Meamram

bord na móna

Don... Manager: Coolnagun	Ón... Chief Engineer (Civil Division)		
do tag.	ár dtag.	ábar	dáta
	HCF/CO'K	Pumped Drainage	03.01.1984

Luaitear an uimhir tagarta

Heretofore, pumped drainage has been confined almost entirely to Sod Peat Bogs. However, in the coming years, pumping will be necessary on an ever increasing proportion of our Milled Peat Acreage. Consequently, it is important that works personnel be fully aware of, and participate in developments in this field.

/ I attach herewith a study of pumping compiled by Mr. O'Beirne, Civil Works, Head Office, and look forward to any comments or suggestions you may have to offer on the subject.

H. C. Flood

Chief Engineer (Civil Division)

Encls.

B O R D   N A   M O N A

CIVIL ENGINEERING DIVISION

Drainage Study with particular reference to Pumping

No. 1

D. O'Beirne,
Civil Works Section,
Head Office.

December 1983.

Drainage Study

The following study is a summary of the approach adopted to considering the problem of bog drainage, particularly where pumping is involved. It does not deal with everything considered in relation to drainage, but is, rather, an indication of the thinking, assumptions, conclusions and methods adopted to drainage design.

The ideas and assumptions are generally based on methods and values already in use. Information was obtained from reports (e.g. P.V. McGill's report), memos, catalogues etc. or from those dealing with drainage related aspects. The methods, values and assumptions used are by no means binding and can be changed if they are invalidated in the future. It is hoped that readers will correct any misconceptions they become aware of and endorse any assumptions if they know them to be valid.

A detailed look at Clooniff Bog in the Athlone Bogs (Blackwater Works) is included as an appendix. This is by way of giving an example of the type of method involved.

C O N T E N T S

A NOTE ON BOG DRAINAGE

There are many complex aspects which have to be considered when dealing with bog drainage design. Although many bogs are similar in production terms it is not ideal to consider drainage aspects under the same categories. It is more appropriate to label bogs for drainage according to their major outfall system. There are two main types; those which drain directly into a major river and those which drain into a minor river/stream which flows into a major, but at a much lower level than the bog.

The former type of bog presents most problems. Flooding, pumping, drain patterns and embankments are major considerations usually, since the water level is at some time or always above the proposed final bog surface level. Examples of this type of bog are those which bank the Shannon or Suck (Blackwater - Garryduff, Clooniff, Cornaveagh, etc; Derryfadda; Mountdillon, etc.).

The second type of bog can usually be drained by gravity. However this does not mean that no drainage problems arise. Often the length of external outfall needing deepening may be too long and/or go through private land. In this case it is possible that the entire bog may require pumping. Usually, though, local pumping of basins within the bog are more likely to be the case. In some instances pumping may be used where it is not absolutely necessary. This may be to prevent problems associated with excavation of subsoil within the bog (e.g. Bracklin bog in Ballivor Group). Examples of this type of bog are Ballivor; Littleton; Templetuohy; Bellair; Monettia; etc.

The approach adopted to drainage is to consider each stage of drainage (initial, production and final) as seperate conditions; each depending on what has previously been done, with the ultimate drainage system being considered at each stage.

Most bogs have already undergone initial drainage which, in general, follows the bog floor contours in such a way as to minimize internal problems and maximize the available bog. For some bogs good drainage pattern and field layout drawings are available (e.g. Blackwater) whereas for other bogs, particularly newer ones, such drawings are not yet available. These drawings are invaluable in determining the drainage characteristics of the bog area.

Initial drainage patterns are carried through to the production period of the bog. Hence only ditching of existing drains and deepening of cross drains is required. As production progresses a stage may be reached where flooding occurs during the production season. This is the time when either pumping or excavation downstream of bog are needed (unless production is decreased or stopped). It is important to determine when this will occur so proper planning can evolve.

The expected life span of bog production is insignificant when compared with that of the land on which the bog lies. Where this is below flood level two basic alternatives exist. The bog can either be left to flood whereupon it has little or no agricultural use; or measures can be taken to prevent flooding. This would entail major arterial drainage downstream of bog or the construction of embankments. Letting the area flood could be put to practical use, for example, as a means of flood control of major rivers (e.g. Shannon) and this option should not be ruled out. However, it is probably desirable to put the land to some agricultural or other use. To this end, flood prevention will apply long after production has ceased; whether Bord na Mona retains possession of the land or not. It seems right therefore that drainage related design should cater for the case that 'usable' bog has been stripped, leaving a small cover, and the bog is still being drained to an appropriate degree. At this point the bog floor contours almost become the surface contours. The 'appropriate degree' of drainage will depend on what the land is to be used for in the future. This will determine the size of pumps, embankments, excavations of outfalls, etc. This aspect will be considered in more detail in the future so that realistic assumptions can be made.

So the three stages of drainage; initial, production and final; are all inter-related and cannot be realistically (or economically) considered in isolation. Some of the problems encountered are mentioned above (embankments; pumping, excavations; land use; etc.). There are many other related aspects which are not so obvious (e.g. silt control; lowering of water table; gradients for trains; construction methods; short term flood control etc.). All these considerations have to be kept in mind in all aspects of drainage design.

METHOD FOR DRAINAGE DESIGN

Stage 1

a. Look at bog surface and floor contour maps and, if necessary, any relevant cross-sections. Consult survey reports; particularly conclusions on drainage. An initial estimate of size and type of bog can be made and the pre-drainage depth can be determined. From the bottom contours the final level of bog surface can be ascertained.

b. Get details of internal outfalls, outfalls at edges of bogs, external outfalls and the river into which outfalls flow. Determine final drainage pattern using drainage plans/ field layout drawings and locate exact course of each outfall to be used. Find existing invert and water levels of external outfalls and the distance downstream available for excavation.

c. Evaluate maximum flood levels for Summer and Winter, and mean flows in rivers if possible. Get relevant details of catchments of external outfalls.

d. Check validity of surveys and water levels. (Often these are superceeded, e.g. O.P.W. drainage).

From the above we get:

1. Catchment area considered for drainage (not necessarily acquisition area). A planimeter is used to measure this. The boundary lines are got by interpreting bottom contour maps.

2. Find final surface level of bog at each point, after production stops. The worth of producing in isolated pockets (e.g. between two marl hills) should be evaluated roughly. For large pockets or basins a more accurate economic appraisal could be done but initially inspection should suffice.

3. Flood levels for Summer and Winter can be evaluated by assuming backwater condition from known levels downstream of bog or from directly available data. It would be possible to estimate a flood of a given return period for any bog using the 'flood studies' methods which might give a more realistic level but this would involve much data collection.

4. Final internal and external outfall levels can be found. A slope of 1:1500 to 1:2000 (depending on size) for external outfalls and 1:1000 for internal outfalls is assumed to be the minimum acceptable slope achievable. During production the slope of cross-drains will probably vary from, say, 1:500 to 1:2000 but this is more controllable as the depth of bog is reduced.

5. The average depth of bog available can be estimated, i.e. initial depth of bog.

Stage 2:

a. Different approaches are adopted within the Board to determine the expected 'life' of a bog. For good planning, and to avoid unnecessary spending, it is important to estimate how long a bog will last. Ideally this could be done by looking at the moisture content of the undrained peat and evaluating the shrinkage and production levels based on the density of the peat. However this would involve a massive data collection program and would still not be absolute. Hence it is better to estimate the shrinkage due to drainage. The progressive shrinkage must be used to estimate the bog surface level in any particular year. An overall shrinkage of 40% (approx) in depth is assumed (roughly equivalent to a 4% reduction in moisture content). As much of this shrinkage probably occurs due to initial drainage it is correct to assume that the moisture content is reduced relatively more in this period than subsequently in each production year. But since initial drainage only goes down a certain depth, only the upper part of the bog is effectively drained. take a value of 40% shrinkage of the top 50% of the bog due to initial drainage (i.e. 20% overall).

When production commences the annual shrinkage rate decreases as better quality peat is reached. Hence it would not be uncommon for a reduction of up to 7 inches to occur in the first few years decreasing to 3 inches eventually.

A rational method to approach this is as follows:-

20% initial shrinkage (overall depth)
(3 in. + 40%) shrinkage per annum for top 25% of bog after initial shrinkage.
(3 in. + 30%) shrinkage per annum for next 50% of bog after initial shrinkage.
(3 in. + 25%) shrinkage per annum for next 25% of bog after initial shrinkage.

Whilst the above method yields a realistic average reduction each year it must be remembered that shrinkage varies from bog to bog and, indeed, field to field. This averages out at 40% reduction per year over the full life of the bog.

The value of 3 inches production is based on ¼ inch per harvest and 12 harvests per year. This yields a surface level estimate for any future year of production.

b. When the surface level of the bog, as evaluated by above method, corresponds to flood level this gives the number of years of production until pumping or excavation of external outfalls is required.

Stage 3

a. Knowing the area of catchment for each outfall the amount of water to be drained can be estimated. It is general practice to use a pump capacity value of 1.5 cubic ft./min./acre. This could possibly be evaluated more realistically for each bog either by direct measurement of by 'flood studies' methods.

b. The head (of water) difference between required final water level and existing flood level is calculated. From this the depth of excavation and/or pumping head can be evaluated.

c. Particular attention should be given to any external catchments draining through bog or into the same outfalls as the bog drains. An allowance of x cu. ft./min./acre could be made depending on the size and type of catchment. Where large catchments (e.g. major tributaries of rivers) are involved the flow should not have to go through bog. If necessary the flow should be re-routed around bog. Obviously it is not desirable to have this flow through silt ponds so this is often done anyway.

d. If pumps are required then due consideration to the type and position of each pump is needed. In some bogs it may be better to have several smaller pumping installations pumping into one or more external outfalls. In other areas, particularly smaller bogs, it may be desirable to bring all drainage through one larger pump site. This is usually determined by the initial drainage plan though ultimately drains could be re-routed if required. If a pump is required within a bog then the optimum position should be used.

The type and method of pumping is important in that it can determine the operating costs of any pumping installation. The Spaans Screw Pump is widely used but may not be the most ideal in all cases. This type of pump allows, to an extent, for any inflow water level down to the base level of the screw so this is not a major problem. However, this system of pumping relies on a fixed outflow (downstream) level, and consequently a fixed head. Hence unnecessary head (and power use) exists when the full design flood is not the downstream condition. There are ways to overcome this but usually these involve extra capital costs. For example, a second, smaller, screw pump system could be installed for Summer floods; or an axial flow pump and flap valve system could be used. Ideally a pump with a variable upstream and a variable downstream head level would be suitable.

It might be worth investigating in detail various pumping systems and their merits for different types of bog drainage conditions.

e. Whether external catchments flow through bog or not a bypass of any pump site will be required. This is needed for two main reasons. Firstly, there is the danger that one or more pumps at any installation may be out of action and so full capacity drainage is not attainable. Secondly, depending on what size flood is catered for, it is possible that a greater flood will occur.

Each pump site should, if possible, have a bypass to another pump site.

f. Power supply and consumption is a major determinant in estimating costs. The power required should be worked out in kW. The length of supply cables needed should then be estimated and costed. Alternatives such as wind power might be worth considering particularly in remote areas.

Stage 4:

a. Knowing the pumping requirements a more detailed examination of any embankments can be made. General practice is to allow an extra 2 ft. (600 mm) above maximum flood level for flood control embankments. This allows for surges and slight settlement not designed for otherwise. The extent and size of embankment required generally involves complex calculations based on good survey and field data along line of embankment.

b. Other aspects not already dealt with should be considered at this stage. These include silt control, construction problems, peat recovery problems, etc. Some of these will have to be dealt with earlier in the design process and this will depend on the particular bog.

Stage 5:

a. At this stage estimates can be done for any alternatives available. This is not a simple matter as it is based on price speculation of both costs (of pumps, excavations, etc.) and also on the value of peat (embankments etc.). From these estimates return periods can be worked out for any alternatives.

b. If the estimated costs are unrealistic or inappropriately high then the process can be repeated with a different set of parameters. At this stage a different 'design flood level' or design runoff figure could be adopted.

c. Finally part or all of any alternative proposed can be adopted for each bog area.

<u>Note</u>: The above five stage system for drainage design outlines the necessary thinking behind a bog drainage system. For particular areas, particular problems will arise and these may change basic concepts to some degree. However, in order to exercise proper budget control then a basic policy has to be adopted.

METHOD FOR DETERMINING DRAINAGE REQUIREMENTS

1. Choose boundary of area. Determine natural and developed drainage pattern and bog contour details.
From this the required minimum drainage level and available fall, (using 1 ft. for every 1000 ft. <u>in</u> bog and 1 ft. for every 1500 ft. externally), can be evaluated.

2. Look at major external outfall (generally main river) and find water level details. Maximum flood and Summer flood levels are estimated. Mean and minimum Summer levels are also noted if known.

3. The average depth of bog is evaluated using top and bottom contours from original survey.

4. The depth of bog after initial drainage is calculated, i.e. 40% of top half of bog is assumed to shrink.

5. 'Years of Production' is estimated based on an average rate of 3 inches milling and x% shrinkage each year. A floor cover of 2 ft. is assumed.

6. The number of years until pumping is required is calculated for Summer and Winter floods.

7. The area of catchment considered for drainage, for each outfall, is determined.
Allowance is made for any external catchment draining through bog.

8. The volume of water to be drained is estimated for each pump site considered. A value of 1.5 cu. ft./min./acre is used to determine design runoff.

9. The head difference between bog drainage level and outfall level is computed for maximum and 'Summer' floods.

10. The equivalent pump head (Spaans pump head) is determined.

11. Pump size is determined for any pumps required.

12. Power requirements are determined for pumping system.

Notes:

For final drainage a water level 2 ft. below surface level is assumed. As 2 ft. bog floor cover is allowed for then the final drainage level (minimum drainage level) is taken as the bog floor level.

Where a bog hasmore than one outfall each is considered as serving a separate catchment area. Hence each outfall location is a potential pump site if required. Where the outfalls flow into each other at some point downstream, outside the bog, an allowance is made.

Consideration is given to possible pump sites (or pump catchment areas) within bog. This might be to see if the number of years until pumping is required can be increased and hence the most economical arrangement can be determined.

The previously described method can be readily presented in tabular form and this makes comparison of different alternatives easier.
Subsequent cost estimates, bearing in mind practical considerations and feasibility, can becarried out to determine the most suitable pumping arrangement.

In considering pumping requirements particular attention is given to a memo derived from a discussion at Blackwater in August 1980 where the Spaans pump system was dealt with in detail. Some of the main points are listed below.

1. $1\frac{1}{2}$ cu. ft./min./acre discharge is equivalent to 60% of one inch of rainfall falling in 24 hours.

2. Two pumps, a bypass to another pump location and an upstream reservoir (if possible) should be made available at each pump site.

3. Downstream flood level should be increased by 1 ft. to allow for "the future case of a flood (or whatever)".

4. Power requirements, costings and installation problems are mentioned.

5. A detailed method of computing Spaans pump head is given.

APPENDIX A

Note on practical considerations:

While it is important to devise a concise drainage plan for each bog for development and costing purposes it must be remembered that the span of any drainage plan can be up to 50 years for most Irish bogs. During the construction phases many problems will arise. A brief note on some problems envisaged at each construction phase is given below.

Initial: Maximum runoff occurs here, so many drains are required. This leads to high drain maintenance costs. Maximum surface movements occur in this phase so design grades for pipes and channels are difficult to maintain. Silt problems are great at this stage due to a large amount of outfalls.

Production: Drains tend to clog up with peat silt quite easily. Machines for drain maintenance and development are involved in other production situations. Cross drains tend to be laid down quickly and inaccurately so production is not interfered with. Manpower is not available to deal with many drainage problems. Intended design proposals often need to be changed or adapted to cope with remedial drainage problems.

Final: While other parties are involved here the cutaway bog is under Bord na Móna supervision for some time after peat is used up. If agriculture is involved then local drainage schemes may need to be thought up not envisaged in the original drainage plan. Minor gravel hills are a big problem here.

Note: Most of these and other problems can lead to very high interim costs. A chief objective of a drainage plan should be to minimize costs by choosing the most suitable scheme while keeping probable problems in mind.

APPENDIX B

Worked Example for Blackwater Group

Note on 'Athlone Group of Bogs/Blackwater'

Note on example

Drainage Report : Clooniff Bog

- Tables
- Sub-Appendices

Note on 'Athlone Group of Bogs/Blackwater'

(Feb. 1983)

The following report goes into some detail with regard to Clooniff Bog. This bog is one of the collective 'Athlone Group of Bogs' connected to Blackwater Works. This group lies along the West Bank of the Shannon between Shannonbridge and Athlone. The bogs in the group considered are (from South to North):

1. Cornaveagh
2. Clooniff
3. Cloonbeggaun
4. Coolumber
5. Cornafulla
6. Dromlosh
7. Carrickynaghton
(8. Creggan)

Although the report concentrates on just Clooniff, most of the findings and assumptions apply equally to some or all of the other bogs in the group because of their proximity to the Shannon.

The tables of the report relate only to Clooniff but similar tables for Cornaveagh,Coolumber and Cloonbeggaun can readily be produced since all the data is prepared.

This report is more detailed than would normally be the case. It is hoped that a brief description; the tables; a map and a conclusion would normally form the report.

Subsequently, details of embankments; exact pump sites; future land use etc. would have to be added and any changes (in method or data) would have to be included.

From the above one global report on each group of bogs (e.g. Athlone group; Derryfadda - Suck Group; etc.) could be established.

The tables etc. are mainly in imperial units of measurement. This is because contour maps, levels, etc. are also. It would be a simple matter to convert all values to metric if required.

NOTE

The report on Clooniff Bog is based on a drainage plan of 1977 (drawing S697). Since the calculations were done a more recent drainage plan (S988) based on existing outfall layout was sent to Head Office by Blackwater Works. This does not mean that the conclusions in the report are invalid but further work could be done based on the new drainage plan. As production progresses the layout may change and it is possible then an outfall layout as used in the report will become the case. Indeed it is probable that only one external outfall will be used when pumping is needed. No detailed calculations of pumping requirements have yet been carried out at Blackwater Works. A copy of the most recent outfall layout (December 1982) is included as an appendix to the report.

Drainage Report: Clooniff Bog - Athlone Group/Blackwater

February 1983

Clooniff Bog banks the west side of the River Shannon some 4 km north of Shannonbridge. It is not yet in production but should be within the next few seasons. It is proposed that it will, along with the other Athlone Group bogs, supply milled peat for Shannonbridge E.S.B. Power Station.

The bog is divided into two distinct areas by a stream which acts as the only outfall for both bogs and flows into the Shannon. These areas are Clooniff 1 and Clooniff 2. Clooniff 1 being the larger area to the South of the stream (see Appendix **1b**).

Clooniff 1 covers an area of approximately 515 acres with an average depth of 22 ft. (6.7 m). Clooniff 2 covers an area of approximately 250 acres with an average depth of 20 ft. (6.1 m). These depths relate to the original survey before any Bord na Mona drainage had occurred. The contour maps show that the floor of each bog is quite uniform in level with only a relatively small ridge and a depression in Clooniff 1.

A field layout and drainage plan from Blackwater Works as of November 1975 is available (Drawing S697) and, assuming that the cross-drain system is laid as shown, this considers the bottom contours. Hence a suitable final drainage layout exists. As can be seen (Appendix **1b**) the bogs drain into a minor tributory of the Shannon which flows directly into the very nearby Shannon. It seems appropriate to collect all bog drainage to the one outfall point for each bog, as is the case. Water and flood levels used in calculations are taken as those estimated for the Shannon at this point. Before final decisions are made it would be worth contacting the O.P.W. to check if any previous or near-future remedial drainage works have invalidated these figures. When considering long term requirements, it might be more desirable to use proposed water levels for the Shannon. Shannon drainage is so uncertain, though, that using proposed levels might not give realistic results.

From these levels and the bog floor contours it is obvious that much of the bog is below max. flood level and, allowing for gravity drainage fall to Shannon, pumping will be required even when mean Summer flow exists in the Shannon.

There are many possible sites for pumps. The most obvious places are where the internal outfalls join the main external stream outfall. This is also the location of proposed silt ponds. These sites are 4 and 5, 4 being for Clooniff 1. (the site numbers relate to the overall drainage of the Athlone Group, 1, 2 and 3 being in Cornaveagh bog). Possible sites for pumps within bog are considered for Clooniff 1 only. These are 4a, 4b, 4c and 4d (see Appendix **1b**). Clooniff 2 does not lend itself to this consideration because of the field layout.

As each of the main sites, 4 and 5, cater for quite a large area, it is not easy to state which part of the bog is likely, to require pumping first. Hence more than one set of 'minimum fall to pump site' are considered. The worst case will be the one which yields the least number of years until pumping is required.

The size of the external catchment served by the external outfall stream is not known. Hence no consideration has yet been given to gravity draining both bogs to stream and then using one pump installation to pump both bogs and external catchment. If external catchment is small then it might be worth considering this. (Flow measurements of stream upstream of bogs would determine this).

The following is the water level data, based on backwater estimates from Shannonbridge.

Maximum flood level	:	126.0'	O.D.
Mean Summer level	:	119.0'	O.D.
High Summer level (assumed)	:	121.0'	O.D.

An allowance of 1' above these levels is made. As can be seen in Appendix 1a the gravity fall (based on a 1:1500 slope) to the Shannon from just downstream of the main pump sites, is 0.7 ft. (Clooniff 2) and 1.7 ft. (Clooniff 1). If external catchment to stream is included then these heads have to be included - otherwise subtract from values in Appendix 1a. Hence

Max. flood level	:	127.0'	O.D.
Max. Summer level	:	121.0'	O.D.

Table 1 of this report gives required and available levels and the years of production before pumping is required for the various cases.

From this we see that Clooniff 1 needs pumping 11½ years after start of production and Clooniff 2 needs it after only 6½ years. This, of course, is if no flooding ever is to occur on bog. Obviously it is not desirable to totally prevent Winter flooding as this is costly and unnecessary in terms of bog production (ultimately complete drainage, Summer and Winter will probably be required).

Pumping in Summer will be required after 29 years in Clooniff 1 and after 24½ years in Clooniff 2. It might be decided to cater for some flow between max. flood and max. Summer flood (e.g. Average Winter/Spring flow). In this case pumping would be needed after 8 to 20 years depending on what water level was picked. This could readily be determined.

Note: As discussed earlier it would be feasible to put smaller pumps in Clooniff 1 (4a, b, c, d). This would mean that the Embankment (mentioned below) would have to be brought back onto bog and a section of the bog north of 4a, 4b, would be liable to flooding. Each of the 'in bog' pumps would be of much smaller capacity than the single installation at outfall (4). This would also mean that deep drains would not be needed to achieve the maximum 1 : 1000 slope as the length of drains to pumps would be reduced.

Note on Embankments: Obviously an embankment would be needed in the long term if flooding is to be prevented. This could be placed around the edge of the bog; in the bog as mentioned above; or along the bank of the Shannon. The latter case would require different pumping requirements than those computed here.

Having decided where to position the pumps and embankment the next step is to determine the area of catchment for each pump and the head against which the pump has to operate. From this the discharge and consequently pump size and power requirements can be evaluated.

Table 2 gives the computed values for pumping.

The static lift is based on water level using max. flood (from table 1) as downstream head and bog floor level less expected field drain drop as the upstream head. Obviously after production ceases it should be possible to achieve 1 : 1500 fall in surface drains.

The capacity is based on 1.5 cubic feet/min./acre, which is equivalent to 0.042 cubic metres/min./acre.

From Table 2 values, the exact size of pumps required can be evaluated. Depending on the pump type being used the pump head can be calculated and an ex-catalogue pump size to suit the capacity; allowing for two or more pumps at any location, can be picked.
The power requirements can then be estimated.

In the case of Clooniff, embankment systems have not been designed here so the type of pump is not obvious. Spaans' pumps are not necessarily the most appropriate since pumping through the embankment is not easy with this type of pump.

However, for the present, calculations for pump sites 4 and 5 using Spaans screw pumps, are done. Hence a comparison can be made with other areas (e.g. Suck Group) where this type of pump is already in use. Table 3 gives details.

As can be seen 2 no. 11 m^3 x 4.45 m lift pumps would be required for Clooniff 1 and 2 no. 5.5 m^3 x 4.91 m lift pumps for Clooniff 2.

These values are of the same order of other pumps in the Blackwater group.

Installation problems are not dealt with at this stage.

Costings:

At the time of writing of this report adequate information was not available for complete detailed costings. Establishing pumping costs is a major objective and this aspect will be dealt with in great detail subsequently.

Of course such items as embankments; timing of installations; power supply; etc. add substantially to drainage costs and each would demand particular attention to obtain optimum solutions. On this point, it would be worth considering alternatives such as wind power.

Based on the pump sizes in table 3, a rough cost estimate based on Spaan's pump costs can be done. For example a 10 m^3 by 4.3 m lift capacity pump costs approximately £10,300; and a 7 m^3 by 4.1 m capacity pump costs £8,500. One could estimate that the required pumps would cost £8,000 (pump site 5) and £11,000 (pump site 4) each. These prices refer to the pump units only and do not include power supply lines etc.

Conclusion:

This report has tried to give a preliminary judgment of the drainage requirements of Clooniff Bog(s). The amount of and time to commencement of pumping is tabulated for various possible pump sites. Further investigation, particularly with regard to embankments and exact pump location and type, is required. This bog is just one of the Athlone group and it should be considered in this global respect particularly where costings are concerned.

	A	B	C	D	E	F	G	H	I	J	
Area No.	Min. Fall to Pump Ft.	Reqd Final Water Level Ft. OD.	Max. Flood Ft. OD.	Summer Flood Ft. OD.	Avg. Depth of Bog Ft.	Depth after Initial Drainage Ft.	Years of Production	Years to Winter Pumping	Years to Summer Pumping	Catchment Area Acres	
4.	6.5	122	127	121	22	17.6	47	18	36	515	
	6.0	122	127	121	22	17.6	47	19½	38	515	
	4.9	118	127	121	22	17.6	47	11½	29	515	*
4a.	2.4	118	127	121	24	19.2	52	23	41	150	
4a.	0.2	115	127	121	26	20.8	57	25	44	150	
4b.	2.5	118	127	121	23	18.4	50	20	39	140	*
4b.	2 9	120	127	121	22	17.6	47	23	41	140	
4c.	1.8	121	127	121	22	17.6	47	29	NEVER	85	
4d.	1.6	120	127	121	22	17.6	47	14	45½	70	
5.	5.2	120	127	121	20	16	42	11	29	250	
	4.7	118	127	121	20	16	42	6½	24½	250	*

CLOONIFF BOG : PRODUCTION YEARS TO PUMPING

TABLE 1

		K			L	M		N		
AREA No.	REQUIRED WATER LEVEL Ft. OD.	Pump Upstream Water Level Ft. OD.	Max. Flood Ft. OD	Summer Flood Ft. OD	Static Head (Max) Ft.	Static Head (Summer) Ft.	Drainage Catchment Area acres	Pump Capacity required ft³/min	m³/min	REMARKS
4	118	114·7	127	121	12·3	6·3	515	772·5	21·9	
4a	118	115·6	127	121	11·4	5·4	150	225	6·4	
4b.	118	115·5	127	121	11·5	5·5	140	210	5·9	
4c.	120	118·3	127	121	8·7	2·7	85	127·5	3·6	using these and 4 would reduce excavation
4d.	120	118·4	127	121	8·6	2·6	70	105	3·0	
5.	118	113·2	127	121	13·8	7·8	250	375	10·6	

CLOONIFF BOG : PUMP REQUIREMENTS

TABLE 2.

EXPLANATION OF DERIVATION OF PARAMETERS IN TABLES:

a. Min. fall to pump: based on slope of 1:1000. (ft.)

b. Final water level: from bottom contour map.

c. Max. flood: data.

d. Summer flood: data or estimate.

e. Avg. depth of bog: from contour maps and survey report.

f. Depth after initial drainage = e -(e/2 x 0.4).

g. Years of production = (f - 2)feet x (12)inches / (3+x8) inches per year.

h. Years to Winter pumping = (b + f) - a - c) x 12/(3+x)

i. Years to Summer pumping = (b + f) - a - d) x 12/(3+x)

j. Catchment area: data (planimeter). (acres)

k. Pump upstream water level: b-(max. relevant a).

l. Static head (max.) = c - k.

m. Static head (Summer) = d - k.

n. Pump capacity = (1.5 cubic feet/min.) byj.

p. Spaans Head = ℓ or m (in m) + 0.7 (approx.).

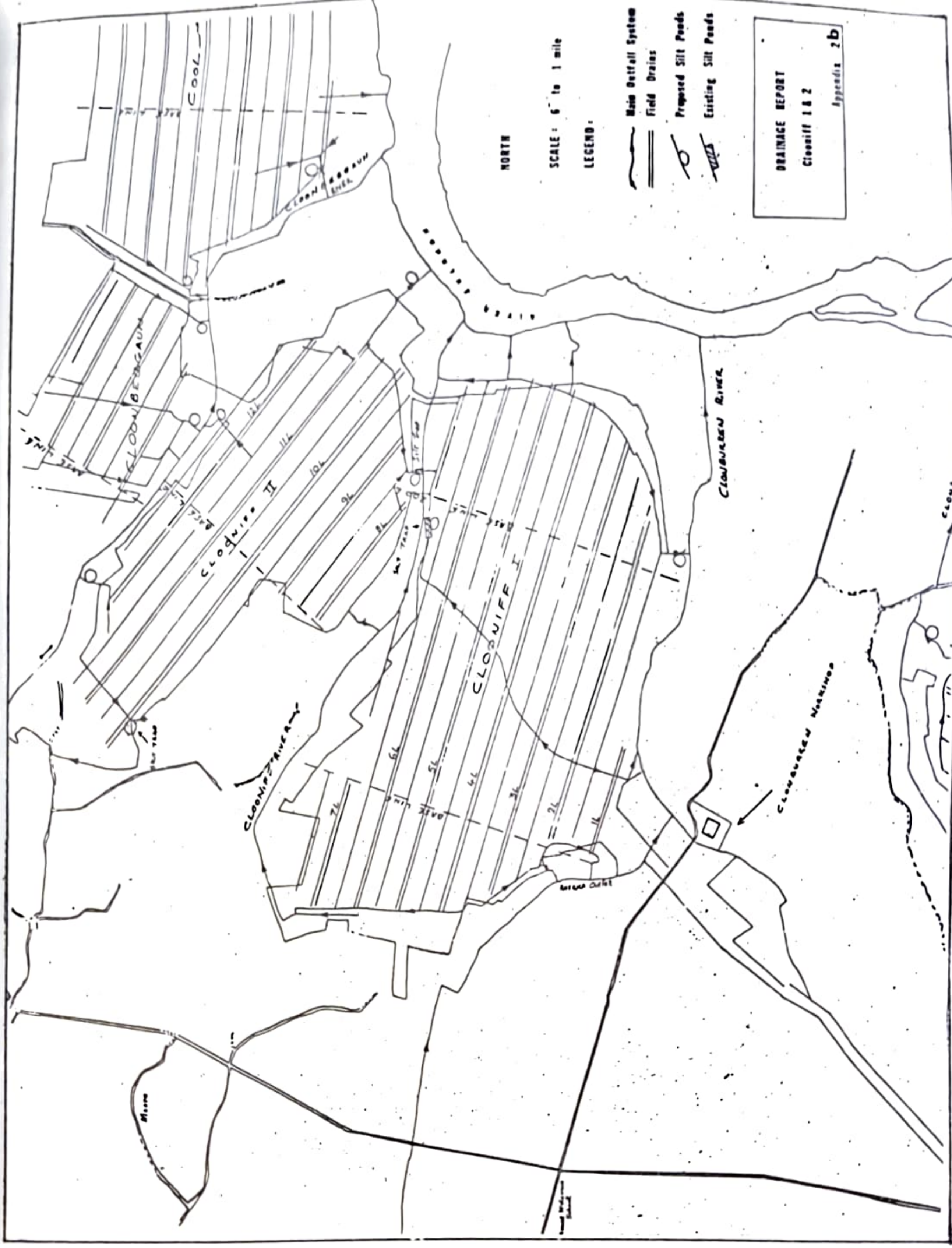
q. Pump size: 2 pumps x half (j) each approx. (2 x m^3/min x lift (m))

r. Horse power of pump = q (one pump) ÷ 2. (hp)

s. kW each pump = 0.746 x r.

t. Total kW = 2 x s.

Scale reduced to 3" to 1 mile



Scale reduced to 3" to 1 mile