BORD NA MÓNA –CORLEA BOG

Drainage Management Plan

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EXECUTIVE SUMMARY

Corlea Bog is located in Co. Longford, approximately 7km northwest of Ballymahon. Corlea Bog discharges to the south west via adjacent land drains to the Bilberry stream and to the east to the Ledwithstown_26 stream which flows south and converges with the Bilberry stream and flows towards Lough Ree.

There are 3 different sub-catchments that drain water from Corlea Bog. 2 of these drain water from both the bog and surrounding agricultural lands outside the bog. The remaining catchment only drains water from areas within the bog.

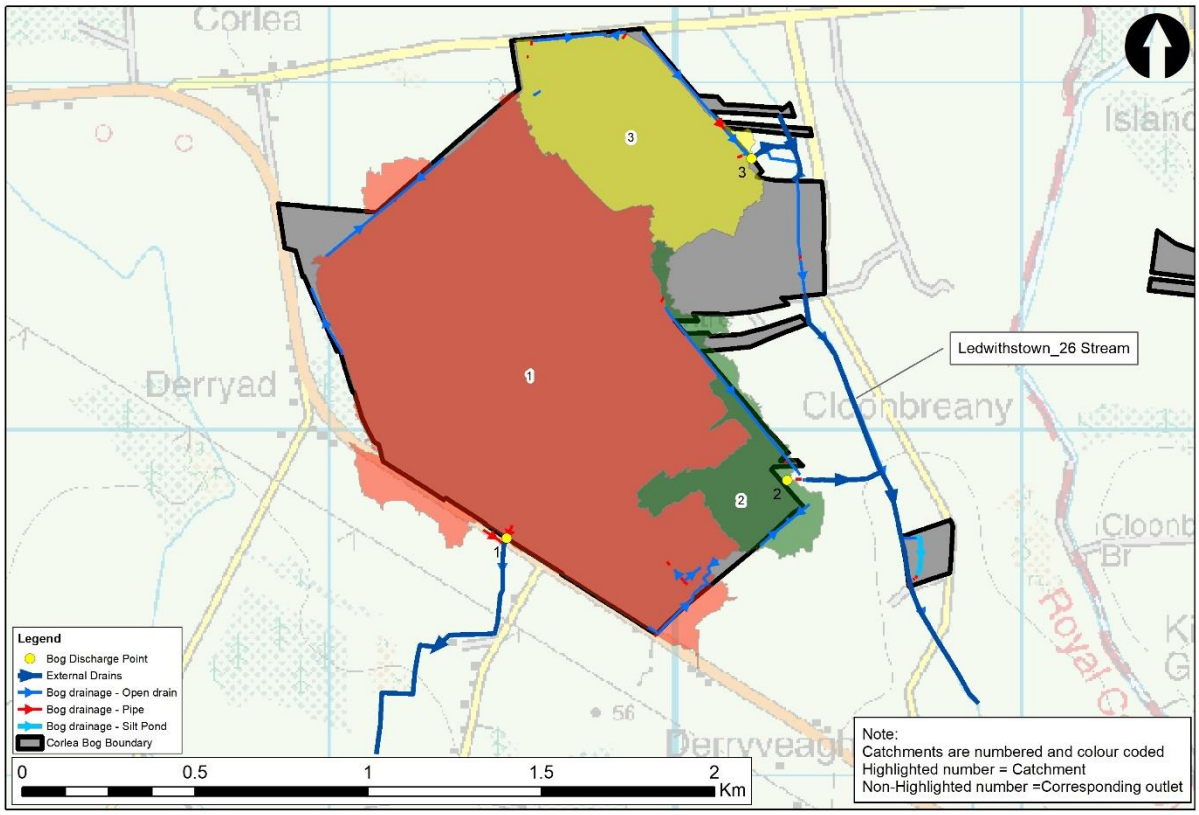

Figure E- 1: Corlea drainage catchments

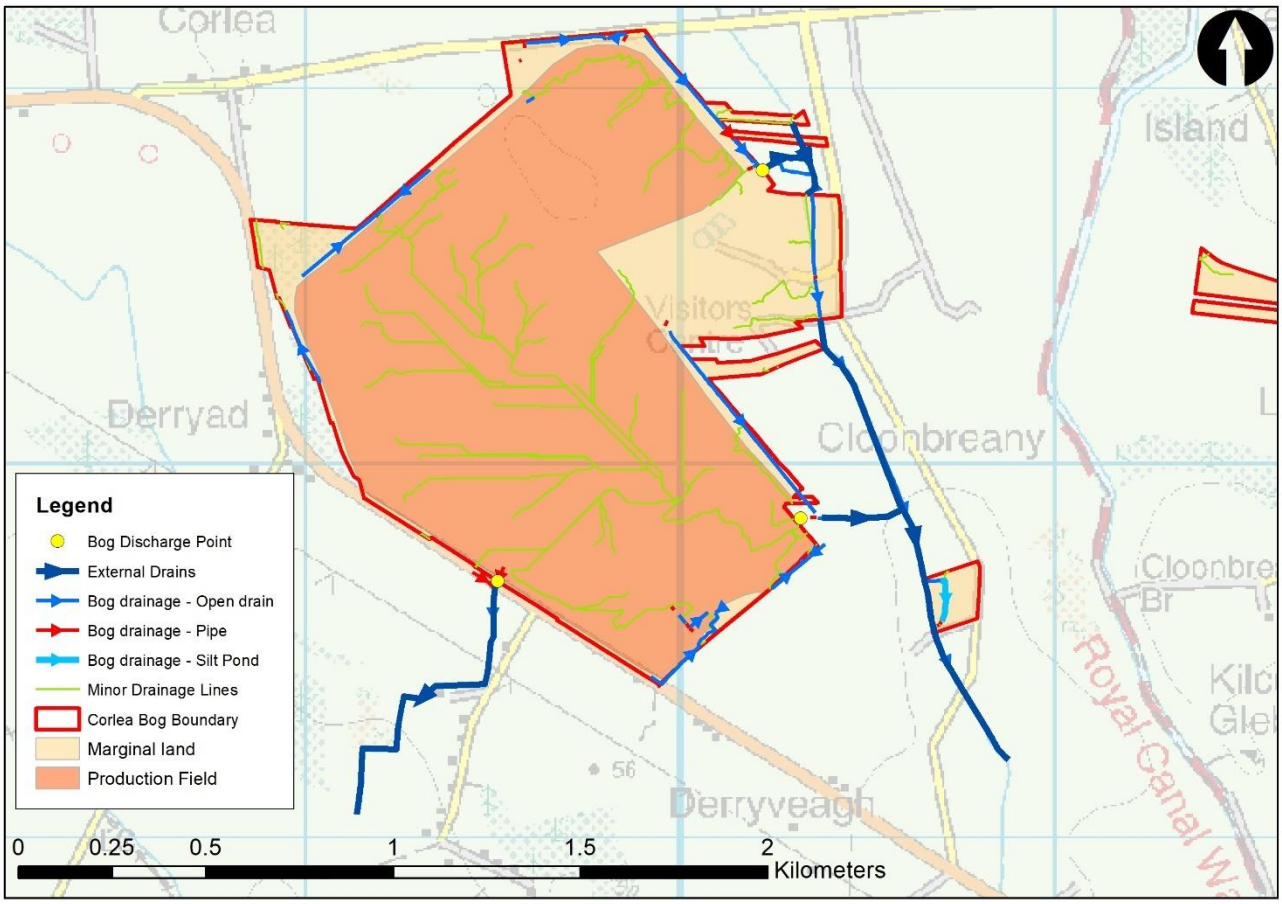

Figure E- 2: Corlea production field drainage

Peat extraction at Corlea Bog has stopped and the bog has been selected by Bord na Móna for rehabilitation through the Peatlands Climate Action Scheme (PCAS). The measures proposed to achieve this include blocking the drainage network, deep peat cell bunding and creating wetland areas. These measures will result in raising the water table within the bog and reducing the rate that water drains out of the bog.

It is important to avoid impacting neighbouring lands from the bog rehabilitation measures. Corlea Bog Drainage Management Plan (DMP) considers the potential impacts on neighbouring lands and identifies the mitigation measures required. This is a key function of the DMP.

The DMP identified water table raising as having the potential to make neighbouring lands wetter by raising their water table. The lands where this could occur were identified as being within the bog's zone of influence. DMP measures were identified which would prevent the water table impacting adversely on neighbouring lands.

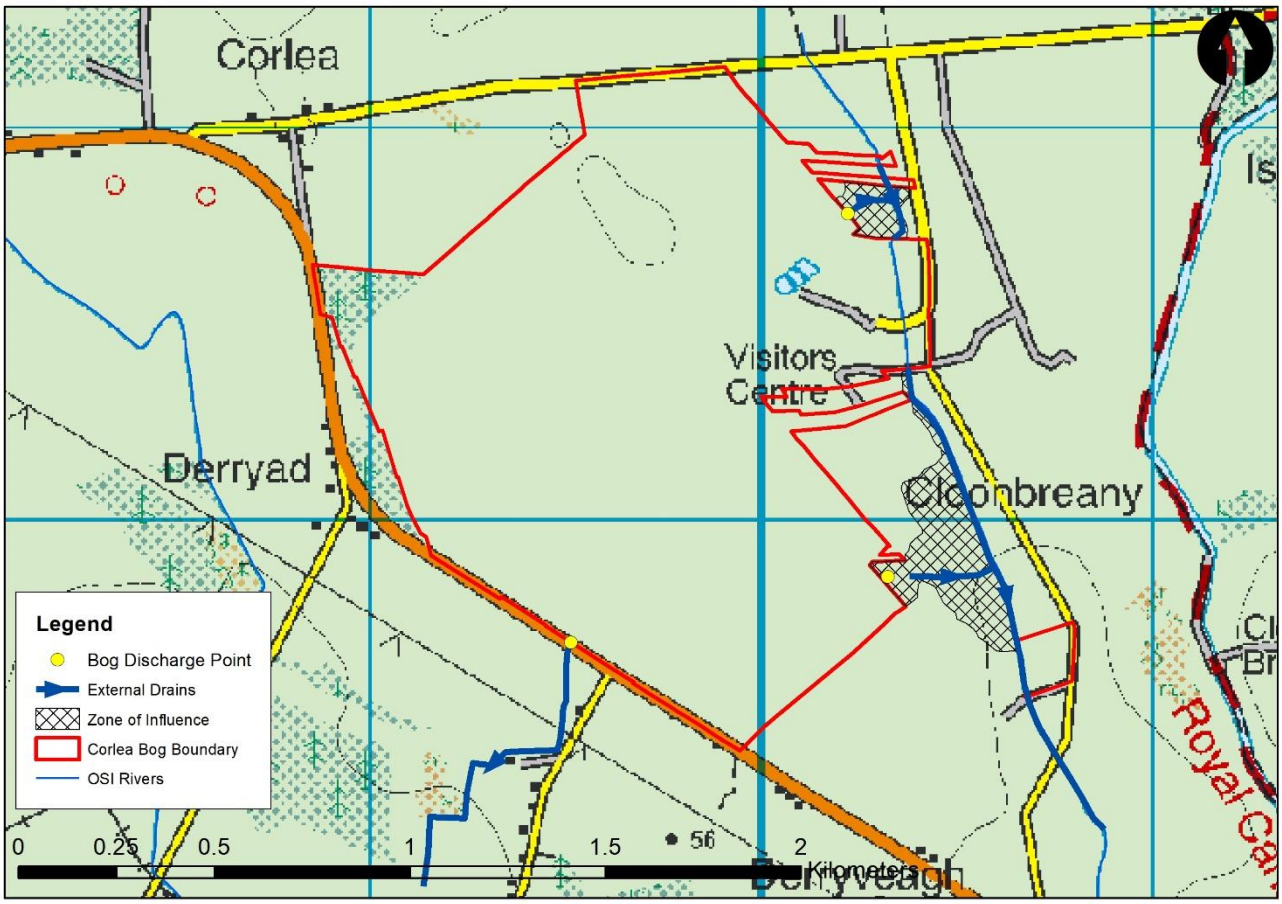

Figure E- 3: Corlea Zone of influence

Existing drains along the boundary of the bog and neighbouring lands were assessed. The area surrounding the bog boundary is generally elevated above the level of the bog, which is located in a topographic basin. There are two small areas outside the boundary of the bog that are potentially at risk of impacts through a rise in groundwater levels. However, these areas are separated from the bog by elevated ridges of high fields and drains which will act as a hydraulic break, preventing the increase in water table from extending into these locations.

In addition to these DMP measures, the creation and extension existing wetland areas where silt ponds are currently submerged will continue to provide silt control at discharge locations. The rehabilitation will, in time, promote the establishment of bog vegetation and will lead to a further reduction in sources of silt.

Figure E- 4: DMP measures for Corlea Bog (1-Retain drains)

1 INTRODUCTION

Corlea Bog is located in Co. Longford, approximately 7km northwest of Ballymahon, further site details are described in the Corlea Bog Site Characterisation Report 2023, hereafter referred to as the Characterisation Report. Corlea Bog is part of the Mountdillon Bog Group. Bord na Móna operated peat extraction within the Mountdillon Bog Group under IPC Licence (Ref. P0504-01) issued and administered by the EPA. Condition 10.2 of this licence requires the preparation of Corlea Bog-Cutaway bog decommissioning and rehabilitation plan 2023[1], hereafter referred to as the Rehabilitation Plan, for permanent rehabilitation of the boglands within the licensed area.

It is proposed by Government that Bord na Móna carry out enhanced decommissioning, rehabilitation and restoration under the Peatlands Climate Action Scheme on peatlands previously used for energy production. This Scheme goes significantly beyond what is required to meet rehabilitation and decommissioning obligations under existing EPA IPC licence conditions. Improvements supported by the Scheme ensures that environmental stabilisation is achieved and significant additional benefits, particularly relating to climate action and other ecosystem services, are delivered.

One of the key issues for Bord na Móna is the potential hydrological impact rehabilitation of this bog may have on surrounding lands and lands downstream which may be hydrologically linked to the bog. Rehabilitation measures generally seek to increase water table levels and surface water retention such that water levels are closer to the surface to encourage peat formation, bringing associated ecological benefits and potential carbon sequestration capacity. While in general terms this will reduce the rate at which water is released from the bog following a rainfall event, the impact on flood run-off is less predictable. Furthermore, the increase in the local water table could result in negative impacts to surrounding lands if mitigation measures are not applied.

This Drainage Management Plan (DMP) for the Corlea Bog PCAS extent seeks to establish the baseline hydrological performance of the bog and the surrounding drainage network. The plan sets out the characterisation of the bog and surrounding lands, the existing performance of the drainage network and the level of flood risk. The plan identifies the potential hydrological zone of influence of the bog and the objectives, risks and opportunities associated with the rehabilitation of the bog. The plan assesses the potential impact of the various rehabilitation measures which are proposed on the local drainage network and flood risk. It sets out, where necessary, mitigation measures required to reduce or avoid impacts. The plan sets out the measures which are required to be delivered in advance or in parallel with the rehabilitation plan as well as the longer term operation and retention of the drainage network and associated infrastructure. The plan assesses the level of residual risk, the potential impact due to climate change and the adaptability of measures in response to these climate change impacts.

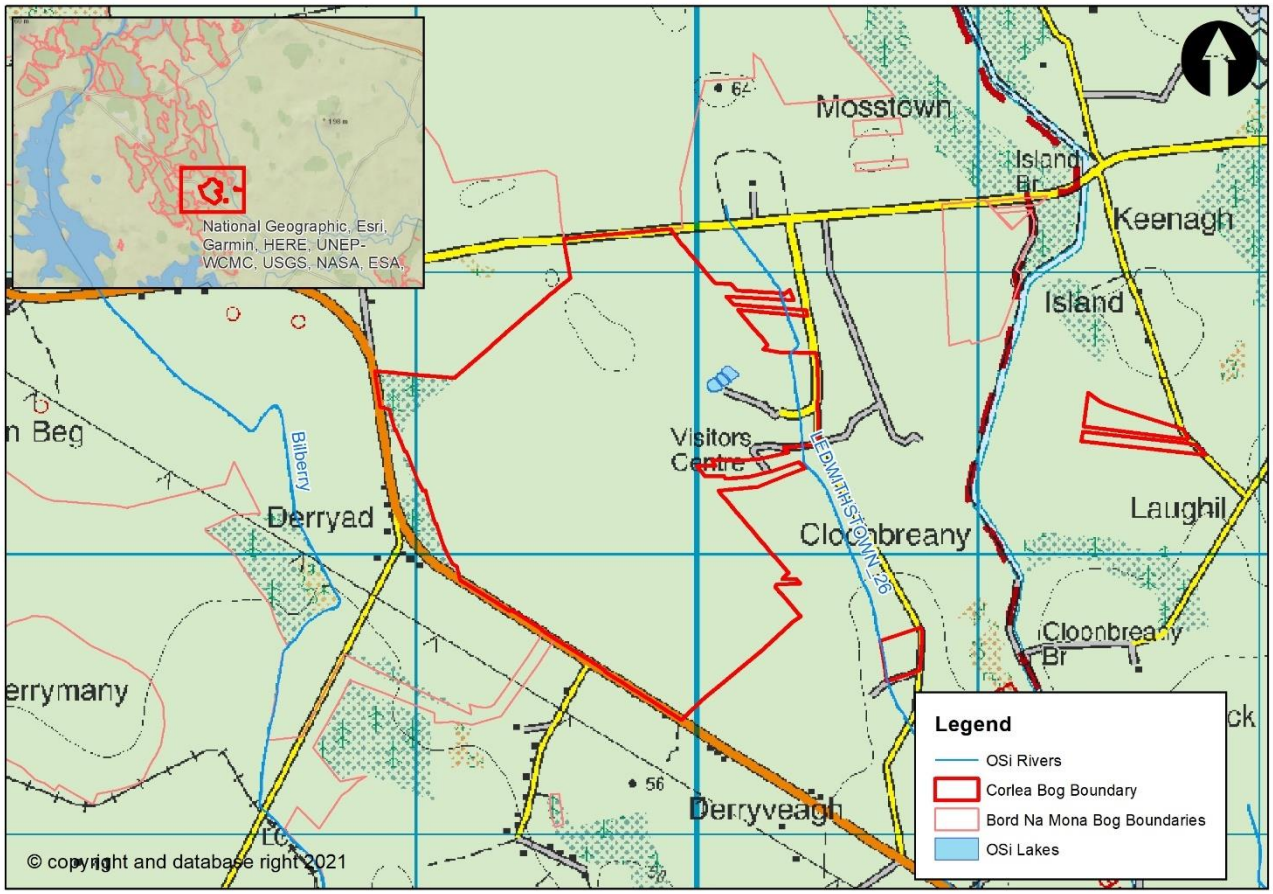

Figure 1-1 Location of Corlea Bog[1]

[1] Further maps and figures can be found in the Corlea Bog GIS map book 2022

2 BASELINE ASSESSMENT

Through cessation of peat extraction and implementation of the Rehabilitation Plan there is the potential to hydrologically impact the adjacent land. The extent of the impact will depend on the existing baseline characteristics of the catchments which drain the bog and the adjacent lands.

The purpose of characterising the catchment area is to develop an understanding of how the catchment currently operates and drains. The characterisation also investigates the risks, constraints and opportunities to the operation and drainage.

Full details of the land use, hydrogeological and soil characterisation can be found in the Corlea Bog – site characterisation report 2023. Land use in the surrounding landscape is primarily agricultural land, transitional woodland and cutaway peatland, at-risk land is considered further in section 3.3.

2.1 Drainage Characterisation

Corlea Bog discharges to the south west via adjacent land drains to the Bilberry stream and to the east to the Ledwithstown_26 stream which flows south and converges with the Bilberry stream and flows towards Lough Ree. Hydrological analysis was carried out to delineate the drains within and around the bog along with their associated hydrological catchment area. A recent survey of drainage was carried out by Bord na Móna and this was reviewed, and the bog sub-catchments confirmed. Sub-catchments of the external drains were identified using ArcGIS Hydrology tools. Figure 2.1 presents the catchments areas either draining into the bog or from the bog. Figure 2.2 presents the internal drainage network of Corlea Bog.

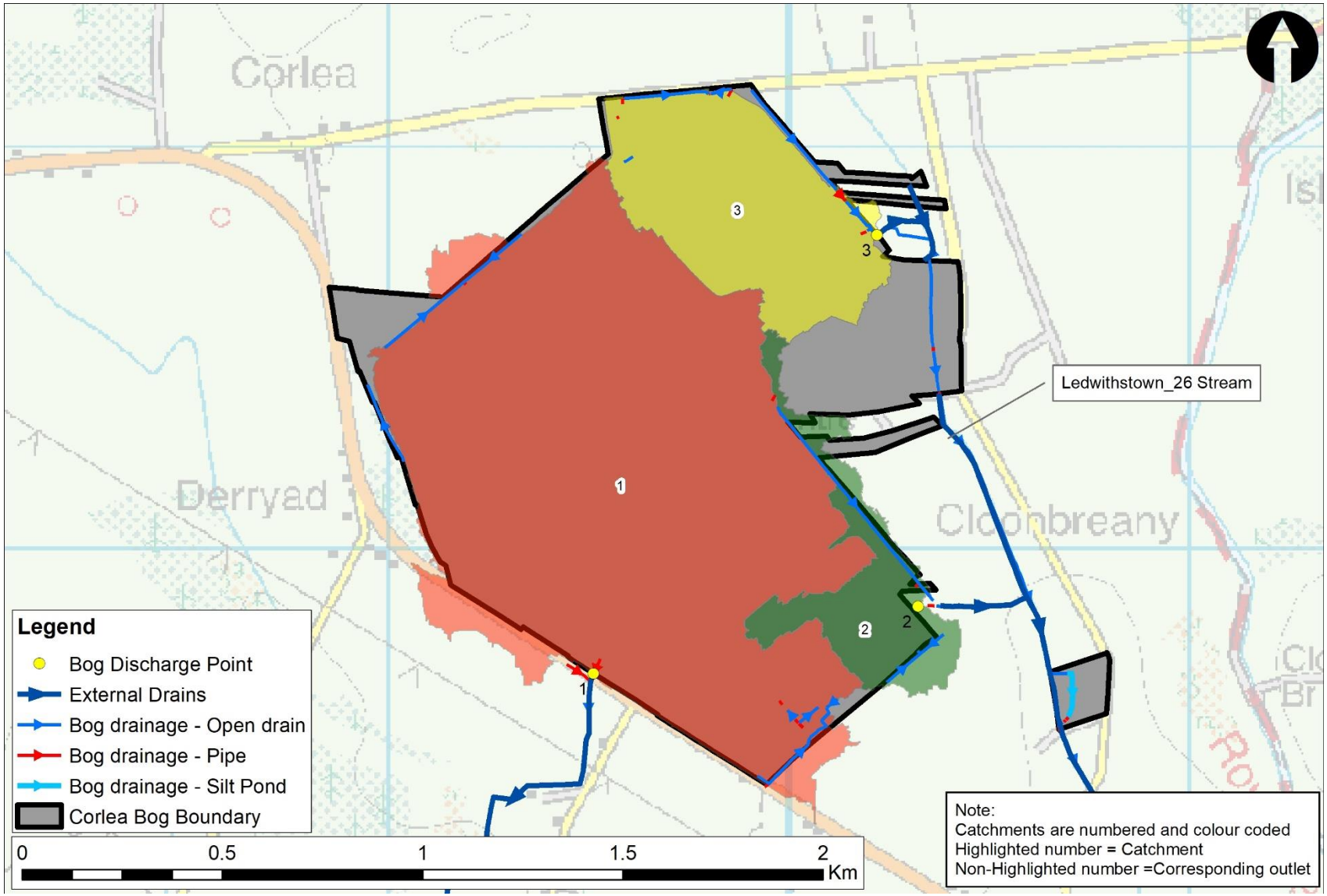

Figure 2-1 Corlea Bog Drainage Network and Sub-Catchments

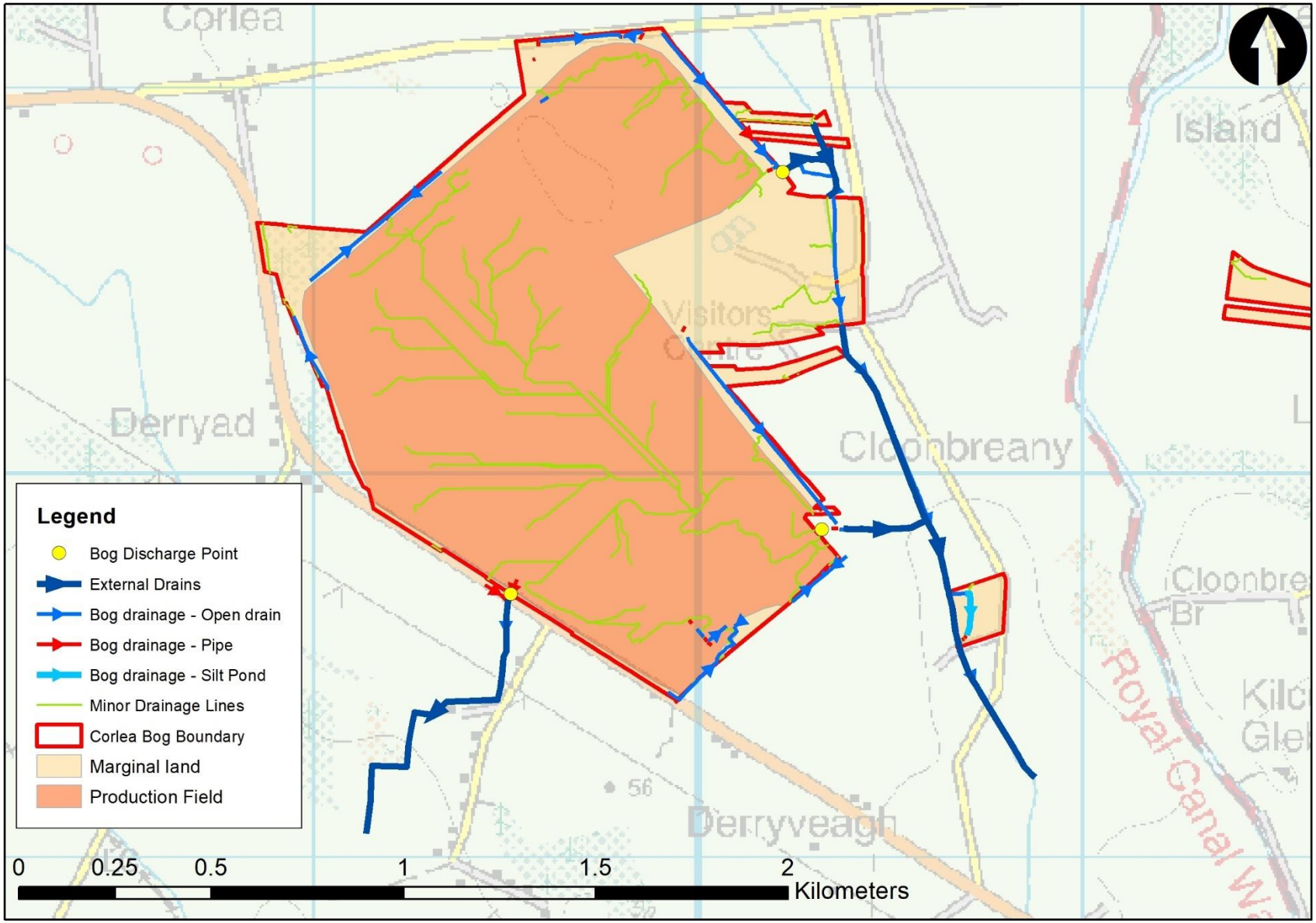

Figure 2-2- Production Field Drainage

The Flood Studies Update (FSU) catchment characteristics provide an overview of how much rain a catchment receives, how impermeable the catchment is and how quickly the water will runoff the catchment due to topography and drainage. Table 2.1 summarises the FSU catchment descriptors for the sub-catchments identified in Figure 2.1.

There are 3 sub-catchments draining Corlea Bog, ranging in area from 0.14km^2 to 1.15km^2. The catchments are subject to an average precipitation of 903mm/year. The Baseflow Index for the catchments is between 0.490 and 0.578 representing a low to moderate catchment permeability. The catchments within the bog are generally quite flat (<3% slope), while catchments that drain areas outside of the bog boundary are typically steeper. This information is based on wider catchment characteristics, and it is acknowledged that these will vary within the bog.

The Index Flood Flow (Q_{med}) values, which represent the typical peak flood flow which might be anticipated (a 50% chance of being exceeded in any given year), for each of the sub-catchments have been calculated. This is based on two different methods, the Flood Studies Update (FSU) 5 variable equation designed for small and / or urbanised catchments in Ireland, and the RPS derived Peat Q_{med} equation, derived in support of the Drainage Management Plan project for SAC sites on behalf of NPWS. Both methods result in very similar Q_{med} values where the proportion of arterial drainage (ARTDRAIN2) is assumed to match the proportion of the catchment managed by Bord na Móna (i.e., drained).

Table 2-1 Physical Catchment Descriptors of Sub-Catchments Draining the Bog

Sub-Catchment Number	Area (km^2)	SAAR (mm)	BFI	FARL	ARTDRAIN2	PEAT (%)	S1085 (m/km)	FSU5 Q_{MED} (m^3/s)	Peat Q_{MED} (m^3/s)
1	1.15	898.2	0.49	1	0.000	100.0	2.755	0.328	0.231
2	0.14	904.7	0.578	1	0.000	100.0	5.563	0.048	0.032
3	0.27	904.7	0.578	1	0.000	100.0	3.265	0.078	0.057

2.2 Morphological and Hydraulic Characterisation

A desk top review was carried out of bog drains and external drains. Morphological and hydraulic features were identified.

The external drains are generally small with gentle bed slopes. Aerial photography shows no signs of erosion or deposition however, given that the external drains are considered small with gentle bed slopes there would be a risk of deposition, and therefore reduced land drainage efficiency. Risk of deposition would occur where there is potential for an erosion or debris source from the surrounding land e.g., woodlands, commercial forest, and peat and where there is potential head loss in the channel due to instream features e.g., culverts, sharp bends, channel widening and inflows. The potential for Corlea bog being a sediment source to the external drains is considered low as silt ponds upstream of the discharge points from production fields mitigate this potential and where deemed necessary additional silt control measures will be provided. A reduction in the mobilisation of silt will be a function of the rehabilitation measures after works are completed.

A review of the bog drains was carried out. The Bord na Móna drainage survey details the open drains, settlement silt ponds and discharge points. All discharge points from the production fields have a silt pond located upstream. The drains in the bog have very gentle bed slopes before discharging from the bog. It is anticipated that the bog drainage network would be sensitive to drain and pipe alterations.

2.3 Flood Risk

A number of sources of flood risk information are available, both predicted and simulated, in proximity to Corlea. These include:

- CFRAM Study maps setting out the predicted fluvial 10%, 1% and 0.1% Annual Exceedance Probability (AEP) fluvial flood scenarios
- GSI predicted water table flood maps for high, medium and low probability events
- Mapped fluvial flood extents for the 2009 River Shannon flood event
- Mapped flood extents for the 2015 flood event (from Sentinel-1 satellite imagery) and a GSI surface water flooding dataset for the same event
- Anecdotal evidence from Bord na Móna

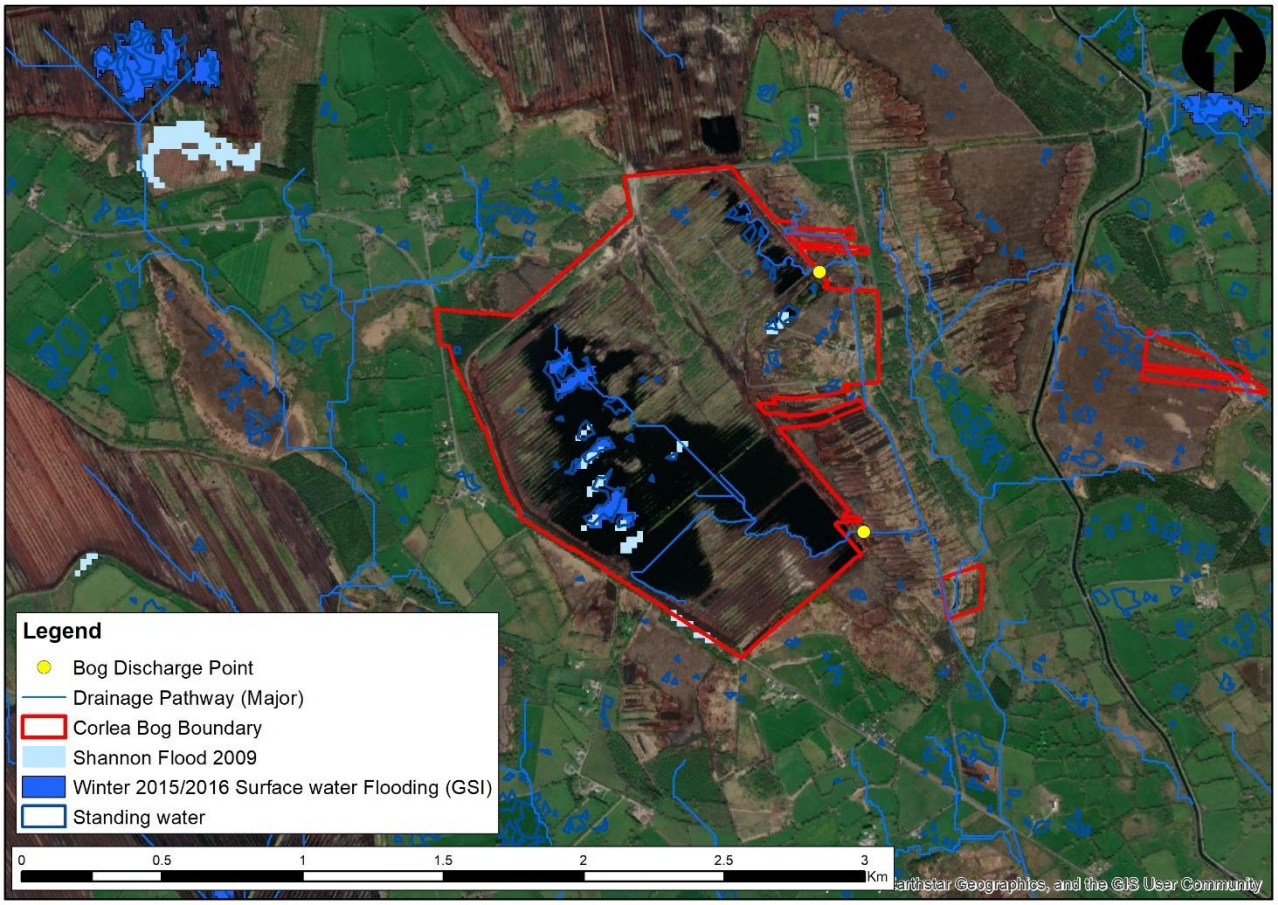

Figure 2-3 Flood Risk and Corlea Bog

The CFRAM maps show that there is low risk of Corlea bog flooding from the Shannon River. It should be noted this analysis did not consider the fluvial flood risk from the smaller watercourses which drain the land adjacent to Corlea bog. The Shannon Flood event in 2009 and the 2015/2016 surface water flooding data also indicates a small amount of surface water flooding on the bog in the past. The aerial imagery in Figure 2-3 illustrates that flooding is now more wide spread across the bog compared to the older sources. This is consistent with the local knowledge from Bord na Móna operatives familiar with Corlea Bog.

Historical anecdotal evidence was reviewed to ascertain if there are any known flooding or drainage issues from these smaller watercourses to the bog or adjacent land. No drainage issues have been identified along the Corlea Bog boundary drains.

There is a small amount of predicted groundwater flooding to the bog indicated on the GSI datasets.

2.4 Constraints and opportunities

Table 2.2 summarises the constraints, risks and opportunities identified as part of the baseline assessment.

Table 2-2 Potential Opportunities / Constraints

Land Parcel / Feature	Risk or Opportunity?	Details
Agricultural land	Constraint	It is important to maintain the productivity of agricultural land surrounding the bog
Peat bog	Constraint	The adjacent peatland is in the possession of BnM. The impact from Corlea bog should be considered.
Roads	Constraint	Minor roads providing access to dwellings, agricultural land and peat bogs are located in the study area. Access to these roads should be maintained.
Rivers	Constraint	The Ledwithstown_26 stream and Bilberry stream flows downstream of Corlea Bog. No activity should adversely impact this area.
External drains	Risk	The potential for Corlea bog being a sediment source to the external drains is considered low as silt ponds upstream of the discharge points from production fields mitigate this potential and where deemed necessary additional silt control measures will be provided.
Bog rehabilitation plan	Opportunity	To improve water quality discharging from the bog; stabilisation or improvement in water quality parameters (e.g. suspended solids)
Bog rehabilitation plan	Opportunity	To reduce carbon emissions from the bog and to set bog on a trajectory towards naturally functioning peatlands habitats.
Bog rehabilitation plan	Opportunity	To improve biodiversity by vegetating bare peat and creating more habitat for flora and fauna.
Bog rehabilitation plan	Opportunity	To reduce runoff and restore a more natural runoff regime, thus contributing to flood risk management.

3 BOG REHABILITATION PLAN

The measures identified for the bog rehabilitation plan are detailed in the Rehabilitation Plan report.

Each measure while designed to promote the rehabilitation and re-wetting of the bog will have a potentially positive and/or negative impact on the adjacent land. This section identifies and assesses these potential impacts.

Figure 3.1 shows the areas where peat extraction took place and production fields were formed, and the areas of marginal land within Corlea Bog. Production field areas will have been most intensively drained during the time of peat extraction and the water table lowered more significantly than the marginal land. The bog rehabilitation measures in the production field areas are therefore expected to increase the water table to a greater extent than in the marginal land and have a greater reduction in rate of discharge from these areas.

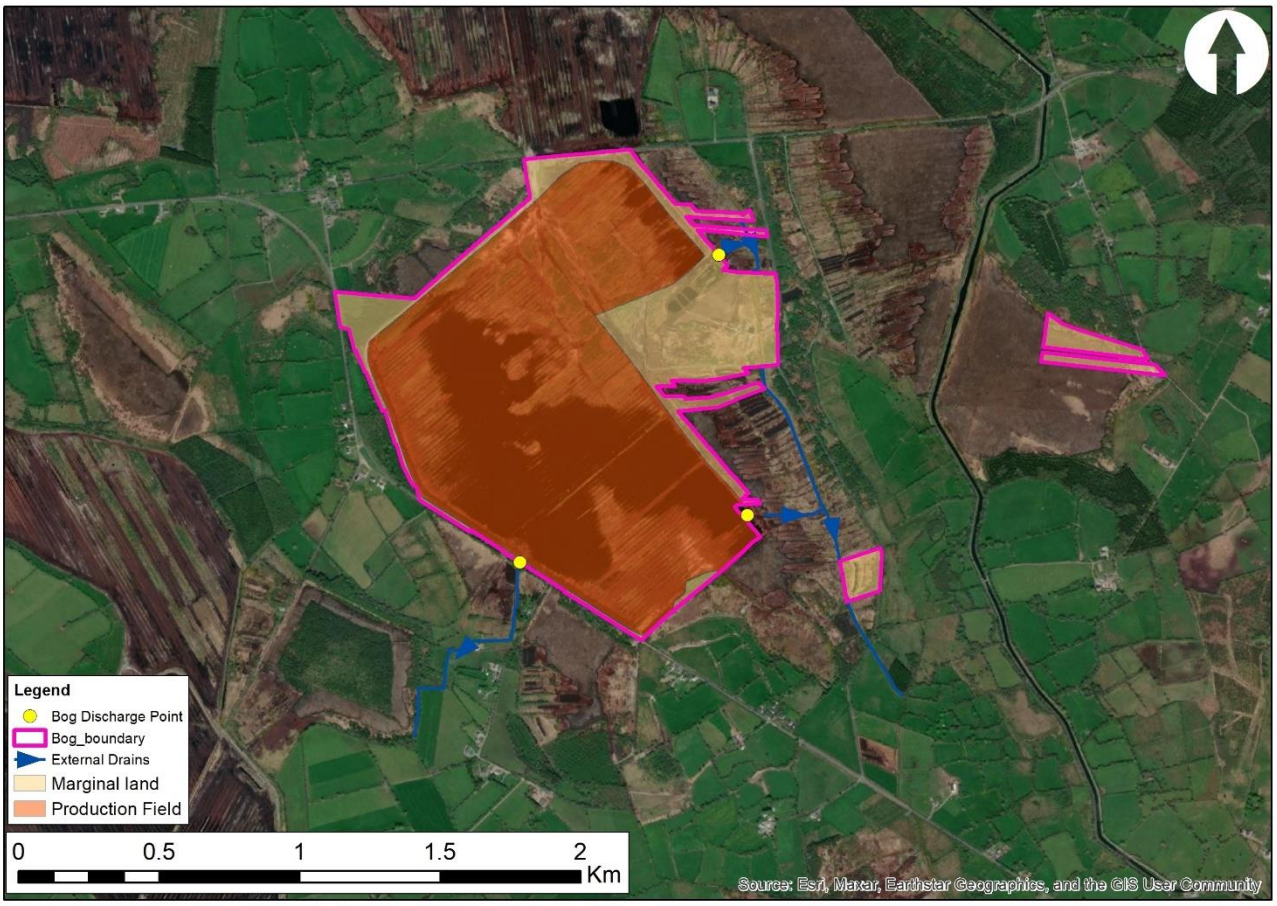

Figure 3-1- Corlea bog production type

3.1 Impact Screening

Table 3.1 summarises the rehabilitation measures proposed for the Corlea Bog and their potential impact to adjacent land.

Table 3-1 BRP measures proposed at Corlea Bog

BnM rehabilitation measure	Description	Potential Impact	Potential Impact Description
Drain blocking	Existing production field drains within the bog areas that convey surface water away from the former peat production fields towards the bog discharge points will be modified to reduce conveyance or removed altogether by infilling. Surface water runoff through the bog will be slowed allowing the bog to store more water	Positive and negative	Reduced runoff from the bog discharge points resulting in less flow in the external drains located downstream. Reduced conveyance at bog inflow point resulting in increased water volume in external drain located upstream if conveyance channels through the bog are blocked.
Blocking outfalls	Most production field drain systems drain into a headland pipe running perpendicular to the peat field. This intersection is known as an outfall. By blocking the outfalls each production field drain will be prevented from operating resulting in the ditch storing water and raising the water table level in the bog. This will allow the bog to store more water and bring the water table level to the surface.	Positive and negative	Reduced runoff from the bog discharge points resulting in less flow in the external drains located downstream. Raised water table levels to the bog surface will create a hydraulic gradient across the bog into the adjacent land. Water table levels in lands within this hydraulic gradient will potentially rise. The effect will be greatest immediately beside the bog. However, mitigation measures in the form of hydraulic breaks will be implemented, see Section 5.
Managing overflows with overflow pipes	This measure is usually combined with blocking outfalls which cause water table levels to rise. As the bog fills up it will want to overtop at the lowest part of the bog boundary. Overflow pipes control the location this occurs and where the overtopping water is discharged to.	Neutral	The control features will determine the location of the discharge from the bog. However the flow leaving the bog once it is full will be the same as prior to remedial works. Overall the volume of water discharging from the bog will be reduced but will contribute to raised water table levels within the bog and potentially within the zone of influence (subject to mitigation).
Silt ponds	Existing silt ponds will be maintained to store runoff water from the bog and allow any suspended peat to settle out of the water before it is discharged to the external drains.	Neutral	Maintained capacity from the bog discharge points to the external drains and river located downstream. Maintained quality of water being discharged from the bogs into the external drains or river.

Wetland creation	Areas prone to flooding and depressions on shallow peat are designated for wetland creation. Shallow standing water will be allowed to occur resulting in increased water storage. Establishment of reeds and other rhizomes will form part of the wetland creation.	Positive and negative	Reduced runoff from the bog discharge points resulting in less flow in the external drains and river located downstream.

3.2 Impact Assessment

Three potential impact sources were identified; water table rise, increased runoff from the bog and low flow risk. These impact sources have the potential to make the adjacent land wetter and drain less efficiently or reduce water supply in adjacent drains. An assessment was carried out to delineate the zone of influence resulting from these potential impact sources. Figure 3.2 presents the areas which are at potential risk.

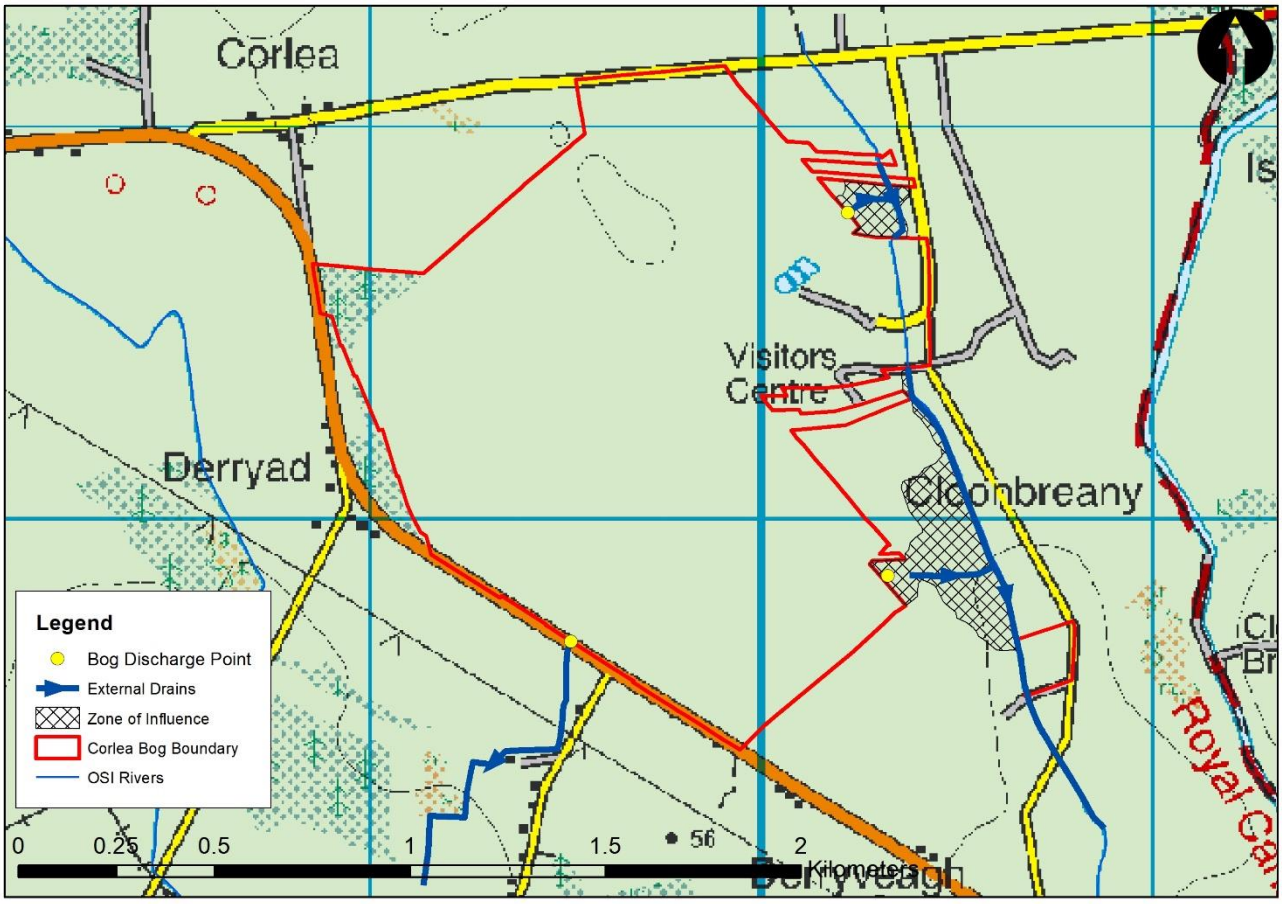

Figure 3-2 Corlea Bog Rehabilitation Plan - Zone of Influence

3.2.1 Water Table Impact

The impact of rehabilitation measures on water table levels within and adjacent to the bog is difficult to assess quantitatively in the absence of long term monitoring data and detailed hydro-geological models of the bog. Nevertheless, it can be assumed that water table levels will rise within the bog itself given that this is an objective of the rehabilitation measures – to restore the hydrological conditions for peat formation. It can also be assumed that the maximum level which the water table will reach outside areas zoned as wetland is the surface of the peat fields post-rehabilitation. This is because topographical flow paths for surface water out of the bog (by gravity) will be retained and large portions of the bog are not dependent on a pumping regime to drain surface water. For areas zoned as wetland or areas no longer to be pumped, the maximum water level will be at or above surface level as shallow water ponding is promoted through rehabilitation measures.

The surface of the bog may lie higher or lower that the adjacent land. This relationship between the bog and adjacent land needs to be considered when assessing potential water table rise. Figure 3.2 show these two relationship scenarios in a simplified schematic. Where the bog is lower than the adjacent land it would be expected that the water table would remain lower on the bog side even when the water table is raised to the bog surface. If wetland areas are created and the water level is raised above the surface it may result in higher levels than the water table in adjacent lands. In this case the presence of a boundary drain can act as a hydraulic break bringing the water table down to its original level and preventing a rise in the water table in the adjacent land. Where the surface level of the bog is higher that the adjacent land the risk of raising the water table in the adjacent land is greater. However, in this scenario the presence of an effective boundary drain will collect runoff from the bog and act as a hydraulic break bringing the water table back down and preventing a rise in the water table in the adjacent land.

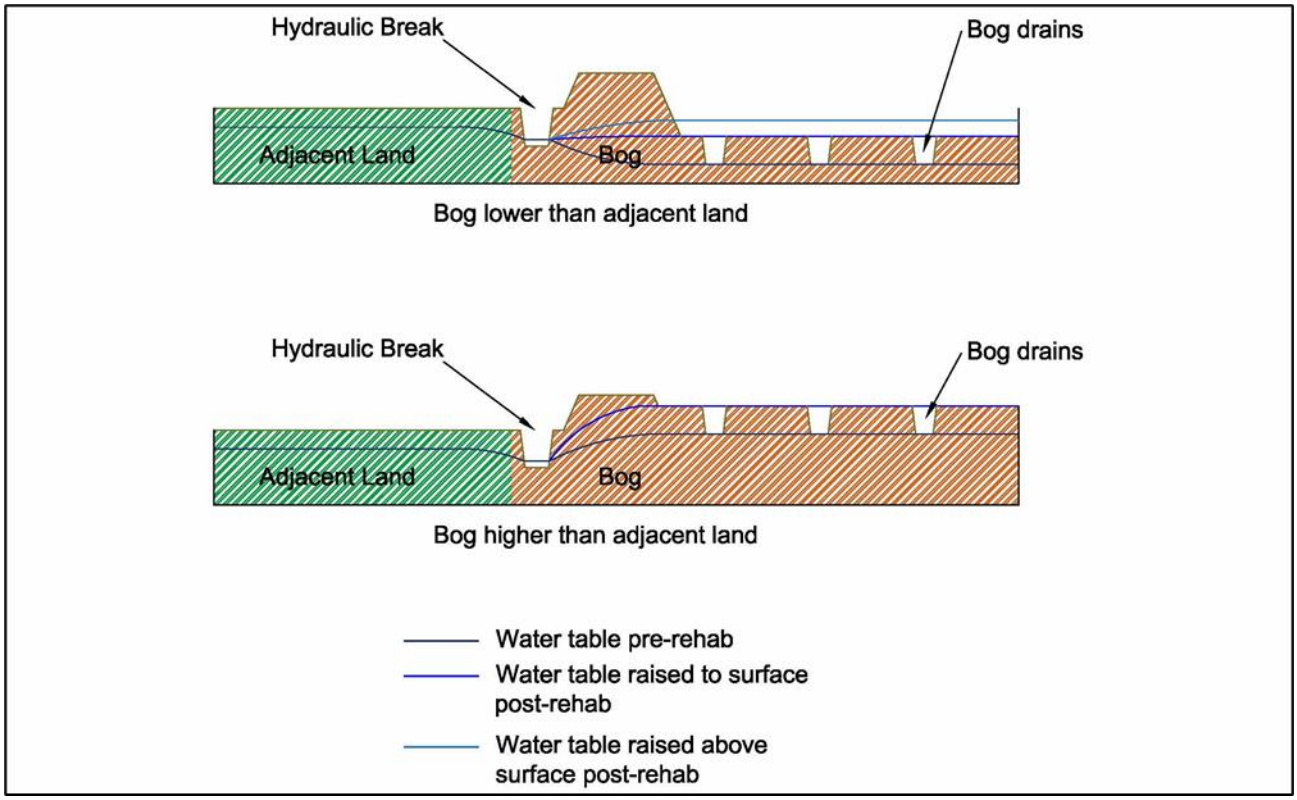

Figure 3-3 The effect of water table rise due to bog rehabilitation

For Corlea Bog the adjacent land lies lower than the bog in some locations, identified in Figure 3.1 as the Zone of Influence, and higher in other locations. Water table rise in lands adjacent to the Corlea was assessed firstly by estimating the potential rise in water table within the bog. The production field drainage system in the bog is typically 0.5m deep. It can be expected that the water table would rise by 0.5m to bring it to the surface. A cross section was surveyed, as shown in Figure 3.3, to assess the potential impact of a water table rise.

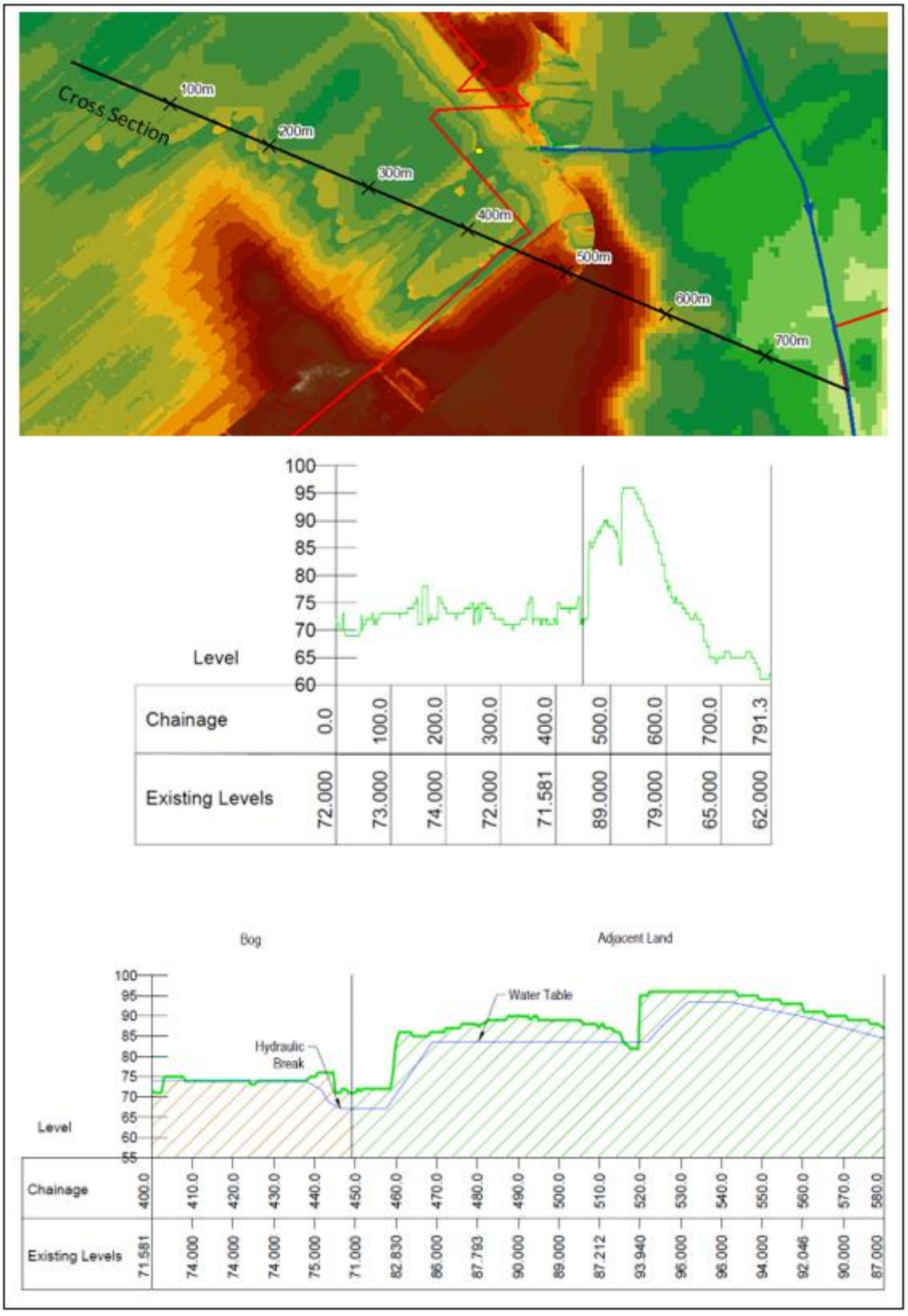

Figure 3-4 Conditions affecting water table

The cross section shows that a rising head in the bog would create a hydraulic gradient across into the adjacent land with the potential for a raised water table in the adjacent land also. This action determines the zone of influence and the areas of potentially wetter ground. The natural presence of more elevated ground around the majority of the bog boundary, means that there is a low risk of impacts through an increase in water table within the bog.

The presence of boundary drains would also act as a hydraulic break by controlling the hydraulic gradient and reducing the zone of influence. As boundary drains lie lower that the adjacent land it is expected that they will function as a hydraulic break. This however is dependent on the drain's ability to adequately convey flow.

Drains that are inefficient with high water levels (independent from the bog rehabilitation measures) will also raise the water table in the bog and potentially in the adjacent lands to the bog would be wet. The avoidance of the drain full condition is dependent on the retention of a positive gravity drainage function of the boundary drains the adequate functioning of which is retained.

Boundary drains were identified by aerial imagery and LiDAR for Corlea, which provide the water table cut-off function to agricultural lands. It is assumed that these drains would be able to convey Q_{med} (2-year return period) flows under non-backwater conditions which would be typical of natural watercourses in Ireland. Therefore, under non-flood conditions it is expected that the external drains identified around Corlea Bog will act as a hydraulic break to any hydraulic gradient created by bog re-wetting. However, there is a risk that should the flow regime in any external drain be changed post rehabilitation that the land adjacent to the drain would become wetter.

Caution should be exercised during any alterations of boundary drains around Corlea Bog. It is important to avoid the creation of new flow paths into the bedrock which has the potential of increasing water table flood risk elsewhere or altering the hydrogeological conditions for peat formation. If deepening of drains is undertaken it should therefore be undertaken with care so as not to deepen the drain beyond the base of the peat. Full details of the land use, hydrogeological and soil characterisation can be found in the Corlea Bog – site characterisation report 2023.

There is also a risk that as the bog fills with water and wants to discharge, and that unintended discharge locations would occur. A review of the bog boundary was carried out. No low points were identified that may become an unintended discharge location. Corlea Bog discharges to the south west via adjacent land drains to the Bilberry stream and to the east to the Ledwithstown_26 stream which flows south and converges with the Bilberry stream and flows towards Lough Ree. There is little risk to adjacent lands from increased flows from the bog owing to elevated water table levels. As previously set out this is dependent on existing boundary drainage network isolating the bog from lower level adjacent lands and providing a positive gravity drainage function. In other words capacity to convey Q_{med} or 2 year return period flows and a free flow (constantly falling) away from the bog.

3.2.2 Increased Runoff

Evidence from bogs that have previously been the subject of restoration measures demonstrates that the measures proposed at Corlea, which are all aimed at reducing runoff and retaining water within the bog, have the effect of reducing the frequency and magnitude of flood events by restoring a more natural hydrological regime. Restoration / rehabilitation has been successfully applied to numerous Bord na Móna bog sites as well as designated raised bogs such as Clara Bog, Raheenmore Bog, Carrownagappul Bog and Lisnageeragh Bog. Elsewhere, the restoration of peatland catchments in numerous sites across the UK, such as Exmoor National Park in Snowdonia, has demonstrated positive flood alleviation as a result of following rehabilitation measures and monitoring has shown reduced runoff from the moorland as a result of increased storage in the peat.

The risk of increased runoff from Corlea Bog is low. All rehabilitation measures being proposed will reduce rate of runoff. However, there is a potential that if bog re-profiling is carried out as part of the bog rehabilitation measures that the bog sub-catchments will be modified. Changes in sub-catchments could result in certain discharge points draining larger areas. This would result in increased flows that could outweigh the effect of the reduced runoff arising from the rehabilitation. This is a moderately low risk at Corlea as the re-profiling of the bog, if carried out, will generally result in the same topographical flow paths, catchment watersheds and discharge locations as in the pre-rehabilitation state. In the absence of a full pre and post rehabilitation runoff model and a precautionary approach has been adopted to ensure that all drainage infrastructure from the bog is retained and is fit for purpose.

3.2.3 Low Flow Assessment

A low flow risk assessment was completed to identify whether any discharge locations from the bog are at high risk of low flow during periods of low rainfall and high evapotranspiration. While it is anticipated that rehabilitation will generally lead to dampening of peak flows and support sustained flows during dry periods, there is a potential risk that during prolonged dry periods that the rehabilitation measures may lead to downstream watercourses drying out as a result of increased infiltration, increased rates of evapotranspiration along with the additional storage capacity created within the bog.

A high level risk assessment was carried out to identify the particular discharge locations where this may be a risk. The following are considered the key factors that are most likely to influence the risk of drains previously unaffected experiencing low flow:

1. The contributing catchment area to each discharge location (as this is one of the main factors that will influence the range of flow rates);
2. The intensity of the rehabilitation works within the catchment (both in terms of measures proposed and proportion of the catchment undergoing rehabilitation)

The larger the contributing catchment area it is considered less likely that a drain will reduce flow, while the more intensive the rehabilitation works the more likely a drain will be to low flow. In order to simplify the risk assessment process three risk categories (High, Moderate and Low) were identified for catchment area and restoration intensity based on experiences from other bogs where this issue has occurred. For rehabilitation

intensity the proportion of the catchment area undergoing rehabilitation was used as an indicator of risk. The overall risk category assigned is determined based on Catchment area risk multiplied by Rehabilitation intensity risk as summarised below:

Table 3-2 Parameters of Catchment Low Flow Risk

Risk category	Catchment area (ha)	Rehabilitation intensity (% of catchment area)	Overall risk category
Low (1)	>20	<30%	Low (1-3)
Moderate (2)	5-20	30-60%	Moderate (4-6)
High (3)	<5	>60%*	High (7-9)

Where any discharge locations are identified as high risk, it is recommended that Bord na Móna undertake a review of the drainage channels downstream of the bog to identify the potential impact to the land owners.

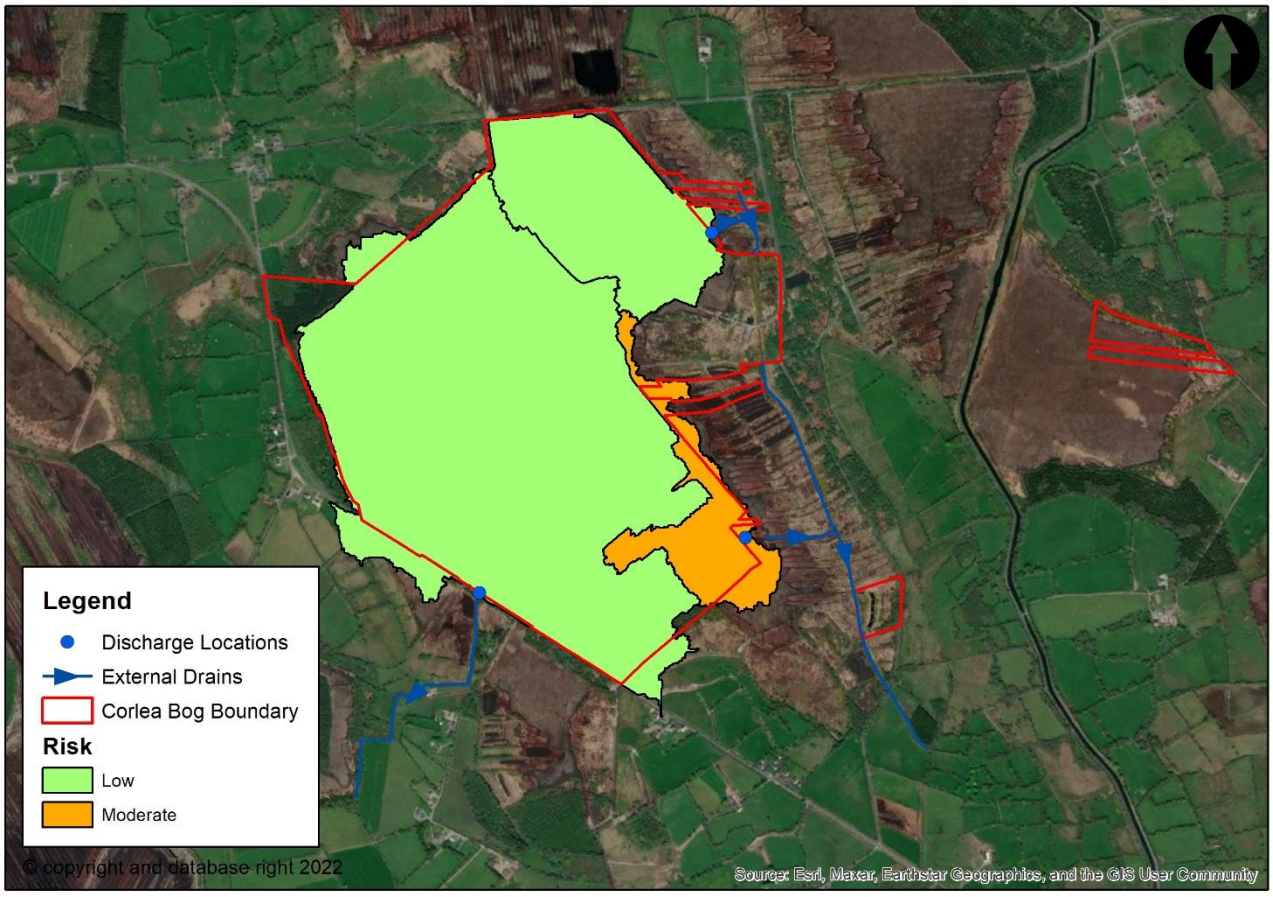

Figure 3-5 Overall Catchment Risk

Through assessing the catchment areas and rehabilitation intensity, two catchments were classified as low risk and one was classified as moderate. No high risk catchments were identified that would require further survey and assessment.

3.3 Potential Risk Areas

The following assets have been identified as being at potential risk from flooding or wetter conditions as a result of measures described in Table 3.1 being implemented.

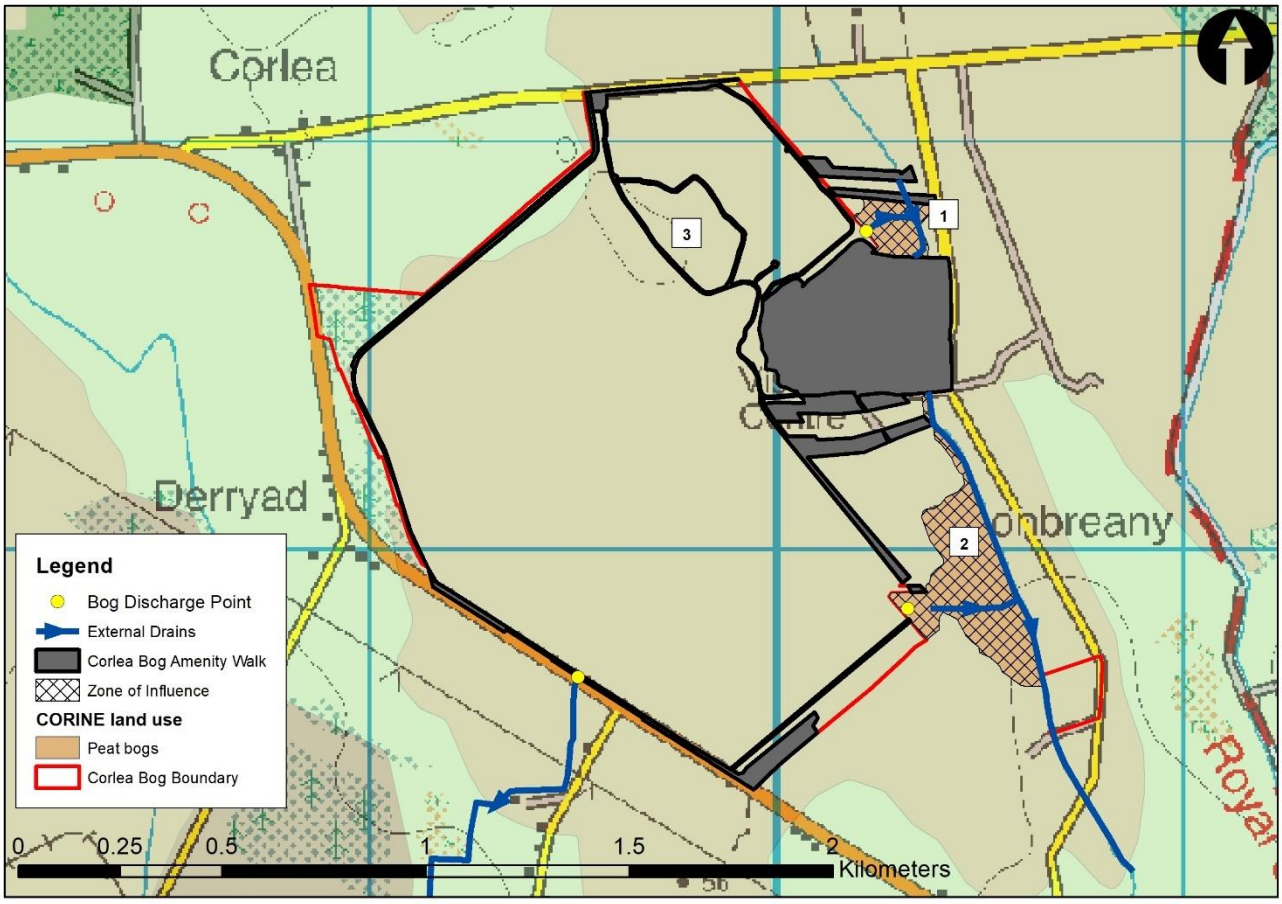

Figure 3-6 Corlea Bog Rehabilitation Plan- Assets at risk

The assets at risk are set out in Table 3.3 along with the vulnerability, based on the current land use, of the asset. It should be noted that the appraisal of the assets at risk considers the consequences of flooding or wetter conditions, not the likelihood of flooding or wetter conditions occurring.

Table 3-3 Assets at Risk

Item	Asset	Vulnerability to flooding and/or wetter conditions
1	Peat	Low Vulnerability. Peat can tolerate wetter conditions.
2	Peat	Low Vulnerability. Peat can tolerate wetter conditions.

3	Amenity Walk	Moderate Vulnerability. Corlea Trackway is mostly raised to a higher elevation than the surrounding peatland. Risk of flooding is low.
4	Roads	Low vulnerability. Road level slightly higher than surrounding land. Risk of flooding is low.

In addition to the above risks there is a general low risk that should degradation of the bog boundary occur surface water could be released into adjacent lands.

4 OBJECTIVES

The overarching objective of the Corlea Drainage Management Plan is to facilitate the rehabilitation of bog through management of potential adverse impacts to adjacent land and waterbodies. SMART[2] objectives were developed for the Drainage Management Plan that provides direction for the overarching objective. These objectives consider constraints, risks and opportunities that were identified in chapters 2 and 3 and are detailed as follows:

1. To manage potential water table impacts between adjacent land and Corlea bog during and after rehabilitation measures.
2. To maintain or reduce flow rate from the bog at the discharge locations.
3. To manage sediment entering the Ledwithstown_26 Stream and Bilberry Stream during and after rehabilitation, these measures are to ensure compliance with current discharge limits in IPC Licence.

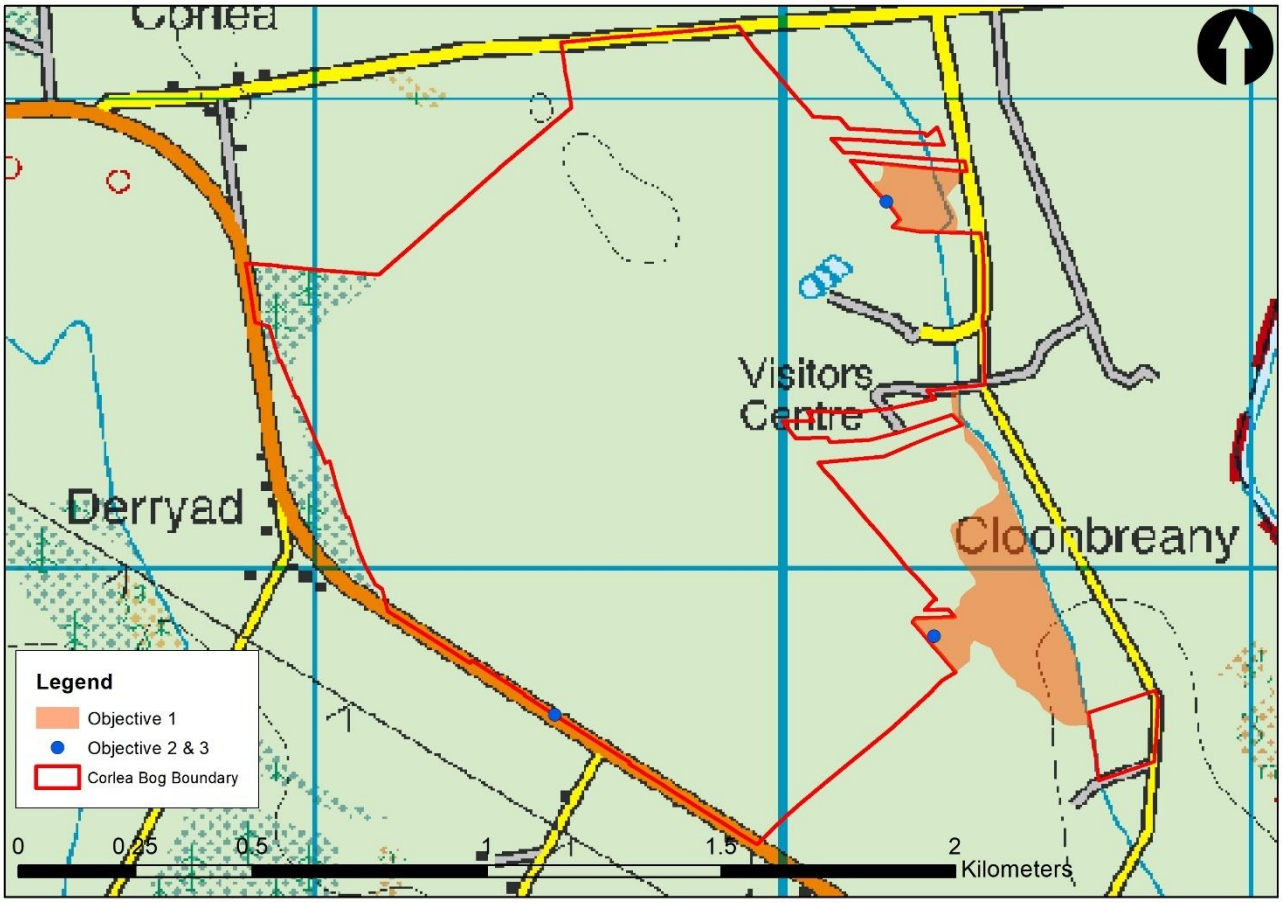

Figure 4-1 Corlea Bog DMP objectives

[2] SMART – Specific, Measurable, Achievable, Relevant, Time bound

5 DRAINAGE MANAGEMENT MEASURES

5.1 Key Drainage Features

Drainage management measures were identified in relation to the objectives set in chapter 4 and are described below. Objective 1 considers the potential impact to adjacent land from water table rise. Objectives 2 and 3 consider the control mechanisms to flow discharging from the bog.

An assessment was carried out to identify the existing key drainage features available to meet the objectives set. Figure 5.1 presents the key drainage features identified. It can be seen in the figure that for water table level rise to be managed between the bog and adjacent land that a hydraulic break will be required where available. To ensure that the flow and sediment discharging from the bog is managed the silt ponds at the discharge control points will need to be maintained.

Outside the Bord na Móna bog boundary key external drains were identified. These drains are hydrologically connected to the bog drainage network. While no drainage issues were identified along these external drains (see section 2.4), a risk of sediment deposition was highlighted from sources outside the bog. The maintenance of the existing silt ponds will mitigate the risk of sediment deposition arising from rehabilitation. Post-rehabilitation there will be in general a reduction in risk of sediment/silt escape once the bog reaches environmental stabilisation. It is noted that sediment deposition in the external drains could impede the drainage of the bog and adversely impact adjacent lands.

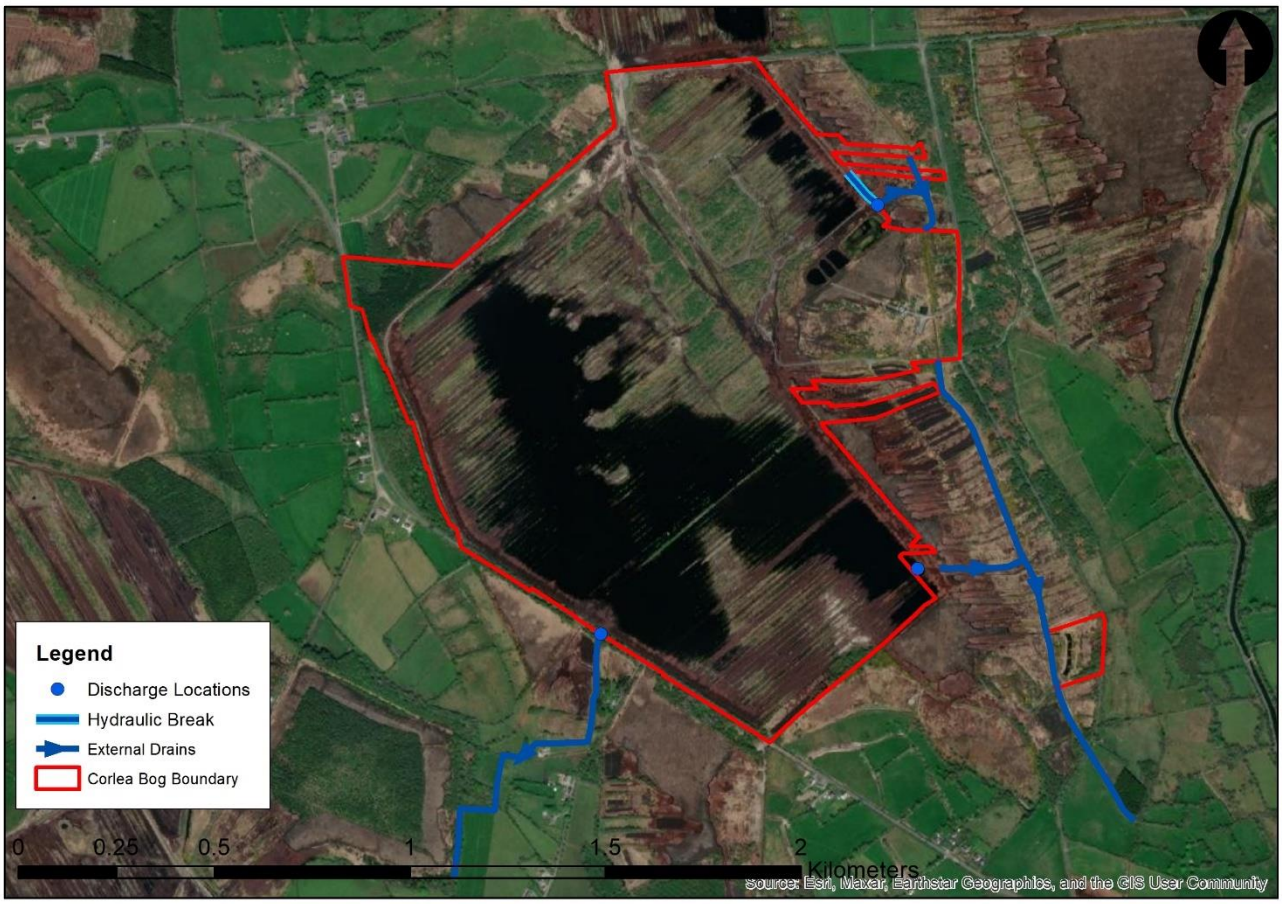

Figure 5-1 Key drainage features for Corlea Bog

When identifying measures to provide the key drainage features a review was carried out of the drains. LiDAR, topographical surveys and local knowledge from Bord na Móna operatives were used in this review. While the review gave a good indication of the key drainage features' performance it is acknowledged that gaps in information or changes to features post survey could change the expected performance. Corlea Drainage Management Plan therefore outlines a suite of responsive measures taking into account such factors as robustness and ongoing on-site observations. The Drainage Management Plan would therefore allow the bog to be managed and adapted as the rehabilitation plan progresses and is retained in the future. The following sections describe the suite of measures that can feasibly be implemented for the Corlea Bog Drainage Management Plan.

5.1.1 Boundary Drains

Boundary drains can provide hydraulic breaks between the bog and adjacent land, see Figure 5.1. In most areas of Corlea Bog where hydraulic break would be required there are existing boundary drains. Available information indicate that these drains are suitable to provide hydraulic breaks and can be designated as such and retained in the future. Observing and recording the suitability of the boundary drains is recommended and where they are found to be not functioning as predicted upgrade works will be required. This would involve modification of the drain to make them larger/deeper/wider/steeper. This may be only in specific locations along the drain or an entire reach may require upgrading. Boundary drains which are currently considered a shared asset between BnM and the adjacent landowner will fall under the responsibility of BnM to retain this asset. Where there is no boundary drain present an alternative measure may be required. This might include a new drain in order to create the hydraulic break required, in these cases a channel of specified dimensions and slope will be required and where possible will not extend into the mineral soils (See section 3.2.1).

5.1.2 Bog Rehabilitation Modification

Where a boundary drain is not suitable to act as a hydraulic break or where none exists it may be possible to review the bog rehabilitation plan to provide the required mitigation measure. This can take the form of sacrificing rehabilitation of the last peat field, or equivalent rehabilitation area, closest to the adjacent land where an existing field drain could provide the hydraulic break function. The field's drainage network would be retained keeping the water table to current conditions and providing a water table cut-off in relation to the adjacent land.

In areas zoned as wetland within the rehabilitation plan control of the water levels may be required. Where there is a potential backwater into adjacent lands or where raised water levels could potentially raise water levels on adjacent lands setting a maximum control water level may be required. This control level will allow water to drain freely from the wetland area although water levels may rise higher than the control level during flood conditions.

5.1.3 Maintenance of Discharge Points

Existing silt ponds are located upstream of the bog discharge points. They help regulate the flow and ensure that suspended solids are settled in the pond, maintaining compliance with the emission limit values regulated by the EPA. Bord na Móna have legal responsibility to maintain these silt ponds and ensure their proper functioning capacity under the existing IPC Licence (Ref. P0504-01).

If alterations occur where no silt point exists upstream of a discharge point and no subsequent silt pond will be utilised before flow would leave the bog alternative silt control measures may be required. This can include blocking and or diverting the discharge point so that the relevant sub-catchment of the bog drains to a different discharge point with a silt pond. The rehabilitation plan can be adapted where required to allow proposed wetlands to act as a silt control measure.

5.1.4 Monitoring

As mentioned above DMP measures were selected based on level of certainty and on-site observations. The most appropriate measure was selected from a suite of measures representing varying levels of intervention. Monitoring of the measure and adjacent land will be required prior, during and after the rehabilitation measures. A monitoring programme can be implemented to observe the impact from the bog rehabilitation to the adjacent land. Monitoring would be observational where the condition of the asset in question is assessed in relation to present day conditions accounting for seasonal variability. Where negative impacts are observed other measures can be implemented that will establish a hydraulic break or an alternate measure will be undertaken that will satisfy the functional requirement of a hydraulic break. Otherwise monitoring should continue until environmental stabilisation has taken place.

5.2 Identification of Measures

The following section along with Figure 5.2 and Table 5.1 lists and describes the DMP measures for Corlea Bog.

DMP 1. Existing silt ponds would be required to be maintained. At Corlea Bog these silt ponds are already submerged with water at areas in the rehabilitation plan which are proposed for wetlands and therefore the entire wetland area is currently acting as silt control
levels in the wetland areas may rise above the invert of the outfalls as they regulate the discharge.

The remaining measures are of low intervention consisting of maintaining the existing features or monitoring lands and features

Table 5.1 list the DMP measures identified for Corlea Bog and where they sit within the suite of possible measures that could be taken.

Figure 5-2 DMP measures for Corlea Bog

Table 5-1 Selection of DMP Measures

Measures Item	Feature	Function required	Suite of measures Level of intervention			
			Low			High
1	Silt ponds	Silt and flow control	**Maintain pond**	Upgrade pond	-	-

5.3 Interaction with Monitoring Plan

As part of the bog rehabilitation plan groundwater level monitoring equipment has been installed at Corlea Bog. These record water table and groundwater levels over the coming months. It will therefore be possible to ascertain if the water table is rising within the bog following the implementation of the rehabilitation plan.

This data should be considered during the monitoring measures of adjacent land. When water table levels are known to be rising within the bog, monitoring of the adjacent land (as described in Section 5.1.4) should take place on a more regular basis to ascertain if impacts to lands outside the bog are observed.

5.4 Residual Risk & Limitations

The level of flood risk to the bog and the surrounding lands has been shown to be low (Section 2.3) generally but with small areas of the bog susceptible to poor drainage and flooding. The impact of the proposed rehabilitation measures will generally be to reduce runoff from the bog but this will lead to increased water table levels and surface water flooding in the bog itself. During flood events no increase in flood risk is envisaged as a result of the rehabilitation measures. During normal flow regime the Drainage Management Plan seeks to identify the measures that should provide a hydrological cut off between the bog and the surrounding lands.

As indicated in previous sections there are limitations to the assessments associated with the drainage network both within the bog and in neighbouring lands. Factors such as flow estimations of small catchments, lack of survey data limiting drain capacity estimations and high level definition of soil porosity all contribute to these limitations. Nevertheless, the measures recommended represent a pre-cautionary approach based on conservative assumptions.

The DMP measures proposed set a baseline approach and a suite of measures in any given location has been provided. This will facilitate a reactive approach to be taken if required. In the event that a measure is found to not be operating efficiently, a higher intervention measure can and will be implemented. This will allow Bord na Móna to identify the most appropriate measure while proceeding with drainage function uncertainties.

5.5 Climate Change Adaptability

There is high uncertainty in relation to the effects of climate change, particularly in how it may manifest in terms of small catchment runoff. Ireland is predicted to have drier summers and wetter winters. The most appropriate guidance in an Irish context can be found in the OPW's Flood Risk Management Climate Change Sectoral Adaptation Plan[3]. For the Mid-Range Future Scenario, representing a central emissions estimate on a 100 year time horizon, it is recommended that allowances for peak flow and rainfall are increased by 20%. If such increases in runoff are realised over the timeframe of establishment of rehabilitation measures this could lead to a perception that bog rehabilitation measures at Corlea are the cause of increased flood risk.

[3] Accessed on 10/12/2020 at https://www.gov.ie/pdf/?file=https://assets.gov.ie/46534/3575554721374f7ab6840ee11b8b066a.pdf#page=1

It is anticipated however that the rehabilitation measures will lead to reduced peak runoff as the water storage function of the bog is increased. This will serve to regulate peak runoff in winter and potentially smooth out the flows in drier periods, essentially acting against the anticipated effects of climate change.

It is therefore anticipated that the bog rehabilitation measures themselves will provide the mitigation of the effects of climate change on runoff and no additional measures will be needed. There are unknowns however in the effectiveness of the rehabilitation measures in this regard and also the severity of climate change impacts. Continued monitoring of the adjacent lands is therefore also crucial to gauge the effectiveness of the bog rehabilitation measures in mitigating these climate change impacts.

6 SUMMARY OF DRAINAGE MANAGEMENT PLAN

The Drainage Management Plan for Corlea consists of a series of measures to be implemented at different stages of the rehabilitation process. Drains along the boundary were identified as hydraulic breaks in order to mitigate against any potential impacts from the bog rehabilitation measures. The effectiveness of all drains acting as hydraulic breaks is dependent on their ability to convey flow which have been outlined in Section 5.1 and deemed suitable subject to the measures recommended. Factors such as channel size and slope will determine this along with any downstream feature which may control water levels. The external drains which these boundary drains discharge into are also key drainage features that will affect the operation of the drainage network.

Measures will range from low intervention to high and consist of monitoring, retention of existing features. Maintenance of measures are proposed to the silt ponds within the bog to ensure that discharge from the bog and sediment is controlled. This is a legal obligation for Bord na Mona and will continue at all existing silt ponds.

Monitoring of adjacent land is included in the plan. The monitoring will observe agricultural land, adjacent bog, and woodland for adverse impacts from the bog rehabilitation. In the event that adverse impacts are confirmed, higher intervention measures can and will be implemented to mitigate the impacts.

Monitoring measures will therefore be ongoing during and after the bog rehabilitation measures. Continued retention and maintenance of the key drains and silt ponds will also be required after the bog rehabilitation measures. Throughout the process landowner engagement is recommended to ensure both the rehabilitation plan and Drainage Management Plan are understood and to promote collaborative working to manage impacts as they arise.

Table 6-1 Drainage Management Plan

Measures required PRE bog rehabilitation measures	Measures required DURING bog rehabilitation measures	Measures required POST bog rehabilitation measures
Landowner engagement if required via community liaison	Landowner engagement if required via community liaison	Landowner engagement if required via community liaison
Retention of boundary drains (see section 5.1.1)	-	-
-	Wetland water level control (see section 5.1.2)	Wetland water level control (see section 5.1.2)
Monitoring boundary drains (section 5.1.4)	IF REQUIRED – Consideration of need for higher intervention measures	-
Maintenance of discharge points (see section 5.1.3)	Maintenance of silt ponds (see section 5.1.3)	Maintenance of silt ponds (see section 5.1.3)
Monitoring of adjacent land (see section 5.1.4)	Monitoring of adjacent land (see section 5.1.4)	Monitoring of adjacent land (see section 5.1.4)
-	-	IF REQUIRED – boundary drain upgrades (see section 5.1.1)

-	-	Retention of key drains and pipes