RSPB INFORMATION AND ADVICE NOTE

LOWLAND AGRICULTURAL LAND DRAINAGE SYSTEMS

Function and modification for wetland conservation

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INTRODUCTION

The purpose of this Information and Advice note is to give those involved with the conservation of wetlands a basic technical understanding of lowland land drainage systems and their potential impact on wetland management, restoration and creation projects.

Relict water meadow system, Glos.

The drainage of land has been undertaken for many centuries in the UK, and has shaped the land use, agricultural practices, wildlife and landscapes that we see today. A peak of field drainage activity was reached in the latter half of the 19th Century; 12m acres were drained from 1840-1890.

Some drainage schemes were large scale and dramatic, such as the drainage of the Fens in the 17th Century, whilst others are small scale and may only affect an individual field. Many allowed more modern or intensive methods of agricultural production to be undertaken, and the maintenance of these drainage systems is often required to support such production today.

Some systems, such as the water meadows of southern England, have particular cultural, archaeological and landscape significance, and may have important habitats and species associated with them.

Even the more ‘mundane’ schemes may have specific cultural significance, being viewed as a source of pride and technological progress, particularly for those who installed or instigated them.

It is widely recognised however, that historic, widespread drainage of the land has adversely effected a broad range of species and habitats, and continues to do so today in some cases. It is therefore, an important factor to consider at the start of wetland projects.

Modern drainage pipe

This note is in three sections;

Section 1: A basic introduction to lowland agricultural land drainage systems

Section 2: Investigating and identifying the existence of drainage systems

Section 3: Modifying drainage systems for wetland conservation objectives

NB: A free partner I&A note from the RSPB – ‘Moorland grip blocking’ – provides further information for a UK upland situation , and is available by emailing conservation-advice@rspb.org.uk

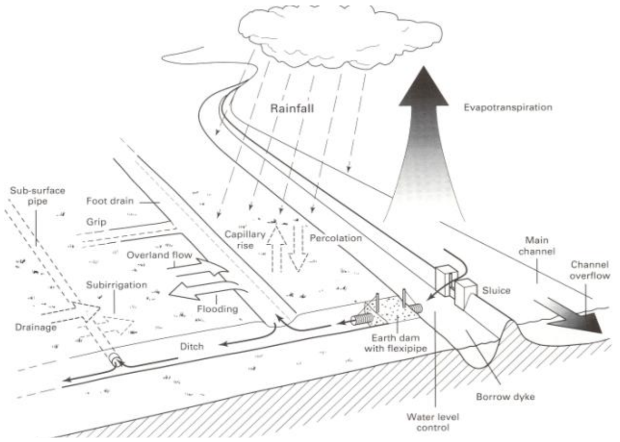
Section 1:

A BASIC INTRODUCTION TO LOWLAND AGRICULTURAL LAND DRAINAGE SYSTEMS

BACKGROUND

In many lowland areas of the UK, some form of agricultural land drainage system may have been installed or upgraded. The purpose of such systems was generally to manage the amount the water entering and leaving a site in a controlled manner. In many cases, this involved lowering water tables and removing ‘excess’ water as quickly as possible from a site. This allowed greater flexibility in the farming practices that could be undertaken, and often meant the land had the potential to be farmed more productively and profitably. Other examples might include the practice of maintaining high ditch water levels to act as ‘wet fences’ for cattle, a traditional and long-standing practice in areas such as the Fens of East Anglia.

An understanding of the potential existence and function of any such drainage system will be important if conservation works are planned to create, restore or manage wetland habitats. Such drainage systems may still be in working operation (even old or derelict systems could still be partially functioning), and could have a substantial effect on the current and future hydrological function of a site. This in turn, can affect the types of wetland habitat that can be supported and managed on a site.



A stylised field drainage system

Measures may need to be taken to utilise, modify, or in some cases remove, the drainage infrastructure to achieve the wetland conservation objectives for a site. This is particularly relevant when considering sub surface drainage systems (see below), which is one of the main topics considered within this note.

Much experience and understanding of modifying land drainage systems for conservation purposes has been gained on wet grassland creation and restoration projects. This note therefore, draws heavily from this experience, whilst hopefully still being applicable to other wetland habitats and situations.

THE BASICS

The following elements of lowland field drainage systems may be commonly encountered today;

- Perimeter open field ditches (visible)
- In field surface grips, drains, rills or other relict shallow drainage features (visible, but not necessarily obvious)
- In field sub surface drainage pipes (not visible)
- Mole drains (not visible)
- Bunds, banks or embankments (visible, but not necessarily obvious)
- Water pumps, water control structures such as sluices, weirs and dams (visible)

Depending on location, function and size, drainage systems may contain a varying combination of the above elements to form an efficient drainage network that may range in size from a few fields to a whole catchment.

Info box 1: Land drainage authorities

Statutory agencies such as the Environment Agency (England and Wales), and/or Internal drainage boards may directly maintain and operate drainage infrastructure, or oversee their operation.

1.PERIMETER FIELD DITCHES

Most fields will have perimeter open ditches surrounding them, that help to draw water away from the field/site, and maintain drier in-field soil conditions. Water enters such ditches via surface flow or by lateral movement through the soil itself. Such lateral water movement may be made more effective by the installation of sub surface drainage systems (see below).

Perimeter field ditch, Yorks.

The effectiveness of such ditches to remove ground water from a field, and lower water tables, will be strongly influenced by soil type and condition. If the soil is fairly permeable and free draining, (a soil with significant sand or gravel content for example) the ditch may exert a drainage influence of perhaps 10-30m in to a field. Conversely, on less permeable soils (a poorly structured clay for example), a perimeter ditch may only really influence a narrow zone of perhaps 5-10m.

Info box 2: Ditches and wildlife

Many ditches (even though designed and used for drainage purposes), may still support significant wildlife interest, and should be viewed as an important wetland feature in their own right. They may be further enhanced with appropriate management and maintenance on the ditch itself, and buffering vegetation.

A free RSPB advisory leaflet - 'Ditch management' - describes conservation techniques to benefit wetland wildlife in ditches and is available by emailing conservation-advice@rspb.org.uk

Water violet in drainage ditch, Oxon

2. IN FIELD SURFACE GRIPS, DRAINS, RILLS OR OTHER RELICT SHALLOW DRAINAGE FEATURES

A variety of landforms and features fall under this category, many being small scale, shallow relict features with a number of local or regional names eg grips, drains or rills, depending on local vernacular. Whilst often excavated for surface drainage purposes, many will now have historic, landscape or biodiversity interest associated with them.

Relict surface feature, Glos.

Although they may still serve a drainage purpose, transferring excess surface water away from a site in times of flood, many will have become redundant, filling in over time with accumulated vegetation and soil; thus limiting their drainage function. For the wetland manager, it is often useful to identify such features, as they are likely to indicate the low spots and likely water pathways on a site.

3. SUB SURFACE DRAINAGE SYSTEMS

i) WHAT IS IT?

Subsurface drainage removes excess water from the soil profile, usually through a network of pipes installed 2 to 4 feet below the soil surface, which ultimately discharge in to perimeter ditch systems. Older systems are comprised of short lengths of clay tiles, whereas the more recent systems are made from perforated plastic tubing.

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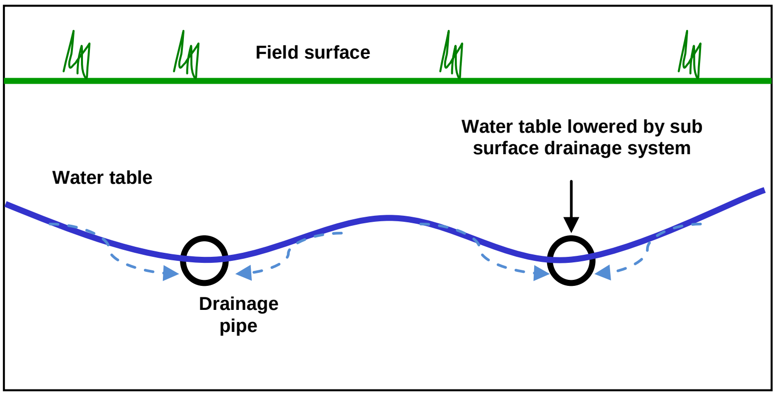
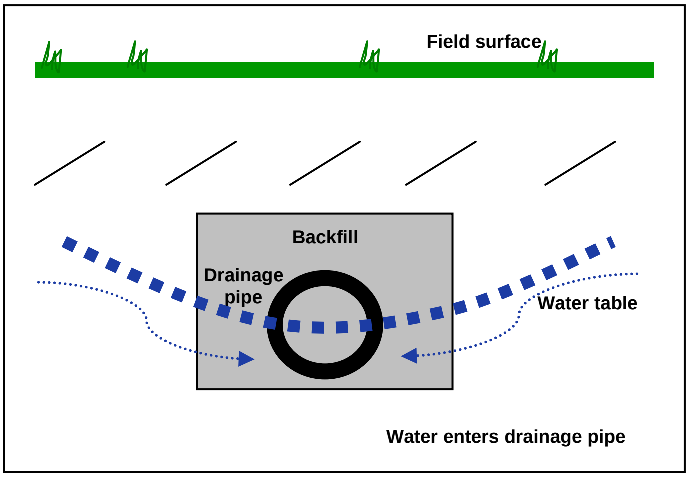


ii) HOW DOES IT WORK?

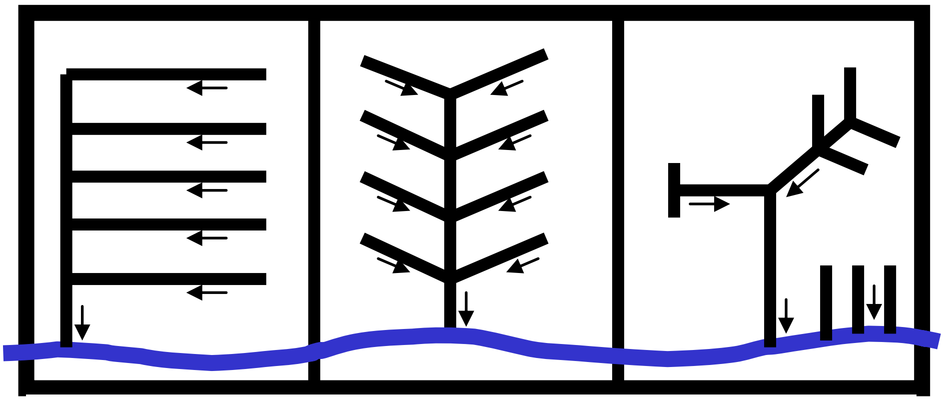
When the water table in the soil is higher than in the tile, water flows into the pipe, either through holes in the plastic tube or through the small cracks between adjacent clay tiles. This lowers the water table to the depth of the tile over the course of several days. However, once the water table has been lowered to the elevation of the tiles, no more water flows through the tiles. In most years, drain tiles are not flowing between April/May and October.



Cross section of a sub surface drainage pipe

iii) HOW IS IT LAID OUT?

Sub surface land drainage systems are laid out in a variety ways depending on site specific requirements and conditions. Soil type and condition, site topography and hydrology and crop requirements are all important factors. These factors will help determine drainage methods, plus the pipe layout and depth of any subsurface drainage system. In some instances, particularly on sites with more regular topography, a systematic grid of equally spaced drains will be laid. In others, only specific areas will be subject to drain installation, such as to intercept spring lines, or to drain particularly wet, low lying areas of a field, and thus follow a less regular pattern.



Sub surface drainage systems can be laid out in a number of ways
i) Regular, flat topography ii) Main collector drain in depression iii) Local systems

If installed correctly, such systems generally have a working life of anything between 20-40 years. Ultimately, siltation, collapse or misalignment of (clay) pipes may reduce efficiency and require maintenance or replacement to ensure ongoing operation. Drainage performance may be enhanced through regular mole drainage or sub soiling every 5-10 years.

Info box 3: Drainage tiles and pipes

<u>Clay drain tiles</u>

Clay drain tiles are orange or red in colour, usually 1 foot in length with an interior diameter of approximately 4 inches. The main collector tiles, collecting water from these field drains can be 6 inches in diameter or more. Tile edges tend to be rough and hence although the tiles are well butted together for stability, water enters the pipes through the cracks between the individual tiles. The trench backfill above the tiles tends to be less compact than the surrounding soil and hence has a higher permeability. On some of the heavier soils, and where mole drainage is practised, stone or gravel is placed above the tile to within 15 inches of the surface as part of the backfill. Clay drain tiles were superseded by the use of perforated plastic drain tiles from the 1970's. However, many clay tile systems are still in situ and are commonly encountered during excavations.

Clay tile

<u>Perforated plastic drainage pipe</u>

Nowadays, the main type of plastic pipe used and encountered is corrugated plastic tubing with small perforations around the pipe to allow water entry. The field drainage pipes are usually 3 inches in diameter, with larger sizes used for the main collector drains. In the less structurally stable silty soils, a filter sleeve may be used around the pipe to minimise sediment entry in to the pipe. Gravel backfill is also used with these pipes on heavier soils.

Plastic drainage pipe

4. MOLE DRAINS:

Mole drains are used on heavier, low permeability, clayey soils in combination with pipe drains to improve drainage efficiency. The mole drains are unlined cylindrical channels formed using a mole plough. They are installed at spacings of approx. 3 m and pulled across more widely spaced gravel backfilled pipe drains. The mole channel passes through the gravel, allowing mole drain water to flow readily downwards through the gravel into the pipe for discharge.

A mole plough

The mole plough comprises of a cylindrical foot attached to the bottom of a vertical leg. The foot is usually approx. 3 inches in diameter and is commonly followed by a chain attached to a 4 inch diameter ‘expander’ which enlarges and helps stabilise the channel. The mole plough leg generates vertical fissures in the soil which extend from the surface layers downwards into the mole channel. These fissures remove water from the surface layers, rapidly transferring it to the drain.

4(A)SUBSOILING:

A subsoiler

Subsoilers are used to fracture compact layers (pans) which may develop in the surface soil layers and to induce fissures in poorly structured subsurface layers. The fractures / fissures allow water to move more rapidly downwards from the surface layers and through the subsurface layers to the drains. The wings, operating just below the pan or within the poorly structured layer, lift the soil mass and drop it back down again. Fissures are generated during the lifting process and also as the soil is ‘bent’ / dropped as it leaves the wings. Whilst subsoilers have been developed as an agricultural tool, they may also have a useful function for the wetland manager, promoting better soil structure, root development and water movement in the surface layers.

5. BUNDS, BANKS AND EMBANKMENTS

Soil embankments may often form part of the overall drainage system, providing greater (overland) control over water movement both on and off a site. They may also help sub divide hydrological units within a site. They may range in scale from tens of cm’s to many metres high/wide. The most obvious examples include artificial riverside flood embankments, designed to limit river flooding on adjoining land. In some cases, they may only be small or imperceptible features such as silt deposits and river/ditch dredgings building up as a lip alongside a water channel.

Artificial river flood bank. Yorks.

However, whatever the size and scale, such features may exert some influence over the capacity to allow inflow, retain or evacuate water from a site, which will be important from a wetland conservation perspective.

6. WATER PUMPS AND CONTROL STRUCTURES

Water control structures may form an additional part of the field-scale drainage infrastructure. Sluices and other water control structures have been used to manage water for centuries and range from historic water meadow penstock structures to more modern tilting weirs and drop board sluices. Such features are commonly used by the wetland conservation manager to achieve different objectives.

Modern pump house, Oxon.

Historic water meadow sluice

Water pumps of varying size and type may also be used to move water off site via main ditches or pumping reservoirs, where gravity discharge is not possible. They may be tractor mounted, enclosed in pump houses/huts, sited on banks or submerged, and hence are not always immediately obvious. Pumps may allow water to be more efficiently (quickly) moved off site, in greater volumes, or even against the natural lie of the land (uphill), and so can have a pronounced effect on the efficiency of any drainage system.

Section 2:

INVESTIGATING AND IDENTIFYING THE EXISTENCE OF DRAINAGE INFRASTRUCTURE

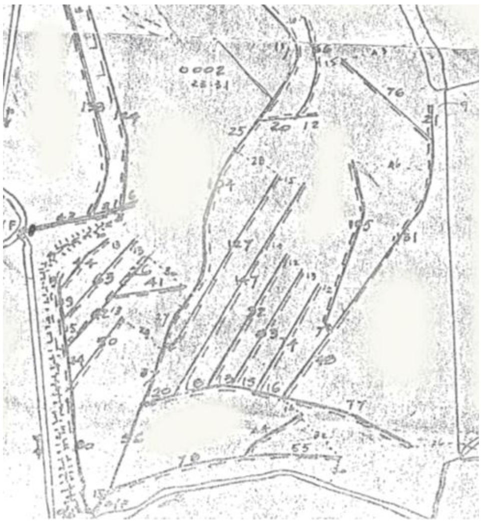
SUB SURFACE LAND DRAINS - HOW DO I KNOW IF THEY ARE PRESENT AND FUNCTIONING?

Identifying the presence of sub surface land drains requires more effort, than for other more visible elements of drainage infrastructure, as for the most part they are buried underground. However, the following guide should help in your investigations.

1. ASK THE CURRENT (AND PAST) LANDOWNER/S

Many systems were upgraded or installed during the 60's, 70's and 80's with government grants, so current owners/families may have had them installed themselves. With larger schemes, accurate drainage maps were drawn up illustrating the location, depth and type of any sub surface field drains. These may still be in the landowners possession.

Drainage outfall pipes from successive schemes, Yorks. Note the differing levels of pipes.



Example land drainage map

However, be aware that in some situations the original systems may have been extended, and not added to any formal map.

In addition, the more modern systems have usually been preceded by older systems that were already in place creating a complex system of sub surface pipes, often at different depths, orientations and function. This may be especially true in areas with peat soils, where soil shrinkage and loss, has led to the lowering of land levels, and the requirement for new drainage systems to be installed at greater depths.

Drainage outfall pipe

2. LOOK/LISTEN FOR DRAINAGE OUTFALLS in main perimeter field ditches, especially when they are flowing after heavy rain during autumn/winter. Be aware that the outfalls may be concealed by vegetation and soil, have been broken off by ditch maintenance, and may be submerged in times of flood or high flows, so might not be easy to spot. They will also not normally be flowing during summer/early autumn. Where permeable gravel/stone backfill surrounds the pipes, it may be visible, and look 'out of place'.

3. LOOK FOR CLAY PIPE DRAINS, (OR MODERN PLASTIC PERFORATED PIPE) ON THE FIELD SURFACE, brought up by ploughing, soil shrinkage or other excavations. Check the bottom of any scrapes or other wetland features (and resultant spoil) that may already have been created, to see if they contain fragments of pipes together with gravel backfill.

Clay drainage pipes on ploughed surface, Yorks.

4. OBSERVE ANY OBVIOUS LINEAR VARIATIONS IN CROPS, GRASS OR VEGETATION. The presence of a field drain may sometimes be indicated by a more lush or vigorous strip of growth. This is due to the better aeration and more vigorous root growth in the more permeable soil above the pipe.

5. CONSULT WITH THE LOCAL IDB OR EA, (or other relevant country agency) who may have responsibility for operating the drainage systems across your site. Whilst they may not have details of individual field drainage layout, they should have knowledge of larger scale schemes, and know of others who may be able to assist or have additional information.

6. USE WELDING RODS/FENCING WIRE to try and identify the line of a drain.

7.DIG AN INSPECTION TRENCH.

Inspection trench, Cambs.

Clay pipe exposed by excavations, Oxon.

Clay drainage pipe fragments in spoil from inspection trench. Staffs.

Gravel backfill exposed by excavations, Shrops.

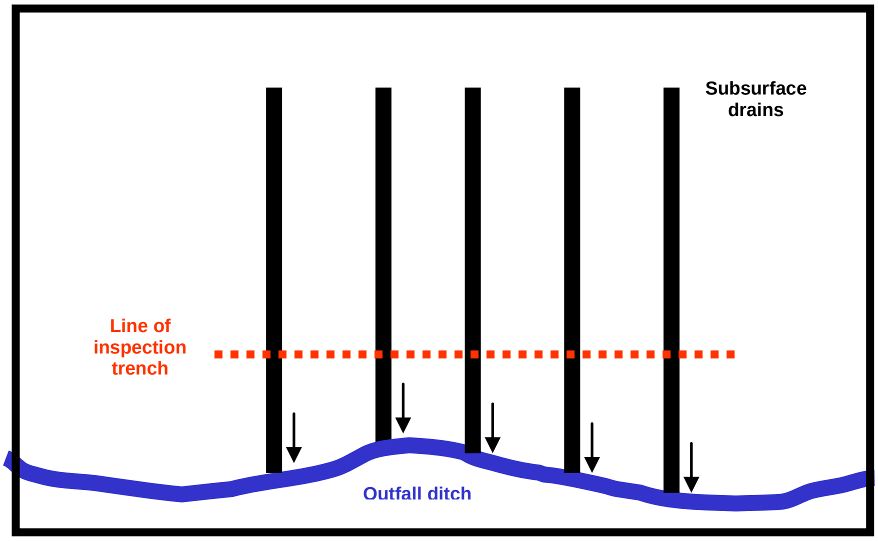
Most radical, but sometimes necessary, is the method of excavating an ‘inspection’ trench, perpendicular to the likely course/grid of tile drains (and therefore parallel to a likely perimeter field drainage ditch, where a system is likely to discharge) in the hope of discovering sub surface pipes.

NB: This will obviously cause a lot of damage to the pipe system, so would normally only be undertaken if the ultimate aim is the location, and subsequent removal/modification, of the pipe system (see Section 3)

An excavator or equivalent should dig a trench down to 1-2m (which only needs to be an excavator buckets’ width), and approximately 10-20m in from the perimeter ditch, to ensure that any sub surface drains are found. Careful observation of the trench and the spoil that is removed as it is opened up should reveal fragments of clay tile and/or the permeable gravel backfill if present.

Once one or two sections are found, it is then easier to locate the rest, as many systems were installed at regular distances and intervals from the next section (eg 20m spacings).

NB: It is worth noting that many/most sub surface tile drains are installed in regular grids. However, in some instances, the grid may progressively branch or split, which may influence what is discovered via inspection trenches, depending on the where you are in the network. Such information may also influence subsequent work to modify any such drainage networks. (See Section 1)



Example location and orientation of inspection trench

OTHER DRAINAGE INFRASTRUCTURE

Drainage ditch and bund, Norfolk

For the most part, identifying the other elements of a drainage system should be more straightforward. Simply walking an area and noting any features that are visible, including their state of repair, function etc will be a useful step.

Visiting at the time of flood or high rainfall, may also highlight water pathways, low spots, bund, banks etc on a site. Identifying the low lying entry and exit point/s using topographic surveys, ariel photographs or Lidar maps may focus your investigations in to the most likely areas for water control structures and pumps, as will investigating the major water ways or drainage ditches than run through or adjacent to a site.

By building an overview of the various drainage systems and functions in place on a site, it should be possible to begin to understand their influence on the current hydrological regime, and implications for future wetland conservation objectives.

Pump infrastructure, Cambs.

Aerial photographs and maps

Section 3:

MODIFYING DRAINAGE SYSTEMS FOR WETLAND CONSERVATION OBJECTIVES

BACKGROUND

There are many issues to consider before planning or undertaking any action to modify existing agricultural land drainage systems for wetland conservation purposes. This section of the I&A note focuses on the particular technical aspects of carrying out such works and does not attempt to provide a comprehensive overview of broader wetland conservation practice.

Such information is more comprehensively explained in two RSPB handbooks; *The Wet Grassland Guide* and *Reedbed Management for Conservation and Commercial Purposes* (see References section for further information). The Fen Handbook (due to be published in 2010) will provide additional information.

LEGAL/STATUTORY CONSIDERATIONS

It is advisable to consult at an early stage with the relevant statutory bodies and planning authorities before undertaking any significant modifications to drainage infrastructure. In a variety of circumstances, consents, licenses or permissions may be required before such work is carried out, and restrictions or conditions placed upon such works. These bodies may also be able to provide advice, and have technical specialists to assist with the planning and delivery of projects.

Consider whether works may effect land (and land drainage) beyond that which it was intended and outside of your ownership. The drainage of your land, or the passage of water across or through your land, may be necessary to facilitate the drainage of land outside of your ownership or control.

UNDERSTAND YOUR SITE

It is essential to investigate and understand the current attributes and function of a site. A variety of factors should be considered before undertaking any modifications or changes in drainage management and will probably include early consideration of the following (and is likely to include many more).

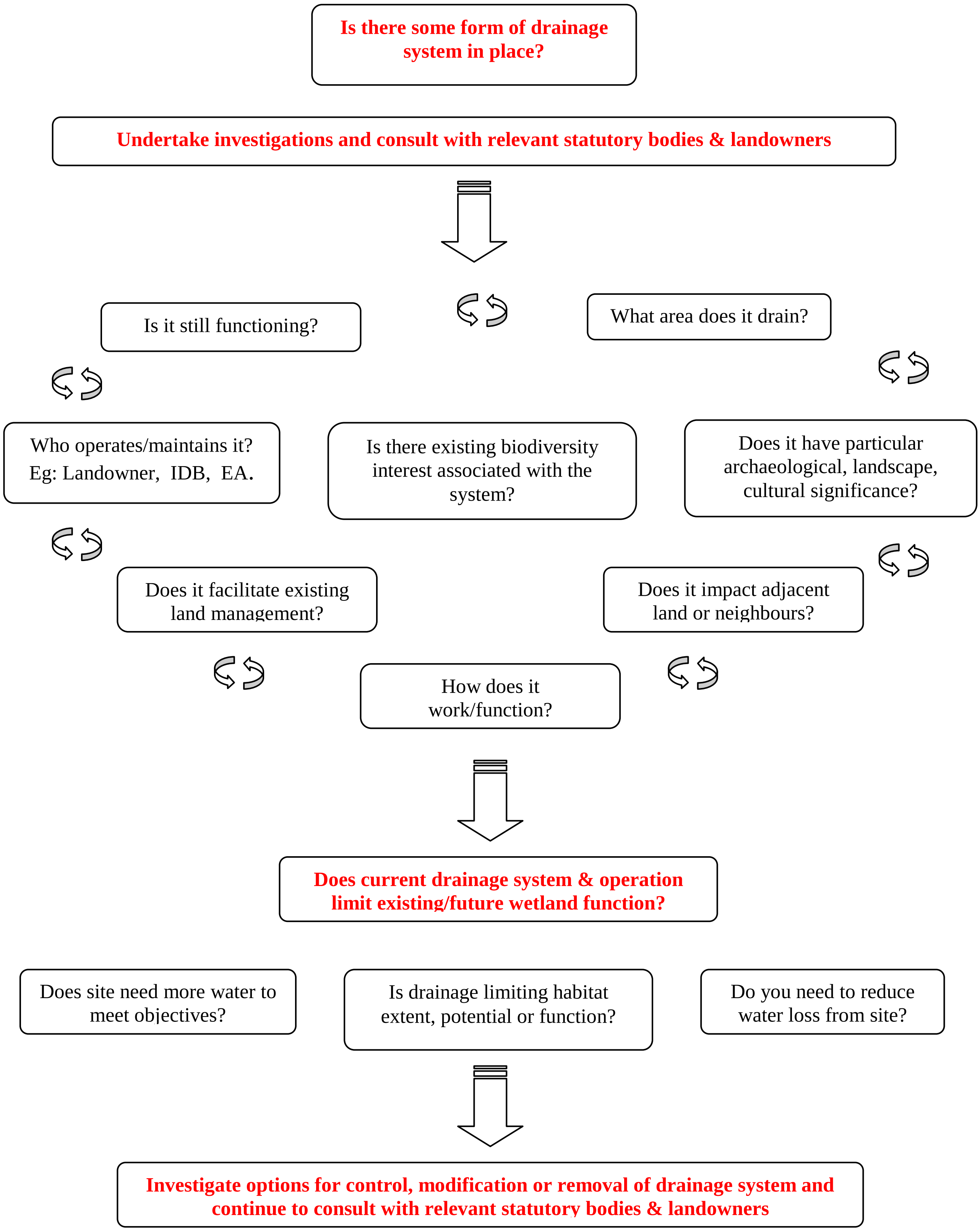
- Statutory/legal consents, licensing and permissions
- Current (and past) land use
- Current (and past) land drainage activity
- Soils
- Topography
- Hydrology
- Archaeological, landscape and cultural significance
- Current (and past) species and habitats/plant communities
- Neighbouring land owners (and land use)

Info box 4: Soils and drainage

Soils are a fundamental consideration for the wetland manager, influencing the design of historic agricultural land drainage systems and their function. Knowledge of the soils on site will help inform any strategy you employ when modifying such systems for wetland conservation purposes.

A free RSPB partner I&A note – 'Re-wetting grassland for birds', provides further information on this topic and is available by emailing conservation-advice@rspb.org.uk. Further advice and information on soils can also be found in a series of Natural England Technical Advice Notes (No. 20, 31 & 52).

ASSESSING LAND DRAINAGE



TAKING ACTION

If the existing drainage system is adversely affecting the wetland conservation objectives of your site, you may wish to take further action.

A test pit to assess soil type and structure, Yorks.

Firstly, gain an understanding of the extent and function of the drainage system. Is it still working? What areas is it draining? What soils are present on site and how does this relate to the drainage function? Does it also drain or effect neighbouring land? It is likely that you will need to conduct further investigations and consult with other landowners and statutory agencies.

Next, are the site habitat objectives or management being adversely affected by land drainage? Does your site need additional water (or a reduction in drainage) to meet your habitat objectives? Eg re-creating wet grassland on an improved, drained area of lowland pasture for breeding waders, may require the retention of additional water in the spring and early summer.

Info box 5. Step by step approach

NOTE: Experience has shown that radically altering the hydrological function of a site 'overnight', may have unforeseen or undesirable consequences. Species and habitats on site will have adapted to suit current conditions, and a swift change to a different hydrological regime may lead to a temporary or more permanent change (or loss). It is always best to take a step-by-step approach and assess conditions at every stage. Try something small-scale and monitor the effects, before moving on to large scale modifications.

On designated sites, you will need to consult at an early stage with the relevant statutory agency before taking any action. It is also useful to employ professional help on larger sites, or those you are less familiar with.

OPTIONS TO MODIFY THE EXISTING DRAINING FUNCTION

The options below are some of the more commonly used techniques that have been successfully implemented on nature reserves and farmland in agri-environment schemes. They are listed in a basic hierarchy, suggesting a step by step approach, ranging from more simple, lower cost options, to more comprehensive, and longer term actions.

Undertaking pilot trials or small scale works in the first instance, will often provide useful information and understanding of a particular site. This may help to inform the feasibility and implementation of subsequent actions.

It is likely that additional management options will need to be considered to fully meet your habitat objectives and hydrological function for a site, once the basics of land drainage have been addressed. A free RSPB partner I&A note – 'Re-wetting grassland for birds', provides further information on this topic and is available by emailing conservation-advice@rspb.org.uk.

1. MAINTAINING AND UTILISING EXISTING INFRASTRUCTURE

In some cases, maintaining (or slightly modifying) the functioning of the existing infrastructure can be enough to meet wetland habitat objectives.

Some practioners recommend using existing drains to 'irrigate' the site, by effectively reversing the sub surface drainage system and 'backing water up' in to the field, through the raising of water levels in the perimeter outfall or receptor ditch. Depending on the relative heights of the sluice and retained ditch water levels relative to the sub surface pipes within the field, it may be possible to 'back up' water in to parts of the sub surface drainage pipe network, and further restrict their drainage effect.

It is less clear what the long term effect of this would be on the drainage system itself. It is likely that increased siltation within, and between the pipes would lead to reduced drainage function, as water is less effectively drawn in to sub surface pipes.

Allowing some periods of unhindered function throughout the year (eg in late summer/early autumn) may help to 'flush' the system and maintain it's function. Serious consideration should be given to the longer term costs of maintaining such a system, including the maintenance, repair and/or replacement of pipe infrastructure, if overall drainage potential needed to be maintained.

Depending on soil type, the reduction in drainage may also effect the ease with which water moves through the soil profile (the hydraulic conductivity of the soil), as soil structure and condition changes with the differing drainage regime. This might also effect the long term function and viability of any existing sub surface drainage system.

Finally, such an option presumes the objective is uniform wetness across a site, which is unlikely to be the desirable outcome in many instances, where variation is often key. In some cases, a topographical (land levels) survey may be required, to fully understand the outcomes on project land and adjacent areas.



On this farm, a simple sluice has been placed mid way along a perimeter outfall ditch, and a right angled pipe control structure placed on one section of sub surface drainage pipe. A small length of the pipe was removed upstream of this to create a ditch/water retaining feature. This created some small scale wetness in a discrete area of the field. The remaining sub surface drainage system network downfield of this point was left in situ.

Info box 6: Soil condition and wetlands

In some circumstances, (such as creating habitat for breeding wading birds) maintaining good soil structure, free movement of water through the soil and a deep grass rooting zone are recognised as important factors. Such conditions may promote soil invertebrate populations, and help ensure soil conditions are robust enough to facilitate grassland management such as rush control, grazing or topping.

In an arable reversion situation, it is good practice to establish a good grass sward, before the raising of water levels. Establishing a sward in this way will facilitate management at an earlier stage, and promote soil condition and structure. Key factors to consider.

A free RSPB partner I&A note – 'Arable reversion', provides further information on this topic and is available by emailing conservation-advice@rspb.org.uk.

2. INSTALLATION OF A WATER CONTROL STRUCTURE IN OUTFALL/RECEPTOR DRAINAGE DITCH

Installing a water control structure in a perimeter drainage ditch may maintain higher ditch water levels, depending on water sources/supply. Controlling water levels and reducing drainage function in perimeter ditches may help to retain 'excess' rainfall and floodwaters in winter, and in spring/summer, help maintain wetter conditions in a zone adjacent to the ditch, by replenishing water losses in the soil profile due to evaporation/transpiration. In addition, this may 'back up water' in to any subsurface or surface field drain system in place (see above).

A sluice is maintaining high winter ditch water levels, Cumbria.

Temporary stone dam, Lancs.

Be sure that the perimeter ditch that is being controlled is not required to help drain other land outside of the project/habitat area. E.g. Does another drainage system outfall in to this ditch? If so, raising ditch levels and submerging pipe outfalls, will severely restrict their drainage function. Ensure statutory agencies and local landowners have been consulted at an early stage, as such work may fall under statutory consents and licensing requirements. The timing of operation of any water control structure, water flows, relative heights of penned levels and land levels on site and habitat objectives will need to be carefully assessed beforehand to assess the full implications of this action.

Using a temporary dam to mimic the effect of a more permanent sluice, may help to inform the outcomes of future work, before costly, longer term work is carried out. Silage bales, earth or stone dams have both been used successfully in this respect. (NB: See Statutory & legal constraints on page 1).

Undertake regular observations using a soil auger to install a series of inspection holes perpendicular to the drainage ditch. This will allow an assessment of the outcomes of ditch blocking on the water tables/soil moisture before, during and after such action and inform future actions.

Info box 7: Ditch re-profiling

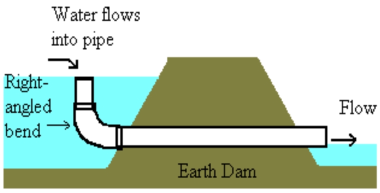
Additional re-profiling of the ditch edge, or the creation of 'cattle drinker' or scrape features may promote greater diversity and interest, but this will depend of current and future conservation objectives. For example, aquatic plants may benefit from a succession of shelves, berms and gentle gradients to provide maximum diversity, whilst breeding wading birds such as lapwing and redshank may utilise shallow grading sections of muddy, vegetation-free ditch edge to feed on soil and surface active invertebrates. Diversity is key.

Small scale ditch reprofiling

A free RSPB information sheet – 'Ditch management', provides further information on this topic and is available by emailing conservation-advice@rspb.org.uk.

WATER CONTROL STRUCTURES

There are a wide range of structures that may be installed for these purposes, the choice dictated by cost, function, and local circumstances such as size of ditch, volume of water etc. In many cases, a simple and cost effective drop board sluice or earth dam and flexi pipe sluice will be sufficient.



Earth dam/pipe sluice

Drop board sluice

A partner Information and Advice Note – *'Water control structures for conservation',* provides advice and case studies of a range of water management structures and their suitability for conservation purposes.. It is available as a free download from rspb.org.uk/sluices or by emailing conservation-advice@rspb.org.uk.

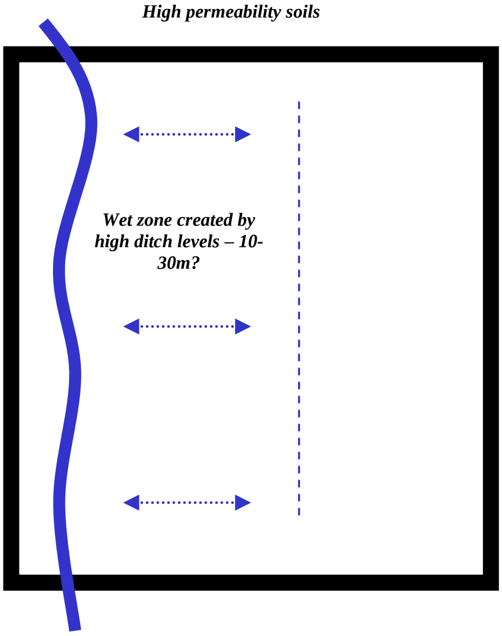
AUTUMN/WINTER
The maintenance of high ditch water levels, and hence the cessation of its drainage function, will severely impede surface/soil water drainage (during high flows floods etc) from the site, particularly in winter. Water, which would have previously drained overland or through the soil profile in to the ditch, and be transported away, is now retained on site. Site habitat objectives, topography of surrounding land and land use will influence the impacts and benefits of this. EG do you require the site to be flooded for extended periods in winter? Is there topographical variation to provide areas above winter levels? Will retained water 'spill' in to other non-project areas?

SPRING/SUMMER
Holding higher perimeter ditch water levels may initially have a fairly local effect on the water table within a field, depending on soil type and condition. (particularly in the absence of any sub surface drainage pipe network). Wetter conditions may be maintained closer to the ditch, but this effect may rapidly reduce with distance. This is because water moves through different soils at varying rates – this is known as the hydraulic conductivity of a soil.

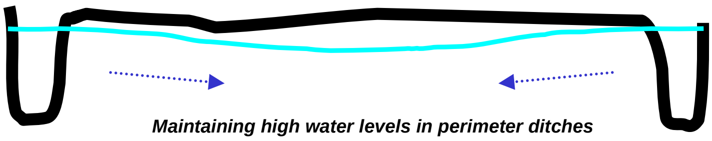
In free draining soils, water will move more easily through the soil profile – the soil has a high hydraulic conductivity. Maintaining high ditch water levels in this scenario may therefore create a broader wet zone extending in the field by perhaps 10-30m(?).

In poorly structured or less permeable soils, this zone may be closer to 5-10m(?), as water movement through the soil profile is slow or restricted. In this scenario, evaporation and transpiration of water from the soil/vegetation/water features is likely to be greater than the rate at which more water can move through the soil from the ditch to replace this.

High permeability soils

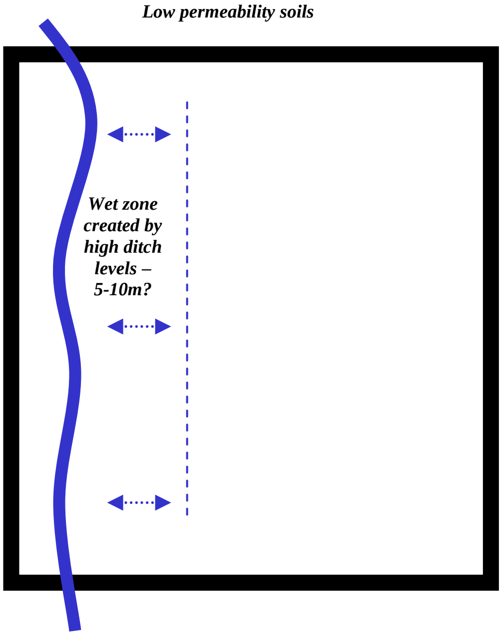


Water table shape - High permeability soils

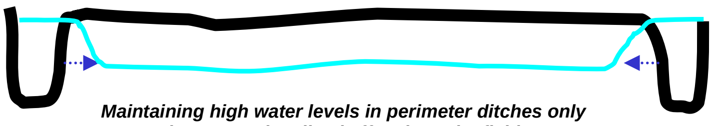


Maintaining high water levels in perimeter ditches creates a broader wetland zone in to the field

Low permeability soils



Water table shape - low permeability soils

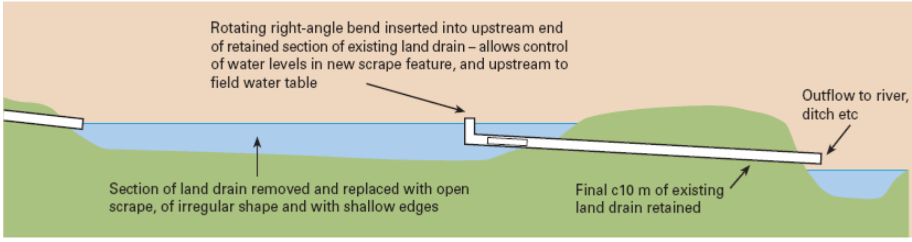


Maintaining high water levels in perimeter ditches only has a very localised effect in to the field

3. INSTALLATION OF WATER CONTROL STRUCTURE ON FINAL SECTION/S OF SUBSURFACE DRAINS

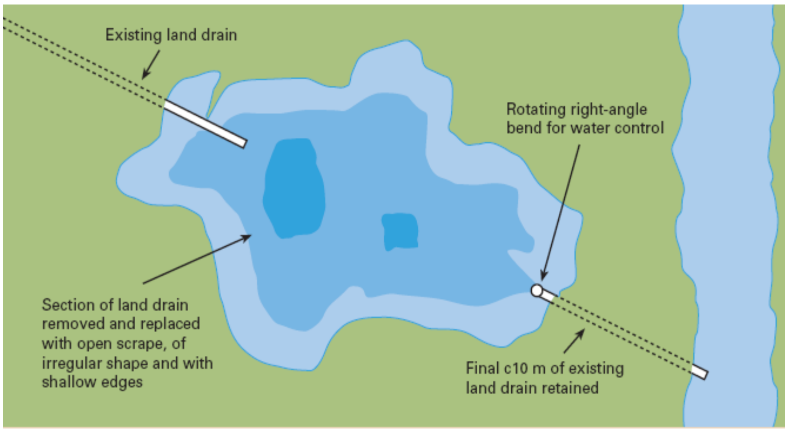
If control of water levels in the drainage ditch is not possible or desirable (and perhaps even if it is), it may be possible to restrict/control water leaving the sub surface pipe system in the first place before it discharges in to the receptor ditch.

One method, developed by staff in the North of England, is to install a control structure on to the final 10m or so of retained land drainage pipe, before it empties in to a drainage ditch, using a 90 degree right angled plastic pipe. Alternatively, you could simply replace the last tile section with a length of non perforated plastic pipe for greater control.



By controlling the outflow in this way, it is possible to restrict the drainage effects of the sub surface systems and 'back up water in to the system. By adjusting the outflow control, it is possible to have a degree of control over this system allowing drainage to occur when required, or when required wetland conditions have been achieved in a season. In addition, by creating a scrape feature immediately upstream of the control point, water can be allowed to collect and pond, forming additional wetland features.

Water will naturally want to seep around any such control point (particularly if this is towards the end of a large drainage system with significant catchment and water pressure). Soil type will in part dictate how pronounced this loss is, with freely draining soils, demonstrating greater seepage loss than a less permeable soil.



If significant losses are occurring, or further control or wetland features are required, additional control points could be installed in the same way further up the system. This has the advantage of manipulating control across discrete sections of a site and its drainage system. It may also be required if land levels vary significantly across a site and one control point at the lower end of a system is insufficient to create desired conditions further back/higher up a site/system.

Info box 8: Outfall pipe controls

A few examples exist of small scale sluices or structures being fitted to individual outfall pipes as they empty in to main receptor ditches, to try and limit flow, but the pressure of backed up water makes this difficult, with frequent 'blow outs' occurring, or water simply forcing its way around any structure.

Outfall pipe control, Warwks.

The first example (top right) uses a small scale 'guillotine' action to open or close the drainage pipe control.

The second example (bottom left) used a standard pipe bung to try and restrict water outfall in to the drainage ditch.

Outfall pipe control, Shrops.

INSTALLING A WATER CONTROL STRUCTURE AND PLASTIC PIPE SECTION ON TO EXISTING SUBSURFACE DRAINAGE PIPE NETWORK
(From *Wet grassland practical manual – RSPB, Cumbria 2005*. Tim.Youngs@rspb.org.uk)

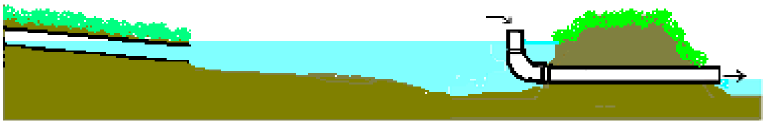
***1.** Exposing the sub surface tile drain*

***2.**Clay tiles removed, and plastic pipe ready for installation*

***3.** New plastic pipe installed with right angles bend control*

***4.** Rotate right angle to control water flow. Currently in upright position, retaining water flowing in to scrape from upstream sub surface drainage pipe*

***5.** A scrape feature after 2 years*



***6.** A plan view of the completed feature*

REMOVAL AND BACKFILLING OF SECTIONS OF DRAIN

A permanent option is to completely remove short (5-10m) sections of sub surface drainage pipe with an excavator, backfilling the hole with the resultant spoil (or other less permeable material if required/available) to form a plug or seal, through which water movement is restricted or blocked, and drainage reduced.

An excavator removing a section of sub surface tile drain, Oxon.

Once again, this may be done at the final section of a drainage system, and /or, undertaken in discrete locations throughout a site to achieve desired results, and avoid excessive seepage of water around the plug, in situations where there is a large pressure of water in the system. The creation of a scrape feature immediately upstream of the blocked length of pipe will add additional habitat diversity.

Depending on the layout of the sub surface drainage system, action might be taken to systematically block the final sections of each drain, before they empty in to a perimeter drainage ditch. (see Section 2 for further details).

Backfilling the line of the drain with clay, Oxon.

Obviously, the drainage system will be partially or wholly destroyed by such works and will not provide any control or ability for drainage in the future without costly remedial action. Such action should be considered a final option, with the impacts on the ability to undertake future management carefully assessed. A small scale trial in one or two locations might be a useful first step.

5. INSTALLING IMPERMEABLE BARRIERS OR MEMBRANES

In some situations, creating an impermeable barrier around the perimeter of a site may reduce/eliminate water loss from the site, regardless of any drainage systems that may be in place, and allow greater control of water levels and wetland conditions, than would otherwise be possible. A method of allowing excess water to leave the system (via a sluice for example) will normally be required in such a 'closed' system.

Alternatively, it may be necessary to 'isolate' a site from the effects of land drainage occurring on surrounding land, such as a deep drainage ditch abutting your site, over which you have no control. This may be particularly relevant in peat areas, where water moves relatively freely through soils, and drainage systems may exert maximum influence.

CLAY BARRIERS

If a source of impermeable material such as heavy clay is available on site, it may be possible to use this as your barrier material. In general terms, a trench is dug with an excavator until an impermeable layer is reached. The resultant trench is backfilled and compacted with the impermeable clay material, forming a seal against lateral water movement/loss. NB: It is essential that such a barrier extends to, and is tied in to, an impermeable soil layer, otherwise water will simply seep under the barrier and continue to drain as before (although possibly at a slower/restricted rate). It may be possible to purchase clay or other impermeable material for this purpose, but this is likely to be very expensive.

PLASTIC MEMBRANES

Installing a plastic membrane, Cambs

An alternative (and probably cheaper) option is using plastic sheeting to form the impermeable barrier. This has been used successfully in the Fens and elsewhere, using a local contractor with a custom made trenching rig that dispenses the plastic sheeting.

NB: See RSPB publication *'Water control structures for conservation',* for more detailed information on impermeable membranes. It is available as a free download from rspb.org.uk/sluices.

Plastic sheet dispensing from trenching rig, Cambs.

6. BUNDS AND BORROW DYKES/DITCHES

Bunds, or low earth banks, preferably keyed in to an impermeable substrate, and made from low permeability soils such as clay, can be used as an additional measure in mitigating the effects of agricultural land drainage. In conjunction with an associated borrow ditch, they may slow, or prevent water loss from the site via the soil profile, and/or surface winter rain/flood water.

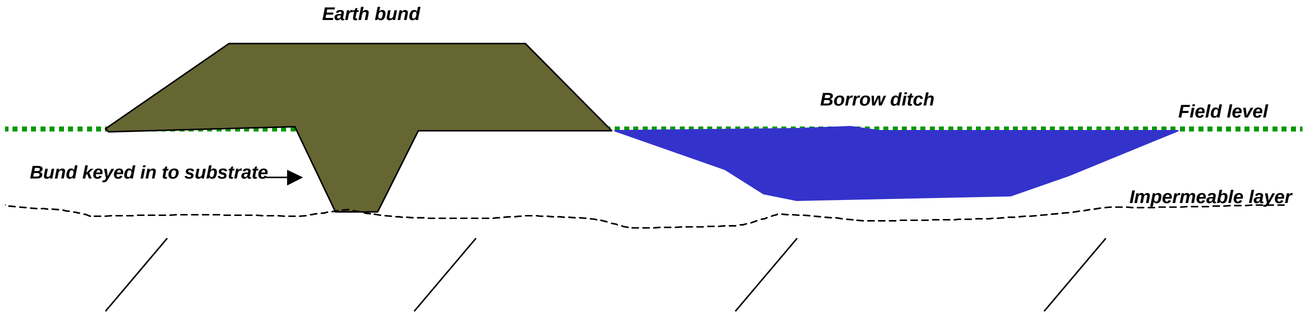
They can;

- Retain additional excess rain/floodwater that would otherwise flow/drain away
- Isolate a site (hydrologically) to prevent raised water levels flooding adjacent land
- Limit the effect of external/adjacent drainage systems on your site, over which you have no control
- Sub divide a site (hydrologically), to allow greater control or range of water levels and management

Bunds should be set well back from the edges of (external/non controlled) drainage channels to reduce seepage, and also to prevent slumping. If the spoil for the bund is won on site (as opposed from being brought in from elsewhere), this can facilitate the creation of an adjacent 'borrow dyke' or ditch, which will provide additional habitats for aquatic plants and invertebrates as well as facilitating the control and distribution of water around a site.

Soil type will play a key role in determining the type of construction and efficacy of operation. Clays, or other less permeable soils, are generally better for constructing water retaining bunds as such soils have reduced seepage and form more stable structures. Well compacted peat bunds will retain water to a degree, but seepage usually occurs. It is also preferable to 'key in' the base of the bund to the existing substrate to reduce seepage loss of water and form a better seal.

NB: There are a large amount of planning, licensing, landscape and archaeological considerations with such constructions. Consult at an early stage with the relevant statutory bodies, neighbours and landowners.



Info box 9: Creating a bund

In general terms, the main steps should include;

1. Remove turf and top soils from line of bund and retain for later use. This should be sufficiently wide to accommodate the keyed in base of the bund

2. Excavate material (preferably clay) from adjacent ground and build up in layers to form bund. Usually, the source material is taken from the inside of the area being bunded, to create the additional ditch feature within the hydrological unit.

3. Ensure shallow gradients on bund to facilitate access for management of vegetation or colonising weeds.

4. Compact the bund material carefully and in stages, as bund will naturally settle and reduce in height over time. – allow 10% for mechanical compaction. Peats may settle even more.

5. Use the retained top soil to cap the bund

Further detailed information on bund construction can be found in (Hawke & José, 1996 and White & Gilbert 2003).

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ADDITIONAL TECHNICAL GUIDANCE NOTES

The RSPB produces a range of practical technical guidance notes, which are available free by emailing conservation-advice@rspb.org.uk.

Habitat management sheets

- Managing water levels to benefit birds
- Reversion of arable/temporary grassland
- Grip blocking
- Ditch management

Technical Information and Advice Notes

- Wader Scrapes
- Re-wetting Grassland
- Arable Reversion
- Moorland Grip Blocking

Species advisory sheets

- Lapwing
- Redshank
- Snipe
- Curlew

TRAINING COURSES

The RSPB runs a series of practical wetland management training courses throughout the year. Contact conservation-advice@rspb.org.uk or visit www.rspb.org.uk for the latest programme.

FURTHER INFORMATION AND ADVICE

Please contact the RSPB National Wetlands Advisor at nick.droy@rspb.org.uk