

# 15 MANAGEMENT OF RECLAIMED LAND

## Chapter contents

<b>15.1</b>	<b>Introduction</b>	<b>533</b>
15.1.1	Definition	533
15.1.2	Management and design	533
15.1.3	The value of management plans	535
<b>15.2</b>	<b>Management arrangements</b>	<b>535</b>
15.2.1	Management planning	535
15.2.2	Management by the public authority	536
15.2.3	Management by the private sector	536
15.2.4	Management by voluntary and non-profit organisations	536
15.2.5	Management through lease, licence or agreement	537
<b>15.3</b>	<b>Management plans</b>	<b>539</b>
15.3.1	Definition	593
15.3.2	Plan preparation: new projects	541
15.3.3	Plan preparation: completed projects	541
15.3.4	Monitoring and review	541
<b>15.4</b>	<b>Site records and reference material</b>	<b>542</b>
15.4.1	Purpose	542
15.4.2	Material for retention	542
15.4.3	The maintenance of records	543
<b>15.5</b>	<b>Vegetation management</b>	<b>544</b>
15.5.1	Requirement and purpose	544
15.5.2	Existing vegetation	545
15.5.3	Naturalistic vegetation	545
15.5.4	Grassland management	545
15.5.5	Agricultural management of grassland	548
15.5.6	Management of grassland for amenity purposes	548
15.5.7	Management of woodlands	553
15.5.8	Management of wetlands	554

continued...

<b>15.6</b>	<b>Management of engineering structures and utility services</b> . . . . .	<b>554</b>
15.6.1	Introduction . . . . .	554
15.6.2	Drainage . . . . .	554
15.6.3	Contaminated areas . . . . .	556
15.6.4	Structures . . . . .	556
15.6.5	Subsidence and settlement . . . . .	556
<b>15.7</b>	<b>The management of site use</b> . . . . .	<b>557</b>
15.7.1	Litter, rubbish tipping and vandalism . . . . .	557
15.7.2	Public safety . . . . .	558
15.7.3	Public access . . . . .	558
15.7.4	Wardening and site staff . . . . .	559

# **15 MANAGEMENT OF RECLAIMED LAND**

## **15.1 Introduction**

### **15.1.1 Definition**

Land which has been reclaimed from dereliction requires continuing management if it is to fulfil its required purpose. Land management encompasses all the activities which are required to ensure that reclaimed land can be used as intended in the long-term. These activities include legal, managerial, administrative, financial and practical matters covering the prevention and repair of deterioration, that is, maintenance activities, the progressive development of features such as vegetation and the use of the site for its intended purpose. Management at some level of intensity will be required for all reclaimed land in perpetuity.

### **15.1.2 Management and design**

The consideration of site management should begin at the earliest stage of the process by which land use objectives are set and the reclamation scheme is designed. The land uses that are selected and the way in which site characteristics are modified in the reclamation scheme will determine the nature and intensity of management inputs which will be required. Conversely, the management skills and resources which will be available should be taken into account as reclamation proposals are formulated. There is little point in spending capital on land reclamation if the site is not managed effectively to achieve and maximise the benefits which were the objectives of reclamation (see Photograph 15.1). Management of revenue-generating land uses is essential if these revenues are to be maximised, either to repay part of the reclamation costs or to provide the funds for maintenance works. Many reclamation schemes have failed to realise their full potential as a result of the neglect of management activities. In the worst cases the land has reverted to a state of further



**Photograph 15.1:**

This neglected public open space provides little benefit to those it was intended to serve (source: Richards, Moorehead and Laing Ltd)

dereliction. The long-term management costs of reclaimed land can be allowed for by:

- selecting land uses which match the skills and resources available;
- including revenue-generating activities within the use of the site;
- establishing an endowment fund at the outset which will provide a continuing source of revenue towards management costs;
- designing details which minimise the requirement for maintenance and minimise the technical difficulty of such operations.

### **15.1.3 The value of management plans**

The long-term management of reclaimed land is frequently the responsibility of individuals or organisations who/which were not those responsible for the objective-setting or scheme design (see Section 15.2). In order that the objectives of reclamation are carried through to the subsequent development and management of the site a management plan should be produced, as an integral part of the reclamation process (see Section 15.3). This plan may set out important constraints on the long-term development or use of the site (Section 15.4), and will guide the management of vegetation (see Section 15.5) and other facilities (see Section 15.6).

## **15.2 Management arrangements**

### **15.2.1 Management planning**

Suitable provision must be made for the implementation of a management plan. Whilst public authorities, such as the local or regional council or a government agency, most commonly carry out land reclamation work, such a body may not wish to retain ownership and control of the site in the long-term. The possible arrangements for long-term management vary according to the after-use of the site.

The following arrangements are typically established for the management of a site. On any one site, a combination of these may apply:

- management by the public authority;
- management by the private sector;
- management by voluntary organisation or charities;
- management by the private sector, voluntary organisations or charities through lease, licence or agreement, but retained in the ownership of the public authority.

## **15.2.2 Management by the public authority**

Under this option, the public authority can retain full control over the use of the site and its maintenance, ensuring that the management objectives and operations remain consistent with the project aims so that the long-term development of the site is not compromised by short-term financial pressures. Management sensitive to the constraints imposed by the site and its intended use will ensure proper site development and functioning only if the authority has the necessary managerial and technical skills and resources. Sensitive management can be especially important in the early years after reclamation.

## **15.2.3 Management by the private sector**

Many sites which have been reclaimed for financially viable uses such as industrial, commercial or residential development have been sold to the private sector (see Photograph 15.2). Uses involving active recreation, such as golf, dry-ski slopes, freshwater fisheries, theme parks and industrial heritage tourism have also been developed by, or sold to, the private sector for long-term management. In such cases it is common for a legal agreement to cover special restrictions on the use of the site to prevent damage to sensitive features such as shaft caps and contaminated areas. The private sector may also contribute to the management of part or parts of a site under lease, licence or contract agreements. Sites reclaimed for hard after-uses such as industrial development or housing, also fall within this category. Those involved in the initial development may sell off their interest, in which case the industrialist or householder will become responsible for continued management, with the public authority usually managing public open space, roads and utility services.

## **15.2.4 Management by voluntary and non-profit organisations**

This arrangement for management can be especially appropriate for smaller sites, or parts of larger sites, and those with amenity after-uses such as nature reserves. Suitable organisations to take over site



**Photograph 15.2:** This reclaimed site was sold for the development of private housing (source: Welsh Development Agency)

management may include charities, wildlife organisations, sports clubs or historical societies. Providing grant-aid to enable a voluntary body to carry out management may prove far more cost-effective than management using a public authority's own staff and equipment, unless the site can be taken into an existing land management programme.<sup>209</sup>

A site may be retained in public authority ownership but be managed by a voluntary organisation, perhaps under the guidance of a management committee.

### **15.2.5 Management through lease, licence or agreement**

Management through lease, licence or agreement allows a public authority to retain ownership and control of a site, but to engage additional expertise in the management of a site on a contract, franchise or mutual basis. On sites where a commercially viable use is desired, the landowner may share in the returns by leasing the site or by developing the facilities and engaging professional management by contract. This

arrangement now applies to many publicly owned recreation facilities (see Photograph 15.3).

For sites where there is a formal sports after-use, for example sailing or motor sports, a lease to a recognised club may be appropriate. For sites of wildlife conservation interest, a long-term management lease can provide the managing organisation with an assurance that their long-term efforts will be worthwhile.

The most common arrangement for agricultural grazing on reclaimed land in the United Kingdom is the short-term let or grazing licence. Under United Kingdom law the landowner retains full control of the land with these arrangements (which can be renewed annually) whereas longer agreements can create a protected agricultural tenancy. Advantages and disadvantages of short-term and long-term arrangements for grazing of reclaimed land are given in Box 15.1.



**Photograph 15.3:** A committee of public authorities and user groups manage this country park, created by reclaiming old coal workings (source: Welsh Development Agency)

**Box 15.1:** Arrangements for grazing on reclaimed land

	<b>Short-term lease</b>	<b>Long-term lease</b>
<b>Advantages</b>	<ul style="list-style-type: none"> <li>• Landowner retains close control</li> <li>• Maintenance assured</li> <li>• Freedom of choice over who uses site and when</li> <li>• No long-term commitment by user</li> </ul>	<ul style="list-style-type: none"> <li>• Improvement of soil and sward</li> <li>• Maintenance controlled by user</li> <li>• Income generated regularly through rent</li> <li>• Security for user of site</li> </ul>
<b>Disadvantages</b>	<ul style="list-style-type: none"> <li>• Little incentive for user to promote soil and sward development</li> <li>• Lack of long-term security for user</li> <li>• Rent may be high to reflect short-term lease</li> </ul>	<ul style="list-style-type: none"> <li>• Over-grazing and bad management may occur</li> <li>• Landowner may lose close control of site</li> <li>• Weaker legal position for owner over change in site use or user</li> </ul>

## 15.3 Management plans

### 15.3.1 Definition

A management plan is a document which provides long-term guidance for the future managers of a land-holding. It contains:

- a reasoned, clear statement of the aims and objectives;
- information for reference;
- a programme of work for implementation;
- a mechanism for periodical review.

The preparation and implementation of a management plan is the means by which the integrated approach to the planning and management of land is applied to a specific site. By providing a framework within which all future management is carried out, the plan enables any person involved to understand how and why decisions are taken, in relation to the reasoning behind the policies and proposals for action.

Box 15.2 gives a generalised description of a management plan which can be applied to most types of post-reclamation land use.

**Box 15.2:** The content and operation of a management plan

**RECLAMATION AIMS**

A statement of the purpose of reclamation, and the broad policies which will underlie the management of the various land uses and interests.

**REFERENCE**

A comprehensive record of the land before and after reclamation, forming a basis for the analysis and objectives. External influences and constraints are included.

**ANALYSIS**

An examination of the options for management of the land and the relationship between potential land uses. The identification of potential problems and conflicts, and weighting of various interests. Objectives are formulated from the decisions reached.

**MANAGEMENT OBJECTIVES**

Specific statement of the land uses and interest to be achieved and promoted, their priorities, and targets for physical/biological/financial performance.

**MANAGEMENT PRESCRIPTION**

An outline of the work required and the resources needed to achieve the management objectives. A long-term outline of the programme for implementation.

**IMPLEMENTATION**

Details of the operations to be carried out within the review period in order to achieve the management objectives. Statements of resource requirements related to yearly programmes for the review period.

**MONITORING AND REVIEW**

An assessment and record of management achievements, with arrangements for a periodic review of the plan and renewal or revision of the rolling implementation programme.

### **15.3.2 Plan preparation: new projects**

The failure to produce a management plan for reclaimed land invites undirected and wasteful management which may unintentionally conflict with the original aims of reclamation. For this reason the preparation of a management plan should begin when the aims of reclamation are set, so that the designer's long-term intentions are clearly recorded. The reference material can then be selected from documents prepared during the design and construction process. The analysis should be commenced in parallel with the scheme design, since the long-term management of a site is an important design consideration, but further analysis will be required once site works are completed.

### **15.3.3 Plan preparation: completed projects**

Many reclamation schemes have been completed without the preparation of a management plan. In these cases preliminary research will be necessary to determine the reclamation aims and to obtain the reference material. In some cases these aims may be absent or fragmented and original survey work will be required to facilitate the analysis and formulation of the management objectives.

### **15.3.4 Monitoring and review**

The management of land requires the flexibility to respond to changes in circumstances within and outside the site. External pressures may, for example, increase the importance of revenue-generation or reduce the resources available for land management. A review of the management prescription may confirm that the management objectives can still be met, or may indicate that a more fundamental review is required. Monitoring of the site to identify, for example, the development of vegetation or the deterioration of structures, will influence the management prescription and provide a basis for the implementation programme.

## **15.4 Site records and reference material**

### **15.4.1 Purpose**

The characteristics of a derelict site and the way in which those characteristics were modified during reclamation, can be essential information for the subsequent owners or users of a site. Large sums of money have been spent on the investigation of sites abandoned by mining or industrial activity. The conservation of records can avoid the need for similar investigations of sites in the decades after reclamation. Accurately recorded information is valuable for:

- the routine maintenance of structures, utility services and vegetation;
- the location and identification of buried hazards and utility services;
- planning and controlling the development of the site;
- the design of new structures;
- the monitoring of ground conditions such as contamination;
- the assessment of the site for new uses.

Site records are particularly useful if new land uses are proposed. Ground contamination, for example, may have been reduced to meet the criteria for the initial after-use, but not to meet the more stringent criteria for uses which are subsequently proposed.

### **15.4.2 Material for retention**

Material that is likely to serve the purposes identified in 15.4.1 should be retained; for example:

- feasibility studies and design drawings;
- site investigation data including physical and chemical analyses;

- photographic and documentary evidence of the site before reclamation, and in particular the previous uses of land;
- the specifications for the works as carried out;
- accurate 'as-built' drawings and records of the landform, surface features and sub-surface details such as utility services;
- details of the location, and characteristics of all buried contaminated material, demolition debris, unbroken foundations, abandoned underground services and drainage systems;
- details of the location construction and contents of all waste containment cells;
- details of the location and treatment of shafts, shallow mine workings and other buried voids;
- the methods and results of all verification testing carried out during and after construction.

The majority of this material will be prepared or collected as a routine part of the reclamation process. Provided that a management plan is commenced at an early stage, it is possible to collate reference material with a minimum of additional effort.

### **15.4.3 The maintenance of records**

The safe keeping of records and information over long periods is essential if future land managers and site users are to benefit. Systems which automatically warn of hazards or other vital information are more reliable than systems which rely on positive action or enquiry by land managers. For this reason it is good practice for features such as shaft caps, containment cells for contaminated material, and utility services such as electricity to be permanently indicated on site by exposed marker posts, and by plaques or plastic warning tapes buried in the ground above the feature to be protected (see Photograph 15.4). Such on-site warnings can refer attention to documentary details stored elsewhere.



**Photograph 15.4:** This raised brick cylinder will indicate the location and size of a capped and buried shaft once the surrounding land is regraded (source: Richards, Moorehead and Laing Ltd)

Documentary material should be stored where it is safe but accessible. Systems of cross-reference which automatically alert new users/managers to the location of documents, are particularly valuable. Such systems include annotations on land ownership deeds, references in management plans, and registers of reclaimed land held by public authorities. Multiple cross-referencing provides a safeguard against the loss of documents when the responsible organisations are reorganised or relocated.

## **15.5 Vegetation management**

### **15.5.1 Requirement and purpose**

Vegetation will develop and change according to the site characteristics and to the balance of external influences such as grazing, public use and management activities. The purpose of vegetation management is to

ensure that the vegetation fulfils the needs of the intended site use, through manipulation of the various external influences. This purpose will be one of the objectives set out in the management plan for the site. Management operations may seek to develop certain features, such as species diversity or soil fertility, or to maintain the vegetation as use of the site continues.

### **15.5.2 Existing vegetation**

Significant areas of vegetation are sometimes retained through the reclamation process, to add maturity or conserve wildlife habitats. This mature vegetation may require different management activities from those applied to newly established vegetation on the site. The management plan should recognise the particular characteristics of the mature vegetation, and any statutory protection or other special status, in prescribing management operations and site use.

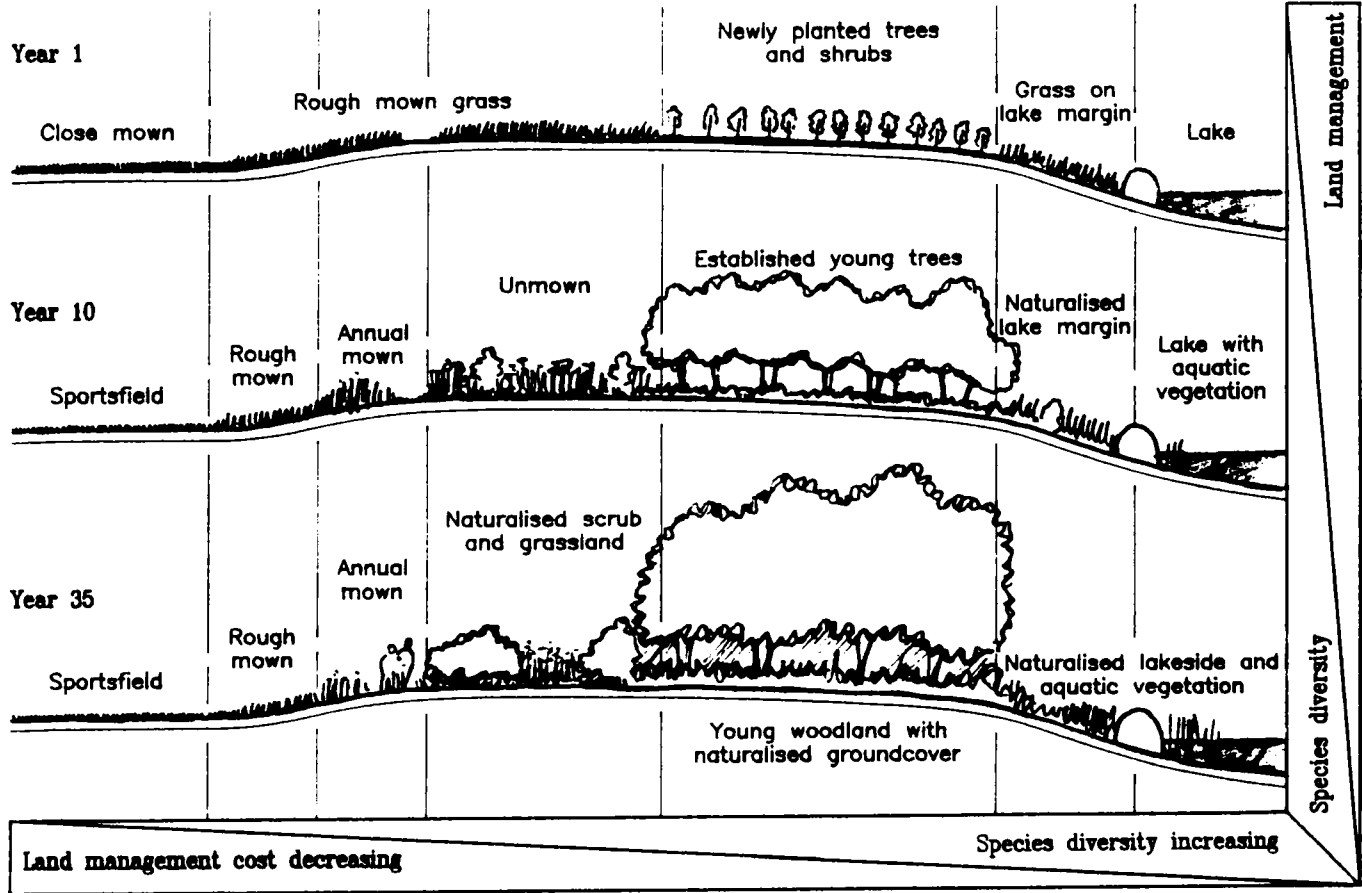
### **15.5.3 Naturalistic vegetation**

A natural approach to vegetation design is described in Box 14.4. One benefit of the establishment of a naturalistic vegetation which is suitable for the site and its use is that the requirements for vegetation management are usually considerably lower than those for more formal or productive vegetation. Figure 15.1 illustrates this relationship.

Naturalistic vegetation requires particular management skills and methods which may not be part of the landowner's existing resources. For example, management to enhance species and habitat diversity (see Box 15.3), requires a good understanding of the ecology of the site.

### **15.5.4 Grassland management**

The grasslands which have been established on reclaimed colliery spoil range from productive grazing swards to species-rich swards for amenity and wildlife conservation purposes. Productive swards, when



**Figure 15.1:** Changes in species diversity and land management with time

**Box 15.3:** Management for species and habitat diversity

Natural colonisation of regraded colliery spoil or iron and steel-making slags can be used to generate a diverse vegetation, if this does not conflict with other objectives of reclamation. If the physical conditions resulting from landform and earthworks (Box 13.5) are right then natural colonisation, guided by an overall strategy for land use and judicious management intervention only where necessary, will produce the most ecologically effective results.

Whether natural colonisation or deliberate planting and sowing are the means of revegetation, the role of the ecologist/land manager is to ensure that the desired habitats and species develop and are sustained. This may involve the deliberate introduction of desirable, appropriate species if monitoring indicates that they are unlikely to colonise naturally, and in many cases will require intervention to prevent or limit natural succession towards a more mature vegetation type. For example, most grasslands are unstable and will be invaded by scrub unless managed by grazing or cutting. Conversely, herbaceous species and trees will only colonise grassland if patches of bare soil are maintained or created by grazing, livestock trampling or cutting. Coppicing or repeated thinning of woodlands are required to maintain a light-demanding ground flora. A management plan is essential if the land manager is to know the original intentions of the reclamation scheme designer and to maintain consistent objectives.

successfully managed to provide worthwhile grazing, hay or silage cropping, can generate significant income towards the cost of management. Swards which are managed primarily for amenity purposes can be cropped at low intensity for hay or silage as a means of off-setting management costs and encouraging biodiversity.

Grasslands established on reclaimed blast furnace and steel-making slags have been restricted to very low productivity swards, managed for aesthetic, wildlife conservation and low-intensity recreational uses.

### **15.5.5 Agricultural management of grassland**

The management of grasslands in grazing use should follow good practice for agriculture, but must take particular account of the poorly-developed soils of reclamation sites (see Section 14.3). The grazing period may be restricted by excessive ground wetness in the winter and by lack of grass growth in dry summers. Swards often lose productivity despite good management, and can be renewed by recultivation and reseeding on a regular basis (see Box 15.4). The selection of grazing animals also has a significant effect on the sward (see Box 15.5).

The presence of heavy metals in the substrate, *e.g.* from flue dusts, should be clearly stated in the management plan since there is a risk that livestock will ingest heavy metals via plant material. Box 15.6 summarises the measures which will ensure that unacceptable metal uptake by animals is avoided.

### **15.5.6 Management of grassland for amenity purposes**

Amenity grassland established on colliery spoil or the slags from iron and steel making can be managed generally in the manner of any other amenity grassland, provided that the objectives of management are guided by the aims of reclamation and take note of any particular circumstances identified in the management plan. These may include:

- the need to ensure a vegetation cover for surface stabilisation;
- the need to restrict nutrient levels to encourage species diversity;
- the need to time mowing to allow seed production by particular species;
- the need to maintain an unmown buffer to restrict access to sensitive habitats.

**Box 15.4:**           Recultivation systems for grassland productivity

Colliery spoil sites which have been successfully reclaimed to grassland frequently become less productive after 5-6 years despite regular ameliorative treatment.<sup>216</sup> The deterioration follows weathering of the spoil, a process described in Chapter 5. Weathering leads to:

- increased acidity;
- consolidation of the upper 150-200mm profile;
- impeded microbial activity;
- nutrient deficiency;
- impeded drainage;
- thatch development;
- impeded root penetration;
- ineffective lime and fertiliser applications;
- extremes of soil moisture availability.

These factors combine to produce an unproductive sward. This has been overcome by aeration and cultivation methods. Aeration and subsoiling temporarily improve the physical condition of the substrate until further weathering leads to a recurrence of the problems listed. Full recultivation, consisting of rotavation to 75mm followed by deep subsoiling, seedbed preparation and reseeding, has a much longer lasting effect through:

- aeration and improved drainage;
- deep incorporation of lime and nutrients;
- effective pH control;
- incorporation of organic matter from the sward;
- increased microbial activity producing nutrient mineralisation and humus;
- formation of a soil crumb structure;
- improved moisture retention;
- deeper root penetration.

Recultivation can be used in conjunction with short-term pioneer crops, such as green manures and legumes, grown specifically to develop soils from spoil and as part of the long-term management of land on a 5-7 year grass ley system. Recultivation will be impeded unless care is taken to eliminate buried obstructions and debris from the upper layer of the substrate during the initial earthworks.

**Box 15.5:** The management of grazing

The nature, intensity and duration of grazing affect the ability of the sward to recover, and its species composition.

Grazing should be managed to crop the sward evenly and closely, without leaving clumps of weeds or unpalatable grasses and without damaging the growing points of the grass. Clover is less tolerant of close grazing than is grass.

Sheep graze closely and evenly. They bite through the grass rather than pulling at it, and so do less damage than horses provided that grazing is stopped when the sward has been cropped. Sheep grazing favours a dense sward of low-growing grasses, and causes little damage to the soil surface. In urban fringe areas dogs cause problems by worrying sheep.

Cattle tear at the grass rather than biting through it. This is damaging to poorly rooted or poorly established grass. Cattle do not graze the sward as closely as sheep, and if stocking rates are low they will avoid the less palatable grass species which can spread as a result. Cattle can cause considerable surface damage on wet or soft land. Calves, being lighter, cause less damage to the ground.

Horses graze very selectively, avoiding unpalatable grasses and weeds. They also tear at the sward, uprooting and damaging the grass plants. The sward rapidly becomes untidy and unproductive and open to weed invasion. Horse hooves do a great deal of damage, particularly on sloping, wet ground. Horses are a potential danger to the public on open land.

Practical considerations can also limit or guide management operations, *e.g.*:

- physical obstructions to close mowing;
- the need to mow regularly to control invasive weeds;
- the need to remove thatch build-up, to control pH and to promote nutrient cycling (see Box 15.4 and Figure 15.2);
- the need for fertiliser to ensure growth to repair sward damage caused by intensive use;

**Box 15.6:** Limiting the intake of heavy metals by grazing animals

High concentrations of inorganic contaminants (except cadmium and zinc) in soils have little influence on the concentrations in herbage provided that the soil pH is maintained at 6.5 or above. In these circumstances the risk to livestock depends almost entirely on the amount of soil ingested and toxic element concentrations in that soil. The soil contamination of the herbage can be minimised by:

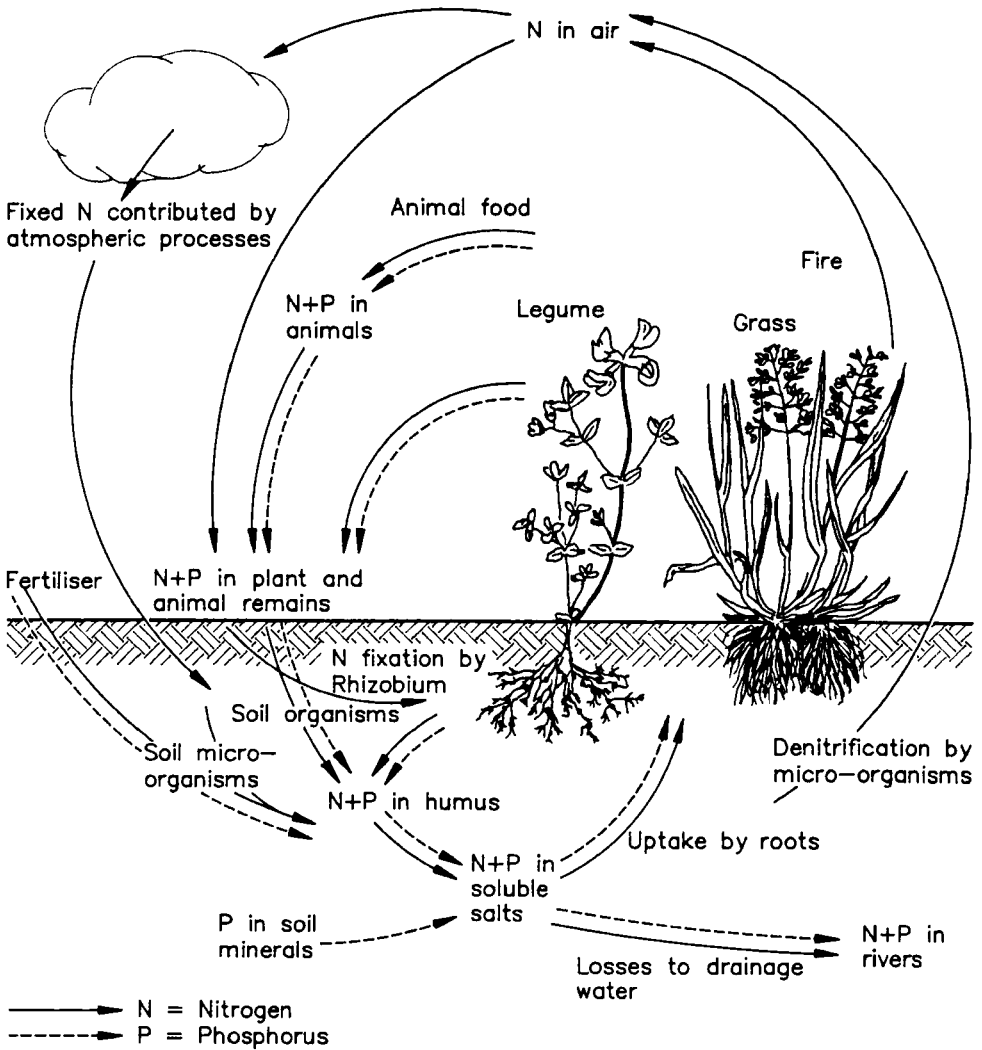
- placing uncontaminated material as the uppermost layer of substrate;
- excluding livestock until a close-knit sward has developed;
- mowing the new grass to encourage a close-knit sward;
- maintaining a close-knit sward;
- maintaining a mat of vegetation debris at the soil surface;
- harvesting silage with a pick-up harvester and leaving a long stubble where contamination of the soil is highest;
- managing grazing to avoid overgrazing and poaching of the surface.

The potential for metal uptake by livestock should be monitored and controlled, by analysis of the herbage and careful rotation of the grazing periods allowed for each group of animals.

Detailed guidance is given in ICRL Guidance Note 70/90.<sup>122</sup>

- the availability of a free source of nutrients *e.g.* sewage sludge, where quality, run-off and public health considerations permit its use.

The costs of grass mowing are significantly influenced by the design of the site, the complexity of shapes and edges, the size and type of machine which can be used, the finish and use of the sward, the species and cultivar mixture established and many other factors. The cost of management should not dictate the design and objectives but should be carefully considered at the design stage so that objectives can be achieved and maintained within the available resources. Many interesting landscapes have been simplified and made bland by measures taken to reduce the costs of maintenance.



The greatest stores tend to be in the organic matter, released by the activities of micro-organisms; there is input of nitrogen by fixation and phosphate by release from the soil minerals, and little is lost.

**Figure 15.2:** Nutrients circulating continuously in the soil/plant ecosystem (after Bradshaw and Chadwick, 1980<sup>40</sup>)

### 15.5.7 Management of woodlands

Woodland and forestry plantations established on colliery spoil can be managed in the same way as those on natural ground, provided that the objectives of management recognise the particular requirements and circumstances of the site. These may include:

- a greater need for nutrient additions after the establishment phase. Such additions are uncommon in commercial forestry;
- the need to retain nitrogen-fixing nurse species. *e.g.* alder and lupin, as a component of the maturing woodland on nutrient-poor substrates;
- the need to monitor the growth of vigorous nurse species and to thin selectively to ensure the development of the desired ultimate species mixture;
- the greater risk of fire damage at urban-fringe and recreational sites. This can be reduced by rigorous control of grass and scrub around the woodland;
- the greater risk of fence damage at public sites, allowing livestock access to young woodlands;
- the greater risk of windthrow where tree rooting is restricted to shallow layers of improved substrate. The selection and management of short trees or scrub will reduce this problem.

Sewage sludge is a source of nutrients and organic matter which can be applied to developing young woodland using irrigation or soil injection equipment if practical difficulties such as access, odour and temporary exclusion of the public can be overcome.

The costs of woodland management can be offset by the harvesting of timber products and the conversion of wastes such as thinnings or brash into useful wood chips, mulch or composts.

'Urban forestry' *i.e.* the management of urban and amenity planting in a semi-commercial way, has been used successfully.

Voluntary groups, such as those concerned with wildlife and woodland conservation, assist with labour-intensive tasks of management in some woodlands where conservation and public amenity is the primary management objective.

### **15.5.8 Management of wetlands**

Where wetland systems have been established to treat acid mine drainage water, as described in Chapter 12, the primary objective of their management is their efficient functioning. The management plan should clearly show that any secondary objectives such as wildlife conservation should not conflict with the water treatment objective. These wetland systems, if properly established, require minimal maintenance but routine monitoring is required to identify any decline in the effectiveness of water treatment. Remedial action may then be required in order to renew plant growth, correct substrate conditions or to restore correct water flow patterns (see Photograph 15.5).

## **15.6 Management of engineering structures and utility services**

### **15.6.1 Introduction**

Reclaimed sites typically contain many structures which protect the integrity and use of the land. If these structures fail to function as designed *e.g.* through deterioration or damage, considerable disruption of the land surface or its use may result.

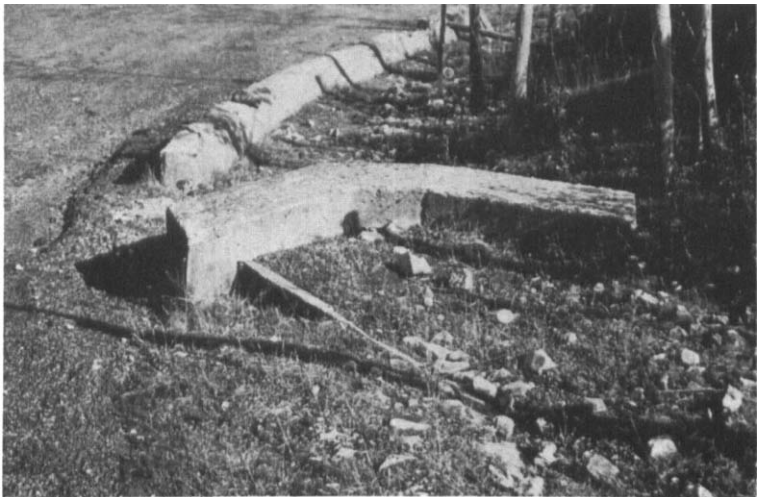
### **15.6.2 Drainage**

Reclamation landforms are highly susceptible to erosion by flowing water, particularly in the stage before a vegetation cover is fully established.

Land drainage systems which concentrate surface water into ditches and channels increase the damage which can be caused should the system fail through inlet blockage, ditch overflow or other causes. The management plan should contain a programme for the routine inspection of drainage systems, based on an analysis of the likely consequences of failure.

Drainage systems are at risk from:

- blockage of inlet pipes and screens by litter, plastic sheets, debris from subsequent development and deliberate obstruction;
- blockage of silt traps and catch pits by eroded material;
- blockage of french drains, filter-fabric and perforated pipe drains by silt particles;
- erosion damage in exceptionally high flow conditions.



**Photograph 15.5:** This drainage system is completely blocked by silt. Regular inspection and clearance is essential (source: Welsh Development Agency)

### **15.6.3 Contaminated areas**

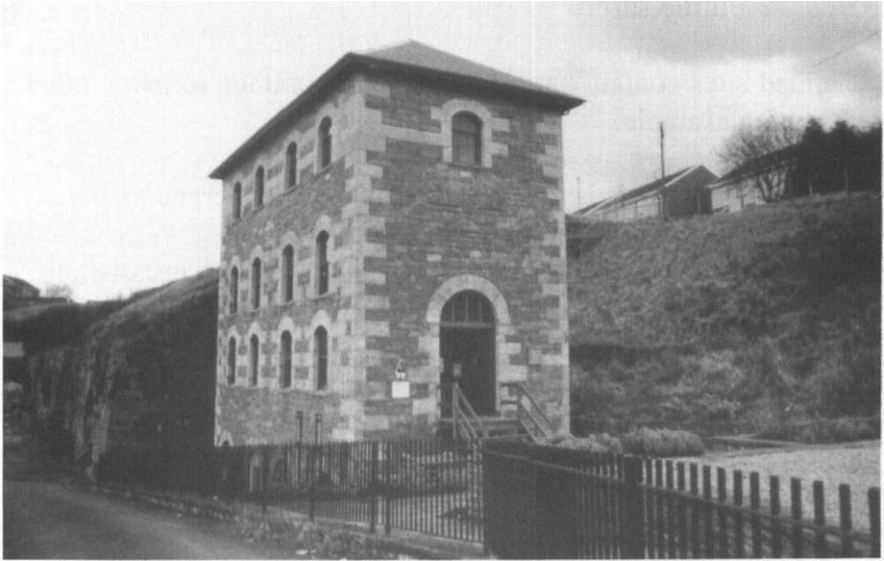
If contaminated materials have been disposed of in on-site containment areas, placed in a manner where dispersal is prevented, or otherwise retained on site, the integrity of the disposal system should be monitored by periodic sampling of groundwater, surface water, vegetation or other indicators. A monitoring programme is often a formal requirement of statutory consents for the disposal of contaminated materials (see Section 11.9).

### **15.6.4 Structures**

The management of new structures such as buildings and bridges which are erected as part of the development of reclaimed sites will typically form part of the routine management programmes of the responsible authorities or landowners. Reclamation schemes may also involve the retention of earlier structures which continue to serve a purpose *e.g.* dams and retaining walls, or have historic interest *e.g.* disused buildings, bridges and industrial relics (see Photograph 15.6). Structures of historical relevance will require periodic maintenance and repair which, because of their age, may be frequent and/or costly. The responsibility for the care of these structures should be clearly identified at an early stage so that appropriate resources can be made available. Without adequate maintenance these structures can become a significant hazard to the public.

### **15.6.5 Subsidence and settlement**

Shallow mine workings, underground voids and significant depths of fill all have the potential for subsidence or settlement which can affect structures or the use of land. The effectiveness and long-term integrity of the engineering treatment of mine workings, voids and filling should be confirmed and monitored (see Chapter 3).



**Photograph 15.6:** This engine house has been carefully restored. A long-term programme of care and maintenance will ensure that it is used and enjoyed by future generations (source: Merthyr Tydfil Heritage Trust)

## **15.7 The management of site use**

### **15.7.1 Litter, rubbish tipping and vandalism**

Litter, tipping of rubbish and vandalism frequently occur on derelict land which may be regarded by some sections of the public as waste land, uncared for and therefore open to misuse. Once such use patterns have built up they commonly continue after the reclamation of a site. Designs which leave areas of unused land or apparently unmanaged land are more likely to prolong the abuse of land than designs which show the land to be in use. If litter and vandal damage are left untreated a pattern of misuse will quickly develop. Land uses which encourage the presence of people throughout the day tend to discourage misuse of the site.

### **15.7.2 Public safety**

Reclaimed sites contain hazards which are common to many other types of land, for example;

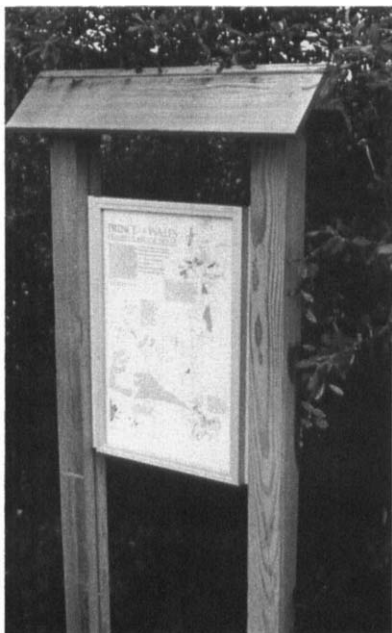
- lagoons, balancing ponds and other waterbodies;
- abrupt changes in level;
- electricity sub-stations and similar service installations.

Protective measures such as fences and barriers, lifebelts and safety equipment, and warning notices need to be inspected and maintained on a routine basis. Such inspection may be a legal requirement.

### **15.7.3 Public access**

The newly established vegetation of reclaimed sites is generally less tolerant of disturbance and wear than similar vegetation on more fertile substrates. Areas of wildlife interest may also be intolerant of disturbance. For these reasons the control of access can be an important part of the management of site use. Access can be encouraged or discouraged by design details such as paths, signs, interpretive information, physical barriers, landform and dense vegetation. The general pattern of access will be decided during site design, but the detail will commonly be refined in response to developing patterns of site use (see Photograph 15.7).

Areas of more intensive use, such as sports pitches and recreation facilities, require control so that the intensity of wear does not exceed the capacity of the facility (particularly the vegetation) to regrow and repair the damage caused.



**Photograph 15.7:**

Paths, signs and information boards help visitors enjoy the busy Brynbach park, but create an informal atmosphere. Low-key signs, using sympathetic materials, are more appropriate for informal and rural areas.



#### **15.7.4 Wardening and site staff**

Staffing by a warden or ranger service, possibly on a voluntary or part-time basis, may be necessary for the satisfactory management of a site. Full-time staffing provides a means for collecting revenue from users of the site, by charging for the use of facilities.