BORD NA MÓNA - DERRYCOLUMB BOG

Drainage Management Plan

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EXECUTIVE SUMMARY

Derrycolumb Bog is located approximately 9.5km to the west of Ballymahon in County Longford. Derrycolumb Bog is located in the Upper River Shannon catchment. The majority of the bog is drained by the Bilberry River, Derrymany Stream and Newtownflanagan Streams.

The catchments that drain through the bog have been delineated. These catchments are a mixture of bog, pastures and transitional cutover / woodland areas. The catchments have relatively poorly draining soils underlain by permeable bedrock layers. The area is drained mainly by a gravity drainage system with two pump locations within Derrycolumb bog aiding drainage of adjacent land and the bog internal drainage.

The rehabilitation measures are generally aimed at reducing runoff and drainage from the existing peat fields through a mixture of techniques including drain blocking, cell bunding and re-profiling. It is assumed that these measures will not significantly alter the existing topographical catchments and that the spine of the drainage networks, those which the upstream catchments drain through, will be retained by Bord na Móna.

Three potential impacts were considered: the potential to reduce the drainage function to upstream lands, the potential for increased flows downstream and the potential for increased groundwater levels impacting adjacent lands. There is no potential for increased flows downstream and the rehabilitation of Derrycolumb Bog, based on evidence from other bogs, will reduce the runoff from the bog by returning the peatlands towards its natural water retention function. The avoidance of reduced drainage function to upstream lands depends on Bord na Móna actively retaining the drainage routes which traverse the bog upon which drainage of adjacent and upstream lands is dependent.

The potential for increased groundwater levels and to a lesser extent marginal alteration of the topographical catchments has been assessed based on a precautionary approach. With drainage routes retained it is assumed that groundwater levels will reach the surface of the re-profiled peat fields throughout most of the bog. However there are some hollow areas where ponding may occur. In these scenarios adjacent lands which are at a lower level than the bog could potentially be impacted and vulnerable areas have been defined through a zone of influence approach.

Each of the land parcels have been assessed based on its vulnerability to increased groundwater levels within the bog. In most cases there exists a boundary drain separating the rehabilitation area from the potentially vulnerable lands. Best evidence has shown that these drains provide a positive gravity drainage function and through retaining them they should prevent any groundwater impacts on adjacent lands due to the hydrogeological break / cut-off they provide. Where no boundary drain exists between the bog and adjacent lands the retention of the outside bog field, with its internal drains, is recommended for retention.

There are some limitations with this approach namely the effect of backwater levels and the lack of detailed survey of the boundary drainage network. Given the low level of risk at Derrycolumb it is appropriate in most cases that the DMP measures involve survey, monitoring and retention of the boundary drainage network. A suite of measures is identified in order to mitigate any deterioration in the drainage to adjacent lands should monitoring of these lands indicate a groundwater or drainage impact on these lands. The creation of a new drain and the maintenance of silt ponds and current pumping regime are proposed as higher intervention

measures. Together with the retention of the boundary drainage network these measures will ensure the rehabilitation measures do not negatively impact the adjacent lands.

1 INTRODUCTION

Derrycolumb Bog is part of the Mount Dillon bog group. Bord na Móna operated peat extraction within the Mount Dillon bog group under IPC Licence (Ref. P0504-01) issued and administered by the EPA. Condition 10.2 of this licence requires the preparation of a 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 proposed Scheme will significantly go beyond what is required to meet rehabilitation and decommissioning obligations under existing EPA IPC licence conditions. Improvements supported by the Scheme will ensure that environmental stabilisation is achieved and significant additional benefits, particularly relating to climate action and other ecosystem services, will also be delivered.

A key issue for Bord na Móna is the potential hydrological impact rehabilitation of this bog may have on the bog itself, on surrounding lands and on lands downstream which are hydrologically linked to the bog. Rehabilitation measures generally seek to increase groundwater levels and surface water retention, such that they are closer to the surface to encourage peat formation, the associated ecological benefits and carbon sequestration capacity. While in general terms this will reduce the volume of water released from the bog following a rainfall event, the impact on flood run-off is not well understood. Furthermore the increase in the local water table could result in negative impacts to surrounding lands if mitigation measures are not applied (e.g. agricultural).

This Drainage Management Plan (DMP) for Derrycolumb Bog 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 impacts to an acceptable level. 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 long 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.

1.1 Bog Details

Derrycolumb Bog is located approximately 9.5km to the west of Ballymahon in County Longford. The bog comprises three main sections, south-eastern, mid and north-western sections that are divided by minor public roads.

Derraghan Bog is located immediately adjacent to two sections of Derrycolumb Bog and is connected via a rail link to Derrycolumb. To the south east, the next adjacent Bord na Móna Bog (Edera Bog) is also connected to Derrycolumb via a rail line.

Derrycolumb Bog is located in the Upper River Shannon catchment. The majority of the bog is drained by the Bilberry River, Derrymany Stream and Newtownflanagan Streams. In addition, an unnamed tributary of the Drumnee Stream occurs along the boundary of the north-westernmost section of Derrycolumb Bog; this watercourse flows south into the Drumnee which drains to Lough Ree, west of Saints Island.

There are travel paths and drainage channels maintained around the bog formerly used for access and drainage of industrial peat production areas. The rail line also runs through Derrycolumb Bog.

Derrycolumb Bog was in industrial peat production from the mid-1980s until 2019. The peat was formerly used as fuel peat in Lough Ree Power in Lanesborough.

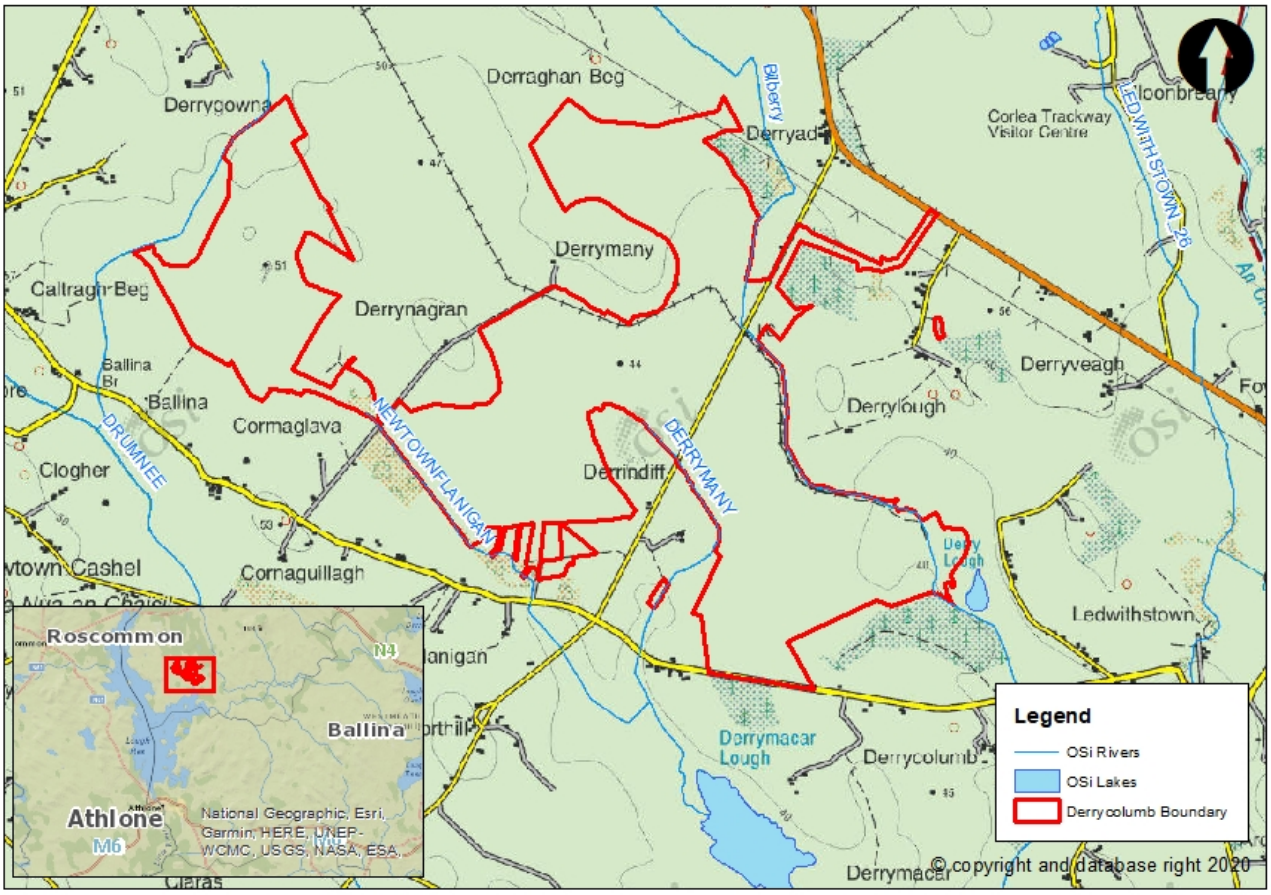

Figure 1.1 Location of Derrycolumb Bog

2 BASELINE ASSESSMENT

Through cessation of peat extraction and implementation of the Derrycolumb Bog rehabilitation plan there is the potential to 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.

2.1 Study Area

To characterise the catchments a study area was determined encompassing the total catchment area draining the bog and adjacent lands through the bog. The drainage under the influence of Derrycolumb Bog discharges into a number of watercourses, including the Drumnee, Bilberry, Newtownflannigan and Derrymany. A review was carried out to delineate the external drains around the bog as presented in Figure 2.1 along with their associated hydrological catchment area.

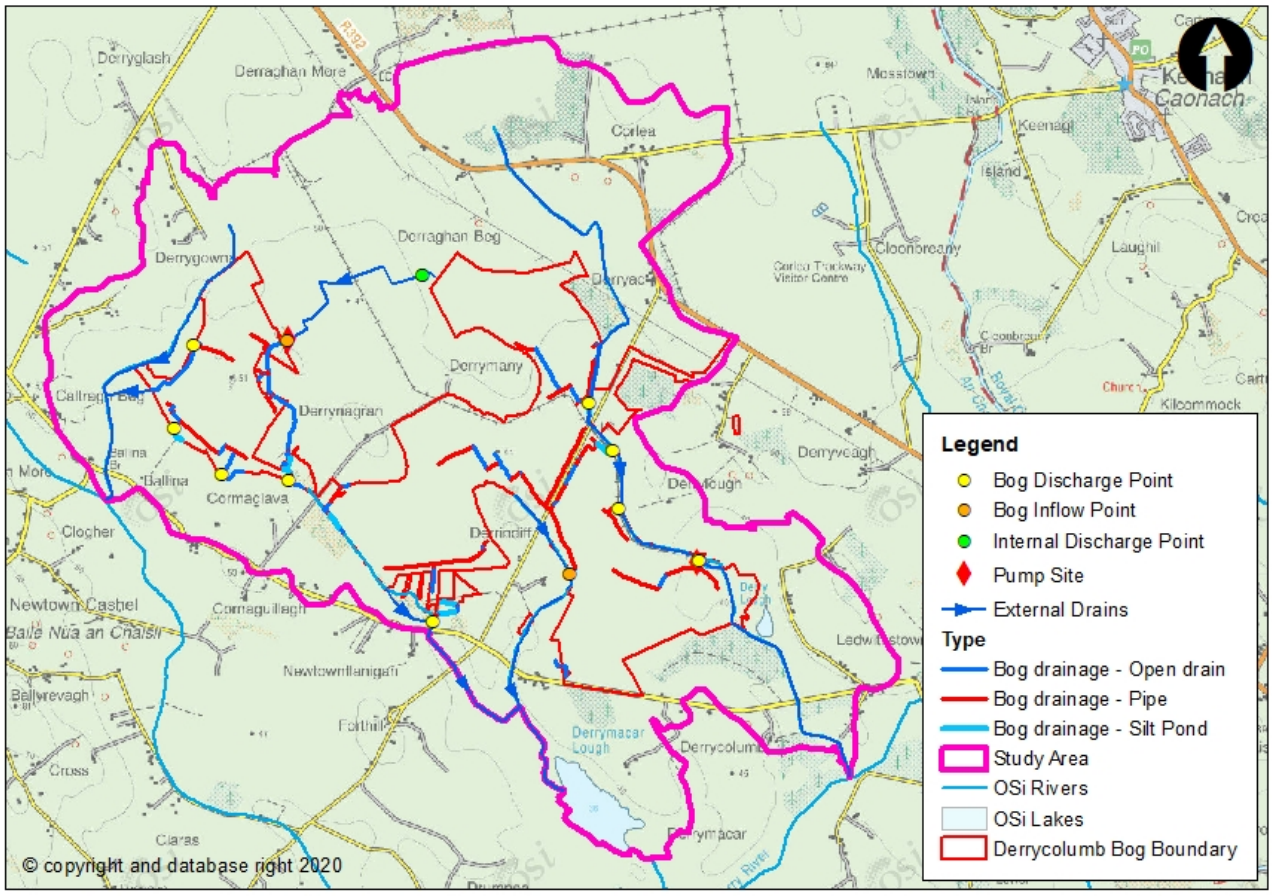

Figure 2.1 Study Area for Derrycolumb Bog

2.2 Catchment Runoff Characterisation

A hydrological analysis was carried out within the study area to delineate the sub catchments of the bog drains and the external drains. The recent Bord na Móna drainage survey was reviewed and the bog sub-catchments confirmed. Sub-catchments of the external drains were identified using ARC GIS tools. The sub catchments are presented in Figure 2.2.

The 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 2.2.

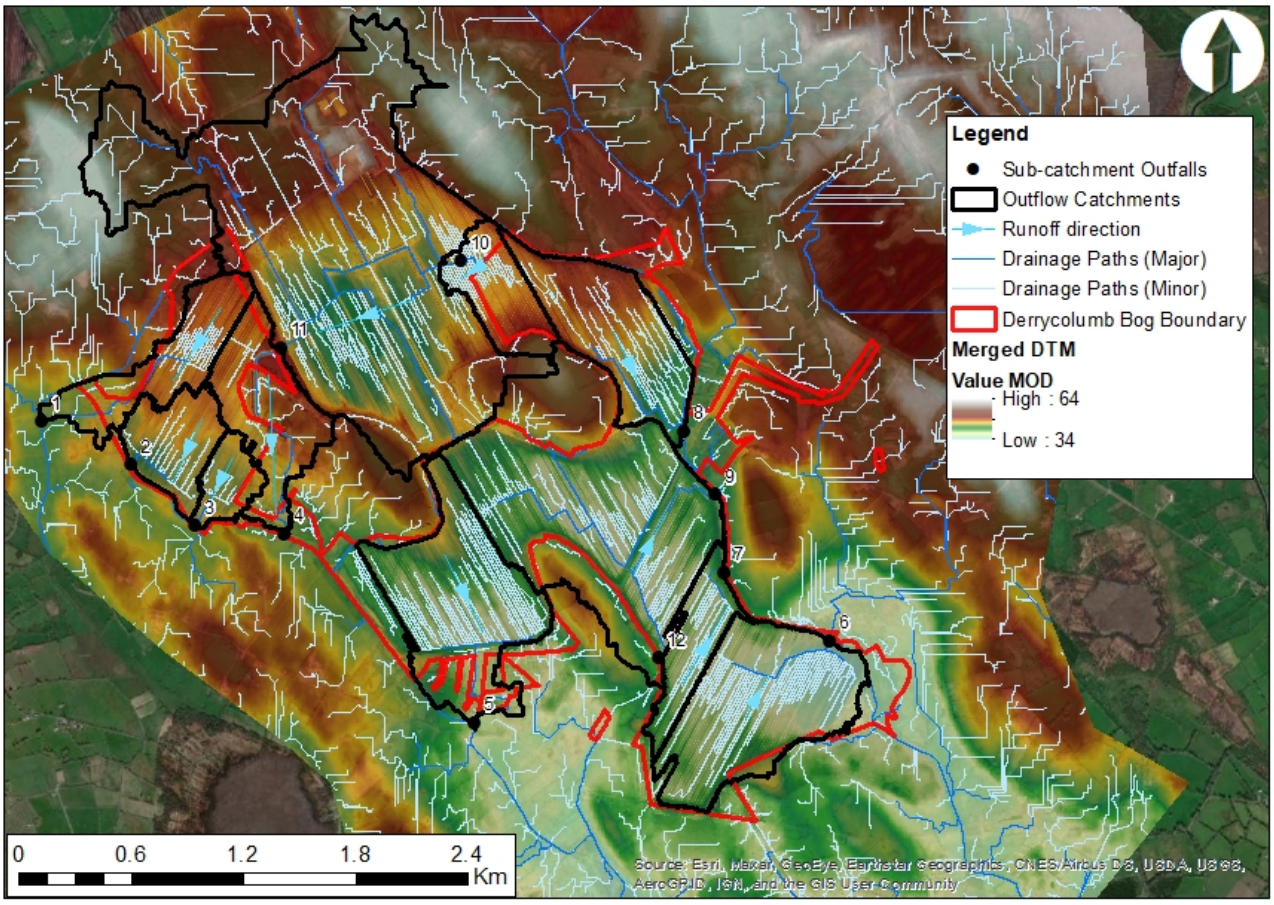

Figure 2.2 Drainage Networks and Sub-Catchments Draining Derrycolumb Bog

There are nine sub-catchments draining Derrycolumb Bog and adjacent lands, ranging in area from 0.119 km^2 to 3.18 km^2. The catchments are all subject to moderate / low amounts of annual average rainfall. The Baseflow Index for all of the catchments ranges from 0.36-0.44 representing a range from fairly impermeable to moderately impermeable. The catchments range from very flat to moderately flat.

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 (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	0.336	893.79	0.435	1	1	100	4.494	0.132	**0.136**
2	0.239	893.79	0.435	1	1	100	5.610	**0.102**	0.101
3	0.119	892.84	0.376	1	1	100	1.843	0.046	**0.063**
4	3.188	892.84	0.376	1	0.909	90.9	0.973	0.819	**1.075**
5	0.679	892.84	0.376	1	1	1	0.292	0.145	**0.284**
6	0.678	900.93	0.357	1	1	1	4.988	**0.313**	0.309
7	0.213	900.96	0.393	1	1	1	1.380	0.071	**0.102**
8	0.481	901.21	0.393	1	1	1	8.821	**0.241**	0.210
9	1.409	900.61	0.393	1	0.827	82.7	3.573	**0.519**	0.504

2.3 Hydrogeological and Soil Characterisation

Derrycolumb Bog and the surrounding area are underlain primarily by Visean limestone bedrock which represents a regionally important, karstified aquifer. Some areas to the south east of the bog are underlain by dark limestone and shale with some areas to the north underlain by limestone and calcareous sandstone. These areas represent a locally important aquifer with bedrock which is moderately productive only within localised zones. Geological Survey of Ireland (GSI) tracing of karst features has not identified any significant features such as springs, swallow holes or turloughs in close proximity to the bog. Nevertheless the bedrock underlying Derrycolumb has potential to facilitate relatively high rates of baseflow / groundwater transfer. The soils covering the catchments are primarily peat, with some peaty gleys outside the extent of the bog and some grey brown podzols to the south of the bog. All of these soils would be considered to be fairly impermeable.

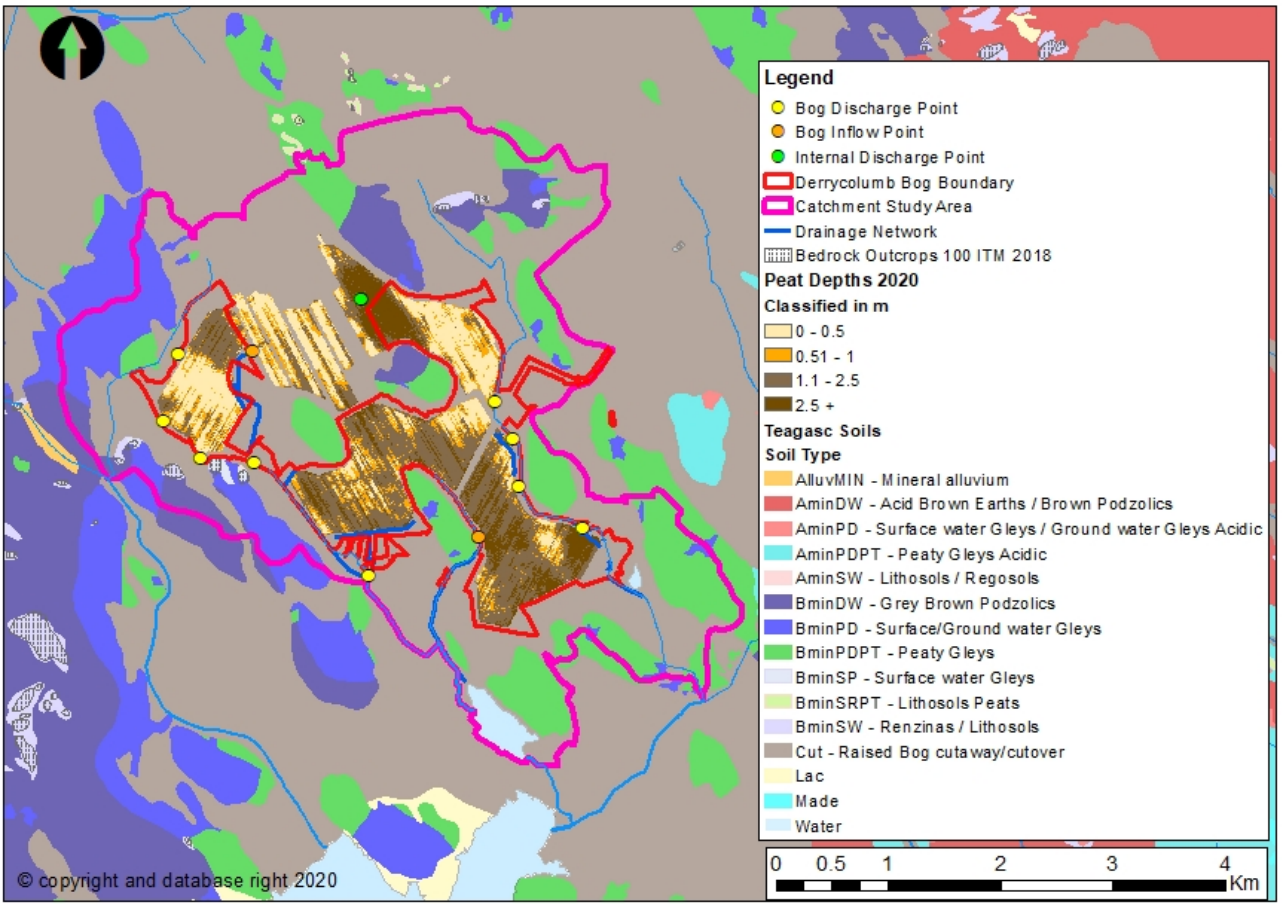

Figure 2.3 Hydrogeological and Soil Characteristics of Derrycolumb Bog

2.4 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 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 and where there is potential head loss in the channel due to instream features. Figure 2.4 details the reaches of the external drains where there are potential erosion or debris sources and where instream features may facilitate deposition. The figure shows that due to the location of commercial forests, woodlands and disturbed peat in the surrounding lands there are existing potential sediment sources that could enter the external drains. Given the presence of culverts, sharp bends and inflows along the external drains there would be a potential of sediment settling and deposition occurring. The potential for Castlegar bog being a sediment source to the external drains is considered low due to the presence of silt ponds at all discharge points and that peat extraction activities have ceased.

A review of the bog drains was carried out. The Bord na Móna drainage survey details the open drains, pipes, settlement ponds and discharge points. Five of the discharge points have a silt pond located upstream which will reduce the amount of peat leaving the bog as water is drained. The drains in the bog have very gentle bed slopes and pass through numerous pipes before discharging from the bog. At location 6 in Figure 2.4 a pump currently aids discharge from the bog into the watercourse. At location 11 a pump currently aid flow into the bog from the adjacent land. It would be expected that the bog drainage network would be sensitive to drain and pipe alterations and the drain which receives an inflow at a pumping station from the adjacent land, as shown in location 11 in Figure 2.4, needs careful consideration. A reduction in this drain's capacity has the potential to impact on the land that drains into the bog.

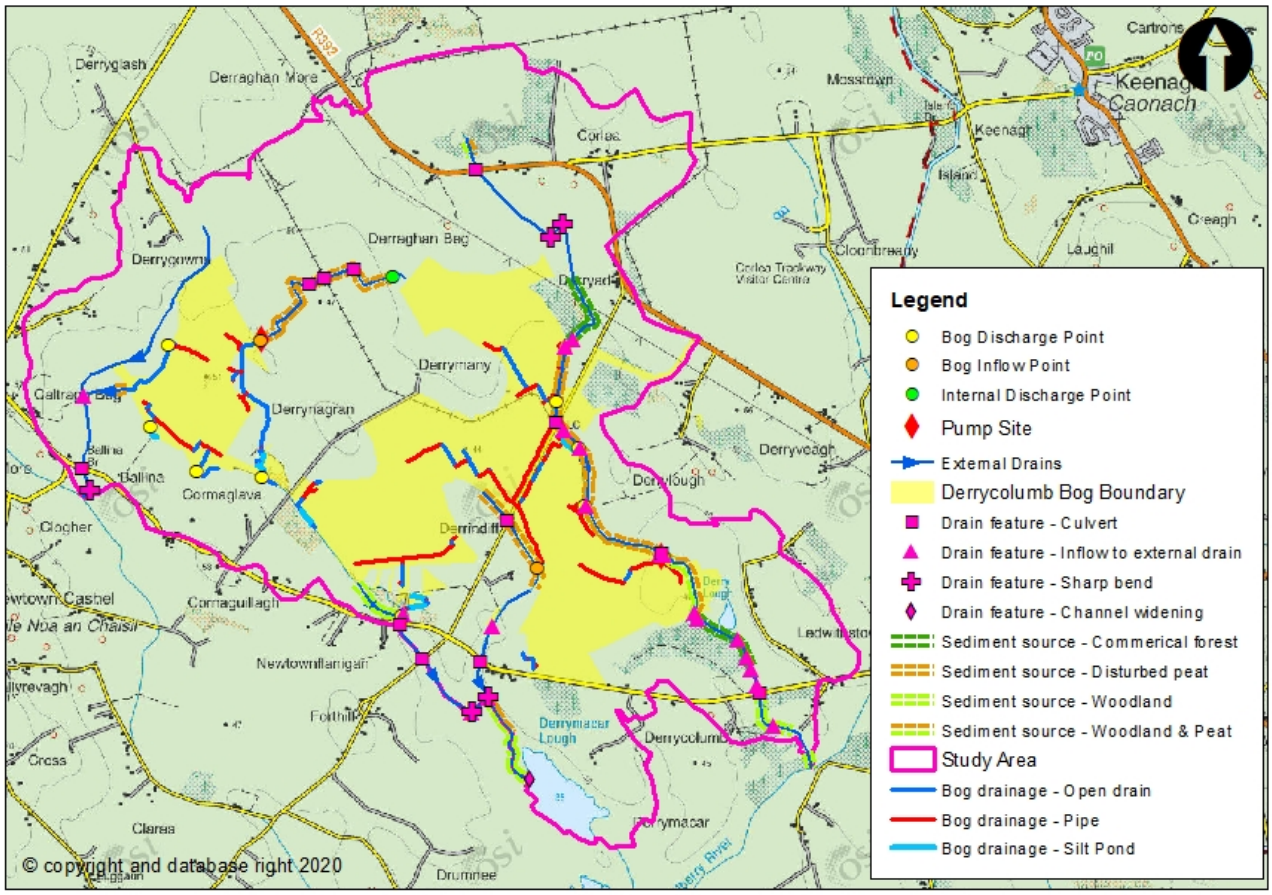

Figure 2.4 Morphological and Hydraulic Characteristics of Derrycolumb Bog and environs

2.5 Land Use Character

The majority of the land within the study area is peat bog and pasture. The remaining areas of the study area consist of areas of coniferous forest, broad-leaf forest and traditional woodland-scrub. The CORINE land use dataset was used to identify landuse types. This dataset was then reviewed using aerial photography to establish landuse amendments or land use alterations. The review found that additional commercial forests and woodland areas are located in the study areas and some peat bog and pasture land have been improved with land drains. An area of water body was identified in the South of the study area. There are some minor roads located in the study area also.

The pasture land is mainly used for livestock which provides food production. The commercial forests provide for timber production. The majority of the peat bog outside the Bord na Móna site shows evidence of being harvested for domestic fuel use. Other areas of peat bog are undisturbed which contribute to carbon storage and biodiversity. The woodland areas are likewise providing carbon storage and biodiversity albeit as a different habitat to the peat bogs. The minor roads within the study area service individual properties and provide access to the pastures, forests and peat bogs.

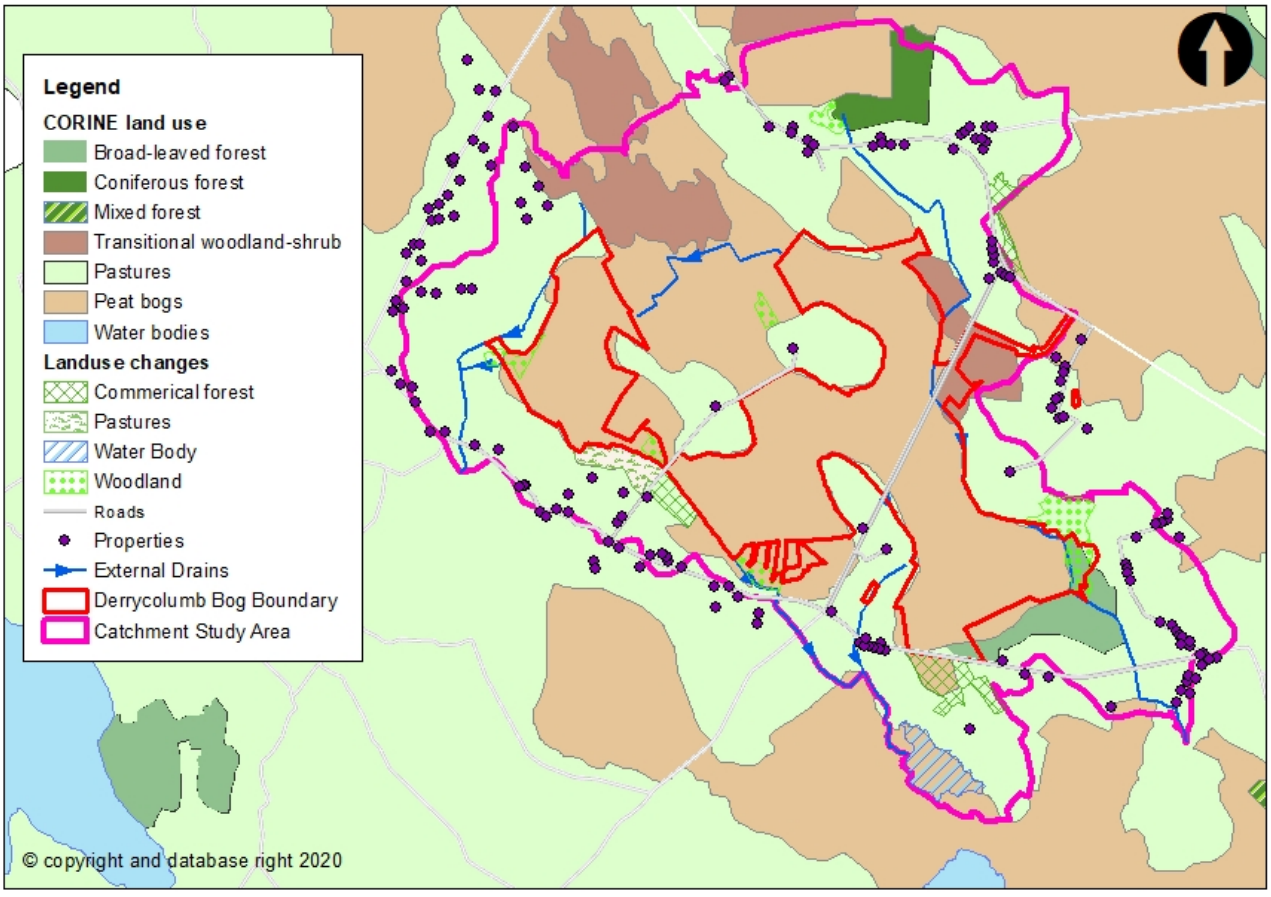

Figure 2.5 Land Use Characteristics of Derrycolumb Bog and environs

2.6 Flood Risk

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

- CFRAM Study maps setting out the predicted fluvial 10%, 1% and 0.1% Annual Exceedance Probability (AEP) fluvial flood scenarios for the River Suck
- GSI predicted groundwater flood maps for high, medium and low probability events
- 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

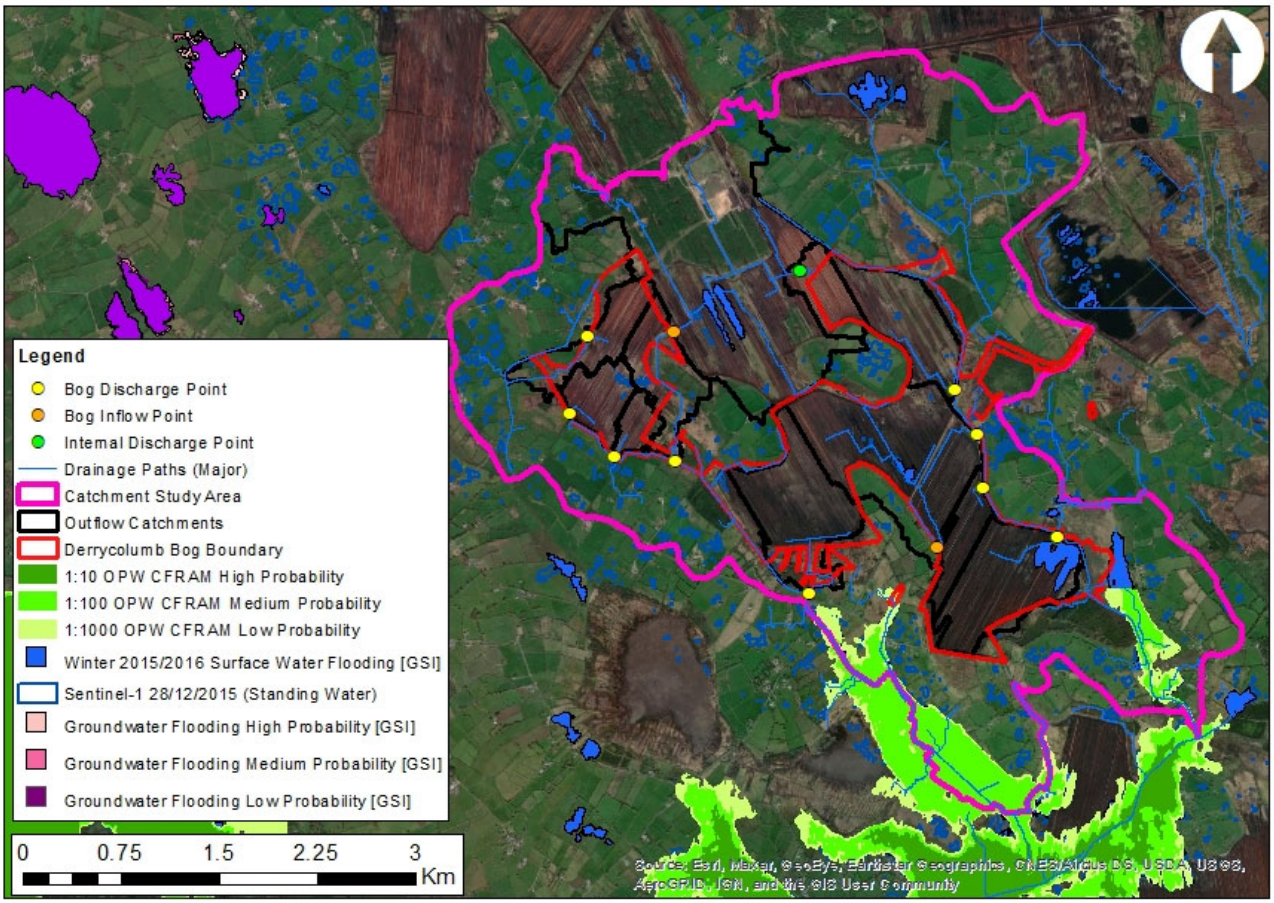

Figure 2.6 Flood Risk at Derrycolumb Bog

The CFRAM maps show that the bog itself is not a risk of flooding. There is an area in the south of the of the study area that is at risk of flooding from the Bilberry River and the Newtownflanigan River for events greater than 1 in 10 year event.

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 Derrycolumb Bog boundary drains.

An area to the south of the bog upstream of discharge point 6 and an area outside the of bog upstream of bog inflow point 11 are subject to surface water / drainage flooding. Both areas are dependent on the pumps operated by Bord na Móna for drainage.

There is no predicted groundwater flooding to the bog indicated on the GSI datasets.

2.7 Summary

The drainage network sub-catchments within Derrycolumb Bog and its environs were used to delineate the study area for the Derrycolumb Drainage Management Plan. The overall catchment area was characterised within the context of hydrology, hydrogeology, morphology, landuse and flood risk.

A detailed drainage network delineation was carried out. Drains within the bog and external drains were identified. The drainage under the influence of Derrycolumb Bog discharges into a number of watercourses, including the Drumnee, Bilberry, Newtownflanigan and Derrymany.

The catchment area is considered to be relatively small, flat, fairly permeable with a low to moderate annual rainfall. Peak flood flows range from around 0.3 – 0.5 m^3/s per square kilometre (3 – 5 l/s per hectare) for the Q_{med} event to 0.9 – 1.2 m^3/s per square kilometre (9 – 12 l/s per hectare) for the Q_{100} year plus climate change event.

The bedrock within the catchment is primarily limestone, however no karst features were identified in GSI records which could influence groundwater movement and flooding. The soil on top of the bed rock is mainly peat with some other peaty gleys and brown podzols outside the extent of the bog boundary. All soil types are relatively impermeable which would restrict groundwater movement.

The morphological and hydraulic characteristics of the external drains were assessed. No signs of erosion or deposition could be observed. Areas of deposition risk were identified along each drain. Culverts, bends, inflows, channel widening were identified as potential factors for sediment deposition. Commercial forest woodlands and bare peat adjacent to the drains were identified as potential sources of sediment. Given that the drains are relatively flat the risk of deposition in the external drains is considered high.

The land use was assessed within the study area. The majority of land is peat bog, some of which has been drained for agricultural purposes. Pasture land makes up a significant proportion of the study area also. The remaining areas of the study area consist of areas of coniferous forest, broad-leaf forest and traditional woodland-scrub. The land provides important services such as food production, timber production, domestic turf cutting, carbon storage, biodiversity and habitat creation.

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 retain the productivity of agricultural land surrounding the bog

Peat bog	Constraint	Where turf is still being extracted from other bog adjacent to Derrycolumb Bog this function could be impacted.
Roads	Constraint	Minor roads are located in the study area providing access to dwellings, agricultural land and peat bogs. Access to these roads should be maintained.
Properties	Constraint	Commercial and residential properties are located in the study area. No adverse impact should be experienced to these properties.
External drains	Risk	Risk of deposition in the drains is considered high due to potential sediment sources in adjacent lands and features within the external drains. External drains may be sensitive to change.
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. Derrycolumb has potential to develop embryonic Sphagnum-rich vegetation that has potential to be a carbon sink.
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 Derrycolumb Bog rehabilitation plan[1] consists of the following measures as summarised in Table 3.1 and presented in Figure 3.1.

Table 3.1 Derrycolumb Bog rehabilitation measures

Restoration	Description of measures
Deep peat restoration	More intensive drain blocking (max 7/100 m) + blocking outfalls and managing overflows
Deep peat restoration	More intensive drain blocking (max 7/100 m) + field reprofiling + blocking outfalls and managing overflows
Dry cutaway restoration	Blocking outfalls and managing water levels with overflow pipes
Dry cutaway restoration	Regular drain blocking (max 3/100m) +blocking outfalls and managing water levels with overflow pipes+ targeted fertiliser treatment
Wetland creation	Turn off or reduce pumping to re-wet cutaway+ blocking outfalls and managing water levels with overflow pipes
Wetland creation	Turn off or reduce pumping to re-wet cutaway + blocking outfalls and managing water levels with overflow pipes + Targeted blocking of outfalls within a site + constructing larger berms to re-wet cutaway + transplanting Reeds and other rhizomes
Wetland creation	More intensive drain blocking (max 7/100 m) + blocking outfalls and managing overflows + transplanting Reeds and other rhizomes
Other	Maintain silt ponds

[1] For further details see Derrycolumb Bog Cutaway Bog Decommissioning and Rehabilitation Plan 2020 report

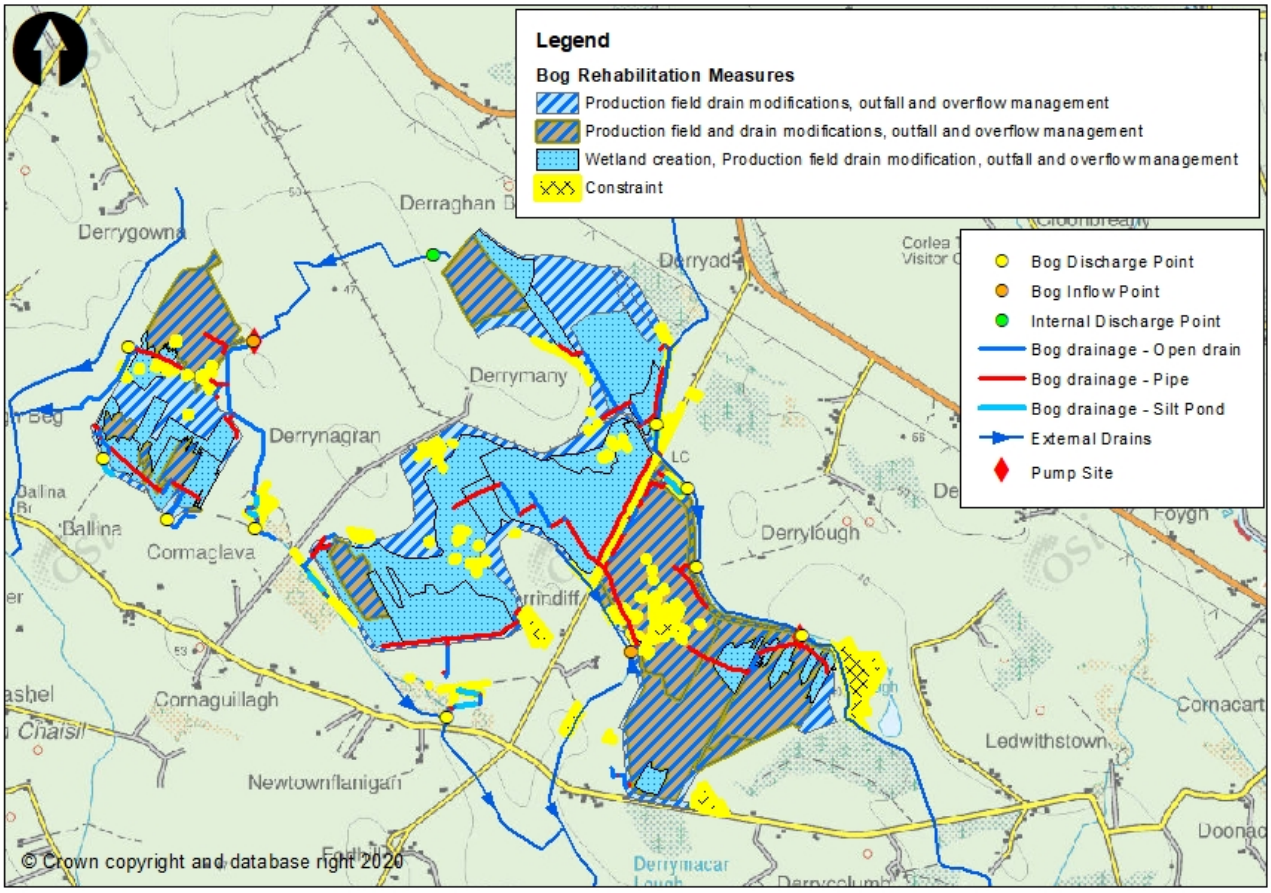

Figure 3.1 Derrycolumb Bog Rehabilitation Plan

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.

3.1 Impact Screening

Table 3.2 summarises the rehabilitation measures proposed for the Derrycolumb Bog and their potential impact to adjacent land.

Table 3.2 BRP measures proposed at Derrycolumb Bog

BnM rehabilitation measure	Description	Potential Impact	Potential Impact Description
Drain blocking, cell blocking, berm and field re-profiling	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.	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 points resulting in increased water volume in external drain located

	Surface water runoff through the bog will be slowed allowing the bog to store more water		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. The location of the ditch/pipe 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 groundwater level in the bog. This will allow the bog to store more water and bring the groundwater 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 groundwater levels to the bog surface will create a hydraulic gradient across the bog into the adjacent land. Ground water levels in lands within this hydraulic gradient will potentially rise. The effect will be greatest immediately beside the bog.
Managing overflows with controlled overflows	This measure is usually combined with blocking outfalls which cause groundwater 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 structures 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 groundwater levels within the bog and potentially within the zone of influence (subject to mitigation).
Drainage channel for excess water	This measure will work in conjunction with the overflow structures. Where suitable drainage channels do not exist or are of insufficient capacity along the bog boundary, a new or upgraded drainage channel will be provided. These drainage channels will convey all flows from the bog to suitable watercourses.	Positive	Drainage channels of sufficient capacity will ensure any overtopping water from the bog does not enter adjacent land. Drainage channels will also act as a hydraulic break in groundwater limiting the impact of bog measures to the groundwater in adjacent lands.
Turn off or reduce pumping	Existing pumps that aid discharge flow from the bog would be turned off or reduced to reduce the discharge and promote the rewetting of the bog.	Positive and negative	Reduced runoff from the bog discharge points resulting in less flow in the external drains located downstream. Raised groundwater levels to the bog surface will create a hydraulic gradient across the bog into the adjacent land. Ground water levels in lands within this hydraulic gradient will potentially rise. The

			effect will be greatest immediately beside the bog.
Sphagnum moss inoculation	This measure will propagate sphagnum moss within the bog. Sphagnum moss will cause bog regeneration as it grows and layers.	Positive	Sphagnum moss can hold up to 10 times its weight in water. As such this measure will store water reducing the runoff from the bog into the exterior drains. This will help retain the external drainage efficiency which adjacent land relies on. This measure may also contribute to runoff reduction and wider catchment FRM goals but in a piecemeal way.
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 discharge 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.
Fertiliser treatment	Introducing fertiliser to the bog to promote the establishment of vegetation	Negative	Excess fertiliser has the potential to be carried into the surrounding watercourses in surface water via the bog discharge points.

3.2 Impact Assessment

Three potential impact sources were identified; groundwater rise, increased runoff from the bog and reduced drainage capacity into and through the bog. These impact sources have the potential to make the adjacent land wetter and drain less efficiently. 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.

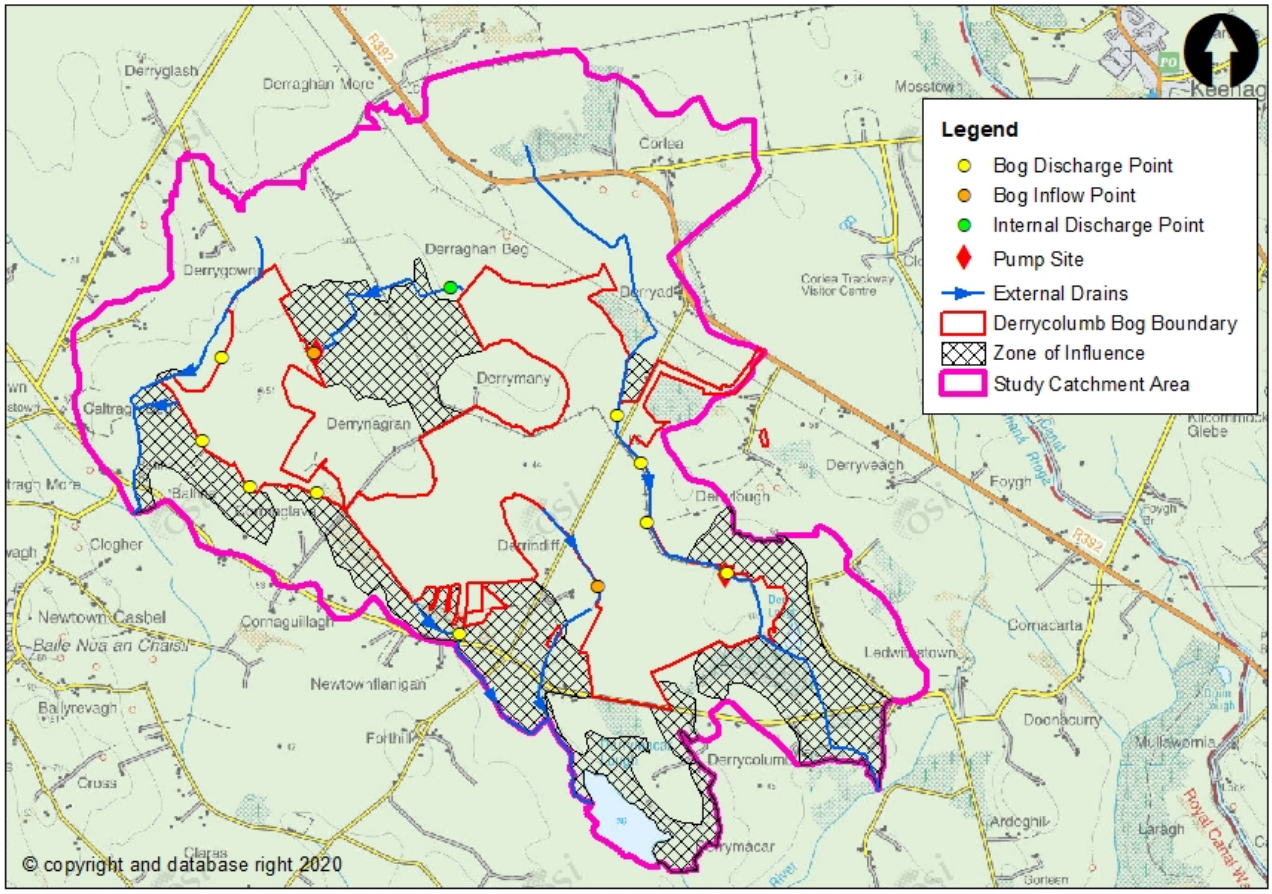

Figure 3.2 Derrycolumb Bog Rehabilitation Plan – Zone of influence

3.2.1 Groundwater Impact

The impact of rehabilitation measures on groundwater levels within and adjacent to the bog is difficult to assess quantitatively in the absence of long term monitoring data and hydro-geological models of the bog. Nevertheless it can be assumed that groundwater 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 groundwater will reach is the surface of the peat fields post-rehabilitation, or where there are hollows, the surface of the higher peat fields surrounding them. This is because topographical flow paths for surface water out of the bog will be retained.

Groundwater rise in lands adjacent to the Derrycolumb Bog was assessed firstly by estimating the potential rise in groundwater within the bog. The peat field drainage system in the bog is typically between 0.5m and 1.5m deep. It can be expected that groundwater would rise by up to 1.5m to bring it to the surface. As the

groundwater rises in the bog to ground surface level a head water difference will be created between the bog and adjacent land forming a hydraulic gradient (see Figure 3.3). Groundwater will flow across the hydraulic gradient. This flow will be dependent on the porosity of the ground it flows through and the head difference. This will determine the extent of the zone of influence and the area of potentially wetter ground. Where external drains are located in the zone of influence they will act as a hydraulic break or groundwater cut-off and reduce the zone of influence (see Figure 3.3c). This however is dependent on the drain's ability to convey water away. Drains that are inefficient with high water levels (independent from the bog rehabilitation measures) will also raise the groundwater and the adjacent lands to the bog would be wet (see Figure 3.3d). The avoidance of the drain full condition is dependent on maintenance of a positive gravity drainage function of the boundary drains through monitoring and reactive maintenance where necessary.

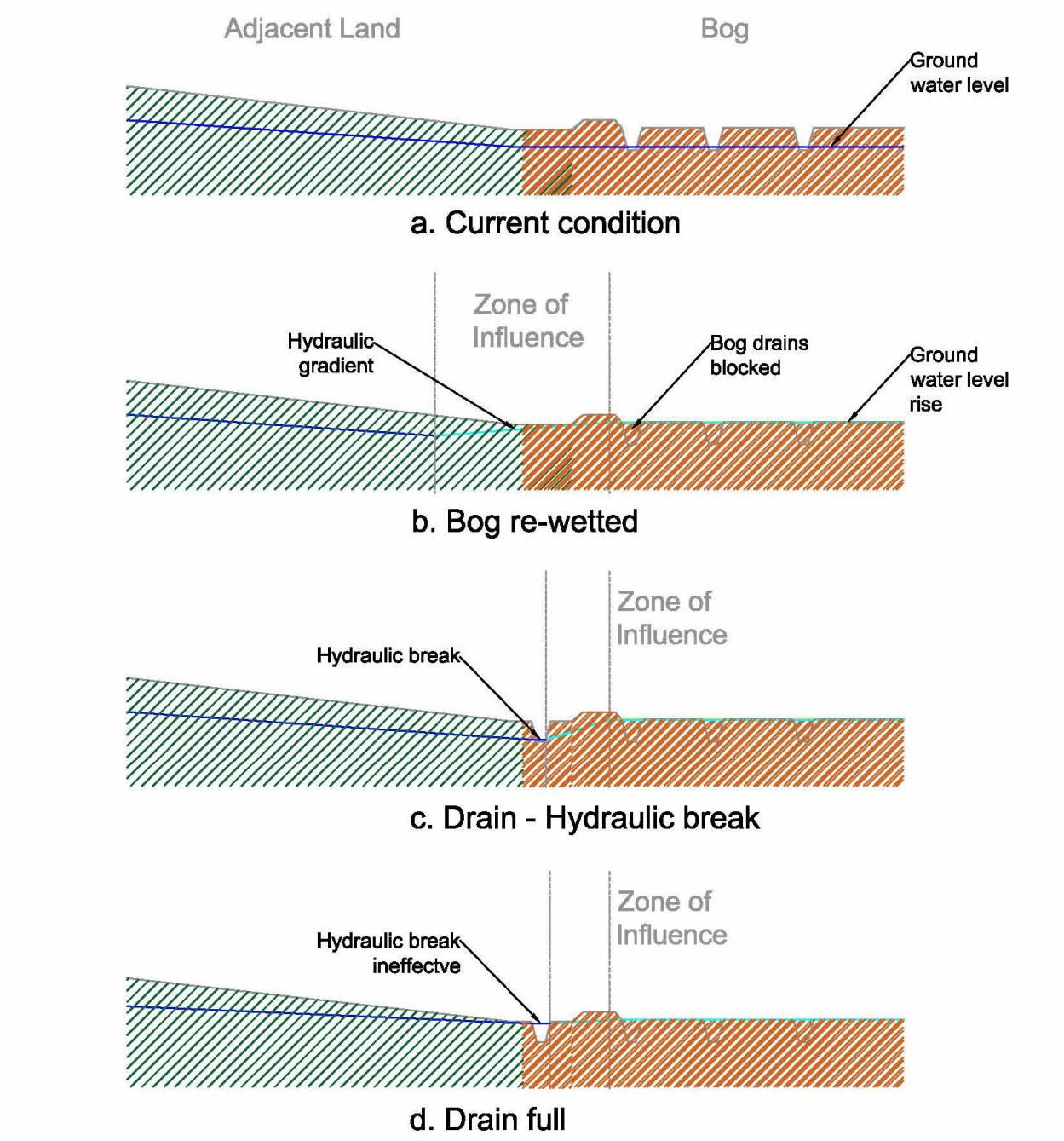

Figure 3.3 Conditions affecting groundwater

A complete survey of the boundary and external drains which provide the groundwater cut-off function to agricultural lands was not available for Derrycolumb Bog. 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 Derrycolumb 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.

There is also a risk that as the bog fills with water and wants to discharge, 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. The south east boundary of the bog discharges into the Bilberry River. The south west boundary discharges into Derrymacar Lough. As such there is little risk to adjacent lands should there be increased flows from the bog owing to elevated groundwater levels. However as previously set out this is based on the ability of the existing boundary drainage network, separating the bog from adjacent lands at a lower level, to provide a positive gravity drainage function in relation to groundwater entering the drain. In other words capacity to convey Q_{med} or 2 year return period flows and free flow (constantly falling) away from the bog.

3.2.2 Insufficient Drainage

It is a significant concern for adjacent landowners that restoration and rehabilitation measures could lead to localised impacts in terms of reduced drainage leading to flooding of agricultural lands upstream of the bog.

There are two inflow locations to Derrycolumb Bog (Figure 3.2) which connect to a drain which flows through the bog. Should these drains' function and capacity deteriorate, low lying parts of the upstream land may reduce in drainage efficiency. This low lying land was identified and included in the zone of influence (see Figure 3.2).

An assessment of the external drains was carried out in chapter 2. Various features were identified that may reduce the drains flow capacity. Culverts, bends, deposition and flooding backwater were identified as potential features that could reduce flow capacity. Careful consideration must be given to the bog inflow point which is located at a pumping station from the adjacent land. The drain which serves the lands in question flows west through the north of Derrycolumb bog and is currently a mix of open drain with culverted sections. The continued drainage of the lands identified is dependent on the continued performance of this drain and pump system and as such its ability to freely drain must be retained.

3.2.3 Increased Runoff

Evidence from bogs that have previously been the subject of restoration works demonstrates that the measures proposed at Derrycolumb, 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 bogs as well as SAC sites such as Clara Bog (East), 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 following rehabilitation measures. Monitoring found that this occurred as runoff from the moorland was reduced due to increased storage in the peat.

The risk of increased runoff from Derrycolumb Bog is low. All rehabilitation measures being proposed will reduce runoff. However there is 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 Derrycolumb as the re-profiling of the bog will generally result in the same topographical flow paths, catchment watersheds and discharge locations as in the pre-rehabilitation state. However in the absence of a full pre and post rehabilitation runoff model and in line with a precautionary approach it is prudent that all drainage infrastructure from the bog is fit for purpose and retained such that at a minimum capacity to convey high frequency flood events (Q_{med} or 2 year return period) is provided.

3.3 Potential Risk Areas

The assets have been identified as being at potential risk from bog rehabilitation are shown in Figure 3.4.

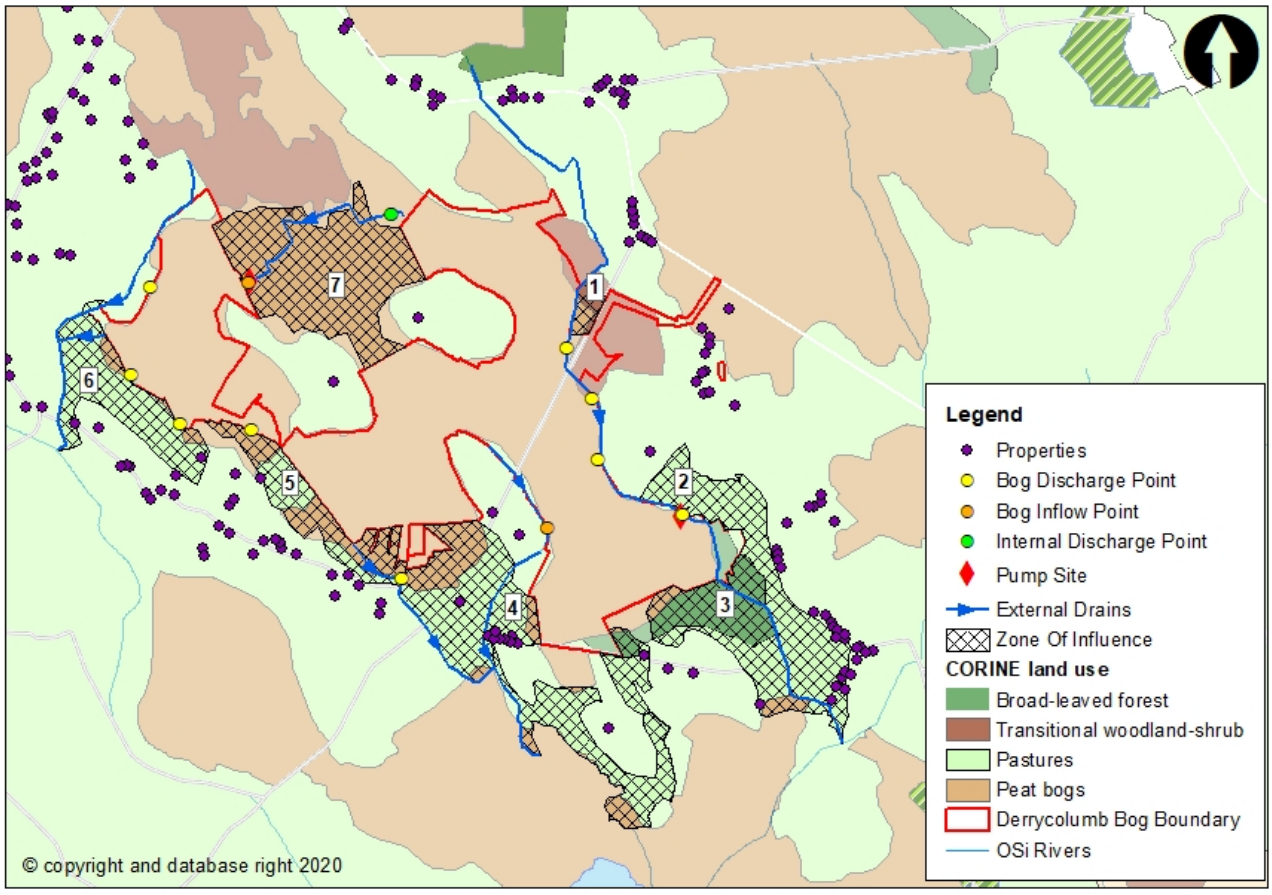

Figure 3.4 Derrycolumb Bog Rehabilitation Plan – Assets at risk

The assets at risk are set out in Table 3.3 along with the vulnerability, based on the current landuse, of the asset. It should be noted that appraisal of the assets at risk is considering 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
1	Transitional woodland and peat bog	Low vulnerability. Land is mainly woodland and bog which could tolerate wetter conditions
2	Derry Lough pNHA and agricultural land	Low vulnerability. Largely made up of poorly drained land, includes wet grassland, fen, fen woodland and open water habitats.
3	Commercial forest and agricultural land	Moderate Vulnerability. Commercial trees adjacent to bog require good drainage. Should the ground become wetter the growth rate of the trees may be reduced. Forest acts as buffer between Derrycolumb bog and

		agricultural land dampening any potential ground water rise.
4	Peat bog and agricultural land	Moderate Vulnerability. Land adjacent to bog is peat bog which can tolerate wetter conditions. Bog acts as buffer between Edera bog and agricultural land dampening any potential ground water rise.
5	Peat bog and agricultural land	Moderate Vulnerability. Land adjacent to bog is peat bog which can tolerate wetter conditions. Bog acts as buffer between Edera bog and agricultural land dampening any potential ground water rise.
6	Agricultural Land	High Vulnerability. Land would become less productive should it be made wetter.
7	Peat Bog	Low Vulnerability. BnM bog due for rehabilitation. Wetter conditions will not impact land.
8	Roads	Low vulnerability. Road level slightly higher than surrounding land. Risk of flooding is low.
9	Properties	Moderate – High Vulnerability. Although the impact of wet ground conditions or flooding to properties would be considered high, the location of these properties is mostly away from the bog at the limit of the zone of influence or the level of the property is at a higher elevation than the surrounding land. Properties at low elevations are considered high risk. A number of the properties are agricultural sheds which would be more resilient to any potential flood risk.

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 Derrycolumb 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 groundwater impacts between adjacent land and Derrycolumb Bog during and after rehabilitation measures.
2. To retain the current drainage capacity of the agricultural land flowing into Derrycolumb Bog both during and after the rehabilitation measures.
3. To maintain or reduce flows released from the bog at the discharge locations.
4. To reduce sediment entering the adjacent watercourses during and after rehabilitation measures to ensure compliance with current discharge limits in IPC Licence.

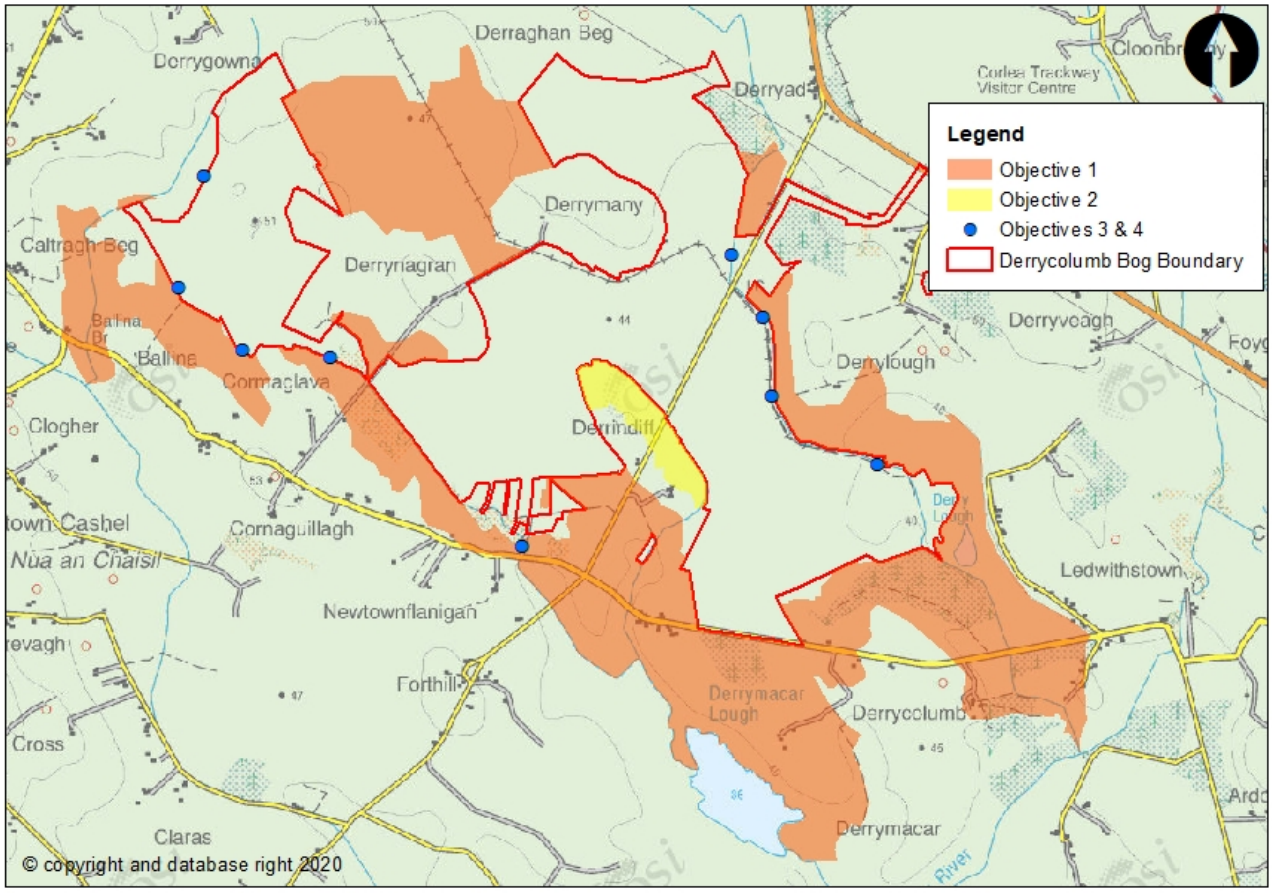

Figure 4.1 Derrycolumb Bog DMP objectives

[2] SMART – Specific, Measureable, 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 groundwater rise. Objective 2 considers the existing drainage network flowing into and through the bog. Objectives 3 and 4 consider the control mechanisms to flow discharging from the bog.

An assessment was carried out to identify the key drainage features required to meet the objectives set. Figure 5.1 presents these features. It can be seen in the figure that for groundwater level rise to be managed between the bog and adjacent land that hydraulic breaks will be required. To ensure that the land draining into the bog is not impacted the drainage path through the bog will need to be retained. And to ensure that the flow and sediment discharging from the bog is managed the discharge control points will need to be retained or upgraded.

Although 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 ensure that the bog will not contribute to an increased risk of sediment deposition arising from rehabilitation. Should this occur drainage from the bog could be impeded and adjacent land could become wetter.

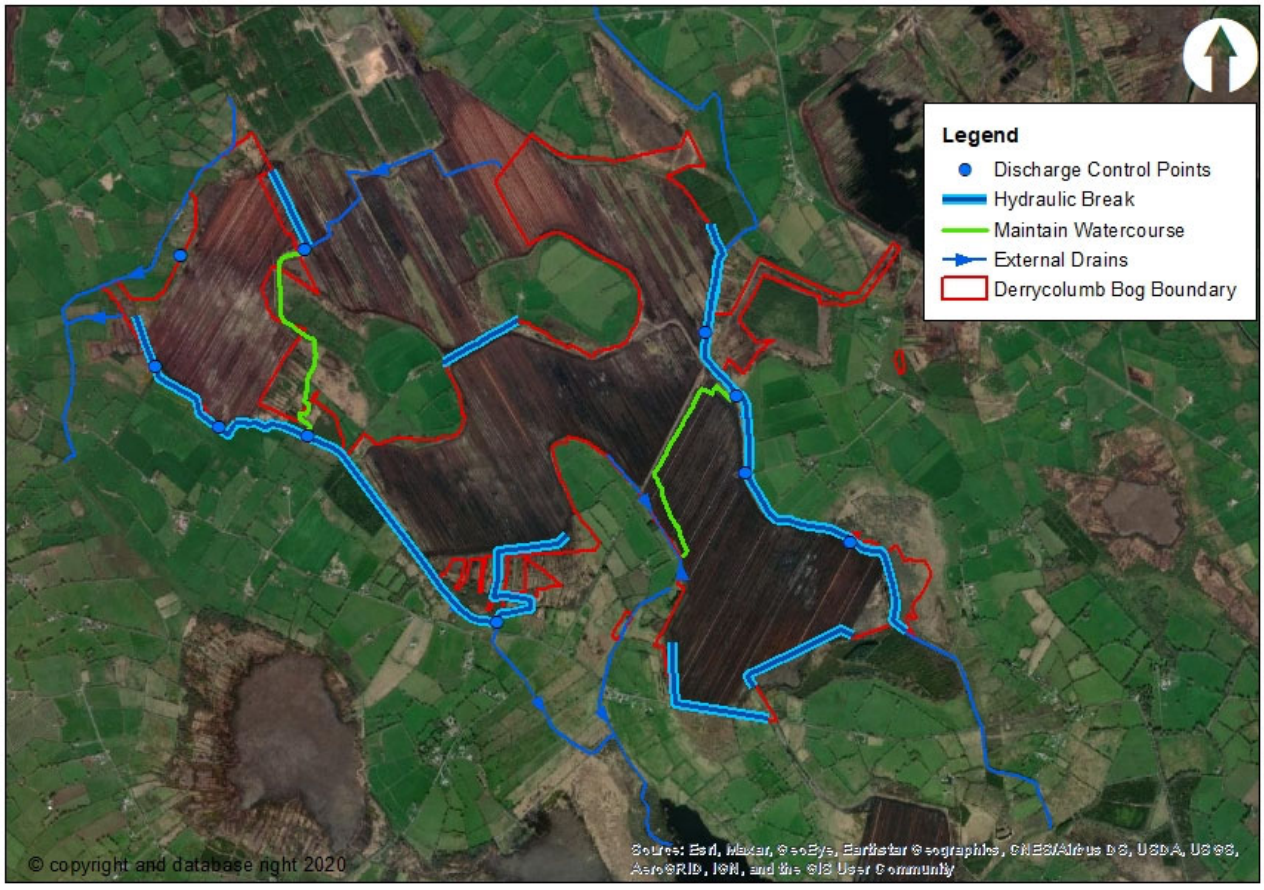

Figure 5.1 Key drainage features for Derrycolumb Bog

When identifying measures to provide the key drainage features a review was carried out of the drains. The review found that there is limited data available for boundary drains to the bog and external drains within the adjacent land. While data is available for internal drains this was found to be limited also. It was therefore required to produce a Drainage Management Plan that could offer a suite of measures whereby the most appropriate measures can be selected based on level of certainty and on-site observations. The DMP would therefore allow the bog to be managed and adapted as the rehabilitation plan progresses and is maintained in the future. The following sections describe the suite of measures that can feasibly be implemented for the Derrycolumb Bog Drainage Management Plan.

5.1.1 Boundary Drains

Boundary drains can provide hydraulic breaks between the bog and adjacent land, see Figure 3.3. In most areas of the Derrycolumb Bog there are existing boundary drains. Available information indicates that these drains are suitable to provide hydraulic breaks and can be designated as such and retained in the future. The observed functional suitability of each drain is recommended and a record kept. Where they are not suitable it may be possible to upgrade the drains. 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. Where there is no boundary drain present a new drain can be excavated in order to create the hydraulic break required. In these cases a channel of specified dimensions and slope will be required.

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, closest to the adjacent land where an existing field drain could act to provide the hydraulic break function. The field's drainage network would be retained keeping the groundwater to current conditions and providing a groundwater cut-off in relation to the adjacent land.

5.1.3 Retention of Internal Drains

Drains within the bog that include adjacent land within their sub catchment may need to be designated as key drainage features and retained to ensure that the drainage to the adjacent land does not deteriorate. This applies to two drains in Derrycolumb Bog one of which relies on pumping to aid the inflow from the adjacent lands. The retention of the pump and associated infrastructure would be required as part of the retention of the internal drain. Similar to boundary drains, where the internal drain is not suitable it may be possible to upgrade reaches of the drain and remove constrictions. This could include the removal of pipes from the drain network and formation of an open channel instead, potentially cutting down on the future maintenance costs associated with elements of pipe network. In the case of drains with pump systems it may be more beneficial to remove the pump and a new drainage channel cut, where falls can be achieved (relying on gravity to function).

5.1.4 Silt Ponds

Existing silt ponds are located at the majority bog discharge points. They help regulate the flow and level of suspended peat leaving the bog into the external drains and rivers. Bord na Móna have legal responsibility to maintain these silt ponds and ensure their proper functioning capacity under the existing IPC Licence (Ref.P05020). One discharge control point was identified with no silt pond to regulate the flow and suspended peat leaving the bog, however in this instance the discharge represents a very small flow and the drain runs across cutaway with reduced potential for downstream sedimentation. Where this situation occurs the drainage network can be modified to reroute the discharge through an existing silt pond. Where this is not possible ~~a~~ new silt ponds would be required.

5.1.5 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. Otherwise monitoring should continue until environmental stabilisation.

5.2 Drainage Assessment

A review was carried out of the existing drainage networks falling within the key drainage features as shown in Figure 5.1. These drainage networks were reviewed to the confluence with streams in order to identify potential downstream control features.

The estimated flood flows were compared with the hydraulic capacity of each of the control structures / features which are important to the effective performance of the drainage network.

Two methods have been considered for the derivation of the Index Flood flow (Q_{med}) as set out in Section 2.2. There is a high degree of uncertainty in the estimation of flood flows at the small catchment scale and therefore the largest of the two estimates has been chosen for each sub-catchment in line with a precautionary approach to uncertainty. Flood flows for Q_{med} (50% AEP) and Q_{100} (1% AEP) peak flows for each sub-catchment have been calculated. A generalised growth curve for peat catchments in the midlands has been used, whereby a growth factor of 2.3 has been used to scale up the Q_{med} peak flow to determine the Q_{100} event (100 year return period flood event).

The best projections on the effect of climate change have been applied to determine the Mid-Range Future Scenario (MRFS). This represents a 20% uplift over the present day flood flows.

Table 5.1 Peak Flows in Each Sub-Catchment

Sub Catchment	Q_{med} / 50% AEP	Q_{100} / 1% AEP	Q100 / 1% AEP MRFS
1	0.136	0.313	0.376
2	0.102	0.234	0.281
3	0.063	0.144	0.173
4	1.075	2.471	2.966
5	0.284	0.653	0.784
6	0.313	0.720	0.864
7	0.102	0.234	0.281
8	0.241	0.555	0.666
9	0.519	1.193	1.432

5.2.1 Assessment Points

Assessment Points have been assigned at key / critical points within the drainage network identified in Figure 5.1 as providing a key drainage management function. The location of the Assessment Points is provided in Figure 5.2.

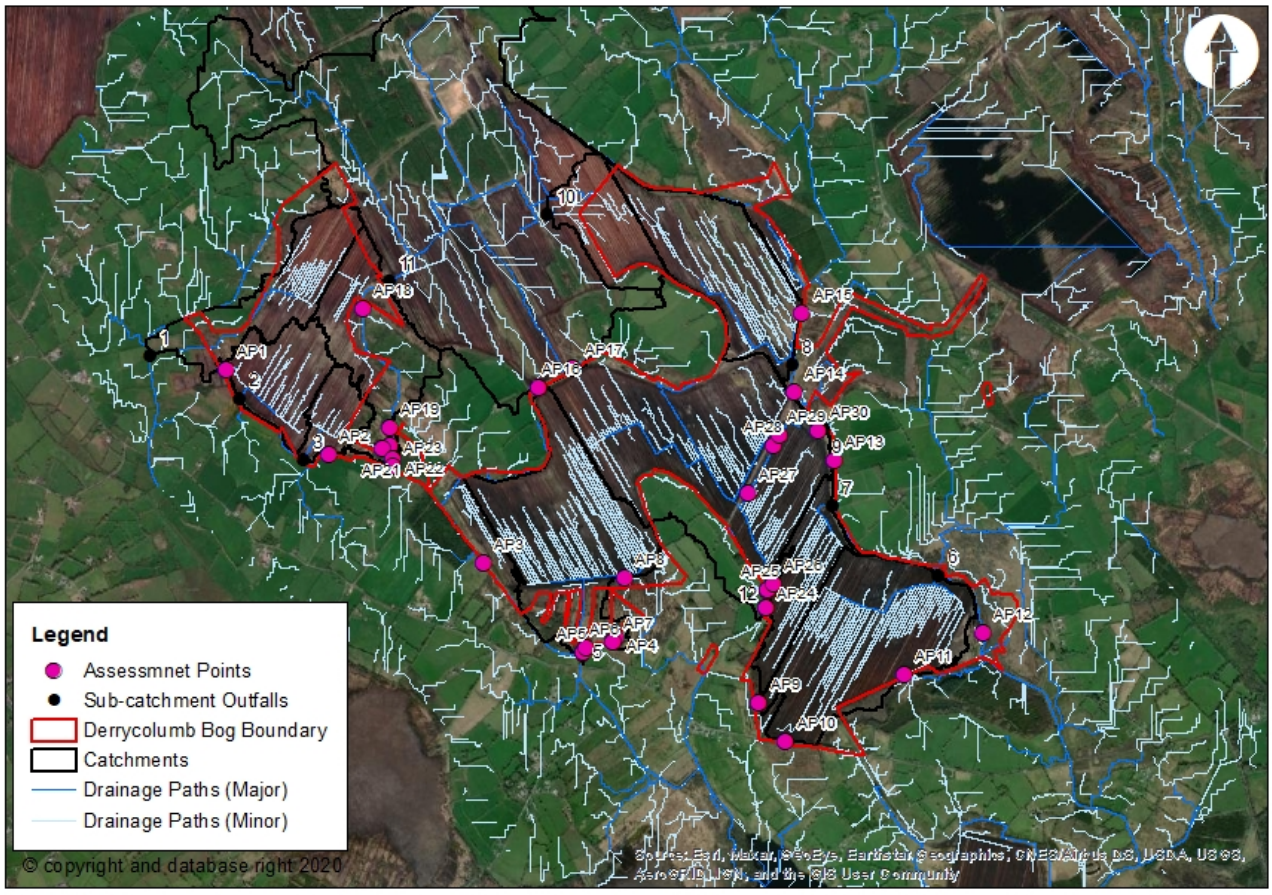

Figure 5.2 Assessment Points at Derrycolumb Bog

5.2.2 Hydraulic Analysis

The peak flows at each Assessment Point (AP) have been compared to the estimated hydraulic capacity of each of the features. A summary of the flood flows that may be generated at each AP along with their likely capacity to convey these flows is summarised below in Table 5.2. Note that capacity issues at an AP may have knock on impacts in terms of flooding for the AP upstream due to backwatering effects which is not considered in this assessment.

Table 5.2 AP Capacity

Assess. Point	Sub-Catch.	Feature Type	Flood Flow Range (m^3/s)	Capacity & Recommendations
AP1	1	Boundary Drain	0.136 - 0.376	Likely capacity to convey all flood flows.
AP2	2	Boundary Drain	0.373 - 1.030	Likely capacity to convey QMED flood flows but very flat potentially flooding in more extreme events.
AP3	4	Boundary Drain	1.657 - 4.572	Likely capacity to convey QMED flood flows but potential flooding in more extreme events.
AP4	5	Internal Drain	0.284 - 0.784	Likely capacity to convey all flood flows.
AP5	5	Internal Drain	0.281 - 0.776	Likely capacity to convey all flood flows.
AP6	5	Pipe	0.276 - 0.763	Likely capacity to convey QMED flood flows but constriction to more extreme events.
AP7	5	Pipe	0.276 - 0.763	Likely capacity to convey QMED flood flows but constriction to more extreme events.
AP8	5	Boundary Drain	0.086 - 0.237	Likely capacity to convey all flood flows.
AP9	7	Boundary Drain	0.029 - 0.079	Likely capacity to convey all flood flows.
AP10	6	Boundary Drain	0.016 - 0.043	Likely capacity to convey all flood flows.
AP11	6	Boundary Drain	0.019 - 0.052	Likely capacity to convey all flood flows.
AP12	6	Boundary / Internal Drain serving large upstream catchment area.	3.834 - 10.583	Likely to flood due to very flat gradient / obstructions in channel. This is an existing wetland area – no recommendations necessary.
AP13	8	Boundary Drain	2.261 - 6.240	Likely capacity to convey all flood flows.
AP14	8	Pipe	2.169 - 5.987	Likely constriction to flood flows.
AP15	8	Boundary Drain	1.831 - 5.053	Likely capacity to convey QMED flood flows but potential flooding in more extreme events.
AP16	4	Boundary Drain	0.074 - 0.206	Likely capacity to convey QMED flood flows but potential flooding in more extreme events.
AP17	4	Boundary Drain	0.071 - 0.195	Open drains have capacity to convey all flood flows. **Check connectivity between open sections and ensure positive drainage function.**
AP18	4	Boundary / Internal Drain	0.947 - 2.614	Likely capacity to convey all flood flows.
AP19	4	Pipe	1.062 - 2.930	Likely constriction to flood flows.
AP20	4	Pipe	1.065 - 2.940	Likely constriction to flood flows.
AP21	4	Pipe	1.072 - 2.958	Likely constriction to flood flows leading to flooding around silt ponds but limited to Bord na Móna lands. Replacement with open
AP22	4	Pipe	1.075 - 2.966	

Assess. Point	Sub-Catch.	Feature Type	Flood Flow Range (m^3/s)	Capacity & Recommendations
				channel may reduce maintenance requirements.
AP23	4	Pipe	1.075 - 2.966	Likely constriction to flood flows.
AP24	9	Boundary Drain	0.013 - 0.035	Likely capacity to convey all flood flows.
AP25	9	Pipe	0.019 - 0.052	Likely capacity to convey all flood flows.
AP26	9	Pipe	0.032 - 0.089	Likely capacity to convey all flood flows.
AP27	9	Pipe	0.514 - 1.418	Check pipe capacity when conditions allow. Potential impacts restricted to BnM lands. Replacement with open channel may reduce maintenance requirements.
AP28	9	Pipe	0.517 - 1.428	
AP29	9	Pipe	0.518 - 1.431	
AP30	9	Pipe	0.519 - 1.432	

5.3 Identification of Measures

The review of drain capacities found that most open drains are likely to have sufficient capacity to convey flow away from the bog. They would therefore be suitable to act as hydraulic breaks provided they are retained with their current estimated carrying capacity. The Bilberry River at DMP measures 5 & 6 was found to have a very flat gradient and potentially require clearance of obstructions. However the land adjacent to this reach of the Bilberry River is largely poorly drained land (including fen and open water habitat). The reduced function of the Bilberry River as a hydraulic break at this location will not significantly impact this land and remedial works to increase the capacity of the channel here could have negative impacts to the hydrological condition of the fen / wet grassland / open water habitat which could outweigh the benefits of providing a more effective hydraulic break.

The pipes along the drain at APs 21 & 22 and at APs 27-30 were found to be likely constrictions to flood flows. The impact, however, would be contained within the bog, not in adjacent lands and as such drainage management is not dependent on their functionality; if they were to become fully blocked overland flow routes and ponding would be restricted to Bord na Móna lands.

Section 2.6 indicates how all boundary drains appear to be functioning sufficiently with no known drainage issues identified along the drain or in adjacent land. Although there is no survey data for some reaches the anecdotal evidence suggests that all boundary drains are functional and can be used as drainage management measures. They would therefore be suitable to act as hydraulic breaks, subject to walkover survey to identify any potential blockages/obstructions, provided they are maintained with their current estimated carrying capacity. Table 5.3 and Figure 5.3 details the level of intervention required along each reach of drainage network.

Figure 5.3 DMP measures for Derrycolumb Bog

DMP measure 12 refers to an inflow point which relies on a pumping regime to drain the adjacent BnM bog. This pump could be reduced or turned off provided upgrades to the drainage network occur to allow the free drainage of the adjacent bog. The adjacent bog is lower than Derrycolumb bog. There would therefore be ponding and a wetland area would form as a result of turning off the pump. As this is fully within BnM land this impact would be deemed acceptable. The wetland water levels would be required to be regulated. Should water be allowed to rise the drainage network within the adjacent bog could back up to the ash pits located to the north. The ash pits would be vulnerable to wetter conditions. It is therefore important to ensure water is not allowed to rise to a level where the ash pits are impacted. This level was determined by the invert level of the discharge pipe from the ash pits site (44mOD). By providing a 500mm freeboard a maximum permissible water level should be set at 43.5mOD. Without the pump operating the water levels will rise to 42.97mOD before it can drain via a pipe through higher ground to the open drain in Derrycolumb Bog. The free drainage of the adjacent bog should be retained.

The majority of DMP measures are retentions of existing drains to provide a drainage or hydraulic break function. Existing silt ponds were identified for continued maintenance. The creation of a new internal drain was identified as a flow control measure to ensure runoff from the bog flows through a silt pond before discharging to external drains.

Table 5.3 Selection of DMP measures

Measures Item	Feature	Function required	Suite of measures Level of intervention				
			Low				High
1	Internal drain	Flow/silt control	Monitor	Retain drain	Upgrade drain	-	**Create new drain**
2	Boundary drain	Hydraulic break	Monitor	**Retain drain**	Upgrade drain	-	Create new drain
3	Boundary drain, internal drain, pipes and silt ponds	Hydraulic break	Monitor	**Retain drain network**	Upgrade drain network	-	Create new drain network
4	Boundary drain	Hydraulic break	Monitor	**Retain drain**	Upgrade drain	-	Create new drain
5	Bilberry River	Hydraulic break	Monitor	**Retain drain**	Upgrade drain	-	-
6	Bilberry River	Hydraulic break	Monitor	**Retain river**	Upgrade river	-	-
7	Internal drain	Drainage of adjacent land	Monitor	**Retain drain**	Upgrade drain	-	Create new drain
8	Boundary drain, internal drain	Hydraulic break	Monitor	**Retain drain**	Upgrade drain	-	Create new drain
9	Boundary drain	Hydraulic break	Monitor	**Retain drain**	Upgrade drain	Retain outside bog field	Create new drain
10	Internal drain	Drainage of adjacent land	Monitor	**Retain drain**	Upgrade drain	Retain outside bog field	Create new drain
11	Silt ponds	Flow/silt control	Monitor	**Maintain pond**	Upgrade pond	-	-
12	Pump	Drainage of adjacent land	**-**	Maintain current pumping regime	**Upgrade drain**	-	-

5.4 Interaction with Monitoring Plan

As part of the bog rehabilitation plan groundwater level monitors will be installed at Derrycolumb Bog. These monitors will record groundwater levels over the coming months. It will therefore be possible to ascertain if groundwater 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 groundwater levels are known to be rising within the bog, monitoring of the adjacent land (as described in Section 5.1.5) should take place on a more regular basis to ascertain if impacts to lands outside the bog are observed.

5.5 Residual Risk and Limitations

The level of flood risk to the bog and the surrounding lands has been shown to be low (Section 2.6). The impact of the proposed rehabilitation measures will generally be to reduce runoff from the bog but this will lead to increased groundwater levels and surface water flooding in the bog itself. There are unknowns in relation to the post-rehabilitation water levels which will be realised, however 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 outside. 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 however a suite of measures in any given location has been provided. This will allow a reactive approach to be taken if required. Should a measure not be operating efficiently a higher intervention measure can be implemented. This will allow Bord na Móna to identify the most appropriate measure while proceeding with drainage function uncertainties.

5.6 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 Derrycolumb 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 BRP measures in mitigating these climate change impacts.

6 SUMMARY OF DRAINAGE MANAGEMENT PLAN

The Drainage Management Plan for Derrycolumb consists of a series of measures to be implemented at different stages of the rehabilitation measures. Drains within the bog and along its boundary were identified as being key drainage paths or 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 5.3 and deemed appropriate 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, upgrading features, updating the rehabilitation plan and creating new 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 Móna and will continue at all existing silt ponds. Maintenance of one pump which aids the drainage of adjacent land is proposed. Monitoring of adjacent land was included in the plan. The monitoring will observe adjacent agricultural land, bog and woodland for adverse impacts from the bog rehabilitation. Should these impacts be confirmed, higher intervention measures can 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 internal and boundary drains (see section 5.1.1)	-	-
Cerate new internal drain (see section 5.1.1)	-	-
Monitoring external drains	IF REQUIRED – Consideration of need for higher intervention measures	-
Maintenance of silt ponds (see section 5.1.4)	Maintenance of silt ponds (see section 5.1.4)	Maintenance of silt ponds (see section 5.1.4)
Maintenance of pump (see section 5.1.3)	Maintenance of pump (see section 5.1.3)	Maintenance of pump (see section 5.1.3)
Monitoring of adjacent land (see section 5.1.5)	Monitoring of adjacent land (see section 5.1.5)	Monitoring of adjacent land (see section 5.1.5)

-	-	IF REQUIRED – boundary drain upgrades (see section 5.1.1)
-	-	Retention of key drains and pipes