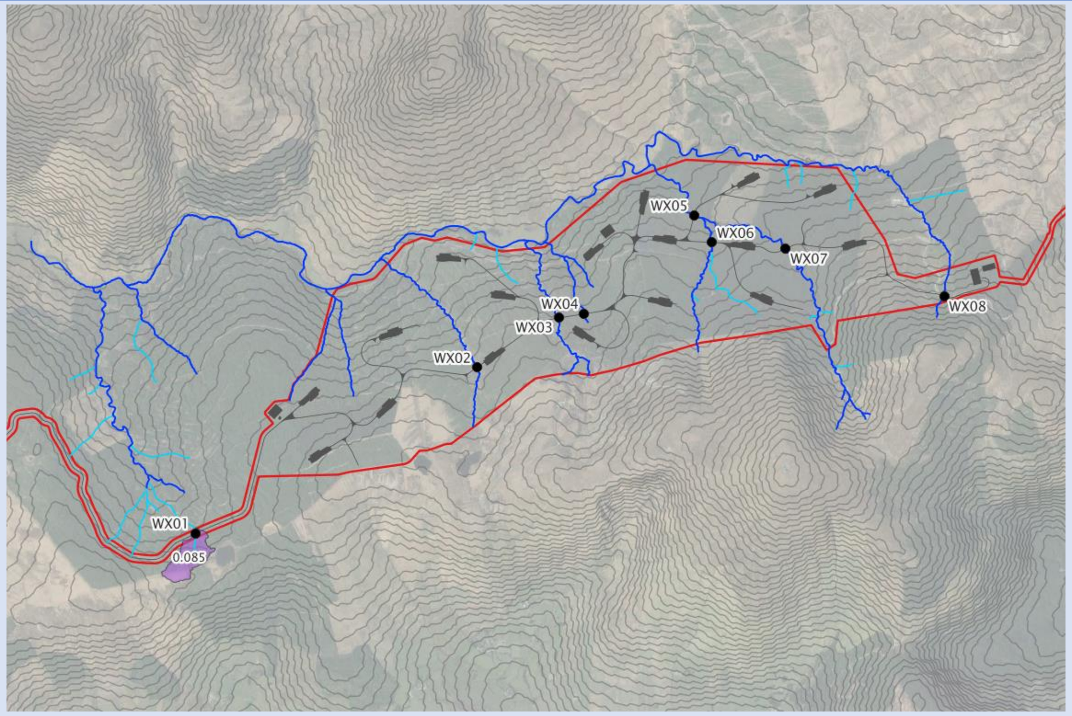
R:_Projects\M01944 Gavin and Doherty Geosolutions UK Ltd\02 Clydaghroe\08 GIS\Data\SWMP Geopackages\Linked Calculations\Borrow Pit Calcs\[CALCBP4 - Settle

Annex D

Watercourse Crossing Schedule

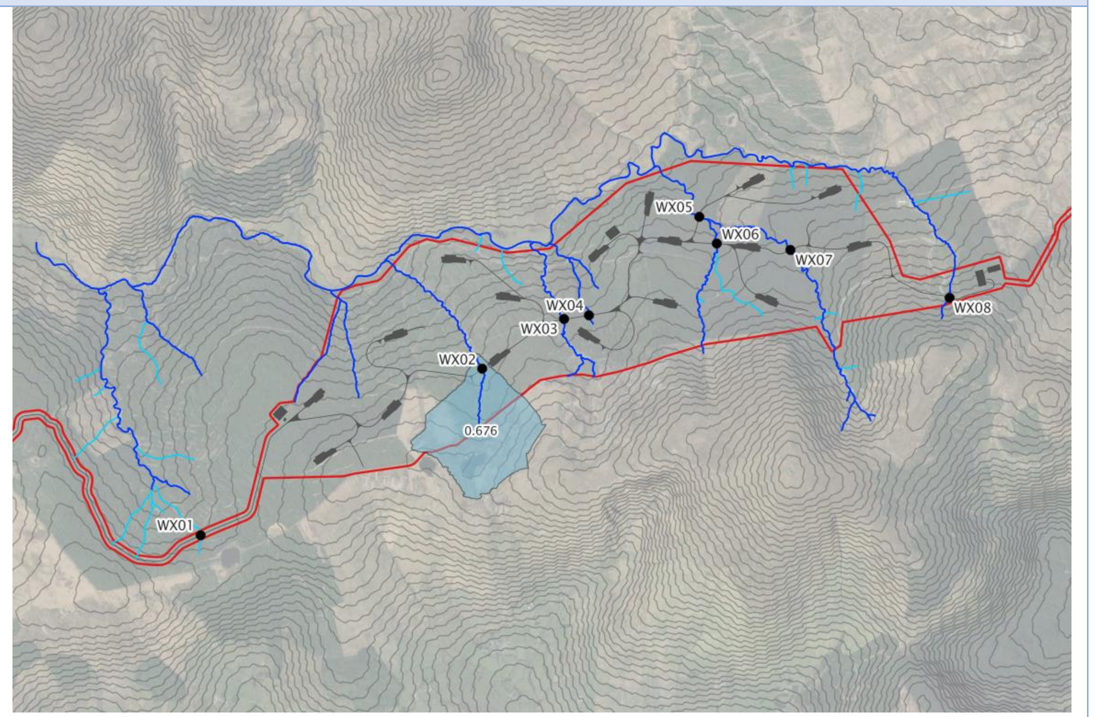
<table>
<tr><th>WX REF</th><th>EASTING</th><th>NORTHING</th><th>DESCRIPTION</th><th>PHOTO</th><th>CATCHMENT MAP</th></tr>
<tr><td>WX01</td><td>516679.46</td><td>581343.65</td><td>PROPOSED TRACK CROSSES EPA WATERCOURSE (UNNAMED).

NEW MIN. 2.5 M x 0.7 M (SPAN x HEIGHT) CLEAR SPAN BRIDGE OR BOTTOMLESS CULVERT (PCC OR EQUIVALENT). CLEAR SPAN IS BASED ON ESTIMATED BANK-TO-BANK WIDTH AND IS TO AVOID DISRUPTION TO RIVERBED TO SUIT FISHERIES REQUIREMENTS.

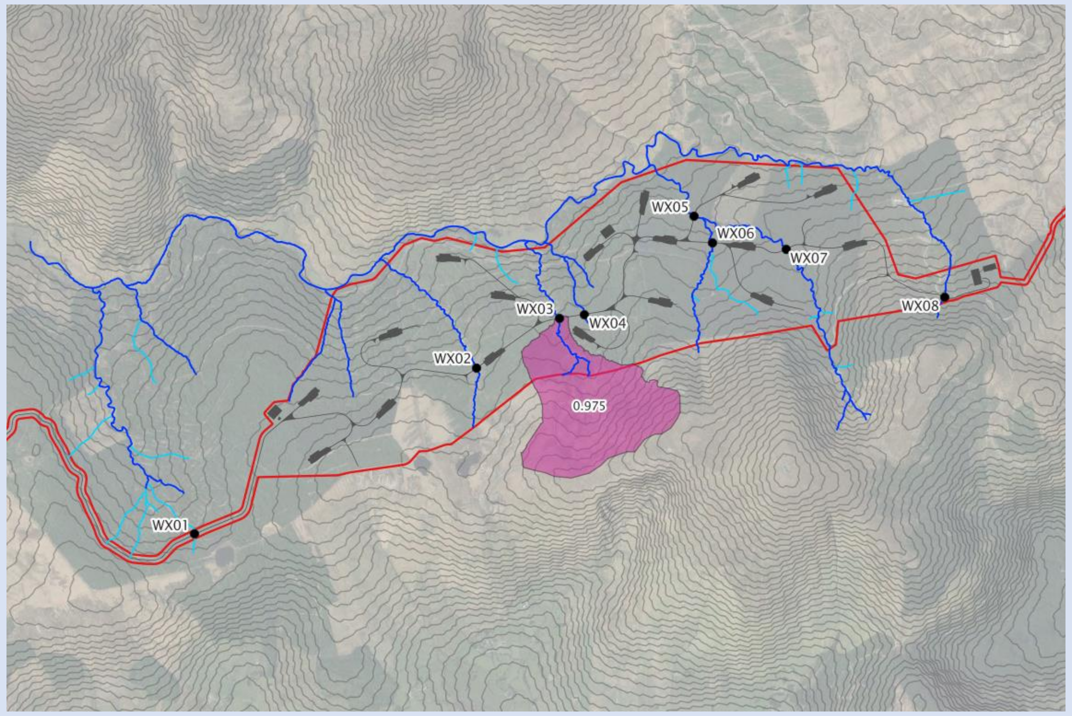
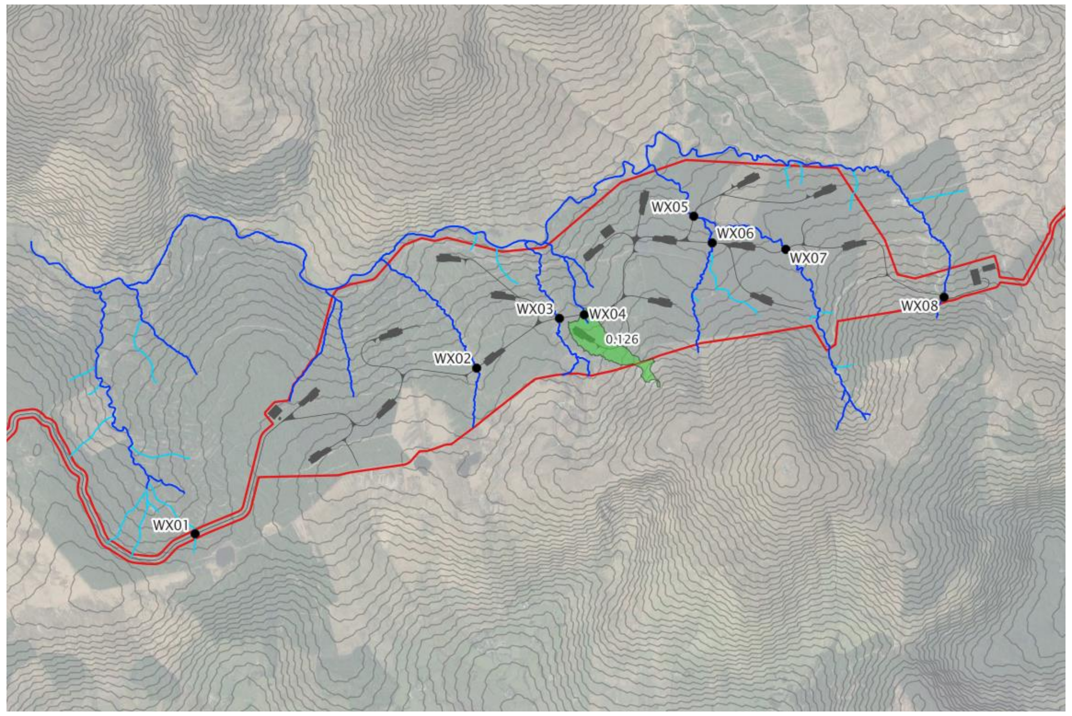
DESIGNED FOR FREE INLET CONDITIONS 1% AEP + CLIMATE CHANGE. HYDROLOGY & HYDRAULIC ASSESSMENT IN ANNEX A & B RESPECTIVELY.</td><td>
TAKEN UPSTREAM OF PROPOSED CROSSING LOCATION (FACING DOWNSTREAM)</td><td>

CATCHMENT AREA: 0.085 KM^2</td></tr>
<tr><td>WX02</td><td>518944.94</td><td>582681.95</td><td>PROPOSED TRACK CROSSES EPA WATERCOURSE (UNNAMED).

NEW MIN. 2.5 M x 1.1 M (SPAN x HEIGHT) CLEAR SPAN BRIDGE OR BOTTOMLESS CULVERT (PCC OR EQUIVALENT). CLEAR SPAN IS BASED ON ESTIMATED BANK-TO-BANK WIDTH AND IS TO AVOID DISRUPTION TO RIVERBED TO SUIT FISHERIES REQUIREMENTS.

DESIGNED FOR FREE INLET CONDITIONS 1% AEP + CLIMATE CHANGE. HYDROLOGY & HYDRAULIC ASSESSMENT IN ANNEX A & B RESPECTIVELY.</td><td>
TAKEN DOWNSTREAM OF PROPOSED CROSSING LOCATION (FACING DOWNSTREAM)</td><td>

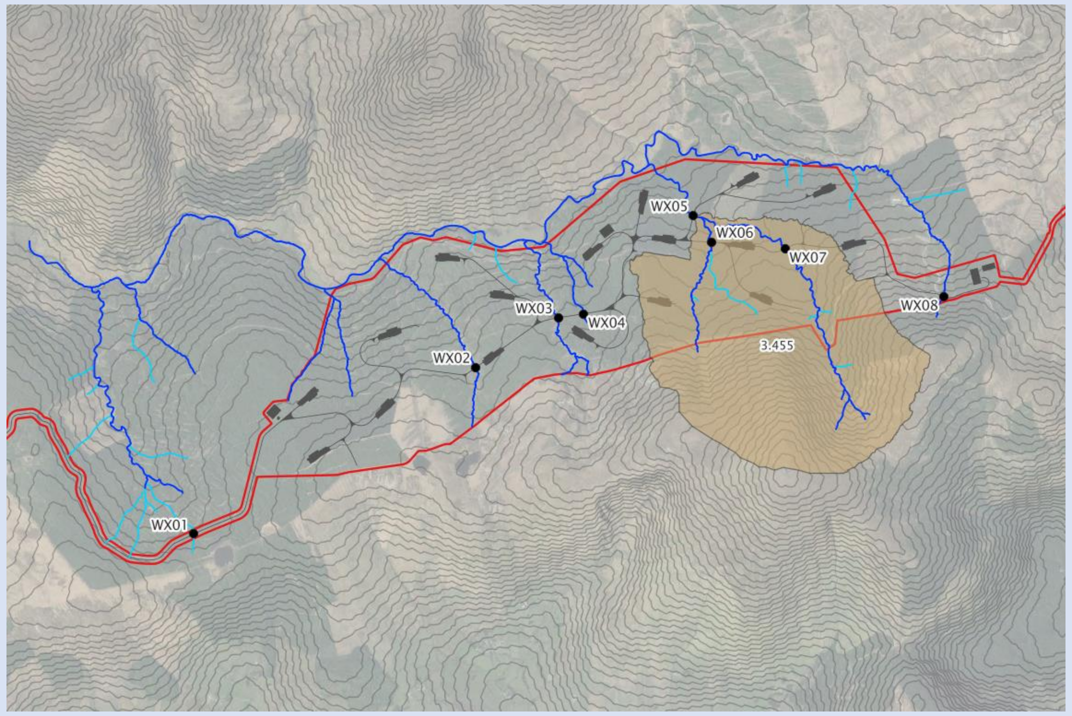
CATCHMENT AREA: 0.676 KM^2</td></tr>
</table>

WX REF	EASTING	NORTHING	DESCRIPTION	PHOTO	CATCHMENT MAP
WX03	519607.07	583080.80	PROPOSED TRACK CROSSES EPA WATERCOURSE (CLYDAGHROE). NEW MIN. 2.8 M x 1.2 M (SPAN x HEIGHT) CLEAR SPAN BRIDGE OR BOTTOMLESS CULVERT (PCC OR EQUIVALENT). CLEAR SPAN IS BASED ON ESTIMATED BANK-TO-BANK WIDTH AND IS TO AVOID DISRUPTION TO RIVERBED TO SUIT FISHERIES REQUIREMENTS. DESIGNED FOR FREE INLET CONDITIONS 1% AEP + CLIMATE CHANGE. HYDROLOGY & HYDRAULIC ASSESSMENT IN ANNEX A & B RESPECTIVELY.	 *TAKEN DOWNSTREAM OF PROPOSED CROSSING LOCATION (FACING DOWNSTREAM)*	 *CATCHMENT AREA: 0.975 KM^2*
WX04	519809.13	583113.67	PROPOSED TRACK CROSSES EPA WATERCOURSE (UNNAMED). NEW MIN. 2.5 M x 0.7 M (SPAN x HEIGHT) CLEAR SPAN BRIDGE OR BOTTOMLESS CULVERT (PCC OR EQUIVALENT). CLEAR SPAN IS BASED ON ESTIMATED BANK-TO-BANK WIDTH AND IS TO AVOID DISRUPTION TO RIVERBED TO SUIT FISHERIES REQUIREMENTS. DESIGNED FOR FREE INLET CONDITIONS 1% AEP + CLIMATE CHANGE. HYDROLOGY & HYDRAULIC ASSESSMENT IN ANNEX A & B RESPECTIVELY.	 *TAKEN DOWNSTREAM OF PROPOSED CROSSING LOCATION (FACING DOWNSTREAM)*	 *CATCHMENT AREA: 0.126 KM^2*

<table>
<tr><th>WX REF</th><th>EASTING</th><th>NORTHING</th><th>DESCRIPTION</th><th>PHOTO</th><th>CATCHMENT MAP</th></tr>
<tr><td>WX05</td><td>520693.80</td><td>583905.07</td><td>PROPOSED TRACK CROSSES EPA WATERCOURSE (UNNAMED).

SURVEY INDICATES GOOD FISH HABITAT.

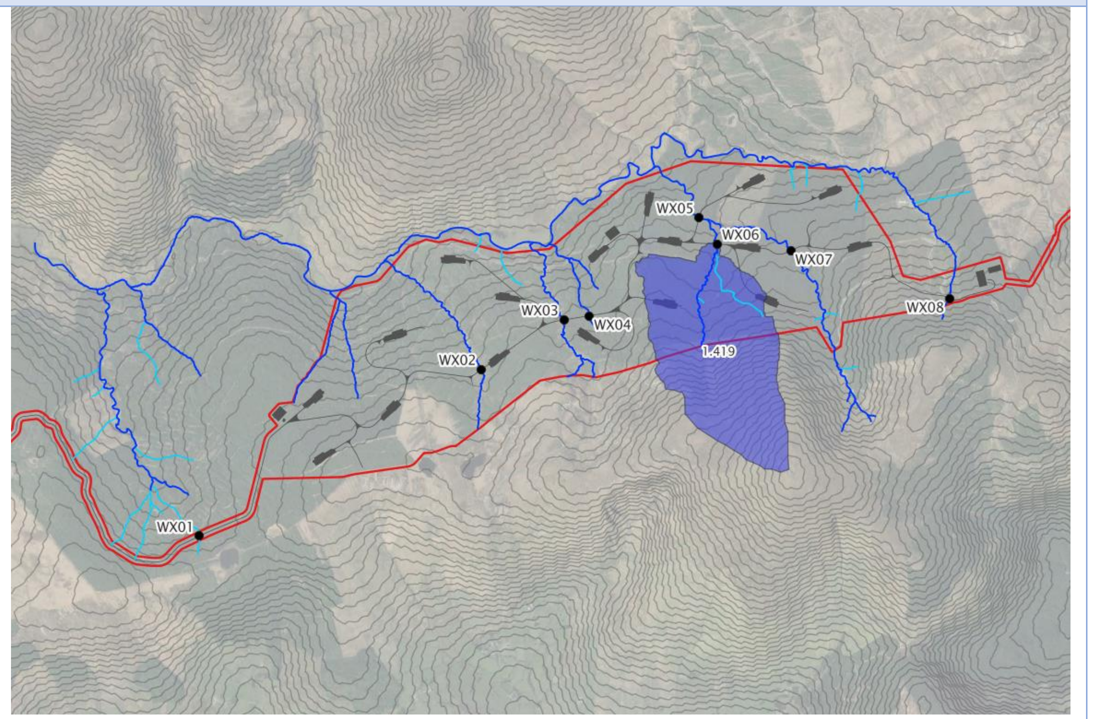
NEW MIN. 8.0 M x 1.2 M (SPAN x HEIGHT) CLEAR SPAN BRIDGE OR BOTTOMLESS CULVERT (PCC OR EQUIVALENT). CLEAR SPAN IS BASED ON ESTIMATED BANK-TO-BANK WIDTH AND IS TO AVOID DISRUPTION TO RIVERBED TO SUIT FISHERIES REQUIREMENTS.

DESIGNED FOR FREE INLET CONDITIONS 1% AEP + CLIMATE CHANGE. HYDROLOGY & HYDRAULIC ASSESSMENT IN ANNEX A & B RESPECTIVELY.</td><td>
TAKEN UPSTREAM OF PROPOSED CROSSING LOCATION (FACING DOWNSTREAM)</td><td>

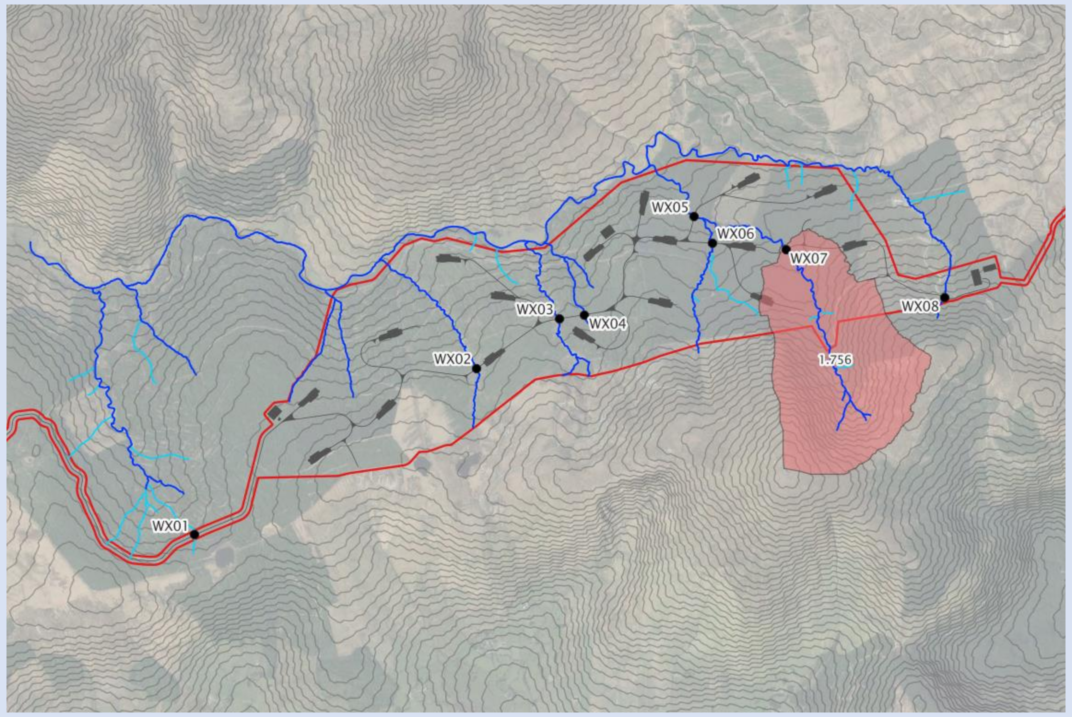
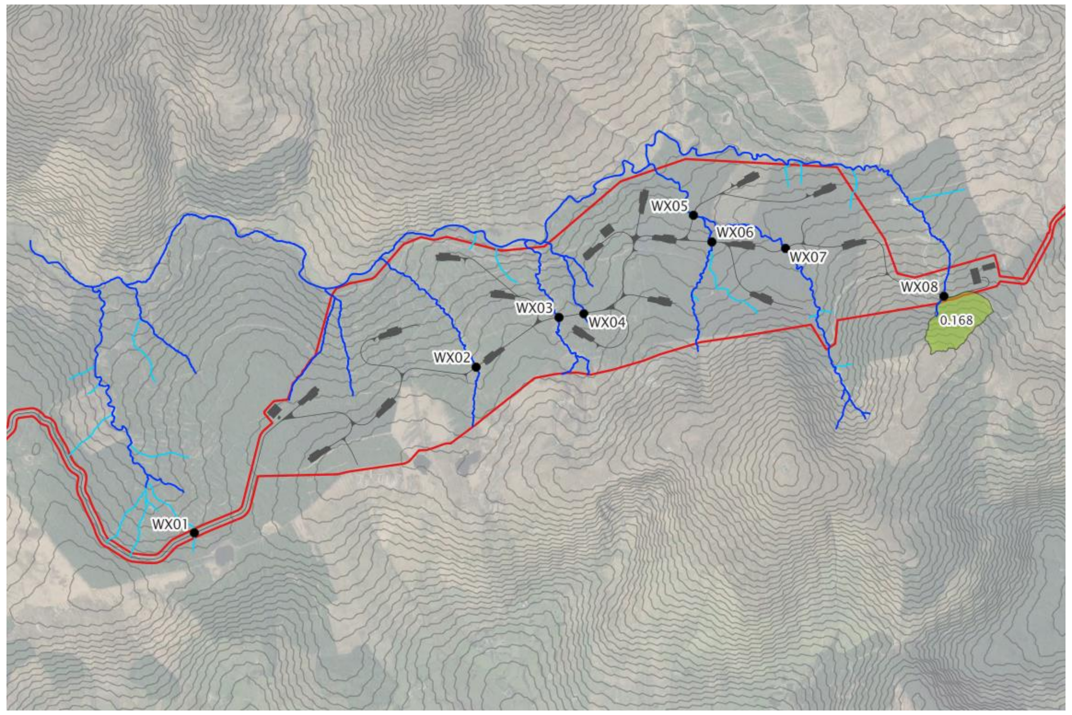
CATCHMENT AREA: 3.455 KM^2</td></tr>
<tr><td>WX06</td><td>520838.50</td><td>583689.23</td><td>PROPOSED TRACK CROSSES EPA WATERCOURSE (MULLAGHANISH).

SURVEY INDICATES GOOD FISH HABITAT.

NEW MIN. 4.0 M x 1.2 M (SPAN x HEIGHT) CLEAR SPAN BRIDGE OR BOTTOMLESS CULVERT (PCC OR EQUIVALENT). CLEAR SPAN IS BASED ON ESTIMATED BANK-TO-BANK WIDTH AND IS TO AVOID DISRUPTION TO RIVERBED TO SUIT FISHERIES REQUIREMENTS.

DESIGNED FOR FREE INLET CONDITIONS 1% AEP + CLIMATE CHANGE. HYDROLOGY & HYDRAULIC ASSESSMENT IN ANNEX A & B RESPECTIVELY.</td><td>
TAKEN UPSTREAM OF PROPOSED CROSSING LOCATION (FACING DOWNSTREAM)</td><td>

CATCHMENT AREA: 1.419 KM^2</td></tr>
</table>

WX REF	EASTING	NORTHING	DESCRIPTION	PHOTO	CATCHMENT MAP
WX07	521429.79	583638.68	PROPOSED TRACK CROSSES EPA WATERCOURSE (UNNAMED). SURVEY INDICATES GOOD FISH HABITAT. NEW MIN. 5.0 M x 1.1 M (SPAN x HEIGHT) CLEAR SPAN BRIDGE OR BOTTOMLESS CULVERT (PCC OR EQUIVALENT). CLEAR SPAN IS BASED ON ESTIMATED BANK-TO-BANK WIDTH AND IS TO AVOID DISRUPTION TO RIVERBED TO SUIT FISHERIES REQUIREMENTS. DESIGNED FOR FREE INLET CONDITIONS 1% AEP + CLIMATE CHANGE. HYDROLOGY & HYDRAULIC ASSESSMENT IN ANNEX A & B RESPECTIVELY.	 *TAKEN DOWNSTREAM OF PROPOSED CROSSING LOCATION (FACING UPSTREAM)*	 *CATCHMENT AREA: 1.756 KM^2*
WX08	522706.72	583253.78	PROPOSED TRACK CROSSES EPA WATERCOURSE (UNNAMED). SURVEY INDICATES GOOD FISH HABITAT 1.2 KM DOWNSTREAM OF PROPOSED CROSSING. NEW MIN. 2.5 M x 0.6 M (SPAN x HEIGHT) CLEAR SPAN BRIDGE OR BOTTOMLESS CULVERT (PCC OR EQUIVALENT). CLEAR SPAN IS BASED ON ESTIMATED BANK-TO-BANK WIDTH AND IS TO AVOID DISRUPTION TO RIVERBED TO SUIT FISHERIES REQUIREMENTS. DESIGNED FOR FREE INLET CONDITIONS 1% AEP + CLIMATE CHANGE. HYDROLOGY & HYDRAULIC ASSESSMENT IN ANNEX A & B RESPECTIVELY.	 TAKEN AT PROPOSED CROSSING LOCATION (FACING DOWNSTREAM)	 *CATCHMENT AREA: 0.168 KM^2*

ANNEX A – HYDROLOGY / FLOW ESTIMATON SUMMARY

Project	Cummennabuddoge WF
Ref	M01944-02
Watercourse	WX01
Date	26/10/2023

McCloy Consulting

Purpose: To estimate design flows for an Irish catchment by the FSSR No. 6 3-Variable Eqn method

This spreadsheet is suitable for estimating design flows on small catchments (less than 20 km^2) using the FSSR no. 6 3-Variable equation for QBAR plus the FSR (FSSR14) regional growth curves.

AREA	*Max from FSU / Height Data*	0.085	km2
SAAR4170	*From FSU*	1968.81	mm
WRAP class:	*From WRAP maps / FSU BFISOIL*	5	
SOIL		0.5	

QBAR	0.18	m3/s

Map Region	Ireland

Return period (years)	Growth Curve Factor	Design flow (m^3/s)	Specific runoff (l/s/ha)
2	0.948	0.169	19.894
30	1.644	0.293	34.519
50	1.775	0.317	37.257
100	1.956	0.349	41.064
500	2.400	0.428	50.381
1000	2.600	0.464	54.580

Outcomes are exclusive of the effect of climate change, estimated seperately

Project	Cummennabuddoge WF
Ref	M01944-02
Watercourse	WX01
Date	26/10/2023

McCloy Consulting

Purpose: To estimate a design flow for a catchment in the Irish hydrological region by the Institute of Hydrology Report 124 (IoH 124) "Flood Estimation on Small Catchments" method.

This spreadsheet is suitable for estimating design flows on small rural catchments (less than 25 km^2) using the IH Report 124 equation for QBAR plus the FSR regional growth curves. Rural can be taken as meaning URBAN less than 0.05, or equivalently URBEX. This sheet does not adopt the <5 sq km alternative method (for plot scale equations) in order to ensure a conservative approach to flood estimation.

AREA	*Max from FSU / Height Data*	0.085	km2
SAAR4170	*From FSU*	1968.81	mm
WRAP class:	*From WRAP maps / FSU BFISOIL*	5	
SOIL		0.5	

QBAR	0.19	m3/s

Map Region	Ireland

Return period (years)	Growth Curve Factor (from FSSR 14 and FSU research)	Design flow (m^3/s)	Specific runoff (l/s/ha)
2	0.948	0.181	21.322
30	1.644	0.314	36.997
50	1.775	0.339	39.932
100	1.956	0.374	44.012
500	2.400	0.459	53.999
1000	2.600	0.497	58.498

Outcomes are exclusive of the effect of climate change, estimated seperately

Project	Cummennabuddoge WF
Ref	M01944-02
Watercourse	WX02
Date	26/10/2023

McCloy Consulting

Purpose: To estimate design flows for an Irish catchment by the FSSR No. 6 3-Variable Eqn method

This spreadsheet is suitable for estimating design flows on small catchments (less than 20 km^2) using the FSSR no. 6 3-Variable equation for QBAR plus the FSR (FSSR14) regional growth curves.

AREA	*Max from FSU / Height Data*	0.676	km2
SAAR4170	*From FSU*	1867.3	mm
WRAP class:	*From WRAP maps / FSU BFISOIL*	5	
SOIL		0.5	

QBAR	1.13	m3/s

Map Region	Ireland

Return period (years)	Growth Curve Factor	Design flow (m^3/s)	Specific runoff (l/s/ha)
2	0.948	1.068	15.799
30	1.644	1.853	27.414
50	1.775	2.000	29.588
100	1.956	2.205	32.612
500	2.400	2.705	40.011
1000	2.600	2.930	43.345

Outcomes are exclusive of the effect of climate change, estimated seperately

Project	Cummennabuddoge WF
Ref	M01944-02
Watercourse	WX02
Date	26/10/2023

McCloy Consulting

Purpose: To estimate a design flow for a catchment in the Irish hydrological region by the Institute of Hydrology Report 124 (IoH 124) "Flood Estimation on Small Catchments" method.

This spreadsheet is suitable for estimating design flows on small rural catchments (less than 25 km^2) using the IH Report 124 equation for QBAR plus the FSR regional growth curves. Rural can be taken as meaning URBAN less than 0.05, or equivalently URBEX. This sheet does not adopt the <5 sq km alternative method (for plot scale equations) in order to ensure a conservative approach to flood estimation.

AREA	*Max from FSU / Height Data*	0.676	km2
SAAR4170	*From FSU*	1867.3	mm
WRAP class:	*From WRAP maps / FSU BFISOIL*	5	
SOIL		0.5	

QBAR	1.14	m3/s

Map Region	Ireland

Return period (years)	Growth Curve Factor (from FSSR 14 and FSU research)	Design flow (m^3/s)	Specific runoff (l/s/ha)
2	0.948	1.079	15.954
30	1.644	1.871	27.683
50	1.775	2.020	29.879
100	1.956	2.226	32.932
500	2.400	2.731	40.404
1000	2.600	2.959	43.771

Outcomes are exclusive of the effect of climate change, estimated seperately

Project	Cummennabuddoge WF
Ref	M01944-02
Watercourse	WX03
Date	26/10/2023

McCloy Consulting

Purpose: To estimate design flows for an Irish catchment by the FSSR No. 6 3-Variable Eqn method

This spreadsheet is suitable for estimating design flows on small catchments (less than 20 km^2) using the FSSR no. 6 3-Variable equation for QBAR plus the FSR (FSSR14) regional growth curves.

AREA	*Max from FSU / Height Data*	0.975	km2
SAAR4170	*From FSU*	1867.3	mm
WRAP class:	*From WRAP maps / FSU BFISOIL*	5	
SOIL		0.5	

QBAR	1.58	m3/s

Map Region	Ireland

Return period (years)	Growth Curve Factor	Design flow (m^3/s)	Specific runoff (l/s/ha)
2	0.948	1.496	15.343
30	1.644	2.596	26.622
50	1.775	2.802	28.734
100	1.956	3.088	31.670
500	2.400	3.788	38.856
1000	2.600	4.104	42.094

Outcomes are exclusive of the effect of climate change, estimated seperately

Project	Cummennabuddoge WF
Ref	M01944-02
Watercourse	WX03
Date	26/10/2023

McCloy Consulting

Purpose: To estimate a design flow for a catchment in the Irish hydrological region by the Institute of Hydrology Report 124 (IoH 124) "Flood Estimation on Small Catchments" method.

This spreadsheet is suitable for estimating design flows on small rural catchments (less than 25 km^2) using the IH Report 124 equation for QBAR plus the FSR regional growth curves. Rural can be taken as meaning URBAN less than 0.05, or equivalently URBEX. This sheet does not adopt the <5 sq km alternative method (for plot scale equations) in order to ensure a conservative approach to flood estimation.

AREA	*Max from FSU / Height Data*	0.975	km2
SAAR4170	*From FSU*	1867.3	mm
WRAP class:	*From WRAP maps / FSU BFISOIL*	5	
SOIL		0.5	

QBAR	1.58	m3/s

Map Region	Ireland

Return period (years)	Growth Curve Factor (from FSSR 14 and FSU research)	Design flow (m^3/s)	Specific runoff (l/s/ha)
2	0.948	1.494	15.324
30	1.644	2.593	26.590
50	1.775	2.798	28.699
100	1.956	3.084	31.632
500	2.400	3.784	38.809
1000	2.600	4.099	42.043

Outcomes are exclusive of the effect of climate change, estimated seperately

Project	Cummennabuddoge WF
Ref	M01944-02
Watercourse	WX04
Date	26/10/2023

McCloy Consulting

Purpose: To estimate design flows for an Irish catchment by the FSSR No. 6 3-Variable Eqn method

This spreadsheet is suitable for estimating design flows on small catchments (less than 20 km^2) using the FSSR no. 6 3-Variable equation for QBAR plus the FSR (FSSR14) regional growth curves.

AREA	*Max from FSU / Height Data*	0.126	km2
SAAR4170	*From FSU*	1732.62	mm
WRAP class:	*From WRAP maps / FSU BFISOIL*	5	
SOIL		0.5	

QBAR	0.22	m3/s

Map Region	Ireland

Return period (years)	Growth Curve Factor	Design flow (m^3/s)	Specific runoff (l/s/ha)
2	0.948	0.208	16.494
30	1.644	0.361	28.620
50	1.775	0.389	30.890
100	1.956	0.429	34.047
500	2.400	0.526	41.772
1000	2.600	0.570	45.253

Outcomes are exclusive of the effect of climate change, estimated seperately

Project	Cummennabuddoge WF
Ref	M01944-02
Watercourse	WX04
Date	26/10/2023

McCloy Consulting

Purpose: To estimate a design flow for a catchment in the Irish hydrological region by the Institute of Hydrology Report 124 (IoH 124) "Flood Estimation on Small Catchments" method.

This spreadsheet is suitable for estimating design flows on small rural catchments (less than 25 km^2) using the IH Report 124 equation for QBAR plus the FSR regional growth curves. Rural can be taken as meaning URBAN less than 0.05, or equivalently URBEX. This sheet does not adopt the <5 sq km alternative method (for plot scale equations) in order to ensure a conservative approach to flood estimation.

AREA	*Max from FSU / Height Data*	0.126	km2
SAAR4170	*From FSU*	1732.62	mm
WRAP class:	*From WRAP maps / FSU BFISOIL*	5	
SOIL		0.5	

QBAR	0.23	m3/s

Map Region	Ireland

Return period (years)	Growth Curve Factor (from FSSR 14 and FSU research)	Design flow (m^3/s)	Specific runoff (l/s/ha)
2	0.948	0.222	17.583
30	1.644	0.384	30.509
50	1.775	0.415	32.929
100	1.956	0.457	36.294
500	2.400	0.561	44.529
1000	2.600	0.608	48.240

Outcomes are exclusive of the effect of climate change, estimated seperately

Project	Cummennabuddoge WF
Ref	M01944-02
Watercourse	WX05
Date	26/10/2023

McCloy Consulting

Purpose: To estimate design flows for an Irish catchment by the FSSR No. 6 3-Variable Eqn method

This spreadsheet is suitable for estimating design flows on small catchments (less than 20 km^2) using the FSSR no. 6 3-Variable equation for QBAR plus the FSR (FSSR14) regional growth curves.

AREA	*Max from FSU / Height Data*	3.455	km2
SAAR4170	*From FSU*	1810.31	mm
WRAP class:	*From WRAP maps / FSU BFISOIL*	5	
SOIL		0.5	

QBAR	4.87	m3/s

Map Region	Ireland

Return period (years)	Growth Curve Factor	Design flow (m^3/s)	Specific runoff (l/s/ha)
2	0.948	4.613	13.351
30	1.644	8.004	23.167
50	1.775	8.639	25.004
100	1.956	9.522	27.559
500	2.400	11.682	33.813
1000	2.600	12.656	36.630

Outcomes are exclusive of the effect of climate change, estimated seperately

Project	Cummennabuddoge WF
Ref	M01944-02
Watercourse	WX05
Date	26/10/2023

McCloy Consulting

Purpose: To estimate a design flow for a catchment in the Irish hydrological region by the Institute of Hydrology Report 124 (IoH 124) "Flood Estimation on Small Catchments" method.

This spreadsheet is suitable for estimating design flows on small rural catchments (less than 25 km^2) using the IH Report 124 equation for QBAR plus the FSR regional growth curves. Rural can be taken as meaning URBAN less than 0.05, or equivalently URBEX. This sheet does not adopt the <5 sq km alternative method (for plot scale equations) in order to ensure a conservative approach to flood estimation.

AREA	*Max from FSU / Height Data*	3.455	km2
SAAR4170	*From FSU*	1810.31	mm
WRAP class:	*From WRAP maps / FSU BFISOIL*	5	
SOIL		0.5	

QBAR	4.69	m3/s

Map Region	Ireland

Return period (years)	Growth Curve Factor (from FSSR 14 and FSU research)	Design flow (m^3/s)	Specific runoff (l/s/ha)
2	0.948	4.443	12.859
30	1.644	7.709	22.312
50	1.775	8.320	24.081
100	1.956	9.170	26.542
500	2.400	11.251	32.564
1000	2.600	12.189	35.278

Outcomes are exclusive of the effect of climate change, estimated seperately

Project	Cummennabuddoge WF
Ref	M01944-02
Watercourse	WX06
Date	26/10/2023

McCloy Consulting

Purpose: To estimate design flows for an Irish catchment by the FSSR No. 6 3-Variable Eqn method

This spreadsheet is suitable for estimating design flows on small catchments (less than 20 km^2) using the FSSR no. 6 3-Variable equation for QBAR plus the FSR (FSSR14) regional growth curves.

AREA	*Max from FSU / Height Data*	1.419	km2
SAAR4170	*From FSU*	1845.17	mm
WRAP class:	*From WRAP maps / FSU BFISOIL*	5	
SOIL		0.5	

QBAR	2.20	m3/s

Map Region	Ireland

Return period (years)	Growth Curve Factor	Design flow (m^3/s)	Specific runoff (l/s/ha)
2	0.948	2.082	14.674
30	1.644	3.613	25.462
50	1.775	3.900	27.481
100	1.956	4.298	30.290
500	2.400	5.273	37.162
1000	2.600	5.713	40.259

Outcomes are exclusive of the effect of climate change, estimated seperately

Project	Cummennabuddoge WF
Ref	M01944-02
Watercourse	WX06
Date	26/10/2023

McCloy Consulting

Purpose: To estimate a design flow for a catchment in the Irish hydrological region by the Institute of Hydrology Report 124 (IoH 124) "Flood Estimation on Small Catchments" method.

This spreadsheet is suitable for estimating design flows on small rural catchments (less than 25 km^2) using the IH Report 124 equation for QBAR plus the FSR regional growth curves. Rural can be taken as meaning URBAN less than 0.05, or equivalently URBEX. This sheet does not adopt the <5 sq km alternative method (for plot scale equations) in order to ensure a conservative approach to flood estimation.

AREA	*Max from FSU / Height Data*	1.419	km2
SAAR4170	*From FSU*	1845.17	mm
WRAP class:	*From WRAP maps / FSU BFISOIL*	5	
SOIL		0.5	

QBAR	2.17	m3/s

Map Region	Ireland

Return period (years)	Growth Curve Factor (from FSSR 14 and FSU research)	Design flow (m^3/s)	Specific runoff (l/s/ha)
2	0.948	2.058	14.501
30	1.644	3.570	25.161
50	1.775	3.854	27.157
100	1.956	4.247	29.932
500	2.400	5.211	36.724
1000	2.600	5.645	39.784

Outcomes are exclusive of the effect of climate change, estimated seperately

Project	Cummennabuddoge WF
Ref	M01944-02
Watercourse	WX07
Date	26/10/2023

McCloy Consulting

Purpose: To estimate design flows for an Irish catchment by the FSSR No. 6 3-Variable Eqn method

This spreadsheet is suitable for estimating design flows on small catchments (less than 20 km^2) using the FSSR no. 6 3-Variable equation for QBAR plus the FSR (FSSR14) regional growth curves.

AREA	*Max from FSU / Height Data*	1.756	km2
SAAR4170	*From FSU*	1784.7	mm
WRAP class:	*From WRAP maps / FSU BFISOIL*	5	
SOIL		0.5	

QBAR	2.57	m3/s

Map Region	Ireland

Return period (years)	Growth Curve Factor	Design flow (m^3/s)	Specific runoff (l/s/ha)
2	0.948	2.432	13.851
30	1.644	4.220	24.034
50	1.775	4.555	25.941
100	1.956	5.021	28.591
500	2.400	6.160	35.079
1000	2.600	6.673	38.002

Outcomes are exclusive of the effect of climate change, estimated seperately

Project	Cummennabuddoge WF
Ref	M01944-02
Watercourse	WX07
Date	26/10/2023

McCloy Consulting

Purpose: To estimate a design flow for a catchment in the Irish hydrological region by the Institute of Hydrology Report 124 (IoH 124) "Flood Estimation on Small Catchments" method.

This spreadsheet is suitable for estimating design flows on small rural catchments (less than 25 km^2) using the IH Report 124 equation for QBAR plus the FSR regional growth curves. Rural can be taken as meaning URBAN less than 0.05, or equivalently URBEX. This sheet does not adopt the <5 sq km alternative method (for plot scale equations) in order to ensure a conservative approach to flood estimation.

AREA	*Max from FSU / Height Data*	1.756	km2
SAAR4170	*From FSU*	1784.7	mm
WRAP class:	*From WRAP maps / FSU BFISOIL*	5	
SOIL		0.5	

QBAR	2.52	m3/s

Map Region	Ireland

Return period (years)	Growth Curve Factor (from FSSR 14 and FSU research)	Design flow (m^3/s)	Specific runoff (l/s/ha)
2	0.948	2.392	13.623
30	1.644	4.151	23.639
50	1.775	4.480	25.514
100	1.956	4.938	28.121
500	2.400	6.058	34.501
1000	2.600	6.563	37.376

Outcomes are exclusive of the effect of climate change, estimated seperately

Project	Cummennabuddoge WF
Ref	M01944-02
Watercourse	WX08
Date	26/10/2023

McCloy Consulting

Purpose: To estimate design flows for an Irish catchment by the FSSR No. 6 3-Variable Eqn method

This spreadsheet is suitable for estimating design flows on small catchments (less than 20 km^2) using the FSSR no. 6 3-Variable equation for QBAR plus the FSR (FSSR14) regional growth curves.

AREA	*Max from FSU / Height Data*	0.168	km2
SAAR4170	*From FSU*	1680.99	mm
WRAP class:	*From WRAP maps / FSU BFISOIL*	5	
SOIL		0.5	

QBAR	0.28	m3/s

Map Region	Ireland

Return period (years)	Growth Curve Factor	Design flow (m^3/s)	Specific runoff (l/s/ha)
2	0.948	0.261	15.535
30	1.644	0.453	26.956
50	1.775	0.489	29.094
100	1.956	0.539	32.067
500	2.400	0.661	39.342
1000	2.600	0.716	42.621

Outcomes are exclusive of the effect of climate change, estimated seperately

Project	Cummennabuddoge WF
Ref	M01944-02
Watercourse	WX08
Date	26/10/2023

McCloy Consulting

Purpose: To estimate a design flow for a catchment in the Irish hydrological region by the Institute of Hydrology Report 124 (IoH 124) "Flood Estimation on Small Catchments" method.

This spreadsheet is suitable for estimating design flows on small rural catchments (less than 25 km^2) using the IH Report 124 equation for QBAR plus the FSR regional growth curves. Rural can be taken as meaning URBAN less than 0.05, or equivalently URBEX. This sheet does not adopt the <5 sq km alternative method (for plot scale equations) in order to ensure a conservative approach to flood estimation.

AREA	*Max from FSU / Height Data*	0.168	km2
SAAR4170	*From FSU*	1680.99	mm
WRAP class:	*From WRAP maps / FSU BFISOIL*	5	
SOIL		0.5	

QBAR	0.29	m3/s

Map Region	Ireland

Return period (years)	Growth Curve Factor (from FSSR 14 and FSU research)	Design flow (m^3/s)	Specific runoff (l/s/ha)
2	0.948	0.276	16.443
30	1.644	0.479	28.531
50	1.775	0.517	30.794
100	1.956	0.570	33.941
500	2.400	0.700	41.642
1000	2.600	0.758	45.112

Outcomes are exclusive of the effect of climate change, estimated seperately

ANNEX B - HYDRAULICS – CULVERT SIZING

Purpose

To determine the adequacy of hydraulic capacity for culverts in accordance with the requirements of CIRIA C689

1.0 *Input Data:*

Culvert Ref:		WX01		
Watercourse Name		Unnamed		
Design Discharge Q		***0.449***	***m3/sec***	As per Hydrological Analysis
Design Return Period		*100+CC*	*Yrs*	As per LA requirement
Elevation of Stream Bed @ Culvert Inlet		368.2	m AOD	From Survey
Elevation of Stream Bed @ Culvert Outlet		368	m AOD	From Survey
Culvert Length		11	m	From Survey
Elevation of Stream bed upstream of Culvert		368.7	m AOD	From Survey
Distance upstream of Culvert		26	m	From Survey
Elevation of Stream bed downstream of Culvert		367.8	m AOD	From Survey
Distance downstream of Culvert		20	m	From Survey
Elevation of Proposed Embankment Crest		370	m AOD	From Survey
Average channel invert width		1	m	From Survey
Average channel top of bank width		1.5	m	From Survey
Average Channel Depth to Bank		0.3	m	From Survey
Left Over-Bank Ground Level (Floodplain) (Culvert Inlet)		368.8	m AOD	From Survey
Distance from bank		6	m	From Survey
Right Over-Bank Ground Level (Floodplain) (Culvert Inlet)		368.8	m AOD	From Survey
Distance from bank		6	m	From Survey
Mannings n - Channel		0.045		From C689 Table A1.1
Mannings n - Overbanks		0.05		From C689 Table A1.1
Bedslope upstream of Culvert 1 in S1	S1	52.00	-	Calculated
Bedslope downstream of Culvert 1 in S2	S2	100.00	-	Calculated
Bedslope across Culvert 1 in S3	S3	55.00	-	Calculated
Bedslope across whole reach considered 1 in S4	S4	63.33	-	Calculated
Channel Side Slopes 1 in X	X =	0.83	-	Calculated
Upstream Left Over- Bank Slope	Y =	20.00	-	Calculated
Upstream Right Over- Bank Slope	Z =	20.00	-	Calculated

2.0 *Calculate Tailwater Depth and Level:*

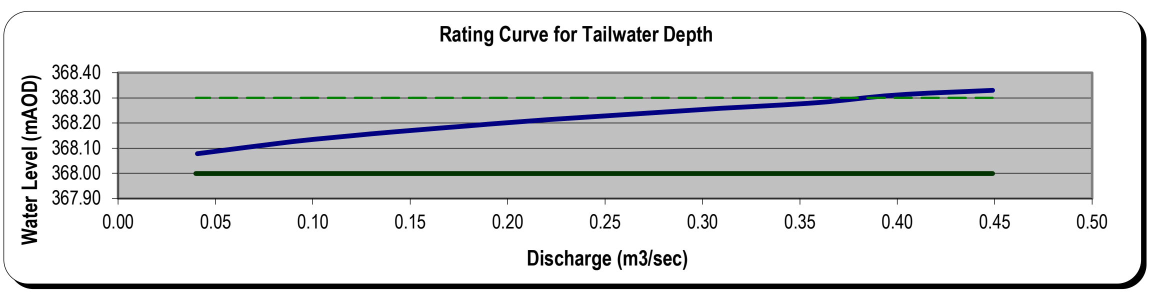
Mannings Equation:

$$Q = VA = \left(\frac{1.00}{n}\right) A R^{\frac{2}{3}} \sqrt{S} \quad [SI] \qquad R_h = \frac{A}{P}$$

Channel Capacity < Discharge, Out of Bank Flooding Considered

Depth of water in channel is	y_{dc}	0.33	m	Calculated
Therefore water level at downstream extent of culvert is	WL_t	368.33	mAOD	Calculated
	V_{dc}	1.07	m/s	Calculated

2.1 Rating Curve for Tailwater Channel Discharge



3.0 *Calculate Tailwater Elevation (Total Head) Ht:*

$$H_t = Z_{bo} + y_{dc} + \frac{V_{dc}^2}{2g}$$

Where: Z_{bo} Elevation @ Culvert Outlet
y_{dc} Water depth in downstream channel
V_{dc} Velocity in downstream channel

Tailwater Elevation: H_t 368.39 mAOD Calculated

4.0 *Calculate Froude No.*

Cross Sectional Area (A)		0.42	m2	
Top Width (B)		2.72	m	
Hydraulic mean depth (A per unit B)	d_m	0.15	m	
Froude Number	Fr	0.87	*Subcritical*	
Critical depth in channel	h_c	0.21	m	
Critical Velocity	v_c	1.23	m/s	

5.0 *Initial Design*

Initial Estimate of required culvert cross sectional area required. Analysis is based on new culvert, therefore design should allow for freeflow conditions. Applicable method is Flow Area Method

5.1 *Flow Area Method - refer to C689 Section 6.7.1*

Depth; Min. Tailwater depth	D	0.33	m	Calculated
Assume 20% Initial loss of culvert height due to Freeboard / Si		0.41	m	Calculated
where freeboard depth is:	F	0.04	m	Calculated
Area required as per tailwater fllow calculation:	A_t	0.42	m2	Calculated
Nominal width (Area / Depth (not inc. freeboard):		1.27	m	Calculated
Therefore prelim culvert dimensions (incl freeboard + sil	D_i	*0.41*	*m*	Calculated
	B_i	*1.27*	*m*	Calculated

6.0 *Detailed Design*

6.1 *Try Culvert dimensions…*

Based on previous Initial Design

Height / Diameter	D	0.70	m	
Breadth (BLANK IF CIRCULAR)	B	2.5	m	
Number of Culverts	nr	1	n/a	
Shape		RECTANGULAR		
Freeboard		0.30	m	Manually Entered Value
Siltation / Depth lowered below ex. stream invert		0.00	m	Manually Entered Value

Therefore:

Upstream Pipe Invert		*368.20*	*mAOD*
Upstream Pipe Base (w/Silt)Elevation	Z_i	*368.20*	*mAOD*
Upstream Soffit Elevation		*368.90*	*mAOD*
Downstream Pipe Invert Elevation		*368.00*	*mAOD*
Downstream Pipe Base (w/ Silt) Elevation	Z_o	*368.00*	*mAOD*
Downstream Soffit Elevation		*368.70*	*mAOD*

6.2 *Calculation of Discharge Intensity*

$$q_i = \frac{1.811Q}{A_b D^{0.5}}$$

Where

Discharge	Q	0.449	m3/s
Depth / Diameter of barrell	D	0.70	m
Culvert cross section area excl. freeboard + siltation	Ab	1.00	m2
Discharge Coefficient	qi	0.97	n/a
Discharge intensity classification is:		Free Flow Inlet Control	

6.3 *Calculation of headwater depth for free flow inlet control*

Based on Table A1.3, Culvert type is Nr 19 n/a

i.e, Rectangular concrete, 90˚ headwall; 20mm chamfers

$$\frac{E_{sh}}{D} = \frac{E_{sc}}{D} + k\left[\frac{1.811Q}{A_b D^{0.5}}\right]^M - 0.5S_0$$ Eqn 6.23

$$\frac{E_{sh}}{D} = k\left[\frac{1.811Q}{A_b D^{0.5}}\right]^M$$ Eqn 6.25

Therefore applicable CIRIA C689 equation reference: Equation 6.25

Where

Discharge	Q	0.449	m3/s	
Depth / Diameter of barrell	D	0.7	m	
Unsubmerged analysis constant	k	0.515		Table A1.3
Unsubmerged analysis constant	M	0.667		Table A1.3
Culvert cross section area excl. freeboard + siltation	Ab	1.00	m2	
Culvert Slope	So	0.02	m/m	1 in 55
$\frac{Q^2 W}{gA^3} = 1$ Critical depth calculated as:	y_c	0.149	m	
Specific Energy at Critical Depth	E_{sc}	0.22	m	
$E_{sc} = \frac{3}{2} y_c$ Therefore Specific Energy of Headwater	E_{sh}	0.35	m	

6.4 *Calculation of headwater elevation for inlet control*

Headwater Elevation H_{hic} determined by:

$$H_{hic} = Z_i + E_{sh} + h_s$$

Where

Headloss due to inlet screen	h_s	N/A	(No Screen Proposed)
Stream Elevation at Inlet	Z_i	368.20	mAOD
Specific Energy of Headwater	E_{sh}	0.35	m
Therefore Headwater Elevation:	H_{hic}	368.55	mAOD

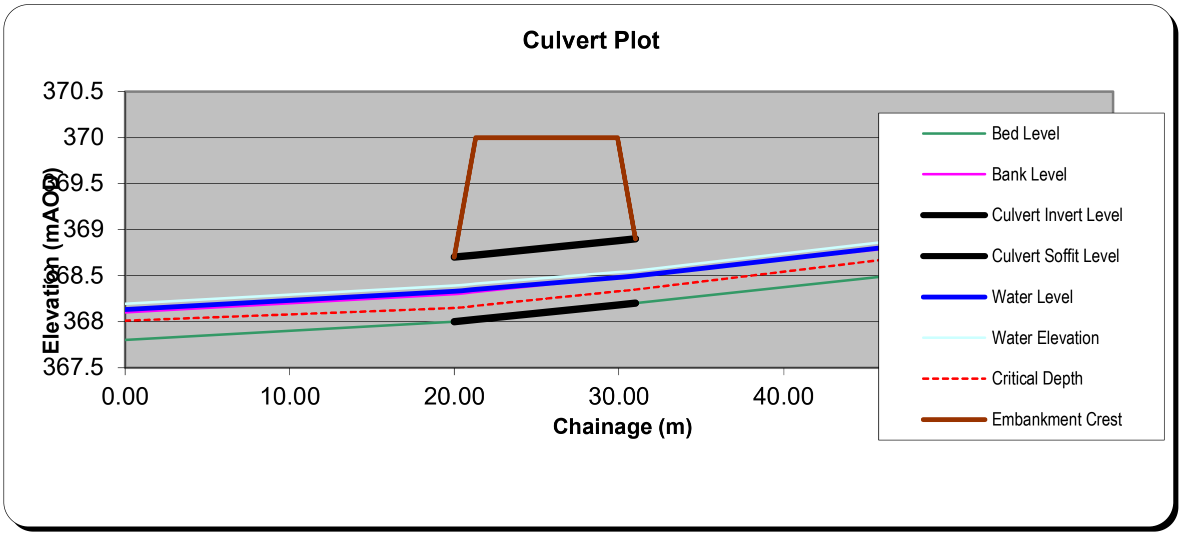
Water Level at the headwater for inlet control WL_{hic} determined by:

$$WL_{hic} = H_{hic} - \frac{V_{uc}^2}{2g}$$

Where

Headwater Elevation:	H_{hic}	368.55	mAOD
Velocity in Upstream Channel	V_{uc}	1.07	m/s
Therefore Water Level at Inlet:	WL_{hic}	368.50	mAOD

6.5 *Culvert Profile*



7.0 *Summary*

	Complies	Fails	Comment
Culvert Inlet Soffit Elevation > Headwater Elevation for Inlet Co	X		
Adequate Freeboard provided to water level?	X		

Therefore proposed culvert dimensions:	**1 nr**	**Height**	**0.70**	**m**
		Breadth / Span	**2.50**	**m**

By	Checked	Revision	Date
DH	KS	Original	21/11/2023

Project	Cummennabuddoge WF
Ref	M01944-02
Date	21/11/2023

Purpose

To determine the adequacy of hydraulic capacity for culverts in accordance with the requirements of CIRIA C689

1.0 *Input Data:*

Culvert Ref:		WX02		
Watercourse Name		Unnamed		
Design Discharge Q		***2.671***	***m3/sec***	As per Hydrological Analysis
Design Return Period		*100+CC*	*Yrs*	As per LA requirement
Elevation of Stream Bed @ Culvert Inlet		389.4	m AOD	From Survey
Elevation of Stream Bed @ Culvert Outlet		386.6	m AOD	From Survey
Culvert Length		43	m	From Survey
Elevation of Stream bed upstream of Culvert		390	m AOD	From Survey
Distance upstream of Culvert		15	m	From Survey
Elevation of Stream bed downstream of Culvert		386	m AOD	From Survey
Distance downstream of Culvert		15	m	From Survey
Elevation of Proposed Embankment Crest		391	m AOD	From Survey
Average channel invert width		1	m	From Survey
Average channel top of bank width		1.5	m	From Survey
Average Channel Depth to Bank		0.5	m	From Survey
Left Over-Bank Ground Level (Floodplain) (Culvert Inlet)		392	m AOD	From Survey
Distance from bank		5	m	From Survey
Right Over-Bank Ground Level (Floodplain) (Culvert Inlet)		392	m AOD	From Survey
Distance from bank		6	m	From Survey
Mannings n - Channel		0.045		From C689 Table A1.1
Mannings n - Overbanks		0.05		From C689 Table A1.1
Bedslope upstream of Culvert 1 in S1	S1	25.00	-	Calculated
Bedslope downstream of Culvert 1 in S2	S2	25.00	-	Calculated
Bedslope across Culvert 1 in S3	S3	15.36	-	Calculated
Bedslope across whole reach considered 1 in S4	S4	18.25	-	Calculated
Channel Side Slopes 1 in X	X =	0.50	-	Calculated
Upstream Left Over- Bank Slope	Y =	2.38	-	Calculated
Upstream Right Over- Bank Slope	Z =	2.86	-	Calculated

2.0 *Calculate Tailwater Depth and Level:*

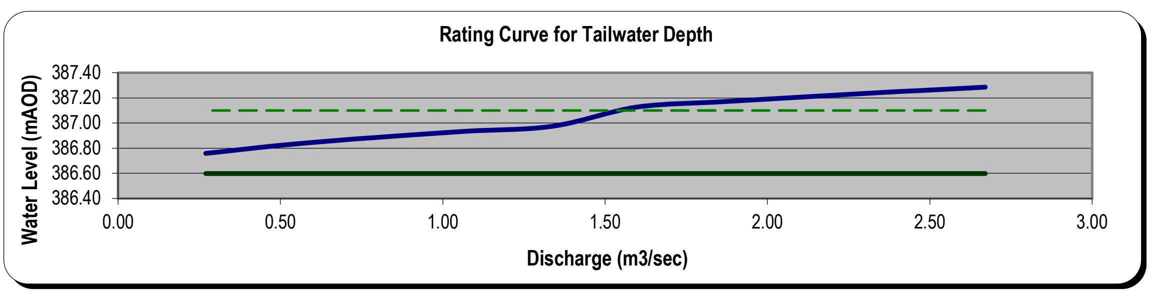
Mannings Equation:

$$Q = VA = \left(\frac{1.00}{n}\right) AR^{\frac{2}{3}} \sqrt{S} \quad [SI] \qquad R_h = \frac{A}{P}$$

Channel Capacity < Discharge, Out of Bank Flooding Considered

Depth of water in channel is	y_{dc}	0.69	m	Calculated
Therefore water level at downstream extent of culvert is	WL_t	387.29	mAOD	Calculated
	V_{dc}	2.91	m/s	Calculated

2.1 Rating Curve for Tailwater Channel Discharge



3.0 *Calculate Tailwater Elevation (Total Head) Ht:*

$$H_t = Z_{bo} + y_{dc} + \frac{V_{dc}^2}{2g}$$

Where: Z_{bo} Elevation @ Culvert Outlet
y_{dc} Water depth in downstream channel
V_{dc} Velocity in downstream channel

Tailwater Elevation:	H_t	387.75	mAOD	Calculated

4.0 *Calculate Froude No.*

Cross Sectional Area (A)		0.92	m2	
Top Width (B)		2.47	m	
Hydraulic mean depth (A per unit B)	d_m	0.37	m	
Froude Number	Fr	1.53	*Supercritical*	
Critical depth in channel	h_c	0.57	m	
Critical Velocity	v_c	1.91	m/s	

5.0 *Initial Design*

Initial Estimate of required culvert cross sectional area required. Analysis is based on new culvert, therefore design should allow for freeflow conditions. Applicable method is Flow Area Method

5.1 *Flow Area Method - refer to C689 Section 6.7.1*

Depth; Min. Tailwater depth	D	0.69	m	Calculated
Assume 20% Initial loss of culvert height due to Freeboard / Si		0.86	m	Calculated
where freeboard depth is:	F	0.09	m	Calculated
Area required as per tailwater fllow calculation:	A_t	0.92	m2	Calculated
Nominal width (Area / Depth (not inc. freeboard):		1.34	m	Calculated
Therefore prelim culvert dimensions (incl freeboard + sil	D_i	*0.86*	*m*	Calculated
	B_i	*1.34*	*m*	Calculated

6.0 *Detailed Design*

6.1 *Try Culvert dimensions...*

Based on previous Initial Design

Height / Diameter	D	1.10	m	
Breadth (BLANK IF CIRCULAR)	B	2.5	m	
Number of Culverts	nr	1	n/a	
Shape		RECTANGULAR		
Freeboard		0.30	m	Manually Entered Value
Siltation / Depth lowered below ex. stream invert		0.00	m	Manually Entered Value

Therefore:

Upstream Pipe Invert		*389.40*	*mAOD*
Upstream Pipe Base (w/Silt)Elevation	Z_i	*389.40*	*mAOD*
Upstream Soffit Elevation		*390.50*	*mAOD*
Downstream Pipe Invert Elevation		*386.60*	*mAOD*
Downstream Pipe Base (w/ Silt) Elevation	Z_o	*386.60*	*mAOD*
Downstream Soffit Elevation		*387.70*	*mAOD*

6.2 *Calculation of Discharge Intensity*

$$q_i = \frac{1.811Q}{A_b D^{0.5}}$$

Where			
Discharge	Q	2.671	m3/s
Depth / Diameter of barrell	D	1.10	m
Culvert cross section area excl. freeboard + siltation	Ab	2.00	m2
Discharge Coefficient	qi	2.31	n/a
Discharge intensity classification is:		Free Flow Inlet Control	

6.3 *Calculation of headwater depth for free flow inlet control*

Based on Table A1.3, Culvert type is Nr 19 n/a
i.e, Rectangular concrete, 90˚ headwall; 20mm chamfers

$$\frac{E_{sh}}{D} = \frac{E_{sc}}{D} + k\left[\frac{1.811Q}{A_b D^{0.5}}\right]^M - 0.5S_0$$ Eqn 6.23

$$\frac{E_{sh}}{D} = k\left[\frac{1.811Q}{A_b D^{0.5}}\right]^M$$ Eqn 6.25

Therefore applicable CIRIA C689 equation reference: Equation 6.25

Where Discharge	Q	2.671	m3/s	
Depth / Diameter of barrell	D	1.1	m	
Unsubmerged analysis constant	k	0.515		Table A1.3
Unsubmerged analysis constant	M	0.667		Table A1.3
Culvert cross section area excl. freeboard + siltation	Ab	2.00	m2	
Culvert Slope	So	0.07	m/m	1 in 15.36
$\frac{Q^2 W}{gA^3} = 1$ Critical depth calculated as:	y_c	0.488	m	
Specific Energy at Critical Depth	E_{sc}	0.73	m	
$E_{sc} = \frac{3}{2} y_c$ Therefore Specific Energy of Headwater	E_{sh}	0.99	m	

6.4 *Calculation of headwater elevation for inlet control*

Headwater Elevation H_{hic} determined by:

$$H_{hic} = Z_i + E_{sh} + h_s$$

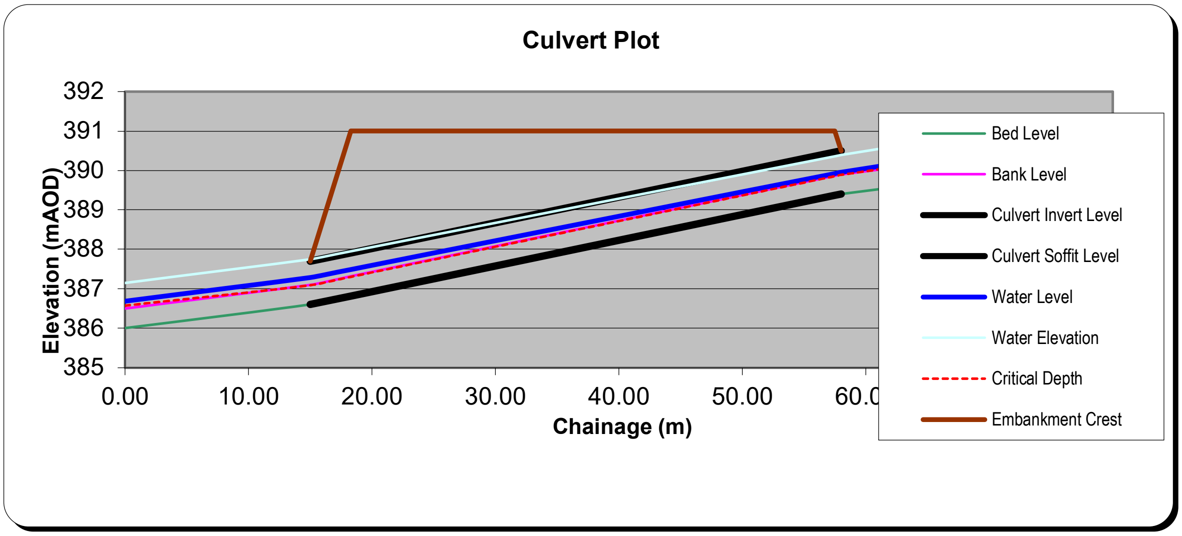
Where			
Headloss due to inlet screen	h_s	N/A	(No Screen Proposed)
Stream Elevation at Inlet	Z_i	389.40	mAOD
Specific Energy of Headwater	E_{sh}	0.99	m
Therefore Headwater Elevation:	H_{hic}	390.39	mAOD

Water Level at the headwater for inlet control WL_{hic} determined by:

$$WL_{hic} = H_{hic} - \frac{V_{uc}^2}{2g}$$

Where			
Headwater Elevation:	H_{hic}	390.39	mAOD
Velocity in Upstream Channel	V_{uc}	2.91	m/s
Therefore Water Level at Inlet:	WL_{hic}	389.96	mAOD

6.5 *Culvert Profile*



7.0 *Summary*

	Complies	Fails	Comment
Culvert Inlet Soffit Elevation > Headwater Elevation for Inlet Co	X		
Adequate Freeboard provided to water level?	X		

Therefore proposed culvert dimensions: **1 nr** **Height** **1.10 m**
Breadth / Span **2.50 m**

By	Checked	Revision	Date
DH	KS	Original	21/11/2023

Purpose

To determine the adequacy of hydraulic capacity for culverts in accordance with the requirements of CIRIA C689

1.0 *Input Data:*

Culvert Ref:		WX03		
Watercourse Name		Clydaghroe		
Design Discharge Q		***3.706***	***m3/sec***	As per Hydrological Analysis
Design Return Period		*100+CC*	*Yrs*	As per LA requirement
Elevation of Stream Bed @ Culvert Inlet		386.7	m AOD	From Survey
Elevation of Stream Bed @ Culvert Outlet		384.7	m AOD	From Survey
Culvert Length		35	m	From Survey
Elevation of Stream bed upstream of Culvert		388	m AOD	From Survey
Distance upstream of Culvert		22	m	From Survey
Elevation of Stream bed downstream of Culvert		383.8	m AOD	From Survey
Distance downstream of Culvert		20	m	From Survey
Elevation of Proposed Embankment Crest		390	m AOD	From Survey
Average channel invert width		1.5	m	From Survey
Average channel top of bank width		1.8	m	From Survey
Average Channel Depth to Bank		0.5	m	From Survey
Left Over-Bank Ground Level (Floodplain) (Culvert Inlet)		390	m AOD	From Survey
Distance from bank		7	m	From Survey
Right Over-Bank Ground Level (Floodplain) (Culvert Inlet)		389	m AOD	From Survey
Distance from bank		5	m	From Survey
Mannings n - Channel		0.045		From C689 Table A1.1
Mannings n - Overbanks		0.05		From C689 Table A1.1
Bedslope upstream of Culvert 1 in S1	S1	16.92	-	Calculated
Bedslope downstream of Culvert 1 in S2	S2	22.22	-	Calculated
Bedslope across Culvert 1 in S3	S3	17.50	-	Calculated
Bedslope across whole reach considered 1 in S4	S4	18.33	-	Calculated
Channel Side Slopes 1 in X	X =	0.30	-	Calculated
Upstream Left Over- Bank Slope	Y =	2.50	-	Calculated
Upstream Right Over- Bank Slope	Z =	2.78	-	Calculated

2.0 *Calculate Tailwater Depth and Level:*

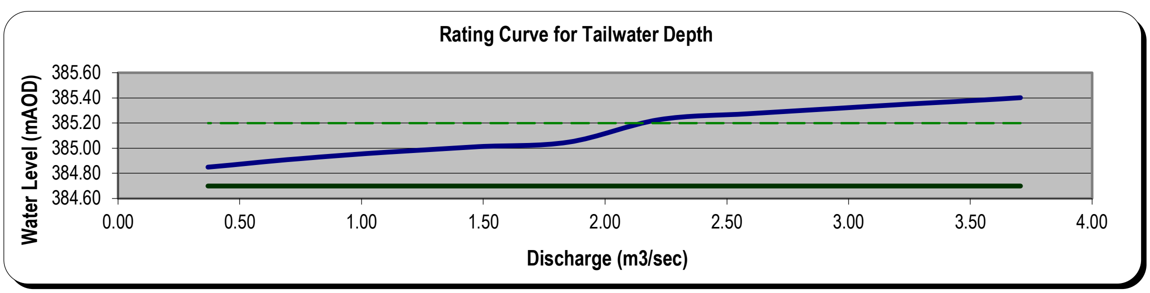
Mannings Equation:

$$Q = VA = \left(\frac{1.00}{n}\right) AR^{\frac{2}{3}} \sqrt{S} \quad [SI] \qquad R_h = \frac{A}{P}$$

Channel Capacity < Discharge, Out of Bank Flooding Considered

Depth of water in channel is	y_{dc}	0.70	m	Calculated
Therefore water level at downstream extent of culvert is	WL_t	385.40	mAOD	Calculated
	V_{dc}	3.09	m/s	Calculated

2.1 Rating Curve for Tailwater Channel Discharge



3.0 *Calculate Tailwater Elevation (Total Head) Ht:*

$$H_t = Z_{bo} + y_{dc} + \frac{V_{dc}^2}{2g}$$

Where:
- Z_{bo} Elevation @ Culvert Outlet
- y_{dc} Water depth in downstream channel
- V_{dc} Velocity in downstream channel

Tailwater Elevation:	H_t	385.92	mAOD	Calculated

4.0 *Calculate Froude No.*

Cross Sectional Area (A)		1.20	m2
Top Width (B)		2.86	m
Hydraulic mean depth (A per unit B)	d_m	0.42	m
Froude Number	Fr	1.52	*Supercritical*
Critical depth in channel	h_c	0.60	m
Critical Velocity	v_c	2.03	m/s

5.0 *Initial Design*

Initial Estimate of required culvert cross sectional area required. Analysis is based on new culvert, therefore design should allow for freeflow conditions. Applicable method is Flow Area Method

5.1 *Flow Area Method - refer to C689 Section 6.7.1*

Depth; Min. Tailwater depth	D	0.70	m	Calculated
Assume 20% Initial loss of culvert height due to Freeboard / Si		0.88	m	Calculated
where freeboard depth is:	F	0.09	m	Calculated
Area required as per tailwater fllow calculation:	A_t	1.20	m2	Calculated
Nominal width (Area / Depth (not inc. freeboard):		1.71	m	Calculated
Therefore prelim culvert dimensions (incl freeboard + sil	D_i	*0.88*	*m*	Calculated
	B_i	*1.71*	*m*	Calculated

6.0 *Detailed Design*

6.1 *Try Culvert dimensions...*

Based on previous Initial Design

Height / Diameter	D	1.20	m	
Breadth (BLANK IF CIRCULAR)	B	2.8	m	
Number of Culverts	nr	1	n/a	
Shape		RECTANGULAR		
Freeboard		0.30	m	As per OPW Guidance
Siltation / Depth lowered below ex. stream invert		0.00	m	Manually Entered Value

Therefore:

Upstream Pipe Invert		*386.70*	*mAOD*
Upstream Pipe Base (w/Silt)Elevation	Z_i	*386.70*	*mAOD*
Upstream Soffit Elevation		*387.90*	*mAOD*
Downstream Pipe Invert Elevation		*384.70*	*mAOD*
Downstream Pipe Base (w/ Silt) Elevation	Z_o	*384.70*	*mAOD*
Downstream Soffit Elevation		*385.90*	*mAOD*

6.2 *Calculation of Discharge Intensity*

$$q_i = \frac{1.811Q}{A_b D^{0.5}}$$

Where			
Discharge	Q	3.706	m3/s
Depth / Diameter of barrell	D	1.20	m
Culvert cross section area excl. freeboard + siltation	Ab	2.52	m2
Discharge Coefficient	qi	2.43	n/a
Discharge intensity classification is:		Free Flow Inlet Control	

6.3 *Calculation of headwater depth for free flow inlet control*

Based on Table A1.3, Culvert type is Nr 19 n/a
i.e, Rectangular concrete, 90˚ headwall; 20mm chamfers

$$\frac{E_{sh}}{D} = \frac{E_{sc}}{D} + k\left[\frac{1.811Q}{A_b D^{0.5}}\right]^M - 0.5S_0$$ Eqn 6.23

$$\frac{E_{sh}}{D} = k\left[\frac{1.811Q}{A_b D^{0.5}}\right]^M$$ Eqn 6.25

Therefore applicable CIRIA C689 equation reference: Equation 6.25

Where				
Discharge	Q	3.706	m3/s	
Depth / Diameter of barrell	D	1.2	m	
Unsubmerged analysis constant	k	0.515		Table A1.3
Unsubmerged analysis constant	M	0.667		Table A1.3
Culvert cross section area excl. freeboard + siltation	Ab	2.52	m2	
Culvert Slope	So	0.06	m/m	1 in 17.5
$\frac{Q^2W}{gA^3} = 1$ Critical depth calculated as:	y_c	0.563	m	
Specific Energy at Critical Depth	E_{sc}	0.84	m	
$E_{sc} = \frac{3}{2}y_c$ Therefore Specific Energy of Headwater	E_{sh}	1.12	m	

6.4 *Calculation of headwater elevation for inlet control*

Headwater Elevation H_{hic} determined by:

$$H_{hic} = Z_i + E_{sh} + h_s$$

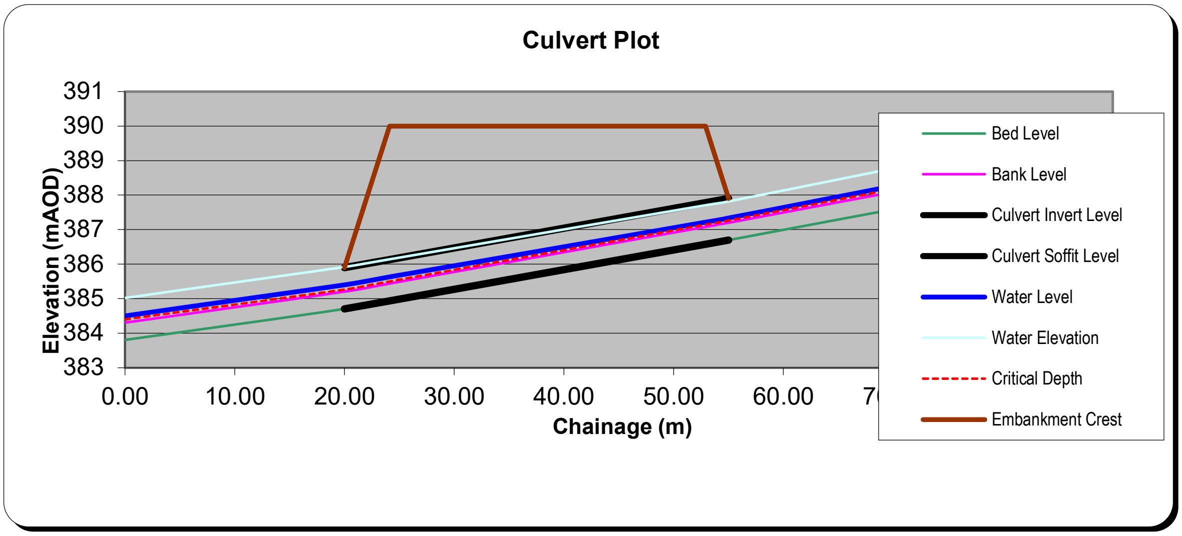
Where			
Headloss due to inlet screen	h_s	N/A	(No Screen Proposed)
Stream Elevation at Inlet	Z_i	386.70	mAOD
Specific Energy of Headwater	E_{sh}	1.12	m
Therefore Headwater Elevation:	H_{hic}	387.82	mAOD

Water Level at the headwater for inlet control WL_{hic} determined by:

$$WL_{hic} = H_{hic} - \frac{V_{uc}^2}{2g}$$

Where			
Headwater Elevation:	H_{hic}	387.82	mAOD
Velocity in Upstream Channel	V_{uc}	3.09	m/s
Therefore Water Level at Inlet:	WL_{hic}	387.33	mAOD

6.5 *Culvert Profile*



7.0 *Summary*

	Complies	Fails	Comment
Culvert Inlet Soffit Elevation > Headwater Elevation for Inlet Co	X		
Adequate Freeboard provided to water level?	X		

Therefore proposed culvert dimensions: **1 nr** **Height** **1.20 m**
Breadth / Span **2.80 m**

By	Checked	Revision	Date
DH	KS	Original	21/11/2023

Project	Cummennabuddoge WF	
Ref	M01944-02	
Date	21/11/2023	

Purpose

To determine the adequacy of hydraulic capacity for culverts in accordance with the requirements of CIRIA C689

1.0 *Input Data:*

Culvert Ref:		WX04		
Watercourse Name		Unnamed		
Design Discharge Q		***0.548***	***m3/sec***	As per Hydrological Analysis
Design Return Period		*100+CC*	*Yrs*	As per LA requirement
Elevation of Stream Bed @ Culvert Inlet		388.6	m AOD	From Survey
Elevation of Stream Bed @ Culvert Outlet		388.2	m AOD	From Survey
Culvert Length		14	m	From Survey
Elevation of Stream bed upstream of Culvert		388.8	m AOD	From Survey
Distance upstream of Culvert		20	m	From Survey
Elevation of Stream bed downstream of Culvert		387.4	m AOD	From Survey
Distance downstream of Culvert		20	m	From Survey
Elevation of Proposed Embankment Crest		390.5	m AOD	From Survey
Average channel invert width		1	m	From Survey
Average channel top of bank width		1.5	m	From Survey
Average Channel Depth to Bank		0.3	m	From Survey
Left Over-Bank Ground Level (Floodplain) (Culvert Inlet)		389.4	m AOD	From Survey
Distance from bank		5	m	From Survey
Right Over-Bank Ground Level (Floodplain) (Culvert Inlet)		389.4	m AOD	From Survey
Distance from bank		5	m	From Survey
Mannings n - Channel		0.045		From C689 Table A1.1
Mannings n - Overbanks		0.05		From C689 Table A1.1
Bedslope upstream of Culvert 1 in S1	S1	100.00	-	Calculated
Bedslope downstream of Culvert 1 in S2	S2	25.00	-	Calculated
Bedslope across Culvert 1 in S3	S3	35.00	-	Calculated
Bedslope across whole reach considered 1 in S4	S4	38.57	-	Calculated
Channel Side Slopes 1 in X	X =	0.83	-	Calculated
Upstream Left Over- Bank Slope	Y =	10.00	-	Calculated
Upstream Right Over- Bank Slope	Z =	10.00	-	Calculated

2.0 *Calculate Tailwater Depth and Level:*

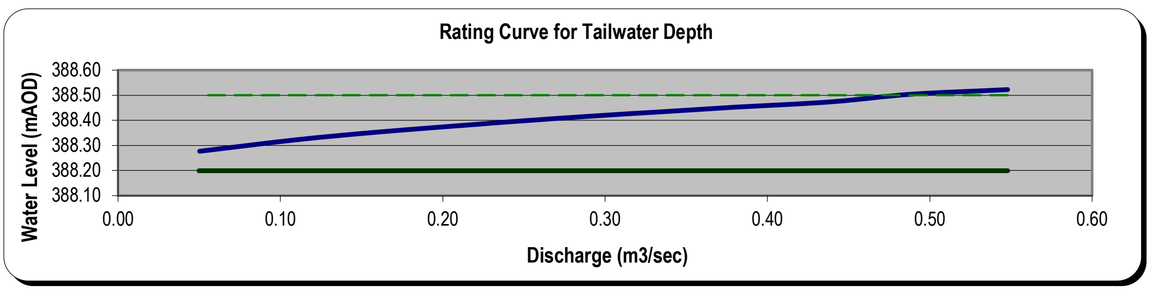
Mannings Equation:

$$Q = VA = \left(\frac{1.00}{n}\right) AR^{\frac{2}{3}} \sqrt{S} \quad [SI] \qquad R_h = \frac{A}{P}$$

Channel Capacity < Discharge, Out of Bank Flooding Considered

Depth of water in channel is	y_{dc}	0.32	m	Calculated
Therefore water level at downstream extent of culvert is	WL_t	388.52	mAOD	Calculated
	V_{dc}	1.34	m/s	Calculated

2.1 Rating Curve for Tailwater Channel Discharge



3.0 *Calculate Tailwater Elevation (Total Head) Ht:*

$$H_t = Z_{bo} + y_{dc} + \frac{V_{dc}^2}{2g}$$

Where: Z_{bo} Elevation @ Culvert Outlet
y_{dc} Water depth in downstream channel
V_{dc} Velocity in downstream channel

Tailwater Elevation:	H_t	388.62	mAOD	Calculated

4.0 *Calculate Froude No.*

Cross Sectional Area (A)		0.41	m2	
Top Width (B)		1.95	m	
Hydraulic mean depth (A per unit B)	d_m	0.21	m	
Froude Number	Fr	0.93	*Subcritical*	
Critical depth in channel	h_c	0.22	m	
Critical Velocity	v_c	1.43	m/s	

5.0 *Initial Design*

Initial Estimate of required culvert cross sectional area required. Analysis is based on new culvert, therefore design should allow for freeflow conditions. Applicable method is Flow Area Method

5.1 *Flow Area Method - refer to C689 Section 6.7.1*

Depth; Min. Tailwater depth	D	0.32	m	Calculated
Assume 20% Initial loss of culvert height due to Freeboard / Si		0.40	m	Calculated
where freeboard depth is:	F	0.04	m	Calculated
Area required as per tailwater fllow calculation:	A_t	0.41	m2	Calculated
Nominal width (Area / Depth (not inc. freeboard):		1.27	m	Calculated
Therefore prelim culvert dimensions (incl freeboard + sil	D_i	*0.40*	*m*	Calculated
	B_i	*1.27*	*m*	Calculated

6.0 *Detailed Design*

6.1 *Try Culvert dimensions...*

Based on previous Initial Design

Height / Diameter	D	0.70	m	
Breadth (BLANK IF CIRCULAR)	B	2.5	m	
Number of Culverts	nr	1	n/a	
Shape		RECTANGULAR		
Freeboard		0.30	m	Manually Entered Value
Siltation / Depth lowered below ex. stream invert		0.00	m	Manually Entered Value

Therefore:

Upstream Pipe Invert		*388.60*	*mAOD*
Upstream Pipe Base (w/Silt)Elevation	Z_i	*388.60*	*mAOD*
Upstream Soffit Elevation		*389.30*	*mAOD*
Downstream Pipe Invert Elevation		*388.20*	*mAOD*
Downstream Pipe Base (w/ Silt) Elevation	Z_o	*388.20*	*mAOD*
Downstream Soffit Elevation		*388.90*	*mAOD*

6.2 *Calculation of Discharge Intensity*

$$q_i = \frac{1.811Q}{A_b D^{0.5}}$$

Where

Discharge	Q	0.548	m3/s
Depth / Diameter of barrell	D	0.70	m
Culvert cross section area excl. freeboard + siltation	Ab	1.00	m2
Discharge Coefficient	qi	1.19	n/a
Discharge intensity classification is:		Free Flow Inlet Control	

6.3 *Calculation of headwater depth for free flow inlet control*

Based on Table A1.3, Culvert type is Nr 19 n/a
i.e, Rectangular concrete, 90˚ headwall; 20mm chamfers

$$\frac{E_{sh}}{D} = \frac{E_{sc}}{D} + k\left[\frac{1.811Q}{A_b D^{0.5}}\right]^M - 0.5S_0$$ Eqn 6.23

$$\frac{E_{sh}}{D} = k\left[\frac{1.811Q}{A_b D^{0.5}}\right]^M$$ Eqn 6.25

Therefore applicable CIRIA C689 equation reference: Equation 6.25

Where

Discharge	Q	0.548	m3/s	
Depth / Diameter of barrell	D	0.7	m	
Unsubmerged analysis constant	k	0.515		Table A1.3
Unsubmerged analysis constant	M	0.667		Table A1.3
Culvert cross section area excl. freeboard + siltation	Ab	1.00	m2	
Culvert Slope	So	0.03	m/m	1 in 35
$\frac{Q^2W}{gA^3} = 1$ Critical depth calculated as:	y_c	0.170	m	
Specific Energy at Critical Depth	E_{sc}	0.25	m	
$E_{sc} = \frac{3}{2}y_c$ Therefore Specific Energy of Headwater	E_{sh}	0.40	m	

6.4 *Calculation of headwater elevation for inlet control*

Headwater Elevation H_{hic} determined by:

$$H_{hic} = Z_i + E_{sh} + h_s$$

Where

Headloss due to inlet screen	h_s	N/A	(No Screen Proposed)
Stream Elevation at Inlet	Z_i	388.60	mAOD
Specific Energy of Headwater	E_{sh}	0.40	m
Therefore Headwater Elevation:	H_{hic}	389.00	mAOD

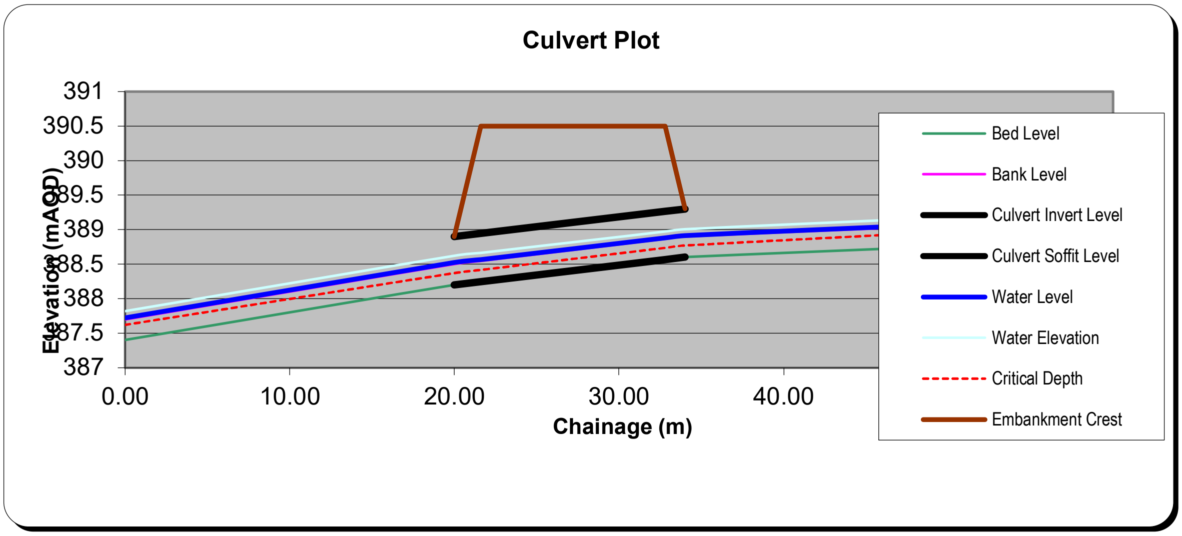
Water Level at the headwater for inlet control WL_{hic} determined by:

$$WL_{hic} = H_{hic} - \frac{V_{uc}^2}{2g}$$

Where

Headwater Elevation:	H_{hic}	389.00	mAOD
Velocity in Upstream Channel	V_{uc}	1.34	m/s
Therefore Water Level at Inlet:	WL_{hic}	388.91	mAOD

6.5 *Culvert Profile*



7.0 *Summary*

	Complies	Fails	Comment
Culvert Inlet Soffit Elevation > Headwater Elevation for Inlet Co	X		
Adequate Freeboard provided to water level?	X		

Therefore proposed culvert dimensions: **1 nr** **Height** **0.70 m**
Breadth / Span **2.50 m**

By	Checked	Revision	Date
DH	KS	Original	21/11/2023

Project	Cummennabuddoge WF
Ref	M01944-02
Date	21/11/2023

Purpose

To determine the adequacy of hydraulic capacity for culverts in accordance with the requirements of CIRIA C689

1.0 *Input Data:*

Culvert Ref:		WX05		
Watercourse Name		Unnamed		
Design Discharge Q		***11.426***	***m3/sec***	As per Hydrological Analysis
Design Return Period		*100+CC*	*Yrs*	As per LA requirement
Elevation of Stream Bed @ Culvert Inlet		358.3	m AOD	From Survey
Elevation of Stream Bed @ Culvert Outlet		357	m AOD	From Survey
Culvert Length		44	m	From Survey
Elevation of Stream bed upstream of Culvert		358.6	m AOD	From Survey
Distance upstream of Culvert		16	m	From Survey
Elevation of Stream bed downstream of Culvert		356.7	m AOD	From Survey
Distance downstream of Culvert		20	m	From Survey
Elevation of Proposed Embankment Crest		360	m AOD	From Survey
Average channel invert width		4.5	m	From Survey
Average channel top of bank width		7	m	From Survey
Average Channel Depth to Bank		1	m	From Survey
Left Over-Bank Ground Level (Floodplain) (Culvert Inlet)		364	m AOD	From Survey
Distance from bank		4	m	From Survey
Right Over-Bank Ground Level (Floodplain) (Culvert Inlet)		362	m AOD	From Survey
Distance from bank		8	m	From Survey
Mannings n - Channel		0.045		From C689 Table A1.1
Mannings n - Overbanks		0.05		From C689 Table A1.1
Bedslope upstream of Culvert 1 in S1	S1	53.33	-	Calculated
Bedslope downstream of Culvert 1 in S2	S2	66.67	-	Calculated
Bedslope across Culvert 1 in S3	S3	33.85	-	Calculated
Bedslope across whole reach considered 1 in S4	S4	42.11	-	Calculated
Channel Side Slopes 1 in X	X =	1.25	-	Calculated
Upstream Left Over- Bank Slope	Y =	0.85	-	Calculated
Upstream Right Over- Bank Slope	Z =	2.96	-	Calculated

2.0 *Calculate Tailwater Depth and Level:*

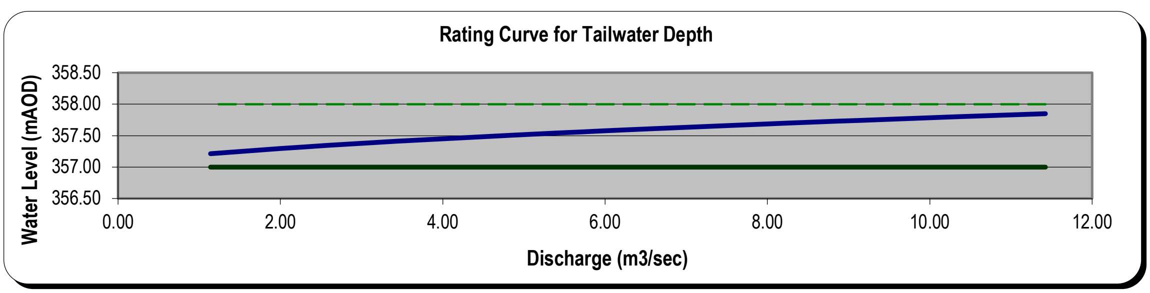
Mannings Equation:

$$Q = VA = \left(\frac{1.00}{n}\right) AR^{\frac{2}{3}} \sqrt{S} \quad [SI] \qquad R_h = \frac{A}{P}$$

Discharge Contained in Channel, Depth of Normal Flow Considered

Depth of water in channel is	y_{dc}	0.85	m	Calculated
Therefore water level at downstream extent of culvert is	WL_t	357.85	mAOD	Calculated
	V_{dc}	2.59	m/s	Calculated

2.1 Rating Curve for Tailwater Channel Discharge



3.0 *Calculate Tailwater Elevation (Total Head) Ht:*

$$H_t = Z_{bo} + y_{dc} + \frac{V_{dc}^2}{2g}$$

Where:
- Z_{bo} Elevation @ Culvert Outlet
- y_{dc} Water depth in downstream channel
- V_{dc} Velocity in downstream channel

Tailwater Elevation:	H_t	358.22	mAOD	Calculated

4.0 *Calculate Froude No.*

Cross Sectional Area (A)		4.40	m2
Top Width (B)		5.86	m
Hydraulic mean depth (A per unit B)	d_m	0.75	m
Froude Number	Fr	0.96	*Subcritical*
Critical depth in channel	h_c	0.61	m
Critical Velocity	v_c	2.72	m/s

5.0 *Initial Design*

Initial Estimate of required culvert cross sectional area required. Analysis is based on new culvert, therefore design should allow for freeflow conditions. Applicable method is Flow Area Method

5.1 *Flow Area Method - refer to C689 Section 6.7.1*

Depth; Min. Tailwater depth	D	0.85	m	Calculated
Assume 20% Initial loss of culvert height due to Freeboard / Si		1.06	m	Calculated
where freeboard depth is:	F	0.11	m	Calculated
Area required as per tailwater fllow calculation:	A_t	4.40	m2	Calculated
Nominal width (Area / Depth (not inc. freeboard):		5.18	m	Calculated
Therefore prelim culvert dimensions (incl freeboard + sil	D_i	*1.06*	*m*	Calculated
	B_i	*5.18*	*m*	Calculated

6.0 *Detailed Design*

6.1 *Try Culvert dimensions…*

Based on previous Initial Design

Height / Diameter	D	1.20	m	
Breadth (BLANK IF CIRCULAR)	B	8	m	
Number of Culverts	nr	1	n/a	
Shape		RECTANGULAR		
Freeboard		0.30	m	As per OPW Guidance
Siltation / Depth lowered below ex. stream invert		0.00	m	Manually Entered Value

Therefore:

Upstream Pipe Invert		*358.30*	*mAOD*
Upstream Pipe Base (w/Silt)Elevation	Z_i	*358.30*	*mAOD*
Upstream Soffit Elevation		*359.50*	*mAOD*
Downstream Pipe Invert Elevation		*357.00*	*mAOD*
Downstream Pipe Base (w/ Silt) Elevation	Z_o	*357.00*	*mAOD*
Downstream Soffit Elevation		*358.20*	*mAOD*

6.2 *Calculation of Discharge Intensity*

$$q_i = \frac{1.811Q}{A_b D^{0.5}}$$

Where			
Discharge	Q	11.426	m3/s
Depth / Diameter of barrell	D	1.20	m
Culvert cross section area excl. freeboard + siltation	Ab	7.20	m2
Discharge Coefficient	qi	2.62	n/a
Discharge intensity classification is:		Free Flow Inlet Control	

6.3 *Calculation of headwater depth for free flow inlet control*

Based on Table A1.3, Culvert type is Nr 19 n/a
i.e, Rectangular concrete, 90˚ headwall; 20mm chamfers

$$\frac{E_{sh}}{D} = \frac{E_{sc}}{D} + k\left[\frac{1.811Q}{A_b D^{0.5}}\right]^M - 0.5S_0$$ Eqn 6.23

$$\frac{E_{sh}}{D} = k\left[\frac{1.811Q}{A_b D^{0.5}}\right]^M$$ Eqn 6.25

Therefore applicable CIRIA C689 equation reference: Equation 6.25

$$\frac{Q^2W}{gA^3} = 1 \qquad E_{sc} = \frac{3}{2}y_c$$

Where Discharge	Q	11.426	m3/s	
Depth / Diameter of barrell	D	1.2	m	
Unsubmerged analysis constant	k	0.515		Table A1.3
Unsubmerged analysis constant	M	0.667		Table A1.3
Culvert cross section area excl. freeboard + siltation	Ab	7.20	m2	
Culvert Slope	So	0.03	m/m	1 in 33.85
Critical depth calculated as:	y_c	0.592	m	
Specific Energy at Critical Depth	E_{sc}	0.89	m	
Therefore Specific Energy of Headwater	E_{sh}	1.18	m	

6.4 *Calculation of headwater elevation for inlet control*

Headwater Elevation H_{hic} determined by:

$$H_{hic} = Z_i + E_{sh} + h_s$$

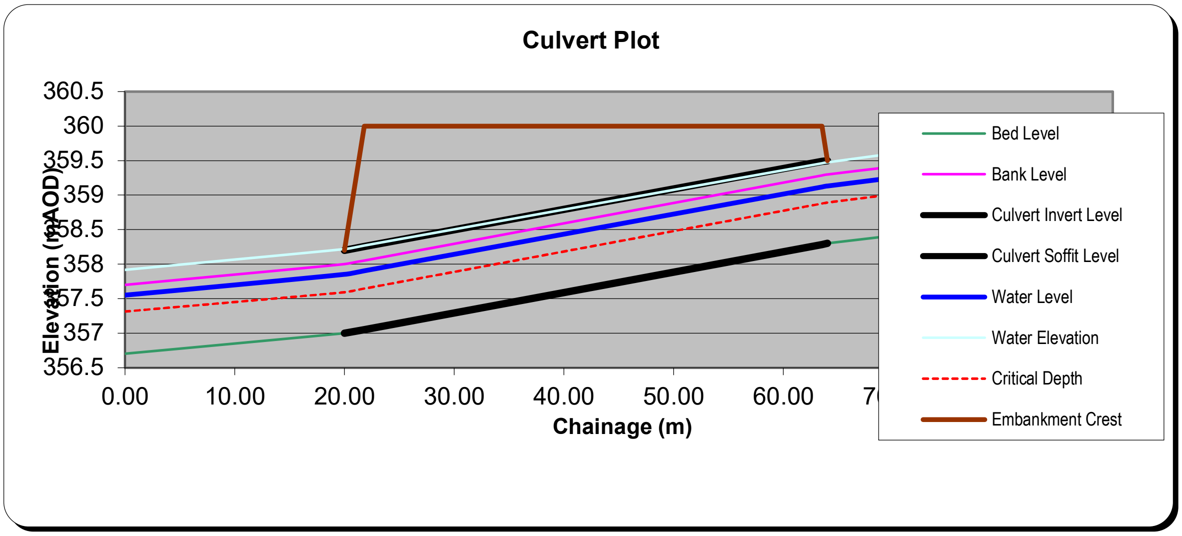
Where			
Headloss due to inlet screen	h_s	N/A	(No Screen Proposed)
Stream Elevation at Inlet	Z_i	358.30	mAOD
Specific Energy of Headwater	E_{sh}	1.18	m
Therefore Headwater Elevation:	H_{hic}	359.48	mAOD

Water Level at the headwater for inlet control WL_{hic} determined by:

$$WL_{hic} = H_{hic} - \frac{V_{uc}^2}{2g}$$

Where			
Headwater Elevation:	H_{hic}	359.48	mAOD
Velocity in Upstream Channel	V_{uc}	2.59	m/s
Therefore Water Level at Inlet:	WL_{hic}	359.13	mAOD

6.5 *Culvert Profile*



7.0 *Summary*

	Complies	Fails	Comment
Culvert Inlet Soffit Elevation > Headwater Elevation for Inlet Co	X		
Adequate Freeboard provided to water level?	X		

Therefore proposed culvert dimensions: **1 nr** **Height** **1.20 m**
Breadth / Span **8.00 m**

By	Checked	Revision	Date
DH	KS	Original	21/11/2023

Project	Cummennabuddoge WF
Ref	M01944-02
Date	21/11/2023

McCloy Consulting

Purpose

To determine the adequacy of hydraulic capacity for culverts in accordance with the requirements of CIRIA C689

1.0 *Input Data:*

Culvert Ref:		WX06		
Watercourse Name		Mullaghanish		
Design Discharge Q		***5.158***	***m3/sec***	As per Hydrological Analysis
Design Return Period		*100+CC*	*Yrs*	As per LA requirement
Elevation of Stream Bed @ Culvert Inlet		372.4	m AOD	From Survey
Elevation of Stream Bed @ Culvert Outlet		370.9	m AOD	From Survey
Culvert Length		45	m	From Survey
Elevation of Stream bed upstream of Culvert		373.1	m AOD	From Survey
Distance upstream of Culvert		16	m	From Survey
Elevation of Stream bed downstream of Culvert		370.2	m AOD	From Survey
Distance downstream of Culvert		15	m	From Survey
Elevation of Proposed Embankment Crest		374	m AOD	From Survey
Average channel invert width		2.5	m	From Survey
Average channel top of bank width		3	m	From Survey
Average Channel Depth to Bank		0.3	m	From Survey
Left Over-Bank Ground Level (Floodplain) (Culvert Inlet)		374	m AOD	From Survey
Distance from bank		4	m	From Survey
Right Over-Bank Ground Level (Floodplain) (Culvert Inlet)		374	m AOD	From Survey
Distance from bank		4	m	From Survey
Mannings n - Channel		0.045		From C689 Table A1.1
Mannings n - Overbanks		0.05		From C689 Table A1.1
Bedslope upstream of Culvert 1 in S1	S1	22.86	-	Calculated
Bedslope downstream of Culvert 1 in S2	S2	21.43	-	Calculated
Bedslope across Culvert 1 in S3	S3	30.00	-	Calculated
Bedslope across whole reach considered 1 in S4	S4	26.21	-	Calculated
Channel Side Slopes 1 in X	X =	0.83	-	Calculated
Upstream Left Over- Bank Slope	Y =	3.08	-	Calculated
Upstream Right Over- Bank Slope	Z =	3.08	-	Calculated

2.0 *Calculate Tailwater Depth and Level:*

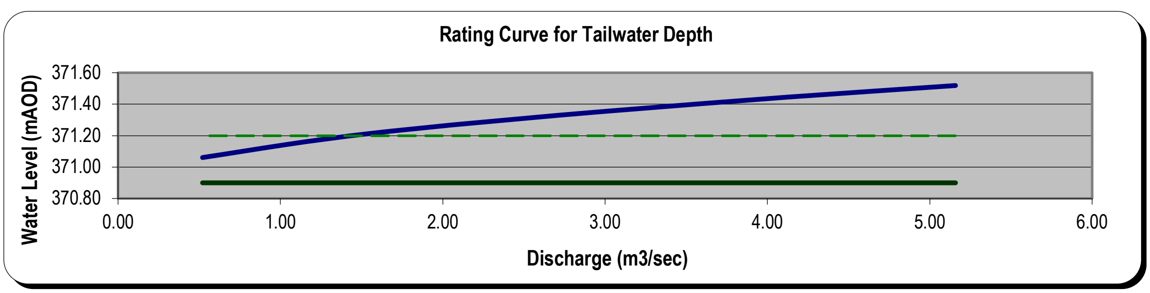
Mannings Equation:

$$Q = VA = \left(\frac{1.00}{n}\right) AR^{\frac{2}{3}} \sqrt{S} \quad [SI] \qquad R_h = \frac{A}{P}$$

Channel Capacity < Discharge, Out of Bank Flooding Considered

Depth of water in channel is	y_{dc}	0.62	m	Calculated
Therefore water level at downstream extent of culvert is	WL_t	371.52	mAOD	Calculated
	V_{dc}	2.84	m/s	Calculated

2.1 Rating Curve for Tailwater Channel Discharge



3.0 *Calculate Tailwater Elevation (Total Head) Ht:*

$$H_t = Z_{bo} + y_{dc} + \frac{V_{dc}^2}{2g}$$

Where: Z_{bo} Elevation @ Culvert Outlet
y_{dc} Water depth in downstream channel
V_{dc} Velocity in downstream channel

Tailwater Elevation:	H_t	371.96	mAOD	Calculated

4.0 *Calculate Froude No.*

Cross Sectional Area (A)		1.81	m2	
Top Width (B)		4.96	m	
Hydraulic mean depth (A per unit B)	d_m	0.37	m	
Froude Number	Fr	1.50	*Supercritical*	
Critical depth in channel	h_c	0.52	m	
Critical Velocity	v_c	1.89	m/s	

5.0 *Initial Design*

Initial Estimate of required culvert cross sectional area required. Analysis is based on new culvert, therefore design should allow for freeflow conditions. Applicable method is Flow Area Method

5.1 *Flow Area Method - refer to C689 Section 6.7.1*

Depth; Min. Tailwater depth	D	0.62	m	Calculated
Assume 20% Initial loss of culvert height due to Freeboard / Si		0.77	m	Calculated
where freeboard depth is:	F	0.08	m	Calculated
Area required as per tailwater fllow calculation:	A_t	1.81	m2	Calculated
Nominal width (Area / Depth (not inc. freeboard):		2.93	m	Calculated
Therefore prelim culvert dimensions (incl freeboard + si	D_i	*0.77*	*m*	Calculated
	B_i	*2.93*	*m*	Calculated

6.0 *Detailed Design*

6.1 *Try Culvert dimensions...*

Based on previous Initial Design

Height / Diameter	D	1.20	m	
Breadth (BLANK IF CIRCULAR)	B	4	m	
Number of Culverts	nr	1	n/a	
Shape		RECTANGULAR		
Freeboard		0.30	m	As per OPW Guidance
Siltation / Depth lowered below ex. stream invert		0.00	m	Manually Entered Value

Therefore:

Upstream Pipe Invert		*372.40*	*mAOD*
Upstream Pipe Base (w/Silt)Elevation	Z_i	*372.40*	*mAOD*
Upstream Soffit Elevation		*373.60*	*mAOD*
Downstream Pipe Invert Elevation		*370.90*	*mAOD*
Downstream Pipe Base (w/ Silt) Elevation	Z_o	*370.90*	*mAOD*
Downstream Soffit Elevation		*372.10*	*mAOD*

6.2 *Calculation of Discharge Intensity*

$$q_i = \frac{1.811Q}{A_b D^{0.5}}$$

Where			
Discharge	Q	5.158	m3/s
Depth / Diameter of barrell	D	1.20	m
Culvert cross section area excl. freeboard + siltation	Ab	3.60	m2
Discharge Coefficient	qi	2.37	n/a
Discharge intensity classification is:		Free Flow Inlet Control	

6.3 *Calculation of headwater depth for free flow inlet control*

Based on Table A1.3, Culvert type is Nr 19 n/a

i.e, Rectangular concrete, 90˚ headwall; 20mm chamfers

$$\frac{E_{sh}}{D} = \frac{E_{sc}}{D} + k\left[\frac{1.811Q}{A_b D^{0.5}}\right]^M - 0.5S_0$$ Eqn 6.23

$$\frac{E_{sh}}{D} = k\left[\frac{1.811Q}{A_b D^{0.5}}\right]^M$$ Eqn 6.25

Therefore applicable CIRIA C689 equation reference: Equation 6.25

Where				
Discharge	Q	5.158	m3/s	
Depth / Diameter of barrell	D	1.2	m	
Unsubmerged analysis constant	k	0.515		Table A1.3
Unsubmerged analysis constant	M	0.667		Table A1.3
Culvert cross section area excl. freeboard + siltation	Ab	3.60	m2	
Culvert Slope	So	0.03	m/m	1 in 30
Critical depth calculated as: $\frac{Q^2 W}{gA^3} = 1$	y_c	0.553	m	
Specific Energy at Critical Depth $E_{sc} = \frac{3}{2} y_c$	E_{sc}	0.83	m	
Therefore Specific Energy of Headwater	E_{sh}	1.10	m	

6.4 *Calculation of headwater elevation for inlet control*

Headwater Elevation H_{hic} determined by:

$$H_{hic} = Z_i + E_{sh} + h_s$$

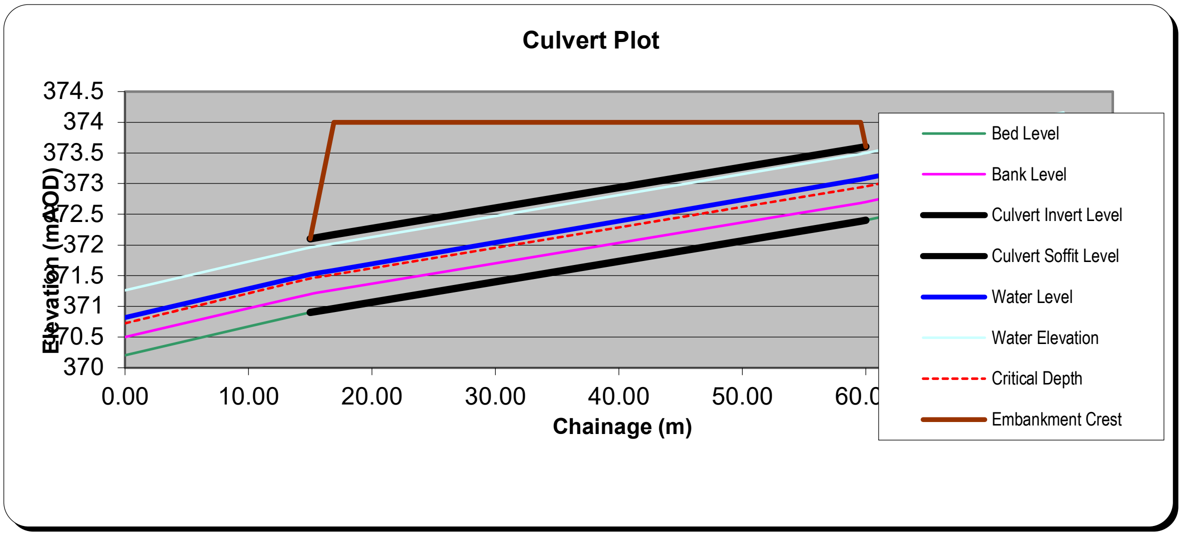
Where			
Headloss due to inlet screen	h_s	N/A	(No Screen Proposed)
Stream Elevation at Inlet	Z_i	372.40	mAOD
Specific Energy of Headwater	E_{sh}	1.10	m
Therefore Headwater Elevation:	H_{hic}	373.50	mAOD

Water Level at the headwater for inlet control WL_{hic} determined by:

$$WL_{hic} = H_{hic} - \frac{V_{uc}^2}{2g}$$

Where			
Headwater Elevation:	H_{hic}	373.50	mAOD
Velocity in Upstream Channel	V_{uc}	2.84	m/s
Therefore Water Level at Inlet:	WL_{hic}	373.09	mAOD

6.5 *Culvert Profile*



7.0 *Summary*

	Complies	Fails	Comment
Culvert Inlet Soffit Elevation > Headwater Elevation for Inlet Co	X		
Adequate Freeboard provided to water level?	X		

Therefore proposed culvert dimensions: **1 nr** **Height** **1.20 m**
Breadth / Span **4.00 m**

By	Checked	Revision	Date
DH	KS	Original	21/11/2023

Purpose

To determine the adequacy of hydraulic capacity for culverts in accordance with the requirements of CIRIA C689

1.0 *Input Data:*

Culvert Ref:		WX07		
Watercourse Name		n/a		
Design Discharge Q		***6.025***	***m3/sec***	As per Hydrological Analysis
Design Return Period		*100+CC*	*Yrs*	As per LA requirement
Elevation of Stream Bed @ Culvert Inlet		392.2	m AOD	From Survey
Elevation of Stream Bed @ Culvert Outlet		391.9	m AOD	From Survey
Culvert Length		22	m	From Survey
Elevation of Stream bed upstream of Culvert		392.5	m AOD	From Survey
Distance upstream of Culvert		15	m	From Survey
Elevation of Stream bed downstream of Culvert		390.9	m AOD	From Survey
Distance downstream of Culvert		24	m	From Survey
Elevation of Proposed Embankment Crest		395	m AOD	From Survey
Average channel invert width		3.5	m	From Survey
Average channel top of bank width		4	m	From Survey
Average Channel Depth to Bank		0.5	m	From Survey
Left Over-Bank Ground Level (Floodplain) (Culvert Inlet)		393	m AOD	From Survey
Distance from bank		4	m	From Survey
Right Over-Bank Ground Level (Floodplain) (Culvert Inlet)		393	m AOD	From Survey
Distance from bank		8	m	From Survey
Mannings n - Channel		0.045		From C689 Table A1.1
Mannings n - Overbanks		0.05		From C689 Table A1.1
Bedslope upstream of Culvert 1 in S1	S1	50.00	-	Calculated
Bedslope downstream of Culvert 1 in S2	S2	24.00	-	Calculated
Bedslope across Culvert 1 in S3	S3	73.33	-	Calculated
Bedslope across whole reach considered 1 in S4	S4	38.12	-	Calculated
Channel Side Slopes 1 in X	X =	0.50	-	Calculated
Upstream Left Over- Bank Slope	Y =	13.33	-	Calculated
Upstream Right Over- Bank Slope	Z =	26.67	-	Calculated

2.0 *Calculate Tailwater Depth and Level:*

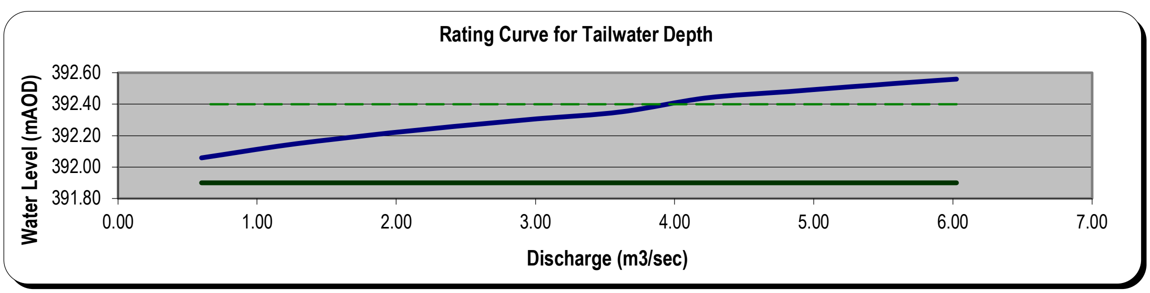
Mannings Equation:

$$Q = VA = \left(\frac{1.00}{n}\right) AR^{\frac{2}{3}} \sqrt{S} \quad [SI] \qquad R_h = \frac{A}{P}$$

Channel Capacity < Discharge, Out of Bank Flooding Considered

Depth of water in channel is	y_{dc}	0.66	m	Calculated
Therefore water level at downstream extent of culvert is	WL_t	392.56	mAOD	Calculated
	V_{dc}	2.40	m/s	Calculated

2.1 Rating Curve for Tailwater Channel Discharge



3.0 *Calculate Tailwater Elevation (Total Head) Ht:*

$$H_t = Z_{bo} + y_{dc} + \frac{V_{dc}^2}{2g}$$

Where: Z_{bo} Elevation @ Culvert Outlet
y_{dc} Water depth in downstream channel
V_{dc} Velocity in downstream channel

Tailwater Elevation:	H_t	392.87	mAOD	Calculated

4.0 *Calculate Froude No.*

Cross Sectional Area (A)		2.51	m2
Top Width (B)		10.37	m
Hydraulic mean depth (A per unit B)	d_m	0.24	m
Froude Number	Fr	1.55	*Supercritical*
Critical depth in channel	h_c	0.49	m
Critical Velocity	v_c	1.54	m/s

5.0 *Initial Design*

Initial Estimate of required culvert cross sectional area required. Analysis is based on new culvert, therefore design should allow for freeflow conditions. Applicable method is Flow Area Method

5.1 *Flow Area Method - refer to C689 Section 6.7.1*

Depth; Min. Tailwater depth	D	0.66	m	Calculated
Assume 20% Initial loss of culvert height due to Freeboard / Si		0.82	m	Calculated
where freeboard depth is:	F	0.08	m	Calculated
Area required as per tailwater fllow calculation:	A_t	2.51	m2	Calculated
Nominal width (Area / Depth (not inc. freeboard):		3.81	m	Calculated
Therefore prelim culvert dimensions (incl freeboard + si	D_i	*0.82*	*m*	Calculated
	B_i	*3.81*	*m*	Calculated

6.0 *Detailed Design*

6.1 *Try Culvert dimensions...*

Based on previous Initial Design

Height / Diameter	D	1.10	m	
Breadth (BLANK IF CIRCULAR)	B	5	m	
Number of Culverts	nr	1	n/a	
Shape		RECTANGULAR		
Freeboard		0.30	m	Manually Entered Value
Siltation / Depth lowered below ex. stream invert		0.00	m	Manually Entered Value

Therefore:

Upstream Pipe Invert		*392.20*	*mAOD*
Upstream Pipe Base (w/Silt)Elevation	Z_i	*392.20*	*mAOD*
Upstream Soffit Elevation		*393.30*	*mAOD*
Downstream Pipe Invert Elevation		*391.90*	*mAOD*
Downstream Pipe Base (w/ Silt) Elevation	Z_o	*391.90*	*mAOD*
Downstream Soffit Elevation		*393.00*	*mAOD*

6.2 *Calculation of Discharge Intensity*

$$q_i = \frac{1.811Q}{A_b D^{0.5}}$$

Where

Discharge	Q	6.025	m3/s
Depth / Diameter of barrell	D	1.10	m
Culvert cross section area excl. freeboard + siltation	Ab	4.00	m2
Discharge Coefficient	qi	2.60	n/a
Discharge intensity classification is:		Free Flow Inlet Control	

6.3 *Calculation of headwater depth for free flow inlet control*

Based on Table A1.3, Culvert type is Nr 19 n/a

i.e, Rectangular concrete, 90˚ headwall; 20mm chamfers

$$\frac{E_{sh}}{D} = \frac{E_{sc}}{D} + k\left[\frac{1.811Q}{A_b D^{0.5}}\right]^M - 0.5S_0$$ Eqn 6.23

$$\frac{E_{sh}}{D} = k\left[\frac{1.811Q}{A_b D^{0.5}}\right]^M$$ Eqn 6.25

Therefore applicable CIRIA C689 equation reference: Equation 6.25

Where

Discharge	Q	6.025	m3/s	
Depth / Diameter of barrell	D	1.1	m	
Unsubmerged analysis constant	k	0.515		Table A1.3
Unsubmerged analysis constant	M	0.667		Table A1.3
Culvert cross section area excl. freeboard + siltation	Ab	4.00	m2	
Culvert Slope	So	0.01	m/m	1 in 73.33
Critical depth calculated as:	y_c	0.529	m	
Specific Energy at Critical Depth	E_{sc}	0.79	m	
Therefore Specific Energy of Headwater	E_{sh}	1.07	m	

$$\frac{Q^2 W}{g A^3} = 1$$

$$E_{sc} = \frac{3}{2} y_c$$

6.4 *Calculation of headwater elevation for inlet control*

Headwater Elevation H_{hic} determined by:

$$H_{hic} = Z_i + E_{sh} + h_s$$

Where

Headloss due to inlet screen	h_s	N/A	(No Screen Proposed)
Stream Elevation at Inlet	Z_i	392.20	mAOD
Specific Energy of Headwater	E_{sh}	1.07	m
Therefore Headwater Elevation:	H_{hic}	393.27	mAOD

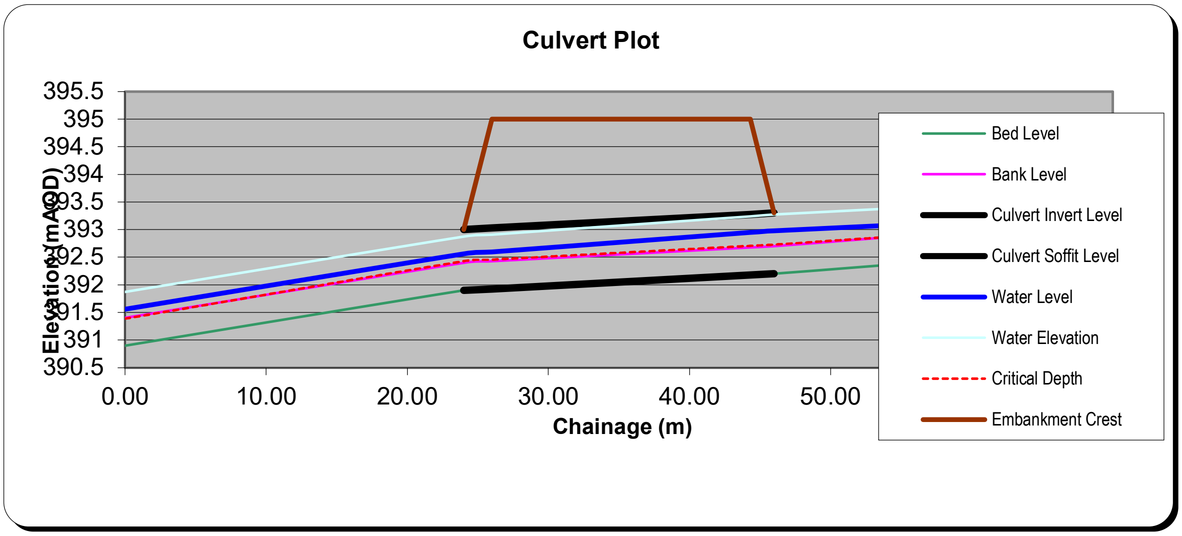
Water Level at the headwater for inlet control WL_{hic} determined by:

$$WL_{hic} = H_{hic} - \frac{V_{uc}^2}{2g}$$

Where

Headwater Elevation:	H_{hic}	393.27	mAOD
Velocity in Upstream Channel	V_{uc}	2.40	m/s
Therefore Water Level at Inlet:	WL_{hic}	392.98	mAOD

6.5 *Culvert Profile*



7.0 *Summary*

	Complies	Fails	Comment
Culvert Inlet Soffit Elevation > Headwater Elevation for Inlet Cc	X		
Adequate Freeboard provided to water level?	X		

Therefore proposed culvert dimensions: **1 nr** **Height** **1.10 m**
Breadth / Span **5.00 m**

By	Checked	Revision	Date
DH	KS	Original	21/11/2023

Purpose

To determine the adequacy of hydraulic capacity for culverts in accordance with the requirements of CIRIA C689

1.0 *Input Data:*

Culvert Ref:		WX08		
Watercourse Name		Unnamed		
Design Discharge Q		***0.684***	***m3/sec***	As per Hydrological Analysis
Design Return Period		*100+CC*	*Yrs*	As per LA requirement
Elevation of Stream Bed @ Culvert Inlet		486.2	m AOD	From Survey
Elevation of Stream Bed @ Culvert Outlet		484.5	m AOD	From Survey
Culvert Length		15	m	From Survey
Elevation of Stream bed upstream of Culvert		489.2	m AOD	From Survey
Distance upstream of Culvert		16	m	From Survey
Elevation of Stream bed downstream of Culvert		483.5	m AOD	From Survey
Distance downstream of Culvert		15	m	From Survey
Elevation of Proposed Embankment Crest		491	m AOD	From Survey
Average channel invert width		1	m	From Survey
Average channel top of bank width		1.5	m	From Survey
Average Channel Depth to Bank		0.5	m	From Survey
Left Over-Bank Ground Level (Floodplain) (Culvert Inlet)		488	m AOD	From Survey
Distance from bank		3	m	From Survey
Right Over-Bank Ground Level (Floodplain) (Culvert Inlet)		488.4	m AOD	From Survey
Distance from bank		3	m	From Survey
Mannings n - Channel		0.045		From C689 Table A1.1
Mannings n - Overbanks		0.05		From C689 Table A1.1
Bedslope upstream of Culvert 1 in S1	S1	5.33	-	Calculated
Bedslope downstream of Culvert 1 in S2	S2	15.00	-	Calculated
Bedslope across Culvert 1 in S3	S3	8.82	-	Calculated
Bedslope across whole reach considered 1 in S4	S4	8.07	-	Calculated
Channel Side Slopes 1 in X	X =	0.50	-	Calculated
Upstream Left Over- Bank Slope	Y =	2.31	-	Calculated
Upstream Right Over- Bank Slope	Z =	1.76	-	Calculated

2.0 *Calculate Tailwater Depth and Level:*

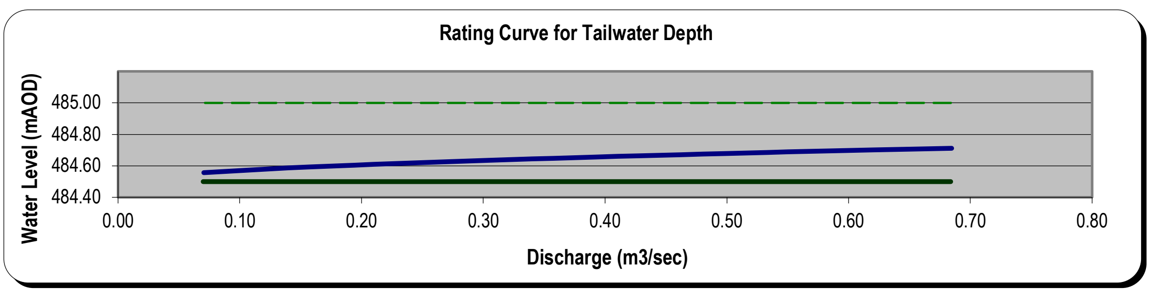
Mannings Equation:

$$Q = VA = \left(\frac{1.00}{n}\right) A R^{\frac{2}{3}} \sqrt{S} \quad [SI] \qquad R_h = \frac{A}{P}$$

Discharge Contained in Channel, Depth of Normal Flow Considered

Depth of water in channel is	y_{dc}	0.21	m	Calculated
Therefore water level at downstream extent of culvert is	WL_t	484.71	mAOD	Calculated
	V_{dc}	2.26	m/s	Calculated

2.1 Rating Curve for Tailwater Channel Discharge



3.0 *Calculate Tailwater Elevation (Total Head) Ht:*

$$H_t = Z_{bo} + y_{dc} + \frac{V_{dc}^2}{2g}$$

Where: Z_{bo} Elevation @ Culvert Outlet
y_{dc} Water depth in downstream channel
V_{dc} Velocity in downstream channel

Tailwater Elevation: H_t 484.99 mAOD Calculated

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4.0 *Calculate Froude No.*

Cross Sectional Area (A)		0.30	m2	
Top Width (B)		1.85	m	
Hydraulic mean depth (A per unit B)	d_m	0.16	m	
Froude Number	Fr	1.78	*Supercritical*	
Critical depth in channel	h_c	0.23	m	
Critical Velocity	v_c	1.27	m/s	

5.0 *Initial Design*

Initial Estimate of required culvert cross sectional area required. Analysis is based on new culvert, therefore design should allow for freeflow conditions. Applicable method is Flow Area Method

5.1 *Flow Area Method - refer to C689 Section 6.7.1*

Depth; Min. Tailwater depth	D	0.21	m	Calculated
Assume 20% Initial loss of culvert height due to Freeboard / Si		0.27	m	Calculated
where freeboard depth is:	F	0.03	m	Calculated
Area required as per tailwater fllow calculation:	A_t	0.30	m2	Calculated
Nominal width (Area / Depth (not inc. freeboard):		1.43	m	Calculated
Therefore prelim culvert dimensions (incl freeboard + sil	D_i	*0.27*	*m*	Calculated
	B_i	*1.43*	*m*	Calculated

6.0 *Detailed Design*

6.1 *Try Culvert dimensions...*

Based on previous Initial Design

Height / Diameter	D	0.60	m	
Breadth (BLANK IF CIRCULAR)	B	2.5	m	
Number of Culverts	nr	1	n/a	
Shape		RECTANGULAR		
Freeboard		0.30	m	Manually Entered Value
Siltation / Depth lowered below ex. stream invert		0.00	m	Manually Entered Value

Therefore:

Upstream Pipe Invert		*486.20*	*mAOD*
Upstream Pipe Base (w/Silt)Elevation	Z_i	*486.20*	*mAOD*
Upstream Soffit Elevation		*486.80*	*mAOD*
Downstream Pipe Invert Elevation		*484.50*	*mAOD*
Downstream Pipe Base (w/ Silt) Elevation	Z_o	*484.50*	*mAOD*
Downstream Soffit Elevation		*485.10*	*mAOD*

6.2 *Calculation of Discharge Intensity*

$$q_i = \frac{1.811Q}{A_b D^{0.5}}$$

Where

Discharge	Q	0.684	m3/s
Depth / Diameter of barrell	D	0.60	m
Culvert cross section area excl. freeboard + siltation	Ab	0.75	m2
Discharge Coefficient	qi	2.13	n/a
Discharge intensity classification is:		Free Flow Inlet Control	

6.3 *Calculation of headwater depth for free flow inlet control*

Based on Table A1.3, Culvert type is	Nr	19	n/a

i.e, Rectangular concrete, 90˚ headwall; 20mm chamfers

$$\frac{E_{sh}}{D} = \frac{E_{sc}}{D} + k\left[\frac{1.811Q}{A_b D^{0.5}}\right]^M - 0.5S_o$$ Eqn 6.23

$$\frac{E_{sh}}{D} = k\left[\frac{1.811Q}{A_b D^{0.5}}\right]^M$$ Eqn 6.25

Therefore applicable CIRIA C689 equation reference: Equation 6.25

Where

Discharge	Q	0.684	m3/s	
Depth / Diameter of barrell	D	0.6	m	
Unsubmerged analysis constant	k	0.515		Table A1.3
Unsubmerged analysis constant	M	0.667		Table A1.3
Culvert cross section area excl. freeboard + siltation	Ab	0.75	m2	
Culvert Slope	So	0.11	m/m	1 in 8.82
Critical depth calculated as:	y_c	0.197	m	
Specific Energy at Critical Depth	E_{sc}	0.30	m	
Therefore Specific Energy of Headwater	E_{sh}	0.51	m	

$$\frac{Q^2W}{gA^3} = 1$$

$$E_{sc} = \frac{3}{2}y_c$$

6.4 *Calculation of headwater elevation for inlet control*

Headwater Elevation H_{hic} determined by:

$$H_{hic} = Z_i + E_{sh} + h_s$$

Where

Headloss due to inlet screen	h_s	N/A	(No Screen Proposed)
Stream Elevation at Inlet	Z_i	486.20	mAOD
Specific Energy of Headwater	E_{sh}	0.51	m
Therefore Headwater Elevation:	H_{hic}	486.71	mAOD

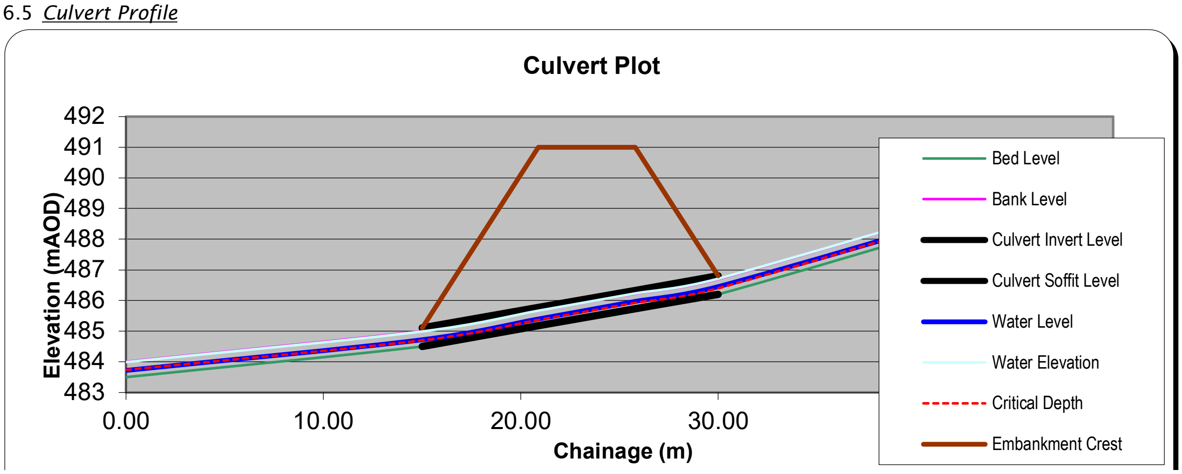
Water Level at the headwater for inlet control WL_{hic} determined by:

$$WL_{hic} = H_{hic} - \frac{V_{uc}^2}{2g}$$

Where

Headwater Elevation:	H_{hic}	486.71	mAOD
Velocity in Upstream Channel	V_{uc}	2.26	m/s
Therefore Water Level at Inlet:	WL_{hic}	486.45	mAOD

6.5 *Culvert Profile*



7.0 *Summary*

	Complies	Fails	Comment
Culvert Inlet Soffit Elevation > Headwater Elevation for Inlet Co	X		
Adequate Freeboard provided to water level?	X		

Therefore proposed culvert dimensions: **1 nr** **Height** **0.60 m**
Breadth / Span **2.50 m**

By	Checked	Revision	Date
DH	KS	Original	21/11/2023