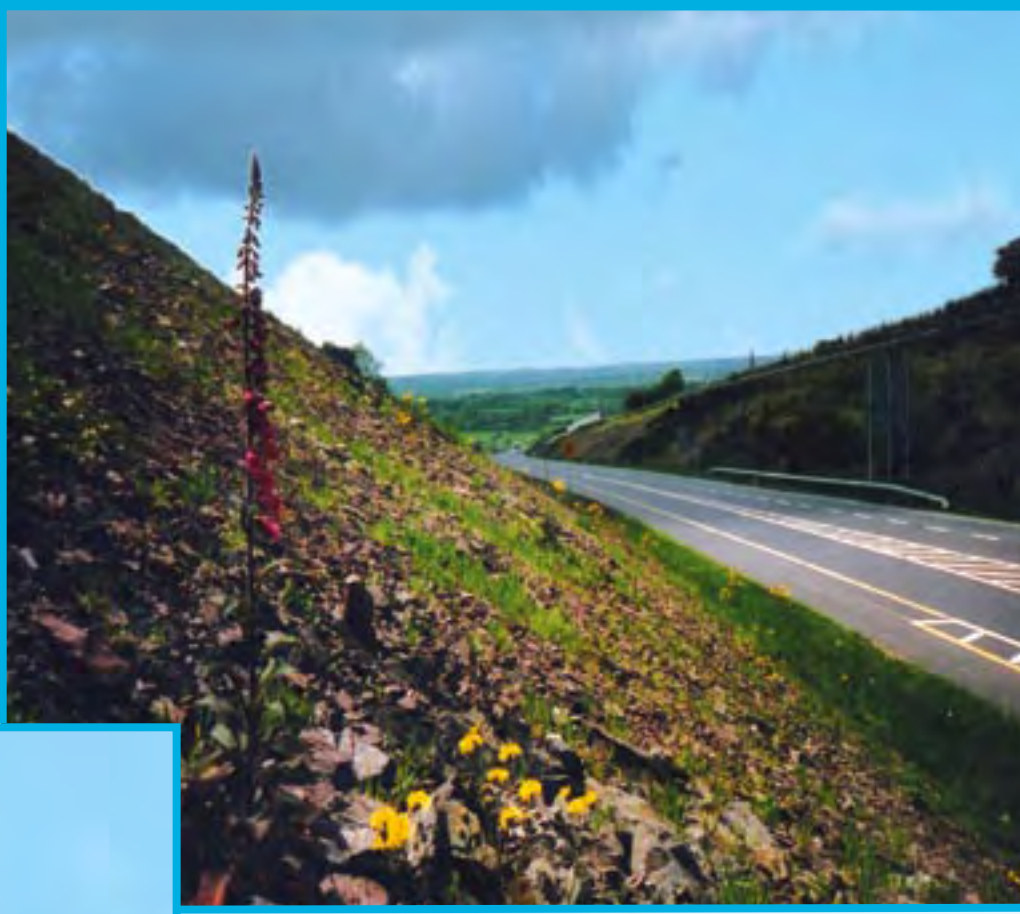
NRA
National Roads Authority
An tÚdarás um Bóithre Náisiúnta

A Guide to Landscape Treatments
for National Road Schemes in Ireland



NATIONAL ROADS AUTHORITY

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Introduction

1. Introduction

In undertaking landscape treatments for Ireland's national road network, the National Roads Authority (NRA) is one of the largest procurers of landscaping works in the country. In light of this responsibility and the potential for the restoration and management of landscape quality, the Authority commissioned the preparation of the following *Guidelines on Landscape Treatments for National Road Schemes*. This document provides guidance in best practice for landscaping works within the design, construction, maintenance and decommissioning phases of rural national road schemes.

Landscape mitigation is concerned with the reduction and remediation of cultural, social and ecological impacts on landscape quality which arise from the interactions between roads and the existing landscape. In providing mitigation of and compensation for impacts, landscape treatments have the potential to make a significant and valuable contribution to biodiversity conservation, environmental aesthetics and to the retention of regional identity, landscape character and diversity, along with visually attractive conditions for the driver and passengers within the vehicle.

More specifically, landscape treatments within the roadside landscape can aim to address, a) habitat loss and habitat fragmentation through the restoration of and/or compensation for disturbed vegetation and b) the restoration of connectivity between the elements of existing native vegetation in the roadside landscape and in the vicinity of the road scheme. Landscape treatments can also integrate fauna passages into the surrounding native vegetation.

The *Guidelines* promote an 'Ecological Landscape Design' approach in the selection of appropriate landscape treatments for national road schemes. The approach entails an integrated understanding of the various cultural, social and ecological aspects of landscape design leading to the selection of treatments that utilise and enhance the positive aspects of the road and the immediate landscape. Ecological Landscape Design also addresses design from the perspective of the mobile road user, i.e. "the driver and passengers within the vehicle", and indeed for the local inhabitants along a road scheme, where landscape treatments incorporate preferred landscape features which will retain regional identity, landscape character and diversity.

Significantly, Ecological Landscape Design is seen as a significant move away from focusing on the need for an immediate visual effect, often linked to planting of homogenous linear belts of trees fronted by vigorous grass verges. This approach, often supported by horticultural practices, including the application of fertilizer, frequent mowing regimes and the use of ornamental plantings, promoted an urban or park-like perspective of Irish rural roadside landscapes.

To enhance the effectiveness of Ecological Landscape Design, the *Guidelines* promote the use of native species from indigenous seed stands in an environmentally sustainable and cost-effective way so as to produce long-term self-sustaining landscape treatments that are underpinned by resource management. This use of native species is an objective of national and international policy, including the *National Biodiversity Plan* (2002) and the *UN Convention on Biological Diversity* (1992), and contributes to Ireland's commitments under the EU Habitats Directive, 92/43/EEC.

In meeting the requirements of national and international objectives, the Guidelines promote a more sustainable use of the landscape and other natural resources associated with the development of national road schemes. The approach sets out a creative framework which provides for conservation of biodiversity, restoration of landscape quality and makes provisions to improve conditions for road users.

Chapter 2
The landscape and policy context

2. The Landscape and Policy Context

2.1 The Interactions between Roads and Landscapes

The European Convention on Landscape, 2000, defines the Landscape as "an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors". Landscape quality is recognised as the dominant feature of a landscape, which is based on a combination of the visual and non-visual attributes of a landscape.

Interactions between roads and the landscape which affect the landscape's visual attributes, impact mainly on peoples' perceptions of a landscape, i.e. the values which they place on a landscape. People's values can be affected through a loss of: regional identity; variety; naturalness and environmental aesthetics. In contrast, the interactions between roads and ecosystems (Figure 2.1) may not always be visible, but may manifest over time. Impacts on the non-visual attributes of a landscape can affect ecosystem function and integrity, i.e. critical ecological services, such as nutrient cycling and flood control. These impacts can arise from soil disturbance, and habitat loss and fragmentation. The fragmentation of habitats also results in a loss of connectivity and of the ability of flora and fauna to disperse between and within ecosystems.

The mitigation, compensation and restoration opportunities provided by the various components of the roadside landscape mean that roads exhibit an ability to adjust to conditions, blend with the landscape, and reach new ecological states, in effect, adding a new ecosystem to the landscape.

An "ecosystem approach" to landscape treatments, developed through Ecological Landscape Design, provides a "method for sustaining or restoring natural systems and their functions and values" through the establishment of treatments which are underpinned by the management of natural resources.

Figure 2.1

The restoration of disturbed habitat and the establishment of a compensatory habitat; a Brackish-Intertidal Marsh was a specific objective of a landscape treatment on the N25 Youghal Bypass, Co.Cork.

2.2 An Overview of Environmental and Landscape Legislation and Direction

The treatment of interactions between roads and landscapes operates against a background of national, EU and international legislation and policy. The following provides an overview of the relevant legislation and international best practice which underpin a best practice approach to landscape treatments for road schemes in Ireland.

2.2.1 National Legislation and Policy

National policy in relation to aspects of landscape treatments is addressed in the *National Biodiversity Plan*, 2002 and the *National Heritage Plan*, 2002 (See sections 2.2.2 and 2.2.3).

The Roads Act, 1993, as amended, provides the principal legislation governing aspects of road development in Ireland and provides for the preparation of an Environmental Impact Statement (EIS) for qualifying schemes. In giving effect to the Directive on Environmental Impact Assessment (85/337/EEC, as amended by 97/11/EC), section 50 (d) (2) of the Roads Act requires that "where significant adverse effects are identified, a description of the measures envisaged in order to avoid, reduce and, if possible, remedy those effects" be given. The provisions and requirements of the Roads Act in this regard are extensively addressed in the NRA's guideline document *Environmental Impact Assessment of National Road Schemes – A Practical Guide* (National Roads Authority, 2005). Where a road project does not require the preparation of an EIS, it is common practice to prepare a similarly structured Environmental Report (ER).

It is important that mitigation requirements, as highlighted in the EIS/ER, are appropriate, clearly defined and consistent, and that the requirement for mitigation measures is clearly identified in the Employers Requirements and in associated supporting material in the tender and contract package. Critically, within Design and Build (D&B), Public Private Partnerships (PPP) and Early Contractor Involvement (ECI) contract formats, it is intended that the tender procedure be flexible and open to the consideration of alternative designs for all aspects of the road project, including the landscape design and treatment.

In relation to road safety, section 70(2) of the Roads Act considers, inter alia, dangerous roadside trees. Such considerations are important when selecting planting material for landscape treatments and in the retention of existing vegetation, especially mature trees, in proximity to carriageways.

In addition, the NRA TD 19 (Part 8A of *NRA Design Manual for Roads and Bridges*) deals with potential obstruction, falling and impacts of hazards within a specified 'Clear Zone', including those relating to the maximum allowable girth of mature trees and many larger shrub species.

There are a number of further critical safety and engineering constraints that must be considered in treatments including those relating to clearance and line of sight issues e.g. in and around junctions and signage. Access for maintenance of boundary fences and other features within road corridors must also be considered in the design and layout of treatments, especially with respect to hedgerow treatments. Similarly, issues relating to the drainage and stability of slopes, and access for maintenance of culverts, swales and other drainage features should be considered

in proposed treatments.

In the maintenance of road landscapes, consideration should also be given to the appropriate and effective control of non-native invasive species and those species listed under the Noxious Weeds Act, 1936. In relation to plant health, the Department of Agriculture and Food operates phytosanitary controls under both national and EU legislation in order to maintain Ireland's plant health status. Any unusual occurrence of disease or pest in planting material should be notified immediately to the Plant Protection Service of the Department.

With respect to wildlife conservation and protection of the natural environment, the Wildlife Act, 1976, as amended in 2000, gives statutory protection to Natural Heritage Areas (NHAs) in Ireland. The Act is complemented by European legislation such as the Habitats Directive (92/43/EEC) (see Section 2.2.2).

2.2.2 European Legislation and Policy

At European level, the Habitats Directive 92/43/EEC provides for the preservation of habitats and species of Community interest and allows for the identification and designation of Special Areas of Conservation (SACs). In encouraging the establishment of corridors and other landscape features between protected areas, Article 10 of the Directive states that "Member States shall endeavour in their land-use planning and development policies, to encourage the management of features of the landscape which are of major importance for wild flora and fauna". Corridors for

Figure 2.2

An example of a marsh/wetland created at Kilmacanogue in County Wicklow, one of the treatments selected for the N11 Glen of the Downs Road Project. Wetland sods and plants disturbed elsewhere along the road scheme were translocated to provide a new compensatory habitat.

the dispersal of wildlife are an example of such features in land-use planning.

The mitigation of habitat fragmentation is a focus of Infra Eco Network Europe (IENE), a network of some twenty countries, including Ireland, which are cooperating to promote an efficient, sustainable and safe pan-European transport network. In 2003, IENE produced the COST 341 Handbook aimed at minimising ecological barriers and the fragmentation effects of transportation infrastructure on wildlife. A compensatory habitat, provided as part of the N11 Glen of the Downs Landscape Mitigation Masterplan (Figure 2.2), features in the handbook as an example of good international practice in this area.

The European Landscape Convention, 2000, which was ratified by Ireland in 2002, is of particular significance to the Guidelines. This Convention emphasises the need to focus on the wider environment and the need for protection and enhancement of its inherent diversity and characteristics. The Convention states that "landscape is a key element of individual and social well-being and its protection, management and planning entails rights and responsibilities for everyone". A stated aim is the adoption of policies aimed at protecting, managing and planning landscapes in Europe so as to maintain and improve "landscape quality" and to bring widespread recognition to the value and importance of the landscape.

The Council of Europe (2001) has drawn up a "code of practice for the introduction of biological and landscape diversity considerations into the transport sector" to help national governments and others involved in the linear transport sector to consider and implement measures relating to the maintenance and enhancement of biological and landscape diversity.

2.2.3 International Legislation and Policy

Internationally, the UN Convention on Biological Diversity, 1992, ratified by Ireland in 1996, imposes obligations for the conservation and sustainable management of biological diversity "and the ecological complexes" of ecosystems and natural habitats both inside and outside protected areas.

The Convention on Biological Diversity promotes the use of "the ecosystem approach" (Decision V/6 of the Conference of the Parties) as an appropriate framework for the assessment of planned actions and policies in relation to transportation infrastructure. The "ecosystem approach" also complements Article 10 of the European Habitats Directive, as it encourages the establishment of corridors and other landscape features between protected areas.

Ireland's response to the issues raised in the European Landscape Convention, the UN Convention on Biological Diversity and others, has involved the parallel preparation of the *National Biodiversity Plan*, 2002, and the *National Heritage Plan*, 2002. These Guidelines aim to complement the intended provisions of both Plans.

2.3 International, European Direction and National Best Practice

The management of landscape quality and natural resources, and the use of native species are strongly promoted best practice policies that should underpin any approach to landscape treatments. In addition, Ecological Landscape Design integrates the professions of ecology and landscape design. In promoting best practice, it offers the following main advantages:

- The integration of the principles of ecology and landscape design moves the design process away from the view of the landscape dominated by visual attributes, towards a more comprehensive understanding of ecosystems, thus helping to conserve biodiversity and ensuring environmental sustainability.

- The selection of treatments evolves from an understanding and appreciation of the preferred features within the landscape, contributing to regional identity in the design process.

In order to conserve biodiversity, best practice dictates that the road be ecologically fitted to the landscape by applying the principles of ecological infrastructure analysis through Ecological Landscape Design. This analysis recognizes that treatments within the roadside landscape can facilitate the extension of ecological networks of corridors between core habitats and protected areas, in order to mitigate the effects of habitat fragmentation and habitat loss (see Chapter 4).

Ecological landscape design also incorporates environmental sustainability as landscape treatments are designed to minimise the ecological footprint of a new road scheme.

The key to developing a sustainable landscape treatment is to minimise the use of energy and natural resource inputs (water, fertilizers, herbicides, pesticides, etc.) in stock production, plant establishment (including ground preparation) and to reduce the need for long-term maintenance of the treatment.

When considering a landscape treatment for a particular location, the landscape designer should focus on the selection of a treatment that best fulfils the identified or desired objective(s) and reflects existing native vegetation and soil types. Landscape treatments should be locally-appropriate (in terms of soil type, choice of native species and sources of native plant material), which will maintain ecological integrity and restore nutrient cycling (see Chapter 6).

The most sustainable type of landscape treatment is natural recolonisation, which requires specific ecological and site conditions for success (see Chapter 5). Natural recolonisation can prove highly attractive to the road user, once people appreciate the ecological function of the landscape treatment.

Where direct planting of native trees and shrubs is envisaged, indigenous plant material is required (see Section 2.4.1) and where feasible, appropriate provisions should be made to retain suitable local soil for ground preparation (see Chapter 5). The plant species mixes selected for planting should reflect the local soil geographic factors, and the detail in the relevant EIS/ER pertaining to the species and the percentage species composition of the native vegetation within the surrounding landscape, e.g., in woodland and wetland remnants, severed hedgerows etc.

The participation of stakeholders in the development process also forms part of the basis for a sustainable approach to landscape treatments. Criteria in Local Agenda 21 stress the importance of seeking public participation, especially in planning and design. Public participation is normally undertaken as part of the Environmental Impact Assessment (EIA) process during the planning and development of national road schemes (see Chapter 3).

Ecological Landscape Design of roadside landscapes also requires the consideration of the contextual framework of the mobile road user or "the driver and passengers within the vehicle". The concept of dynamic scale determines the view from within the vehicle and should be incorporated into treatments; especially those whose main objective is to mitigate impacts of road construction on the visual attributes of the landscape (see Chapter 3).

A reduction in driver monotony and fatigue or improved conditions for driver safety should also be of key concern to the landscape designer, e.g. the creation of vistas for the driver needs to be based on an awareness of the resultant effects on the driver and others (see Chapter 3).

In summary, international best practice promotes an integrated Ecological Landscape Design approach to landscape treatments, where the objectives are:

- to ecologically fit the road to the landscape through the establishment of treatments that will complement the ecological network, thus countering the potential barrier and fragmentation effects of roads;
- to address environmental sustainability through the minimisation of natural resource inputs and long-term maintenance, including facilitating natural recolonisation and public appreciation of the wider environmental benefit of self-sustaining treatments;
- to promote the adoption and use of native plant species grown from indigenous seed sources;
- to incorporate the contextual framework of the driver and passenger within the vehicle and reduction in driver monotony and fatigue through increasing driver alertness; and
- to encourage regional identity in the design process.

2.4 Policy on the use of Native and Non-Native Species

2.4.1 Use of Native Species

The National Roads Authority (NRA) recognises the work of the Forest Service (Department of Agriculture and Food) in the development of the Native Woodland Scheme, in association with Woodlands of Ireland, the National Parks and Wildlife Service, the Heritage Council and others. This Scheme provides grant aid for the conservation and restoration of existing native woodland, and the establishment of new native woodland. A central principle of the Native Woodland Scheme is that all forest reproductive material used under the Scheme must originate from suitable sources within Ireland.

Furthermore, the planting stock for use in or adjoining Special Areas of Conservation (SACs), Natural Heritage Areas (NHAs), Nature Reserves, National Parks and known ancient woodlands must originate from seed collected from within or close to these areas.

Central to the core objective of these Guidelines is promotion of the use of native plants and seed from indigenous seed sources within landscape treatments. The NRA acknowledges that the use of native species can make a significant and important contribution to the conservation of biodiversity whilst retaining regional identity, distinctive landscape character and the cultural significance of the Irish landscape. The Authority promotes the use of native species and indigenous plant material that meet the criteria of the Native Woodland Scheme so as to:

- comply with international and national landscape policies which emphasise the management of landscape quality;
- contribute to national commitments on the conservation of biological diversity, by providing a positive step towards establishing native habitats and reducing the planting and dispersion of non-native plants;
- restore or compensate for loss of habitat and to maintain regional identity, landscape character and diversity;
- promote species-specific planting as a valuable tool for biodiversity conservation, as native fauna evolved with native flora;
- complement the establishment of self-sustainable treatments as native species may be "pre-adapted" to site conditions, therefore requiring minimal resource inputs; and,
- ensure a reduction in the threat posed by the importation of pests and diseases carried on non-native plant material, which have potential for major impact on native flora and fauna, the landscape, agriculture and forestry.

Where the use of native species is recommended in a proposed landscape treatment, it is important to ensure, to the extent feasible, that the native species selected and the plant species mixes reflect native plant communities adjacent to or in the vicinity of the road scheme. Therefore, only planting stock that complies with the sourcing conditions of the Native Woodland Scheme should

be considered for landscape treatments on national road schemes. In such cases, deliveries must be accompanied by an approved Provenance Declaration Form/Suppliers Document incorporating the appropriate Certificate of Provenance number. This requirement only applies to those species acceptable under the Native Woodland Scheme.

In order to provide an appropriate lead-in time for obtaining plants from indigenous seed sources, the civil (main) road contractor will be required to appoint the landscape contractor/ supplier at the awarding stage of the main engineering contract. As the majority of road schemes will require a number of years of construction prior to the requirement for planting, this early appointment should afford the necessary timing for the sourcing of seed, plant establishment and stock production of the required plants for treatments.

In comparison to mainland Europe, Ireland has a small number of native trees and shrubs, of which only about 50% are common or widespread and, as such, appropriate for general use in landscape treatments for road schemes. As the remaining species are rare in Ireland and tend to have a very restricted habitat range they cannot be considered suitable for general roadside planting. They should only be considered for use where they are specified within the EIS/ER as being present in the landscape influenced by new road schemes.

The most common native trees and shrubs that are deemed suitable to a wide range of landscape treatments for road schemes in Ireland are outlined in Appendix 1.

Figure 2.3

The non-native species Beech, Chestnut and Lime within this copse along a section of the old N11 carriageway in County Wicklow are of local cultural significance.

2.4.2 Use of Non-native Species

In particular situations, treatments that make limited use of non-native or introduced species such as Beech (*Fagus sylvatica*), Chestnut (*Aesculus hippocastanum*) and Lime (*Tilia spp.*) may be acceptable so as to retain local landscape character. Where non-native trees within tree-lined avenues, parkland trees, estate boundaries and planted copses (Figure 2.3) are disturbed during construction, and where the particular trees were identified in the EIS/ER, or otherwise, as being of local cultural significance, the same non-native species can be considered for replacements. Where the particular species is not identified as being of local cultural significance, native tree species should be utilised as replacements.

It should be noted that non-native species should be sensitively used as they can contribute to a loss of naturalness through the urbanisation of a rural landscape. Non-native species should not be utilised in treatments on or near sites of local ecological importance, for example, near existing native woodlands, or sites adjoining or within NHAs, SACs, or Special Protection Areas (SPAs).

Certain non-native species - in particular, non-native invasive species such as Rhododendron ponticum, and Sycamore (*Acer pseudoplatanus*) have significant potential to affect naturalness, regional landscape identity and character and can seriously interfere with ecosystem function and consequently should not be used in treatments on road schemes.

2.5 Summary of Policy on Best Practice for Landscape Treatments

The following provides a summary of the most important policy principles for best practice in the design, preparation, implementation, maintenance and management of landscape treatments on national road schemes.

- Landscape treatments for road schemes should be developed under a multidisciplinary management approach where engineers, ecologists, landscape designers, environmental scientists and other specialists (e.g. soil, noise, historians, cultural heritage, archaeologists) work in an integrated manner so as to provide for maximum mitigation of impacts on the landscape.

- When selecting treatments, the landscape designer should liaise with the Project Design Team in order to address any concerns relating to the engineering design of the road scheme.

- Clear Zones, identified for the purposes of road safety and appropriate to the design of the road, should be maintained free of all specific hazards, including inappropriate planting.

- Sightlines should be maintained free of planting capable of obstructing junction visibility, forward or passing visibility or obscuring visibility of signage.

- Treatments should consider the requirement for access in terms of general maintenance of road features, including fences, culverts and drainage.

- The EIS/ER should identify specific, integrated and relevant landscape mitigation proposals which are capable of being transposed to the detailed design, preparation, implementation, maintenance and management of treatments for road schemes.

- In relation to landscape treatments, the Employers Requirements together with any supportive documentation should be clear, consistent and appropriate to the proposed design, construction and maintenance of the roadside landscape.

- Contract documentation and tender procedure, particularly for Design and Build, Early Contractor Involvement and Public Private Partnership format tenders, should be flexible in terms of their capacity for consideration of potentially improved designs and treatments.

- The landscape contractor/supplier should be appointed at the earliest possible opportunity so as to facilitate the sourcing of seed, stock production and delivery of the specified native plants.

- An appropriate mix of native species of indigenous seed source (reflecting native plant communities in the vicinity of a road scheme) should be utilised in treatments, where recommended. All such planting material should be accompanied by a Provenance Declaration Form/Suppliers Document as required by the Native Woodland Scheme.

- Non-native species should only be considered where their presence can be identified in the EIS/ER as having been of significant local cultural importance. Non-native species should not be used where they can adversely impact on locally sensitive sites or protected areas.

- Potentially invasive species should not be used in landscape treatments.

- Treatments should be capable of developing into self-sustaining habitats without future potential hazard or requirement for input of resources.

- Extensive rather than intensive practices should be employed as opposed to overly horticultural based maintenance and aftercare practices.

- The application of fertilizer should be avoided on roadside landscapes.

- The application of pesticides and herbicides should also be avoided or minimised in the maintenance of road landscapes.

Chapter 3
Landscape Treatments - Principles & Approach

3. Landscape Treatments – Principles and Approach

This chapter sets out the approach to be utilised in the selection and detailing of landscape treatments in a Landscape Mitigation Masterplan for road schemes. In selecting treatments, the context of the road scheme should be fully investigated and clear objectives established for determining appropriate landscape treatments. Such objectives should relate to both the aesthetic, visual and the non-visual attributes of the landscape and should also consider the environment of the road user. Appropriate detail and specification should be outlined specifying requirements for the preparation, implementation, maintenance and management of selected treatments. Regular supervision is recommended to ensure adherence to the design objectives and specifications. Finally, the developing landscape should be reviewed over time not only from the perspective of monitoring maintenance and management but in furthering the dynamic of various landscape treatments.

Road construction has the potential to create adverse impacts on the landscape and ecosystems (Figure 3.1). However, it should also be recognised that landscape treatments associated with road construction present an opportunity for the management and restoration of landscape quality and biodiversity affected not just by road construction but also as a result of other modern land uses.

Figure 3.1

Initial road construction has the potential to result in significant environmental and landscape disturbance and creation of a "barrier effect" to wildlife, all of which require appropriate mitigation.

The extent of roadside landscape afforded by the design of the modern road has the potential to provide for a variety of treatments which will restore regional identity, landscape character and diversity, but also create new habitat for wildlife (Figure 3.2). Such additional habitat can also contribute to the size, distribution and connectivity of habitat, including that of adjacent protected areas.

Figure 3.2

Natural recolonisation of a wider roadside verge area, where native orchid species successfully colonised a nutrient poor substrate.

In the management of landscapes, the key principles, values and aims of Ecological Landscape Design are promoted as a best practice approach to the development of landscape treatments for road schemes.

Landscape treatments which address the effects of habitat fragmentation (Figure 3.3) are required on all road schemes, because of the potential barrier effects that can arise when a road bisects and fragments an ecosystem, leaving separated habitat on either side of a road. Significantly, the effects of fragmentation may not be visible at the site level. For this reason, the identification and mitigation of the effects of habitat fragmentation require the adoption of the concept of "ecological infrastructure analysis". This concept involves defining ecological networks of core habitat areas and connectivity zones for the roadside landscape, in order to decrease overall fragmentation. In order to achieve this, the ecologist and landscape designer should focus on the landscape scale utilising habitat mapping prepared at the EIS/ER stage (see Figure 3.8) and aerial photography from which such effects can be more clearly identified (see Figure 3.7 and Section 3.2).

Figure 3.3

An example of habitat fragmentation where connectivity along tree-lined hedgerows has been severed by construction of the road.

The landscape designer should design treatments that will develop into self-sustaining habitats that do not present a future hazard to the road user or require the use of fertilizer, general broad-leaved herbicides and frequent cutting or mowing regimes. Appropriate soil preparation (See Chapter 5) and management are central to the establishment of a self-sustainable landscape.

The key to a sustainable approach to planting is to preserve and integrate existing native plant communities that are already present on site. Therefore, a thorough knowledge of the existing vegetation is necessary to form a baseline for the design of treatments. The designer should identify the processes that bind the topography, flora, soil and geology. This method allows the designer not only a holistic and dynamic comprehension of landscape, but, just as significantly, allows the designer to integrate this understanding into the design process. Therefore the "building blocks" for the design of treatments should be based on soil geographic factors and on the existing native vegetation adjacent to the road as categorised in Fossitt (2000) and in the relevant EIS/ER (see Appendix 2).

The application of fertilizer is considered counter-productive as it encourages the development of agricultural weed and grass species that require regular maintenance activities. In addition, herbicide use should be minimised and essential use should not extend beyond the initial landscape establishment/maintenance period (usually three years).

Where there has already been significant habitat loss as a result of other land-uses, eg. intensive agricultural practices, an adequate baseline for the identification of appropriate plant species mixes may not exist. In this case, the landscape designer may consider utilising information pertaining to the "potential natural vegetation" of an area. Cross (1997) has provided detailed analysis and suggestions as to the likely native plant communities of a given area if human influences were removed. Figure 3.4, extracted from Cross (1997) represents a map of the Potential Natural Vegetation of Ireland. The plant communities as listed by Cross (1997) can be supported by the detailed categories described in Fossitt (2000).

When addressing the needs of the mobile road user in the development of landscape treatments, consideration should be given to the complex nature of the contextual framework of the mobile road user, dynamic scale and a reduction in driver monotony and fatigue. The design should aim to improve conditions for driver alertness, especially in homogeneous landscapes where extensive stretches of similar vegetation may exist or where a lack, or potential loss, of vista quality has been identified. It should be noted that, where landscape treatments (which are selected to mitigate impacts on environmental aesthetics) do not incorporate the concept of dynamic scale, the resultant planting may not be visible to, and appreciated by, the road user at certain speeds and can thus be rendered ineffectual in this context (see Section 3.1.1).

The retention or restoration of regional identity, landscape character and diversity should also be addressed through the appropriate design and placement of treatments and the incorporation of locally distinctive features. Treatments can include the incorporation of roadside art sculpture as part of the overall design process. Roadside art sculptures have been identified by road users as one of several preferred features of the Irish road landscape (see Section 3.1.1). The design, including the scale and placement of such sculptures within the roadside landscape, should also consider the concept of dynamic scale.

3.1 Approach to Selection of Appropriate Landscape Treatments

The identification of an appropriate treatment for a site involves a detailed process (see Figure 3.5) which requires:

- an understanding of the context and the identification of specific objectives;
- the selection of the most appropriate landscape treatment(s);
- the provision and specification of detail;
- the supervision of implementation; and
- the active management of the establishing landscape.

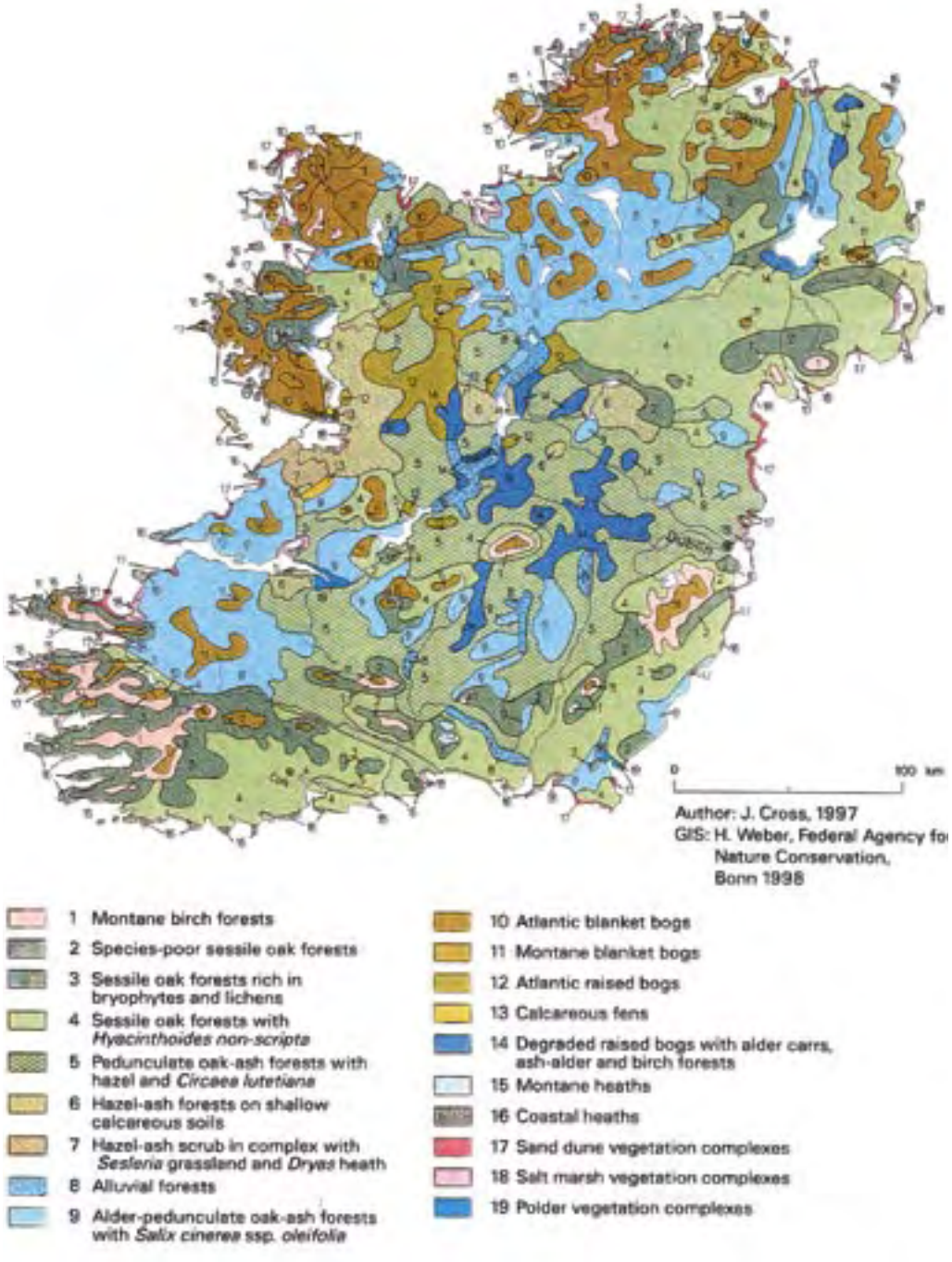


Figure 3.4

Map of Potential Natural Vegetation of Ireland. The map is an extract from *"An outline and map of the potential natural vegetation of Ireland"* (Cross J.R., 1997).

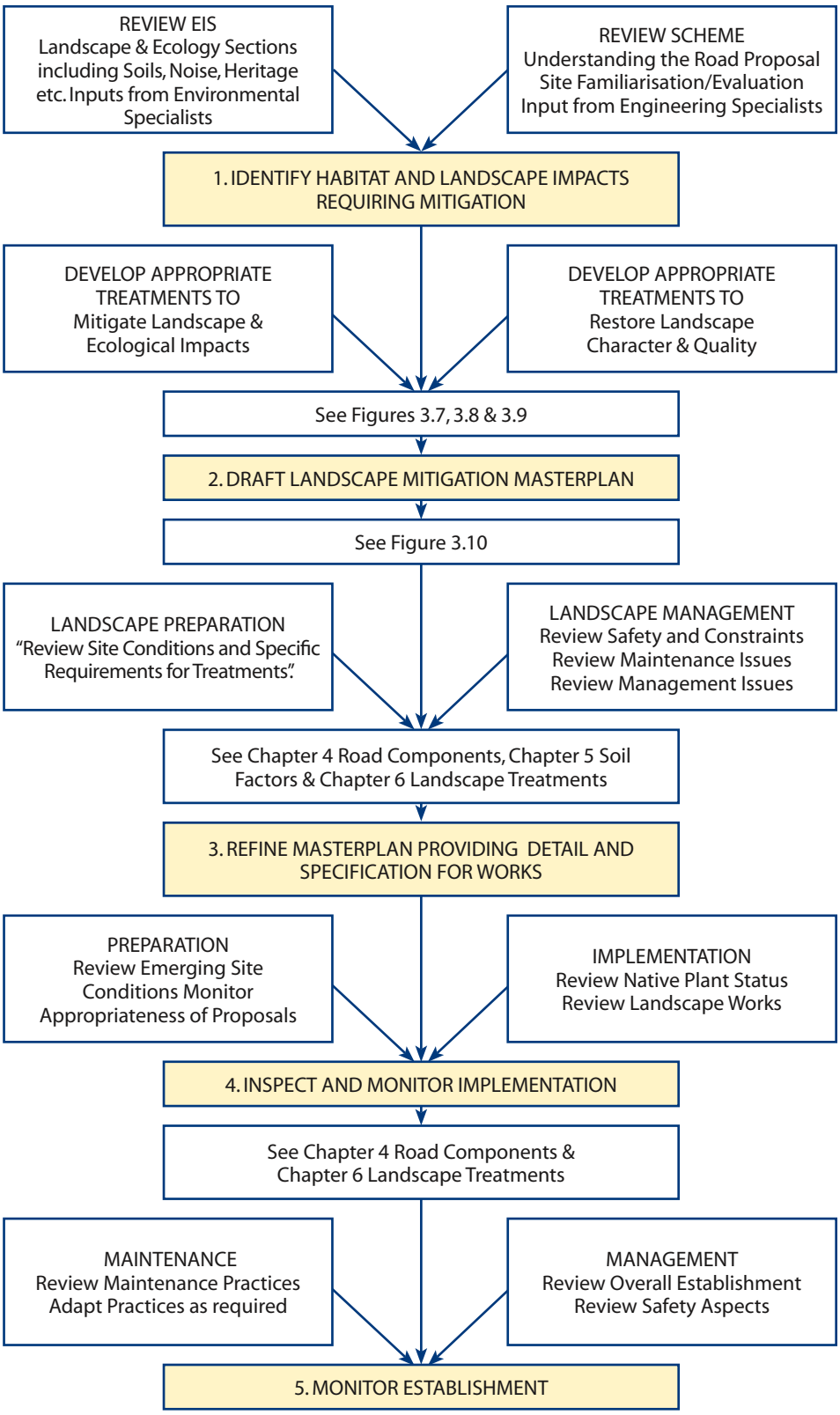


Figure 3.5

Process for the selection of Landscape Treatments leading to the development of a Landscape Mitigation Masterplan.

3.1.1 Understanding the Context and Identification of Objectives

The identification of treatment objectives requires a thorough understanding of the individual sites and their constituent components (see Chapter 4), within the context of the road scheme and the surrounding environment, including the adjacent native vegetation, soil and landscape types. Most of this information is normally contained within the relevant EIS/ER.

An ecologist and landscape designer should review the roadside landscape and the road corridor in order to:

- understand the context of the existing landscape;
- note any significant changes since the publication of the EIS/ER;
- identify any impacts not necessarily recorded in the EIS/ER; and
- to acquire information where no EIS/ER exists.

Once this review is complete, the landscape treatments should then address:

- impacts on attributes of the visual field;
- the contextual framework of the road user;
- impacts on attributes of the non-visual field; and
- the contextual framework of wildlife.

3.1.2 Treatment Objectives and the Attributes of the Visual Field

The mitigation of impacts on the visual field requires the conservation or restoration of environmental aesthetics, including scenic landscape qualities, where the objective of treatments is to integrate the road corridor with the post-construction landscape, mainly through the management of scale and vegetation. Table 3.1 outlines treatment objectives in the mitigation of impacts on the attributes of the visual field.

The use of noise barriers and other structures should also be sensitively treated and integrated to avoid simplifying and narrowing down the field of view of the road user. It is important to note that the opening up of vistas through the thinning or the removal of vegetation may impact negatively on a corridor for the dispersal of wildlife and increase visual impact on residences along or nearby national roads.

In selecting visual field treatments, the landscape designer should ensure that:

- treatments are not homogeneous and appear disconnected from the existing landscape;
- large extensive areas of a roadside landscape are not perceptually monotonous, and
- screening treatments do not create unnatural looking, simplified and repetitive vegetation patterns.

Treatments in visual field can mitigate:

- Loss of variety: through the provision of aesthetically effective treatments.
- Loss of naturalness: through the provision of treatments which will restore native vegetation and which will integrate new technical elements such as flyovers, bridges and culverts.
- Loss of 'rural' structuring: through achieving agreement of scale, by using trees and hedgerows which will reduce pattern and orientation effects.
- Loss of regional identity: through the restoration of spatial arrangements which defined the character and appearance of the former landscape and the retention of locally distinctive features and views of the same.
- Loss of vista quality; through the creation of new vistas by opening up and/or the planting of vegetation to create views with bounded margins.

Table 3.1 **Mitigation Objectives in the Visual Field**

3.1.3 The Contextual Framework of the Road User

In preparing the Landscape Mitigation Masterplan and the appropriate individual landscape treatments, the landscape designer should consider the contextual framework of the various road users.

The roadside landscape provides particular opportunities for users to experience and view a diverse range of features such as roadside art exhibits, sites of historical interest, as well as elements of the natural terrain such as distant mountains and seascapes. For this reason, the landscape designer should address the following issues when selecting treatments:

- preferred landscape features;
- the view from the vehicle;
- dynamic scale;
- driver monotony and fatigue; and,
- vegetation and scale.

Preferred Landscape Features

Ecological Landscape Design promotes an understanding of environmental aesthetics, including consideration that visual encounters with preferred features of the landscape can lead people to form attachments to the landscape and to develop appreciation for sustainability goals. Recent research has identified preferred features within the Irish landscape that may be effectively incorporated into the design of landscape treatments. Features identified as desirable by road users and local inhabitants residing in close proximity to national roads included roadside art, water features, woodlands, vistas, geological features and sites of historical and archaeological interest. The retention and incorporation of such locally distinctive features including rock faces or views of cultural features (e.g. Old Brick Works on the N25 Youghal Bypass, Moat of Ardscull on the N78 Athy-Kilcullen and Bunratty Castle on the N18 Limerick-Ennis Road) promote regional identity including orientation, or a sense of place, for the road user within the road corridor.

The View from the Vehicle

The two fundamental types of views are the 'panorama' and the 'vista'. A panorama refers to a broad view with a good vantage point, while a vista refers to a framed view e.g. a view restricted by bounding margins such as trees.

The relationship between the mobile road user, i.e. the driver and passenger within the vehicle, and the roadside landscape is more complex than the relationship between a person who is viewing the landscape from a stationary position; the mobile road user views many more features and landscape types as they move along a road corridor.

Furthermore, certain features of the landscape can only be viewed at particular speeds (see dynamic scale). All views are restricted or bounded by the confinements of the vehicle structure, while at the same time being framed or blocked by vegetation, buildings and other infrastructure along with elements of the natural terrain.

Dynamic Scale

The concept of dynamic scale is important in understanding the ability of mobile road users to view features along a road corridor. The speed at which the driver travels determines how far ahead, for what duration, and at what angle it is possible to focus on and appreciate landscape features (see Figure 3.6). In this way small scale objects, such as small areas of shrub planting, or subtle changes in vegetation type, will not be experienced at high speeds of up to 120 km/h on motorways, while vistas may need to be of a minimum width in order to be seen.

Further, the linearity of a road corridor reinforces the importance of spatial arrangement and visual sequencing of features within the roadside landscape. For this reason, the frequent use of a single or few relatively large treatments along a road corridor can become repetitive, leading to a loss of perceived naturalness, and may contribute to driver monotony and fatigue.

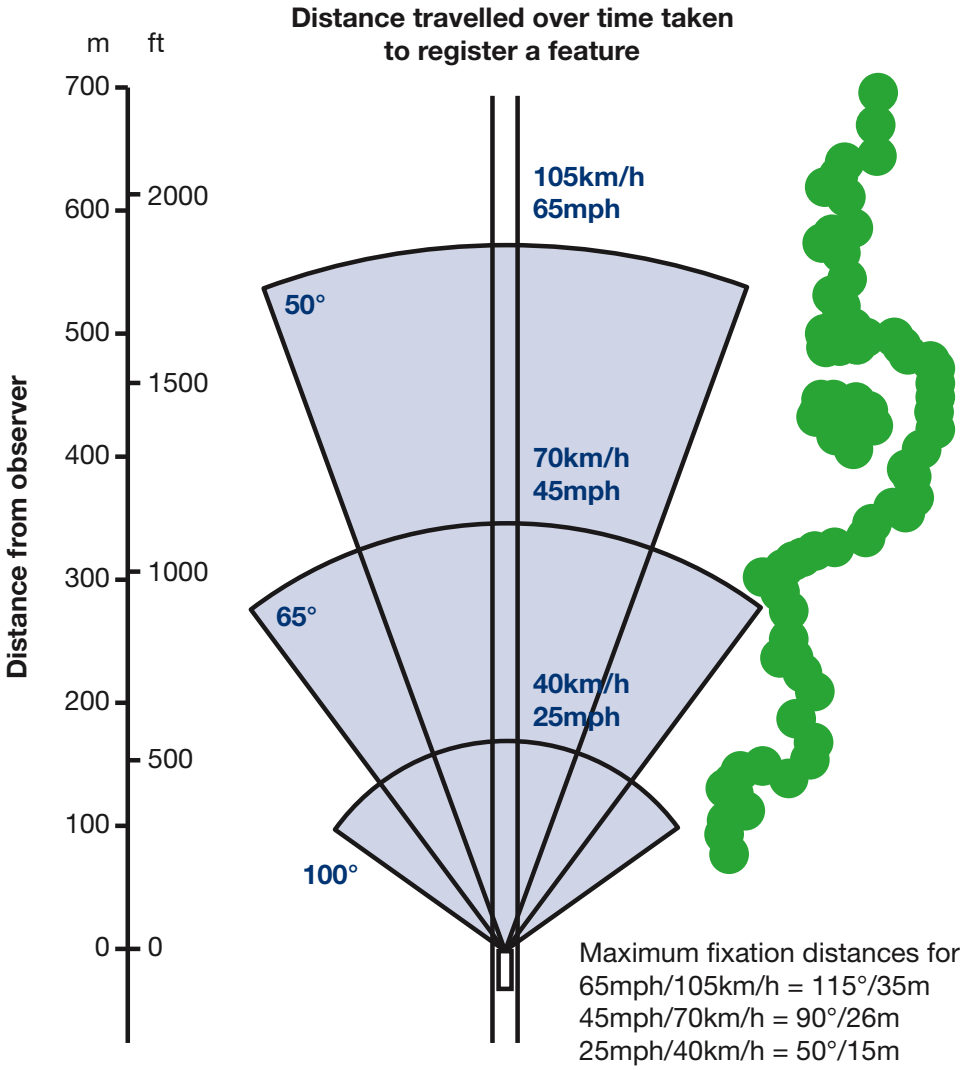


Figure 3.6

The importance of dynamic scale in Roadside Landscape Planning. The roadside landscape must be developed taking account of the speed at which the motorist is expected to drive. This determines how far ahead it is possible to focus on the landscape, and at what angle from the vehicle it is possible to see it. Also the views need to be of a minimum width in order to be seen; the faster the speed of the car, the wider the view needs to be. For example, a 1 second duration at 100km/h requires an opening of 27m, while at 42km/h the space needed will only be 9.6m wide. (Source: Bell, S. 1997).

Driver Monotony and Fatigue

The landscape designer should address the objective to counteract monotony and fatigue in the road user by providing improved conditions for driver alertness, especially where extensive stretches of similar vegetation may exist, or where loss of vista quality is identified. This can be achieved through a Landscape Mitigation Masterplan, which addresses the concept of dynamic scale, and which provides the road user with views to treatments and features which can maintain or stimulate interest in the driver, thus reducing the likelihood of fatigue. For mobile road users travelling at night, roadside art sculptures, such as that on the M7 Kildare Town Bypass which reflects light and changes pattern under the light of vehicles, alerts drivers and provides them with a sense of place along the road corridor. Lighting (including floodlighting) of roadside art sculptures should, where feasible, be powered by solar panels, therefore addressing the principles of sustainable energy.

The Landscape Mitigation Masterplan should:

- maintain variety along the road corridor;
- retain vistas and views to locally distinctive landscape features;
- provide new views of locally distinctive features; and,
- provide new vistas and panoramas including views of watercourses, ponds and roadside art exhibits etc.

Vegetation and Scale

In landscape treatments, the design, nature and layout of vegetation provides for a changing relationship in terms of Agreement, Unity, Contrast and Transition of Scales.

Agreement of scales occurs when features of the same scale are present in the landscape. For example, large scale features such as high canopy woodland treatments randomly dispersed along a road corridor will provide for agreement of scale within a landscape which already contains native high canopy woodland. In a 'bocage' landscape which is dominated by small scale hedgerow elements, hedgerow treatments can be utilised to reconnect existing severed hedgerows while also providing agreement of scale.

Unity of Scale is achieved when landscape treatments of very different sizes create a transition between the smallest and largest scale. For example, in a landscape which contains high-canopy woodland and semi-natural grasslands, hedgerows, tree-lined hedgerows and low-canopy woodland, treatments can provide a transition between the small scale semi-natural grassland and the large scale high-canopy woodland.

Contrast of scale occurs where features or vegetation of different scales are present within a landscape, e.g. a tree-lined hedgerow treatment will provide contrast of scale in an otherwise open landscape, e.g. The Curragh (Co. Kildare). Similarly, the use of one continuous treatment type such as a low canopy woodland treatment will result in contrast of scale in a landscape which is dominated by a variety of habitat types.

Transition of scale occurs where landscape treatments are utilised to convey transitions from one scale to another e.g. where the scale or size of treatments along regional roads is purposefully increased as one moves towards a motorway, thereby providing for a transition of scale between the small scale of a regional road and the larger scale of a motorway corridor.

3.1.4 Treatment Objectives and Attributes of the Non-visual Field

The mitigation of impacts on the non-visual field requires the restoration of ecological function and integrity including critical ecological services, such as nutrient cycling and flood control through the establishment of native vegetation and retention of local soil types.

Connectivity within the landscape may also require restoration as a result of habitat loss and fragmentation (See Table 3.2). A loss of connectivity occurs where gaps are created in wildlife corridors or where barriers are created which prevent dispersal of wildlife, e.g., the road pavement, noise and other disturbances. Such areas are often referred to as "bottlenecks" or barriers to wildlife. Within the Irish landscape, a loss of connectivity is often illustrated by the presence of severed hedgerow networks or where habitat has become fragmented and isolated, or indeed, at the intersection between roads and wildlife crossing points. In the case of the latter, the EIS usually recommends the placement of fauna passages which are structures that provide for the safe passage of wildlife (e.g. badgers and otters) under roads (See *Guidelines for the Treatment of Badgers Prior to the Construction of National Road Schemes,* National Roads Authority *2005*).

Treatments in the non-visual field can mitigate:
• Habitat loss; through the provision of compensatory or replacement habitat.
• Habitat fragmentation; through the identification of connectivity zones and the linking of core natural habitats.
• Loss of habitat diversity; through the provision of a variety of habitat type and structure.
• Loss of species diversity; through the utilisation of locally appropriate native species from indigenous seed stands in landscape treatments.
• Loss of ecological function and integrity; through the restoration of ecological processes such as nutrient cycling and flood control through establishment of locally appropriate native species and soil type.

Table 3.2 **Landscape treatment objectives in the non-visual field**

In restoring connectivity to elements of vegetation and habitats, ecological infrastructure analysis (see explanation in Chapters 1-2) not only allows the designer to visualise the impacts of roads on the landscape, but also allows the landscape designer to ascertain how a proposed treatment will interact with, and fit into, the context of other elements of vegetation and habitats, or indeed, landscape features found within the adjacent and wider landscape. Ecological Infrastructure Analysis requires:

- the creation of the map of the ecological network based on existing habitat mapping in the EIS/ER;
- identification of bottlenecks or barriers to wildlife; and
- identification of suitable connectivity zones.

A map of the ecological network requires the use of available aerial photography (see Figure 3.7) and habitat mapping as per the relevant EIS/ER (see Figure 3.8) in order to identify core habitats, corridors, buffer zones and bottlenecks to wildlife. For ease of interpretation and cross referencing, the map of the ecological network and the Landscape Mitigation Masterplan are based on Figure 3.7 An Example of habitat mapping using aerial photography for an Environmental Impact Statement on a road scheme which is extracted from the *NRA Guidelines for Assessment of Ecological Impact of National Road Schemes*).

When completed, a map of an ecological network (see Figure 3.9) will depict the distribution of core habitats together with the elements of connectedness, i.e. the major wildlife and water corridors, streams and wetlands, rare habitats and species, and topographic sites. The challenge is then to define ecological networks of core habitats and to locate potential bottlenecks to wildlife. Once located, connectivity zones can be identified where landscape treatments can be put in place to defragment the core habitat areas and to reconnect wildlife corridors such as hedgerow networks (see Figure 3.10).

3.1.5 The Contextual Framework of Wildlife

Landscape treatments need to be put in place with an understanding of the resultant effects on wildlife. For instance, the planting of tree-lined hedgerows and high and low woodland canopy treatments within the roadside landscape may serve to naturally force birds/bats to fly higher above roads when crossing between existing woodland on either side of a road carriageway. (See Best Practice Guidelines for the Protection of Bats in the Planning of National Road Schemes, National Roads Authority, 2005).

Landscape treatments utilising trees and shrubs on bends or curves on a road should be set back, to improve visibility and to discourage crossings by wildlife. In contrast, along straight sections of road carriageway, where greater visibility exists for both wildlife and road user, landscape treatments can extend as close to the road as permitted by road construction and safety standards.

The landscaping of centre medians, junctions, roundabouts or interchanges should be sensitive to wildlife. Berry-producing plants should not be selected as they may prove attractive, yet fatal, to wildlife due to the close proximity of traffic.

3.1.6 Summary of Context and Identification of Objectives

In summary, an understanding of the context and the identification of specific objectives should establish that locally-appropriate treatments using locally-appropriate plant communities offer aesthetic, ecological and sustainability advantages, as they address local distinctiveness, character and diversity and maintain the ecological integrity of a site.

Figures 3.7, 3.8, 3.9 and 3.10 provide a worked example of habitat mapping, the drafting of a map of the ecological network and the methods by which impacts may be identified and treatment objectives selected within a Landscape Mitigation Masterplan.

It is clear that while each site within a roadside landscape will have specific requirements, a range of functions or objectives for which treatments can be developed include:

- blending the road into the landscape to restore regional landscape identity, character and diversity;
- providing visual screening for technical elements, where appropriate;
- integrating local features such as sites of architectural and cultural heritage significance;
- creating vistas or views with bounded margins;
- countering habitat severance and fragmentation through the reconnection of severed habitats (See Figure 2.1); and
- compensating for tree, hedgerow and other habitat disturbance or loss.

3.2 The Selection of Landscape Treatments

Once treatment objectives have been identified, a range of conceptual treatments may be presented for each site. The aim of this stage is to review a variety of proposals for each site that best address the mitigation objectives while maximising any additional benefit to the environment and landscape quality. Therefore, while two treatments may address the desired objective, i.e. provide for the mitigation of identified impacts at a particular site, the one that provides the greatest environmental benefit and value for money should be selected and developed as part of the Final Landscape Mitigation Masterplan for the road scheme. A worked example of how a Landscape Mitigation Masterplan is developed and the various stages of the process are shown in Figures 3.7, 3.8, 3.9 & 3.10.

Figure 3.7

An aerial photograph of a section of a national road scheme.

Figure 3.8

Figure 3.8 Example of habitat mapping based on the aerial photograph in Figure 3.7

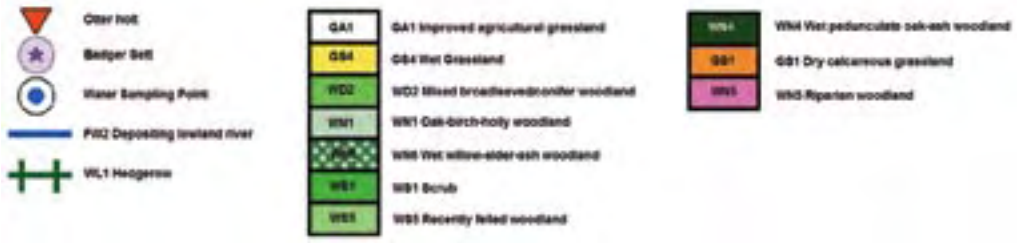
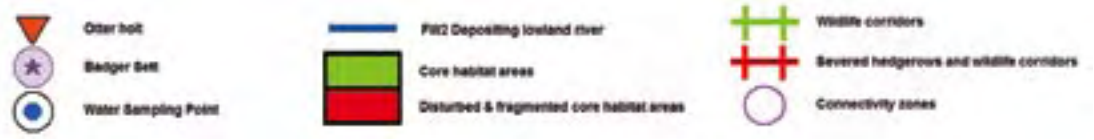


Figure 3.9

Example of a Map of the Ecological Network based on the aerial photograph in Figure 3.7



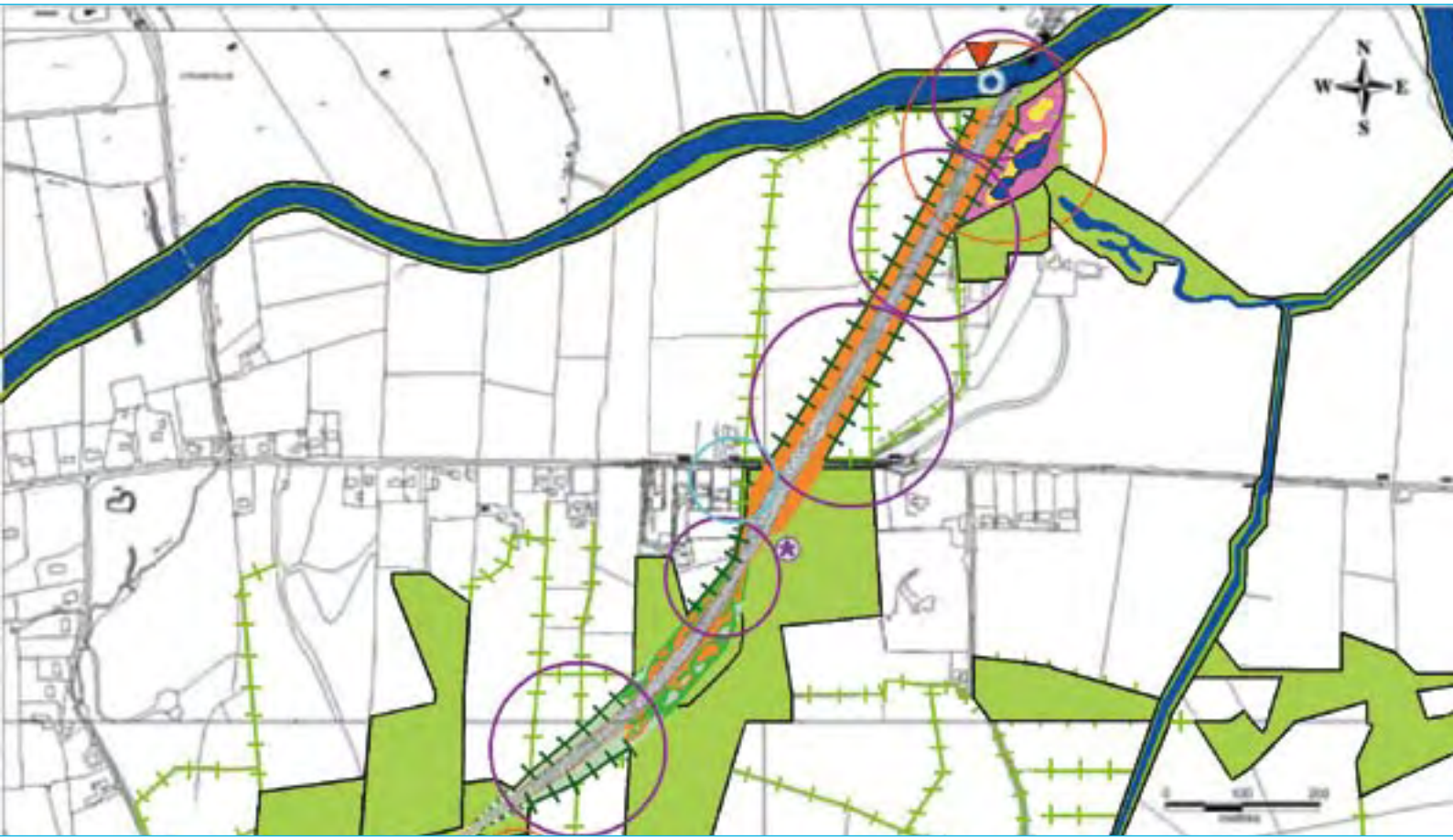


Figure 3.10

Example of a Landscape Treatment Plan based on the aerial photograph in Figure 3.7

A Landscape Mitigation Masterplan will, therefore, contain a number of landscape treatments for a road scheme.

As roads interact with a wide variety of environmental aspects, ranging from landscape types to flora and fauna, soils, cultural heritage and human beings, it is considered critical that the identification of potential impacts and the selection of treatments should be developed by landscape designers working with ecologists in a multidisciplinary management approach involving engineers, archaeologists, soil scientists, stakeholders/road users and environmental and design team members.

Additional environmental or landscape benefits that may arise from conceptual treatments and can be developed within a Landscape Mitigation Masterplan include:

- increased structure and diversity of habitat;
- opening-up of new scenic vistas, and the establishment of treatments (Figure 3.11) whose objective is to reduce driver monotony and fatigue; and
- potential for provision of major plots of native woodland and other habitat types.

Figure 3.11

The retention of open scenic views of the Wicklow landscape was achieved for the benefit of the road user on the N11 Newtownmountkennedy Bypass Project.

3.3 Provision and Specification of Detail

When a specific Landscape Mitigation Masterplan has been drafted the proposal should be further reviewed by the ecologist, landscape designer and other environmental and design team members, in order to detail the techniques and methods required to achieve the establishment of treatments and the desired objectives. The methods to be employed and the associated specifications required for the various treatments should be transposed to the contract documents, including the Employers Requirements, Environmental Operating Plan and the Works Specification.

In particular, the process of natural recolonisation, the planting of native species, the selection and sizing of plant mixes, ground preparation considerations and programming, together with the cost-effectiveness of the treatment, need to be detailed for implementation.

Specific detail regarding ground preparation and management is of paramount importance to the design specification for a treatment.

Where suitable ecological and site conditions exist, (e.g., similar soil geographic factors and an appropriate donor site) and with appropriate management during the initial stages of development, natural recolonisation should be considered the most appropriate and cost-effective treatment along a new road scheme. In particular, natural recolonisation should be considered as an appropriate and cost effective treatment for sensitive locations (e.g. adjacent to protected areas and sites of local ecological importance as identified in the EIS/ER). Alternatively, where existing plant communities are to be relocated and suitable reproductive plant material is available (including roots and rhizomes, see 5.3), specialist treatments such as local seed collection, or significant intervention for the retention of existing soils or sods, can be utilised to restore the original habitat.

In summary, the specification of detail for treatments for road schemes should incorporate the fundamental principles of cost-effectiveness and sustainable development. In particular, the specification should seek to reduce inputs of resources, including the use of peat compost, water, fertilizers, herbicides and pesticides, thereby reducing future inputs and maintenance costs.

3.4 Supervising Implementation

For each road scheme, an appropriately qualified individual (e.g. Ecologist, Landscape Designer or Environmental Scientist) should attend the site to inspect and monitor construction works on a regular basis. Such professionals (and others, including soil scientists) may also be required, where necessary, to review specific issues which may arise from time to time.

Such supervision is of importance, particularly during various stages of the construction works, including:

- tree and hedgerow removal – when informed decisions should, where feasible, be made with regard to retention of mature trees and hedgerows within the land-take;
- soil stripping and storage – when it may be important to ensure soil integrity is maintained and existing soils are retained locally, and stored separately from fertile agricultural land-use (A horizon, see Section 5.1.3) topsoils, for local re-spreading;

- final shaping and soil preparation - when the soil conditions for the establishment of treatments will be finally determined; and

- the establishment of specialised works particularly for sensitive areas, such as the respreading of stored soil, facilitating natural recolonisation, hay-strewing, lifting and translocation of existing species-rich sods or turves from existing wetland or marsh habitats (Plate 2).

Supervision will ensure that the preparation for the landscape treatment is completed, as specified, so as to provide the best opportunity for the overall success of the landscape treatment. Supervising works in progress may also afford an early opportunity for potential modification of treatment objectives, where appropriate. Such modifications should be reviewed with the Design Team and should only be undertaken where they have no significant programme or financial implications.

3.5 Managing the Establishing Self-Sustaining Landscape

For each road scheme an appropriately qualified individual (e.g. Ecologist, Landscape Designer or Environmental Scientist) should continue to review the establishment of landscape treatments in order to ensure that they develop or transform into self sustaining habitats which require minimal further input of resources or maintenance. The treatment objectives may take many years to develop fully, during which time circumstances may change significantly or opportunities for a new approach may be considered. The principal activities include:

- ensuring that specified treatments are developing as envisaged;

- monitoring the new landscape to ensure that it complies with safety requirements (Figure 3.12);

- where maintenance is required, to adapt maintenance regimes (i.e. reducing input of physical resources and energy) over time to suit the developing landscape, and

- to acknowledge that it is a dynamic learning process and that experience should be incorporated into the establishment of future treatments.

Figure 3.12

Rock cuttings have potential to develop as roadside features of significant visual interest and are particularly appropriate for the facilitation of natural colonisation.

Chapter 4
Components of the Roadside Landscape

4. Components of the Roadside Landscape

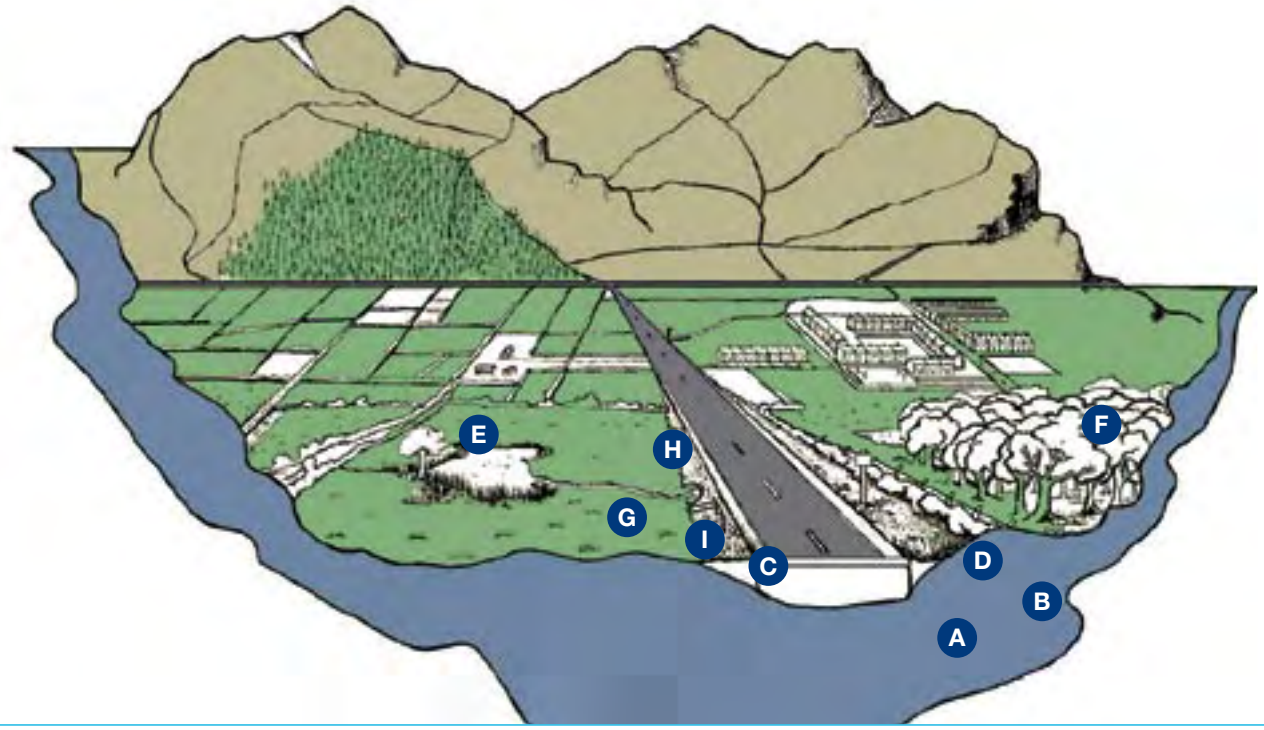
The roadside landscape is comprised of a number of distinct components, including cuttings, embankments, junctions and verges, which are common to the majority of road schemes. The roadside landscape may also comprise a range of further components, such as attenuation ponds and rock cuttings, depending on the road scheme. In particular, features such as deep cuttings, high embankments and large junctions significantly increase the area of roadside landscape and in doing so afford additional potential for biodiversity conservation, environmental aesthetics and the restoration of landscape quality. Components of the roadside landscape can be managed to provide a range of functions (see Table 4.1).

The components of the roadside landscapes can
• Provide refuges for the conservation of flora and fauna, especially in areas of otherwise intensive agricultural land use.
• Provide connectivity within the landscape, defragmenting core habitat areas and uniting semi-natural ecosystems that interface with the road.
• Restore landscape quality, by mitigating impacts on the visual field including the restoration of naturalness, 'rural' structuring and regional identity.
• Function as a buffer zone between the road carriageway and adjacent semi-natural ecosystems.
• Function as sites for the natural recolonisation of native vegetation.
• Function as food source for Raptors, Barn Owls and Peregrine Falcons.
• Function as traps for sediments and potential contaminants from road run-off.
• Function in reducing perceived noise disturbance.

Table 4.1 **Environmental Functions of Roadside Landscapes**

For each roadside component a series of issues require specific consideration when determining appropriate landscape treatments. The following sections consider the key issues and principles associated with the main components of the roadside landscape, including:

- Verges;
- Cuttings: Soil Slopes, Rock Cuttings and Scree Slopes;
- Embankments;
- Junctions;
- Central Reservations or Medians;
- Watercourses, Attenuation Ponds and Wetlands;
- Additional Plots and Other Areas;
- Greenways.



A – Road corridor
B – Roadside Landscape
C – Immediate verge
D – Wider verge area
E – Wetland ecosystem
F – Woodland ecosystem
G – Watercourse
H – Pipe culverts
I – Barrier fencing

Figure 4.1

An illustration of a National Road Ecosystem and its various components within the Irish landscape (Source: Dolan and Whelan, 2004).

4.1 Verges

The verge describes a level or gently sloping area of land located alongside the edge of the hard shoulder or carriageway. Where the road is located at or close to the level of the existing landscape, the verge may extend to the land-take boundary (see Figure 4.2).

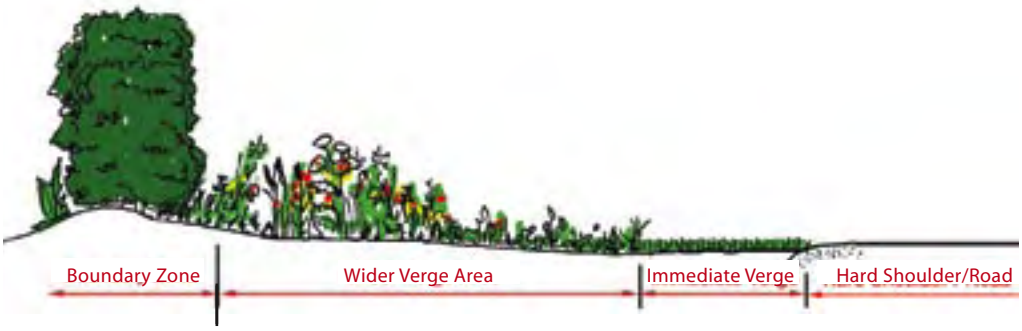


Figure 4.2

Typical roadside landscape components where the road is at or close to the level of the existing landscape (Modified after Kent Trust for Nature Conservation, 1990).

Alternatively, where the road is below or above the level of the existing landscape the verge will extend to the beginning of either the bottom of the cutting or the top of the embankment respectively (see Figures 4.3 and 4.4). In such instances the verge may be narrow, generally of between 2 and 4m in width.

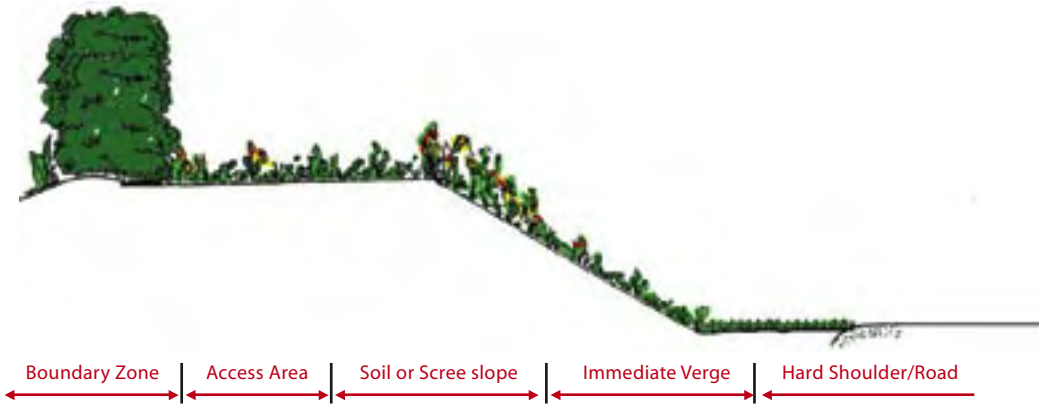


Figure 4.3

Typical roadside landscape components within a cutting (Modified after Kent Trust for Nature Conservation, 1990).

Figure 4.4

Typical roadside landscape components with an embankment (Modified after Kent Trust for Nature Conservation, 1990).

Two distinct zones may be identified within the verge:

- the immediate roadside verge; and
- the wider verge area.

Each zone has particular issues of relevance in the determination of appropriate landscape treatments.

4.1.1 Immediate Roadside Verge

The immediate roadside verge (Figures 4.2 – 4.4) refers to the area located directly adjacent to the hard shoulder or carriageway (Figures 4.5 and 4.6). While it is likely that all of the area will fall within clear zones (see Section 2.2.1), the immediate roadside verge also has specific design requirements, which may relate to any or all of the following:

- the maintenance of sightlines;
- the provision of signage and lighting, the incorporation of drainage systems; and
- the provision of a margin of safety or demarcation between the carriageway and the wider landscape resource or road boundary.

Figure 4.5

An 'immediate roadside verge' defined by a low maintenance, infrequently mown edge. Note: The zone includes provision for drainage requirements, safety measures (barrier and forward sightlines) and the location of light standards.

Given its proximity to traffic, the immediate verge may be subject to the effects of salting, gritting, wheel splash, high wind speeds, high noise, disturbance from parking, construction activities and maintenance (including more frequent mowing). Such an environment has limited potential in providing for the restoration of landscape quality or conservation of biodiversity. However, the immediate roadside verge offers significant potential as a buffer zone between the road carriageway and the remaining roadside landscape.

Treatments selected for the immediate roadside verge should not prove attractive to fauna that could otherwise be at increased risk due to the proximity of traffic. Treatments should be designed with minimal input of natural resources and the need for long-term maintenance, through the avoidance of fertilizers which will reduce the frequency of mowing. The immediate verge can form a buffer zone through the establishment of a robust but low-maintenance grass treatment (see Section 6.1.2).

Key Issues for the Immediate Roadside Verge

- The verge should be of the minimum width required to provide for its safety and design functions, which include the provision of sightlines and the accommodation of signs, lighting columns, etc.
- The verge should function as an environmental and physical buffer between the road and the wider landscape.
- Appropriate treatments should aim to establish a robust, low maintenance grass sward.
- The verge should be maintained to a minimum width with minimum input of natural resources such as fertilizer.
- The treatment should not prove attractive to fauna.

4.1.2 Wider Verge Area

The wider verge area refers to the remainder of generally level or gently sloping area alongside the immediate roadside verge (see Cross Section A). The wider verge may vary significantly in width from a few to several metres (Figure 4.6) and in general provides for an area of safe demarcation and distance between the carriageway and the land-take boundary or an adjoining cutting or embankment.

Figure 4.6

A wide verge area which has been allowed to develop into a self-sustaining semi-natural grassland requiring minimal maintenance. Note: the immediate roadside verge is defined by an infrequently-mown edge.

As with the immediate roadside zone, this wider verge area may also have design requirements relating to:

- the maintenance of sightlines;
- the provision of signage and lighting;
- the incorporation of drainage systems; and
- the provision of a margin of safety or demarcation between the carriageway and the wider landscape resource or road boundary.

As with the immediate roadside verge, much of the wider verge area may continue to fall within clear zones or act as access areas for a particular road scheme (see Section 2.2.1), thereby restricting potential for planting of trees and shrubs, e.g. high-canopy or low-canopy woodland treatments.

In such circumstances, preference should be given to the establishment of semi-natural grassland treatments (Figure 4.7; see Section 6.1.3) through direct seeding or, where appropriate, natural recolonisation (see Sections 2.3 and 5.5.2). In the selection and specification of such treatments, consideration must be given to the specific environmental and site conditions, particularly, soil characteristics (see Chapter 5).

Where a significant area within the wider verge falls outside clear zones and, where aspects of road safety are not an issue, consideration can be given to a more diverse range of treatments such as a mosaic of semi-natural grassland and tree and shrub plantings (see Chapter 6).

Diverse treatments can, inter alia, provide additional habitat for wildlife, function in the defragmentation of core habitat areas, restore landscape quality, including landscape character and diversity, and mitigate impacts on attributes of the visual field. Treatments that aim to restore connectivity between core habitat areas should be given particular priority where they occur within areas identified as connectivity zones within the map of the ecological network (see Figures 3.7 and 3.8).

Figure 4.7

Example of species-rich semi-natural grassland treatment established through natural recolonisation within the wider verge area.

Key Issues for the Wider Verge Area

- The selection and layout of treatments must address aspects relating to clear zones as well as any other access, drainage, safety and design functions.
- A diverse layout of treatments should be considered wherever appropriate
- The area can be managed to provide habitat for wildlife and to restore connectivity through the defragmentation of core habitat areas.
- The area can be managed to restore landscape quality and the mitigation of impacts on the visual field.

4.2 Cuttings and Embankments

Major road projects have maximum and minimum design limitations associated with their horizontal and vertical alignments. Therefore, where a proposed road corridor encounters variation in local topography, cuttings and embankments are generally utilised to maintain an optimum engineering design. As a result, cuttings and embankments represent the most common form of engineering earthworks associated with the construction of national road schemes (Figures 4.2 – 4.4).

Cuttings and embankments are usually designed to an average slope of 1 in 2 (vertical to horizontal). In certain situations earthworks may be graded to shallower or steeper slopes depending on the stability of the material encountered, e.g. cuttings in rock may be near-vertical (see Section 4.2.1) while embankments over peat may be broadened out to 1 in 3 or even more gentle slopes. In any case, cuttings and embankments add significant area to the potential roadside landscape.

Cuttings and embankments are suitable for a diverse range of landscape treatment(s). However, the selection and layout of treatments should reflect local site conditions and address issues relating to soil stability, gradient, underlying geology, soil type, drainage and adjacent habitat types which will influence the selection and layout of the most appropriate treatments and the particular species to be utilised in treatments.

Cuttings and embankments are considered separately in the following sections as the selection of treatments should address the fact that cuttings are at the same level or above the field of vision of the driver, while embankments are generally found below the field of vision of the mobile road user, therefore requiring a different set of treatments.

4.2.1 Cuttings

Cuttings involve a reduction in the existing grade (see Figure 4.3), i.e. where a road is set at a level that is below the existing topography such as in the crossing of local ridges or hills (Figure 4.8). Cuttings are also utilised in the design of junctions (see Section 4.3) and road crossings, where one road passes under another.

In the adjacent and wider landscape, cuttings tend to reduce the visual prominence of a road and its traffic for local inhabitants, particularly, where the cutting runs perpendicular to the line of view. However, by contrast, cuttings through ridges and hills can impact on attributes of the visual field causing a loss of 'rural' structuring and naturalness (see Section 3.1.1).

In terms of the mobile road user, cuttings tend to narrow down or simplify the field of view, particularly where significant stretches of cuttings exist on both sides of the road corridor. This has the effect of emphasising the linearity of the road corridor and in creating a loss of variety, regional identity and vista quality. For this reason, the landscape designer must consider the importance of managing spatial arrangements and the visual sequencing of features including the layout of landscape treatments within the roadside landscape (see Section 3.1.1).

Cuttings into the landscape may displace soil, rock or scree (i.e. a surface comprising loose material, often rock fragments). Given the differing nature of their characteristics each are considered separately in the following sections.

Soil Cuttings

Cuttings that expose soil slopes are the most common type of cutting. Such features may be shallow or very deep (Figure 4.8), emphasizing the linearity of a road corridor.

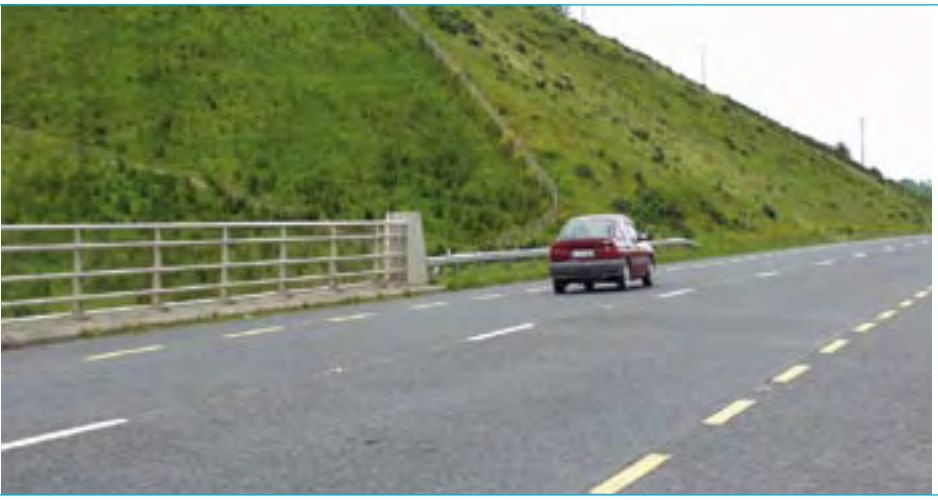


Figure 4.8

Example of a visually significant deep cutting on the N15 Donegal Bypass. Large cuttings which produce soil slopes add substantial area to the roadside landscape and offer significant potential for a diverse layout of treatments and the mitigation of impacts on attributes of the visual field.

In terms of selection and layout of treatments, the landscape designer can reduce the potential impoverishment of the visual field by managing the spatial arrangements and the visual sequencing of treatments. Continuous or entire mass plantings, particularly of single or limited species mix, (Figure 4.9), should be avoided especially near the top of the cutting. Such treatments can potentially emphasise the scale of earthworks as well as enclose the road corridor, whilst also providing limited horizontal and vertical structural differentiation and a limited variety of habitat types for wildlife.

Figure 4.9

Long straight formal plantings of single species emphasise the linearity of the road corridor and lead to a loss of variety and visual quality. Single species treatments provide little benefit in terms of biodiversity conservation.

The landscape designer should consider maximizing the diversity of treatments on soil slopes in both dimensions, i.e. along and away from the road. The objective should be to create a

landscape featuring a more open and visually interesting 'mosaic of habitats', where a variety of low-canopy trees and shrubs are established in finger-like projections and sympathetic groupings within a basic fabric of a semi-natural grassland treatment (Figures 4.10 and 4.11) (see Chapter 6.1.3). The width and sequencing of the various plant groupings should vary within the mosaic to avoid obvious patterning effects.

Tree and shrub plantings should comprise a variety of low-shrubs, high-shrubs, low-canopy and finally, where space permits, high-canopy woodland treatments (see Chapter 6) that reflect the natural species composition of vegetation within the surrounding landscape. At the design stage, consideration should be given to maintenance issues, particularly those aimed at reducing inputs of natural resources and long-term maintenance requirements, by seeking to establish a self-sustainable landscape. The design should also have regard to the likely development/maturation of proposed plantings (e.g. high-canopy woodland).

Figure 4.10

A cutting which has been treated with a mosaic of habitats with widely spaced plantings set within a semi-natural grassland. The overall approach maintains strong visual interest for the mobile road user; provides for variety of habitats; and, in time will disguise the scale of the deep cutting.

The provision of a mosaic of habitats maximises the potential for diversity of flora and fauna by providing a significant extent of "edge" habitat which encourages both edge and generalist species and by providing greater horizontal and vertical structural differentiation for species. Appropriate treatments can also be placed within identified connectivity zones in order to reconnect severed hedgerows and core habitat areas such as woodland remnants.

In certain situations such as open landscape types, tree and shrub planting may not be appropriate within treatments. However, diversity and interest can be achieved through the selection of treatments which reflect local dry or wet semi-natural grasslands and heaths (see Chapter 6).

Figure 4.11

A further example of a varied and structurally diverse treatment that avoids the temptation for over-planting with tree species. The treatment breaks the continuity of the large cutting and provides strong visual interest, good cover and a diverse range of habitats for wildlife.

Key Issues for Soil Cuttings

- Cuttings are major earthworks of visual significance and consequently landscape treatments should be selected to avoid emphasising the linearity of the road corridor.
- Selected treatments need to consider the physical nature of the site, including aspects of geology, engineering, soil, stability, drainage and microclimate.
- Given the general inaccessibility of steep slopes, the selection of treatments should aim to minimise maintenance requirements.
- The design and selection of treatments should seek to maximise the diversity of habitat with any tree planting set back at appropriate distances from the carriageway.
- Where slopes permit, an open habitat-mosaic approach, with good horizontal and vertical structural differentiation should be considered for the selection and layout of treatments.

Rock Faces

Cuttings that expose solid rock faces are a distinctive feature of many major road schemes in the Irish landscape. They may consist of Old Red Sandstone or, more commonly, Limestone. Rock faces, in contrast to soil slopes, can be of significant visual interest to mobile road users and local inhabitants, promoting regional identity and a sense of place along the road network. As such, rock faces and scree slopes have a function in restoring regional identity and in defining local landscape character by forming locally distinctive features within the landscape.

Where rock is exposed in a cutting and where aspects of safety and stability can be addressed, the rock face should be retained as a locally distinctive feature. In cuttings through stable solid rock the face may be very steep or near-vertical (Figure 4.12). By contrast, in less solid or fractured rock, some grading or profiling may be required to retain the exposed feature safely (Figure 4.13).

Figure 4.12

A steep rock face which, though severe, is locally distinctive and will gradually weather over time.

Where the exposed rock face is retained, it will be gradually recolonised by vegetation over time. While the process will occur naturally, it can be assisted through the formation of small ledges and crevices in the profiled face (Figure 4.13). Such varied micro-topography provides appropriate conditions for accumulation of small amounts of organic matter and the recolonisation of vegetation over time.

Figure 4.13

Profiling of rock face underway on a new cutting on the N11 near Ashford in County Wicklow. The objective of profiling is to create a stable rock face with a varied micro-topography of crevices and ledges to facilitate recolonisation.

Scree Slopes

Scree slopes, in contrast to rock cuttings, are comprised mainly of loose material such as shale, slate or till (including sand, gravel and boulders), and are usually finished to a shallow angle. Where immediate stability is not a key issue, natural recolonisation may be selected as the most appropriate treatment.

In the early stages of vegetation succession, stable scree slopes are typically colonised by lichens, mosses and other pioneering species. While gradually adding organic matter and initiating basic soil development, these pioneering plants begin a binding process that, in time, encourages larger species of plant to colonise (Figure 4.14). At the final succession stages, scree slopes provide an excellent substrate for the development of dry semi-natural grassland or scrub (see Chapter 6).

Figure 4.14

Stable scree slopes will be naturally recolonized over time by semi-natural grassland and native pioneering tree and scrub species.

While it is preferable to ease gradients to stabilise scree slopes, this may not always be an option due to technical constraints. In such cases, the slope may be seeded directly with a locally appropriate semi-natural grassland seed, or, where suitable, a tree and shrub seed mix. Alternatively, the slope could be covered with a thin layer of subsoil (approximately 50–100 mm), depending on the nature of the scree material which may then be either direct seeded or allowed to colonise naturally.

Treatments that aim to establish trees and shrubs on exposed scree slopes through direct planting have little chance of success because of inherent dry conditions and the lack of organic matter. Tree and shrub planting may be considered appropriate where it is set back from the top of rock faces or scree slopes where a treatment is required for reconnection of severed hedgerows or core habitat areas.

Key Issues for Rock and Scree Cuttings

- Aspects of stability and safety are a priority.
- Scree slopes, and particularly rock cuttings, provide visual interest and, where incorporated into the design layout, can contribute to regional identity.
- Rock faces, and particularly scree slopes, will be naturally recolonised over time. Self-seeding tree species may need to be removed prior to becoming a potential safety hazard.
- Rock face profiling may be utilised to provide a stable cutting with a varied micro topography that will be more receptive to natural recolonisation.

4.2.2 Embankments

In contrast to cuttings, embankments involve an increase in the existing grade, i.e. where a road is set at a level that is above the existing topography (see Figure 4.4). As such, embankments generally occur where the road moves through a local depression in the landscape. Sections of embankment are also commonly utilised in the realignment of roads, over or under other roads and in approaching river or stream crossings (see *Guidelines for the crossing of watercourse during the construction of national road schemes (*National Roads Authority, 2005*)*.

In the wider landscape, embankments tend to increase the visual prominence of a road (Figure 4.15) and its traffic. Therefore, treatments may need to mitigate impacts on attributes of the visual field, such as loss of 'rural' structuring, naturalness and regional identity. The selection and layout of treatments must also aim to restore environmental aesthetics by providing visual screening for the local inhabitants. In terms of the mobile road user, an embankment expands the drivers' field of view and creates opportunities for development of vistas and panoramic views of the adjacent and wider landscape (see Section 3.1.1).

Figure 4.15

Elevated embankment through low-lying terrain on the M7 Kildare By-Pass.

As with cuttings, high embankments significantly increase the area of roadside landscape and the potential for a diverse range of landscape treatments. The landscape designer may consider an open habitat-mosaic approach, where the width and patterns of the various plant groupings should vary within the mosaic to avoid obvious patterning effects. In general, extensive planting of embankments is rarely required for aesthetic reasons. Mass planting should be avoided as it restricts the field of view for the mobile road user and reduces potential for habitat diversity. In some circumstances, treatments may be utilised for visual screening in order to reduce loss of naturalness and contrasts of scale, where such components and traffic are visible to local inhabitants and from amenities.

Treatments can also be designed to facilitate the creation of vistas (Figure 3.11) through the planting of trees and shrubs, where appropriate, near the top of embankments. Such planting will have the effect of framing views (vistas) whilst also screening the upper embankment and associated traffic. By contrast, appropriate treatments can also be placed at the base of slopes in order to provide connectivity and to defragment core habitat areas. The latter will also retain more open views (panoramas) for the mobile road user on the elevated road.

Key Issues for Embankments

- Selected treatments need to consider the physical nature of the site, including aspects of geology, engineering, soil, stability, drainage and microclimate.
- Given the general inaccessibility of steep slopes, treatments should aim to minimise long-term maintenance requirements.
- An open habitat-mosaic approach, with good horizontal and vertical structural differentiation, should be considered for the selection and layout of treatments.
- Where embankments are visually dominating within the adjacent and wider landscape, treatments should be selected so as to provide visual screening, where appropriate.
- The selection and layout of treatments should also seek to provide connectivity and defragmentation of core habitat areas and opportunities for the creation of framed (vista) and open (panoramic) views.

4.3 Junctions, Interchanges and Roundabouts

Junctions, interchanges and roundabouts are large-scale technical elements, which, with associated illumination, can form significant and often visually dominating features within a rural landscape. As such, the layout of treatments should address impacts on naturalness, 'rural' structuring and the management of vegetation and scale. The management of scale may include treatments that address the agreement, unity, contrast and transition of scale through the appropriate selection of treatments, plant sizes and mixes (see Section 3.1.1).

On major road schemes, junctions may consist of large-scale grade-separated arrangements often comprising significant land-take. By their nature junctions tend to be visually intrusive with overbridge and/or underbridge structures, topographical variation, elevated traffic movements and illumination (Figure 4.16). Junctions also carry traffic of varying speeds in merging/diverging

movements. For this reason it is critical that the layout of landscape treatments takes particular regard of clear zones, sightlines and safety implications (including potential effects of lighting, leaf fall and shade). Selection of treatments should also take account of the development and maturation of the vegetation over time.

Junctions have specific design requirements which will influence the design and selection of landscape treatments, the most important of which include:

- the maintenance of sightlines, including forward sightlines;
- the location of signage and lighting;
- the incorporation of drainage systems;
- the requirement for significant variation in ground levels;
- the requirement for significant areas of land-take, and
- the existence of 'habitat islands' within the design of the junction.

Figure 4.16

An example of a grade-separated interchange showing typical elevational variation, overbridge and lighting.

As grade-separated junctions may enclose large areas of land, it may be feasible to retain, existing mature trees and shrubs as a feature of the design layout (Figure 4.17). Diverse semi-natural grassland, shrub plantings and occasionally low-canopy woodland (see Chapter 6) can be considered as appropriate treatments. However, the area enclosed by junctions is generally severed and isolated from the surrounding landscape by access lanes and roundabouts. Therefore the selection and layout of treatments should not prove attractive to fauna that could otherwise be at increased risk due to the proximity of traffic.

Figure 4.17

Mature trees have been retained within the design of the junction. However, the otherwise over-planted area would benefit from thinning/ partial removal so as to incorporate open grassland to provide visual interest and increase biodiversity value.

In certain circumstances, consideration can be given to treatments that will cater for wildlife where significant 'habitat islands' exist. This may only be considered where appropriate connection to the roadside landscape and the adjacent, and wider, landscape can be readily provided. In such areas (and sightlines permitting), a wide variety of treatments including semi-natural grassland, mixed shrub and low-canopy woodland planting can be established. High-canopy woodland planting should be avoided or restricted within such areas. Where small enclosed sections of land (i.e., land between slip roads and the main motorway) are inaccessible for safety reasons and isolated from the main roadside landscape, consideration should be given to the provision of a treatment that will require minimal future maintenance. Such treatments may include paving or the use of a plant suppressing plastic layer covered with a layer of rough gravel or dry filling.

Consideration must also be given to the selection and layout of treatments in the wider vicinity of interchanges. Such treatments can serve to address impacts of scale, mitigation of impact from illumination and act as visual screening to traffic movements within the junction, where acceptable, having regard for sight lines and safety requirements.

Inappropriate treatments on roundabouts may create habitat islands. The design and selection of treatments, therefore, must be selected so as to avoid attracting wildlife, due to the risks associated with proximity to high levels of traffic activity. While the disturbance associated with traffic activity will, in many instances, deter animals from establishing in these locations, birds may still be attracted, in particular, by the presence of berry producing plants.

Key Issues for Junctions

- Junctions are significant features incorporating major structures, topographical variation, illumination and varied traffic movements.
- Junctions have specific design and safety related functions which must be considered in the selection and layout of appropriate landscape treatments.
- Selected treatments need to consider the physical nature of the site, including aspects of engineering, soil, stability, safety, drainage and microclimate.
- Given the general inaccessibility of steep slopes, treatments should aim to minimise requirements for maintenance inputs.
- Isolated, potential 'habitat islands' within junctions should not be made attractive to larger mammals and birds due to the risk of traffic collisions. The provision of low maintenance treatments should be considered in such situations.

4.4 Central Reservations or Medians

Central reservations or medians are a common component of many existing road schemes. In recent years, however, as the width of central reservations has become reduced and they increasingly include various drainage and safety-barrier features, there is often little remaining in terms of 'soft landscape' area. From an ecological viewpoint, central reservations are isolated linear areas of land which can potentially form 'habitat islands'. For this reason, treatments should not prove attractive to birds or mammals where the risks associated with the proximity of traffic are very high.

Where appropriate, landscape treatments for central reservations should primarily focus on safety and aesthetic related issues. From an aesthetic perspective, a central reservation can mitigate the dominance of the 'hard' road surface by promoting naturalness and can provide important visual separation between opposing traffic and resultant night-time glare or dazzle from head-lights. However, as with the immediate roadside verge (see Section 4.1.1), central reservations have various demarcation, safety and sightline functions.

The treatment of central reservations must provide for the safety restriction of clear zones (see Section 2.2.1) and forward sightlines, and as such, even where protected by barriers, trees and shrubs should not be allowed to develop a strong main trunk. Ideally, treatments should have a low maintenance requirement so as to reduce the requirement for lane closures commonly associated with the maintenance of central reservations. With this in mind, low growing or low maintenance non-berry producing shrub species are preferable within treatments, especially where narrow reservations are present.

The central reservation is also often used for bulb planting. Such planting offers distinctiveness but tends to "urbanise" a rural landscape, and as such should be restricted in use, to an urban-edge/suburban context.

Key Issues for Central Reservations or Medians

- Central reservations have important safety and demarcation functions. Treatments and their management must conform to clear zone, sightline and safety regulations/requirements
- As 'habitat islands' in proximity to high speed traffic, central reservations should not be made attractive to wildlife
- Treatments should require a low maintenance regime. Medians may incorporate semi-natural grassland swards but should retain a visually distinct demarcation with the carriageway
- In the management of the central reservation, consideration must be given to maintaining relevant sightline and safety aspects including the on-going requirement for possible lane closures for maintenance and the safety of those carrying out such activities

4.5 Watercourses, Attenuation Ponds and Wetlands

In the course of construction, road schemes will intersect with stream and river crossings, some of which will require diversion and re-alignment. Furthermore, in the design of drainage features, a range of further components, including swales, attenuation ponds and wetlands may be used in the management and control of road drainage.

4.5.1 Watercourses

Road schemes that traverse rural landscapes may cross numerous watercourses including drainage ditches, small streams and rivers (see *NRA Guidelines on Watercourse Crossings*, National Roads Authority, 2005). The intersections or crossing points between roads and streams and rivers present a number of engineering and ecological challenges in terms of maintaining connectivity for wildlife along these linear wildlife corridors. Work on such watercourses may also require appropriate clearance from the relevant statutory authorities (e.g. Regional Fisheries Board, National Parks and Wildlife Service, Office of Public Works) particularly where the watercourse has a specific designation such as Salmonid water or a Special Area of Conservation (SAC).

In order to minimize culvert or bridge length under a road, realignment of the watercourse may be required. In such instances the land-take requirement for realigned stretches of watercourse should be adequate to allow for the recreation of the natural architecture of the stream or river, incorporating the former natural 'meanders' of the channel, where feasible. Reconstruction of the architecture of the stream-bed may use sections of nearby stream channel as a template and river bed gravels may be salvaged from impacted sections for reuse in the diverted channel. The channel banks or edges may be replanted with treatments that reflect the native vegetation within the existing stream or river corridor (Figure 4.18). Sharp bends or drops in the river channel should be avoided, as these will give rise to scouring conditions.

Where gently sloping banks are constructed and stabilization of a channel is not an issue, treatments can facilitate natural recolonisation within the constructed channel. Where bank-

side protection is required to prevent scouring, gently-sloping banks, stabilized with plants or strategically placed boulders, should be used in preference to concrete walls, gabion baskets and other hard-engineering solutions. The cost-effective use of 'live-plant' cuttings of Willows (*Salix spp.*) and Alder (*Alnus glutinosa*) can be utilised in the stabilisation process.

Translocation of native vegetation can also be considered where sensitive habitats have been impacted by construction. Riparian and marginal aquatic vegetation as well as soils and river substrate from an impacted watercourse can be utilised in newly constructed channels. The salvage, storage and reinstatement should be carried out in appropriate seasons, having regard to spawning and other relevant considerations and under appropriate conditions. The ecologist/landscape designer must also ensure that non-native invasive species are not present within the salvaged material.

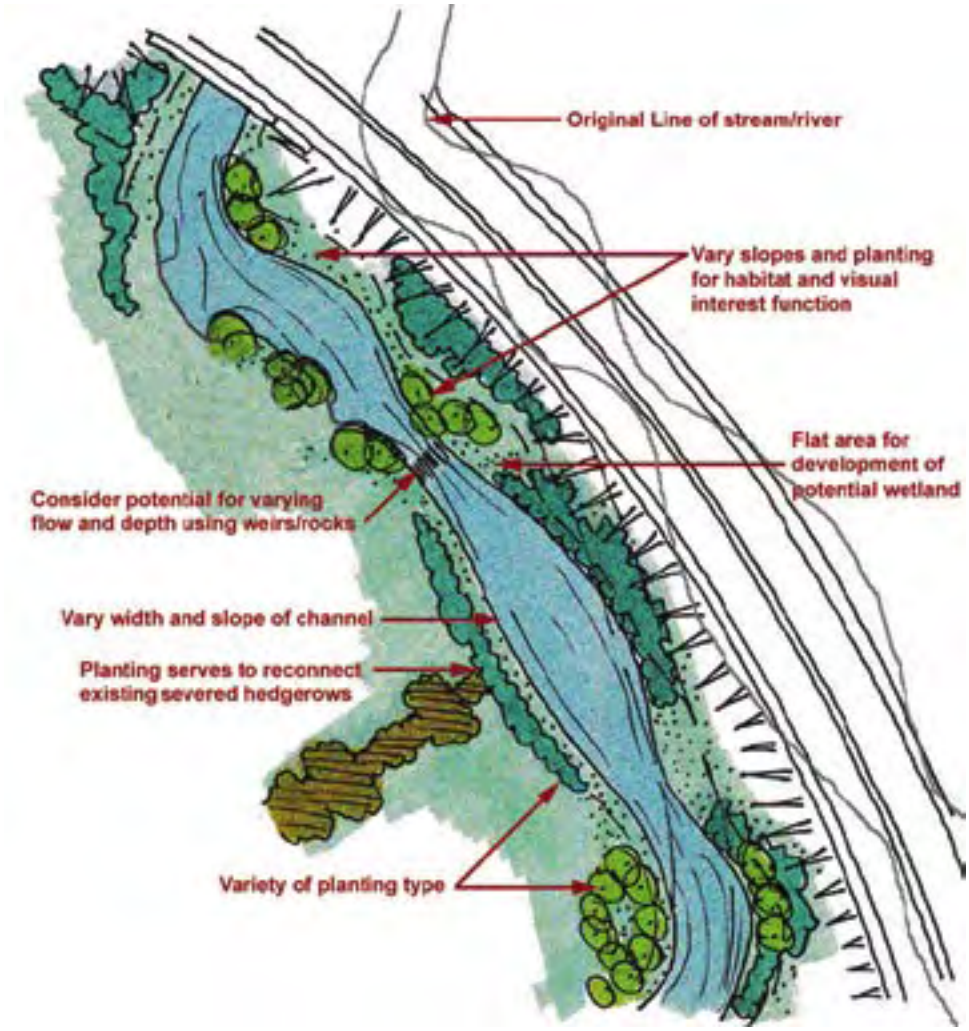


Figure 4.18

Example of potential stream re-channelling. Realigned or re-channelled watercourses should have a variety of edge habitat and flow speed, if locally appropriate. Weirs, islands, pools and varying widths may all be employed to good effect. However, the overall objective is to minimise 'in-water' disturbance and to rapidly re-establish diverse bank-side vegetation.

Key Issues for Riparian Habitats

- Works on watercourses should have appropriate clearance from relevant statutory authorities. Particular attention is required where the watercourse has a specific designation such as Special Area of Conservation (SAC) or Salmonid water.
- The design of newly constructed channels should incorporate a meandering architecture with a natural gravel river bed, where feasible.
- The design of realigned watercourses should ensure that scouring of banks is avoided. Issues relating to stabilization of river and stream banks need to be addressed through the use of appropriate treatments.
- In sensitive situations it may be appropriate to consider the translocation of marginal and aquatic plant material to facilitate the early recovery of aquatic vegetation and the stabilization of soil.
- Treatments should reflect the natural species composition of local riparian habitat and existing native watercourse vegetation.

4.5.2 Swales and Attenuation/Balancing Ponds

Ecological engineering features in the form of swales, attenuation/balancing ponds and constructed wetlands (see Section 4.5.3) are sustainable components which utilise natural systems and their processes in the management of run-off from road schemes. Where appropriate treatments are applied, such features can also have additional aesthetic and wildlife benefits.

Swales, attenuation or balancing ponds are increasingly used on road schemes to control the quality and quantity of run-off arising from extensive areas of paved road surface. The use of ecological engineering approaches in the management of road run-off offers significant potential for the creation of habitats and locally distinctive features, which can contribute to regional identity, variety and naturalness within the landscape.

Swales located within the verge are, in effect, channels that carry water run-off during heavy rain. However, for most of the year the channels are dry or at least semi-dry. While such channels should be kept free of planting or vigorous grass, which could restrict or impede drainage, robust low maintenance grass sward and/or semi-natural grassland treatments can be utilised. In appropriate locations, local deepening of a swale may encourage permanently damp/wet conditions potentially facilitating the natural recolonisation of marsh plant communities within the swale. Such treatment may also help to filter pollutants, slow water movement and to remove suspended material.

Attenuation or balancing ponds provide storage, and hence a control, in the release of drainage water into existing watercourses. While the majority of ponds may also be dry for considerable periods, others may offer potential for the presence of a permanent water level. Where permanent water may be provided, such ponds offer significant opportunity for the establishment of new native wetlands, which can be of both ecological and aesthetic benefit.

While permanent water will improve biodiversity, varied designs may also be developed for intermittent flooding situations. Shallow water will quickly become colonised by native emergent and marginal aquatic plant species such as Yellow Flag Iris (*Iris pseudacorus*), Reeds (*Phragmites australis*) and Bulrush (*Typha latifolia*), especially where a pond is constructed adjacent to an existing wetland (Figure 4.19). As with reconstructed channels, consideration can be given to utilising translocated native marginal and emergent vegetation as well as soils and substrate from a disturbed water body. The immediate area surrounding the pond should also be included within the design layout and may be planted with wet semi-natural grassland, marsh habitat or wet woodland treatments (Figure 4.20).

Figure 4.19

Attenuation Ponds on the N25 Youghal Bypass located adjacent to the protected Ballyvergan Marsh, a proposed Natural Heritage Area (NHA).

The design of attenuation and balancing ponds should incorporate gently sloping banks and gentler slopes with flowing natural contours and shallow edges which will facilitate natural recolonisation and wildlife access. This will give the pond a more natural appearance in the landscape and allow for the development of more varied micro-habitats with additional ecological benefits.

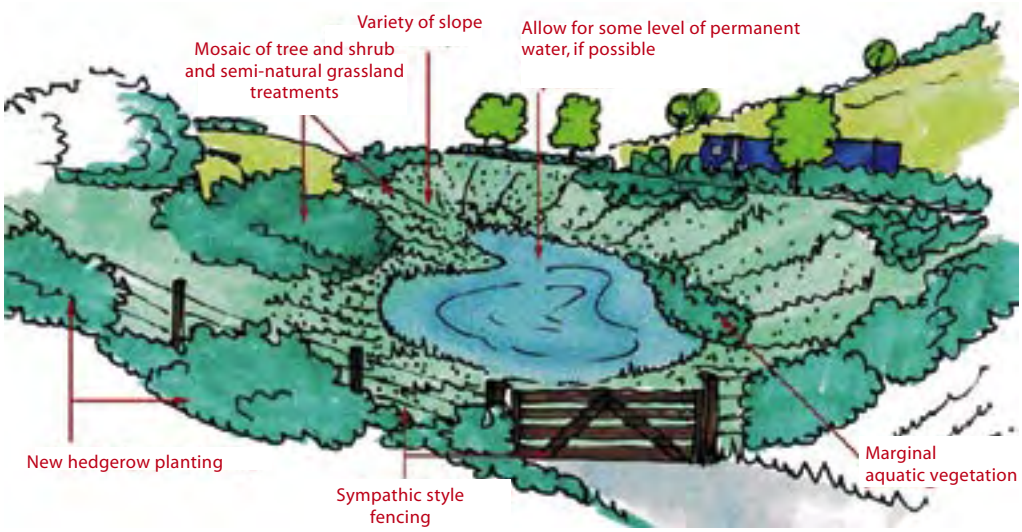


Figure 4.20

Example of an Attenuation Pond. Surrounding banks should be graded to gentle slopes, natural contours and shallow edges. The immediate area surrounding the pond can be planted with a diverse range of landscape treatments.

In a permanent water situation, the presence of aquatic vegetation can help to retain water and slow the discharge of flood waters. In addition, wetland species also function as helophyte filters or bio-filters - removing sediments, nutrients and potential pollutants from the water. As these features may also act as spill containment facilities, it is recognised that in the event of an accidental spillage, the associated ecology of the ponds may be destroyed, but such incidents are likely to be rare.

Due to the colonising abilities of wetland vegetation, open water can quickly become choked with plant material. Periodic maintenance will be required to keep vegetation in check. The frequency of such maintenance will depend on the size of the pond, depth and nutrient inputs. Phased or staged maintenance and cleaning of the pond will facilitate the migration of flora and particularly fauna from areas of disturbance to adjoining unaffected pond areas.

Key Issues for Attenuation Ponds

- Where permanent water is proposed, consideration must be given to appropriate signage and fencing, for health and safety reasons.
- The design of attenuation ponds should include a variety of shallow slopes with flowing natural contours.
- A wide variety of treatments can be utilised in the immediate area surrounding the pond.
- The selection of tree and shrub species should include a diversity of native species adapted to wetland areas and should reflect the natural species composition of existing wetland plant communities in the surrounding landscape.
- Where existing watercourses/ponds have been disturbed, consideration can be given to the translocation of native marginal and emergent plants and soils to the newly constructed pond(s).

4.5.3 Constructed Wetlands

Constructed wetlands or helophyte filters are purpose-built ecological engineering features specially designed for the control and treatment of water run-off. Careful design and selection of native plant species are required to provide the correct biological environment for treating run-off waters. Constructed wetlands also have the potential to be aesthetically pleasing while providing additional benefits to wildlife. The appropriate treatment of the banks, slopes, use of native marginal and emergent vegetation and the immediate areas surrounding the constructed wetland is similar to that of attenuation ponds (see Section 4.5.2). However, given the specific design and function of constructed wetland features, it is recommended that expert advice be sought from appropriate specialists on the selection of native species for use in the design layout of such features.

4.6 Additional Plots and Other Areas (including decommissioned sections of roads)

In the course of road planning, a number of further areas (or plots) may frequently occur along a road scheme. Primarily, these include areas of landholding severed by the mainline construction, or by the realignment of local roads (which can result in decommissioned sections of road surface) and by the provision of access or other accommodation works. In general, such areas are small, but occasionally, they can be large enough to provide a significant resource in terms of potential for biodiversity conservation and the restoration of landscape quality.

Sections of old road pavement generally result from the severance and realignment of existing roads. Where such roads are abandoned the pavement should be broken up and mixed with the underlying soil or covered with suitable soil. The resulting decommissioned section of road may be directly landscaped or allowed to recolonise naturally where located adjacent to existing native plant communities (e.g. semi-natural grassland, heath, marsh, hedgerow or woodlands habitat) (Figure 4.21) resulting in valuable additional habitat for wildlife, especially birds.

In the EIS/ER, severed plots and other areas are frequently highlighted for specific mitigation

treatments, particularly for the provision of compensatory habitat. Measures such as the provision of new woodland, dry and wet semi-natural grasslands, and wetlands are common compensatory measures undertaken where such sensitive habitats have been disturbed by a road scheme. Such areas are also often identified as suitable candidate sites for potential connectivity zones between existing core habitat areas within the landscape as identified on the map of the ecological network.

Figure 4.21

Natural recolonisation on a decommissioned section of old road pavement.

Before commencing compensatory treatments, the ecologist/landscape architect should consult the EIS/ER to ascertain the ecological value of existing vegetation on the proposed site as it may have already been identified as being of some significance. Depending on site-specific issues such as drainage, soil conditions, the existing vegetation within the plot and the surrounding land use, such plots can have potential for a wide range of landscape treatments and may be developed both as a receptacle for local biodiversity and for aesthetic interest. Appropriate treatments for plots may include:

- the provision of compensatory habitat, such as woodland, heath, dry or wet grassland;
- a variety of treatments which can create a diversity of habitat types, including woodland with glades and larger areas of open grassland or wet grassland;
- the specific restoration of indigenous broadleaved woodland which was lost as a result of past land uses or impacted by the road scheme;
- reconnection or provision of new wildlife corridors between core habitat areas (e.g., hedgerows, wetlands, semi-natural grasslands and low or high-canopy woodland treatments) within designated connectivity zones; and

- the retention of an area already identified as being of local ecological value, or of potential value, but requiring some intervention.

Plots are usually located at some distance from the carriageway, where issues such as clear zones and sightlines are normally not limiting factors.

Key Issues for Additional Plots

- Consideration should be given to identifying the potential contribution of a site in providing new habitat and in the defragmentation of core habitat areas as identified on the map of the ecological network.
- Consideration should be given to the presence of any sensitive habitats in the vicinity of the site which may provide baseline information for the selection of a treatment or which may be adversely altered or damaged by proposed treatments.
- Consideration of issues relating to local inhabitants and the potential requirement for visual screening along adjoining boundaries.
- The extent to which safety aspects are likely to be a determining factor if wetlands/water treatment are to be considered.
- The need for and frequency of access to the site for maintenance.

4.7 Greenways

In specific situations where national road schemes enter urban areas, consideration should be given to the development of Greenways. Greenways are multifunctional-use corridors which are usually established alongside road, rail or canal ecosystems where they enter or leave urban landscapes (see Figure 4.22). Greenways provide significant opportunities to increase the ecological value and landscape quality of rural and urban roadside landscapes. The potential for establishing a greenway system should be identified during the planning phase of a road scheme.

Up to the mid-1980's greenways were generally trail-orientated recreational routes that provided access to rivers, streams, ridgelines, rail beds and other corridors within an urban landscape and were usually vehicle-free. More recently, greenways have evolved beyond recreation and beautification, to address: biodiversity conservation and connectivity needs for wildlife; flood control; visual screening, barriers to perceived noise disturbance; improved water quality; outdoor education; historic preservation; and, other infrastructural objectives. However, in order to function as wildlife corridors, greenways need to be of a sufficient width and provide sufficient cover for wildlife in the form of native vegetation to encourage the dispersal of wildlife.

As greenways often form a transition zone between the urban and rural landscape, the landscape designer may consider providing a more formal design layout utilising native species as the greenway enters the urban area.

Figure 4.22

A cross section of a multifunctional greenway that attempts to integrate wildlife corridors and recreational activities within a roadside landscape in close proximity to an urban area.

Key Issues for Greenways

- Greenways may form the transition zone between urban and rural roadside landscapes. Therefore, consideration should be given to treatments utilising native species in a more formal design layout as one nears the urban zone of a town or city.
- Consideration should be given to the establishment of a wildlife corridor within the greenway system which would aid in the defragmentation of core habitat areas as per the map of the ecological network.
- Where appropriately designed, greenways can provide visual screening for local inhabitants.
- Where appropriately designed, greenways can provide a buffer zone for perceived noise disturbance.

Chapter 5
Soil Geographic Factors

5. Soil Geographic Factors

In accordance with best practice it is paramount that, if landscape treatments are to successfully address sustainability issues, and to achieve self-sustaining characteristics such as low maintenance requirements, landscape designers need to take account of specific on-site conditions, in particular, local soil geographic factors. The early identification (and where required, the appropriate storage - see *NRA Specifications on the General Requirements for Earthwork Materials Series 600*) of suitable soil during initial construction will ensure the availability of the required soil type and quality of soil, for later use in the preparation of treatments.

5.1 Soil Classification and Profiles

5.1.1 Main Soil Groups

Soils vary considerably in their characteristics, depending on the parent material or bedrock, the conditions under which they were formed, and the length of time which has subsequently elapsed. Soils may differ in depth, physical structure, organic matter content, water content and in their chemistry. These differences determine the fertility of soil, the type of associated plant communities and the range of potential land-uses, amongst others.

For example, certain soil types sustain unique plant communities of local, national and international importance e.g. semi-natural grasslands, wetlands and woodlands designated as Special Areas of Conservation (SACs), while other soil types which have been found to be capable of providing high annual yields of grass and cereals may be intensively managed for agriculture grassland and tillage. The soils of Ireland have been classified into ten main Great Soil Groups (see Table 5.1).

Podzols	Redzinas
Brown Podzolics	Regosols
Grey Brown Podzolics	Lithosols
Brown Earths	Blanket Peats
Gleys	Basin Peats (incl. raised bogs and fen peats)

Table 5.1 **The ten main great soil groups of Ireland (EPA, 2002)**

The various soil groups present on a road scheme will be detailed within the EIS/ER. Detail will include the key soil geographic factors such as the soil profile, soil fertility, structure, pH, depth and the local plant communities which they support. The likely inherent seed bank and reproductive plant material (roots and rhizomes) present within the soils (see Section 5.3) must also be identified on site by the ecologist/landscape designer and will, in part, be based on the type of above-ground plant community which the soil sustains.

5.1.2 Soil Profiles

Soil groups exhibit various degrees of vertical differentiation, known as a soil profile. A soil profile is formed as a result of changes in soil properties which occur with depth, mainly as a result of reduced levels of organic matter and associated biological activity. A soil profile may be revealed during excavations for road construction, where a transverse section through the landscape surface exposes the vertical face of a soil pit.

A profile typically contains bands or layers of soil that are visually distinct from each other. The layers known as "horizons" occur approximately parallel to the landscape surface (unless previously disturbed by past land-uses or by natural factors such as a fluctuating water table). Each horizon may differ in colour, texture, structure, consistency, porosity, chemical constituents, organic matter and biological activity. For this reason the soil profile is the basic unit in identifying and classifying the character of soil.

There are three main horizons found within the profile of the soils, and they are usually identified by the letters A, B and C. The combined A and B horizons constitute the solum, or "true soil", while C refers to the unconsolidated parent material beneath (see Figure 5.1). For certain soil groups, the soil profile may also contain additional horizons specific to a group, such as an O horizon (in a woodland soil profile) and an L horizon (in an agricultural land-use soil profile). The O horizon is not always present and is generally absent in very acidic woodland soils or podzols.

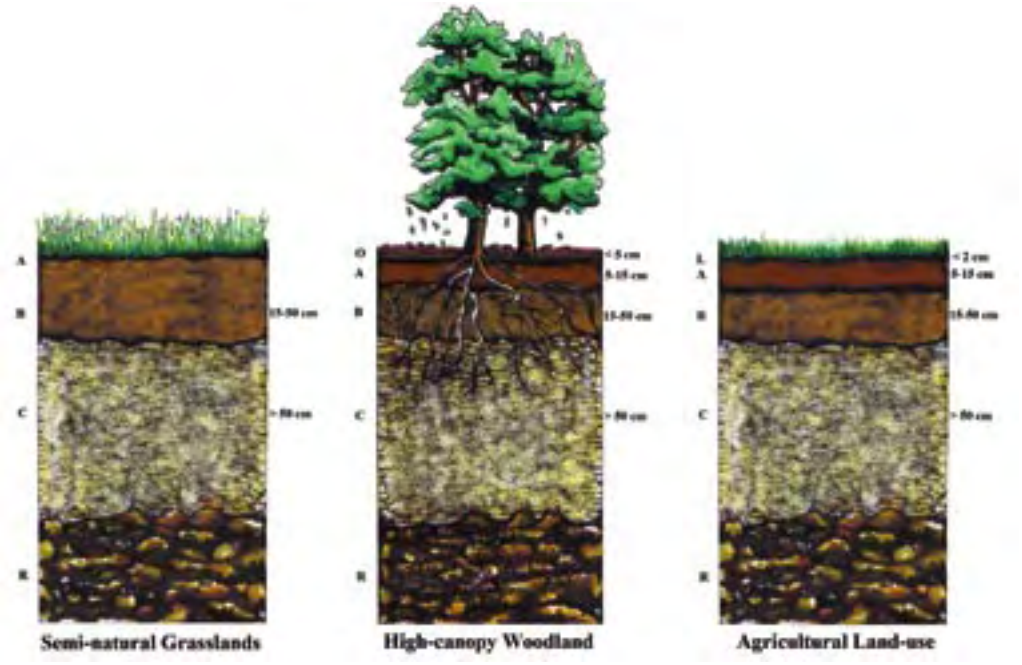


Figure 5.1

Soil Profiles for Semi-natural Grasslands, Native High-canopy Woodland and Agricultural Land-uses.

(O = organic or humus layer, including leaf litter, L= rapid decomposition layer, A = Topsoil (the topsoil layer may be significantly deeper in soil horizons of tillage/arable land), B = Subsoil, C = Unconsolidated Material, R = Parent Bedrock). Note the absence of the O horizon in Agricultural/ base-rich land-uses. (Source: Dolan and Whelan, In Preparation).

The A horizon, which equates with topsoil, is recognisable as a dark brown organic layer. It is usually found in the top 150 to 250mm of a soil profile. It is relatively fertile, containing organic matter, a seed bank, roots and rhizomes of the above ground plant community. Beneath the A horizon is the B horizon or subsoil, which is paler and more yellow in colour (see Figure 5.1). Subsoil is derived from materials transported from the overlying A horizon through leaching, and the weathering of the unconsolidated material of the C horizon and is less fertile with a lower organic matter content than the A horizon, containing a smaller seed bank, with fewer roots or rhizomes.

5.1.3 Agricultural Soil Horizons

Under agricultural land-use, soil is prepared and planted with a non-native agricultural grass seed mix such as Perennial Ryegrass (*Lolium perenne*) or a tillage crop. Such improved agricultural grassland contains a narrow rapid decomposition layer - the L horizon and is treated with fertilizer – Nitrogen (N), Phosphate (P) and Potassium (K) and trace elements. The depth of the fertile A horizon may vary greatly from almost 0 to 500mm deep, depending on field conditions. The A horizon contains the seed bank, roots and rhizomes of the above ground grass or tillage crop, but also the seeds of associated weed species.

Beneath the topsoil, the B horizon or subsoil is paler and more yellow in colour (see Figure 5.1) and is generally less fertile, with a low organic matter content, and contains a smaller seed bank, and fewer roots or rhizomes of the above ground improved grassland, tillage crop or weed species.

As the majority of roads in Ireland traverse intensively managed rural agricultural landscapes, a fertile A horizon is usually abundant on road schemes.

5.2 Significance of Soil Nutrient Status

Nitrogen and Phosphorus are the key soil nutrients. N is released from decomposition of organic matter in the O or L horizon and is highly mobile in soil, in effect, widely available to plants. P is highly immobile and only available to roots in the immediate vicinity.

The intensively managed, fertile, A horizon of improved agricultural grassland contains excessive quantities of Nitrogen to support the grass or tillage crop. This highly fertile horizon also supports opportunistic weed species, therefore, encouraging competition amongst plants where vigorous nutrient demanding species can out-compete less aggressive more desirable native broadleaved herbs typical of native semi-natural grasslands.

In contrast, an unmanaged nutrient poor, infertile, A horizon of an appropriate soil group which sustains a species-rich grassland of desirable broadleaved herbs (i.e. a semi-natural grassland) does not contain agricultural weeds as they are not presented with the opportunity to out-compete the more desirable species.

Significantly, the nutrient poor, less fertile, B horizon or subsoil from an agricultural land use has similar soil geographic factors to soils which sustain semi-natural grasslands. For this reason the use of subsoil in the preparation of a semi-natural grassland treatment has the ability to push the balance in favour of the establishment of desirable broadleaved herbs and to sustain a semi-natural grassland community as it does not have the nutrient levels to sustain vigorous weed species. Such soil also contains only a small seed bank.

5.3 Significance of Soil Seed Banks

It is the A horizon of the various soil groups which generally contains the bulk of the seed bank and potential reproductive plant material (i.e. seeds, roots and rhizomes) of above ground plant communities.

For this reason, in improved agricultural grassland, the A horizon contains excessive quantities of agricultural grass, tillage crop and weed seed within its seed bank, along with the potential reproductive material of same. Once disturbed, the seed bank will germinate and plant material may re-establish to provide a vigorous, undesirable plant community of agricultural grassland dominated by weed species such as thistles, docks and nettles. Such soil is, therefore, unsuitable for the establishment of semi-natural grassland treatments.

In contrast, the B horizon or subsoil from an agricultural land-use type contains little or no seed bank, roots or rhizomes. Therefore, where utilised in a landscape treatment, it will not contribute weed species to the establishing treatment thus providing an opportunity for broadleaved herbs to establish. For this reason also, subsoil is suitable for the establishment of semi-natural grassland treatments.

Where native plant communities, such as semi-natural grassland, wetland and woodland are found within the land-take of a road scheme, the A horizon of the soil group which sustains the plant community should be stripped and retained for later use in the preparation of a treatment within the roadside landscape. This is important as it will contain the seed bank of the desirable native broadleaved herbs and/or woody species (shrub and trees) of the above ground plant community.

However, in some circumstances, the seed bank of an A horizon may also contain dormant seed of plants which are not reflected in the above ground plant communities. This may have positive or negative repercussions. Where modified woodland such as mixed broadleaf/conifer woodland is disturbed by road construction, the seed bank of the former past native plant community may persist within the A horizon and the soil can be retained for later use in the preparation of treatments. In contrast, native broadleaf woodland soils may contain dormant seeds of species such as thistle that are not visibly present within the woodland flora. Where the woodland is disturbed or soil is retained for later use in a treatment, thistles may germinate and require management such as pulling by hand or appropriate spot treatment with herbicide.

Soil stripping and movement during road construction may also reveal an intact A horizon from a soil type which sustained past native plant communities which was buried with topsoil during the preparation of soil for improved agricultural grassland or tillage. It should be noted that the seed bank of wetlands buried in such a manner can remain dormant but intact for up to 25 years or more. In such circumstances the uncovered A horizon should be retained in situ or stripped and stored for later re-use where the seed bank may be allowed to germinate.

5.4 Selection of Appropriate Soil for Preparation of Treatments

The selection of treatments for a site must be compatible with suitable soil geographic factors, or the soil should be reasonably capable of being altered or managed so as to be compatible.

5.4.1 Semi-natural grassland treatments

Where the A horizon of a soil profile which supports native semi-natural grassland is disturbed by a road scheme, it can be retained for the establishment of grasslands elsewhere within the road scheme, as it contains a valuable local, indigenous seed bank of native broadleaved herbs and grasses.

The use of topsoil in the establishment of semi-natural grasslands results in grass/weed swards of little ecological value which require physical and natural resource inputs in terms of maintenance, including herbicides and/or frequent mowing. In contrast, the less fertile soil or B horizon of agricultural land-use profile will support a more desirable range of native, broadleaved herbs. The use of a B horizon will also promote the establishment of self-sustaining treatments as it reduces the need for use of herbicides, fertilizers and long-term maintenance of treatments.

In the preparation of sites for the establishment of semi-natural grassland, where the amount of available subsoil within a road scheme is limited, consideration can be given to covering topsoil with a 300mm or more layer of subsoil which will support the desirable broadleaved herbs, while smothering existing weeds which may have germinated and/or burying the seed bank and the potential reproductive vegetative material of weeds, present within the topsoil.

Where possible, a good tilth, no more than 100mm deep should be prepared. This may not be required on light sandy soils. Deep cultivation should be avoided as this will release nutrients, promote germination of weed seeds and encourage moisture loss from within the soil.

Species-rich semi-natural grasslands may establish slowly on nutrient poor subsoil and may give rise to an initial perception of lack of management. However, the grassland will develop both ecologically and aesthetically over time to produce a species-rich semi-natural grassland in the absence of the competitive and vigorous weed species. For this reason, it is important that the positive and developmental aspects of landscape treatments are promoted both generally and especially amongst the local community in the immediate locality of works.

5.4.2 Tree and Shrub Treatments

Where the A horizon of a soil profile that supports native woody plant communities such as hedgerow, tree-lined hedgerow, scrub/transitional woodland, low-canopy and high canopy woodland, is disturbed by a road scheme, it can be retained for the establishment of new woody treatments elsewhere within the road scheme. The A horizon contains a valuable local indigenous bulb/seed bank/root/rhizome source facilitating the regeneration of woody plant communities.

Where soil geographic factors for the establishment of woody plant communities are not present within the land-take of a road scheme, the landscape designer will have to locate suitable soil within the road scheme for the establishment of tree and shrub treatments.

In general, fertile A horizon from agricultural land-use or topsoil may be utilised for tree and shrub planting, as such species require nutrient-rich soil for growth. An adequate depth of soil is required for tree planting, as trees which are planted into shallow topsoil (e.g. 100 to 200mm topsoil) will quickly begin rooting into subsoil which can reduce growth rates.

In contrast, deep topsoil layers (300mm plus) will significantly increase tree and shrub growth. Furthermore by using deeper topsoil layers in treatments, the topsoil resource within the road scheme is depleted. This is significant where subsoil is limiting and excess topsoil is available within a road scheme. Woodland treatments may in effect act as borrow pits, i.e. a source of subsoil, and a sink for topsoil, which will increase opportunities for the establishment of treatments on subsoil elsewhere within a road scheme.

For tree and shrub planting, consideration can be given to covering topsoil with a thin layer (approximately 100mm) of subsoil. The top layer of subsoil will support desirable broadleaved herbs, while smothering existing weeds and/or burying the seed bank and the potential reproductive material of weeds, present within the topsoil. The topsoil beneath will continue to support the growth of trees and shrubs. Such an approach also provides for the establishment of species-rich grassland as a basic fabric within a woodland treatment, where a diverse layout of treatments, including the open-habitat mosaic approach, is required (see Section 4.2).

5.5 Soil Management Plan

It is clear that the successful establishment of treatments will demand commitment to soil management – especially in terms of on-site soil identification, stripping, storage or retention and re-use. A soil management plan must be put in place to provide a protection strategy for particular soil types, their properties, functions and uses. A soil management plan is of particular importance where:

- natural recolonisation is proposed and the identification of suitable soil and assessment of soil geographic factors is required;
- soils are to be retained for the preparation of treatments for habitat compensation or reinstatement of disturbed plant communities adjacent to sensitive or protected habitats, e.g. mature broadleaf woodland soils such as oak-ash-hazel woodland; and
- suitable soil is required for the establishment of semi-natural grasslands.

The programme of stripping, storage, management and reuse of soil horizons A and B, or topsoil and subsoil, should be detailed in the Soil Management Plan.

5.5.1 Stripping, Storing and Use of Soil

Where an A horizon which is sustaining native plant communities is disturbed during road construction and where such plant communities are to be recreated within treatments, the A horizon should be stored separately for the minimal period of time at locations which will not require the soil to be relocated to a further storage point. Where soil is stripped from a marsh or other wetland plant community, the soil should be stored under suitable conditions to prevent desiccation of the soil, its seed bank and reproductive plant material. Where a road disturbs native woodland, it is the fertile woodland soil (soil horizon O and A) which should be stored for re-use in the preparation of treatments as it will contain the seed source for the re-establishment of the woodland ground flora.

Topsoil and subsoil from agricultural land-use should be identified on-site and thereafter stripped and stored separately. Subsoil may be retained for use in semi-natural grasslands treatments. It should be noted that subsoil is often susceptible to a high degree of compaction, smearing, etc. It is important that the soil is handled in dry weather when the material is not saturated. After placement, the soil should be decompacted, by ripping so as to improve drainage, aeration and rooting establishment. However, it must be noted that the stripping and disturbance of soils, even woodland soils, will encourage the release of nutrients, thereby altering soil fertility and may also promote an initial flush of undesirable weed species, such as thistles and docks. These species may require appropriate early pre-planting/pre-seeding control through pulling or appropriate spot treatments with herbicide, in order to promote the development of self-sustaining treatments (see Section 3.2).

Best practice also dictates that careful consideration should be given to the movement of soil during the preparation, implementation and maintenance phases of landscape treatments, as both soil and vehicles are known to transport plant fragments. Appropriate measures and effective in situ control should be applied to potentially invasive weed and non-native invasive species.

5.5.2 Natural Recolonisation

The process of natural colonisation depends on soil geographic factors, the seed bank and reproductive material within the soil, and the type of plant communities present within the surrounding landscape. Natural recolonisation is likely to be most successful on small areas, close to existing plant communities. The soil within the treatment of the receiving site must have similar soil geographic factors as that soil which sustains the adjacent native plant communities (the donor site). Such plant communities will provide a seed source for the receiving site through wind and animal seed dispersal. The selection of natural recolonisation as a treatment must be based on an awareness of the presence of invasive weeds and non-native invasive species in the surrounding landscape.

5.5.3 Translocation of Turves or Sods

In sensitive locations, translocation can play a significant role in providing compensatory habitats (such as in conserving rare plants or rare plant communities) as identified in the EIS/ER. Translocation involves the relocation of rescued material usually turves and sods from disturbed sites which contain native plant communities. The turves/sods should have the root-zone or A horizon intact.

Translocation can be considered for sensitive habitats, e.g. in the relocation of semi-natural grassland, marsh or woodland ground flora. Such an approach is likely to have programming implications between initial lifting and final placing and may require appropriate intermediate storage. It is also potentially a time-consuming and costly option, and as such, should be reserved for relocation of plant communities that have been identified as being of particular importance, especially protected areas, i.e. SACs and NHAs. Turves and sods should ideally be stored for the minimum period possible and material should be kept under appropriate conditions to promote survival of the vegetation, seed bank and reproductive plant material.

In order for treatments to be successful, it must be feasible to readily create the conditions of the donor site within the receiving site, especially in terms of its characteristic hydrology and soil geographic factors. Where possible, it is desirable to relocate directly to the donor site so as to avoid having to recreate interim matching holding/storage conditions. Because of added stress factors (desiccation, water-logging, etc.), interim storage increases the potential for failure of the treatment. However, straight transfer is likely to result in restricted programming for the civil works and accordingly must be clearly identified at any early stage. After translocation, monitoring (by way of follow up survey of the receiving site) will be required to assess site conditions and sod re-establishment. Hydrological adjustments, such as increasing or reducing water levels or moisture content of the site, may also be required.

In certain situations a more limited application of translocation may be utilised so as to encourage the natural recolonisation process described above. This entails lifting small 'plugs' of impacted turves/sods (or even individual plants) for dispersed relocation to sites within the roadside landscape which have similar hydrological and soil geographic factors as the donor site.

Chapter 6
Landscape Treatments

6. Landscape Treatments

This chapter describes the most commonly utilised landscape treatments in detail. The treatments are discussed under two broad categories: 'Grassland Treatments' and 'Tree and shrub Treatments'. Throughout this chapter, where reference is made to a treatment, the corresponding habitat classification code as listed in The Heritage Council's '*A Guide to Habitats in Ireland*' (Fossitt, 2000) is also given. In the development of all landscape treatments for road schemes, the landscape designer should refer to this document to provide outline detail on native plant communities. However, more specific detail on the building blocks for the design of treatments, i.e. on soil geographic factors and the local plant communities within the land-take of, and adjacent to, a road scheme can be found within the relevant EIS/ER. Where baseline data are absent, Cross (1997) can provide a baseline which will aid in the selection of appropriate treatments. The plant communities as listed by Cross (1997) can be supported by the detailed categories described in Fossitt (2000).

The preparation, implementation and management of treatments must address a minimal input of natural resources and the need for long-term maintenance requirements. The application of fertilizer should be avoided while the use of herbicide should be minimized. Control of weed species should focus on pulling (where feasible) or spot treatments of vigorous weed and grass species.

6.1 Grassland Treatments

'Grassland' refers to plant communities where the vegetation consists of a mixture of grasses and broadleaved herbs, where woody shrubs are largely absent and where vegetation height is normally less than one metre. Grassland plant communities include a variety of semi-natural grasslands primarily categorized by soil type including neutral, calcareous, acidic and wet (or marshy) grasslands and marsh and also improved grasslands such as Agricultural Grassland (GA1) and Amenity Grassland (GA2). For detail regarding Heath (HH) plant communities see Fossitt (2000).

Semi-natural grassland treatments can be considered for most road components, once suitable soil geographic factors are present or where soil can be managed to provide for the establishment of such grassland (see Section 5.4.1).

The reasons for establishing grasslands are many, ranging from the provision of buffer zones, as in Amenity Grassland (GA2), while semi-natural grasslands offer significant potential for biodiversity conservation and restoration of landscape quality. Where a road scheme disturbs existing semi-natural grassland, mitigation or compensation measures may be proposed within the EIS/ER. Semi-natural grasslands are also suitable for additional plots and the immediate area surrounding attenuation ponds and constructed wetlands. Furthermore, semi-natural grassland treatments can be considered for roadside components including the wider verge area, soil and scree slopes and, in certain circumstances on embankments, as a single treatment or as part of a more diverse layout of treatments. Semi-natural grasslands can form the basic fabric within an open habitat-mosaic approach (see Sections 4.2.1, 4.2).

It must be recognized that most semi-natural grasslands are at an early successional stage to scrub-transitional woodland and may develop into scrub/woodland without management or with inappropriate management.

Recently, the establishment of grasslands within roadside landscapes has been commonly associated with the establishment of generalized and floriferous 'wildflower meadows'. However, where the selection of grassland treatments is not based on local semi-natural grassland plant communities and/or on awareness of soil geographic factors (see Chapter 5), such treatments, while presenting an initial flush of colour, are not self-sustaining and species diversity may be quickly depleted. Furthermore, the overly floriferous nature of the initial meadow swards (Figure 6.1), while colourful, is often ecologically and visually inconsistent with native semi-natural grasslands typical of the Irish landscape (Figure 6.2).

Figure 6.1

A 'wildflower meadow' dominated by non-native species. Such landscape treatments are not ecologically and visually typical of the Irish landscape.

The over-riding factor in the preparation and implementation of semi-natural grassland treatments is the identification of, or creation of, suitable soil geographic factors and the selection of a locally appropriate indigenous seed source.

The following sections outline various grassland treatments, including semi-natural and improved grassland types.

Figure 6.2

A native species-rich semi-natural grassland dominated by Cat's-ear (*Hypochoeris*), Black Knapweed (*Centaurea nigra*) and Yarrow (*Achillea millefolium*).

6.1.1 Semi-natural grasslands

Semi-natural grasslands are described in some detail in, '*A Guide to Habitats in Ireland*', (Fossitt, 2000) under the following categories:

- Dry calcareous and neutral grassland (GS1),
- Dry meadows and grassy verges (GS2),
- Dry-humid acid grassland (GS3),
- Wet grassland (GS4), and
- Marsh (Freshwater) (GM1).

Less common or more restricted grasslands, including salt marshes and sand dunes systems (classified as CM1 & CM2 and CM 1 to CM6 respectively) are not referred to in these Guidelines. Together with some information provided in '*A Guide to Habitats in Ireland*', (Fossitt, 2000), the following provides a brief description of each grassland treatment.

Dry Calcareous and Neutral Grasslands (GS1)

Calcareous grassland is largely confined to steep slopes on eskers and moraines in the midlands and to other areas with shallow and rocky limestone soils with a pH of between 6.5 and 8.5.

Neutral grasslands are associated with low intensity agriculture and typically occur on moist but free-draining mineral soils of various depths with a pH of between 5 and 6.5.

Dry Meadows and Grassy Verges (GS2)

Dry meadows have established on areas that are rarely fertilised or grazed and are mown (or treated with herbicides) only once or twice per year. The plant communities which have a high percentage of tall coarse and tussocky grasses are best represented on old roadside verges and within neglected areas such as embankments and the margins of tilled fields.

Dry-Humid Acid Grassland (GS3)

This grassland occurs on free-draining acid soils that may be dry or humid, but not waterlogged. This grassland occurs on mineral-rich or peaty podzols with a pH below 5 or on siliceous sandy soils, as in the case of the Curragh in County Kildare. Otherwise this grassland is most common on hills and mountains at the upper range of enclosed farmland and on steep upland and coastal slopes.

Wet Grassland (GS4)

These grasslands occur on wet or waterlogged mineral and organic soils that are poorly-drained or, in some cases, subjected to seasonal or periodic flooding such as the Shannon callows or turlough basins. The plant community often contains abundant rushes (*Juncus* species) and/or small sedges (*Carex* species).

Marsh (GM1)

Marsh is found on level ground near river banks, lakeshores and in other places where mineral or shallow peaty soils are waterlogged, and where the water table is close to ground level for most of the year, as in the case of Kilmacanogue Marsh in County Wicklow. To be considered a marsh, the proportion of sedges and grasses within the plant community should not exceed 50%.

6.1.2 Amenity grassland

Amenity grassland (GA2), as a category, covers a wide range of treatments where various commercial seed mixes are utilised for specific design requirements. Robust low-maintenance grass mixes will be the most frequently utilised type of Amenity Grassland.

Robust Low-Maintenance Grassland

In terms of road construction, most grassland treatments will be established on sites which have specific design requirements and which are far from ideal for the establishment of semi-natural grasslands. Robust low-maintenance grassland treatments are generally recommended for roadside components which have specific design, maintenance and safety requirements relating to sightlines, clear zones, demarcation and the establishment of buffer zones. Such areas include the immediate roadside verge, central reservations or medians, along mainlines at junctions, interchanges and roundabouts. Tolerance to salting, gritting, wheel splash, disturbance from parking, construction activities and maintenance (including more frequent mowing) is critical and accordingly species diversity is not a critical determining factor. Priority should be given to the selection of hard wearing low growing grass species from indigenous seed sources such as

Fescues (Festuca spp.) or sterile grass mixes. Treatments may include the use of appropriate low maintenance Amenity Grassland (GA2) mixes.

While Red Clover may be included in the grass seed mix, incorporating aggressive leguminous species such as White Clover (common in many grass seed mixes) should be avoided, as these will facilitate an increase in soil fertility, thereby increasing maintenance inputs including the need for more frequent mowing. For similar reasons, the use of fertilizer should be avoided in the preparation and implementation of these treatments.

6.1.3 Selection of Semi-natural Grassland Treatment

The objectives for creating semi-natural grasslands range from biodiversity conservation, habitat compensation, connectivity and defragmentation of core habitat areas, the restoration of landscape quality and the mitigation of impacts on attributes of the visual field.

The selection of grassland treatments should be based on appropriateness to a given situation. Furthermore, the processes required for managing the establishing grassland must address sustainability issues and provide value for money while maximising any additional benefit to the environment and landscape quality.

In the selection of semi-natural grassland treatments for general landscaping (see Section 3.3 for sensitive sites) consideration should be given to the following methods of implementing such treatments. These treatments are presented in descending order of preference:

Treatment 1: Natural recolonisation;

Treatment 2: Simple grassland mix of Creeping Bent (*Agrostis stolonifera*), Red Fescue (*Festuca rubra*) and Sheep's Fescue (*Festuca ovina*) from indigenous seed sources - areas treated in this manner will be colonised naturally, over time, by species from adjacent plant communities;

Treatment 3: Hay strewing with hay gathered from local semi-natural grasslands;

Treatment 4: Commercial seed mixes from locally sourced indigenous semi-natural grasslands;

Treatment 5: Commercial seed mixes from indigenous seed sources.

The higher preference treatments outlined above are driven by sustainability and ecological principles while the latter treatments are governed by environmental aesthetics.

In order to improve the potential for success in the development of such treatments it is important to consider the following at an early stage in the design process:

- reasons for selecting such treatment;
- requirements for its preparation and implementation;

- method of implementation; and

- requirements for the management of the establishing grassland.

6.1.4 Selection and Preparation of the Site

The careful selection of appropriate sites and compatible treatments will significantly improve the likelihood of the successful establishment of grasslands. The following site related issues should to be considered:

1. Local site conditions, including soil geographic factors; stability, gradient, underlying geology, drainage, microclimate, and level and variation in water table, e.g. a basin site with a relatively high water table would be preferable for Marsh (GM1) or Wet Grassland (GS4),

2. Soil geographic factors: soil must be compatible with that which supports a semi-natural grassland or must be reasonably capable of being altered or managed so as to be compatible (see Chapter 5). It should be noted that calcareous soils are rarely encountered and it is difficult to alter or manage a soil group to sustain calcareous grassland in a manner that would be considered sustainable. Therefore, the potential for the establishment of Dry Calcareous grassland (GS1) will be limited by the presence of the appropriate site conditions and soil geographic factors,

3. Nature of ecological network: the manner in which the proposed treatment is likely to complement existing semi-natural grasslands and other habitats, e.g. a Wet Grassland (GS4) treatment may serve to reconnect existing wet grasslands adjacent to the road scheme which have become fragmented and isolated (see Section 3.1.1),

4. The appropriateness of the treatment, including value for money.

6.1.5 Implementation

There are various methods of implementing semi-natural grassland treatments. Methods include natural recolonisation, translocation of sods, turves and plugs (see Sections 5.5.2, 5.5.3) and direct intervention/implementation through hay-strewing or seeding. Natural recolonisation and translocation are discussed in Chapter 5.

The basic requirement in the successful implementation and establishment of semi-natural grasslands is to avoid the application of fertilizer prior to, or during, sowing and in the management of the establishing treatment. Sowing of seed or hay-strewing in late summer - early autumn generally gives best results - conditions remain warm and moist and young plants have the winter to establish without significant competition prior to the vigorous growth of spring. Also the seeds of some species require a cold spell (process called vernalisation or stratification) in order to successfully stimulate germination in the spring.

The harvesting of hay by a mower and baler or the collection of seed by seed-collection machines, is not often possible for wet grassland or marsh plant communities due to the potential

disturbance to the plant communities and damage to soil structure. Hand collection is possible in limited situations. Where such habitats are disturbed by road construction, translocation of sods and turves or plugs is seen as the most appropriate treatment.

Direct Intervention/Implementation – Hay-Strewing

Hay-strewing involves the use of hay from local semi-natural grasslands which contains the seed of desirable native broadleaved herbs and grasses (Plate 28). As with natural recolonisation, it provides a locally appropriate indigenous seed source. Suitable donor semi-natural grasslands can be located through the EIS/ER, consultation with local landowners, the County botanical recorder and the National Parks and Wildlife Service. The harvesting of hay from a source grassland will require landowner consent/written permission. If the source grassland is within or adjoining a designated protected area, statutory consent may also be required.

- Hay is cut in late August/September before seed has dropped. This will provide the highest diversity of seed.

- Hay from the source grassland is spread loosely onto the area to be treated and in the following spring the seed germinates under the protection of the hay covering.

Alternatively seed may be collected from local semi-natural grasslands by hand (small areas) or through seed collection machines (larger areas).

Direct Intervention/Implementation – Seeding

Seeding involves the use of a hand-collected or machine-collected seed mix. It must be emphasised that only seed from indigenous seed sources should be utilised within landscape treatments and species mix should reflect the species composition of semi-natural grasslands in the vicinity of the road scheme, or within the adjacent wider landscape or region.

Seeding will remain the primary approach for the establishment of grassland/semi-natural grassland treatments within roadside components. Seeding may be achieved by hand sowing, drill sowing or hydro-seeding. Hand sowing is likely to be the most cost effective and feasible option for small areas. By contrast, large areas will be machine-sown, either by direct tractor-mounted or pedestrian drill machines or by hydro-seeding steep slopes. Rolling the soil following seeding improves germination by maximising seed surface contact with the soil. However, this may not be appropriate for steep slopes and over-compaction of the soil must be avoided.

6.1.6 The seed mixture

Central to the core objective of these Guidelines is promotion of the use of native seed from indigenous seed sources within landscape treatments. Seed mixes which aim to establish semi-natural grasslands should accordingly, to the extent feasible, utilise native species whose seed is from indigenous seed sources, and the species mix should reflect the species composition of semi-natural grasslands in the vicinity of the road scheme, or within the adjacent wider landscape or region. In the absence of such baseline data, the selection of the most appropriate semi-

natural grassland treatment should be based on soil geographic factors and Cross (1997). Where indigenous locally-sourced seed mixes are not available, the landscape designer can recommend a simple grassland mix of Creeping Bent (*Agrostis stolonifera*), Red Fescue (*Festuca rubra*) and Sheep's Fescue (*Festuca ovina*) from indigenous seed sources. Areas treated in this manner will be colonised naturally, over time, by species from adjacent plant communities.

It should be noted that the process of natural recolonisation and the practice of hay-strewing will generally provide local indigenous seed. The following considerations should inform the selection of commercial seed mixes:

- seed mixes should be ordered from recognised suppliers who should be required to supply a list of the species, their percentage composition within the mix and, most importantly, the seed sources;
- in order to conserve genetic diversity, seeds of rare or protected species should be avoided unless guaranteed as being of local indigenous seed sources;
- species with restricted ranges should not be utilised outside their natural geographic range;
- species requiring specialist habitat, germination or management conditions should be avoided or minimised as these species are less likely to establish successfully;
- the species selected must be locally appropriate species which germinate easily over a wide range of conditions and which are widespread, e.g. Meadow Buttercup (*Ranunuculus acris*), Yarrow (*Achillea millefolium*) and Self-heal (*Prunella vulgaris*); and
- legumes such as clover, especially White Clover (*Trifolium repens*) should not be used.

Studies have shown that the sowing of Yellow Rattle (*Rhinanthus minor*), a semi-parasitic angiosperm that inhibits the growth of surrounding grass species, can assist in improving the balance in favour of broadleaved herb species, thus increasing the likelihood of the establishment of species-rich semi-natural grasslands. The source and utilization of Yellow Rattle seed must conform to those conditions described above for seed mixes.

6.1.7 Management and Maintenance of Establishing Treatments

The development of semi-natural grasslands into species-rich, self-sustaining, treatments requires one or more of the following inter-related factors:

- nutrient poor soil and maintenance of low nutrient levels through mowing and removal of cut hay;
- a gradual reduction in soil nutrient levels through frequent mowing and removal of cut hay;
- control and management of woody species; and,
- control of initial flushes of otherwise undesirable and vigorous weed and grass species.

Semi-natural grasslands are at an early successional stage to scrub-transitional woodland. Therefore, management is required in order to inhibit vegetation succession processes to proceed to scrub/woodland. Appropriately-timed mowing will inhibit this process as it maintains a balance between the more desirable broadleaved herbs and the invading woody species. It also reduces the potential dominance of more vigorous weed and grass species over the low-growing desirable broadleaved herbs and fine grasses.

In accessible areas, an extensive mowing regime can be put in place. In inaccessible areas, where maintenance of the treatment is impossible, vegetation successional processes should be allowed to proceed to scrub/transitional woodland.

Accessible Areas

If inappropriately managed, especially in the initial years of establishment, many semi-natural grasslands will evolve into scrub/transitional woodland and/or degenerate to species-poor grassland dominated by vigorous weed and grass species.

While one cut per annum in late September (after the seed has fallen from the flower heads) should suffice for grasslands on nutrient poor soils, two cuts may be required on more fertile soils, one in early March and a second in late September, and none may be required in the first year on extremely nutrient poor soils. The following general points should be considered:

- remove cut hay, at least from initial mowings, so as to prevent nutrient cycling and to reduce competition for low-growing broadleaved herbs and fine grasses;
- in general the cut should be set high, i.e. above 4cm, so as to avoid scalping the turf thereby creating disturbed bare ground which could encourage weed invasion; and,
- mowing in damp conditions should be avoided since, under such conditions, heavy machinery will compact or otherwise damage the soil structure.

Intensive horticultural practices including the use of fertilizer and frequent and inappropriately timed cutting regimes should be avoided, as such activities will only serve to increase disturbance and reduce potential species diversity. Use of herbicides should be minimised by focusing on pulling or spot treatments of vigorous weed and grass species.

Less accessible areas

Where grassland treatments are implemented on slopes or embankments, mowing regimes may be less feasible. The designer should make on-site decisions regarding mowing regimes. For example, where nutrient poor soils are present and where invasive weeds and grasses are absent, or can be controlled, grassland may develop into self-sustaining species-rich semi-natural grassland, without the need for mowing. In contrast, where more fertile soils are present, minimal mowing may be recommended in order to prevent the development of vigorous grass swards and rank grassland. In such circumstances infrequent, but appropriately-timed, cutting regimes can be utilised to push the balance in favour of desirable broadleaved herbs. The cutting

regime could include one cut, in late September, after the seed has fallen from the flower heads. The cut hay should be removed, where feasible.

Inaccessible Areas

On steep embankments and cuttings, (i.e. slopes greater than 1 in 3) mowing may not be feasible. In such circumstances, the treatment should seek to maximise the potential for development of a self-sustaining treatment using low-fertility soils with a programmed regime for the control of invasive or inappropriate weed and grass species, including self-seeding tree and shrub species, e.g. Sycamore. The initial low soil fertility should provide for the gradual development of species-rich semi-natural grassland, which in the absence of a mowing regime, will facilitate a natural longer term succession to scrub/transitional woodland. The establishment of scrub/transitional woodland (in the absence of mowing) will provide an undisturbed refuge for fauna, particularly for less mobile and invertebrate species that may otherwise be significantly disturbed by typical grassland maintenance regimes.

6.2 Tree and Shrub Treatments

Tree and shrub treatments refer to plantings where woody species are the principal component within the species mix. Treatments include hedgerows (Figure 6.3), tree-lined hedgerows, scrub/transitional woodland, low canopy and high canopy woodland. Tree and shrub plantings may also be utilised as part of a diverse range of treatments in the open habitat-mosaic approach, which is recommended for particular roadside components.

Figure 6.3

An example of a varied and dense hedgerow located along the roadside boundary.

The selection of tree and shrub treatments is particularly appropriate where sites within the roadside landscape adjoin existing native woody plant communities, e.g. where a road scheme disturbs adjacent semi-natural high-canopy woodland, the establishment of oak-ash-hazel woodland (WN2) may be proposed as a mitigation or compensation measure within the EIS/ER. Tree and shrub treatments may also be proposed for a variety of roadside components where clear zones, set-back distances, sightlines and access areas are not an issue, e.g. wider verge areas, large junctions and additional plots.

Each of the principal tree and shrub treatments is discussed in greater detail in the following sections.

6.2.1 Hedgerows & Tree-lined Hedgerows

The Irish landscape is characterized by linear landscape elements or hedgerow networks associated with field patterns. These field patterns define the basic structure of the Irish landscape, contributing to landscape character, diversity and regional identity. Hedgerows provide land boundaries, wind breaks and stock-proof enclosures for domestic animals (Figure 6.4), while also forming an important aesthetic and ecological feature within the landscape. '*A Guide to Habitats in Ireland*' (Fossitt, 2000) classifies these linear features as either:

- Hedgerows (WL1), or
- Treelines (WL2).

Figure 6.4

The Irish 'bocage' Landscape: hedgerows play a significant role in providing connectivity for wildlife dispersal between habitats. Hedgerows also form an important aesthetic feature within the landscape contributing to landscape character, diversity and regional identity (Source: National Parks and Wildlife Service).

Hedgerows (WL1) are linear strips consisting predominantly of shrubs generally less than 5m high and 4m wide with occasional trees. They commonly support a high proportion of spinose plants such as Hawthorn (Crataegus monogyna), Blackthorn (*Prunus spinosa*) and Gorse (*Ulex europaeus*) amongst others. Tree-lined hedgerows (WL2), in contrast, tend to consist of a narrow row or single line of trees that is greater than 5m in height and typically occurs along field or property boundaries. The category includes tree-lined roads or avenues, narrow shelter belts and hedgerows dominated by trees.

Hedgerows provide habitat and connectivity for the dispersal of wildlife, especially small mammals and bats. For this reason, the mitigation of disturbance to, or severance of, hedgerow networks plays an important role in countering habitat fragmentation. Where dense tree-lined hedgerows are present along a new road scheme, they are best considered as linear strips of low canopy or scrub/ transitional woodland and should be managed as such (see Section 6.2.2 & 6.2.3).

The establishment of hedgerows in the roadside landscape may not always be appropriate. In many parts of Ireland, the landscape is open, especially in the western counties such as Roscommon, Galway and Clare, where stone walls often predominate. In such instances the provision of hedgerows may serve to accentuate the visual prominence of the road.

Hedgerow establishment is an appropriate treatment within the following roadside components: the wider verge areas (where clear zones permit); at the base of embankments; set-back from the top of cuttings (including soil and scree slopes and rock cuttings), and additional plots or other areas where the existing hedgerow networks have been disturbed or severed by road construction.

Important design considerations for hedgerow treatments include the need for the retention of clear access routes for maintenance. While boundary fences along new roads provide a natural and obvious delineation for the replacement or establishment of hedgerow treatments, where space permits, consideration may be given to the establishment of the hedgerow 'in' from the fence-line, e.g. within the wider verge area or near the base of embankments/top of slopes. This allows for retention of maintenance access routes along the fence-line, while the setback hedgerow can still provide for visual screening and habitat defragmentation.

In the majority of situations direct planting of trees and shrubs will be utilised in the establishment of hedgerows. In appropriate locations, treatments may be established through the process of natural recolonisation. Natural recolonisation of hedgerows is likely to be most successful in cases where the treatment objective is to increase the width of an existing hedgerow for screening and/or wildlife corridors. It can also be used to close small gaps in existing hedgerows.

In proposing hedgerows the following key issues should be considered:

- provision of clear access routes for maintenance;
- identification of the function(s) of the hedgerow (may involve one or more of land boundary demarcations, reconnection of severed habitat, provision of visual screening, or the retention or restoration of landscape quality) (Figure 6.4);

- as hedgerow treatments often facilitate the reconnection of existing severed hedgerows, it is important that the native species selected reflect the percentage species composition of existing hedgerows in the locality identified within the EIS/ER, or as identified on site;
- hedgerow planting can serve to complement and connect adjacent treatments, (Figure 6.5), e.g. where woodland or other woody treatments have been selected for adjacent roadside landscape components;
- hedgerow planting can play a significant role in re-directing fauna, including bats, away from the carriageway; and
- native tree species, appropriate to the surrounding landscape and consistent with set back and safety requirements, should be randomly dispersed along the hedgerow treatment. A wide range of tree sizes should be planted, while obvious repeat patterns or avenue effects should be avoided. Individual trees may be allowed to mature, though the species selected should be capable of surviving cutting and trimming operations.

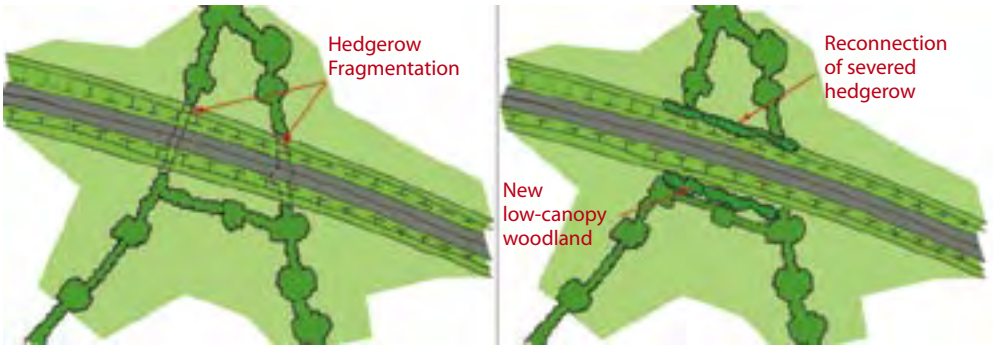


Figure 6.5

Examples of hedgerow treatments which can reduce the effects of Habitat Fragmentation.

Selecting Species

Species selected for hedgerow treatments should aim to provide dense growth, especially at the base of the treatment. This is best achieved through the utilisation of a diverse range of species. The selection of species should be based on the percentage species composition of existing hedgerows in the vicinity of the road scheme as detailed within the relevant EIS/ER, or as identified on site.

In certain situations, hedgerow treatments provide an opportunity to enhance or restore local hedgerow diversity, where such diversity may have been lost due to previous management or

land-use practices. In order to maximise this potential, selected mixes, while remaining sensitive to local character, should be as diverse as possible.

Regular trimming and 'laying' of roadside hedgerows is not environmentally sustainable as it requires major input of resources and as such is not cost-effective. Furthermore, where inappropriately timed, cutting or trimming of hedgerows can give rise to the disturbance of habitat and fauna. However, coppicing or 'laying' of hedgerows at 20 to 30 year intervals will help prevent succession into open tree-lines.

The following principal species should be considered for use in hedgerow treatments.

- Hawthorn (*Crataegus monogyna*) is the most common species in Irish hedgerows and should be included within most rural hedgerow treatments. Hawthorn may be used along with other spinose plants (Blackthorn, Bramble, Dog-rose and Holly) in establishing a robust stock-proof enclosure.

- Blackthorn (*Prunus spinosa*), is also a common species of hedgerows. Being lower growing than Hawthorn, it can increase the density of growth at the base of hedgerows.

- Holly (*Ilex aquifolium*) is one of a few native evergreen species. It can increase hedgerow density and, being evergreen, it can significantly improve screening value. Male and female plants are required for the production of berries.

A variety of further hedgerow species are suitable for incorporation within hedgerows depending on local site conditions:

- Dog-rose (*Rosa canina*)

- Elder (*Sambucus nigra*)

- Guelder Rose (*Viburnum opulus*)

- Hazel (*Corylus avellana*)

- Spindle (*Euonymus europaeus*)

- Yew (*Taxus baccata*). However, due to its poisonous characteristics, Yew should not be planted where it may be grazed by animals, e.g. boundary hedgerows – see also Footnote 2, Appendix 1.

- A wide variety of native tree species may also be included in the hedgerow for increased species diversity, local character and aesthetics, density and horizontal and vertical structural differentiation. Again species selected should reflect the composition of existing hedgerows in the surrounding landscape. Where tree species are included in rural hedgerows they should be randomly dispersed, thereby avoiding potential for development of simple repeating patterns and formal avenues. Depending on local conditions and set-back and safety requirements, the following tree species may be considered within hedgerows :

- Alder (*Alnus glutinosa*)
- Ash (*Fraxinus excelsior*)
- Silver Birch (*Betula pendula*)
- Oaks (*Quercus robur & Q. petraea*)
- Rowan (*Sorbus aucuparia*)
- Scots Pine (*Pinus sylvestris*)
- Willows (*Salix spp.*)
- Wild Cherry (*Prunus avium*)
- Some non-native tree and shrub species may be encountered in disturbed or severed hedgerows. In particular, these species may include Beech (*Fagus sylvatica*), Horse Chestnut (*Aesculus hippocastanum*), Field Maple (*Acer campestre*), Fuchsia (*Fuchsia magellanica*), Lime (*Tilia spp.*) and Sycamore (*Acer pseudoplatanus*). The planting of these species in a replacement hedgerow should only be considered where their presence is identified (within the EIS/ER, or on site) as having being of local cultural significance. Sycamore should not be planted due to its invasive nature.

Planting Hedgerows

- Height of Plants: In general, taller species such as Hawthorn (*Crataegus monogyna*) should be in the order of 900 to 1000mm in height while lower growing and trailing species may be between 300 to 450mm in height/length. Where trees are included and, depending on the growth rate of individual species, the majority of plants should be between 900 and 1200mm in height. Occasionally taller trees, up to and including 'standard-sized' plants, may be provided at random or irregular intervals along the hedgerow.
- Spacing of Plants: Hedgerows are best planted as double rows, particularly for the establishment of strong diverse plantings. Double rows should be set approximately 300 to 400mm apart, with plants at between 400 to 500mm centres, in staggered rows. In single rows, plants should be set approximately 300 to 400mm apart.
- Staking: Normal hedgerow plants should not require staking. Appropriate staking and ties should be provided for stability and establishment purposes where trees exceeding 1.5m in height are included.

Management and Maintenance of Establishing Hedgerows

- The principal maintenance required in the early years of establishment is controlling development of competing vegetation along the base of the hedgerow. This will ensure better overall establishment and allow for the development of lower branches giving a more desirable dense base.

- Particular care is needed in the use of herbicides in more mature hedgerows as base growth is desirable and, newly established, desirable species may have naturally recolonized the base of the hedgerow. Control should be focused on undesirable, vigorous or competitive species, e.g. Ragwort or Sycamore. Manual weeding or application of a minimum 50mm deep layer of mulch (bark chipping, etc), will reduce potential for weed growth and hence control weeds.

- Cutting back Hawthorn (*Crataegus monogyna*) at least once within the first three years after planting will encourage dense growth.

- In vulnerable areas, fencing may be initially required to protect plants from browsing by rabbits or hares. Rabbit guards may also be used in limited circumstances where protection is considered appropriate for more expensive plants (especially taller trees) and sensitive species.

- Replacement of plants which fail to grow is necessary at the earliest opportunity so as to maintain the integrity of the establishing hedgerow. Occasional plant failure within densely planted features is not a particular concern – and may lead to development of a more natural hedgerow appearance.

- In time, particularly wide spreading or leaning trees and shrubs may have to be pruned or removed for safety reasons.

- Long-term coppicing or 'laying' of hedgerows at 20 to 30 year intervals will retain hedgerow biodiversity, density and structure.

6.2.2 High-Canopy Woodland

Landscape treatments for the mitigation, restoration or provision of high-canopy woodland involve the establishment of woodland treatments which will ultimately establish into stands of mature broadleaf woodland containing one or more dominant species (Figure 6.6). Given the specific factors required for high-canopy woodland (see below), suitable sites along road schemes will be limited. Roadside components which may be suitable for such treatment include wider verge areas, deep cuttings, high embankments, additional plots and at large junctions that have appropriate set-back distance from the road carriageway.

High-canopy woodland treatments can contribute to biodiversity conservation, through the provision of new habitat, and connectivity through the defragmentation of core habitat areas. Such treatments can also help to restore the past natural vegetation of an area, i.e. where woodland has been removed as a result of previous land-uses. In such landscapes, where baseline data is absent, the landscape designer should refer to Cross's (1997) *Map of the Potential Natural Vegetation of Ireland* (see Figure 3.4).

While, for the majority of treatments, direct planting of trees and shrubs will be utilised in the establishment of high-canopy woodland, in appropriate locations, treatments may be established through the process of natural recolonisation. Natural recolonisation of woodlands is likely to be most successful on small areas, close to existing semi-natural woodland. Where appropriate

Figure 6.6

Ballyseedy Wood, Co. Kerry. An example of high canopy woodland which contributes to landscape quality whilst providing structural diversity for wildlife in the form of open grassland glades within the woodland (Source: Kerry County Council).

woodland soil is retained, during construction, it can complement the process by providing an instant bulb/seed bank/root/rhizome source, facilitating the regeneration of woodland ground flora. However, such soils may also contain a seed bank of undesirable species, which, on germination, will require pulling or appropriate spot treatment (see Sections 5.4.2 and 5.5).

Consideration can also be given to recycling young trees from within a disturbed site, and replanting them within woodland treatments. Young Alder (*Alnus glutinosa*) trees, in particular, but also Ash (*Fraxinus excelsior*) and Oak (*Quercus spp.*) can be replanted in this manner, where they are present within the land-take of a road scheme. The young trees are best cut back or coppiced first and the stumps relocated directly to the receiving site, preferably during the dormant winter season. After re-sprouting, these trees will grow quickly within the treatment. The establishment of Alder carrs or Wet willow-alder-ash woodland (WN6) requires specific conditions for establishment, including appropriate waterlogged mineral and organic soils that are poorly-drained or which may be subjected to seasonal or periodic flooding.

Locally appropriate woody species mixes must be developed for each location based on the EIS /ER, or as identified on site, and treatments must be designed with full knowledge of site conditions. Certain

non-native tree and shrub species may be encountered where road schemes disturb existing semi-natural woodland. The planting of these species as part of the species mix should only be considered where their presence has been identified as having being of local or cultural significance.

'*A Guide to Habitats in Ireland*' (Fossitt, 2000) lists the following classification, which, depending on species mix, may be appropriate to high-canopy woodland treatments:

Semi-Natural Woodlands

- Oak-birch-holly woodland (WN1),
- Oak-ash-hazel woodland (WN2),
- Wet pedunculate oak-ash woodland (WN4).

In proposing high-canopy woodland the following key factors should be considered:

- high-canopy woodland has the potential to develop into mature broadleaf stands; therefore treatments should be located at an appropriate set-back distance from carriageways, junctions, interchanges and adjoining residential properties;
- high-canopy woodland should be avoided where mature planting may excessively overshadow or otherwise adversely impact on adjoining sensitive habitats, such as riparian corridors and wetlands;
- ideally, high-canopy woodland should be structurally diverse, displaying horizontal and vertical differentiation of the canopy (Figure 6.2). Diverse woodland will require the selection of species from across the full range of tree and shrub treatments, including high-canopy, low-canopy, understorey/fringe or high-shrub and understorey/edge or low-shrub species;
- the structural diversity of high-canopy woodland can be enhanced where the treatment also provides for areas of natural recolonisation and incorporates grassland treatments which may be allowed to develop as open glades or "windows" within the developing woodland canopy; and,
- additional plots within the roadside landscape may be especially suitable for high-canopy woodland treatments. The design of such treatments must provide for connectivity between other landscape treatments and the defragmentation of existing core habitat areas within the surrounding landscape in order to facilitate the establishment of corridors for both flora and fauna.

Selecting Species and Mixes

As individual trees within high-canopy woodland treatments have the opportunity to reach their maximum potential in relation to height and girth, a dominant canopy can be established from a relatively small number of plants. In this way, it is possible that one individual dominant tree will reach maturity where 10 or so were originally planted at an average 1.5m x 1.5 m grid of centres.

In identifying suitable densities or spacing for the layout of the treatment, it must be remembered that the objective of the treatment is not the production of commercial woodland with even spacing. The aim should be the establishment of a semi-natural native woodland canopy with natural or random plant spacing, where the objectives are to establish habitat for flora and fauna and the restoration of landscape quality.

Given the potential development of mature high-canopy trees, it is recommended that the selected high-canopy dominant species should comprise less than 20% of the planting mix. The remaining percentage should be divided between sub-dominant species (20 to 25%), understorey/fringe or high-shrubs (20 to 40%) and understorey/edge or lower-shrub species (15 to 25%).

Species selection for high-canopy woodland should ideally reflect the percentage species composition of native species within woodland in the existing landscape and, most importantly, must take account of the prevailing site conditions including soil geographic factors. The illustration in Figure 6.7, together with the following table provides an outline of the principal percentage species composition of trees and shrubs recommended in the selection of species mixes for high-canopy woodland treatments.

High-Canopy:	Ash (*Fraxinus excelsior*)
Dominants (<20%)	Pedunculate Oak (*Quercus robur)*
	Sessile Oak (*Quercus petraea*)
	Scots Pine (*Pinus sylvestris*)
Low-Canopy:	Alder (*Alnus glutinosa*)
Sub-dominants (20-25%)	Downy Birch (*Betula pubescens*)
	Silver Birch (*Betula pendula*)
	Wild Cherry (*Prunus avium*)
Understorey & Fringe:	Bird Cherry (*Prunus padus*)
High-Shrubs (20-40%)	Crab Apple (*Malus sylvestris*)
	Elder (*Sambucus nigra*)
	Hawthorn (*Crataegus monogyna*)
	Hazel (*Corylus avellana*)
	Holly (*Ilex aquifolium*)
	Rowan (*Sorbus aucuparia*)
	Goat Willow (*Salix caprea*)
	Rusty Willow (*Salix cinerea ssp. oleifolia*)
	Purple Willow (*Salix purpurea*)
	Yew (*Taxus baccata*) See Footnote 2, Appendix 1

Understorey & Edge:	Blackthorn (*Prunus spinosa*)
Lower-Shrubs (15-25%)	Broom (*Cytisus scoparius*)
	Dog-rose (*Rosa canina*)
	Eared Willow (*Salix aurita*)
	Guelder Rose (*Viburnum opulus*)
	Spindle (*Euonymus europaeus*)
	Ivy (*Hedera helix*)
	Honeysuckle (*Lonicera periclymenum*)

The sowing of semi-natural grassland on the perimeter of woodland treatments and in small open glades (as may be available within the extent of the land-take) within a woodland treatment will prove attractive to fauna and many invertebrates, as it promotes a more horizontal and vertical structurally diverse woodland complementing the understorey fringe or understorey edge woodland.

Figure 6.7

Example of a Structurally Diverse High-Canopy Woodland Treatment. High-canopy woodland treatments should be structurally diverse, comprising high- and low-canopy trees, high-shrubs or understorey fringe, low-shrubs or understorey edge species and areas of open grassland both on the perimeter and within the treatment.

Planting High-Canopy Woodlands

- Plant age and size: Trees should be in the order of 750 to 1200mm in height and should have been transplanted at least once, while taller shrubs may be 600 to 750mm on average. Lower growing shrubs may only be 300 to 450mm in height at planting.

- Spacing: High-canopy woodlands should be diverse and include areas for the development of glades. Such sites should be divided up into planting areas and retained open areas. In addition, planting areas should be further divided to incorporate small, randomly located, individual groups (3 to 5 trees) of dominant tree species such as Oak and Ash.

- Trees: These should be planted at varying distances between 1.5 x 1.5m to 3.0m x 3.0m spacings, while mixed arrangements of shrubs are best planted at between 900 and 1500mm centres depending on species.

- Staking: In general, trees should not require staking. However, appropriate staking and ties should be provided if plants in excess of 1.5m in height are included.

- Specification: As the planting is proposed for ecological and environmental aesthetic reasons (i.e. not for a commercial forest), forked or leaning woody plants, can be incorporated within tree and shrub treatments within the roadside landscape.

- The principal maintenance requirement for the establishment of successful high-canopy woodland treatments is control of competing vegetation at the base of individual trees or shrubs. This will ensure better overall establishment and allow for the development of a varied branching structure. Importantly weed control is not required over the entire site as individual plants may be well-spaced and semi-natural grassland treatments may be present in open areas and between individual trees.

- The application of a minimum 50mm deep layer of mulch (bark chipping, etc.) to a 400mm radius circle around the plant will reduce the potential for weed growth and hence the need for weed control. Otherwise, pulling or spot treatment of noxious and invasive weeds will be required on a regular basis.

- Initially, fencing may be required to protect plants from browsing by rabbits or hares. It may be possible to utilise rabbit proof fencing around a plot. Rabbit guards may also be used on individual plants. However, it is recommended that, where guards are used, stakes should be provided for plant support if the measure is to prove effective.

- The replacement of failed plants should be undertaken at the earliest opportunity so as to maintain the integrity of treatments. Particularly large areas of woodland treatments, with low failures rates, may not require replacement planting as occasional losses will provide for some random windows in the canopy and a more natural appearance to the woodland.

- In time, particularly wide-spreading or leaning trees which pose a hazard to road safety may have to be pruned or removed for safety reasons.

- Leaving cuttings from tree and shrub thinnings at the site will promote nutrient cycling and restore nutrients to the soil, while, at the same time, providing a substrate for many plant species and providing suitable conditions for use by birds, small mammals and many invertebrates.

6.2.3 Low-Canopy Woodlands

Low-canopy woodland treatments focus on the establishment of sub-dominant canopy species and, accordingly exclude, or significantly reduce the use of dominant woodland tree-species such as Ash (*Fraxinus excelsior*) and Oak (*Quercus petraea or Q. robur*) within treatments. In avoiding or

reducing the presence of such species, low-canopy woodland can be applied to a significantly greater number of roadside landscape components. Even at maturity, such a treatment is less likely to develop potential safety hazards for road users within the road corridor, while still providing a significant degree of horizontal and vertical structural diversity and tree canopy cover (Figure 6.8).

While, for the majority of treatments, direct planting of trees and shrubs will be utilised in the establishment of low-canopy woodland, in appropriate locations, treatments may be established through the process of natural recolonisation. Natural recolonisation is likely to be most successful on small areas, close to existing low-canopy woodland, such as stands of Alder (*Alnus glutinosa*), Hazel (*Corylus avellana*), Silver Birch (*Betula pendula*) and Willows (*Salix spp.*). Where appropriate woodland soil is retained during construction, it can complement the process by providing an instant bulb/ seed bank/root/rhizome source, thus facilitating the regeneration of woodland ground flora. However, such soils may also contain a seed bank of undesirable species, which, on germination, will require pulling or appropriate spot treatment (see Section 5.4.2 and 5.5).

Figure 6.8

A low-canopy woodland which includes species such as Alder (*Alnus glutinosa*) and Silver Birch (*Betula pendula*) is an appropriate treatment for a wide range of roadside landscape components.

As noted under High-Canopy Woodlands (See Section 6.2.2), consideration can also be given to the recycling of young Alder and other tree species for the establishment of low-canopy woodland, including riparian vegetation along realigned watercourses, in the immediate area of attenuation/ balancing ponds and constructed wetlands or in existing wet pedunculate oak-ash (WN4) and riparian

woodland (WN5) disturbed by construction. Live cuttings of willows (*Salix spp.*) and Alder (*Alnus glutinosa*) can also be utilised in the dormant season in the establishment of wet pedunculate oak-ash or riparian woodland treatments as a more sustainable alternative to utilising nursery grown plants.

'*A Guide to Habitats in Ireland*' (Fossitt, 2000) lists the following classification, which, depending on species mix, may be appropriate to low-canopy woodland treatments:

Semi-natural Woodlands

- Oak-birch-holly woodland (WN1),
- Oak-ash-hazel woodland (WN2),
- Wet pedunculate oak-ash woodland (WN4),
- Riparian woodland (WN5),
- Wet willow alder-ash woodland (WN6),
- Bog Woodland (WN7).

In proposing Low-canopy woodland the following key issues should be considered:

- low-canopy woodland, despite the exclusion or significant reduction in dominant high-canopy tree species, has the potential to develop into mature woodland stands comprising sizeable individual trees and, consequently, planting areas should be located at appropriate set-back distance from carriageways, junctions and adjoining residential properties;
- low canopy woodland should be avoided where mature planting may excessively overshadow or otherwise adversely impact on adjoining sensitive habitats such as riparian corridors and wetlands;
- diverse low-canopy woodland will require the selection of species from across the full range of tree and shrub treatments including low-canopy, understorey/fringe or high-shrub and understorey/edge or low-shrub species;
- the structural diversity and associated biodiversity of low-canopy woodland treatments can be enhanced where the treatment also provides for areas of natural recolonisation and incorporates grassland treatments which may be allowed to develop as open glades or "windows" within the developing woodland canopy;
- larger areas of land-take within wider verge areas, embankments and cuttings (with soil slopes), major junctions, interchanges, riparian vegetation along realigned watercourses, the immediate area of attenuation/balancing ponds and constructed wetlands and additional plots may all be suitable for low-canopy woodland treatment.

Selecting Species and Mixes

While dominant high-canopy tree species may be included within low-canopy woodland, the overall percentage of such species must be restricted in order to prevent the development of high canopy along the carriageway. Given the potential dominance of mature high-canopy trees, it is recommended that, in approximate terms, such species comprise less than 10% of the overall planting stock. Sub-dominant tree species should comprise approximately 30% of the overall planting and these species should be encouraged to form the final mature canopy of the planting. The remaining percentage should be divided between understorey/fringe or high-shrubs (30%) and understorey/edge or low-shrub species (30%).

Species selection for low-canopy woodland should reflect the percentage species composition of existing vegetation as defined in the EIS/ER or as identified on-site, and must take account of the prevailing site conditions, including soil geographic factors. The following provides an outline of the principal percentage species-composition of trees and shrubs recommended in the selection of species mixes for low-canopy woodland treatments.

High-Canopy:	Ash (*Fraxinus excelsior*)
Dominants (<10%)	Pedunculate Oak (*Quercus robur*)
	Sessile Oak (*Quercus petraea*)
	Scots Pine (*Pinus sylvestris*)
Low:	Alder (*Alnus glutinosa*)
Sub-dominants (25-30%)	Downy Birch (*Betula pubescens*)
	Silver Birch (*Betula pendula*)
	Wild Cherry (*Prunus avium*)
Understorey & Fringe:	Bird Cherry (*Prunus padus*)
High-Shrubs (25-40%)	Crab Apple (*Malus sylvestris*)
	Elder (*Sambucus nigra*)
	Hawthorn (*Crataegus monogyna*)
	Hazel (*Corylus avellana*)
	Holly (*Ilex aquifolium*)
	Rowan (*Sorbus aucuparia*)
	Goat Willow (*Salix caprea*)
	Rusty Willow (*Salix cinerea ssp. oleifolia*)
	Purple Willow (*Salix purpurea*)
	Yew (*Taxus baccata*) See Footnote 2, Appendix 1
Understorey & Edge:	Blackthorn (*Prunus spinosa*)
Lower-Shrubs (15-25%)	Broom (*Cytisus scoparius*)
	Dog-rose (*Rosa canina*)
	Eared Willow (*Salix aurita*)
	Guelder Rose (*Viburnum opulus*)
	Spindle (*Euonymus europaeus*)
	Ivy (*Hedera helix*)
	Honeysuckle (*Lonicera periclymenum*)

Planting Low-Canopy Woodlands

- Plants: Low-canopy tree species should be in the order of 750 to 1200mm in height and should have been transplanted at least once, while small tree and high shrub species may be 600 to 750mm on average. Lower shrubs will be in the range of 300 to 450mm in height.

- Spacing: Low-canopy woodlands should be diverse and provide for the development of small open areas or glades. Such sites should be divided up into planting areas and retained open areas. In addition, planting areas should be further divided so as to incorporate small randomly located individual groups (3 to 5) of the sub-dominant tree species.

- Trees: These should be planted varyingly at between 1.5 x 1.5m to 3.0m x 3.0m spacings, while a mixed arrangement of shrubs are best planted at between 900 and 1500mm centres, depending on species.

- Staking: In general, trees should not require staking. However, appropriate staking and ties should be provided if trees in excess of 1.5m in height are utilised in treatments.

- Specification: As the planting is proposed for mainly ecological and environmental aesthetic reasons (i.e. not for a commercial forest), forked or leaning woody plants can be incorporated within roadside woodland treatments.

Management of Establishing Low-Canopy Woodlands

- The principal maintenance requirement for the establishment of low-canopy woodland treatments is to prevent the development of competing vegetation at the base of individual trees and shrubs. This will ensure better overall establishment and allow for the development of varied branching structure. Importantly, weed control is not required over the entire site as individual plants may be well-spaced and semi-natural grassland treatments may be present in open areas and between individual trees.

- Limited use of herbicides may be appropriate, especially in the initial years after planting. The application of a minimum 50mm deep layer of mulch (bark chipping, etc.) to a 400mm radius around the plant will reduce the potential for weed growth and hence the need for weed control. Otherwise, pulling or spot treatment of noxious and invasive weeds will be required on a regular basis.

- Initially fencing may be required to protect plants from browsing by rabbits or hares. It may be possible to utilise rabbit proof fencing around a plot. Rabbit guards may also be used on individual plants. However, it is recommended that where guards are used, stakes should be provided for plant support if the measure is to prove effective.

- The replacement of failed plants should be undertaken at the earliest opportunity so as to maintain the integrity of the treatment. Particularly large areas of woodland treatments, with low failure rates, may not require replacement planting as occasional losses will provide for some random windows in the canopy and a more natural appearance to the woodland.

- In time, particularly wide-spreading or leaning trees which pose a hazard to road safety may have to be pruned or removed for safety reasons.

- Leaving cuttings from tree and shrub thinnings at the site will promote nutrient cycling and restore nutrients to the soil, while, at the same time, providing a substrate for many plant species and providing suitable conditions for use by birds, small mammals and many invertebrates.

6.2.4 Shrub (or Scrub) Treatments

High and low-shrub plantings are amongst the most appropriate treatments for roadside landscape components as they can be applied to wider verge areas, cuttings (soil slopes), embankments, and, where clear zones and sightlines permit, at junctions, interchanges and roundabouts. While a limited percentage of sub-dominant tree species may be included in treatments for the latter components, all high-canopy tree species should be excluded.

The overall objective may be to develop diverse shrub treatments (or scrub habitat) for environmental aesthetics and visual screening. Alternatively, scrub/transitional woodland treatments may be utilised for biodiversity conservation where the objective is to provide a medium to low-growing thicket of shrubs which will provide habitat for wildlife, and connectivity (by defragmenting core habitat areas), while also providing low-level visual screening for local inhabitants and/or amenities. (Figure 6.9).

Treatments may include shade-providing understorey/fringe or high shrubs such as Rowan (*Sorbus aucuparia*), Holly (*Ilex aquifolium*) and Spindle (*Euonymus europaeus*), which would be otherwise less vigorous, less floriferous and less productive in terms of fruit when planted under more dominant tree species.

In the majority of situations, direct planting of trees and shrubs will be utilised in the establishment of shrub (scrub) treatments. In appropriate locations treatments may be established through the process of natural recolonisation. Natural recolonisation is likely to be most successful in cases where the treatment objective is to increase the width of an existing scrub/transitional woodland for screening and/or wildlife corridors.

In proposing shrub/scrub treatments the following issues should be considered:

- in shrub planting, low-canopy tree species should form only a small percentage of the overall treatment so as avoid excessive shading of shrubs as they mature;

- shrub planting may be used within, and particularly on, the fringe or edge of low-canopy and high-canopy or as part of scrub/transitional woodland treatments, where they extend into semi-natural grassland treatments;

- shrub planting should be structurally diverse, comprising some sub-dominant tree species and a variety of shrub species (single species plantings should be avoided);

- the structural diversity of treatments can be enhanced where the treatment provides for sparse and more densely planted areas and open areas which allow for the natural recolonisation of scrub vegetation and open grassland glades; and

- species selected for roundabouts, in particular, should not prove attractive to fauna.

Figure 6.9

Natural recolonisation of Scrub vegetation including Bramble (*Rubus fruticosus*), Blackthorn (*Prunus spinosa*), Hawthorn (*Crataegus monogyna*) and Gorse (*Ulex europaeus*).

'*A Guide to Habitats in Ireland*' (Fossitt, 2000) lists the following classifications, which depending on species mix, may be appropriate to shrub treatments:

Semi-Natural Woodlands

- Riparian woodland (WN5)

Scrub/Transitional Woodland

- Scrub (WS1)

Selecting Species and Mixes

While low-canopy tree species may be included within shrub and scrub/transitional woodland treatments, the overall percentage of such species must be restricted in order to prevent overshadowing of high and low shrubs and creation of safety hazards. In high-shrub planting, low-canopy species should comprise less than 10% of the planting. The remaining percentage should be divided between high-shrub/fringe species and low-shrub/edge species. In low-shrub planting, high-canopy trees should be avoided entirely within mixes.

The selection of species for treatments should reflect the species composition of scrub/transitional woodland within the landscape as detailed in the EIS/ER or as identified on-site. Species selection must take account of the prevailing site conditions, including soil geographic factors. The following provides an outline of the principal percentage species composition of trees and shrubs recommended in the selection of species mixes for shrub and scrub/transitional woodland treatments.

Low-Canopy:	Alder (*Alnus glutinosa*)
Sub-dominants (<10%)	Downy Birch (*Betula pubescens*)
	Silver Birch (*Betula pendula*)
	Wild Cherry (*Prunus avium*)
Understorey & Fringe:	Bird Cherry (*Prunus padus*)
High-Shrubs (40-50%)	Crab Apple (*Malus sylvestris*)
	Elder (*Sambucus nigra*)
	Hawthorn (*Crataegus monogyna*)
	Hazel (*Corylus avellana*)
	Holly (*Ilex aquifolium*)
	Rowan (*Sorbus aucuparia*)
	Goat Willow (*Salix caprea*)
	Rusty Willow (*Salix cinerea ssp. oleifolia*)
	Purple Willow (*Salix purpurea*)
	Yew (*Taxus baccata*) See Footnote 2, Appendix 1
Understorey & Edge:	Blackthorn (*Prunus spinosa*)
Lower-Shrubs (40-50%)	Broom (*Cytisus scoparius*)
	Dog-rose (*Rosa canina*)
	Eared Willow (*Salix aurita*)
	Guelder Rose (*Viburnum opulus*)
	Spindle (*Euonymus europaeus*)
	Bramble (*Rubus fruticosus*)
	Ivy (*Hedera helix*)
	Honeysuckle (*Lonicera periclymenum*)

Planting Shrubs and Scrub/Transitional Woodland

- Plants: Taller shrubs may be in the range of 450 to 600mm in height while other shrubs may be 300 to 450mm in height.

- Spacing: All areas should incorporate open areas for natural recolonisation and grassland glades. Within planted sections, high-shrubs are normally planted at between 900 and 1500mm spacings, while lower-shrubs are best planted at between 750 and 900mm centres. This should ensure a closed canopy cover within 3 to 5 years of planting.

Management of Establishing Shrub and Scrub/Transitional Woodland

- The principal maintenance requirement in the establishment of shrub treatments is to prevent the development of competing vegetation within the planting.

- Limited use of herbicides may be appropriate especially in the initial years after planting. The application of a minimum 50mm deep layer of mulch (bark chipping etc.) to the area will reduce the potential for weed growth and hence weed control.

- Shrub planting can be susceptible to damage/loss as a result of browsing by rabbits and hares. As it is difficult to adequately protect individual shrubs, in vulnerable areas it may be preferable to utilise rabbit proof fencing around the entire planting area.

- Plants should be allowed to grow naturally, with maintenance confined to essential practices such as replacing larger areas of failed plants and the control of invasive species.

- In time, particularly wide-spreading plants may need to be cut back for safety and sightline reasons.

- Leaving cuttings from tree and shrub thinnings at the site will promote nutrient cycling and restore nutrients to the soil, while, at the same time, providing a substrate for many plant species and providing suitable conditions for use by birds, small mammals and many invertebrates.

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Appendices

Appendix 1:

List of Common Native Trees and Shrubs

The following provides a list of the native species that are most widely available and suitable to a wide range of roadside landscape treatments. However, native stands of some species, e.g. Bird Cherry (*Prunus padus*) are not very common or may have a restricted range and as such when encountered, new planting should be of local origin. Apart from the more common native species, there are also a number of other native tree and shrub species which, because of their restricted habitat range, are rare in Ireland. The genetic diversity of these native populations may be compromised through the introduction of non-indigenous plant material/ non-local provenance and as such are not listed. While most of these rare species are not suitable for general roadside treatments, if they are to be considered in specific locations such species should only be planted where local-provenance indigenous plant material can be guaranteed.

Tall Trees (High-Canopy or Dominant species)

- Ash, *Fraxinus excelsior*
- Aspen, *Populus tremula*[1]
- Pedunculate Oak, *Quercus robur*
- Scots Pine, *Pinus sylvestris*[2]
- Sessile Oak, *Quercus petraea*

Medium Trees (Low-Canopy or Sub-dominant species)

- Common Alder, *Alnus glutinosa*
- Downy Birch, *Betula pubescens*
- Silver Birch, *Betula pendula*
- Wild Cherry, *Prunus avium*

Small Trees / Tall Shrubs (Tall Fringe and Understorey species)

- Bird Cherry, *Prunus padus*[1+2]
- Crab Apple, *Malus sylvestris*[1]
- Elder, *Sambucus nigra*
- Hawthorn (Whitethorn), *Crataegus monogyna*
- Hazel, *Corylus avellana*
- Holly, *Ilex aquifolium*
- Goat Willow, *Salix caprea*
- Purple Willow, *Salix purpurea*
- Rowan (Mountain Ash), *Sorbus aucuparia*
- Rusty Willow, *Salix cinerea ssp. oleifolia*
- Yew, *Taxus baccata*[1+3]

Medium or Small Shrubs (Edge and Understorey species)

- Blackthorn (Sloe), *Prunus spinosa*
- Broom, *Cytisus scoparius*
- Dog-rose, *Rosa canina*
- Eared Willow, *Salix aurita*
- Gorse, *Ulex europaeus*[4]
- Guelder Rose, *Viburnum opulus*
- Spindle, *Euonymus europaeus*

Climbing / Trailing Plants (Ground Layer species)

- Bramble, *Rubus fruticosus*
- Honeysuckle, *Lonicera periclymenum*
- Ivy, *Hedera helix*

1 native stands are less common or of restricted range

2 indicates that there is some debate as to its native status

3 Yew (*Taxus baccata*) should be planted with care as cut foliage is poisonous to animals and the attractive red berries are poisonous to humans

4 While Gorse (*Ulex europaeus*) is common and widespread in the Irish landscape, the use of this species should be restricted, particularly where fire may pose a hazard or potential risk to adjoining sensitive areas, such as peatlands or forest

Appendix 2:

Heritage Council Habitat Classification Summary of the scheme in *A Guide to Habitats in Ireland* (Fossitt, 2000) with standard alphanumeric habitat codes.

Non-Marine

F	Freshwater
FL	Lakes and ponds
FL1	Dystrophic lakes
FL2	Acid oligotrophic lakes
FL3	Limestone/marl lakes
FL4	Mesotrophic lakes
FL5	Eutrophic lakes
FL6	Turloughs
FL7	Reservoirs
FL8	Other artificial lakes and ponds
FW	Watercourses
FW1	Eroding/upland rivers
FW2	Depositing/lowland rivers
FW3	Canals
FW4	Drainage ditches
FP	Springs
FP1	Calcareous springs
FP2	Non-calcareous springs
FS	Swamps
FS1	Reed and large sedge swamps
FS2	Tall-herb swamps

G	Grassland and marsh
GA	Improved grassland (highly modified)
GA1	Improved agricultural grassland
GA2	Amenity grassland (improved)
GS	Semi-natural grassland
GS1	Dry calcareous and neutral grassland
GS2	Dry meadows and grassy verges
GS3	Dry-humid acid grassland
GS4	Wet grassland
GM	Freshwater marsh
GM1	Marsh

H	Heath and dense bracken
HH	Heath
HH1	Dry siliceous heath
HH2	Dry calcareous heath
HH3	Wet heath
HH4	Montane heath
HD	Dense bracken
HD 1	Dense bracken
H	Heath and dense bracken
HD	Dense bracken
HD1	Dense bracken

P	Peatlands
PB1	Bogs
PB1	Raised bog
PB2	Upland blanket bog
PB3	Lowland blanket bog
PB4	Cutover bog
PB5	Eroding blanket bog
PF	Fens and flushes
PF1	Rich fen and flush
PF2	Poor fen and flush
PF3	Transition mire and quaking bog

W	Woodland and scrub
WN	Semi-natural woodland
WN1	Oak-birch-holly woodland
WN2	Oak-ash-hazel woodland
WN3	Yew woodland
WN4	Wet pedunculate oak-ash woodland
WN5	Riparian woodland
WN6	Wet willow-alder-ash woodland
WN7	Bog woodland
WD	Highly modified/non-native woodland
WD1	(Mixed) broadleaved woodland
WD2	Mixed broadleaved/conifer woodland
WD3	(Mixed) conifer woodland
WD4	Conifer plantation
WD5	Scattered trees and parkland

WS	Scrub/transitional woodland
WS1	Scrub
WS2	Immature woodland
WS3	Ornamental/non-native shrub
WS4	Short rotation coppice
WS5	Recently-felled woodland
WL	Linear woodland / scrub
WL1	Hedgerows
WL2	Treelines

E	Exposed rock/disturbed ground
ER	Exposed rock
ER1	Exposed siliceous rock
ER2	Exposed calcareous rock
ER3	Siliceous scree and loose rock
ER4	Calcareous scree and loose rock
EU	Underground rock and caves
EU1	Non-marine caves
EU2	Artificial underground habitats
ED	Disturbed ground
ED1	Exposed sand, gravel or till
ED2	Spoil and bare ground
ED3	Recolonising bare ground
ED4	Active quarries and mines
ED5	Refuse and other waste

B	Cultivated and built land
BC	Cultivated land
BC1	Arable crops
BC2	Horticultural land
BC3	Tilled land
BC4	Flower beds and borders
BL	Built land
BL1	Stone walls and other stonework
BL2	Earth banks
BL3	Buildings and artificial surfaces

C	Coastland
CS	Sea cliffs and islets
CS1	Rocky sea cliffs
CS2	Sea stacks and islets
CS3	Sedimentary sea cliffs
CW	Brackish waters
CW1	Lagoons and saline lakes
CW2	Tidal rivers
CM	Salt marshes
CM1	Lower salt marsh
CM2	Upper salt marsh
CB	Shingle and gravel banks
CB1	Shingle and gravel banks
CD	Sand dune systems
CD1	Embryonic dunes
CD2	Marram dunes
CD3	Fixed dunes
CD4	Dune scrub and woodland
CD5	Dune slacks
C	Coastland (Continued)
CD6	Machair
CC	Coastal constructions
CC1	Sea walls, piers and jetties
CC2	Fish cages and rafts

Marine

L	Littoral (intertidal)
LR	Littoral rock
LR1	Exposed rocky shores
LR2	Moderately exposed rocky shores
LR3	Sheltered rocky shores
LR4	Mixed substrata shores
LR5	Sea caves
LS	Littoral sediment
LS1	Shingle and gravel shores
LS2	Sand shores
LS3	Muddy sand shores
LS4	Mud shores
LS5	Mixed sediment shores

S	Sublittoral (subtidal)
SR	Sublittoral rock
SR1	Exposed infralittoral rock
SR2	Moderately exposed infralittoral rock
SR3	Sheltered infralittoral rock
SR4	Exposed circalittoral rock
SR5	Moderately exposed circalittoral rock
SR6	Sheltered circalittoral rock
SS	Sublittoral sediment
SS1	Infralittoral gravels and sands
SS2	Infralittoral muddy sands
SS3	Infralittoral muds
SS4	Infralittoral mixed sediments
SS5	Circalittoral gravels and sands
SS6	Circalittoral muddy sands
SS7	Circalittoral muds
SS8	Circalittoral mixed sediments

M	Marine water body
MW1	Open marine water
MW2	Sea inlets and bays
MW3	Straits and sounds
MW4	Estuaries

Appendix 3:

Glossary of Terms

Biodiversity (Biological Diversity): the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are a part; this includes diversity within species, between species and of ecosystems. Thus biological diversity may be considered at three levels, ecosystem diversity, species diversity, and genetic diversity within species.

Cuttings: side slopes arising where a road is constructed at a lower level than the landscape. Usually occurs where a road corridor encounters areas of local elevation.

Ecological Infrastructure Analysis: the concept of ecological infrastructure analysis involves defining ecological networks of core habitat areas and connectivity zones for a region in order to decrease the overall fragmentation of core habitats.

Ecological Landscape Design: a landscape design approach which integrates the principles of landscape architecture and landscape ecology while addressing the principles of Sustainable Development including Local Agenda 21 criteria.

Ecosystem: a community of different plant and animal species interacting with one another and with their non-living environment.

Embankments: side slopes arising where a road is constructed at a higher level than the landscape. Usually occurs where a road corridor encounters areas of local depression.

Habitat: the physical and living environment in which an organism or community of organism live.

Habitat Fragmentation: with respect to landscapes, ecosystems or habitats, fragmentation has been defined as the direct removal of or breaking up of habitat leading to the fragmentation of remaining habitat into smaller parcels, isolated remnants or patches.

Immediate Roadside Verge: the section of landscape area immediately adjacent to the hard shoulder or carriageway (approx. 1-2m wide).

Landscape Mitigation Masterplan: a schematic map which depicts any actions required to reduce or remove impacts on the landscape, i.e. on landscape quality and biodiversity, for a road scheme.

Landscape Quality: a particular combination of the visual and non-visual attributes of the landscape.

Locally Motivated Elements: elements of a landscape which contribute to regional identity as they are perceived and experienced as part of the familiar landscape due to their characteristic traits and peculiarities. Often contributing to an (aesthetic) sense of the place, which presupposes some history e.g. exposed rock outcrops, archaeological features (e.g. Ogham stones), old churches, vernacular architecture etc.

Map of the Ecological Network: depicts the distribution of core natural habitats together with the elements of connectedness i.e. the major wildlife and water corridors, streams and wetlands, rare habitats and species, and topographic sites.

Native Species: A native species is one which naturally exists at a given location or in a particular ecosystem, i.e. it has not been moved there by humans.

New Technical Elements: newly introduced elements in the landscape, such as flyovers, bridges and culverts which cannot serve as typical features - at least not for some time - as they do not possess any regionally or locally motivated characteristic traits and peculiarities.

Nutrient cycling: involves leaving cuttings from tree and shrub thinning at a site, which will return nutrients to the soil.

Provenance: the place of origin of a species, subspecies or variety.

Regional Identity: a particular spatial arrangement, which moulds the specific character of a landscape giving it a unique and individual character, and appearance.

Riparian: associated with the banks of streams, rivers and lakes, Riparian sites are generally regarded as the land between the river bank and the upper level of normal flooding. Distinctive native woodland types, usually characterised by Willows, Alder, Ash and sometimes Pedunculate Oak, occur naturally on such sites.

Self-sustainable Treatment: is that which minimises energy or physical resource inputs (water, fertilizers, herbicides, pesticides etc.) in stock production, plant establishment (including ground preparation) and vegetation management, is locally-appropriate (in terms of substrate type, choice of species and sources of plant material) and maintains ecological integrity through nutrient cycling, whilst incorporating the preferred features of road users.

Wider Verge Area: the landscape area outside of the immediate roadside verge.

NRA
National Roads Authority
An tÚdarás um Bóithre Náisiúnta

The National Roads Authority
St. Martin's House,
Waterloo Road,
Dublin 4,
Ireland

Telephone: +353 1 6602511
Fax: +353 1 6680009
Email: info@nra.ie
Web: www.nra.ie