SECTION 4 ASSESSMENT AND EVALUATION OF RETREAT

4.1 The Overall Context

4.1.1 Introduction

Section 3 outlines some of the technical requirements for the creation or restoration of coastal habitats under a scenario of managed retreat. Such information forms an important input into the decision-making process by determining the technical viability and hence the likely success of a particular proposed initiative. Having established the critical physical and biological parameters it will then often be necessary to evaluate the various options at a site, in qualitative, quantitative or monetary terms, for example to compare the benefits of retreat against the benefits of maintaining a flood defence. Placing values on alternatives in this way can help both to establish their relative environmental desirability and to ensure that the best possible value for money will be obtained.

Section 4.1 reviews the need for, and context of, such evaluations. It summarises the process within which decisions concerning flood defence have traditionally been made and discusses some of the general issues related to the identification and valuation of retreat options. Sections 4.2 to 4.4 review non-monetary and monetary assessment procedures and discuss their respective roles in the evaluation process. Section 4.5 examines the attitude of the main interested parties to environmental evaluation, and Section 4.6 develops a framework for the future economic valuation of habitat creation or restoration initiatives, comparable to that which already exists for flood defence evaluation.

4.1.2 The Evaluation Context

The decision making process at sites where the existing flood defences have a low residual life has traditionally revolved around determining whether the defences should be improved, maintained or abandoned. There may be a number of different engineering options under the headings of maintenance or improvement, while abandonment is usually equivalent to a "do-nothing" option. Once such a set of options has been identified, they are assessed and evaluated taking into account technical (engineering), economic, environmental, and political considerations.

Environmental and economic considerations will usually be addressed through some form of Cost Benefit Assessment and/or Environmental Assessment. Factors appraised through the former will typically include the costs of capital engineering works and subsequent maintenance, and scheme benefits in terms of the damage-costs-avoided. Potential damages may include flood damage to properties, vehicles, infrastructure and services; loss of agricultural output; and other economic and environmental impacts. Ecological, landscape, amenity and recreation impacts might be expressed qualitatively, quantitatively or in money terms. The form in which impacts are expressed or evaluated will depend to some degree on the purpose of the exercise. For example, if the proposed flood defence works are to receive grant-aid funding from MAFF, a full monetary assessment of costs and benefits will usually be required (see Section 5.3.3).

The decision rule generally adopted in the evaluation of maintain/improve options is based on economic viability. If the damage-costs-avoided - in other words, the benefits - are greater than the engineering costs, the maintenance or improvement works would be justified. If the engineering costs are greater than the damage-costs-avoided, however, the engineering works would not be justified and a decision may therefore be taken to do-nothing.

4.1.3 The Managed Retreat Option

Various retreat strategies can be identified, ranging from the true do-nothing approach, through a minimum intervention approach to heavy engineering works undertaken to create a desirable habitat. In a true do-nothing strategy, the sea defence is abandoned and no further action of any kind is taken. The way in which the site evolves over time is left entirely to natural forces, usually without monitoring or intervention of any kind. Managed retreat, on the other hand, covers a variety of potential options, with the common aim of restoring or creating desirable habitat, landscape or amenity features. Possible "management" activities range from carrying out feasibility studies, monitoring site changes or controlling access, to the introduction of flora and fauna or the undertaking of engineering works to change site elevation. Given this wide variety of scenarios, it should be stressed that the term "managed" indicates that the future development of the site is being planned in some way. As discussed in Section 1.4.6, good management does not necessarily mean intervening in the natural processes of site evolution.

The first step in assessing and evaluating alternative retreat strategies is to identify both the consequences of a minimum intervention approach and possible alternative management options. The following questions are likely to be particularly important in this process:

- what type of habitat would develop if nothing was done to influence the natural development of the site?
- are the habitat, landscape or amenity improvements proposed under managed retreat of the greatest possible nature conservation value given both national desirability criteria and the local context of the particular site?
- what is the nature and extent of management that would be required to realise the preferred habitat option and are any proposals technically viable?
- what are the sustainability criteria and long-term maintenance requirements for the restored or created habitat?

4.1.4 Environmental Desirability

As indicated by the above questions, the identification of potential retreat options should take into account not only technical and economic viability but also the nature conservation and landscape desirability of the restored or created habitat.

In identifying sites of existing conservation or landscape value for designation and hence protection, certain criteria defined by the various conservation agencies must be met. To be designated as a biological SSSI for example, a site must meet some or all of the pre-determined criteria set by the NCC (NCC, 1989). The NCC are also responsible for identifying British sites of outstanding international importance for migratory wildfowl and waders under both the Ramsar Convention and the EC Birds Directive. Again, very specific criteria are used to determine which sites should be protected (NCC, 1990). Countryside Commission also designate sites with high quality and often nationally important landscape and amenity features - as Heritage Coasts, National Parks and Areas of Outstanding Natural Beauty.

Sites where managed retreat is being considered in order to improve nature conservation and landscape values will usually have, by implication, little or no existing interest. They may, however, have significant potential, for example as sites which could be developed as NNRs and Local Nature Reserves. In any area subject to a planned retreat, it is important that landscape, recreation and habitat creation objectives are assessed as a whole and not in isolation. In many instances, the coastal environment depends on a variety of habitats and landscapes and a mixture of ecological and landscape criteria such as those identified in Tables 4.1.1 and 4.1.2 should therefore form the basis not only for identifying restoration and creation priorities, but also for assessing and evaluating potential options.

At any particular site some of the criteria discussed in these tables will be more important than others. Nature conservation criteria and landscape criteria will often be compatible, and recreation interests might be accommodated if they are not detrimental to the former. Even so, priorities might be quite different depending on whether the proposed site for retreat is adjacent to a site of existing environmental importance or whether it is effectively isolated from such interest. Within the framework provided by this report, however, it is not possible to generalise and it is recommended that detailed discussions should be held with representatives of the appropriate nature conservation and landscape bodies to establish priorities on a site specific basis.

As a guide in setting priorities for creation or restoration it may nevertheless be useful to refer to the general priorities of the main conservation bodies and to the key ecological and landscape criteria used by these bodies in their own assessments. These are reviewed in Table 4.1.3.

Table 4.1.1 Key Ecological andManagement Factors in the Evaluation of Habitat Creation or Restoration Options for a Particular Site

CRITERION	EXPLANATION	APPLICATION TO MANAGED RETREAT
Existing nature conservation interest	Sites of existing importance (e.g. assessed in relation to NCR criteria).	Established habitats of importance should not be lost to managed retreat unless it can clearly be demonstrated beyond reasonable doubt that what is likely to replace it will be of significantly higher conservation value (see Section 4.1.6).
Necessity for intervention	The likely results of a non-intervention approach should be fully assessed.	The level of management should be determined and the objectives of any management clearly stated (see Section 3.1.4).
Resource Implications of Intervention	The cost in staff time, capital and maintenance works, and management.	Resource implications of managing the site from construction to maintenance must be fully considered and an appropriate long-term management framework identified and put in place (see Sections 4 and 5).
Technical Viability	The creation/restoration options which are technically feasible at a given site.	The range of options needs to be reviewed alongside the corresponding likelihood of success (see Sections 3.3 to 3.5 inclusive).
Sustainability of created/restored habitats.	Capacity for survival and regeneration. Coastal habitats are dynamic not static. Change is an important element of survival.	To minimise management costs in the long-term, sites and habitats involved should be persistent and self-sustaining (see Section 3.1.4). Selection of habitats for creation/restoration should also consider natural succession and the sensitivity of the habitat to storms, etc.
Degree of control over influencing factors.	Ability to control physical and human influences.	Factors which might affect the site's ecology, including drainage and pollution, need to be under the control of site managers.

CRITERION	EXPLANATION	APPLICATION TO MANAGED RETREAT
Location adjacent to designated sites of existing nature conservation interest.	The need for buffer zones; the need to extend established sites of conservation value.	By selecting sites adjacent to current interest, the existing SSSI legislation might be utilised for management agreements (see Section 5.3). In some cases, existing site management staff and facilities may already be in place.
Site size.	Larger habitats are likely to be more valuable for nature conservation.	Site size should be maximised to help ensure greatest sustainability and to accommodate species with larger range requirements. Management resources should, however, be sufficient to adequately cover the site.
Rarity	Rare habitats or habitats supporting rare species	The reason for initial rarity must be understood. Re-establishing viable populations of rare species can be a lengthy, costly and ecologically difficult process. Notable successes, however, include work undertaken by RSPB to create habitats to encourage the Avocet to recolonise UK estuaries. (Marchant et al., 1990)
Degree of threat	Priority for habitat restoration/creation should be given to habitats or species which are threatened by (undesirable) natural change or human influence.	Firstly, the severity of any threat should be assessed in local, national and international terms (see Note 1). One approach is then to remove the threat (e.g. allowing the seawall to fail may remove the obstacle preventing the habitat's inland migration). Where the threat cannot be removed, it may be possible to restore/create that habitat elsewhere.

CRITERION	EXPLANATION	APPLICATION TO MANAGED RETREAT
Diversity	Diversity of habitat types increases the range of species present at a site.	Site management can be used to improve habitat diversity and hence opportunities for wildlife observation and research into intra-species interaction. However, care must be taken to ensure that each habitat unit remains an ecologically viable size.
Vulnerability to disturbance	Some habitats/species are more tolerant of disturbance than others.	Those habitats and species vulnerable to disturbance must be identified and protected by effective management of access. Where human disturbance cannot be excluded, careful selection of habitats for creation/restoration is essential. Screening using vegetation (e.g. reeds) or embankments could be considered; visitor management should ensure that habitats are not damaged by trampling, etc.
Naturalness	Natural appearance of coastline contributes to overall value.	The large open vistas of the coastal zone invoke a feeling of wilderness. Managed retreat may provide an opportunity to remove artificial features which can impede this feeling. Natural plants and habitat should also be encouraged, notably those native to the UK or to the particular region. Landscape requirements are further discussed on Table 4.1.2.
Position on migration route	Particularly relevant to habitats for birds.	Identifying and restoring/creating habitats suitable for migratory species.
Long term trends	Recorded changes in habitat composition, species numbers, etc.	Habitat creation/restoration should accommodate desirable trends in species population growth, etc. and may also be used to counter undesirable changes (see Note 2).

CRITERION	EXPLANATION	APPLICATION TO MANAGED RETREAT
Source of colonising flora and fauna	Vital for initial colonisation and long term sustainability.	Habitats which colonise naturally may have a greater chance of survival in the long term than those planted artificially. Natural colonisation may therefore be desirable for some habitat types (see Section 3.4.2).
Wildlife corridor	Linking areas of similar habitat.	Reduces isolation, improves species mobility and hence chance of survival. Opportunities to create/restore such corridors may therefore be important particularly if existing or created sites are small.
Education and research potential	Important at certain sites (e.g. Local Nature Reserves, near centres of population, research establishments, etc).	Careful habitat selection required to maximise educational value and usefulness for research.
Amenity and recreation value	Leisure use may encourage the public to develop an interest in conservation.	Access and safety issues may be important. With careful management, it may be possible to combine nature conservation objectives with activities such as fishing, cycling or wildfowling.

NOTES:

1. Human threats to British habitats are increasingly well documented (e.g. RSPB, 1990a; NCC, 1991) and, as a result, rates of coastal habitat loss are now beginning to be quantified. The degree of threat to coastal habitats in northern Europe as a whole is not yet clear, but attempts are being made to bring such information together, through such projects as the EC's Environmental Directorate CORINE geographical information system (Pritchard, 1989).

2. A number of long term monitoring programmes operate for coastal species, enabling trends in species to be identified. Relevant examples include the Birds of Estuary Enquiry (BTO), National Wildfowl Count (WWT), Seabird Colony Register (NCC), and the Reedbed Survey (RSPB).

Table 4.1.2(a) Primary Landscape Requirements for British Habitat Creation or Restoration Initiatives

Criterion	Explanation	Application to Managed Retreat
Holistic approach	Assess landscape requirements alongside those of nature conservation, amenity, etc.	Ensures a variety of habitats, a diversity of landscapes and compatibility with surrounding area. Should include a consideration of access and informal recreation opportunities.
Conservation versus preservation	Conservation accepts change. Preservation maintains the status quo.	In areas designated for their unspoilt character, a conservationist rather than preservationist approach should be taken to potential loss of land to the sea.
Coastal management	Establishes a moveable and transient coastline.	A flexible, long-term approach, enabling natural systems to migrate as required.
Control of development	Development needs to be in harmony with, and contribute to, landscape character.	The Countryside Commission do not promote, for example, the development of formal recreational facilities in areas notified as being of landscape importance.

Table 4.1.2(b) Countryside Commission Objectives for British Habitat Creation or Restoration Initiatives

Countryside Commission Objective	Explanation	Application to Managed Retreat
Attractive and diverse countryside	Natural beauty and landscape diversity should be conserved and new countryside should be created wherever possible.	New landscapes and land cover should be harmonious and sympathetic to existing characteristics. Important facets in the creation of new countryside include the creation or natural regeneration of habitats for a range of wildlife, and the creation of places accessible to the public.
Countryside of quality	Quality of structural design of houses, barns and bridges, for example, is essential.	Would apply to any structures required.
Accessible countryside	The quiet enjoyment of the countryside is vital to the quality of life for millions of people.	There should be public access wherever this can be integrated with other conservation objectives.
Thriving countryside	Much of the beauty an diversity of the countryside depends on the presence of a prosperous rural economy.	In terms of the retreat option, the growing of reeds, the promotion of wildfowling, and the opening of new nature reserves all represent environmentally sympathetic and sustainable rural development options.

Countryside Commission Objective	Explanation	Application to Managed Retreat
Environmentally healthy countryside	New landscapes must be managed and protected.	Economic development, landscape and wildlife conservation and public access must be integrated to achieve a sustainable and multi-purpose countryside.

Table 4.1.3 Habitat Creation/Restoration Priorities of Nature Conservation Agencies

AGENCY	PROCESS	AVAILABLE DATA	COURSE OF ACTION
Nature Conservancy Council (now English Nature and Countryside Council for Wales)	■ Habitat prioritisation 1. Establish current extent of habitat 2. Monitor rate of change 3. Identify habitats under threat	Estuaries Review; Coastwatch; Coastal Habitat Inventories (Saltmarsh Survey, Shingle Survey, Sand Dune Survey) (NCC, 1989a; 1991)	Site protection where possible then restore/create most threatened habitats.
	■ Prioritisation of conservation needs in agricultural lowlands 1. Protect surviving semi-natural areas 2. Control pollution 3. Retain and enhance important habitats 4. Create new habitats on intensively farmed sites of low existing conservation value	Nature Conservation and Agricultural Change (NCC, 1990)	Habitat creation/restoration works should not be considered if important sites of existing interest will be lost. Preference shown for such initiatives on intensively farmed land.

AGENCY	PROCESS	AVAILABLE DATA	COURSE OF ACTION
Royal Society for the Protection of Birds (RSPB)	1. Review all major vegetation/habitat types. 2. Identify community classes of greatest ornithological importance (10/25 habitat groupings identified as such). 3. Establish degree of threat.	National Vegetation Classification	Protect/restore/create "high value" habitats for birds (e.g. native wet grassland; swamp, fen and carr; sand, shingle and machair; intertidal flats; saltmarsh; coastal lagoons).
World Wide Fund for Nature (WWF)	■ In consultation with other conservation bodies, review major threats to habitats.	Advice from voluntary and statutory conservation agencies.	Allocation of grant-aid for land purchase and management costs for priority habitats.
National Trust	■ Land acquisition depends on donations, bequeaths, etc. ■ Some targeting of funds through Operation Neptune. ■ Main emphasis on hard coastlines rather than low-lying areas.	Site assessment by regional staff.	Preference for land acquisition in areas of national quality for existing natural beauty. NT have only limited interest in low-lying agricultural areas.
Wildfowl and Wetlands Trust (WWT)	■ Establish value of different habitats for wildfowl.	National wildfowl counts	Enhance/create habitats for wildfowl (e.g. wader scrapes; pastures managed for geese; open water areas; fringing habitats such as reedbeds).
Royal Society for Nature Conservation (RSNC)	■ Establish rate/cause/ extent of habitat loss.	Internal review on habitats under threat from sea level rise (with County Trusts)	No clear priorities yet identified.

AGENCY	PROCESS	AVAILABLE DATA	COURSE OF ACTION
British Association for Shooting and Conservation (BASC)	■ Establish existing value of site for shooting.	Feedback from wildfowling clubs, etc.	Protect valuable sites from saline flooding. BASC would not generally support saltwater creation/restoration if freshwater grazing marsh were to be lost; otherwise favour habitats supporting quarry species.

4.1.5 **Assessment and Evaluation of the Retreat Option**

Once a set of potential retreat options have been identified using technical viability and environmental desirability criteria, the next step is to assess the "benefits" (and "costs") associated with each. Different options can then be compared and/or cost-effectiveness can be demonstrated. It will be important to determine whether or not the benefits gained through the management activities are greater than any costs incurred. In other words, would the environmental or habitat gains associated with the managed retreat option justify any capital, management and/or maintenance costs?

A clear definition of criteria for comparing options, such as the "desirability" criteria defined in Tables 4.1.1 to 4.1.3, is therefore important for several reasons.

i. Any expenditure on habitat creation or restoration should be focused on those sites and habitats where maximum nature conservation and/or landscape benefit will accrue. To enable the identification of such sites and habitats, clear criteria must be established by which the comparative worthiness of one scheme or habitat against another can be established.

ii. By setting such criteria, the goals for restoration and creation are made explicit. This provides a means by which success or failure can be measured and is likely to be important for conservation bodies when approaching government for funding for a managed retreat scheme. The Treasury is likely to want a clear indication of how value for money is being obtained in achieving conservation benefit.

iii. Ecological criteria will have a role to play where the benefits of managed retreat have to be compared with the value of any conservation assets that would be lost in the retreat process.

iv. By identifying the most beneficial options for retreat in a particular area, conservationists can be more pro-active in planning and campaigning for the longer term selection of optimum sites for managed retreat. Conservation organisations increasingly have the capacity to carry out economic and technical appraisal of schemes outside their traditional areas of conservation expertise, and are therefore able to research the socio-economic, and engineering components of managed retreat options as well as the environmental aspects. The identification of economically and technically feasible retreat options can therefore be more thoroughly investigated, by a wider range of bodies, at an earlier stage in the decision making process.

v. Landowners may seek clarification of the options assessed for managed retreat, including the potential benefits for conservation. Ecological selection criteria will help provide these answers.

The assessment process itself will therefore frequently involve more than one stage. The ecological and landscape criteria will generally be used first, to screen and assess potential options. A more formal evaluation should then be carried out using either non-monetary or monetary techniques. The type of technique chosen will depend on the type of decision criteria to be used for evaluating the various options. In general, however, a cost-benefit approach should be adopted as this approach requires that the full implications of an option are taken into account (rather than those pertaining to only one or a few criteria). In some cases within this framework, an indication of cost-effectiveness or value for money may then be sufficient for decision-making purposes. In others, either the size of the proposed expenditure or the nature of the funding mechanism may require that economic benefits should be shown to exceed the costs.

Non-monetary techniques can also be used, particularly to determine how different retreat options perform relative to each other. They can be used to demonstrate maximum cost-effectiveness or can form part of a wider cost-benefit assessment which may also include the use of monetary valuation techniques. The techniques in both categories which are most relevant to the assessment and evaluation of retreat options are therefore reviewed in the Sections 4.2 and 4.3.

4.1.6 Continued Protection Against Inundation for Sites of Existing Interest

As discussed in Section 3.1.1, there may be some circumstances in which an (economic) evaluation is required to evaluate protection for an existing site of high environmental value. The Ministry of Agriculture, Fisheries and Food (MAFF) has recently commissioned the University of East Anglia and Southampton University to evaluate the economic implications of rising sea levels for the East Anglian and South coasts respectively. The main objective of this research is to define a methodology for assessing the economic implications of sea level rise for each area's assets. The studies are looking at three different scenarios in respect of coastal defence: do-nothing, maintain current defences and improve current defences. Wherever practicable, economic values are being assigned to different assets to reflect the social loss associated with their damage or destruction. Assets considered in the studies include infrastructure; domestic, industrial and commercial properties; and agricultural resources. Areas of specific environmental value, amenity value and recreational value are also being considered.

The findings of the UEA and Southampton studies will provide a valuable contribution to the overall problem of wetland and coastal habitat valuation. Conclusions drawn on the applicability of the different techniques, together with any values developed through their application, will be useful to this study in terms of providing reference values for **existing** habitats of different types and quality (see Section 4.3.3). It is not the purpose of this study, however, to further investigate mechanisms by which the continued protection of sites of existing nature conservation interest might be achieved.

4.2 Non-Monetary Assessment Techniques

4.2.1 Introduction

Non-monetary techniques have been widely used to aid the assessment of environmental costs and benefits, particularly those related to habitats, landscapes and amenity and recreation. For evaluation purposes, these techniques generally rely on the definition of a set of criteria (such as those listed in Tables 4.1.1 and 4.1.2), against which the characteristics of different sites or, in the case of alternative retreat strategies, of different proposals for a given site are judged.

Non-monetary evaluation methods can be divided into three different categories: qualitative methods, quantitative methods and methods which allow a mixture of qualitative and quantitative criteria to be considered. The types of techniques in each of these categories are discussed below.

4.2.2 Qualitative Techniques

Qualitative techniques aim to provide information which allows comparisons to be made between sites or proposals, rather than providing some absolute figure representing conservation or habitat "value". The techniques are generally based on the use of subjective judgement to determine performance in respect of different evaluation criteria. Some criteria may be measured in objective terms in that they are based on scientific assessments, but qualitative descriptions or values are then used for assessment purposes.

Qualitative methods generally involve some form of distribution mapping or site "type" classification, and frequently result in the development of a system which ranks different proposals or alternative sites. Although methods will differ, application will usually involve the following steps:-

- description of the characteristics or attributes of the existing area and the created resource. This will include details of location, species, numbers, density, etc;
- classification or organisation of this information through mapping, tabulation or the use of checklists;
- definition of criteria to be used in developing overall rankings for various sites or proposals, reflecting the relative importance of different attributes;
- undertaking a ranking exercise to indicate the relative overall performance of the different sites or proposals.

The selection of criteria to be used in the evaluation has been the area of most debate and, as can be seen from those listed in Table 4.1.1, criteria rarely relate to biological or physical factors alone, frequently including political and other criteria. Similarly, the mix between objective and subjective criteria will inevitably depend to some extent on what is being examined. Landscape, for example, may be assessed wholly in subjective terms, while habitat and other ecological concerns may be measured objectively and then evaluated in qualitative terms.

4.2.3 Quantitative Techniques

Quantitative techniques were developed in response to the need for more scientific and objective assessments of environmental goods such as habitat, landscape and amenity. They also help to provide greater differentiation between sites or proposals in that they indicate not only that one is better than another, but also by how much.

The sophistication of quantitative techniques varies considerably, with some relying on simple scoring approaches and others involving more complex scoring and weighting systems. Most of the techniques result in the development of a rank order using a numerically derived index. This may involve the aggregation of information into a single measure (i.e. an overall measure of conservation value).

Quantification supposedly allows for greater repeatability of the results than is achievable using descriptive techniques. As is the case with qualitative techniques, however, the selection of criteria (or evaluation variables) may not be straightforward, and those used can vary considerably between different assessments.

It should be noted that the application of weighting techniques to derive overall indices of value relies on the use of subjective judgement. Choices must be made concerning the relative importance to be placed on the different characteristics or attributes included in the assessment. Individuals with varying environmental interests may, for example, assign very different weights to the same attributes.

Problems can also arise in the choice and application of aggregation procedures. Such procedures must be mathematically valid: "5" (parts per thousand of salinity) cannot be added to "7" (invertebrate species recorded at a particular site). If aggregation has to take place, the calculation of standard scores may offer one means of adding like with like.

The mixed nature of data, and the inter-relationships between the different variables used in the assessment, may also make it difficult to define the attributes to be assessed in a comprehensive manner but avoiding double-counting. If this cannot be resolved, it may not be appropriate to aggregate the information. Finally, although the aggregation of information into a single value may make decision making easier, it also results in the loss of valuable information, notably on the differences between sites. It may not be possible, for example, to differentiate between a site which is "about average" over all variables and one which is "exceptional" but only for one or two variables.

4.2.4 Mixed Techniques

The various types of scoring and weighting techniques described above can also be applied to the assessment and evaluation of a mixture of qualitative and quantitative criteria. Multi-attribute scoring and weighting techniques or more complex multi-criteria analysis can, for example, be used to transform information on different types of characteristics (measured in qualitative terms, in quantitative terms based on natural physical units, and in monetary terms) into a common form which can then be aggregated to provide a single measure of value.

However, because these methods involve the specification of attributes and related criteria, the aggregation of large amounts of information and the use of subjective judgement in the setting of weights, they suffer from the same sort of problems as noted in Section 4.2.3.