Shannon Bridge Crossing
Route Selection Report
Volume A - Text

Jan. '06

Rev. F01

NDP
NATIONAL DEVELOPMENT PLAN

RPS Consulting Engineers

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1 EXECUTIVE SUMMARY

1.1 BACKGROUND

Clare County Council is developing the Shannon Bridge Crossing Project in association with North Tipperary County Council and Limerick County Council. The purpose of the project is to link the R463 to the west of the Shannon with the R525, R466 or R494 to the east via a new bridge across the River Shannon in the vicinity of Killaloe/Ballina and O'Briensbridge/ Montpelier to improve the flow of traffic on the existing road network and to alleviate traffic congestion on the existing bridges at these towns.

The need for the project is well established, and is evident from current and predicted traffic flows at the existing bridges in Killaloe/Ballina and O'Briensbridge/Montpelier. Both of these bridges are narrow, historic structures and are incapable of accommodating the volume of traffic wishing to use them. The width of the bridges preclude satisfactory two-way flow, particularly in the presence of heavy vehicles, giving rise to traffic congestion and safety risks for pedestrians. These congestion problems not only reduce the capacity of the road network but, in conjunction with high volumes of heavy vehicles, adversely affect the communities in the wider sense.

Consultants RPS Consulting Engineers and traffic sub-consultants Colin Buchanan and Partners have been appointed to undertake a Feasibility Study and Preliminary Design for the project comprising three phases, Constraints Study, Route Selection and Preliminary Design. The current phase of the project is the Route Selection and follows from the publication of the Constraints Study Report in May 2005. The consultants have examined the options for route and crossing locations, working closely with a Technical Steering Committee comprising members of Clare, North Tipperary and Limerick County Councils.

1.2 ROUTES AND CROSSING OPTIONS

1.2.1 Routes Considered

Eight routes were initially assessed in various locations within the Study Area considered in the Constraints phase, extending from south of O'Briensbridge to north of Killaloe. These routes were assessed in terms of the following criteria:-

- **Traffic**
  Based on the traffic model developed in the Constraints phase, the capacity of the proposed routes to relieve the traffic volumes at the existing bridges and improve the level of service on the road network as a whole was assessed for each route.

- **Engineering**
  The technical feasibility of providing a crossing at each of the route locations considered was assessed, except for Route 8 north of Killaloe for which there was insufficient traffic demand. All other routes were found to be feasible, although there were technical advantages and disadvantages in each case.

- **Economic**
  A preliminary cost estimate was prepared for each proposed route, except Route 8. The value of the benefit to the traffic on the network was calculated for each route and the resulting benefit/cost ratios derived.

On the basis of this analysis, those routes which were regarded as feasible, and which would meet the objectives of the project were shortlisted. It is evident that no single route would effectively relieve the problems at both O'Briensbridge/Montpelier and Killaloe/Ballina while providing cost effective improvement to the traffic network as a whole, and thus the objectives of the project cannot be met by the provision of any one route. Route 1 provides maximum relief to O'Briensbridge/Montpelier, and Routes 6 and 7 provide maximum relief to Killaloe/Ballina, but Routes 6 and 7 offer significantly greater benefits to the traffic network as a whole than does Route 1. Routes 1, 6 and 7 are also the cheapest and most technically feasible of the eight routes considered. Routes 4 and 5, approximately equidistant between Killaloe and O'Briensbridge, cost nearly as much the combined cost of both Route 1 and 7, but do not provide substantial relief to either of the existing bridges. Routes 2 and 3 provide inadequate relief to Killaloe/Ballina, and Route 8 serves a similar function to Route 7 but much less effectively.

Routes 1, 6 and 7 were consequently the routes shortlisted. Route 7 consists of three sub-options, 7a, 7b and 7c, which have the same start and end points, but follow slightly differing horizontal alignments.

Routes 6 and 7 are effectively the shortlisted routes for the project, on the basis of a single crossing being provided or prioritised, due to the greater benefits which they offer over Route 1. However, recognising that these routes would do little to relieve the critical situation at O'Briensbridge/Montpelier, Route 1 was also shortlisted for detail assessment with a view to recommending an additional crossing at this location.

Junction capacity tests undertaken at each end of the proposed routes show that in each case a priority junction would cope with the demand up to the year 2022. However, a roundabout has been proposed at the east end of Route 7 to facilitate the 4-way layout of this junction.

1.2.2 Shortlisted Routes

Routes 1, 6 and 7 have been assessed in further detail, and ranked in preference, in terms of the following criteria:-

- **Environmental**
  The environmental impacts of the shortlisted routes have been assessed in terms of ecology, noise, cultural heritage, underwater archaeology, landscape/visual, human environment and agriculture.

- **Site Investigations**
  Geotechnical and topographic surveys were conducted at each of the shortlisted routes. These investigations included a desktop assessment of the soils, geology and hydrogeology at the route locations.

- **Structures**
  A preliminary assessment of the options for bridge structures has been undertaken for the shortlisted routes.

1.3 PUBLIC CONSULTATION

A second Public Consultation on the project was held on September 6th 2005, at the Lakeside Hotel in Ballina, to inform the public as to the range of route options initially considered, and those which had been shortlisted. The meeting commenced with a presentation to elected representatives following which the meeting was open to the public. All attendees were provided with an information leaflet and were invited to complete a questionnaire or make a submission. The meeting was well attended and a large number of questionnaires and submissions were received.

Additional meetings with the elected representatives of each of the three Local Authorities was held at the Castle Oaks Hotel in Castleconnell on the 15th and 29th November 2005.

1.4 CONCLUSIONS

In terms of the shortlisted routes i.e. 1, 6, 7a, 7b and 7c the following conclusions can be made:-

- It is evident that no single route would effectively relieve the problems at both the O'Briensbridge/Montpelier and the Killaloe/Ballina locations.
- Route 1 provides maximum relief to O'Briensbridge/Montpelier,
- Routes 6, 7a, 7b and 7c provide maximum relief to Killaloe/Ballina.
- Routes 6, 7a, 7b and 7c offer significantly greater benefits to the traffic network as a whole than does Route 1.

1.5 RECOMMENDATIONS

The various routes have been assessed and ranked in terms of the criteria listed in paragraphs 1.2.1 and 1.2.2 above, and following evaluation of a multi-criteria framework assessment of the routes, the following recommendation have been made:-

a) Route 7c is to be selected as the Preferred Route for this project. This route is to be prioritised and progressed to Preliminary Design.

b) In view of the limited benefit which Route 7c will afford to the O'Briensbridge/ Montpelier area, a second crossing is recommended at Route 1.

1.6 FOLLOWING ACTIVITIES

If the recommended scheme is endorsed by the Local Authorities, the consultants will proceed to the preparation of the Preliminary Design. An Environmental Impact Statement (EIS), and other associated documentation required for the statutory processes will be required thereafter.

2 INTRODUCTION AND BACKGROUND TO PROJECT

2.1 THE SCHEME

The Shannon Bridge Crossing scheme will consist of a new river crossing of the Shannon in the vicinity of Killaloe/Ballina and O'Briensbridge/ Montpelier, with associated approach roads and junctions as required, to improve the flow of traffic on the existing road network and existing bridges.

This Scheme will link the R463 Regional Road (Limerick to Scariff via Killaloe) to the west of the Study Area with one of the following regional roads to the east of the Study Area:-

- R466 (O'Briensbridge – Birdhill).
- R494 (Birdhill – Ballina – Portroe – Nenagh).
- R525 (Castleconnell – O'Briensbridge).

The R463, R466, R494 and R525 can be seen on Figure 2.1: Existing Road Network and Figure 2.2: Study Area, in Volume B.

The existing N7, National Primary Road (Dublin – Limerick) passes through the south eastern corner of the Study Area. The proposed N7 Nenagh to Limerick High Quality Dual Carriageway can be seen on Figure 2.2, southeast of the Study Area.

2.2 PROJECT HISTORY

The Ballina/Killaloe Traffic Management Strategy (2003) (JB Barry & Partners) made extensive reference to the existing crossings and their associated problems.

The Feasibility Report on Bridge Widening (1996) (Michael Punch & Partners) considered the issues relevant to a possible widening of the existing Killaloe/Ballina Bridge. Clare & North Tipperary County Councils subsequently ruled out widening of the existing bridge for reasons which included the bridge being a protected structure.

Killaloe Bridge Widening: Environmental Impact Assessment (2000) (Michael Punch & Partners) considered the environmental impact relevant to three alternative options to increase the capacity of the bridge. The options considered were:-

Option 1: New stand alone footbridge adjacent to the existing bridge,

Option 2: New bridge c. 1.1 km downstream of the existing bridge accommodating two way traffic and pedestrians, and,

Option 3: New bridge adjacent downstream to the existing bridge, accommodating one way traffic and pedestrians, which would act in conjunction with the existing bridge.

The EIS concluded that from a cultural heritage point of view, Option 2 was clearly most advantageous. The preferred location of this crossing point was just north of the Clarisford Estate.

2.3 THE STUDY

In December 2004, Clare County Council (the Client), acting on behalf of Limerick County Council, North Tipperary County Council and themselves, appointed RPS Consulting Engineers to undertake a Feasibility Study and Preliminary Report for the crossing consisting of the following:-

- Constraints Study – the Constraints Study Report was issued in May 2005,
- Route Selection – this Route Selection Report is the culmination of this stage,
- Preliminary Design – Preliminary Design Report providing sufficient design information to allow the EIS and CPO processes to proceed.

The purpose of this report is to describe the Route Selection phase of the study and recommend a preferred route. If approved, the Preliminary Design of the preferred route will follow.

2.4 SCHEME OBJECTIVES

The purpose of the scheme is to provide a new crossing via a bridge across the River Shannon to link the regional road R463 on the west side of the Shannon to the regional roads R525/R494/R466 on the east side in the vicinity of Killaloe/Ballina and O'Briensbridge/ Montpelier. Refer to the Study Area shown on Figure 2.2 in Volume B.

There are two existing river crossings in the Study Area, one at Killaloe/Ballina and the other at O'Briensbridge/Montpelier. The next alternative to the north is at Portumna, at the north end of Lough Derg, and the next alternative crossing to the south is at Limerick. The existing bridges thus carry a large volume of through traffic, as well as local traffic. The traffic crossing the existing bridges includes a high proportion of HGVs, partly due to a number of quarries being located in the vicinity.

The purpose of the scheme is to provide maximum traffic relief to the existing river crossings at Killaloe/Ballina and O'Briensbridge/Montpelier, and improve the flow of traffic on the existing road network.

Traffic circulation around Killaloe and Ballina is restricted as all of the radial routes to the town converge at the single river crossing at the Killaloe/Ballina Bridge shown in Figure 2.3. As a result severe congestion occurs on the bridge and on all approaches to the bridge especially at peak times. The bridge at Killaloe/Ballina is an historic, 13-arch masonry structure with a width of 4.8 – 5.0 metres, which is inadequate for two-way traffic. The problem is compounded by significant pedestrian traffic, a pedestrian/cyclist survey undertaken for the Killaloe Bridge Widening Environmental Impact Statement showed that 748 pedestrians and 8 cyclists used the bridge from 7am to 7pm on Thursday 9th of March 2000. Traffic lights have been recently installed at either end of the bridge and are in operation since 16th September 2005. A designated footway has also been demarcated along one side of the bridge.

Figure 2.3: Killaloe/Ballina Bridge

The crossing at O'Briensbridge/Montpelier consists of two bridges, one over the Shannon, shown in Figure 2.4, and the other over the adjacent Ardnacrusha headrace, shown in Figure 2.5. The Shannon Bridge is an historic 6-arch masonry structure with a width of only 4.7 metres, which is inadequate for two-way traffic, and has no separate provision for pedestrians.

Figure 2.4: O'Briensbridge/Montpelier Bridge

The bridge over the Headrace Canal was constructed around 1930 and has a width of 5.0 metres with a separate pedestrian walkway. While this bridge width permits limited two-way traffic, the carriageway is very narrow for the current traffic volumes, and a sharp crest curve on the bridge obstructs visibility along its length, refer Figure 2.5.

Figure 2.5: Headrace Canal Bridge

2.5 PUBLIC CONSULTATION

2.5.1 First Public Consultation

The guidelines for road schemes in the March 2000 NRA National Roads Project Management Guidelines publication have generally been followed in this project. In accordance with these guidelines, the first Public Consultation meeting was held prior to concluding the Constraints Study Report. This consultation was held at the Kincora Hall Hotel in Killaloe on Tuesday 19th April 2005 and included the following:-

- Session for elected representatives.
- Session for the general public.

A presentation was made to the elected representatives by RPS Consulting Engineers. At both sessions, staff from RPS Consulting Engineers, Colin Buchanan and Partners and staff from each of the three local authorities were available to answer questions relating to the scheme and mapping was displayed showing the Study Area and Constraints.

Each person attending was asked to sign in and was given an Information Leaflet and Questionnaire.

Approximately 13 elected representatives and 36 members of the public attended the meeting. Some of the more important comments/concerns expressed on the questionnaires are as follows: -

- The vast majority agreed with the need for a new crossing.

- Some expressed concern that a bypass of Killaloe did not seem to be part of the current plan.

- Some suggested that the new crossing and the associated road network should be linked to the proposed N7.
- Some expressed their concern of the damage caused to the old bridges, particularly the historic Killaloe/Ballina Bridge, as a consequence of traffic volumes and HGV traffic crossing the bridge.
- When asked which features the public would like to be avoided, many suggested archaeological and historic features, the widest part of the Shannon, the weir, Inishlosky Island and the Clarisford area.
- Weight restrictions should be imposed on the existing two bridges once the new bridge is open to traffic.

The first public consultation meeting was deemed a success and gave people from the local area an opportunity to input to the project at the outset of the scheme. A second public consultation meeting was held during this Route Selection phase of the study, refer to Chapter 6.

2.6 BODIES CONSULTED

During the course of the Route Selection phase, various groups were consulted, including the following:-

- Burren National Park.
- Clare County Council – Heritage Officer, Conservation Officer.
- North Tipperary County Council – Heritage Officer.
- Limerick County Council – Heritage Officer, Conservation Officer, County Archaeologist.
- Department of the Environment, Heritage and Local Government – National Parks and Wildlife Service (NPWS), National Monuments Service.
- ESB (Ardnacrusha).
- ESB (Fisheries).
- Geological Survey of Ireland (GSI).
- Office of Public Works.
- Shannon Development.
- Shannon Regional Fisheries Board.
- Waterways Ireland.

In addition, a number of other groups had been consulted during the Constraints Study phase of the project, including the following:-

- Bord Gais.
- Department of the Marine and Natural Resources.
- Eircom.
- ESB (Networks).
- ESB International (ESBI).
- Esat Digifone.
- Gardai.
- Irish Multichannel.
- Ocean Communications.
- Ordnance Survey Ireland.

Written submissions in relation to the Route Selection phase of the project were received from the following:-

- Department of the Environment, Heritage and Local Government.
- Shannon Regional Fisheries Board.
- Shannon Development.
- Office of Public Works.
- ESB (Fisheries).
- Limerick County Council – Executive Archaeologist.

The content of these submissions was given due consideration prior to the recommendation of the preferred route. These bodies will be consulted with in more detail during the Preliminary Design Phase of the project.

2.7 SCOPE OF REPORT AND APPROACH

This report describes the selection and evaluation of the route options considered, having regard to traffic, engineering, environmental and economic criteria, and the selection of a preferred route. The approach is generally in accordance with the NRA Project Management Guidelines.

The approach taken is as follows:-

a) **Constraints Study** report is used as a basis for the process and contains background information and listing of all identified constraints.

b) **Routes** are identified which are considered feasible. Refer to Chapter 3.

c) **Traffic Analysis** is undertaken on all the routes identified. The options are ranked in terms of traffic demand and user benefit. Refer to Chapter 3.

d) **Engineering** issues are considered in terms of required road and bridge works, soil conditions, drainage and utilities etc. for all routes. Refer to Chapter 3.

e) **Land Acquisition** requirements are assessed and costed. Refer to Chapter 3.

f) **Costs** associated with the procurement of each route are estimated and benefit/cost ratios calculated. Refer to Chapter 3.

g) **Preferred Routes** are identified based on an assessment of the advantages and disadvantages associated with each of the routes considered. The shortlisted routes are carried forward for further investigation. Refer to Chapters 4 and 5.

h) **Environmental Assessments** are undertaken in detail on the shortlisted routes. Refer to Chapter 4.

i) **Engineering Surveys and Assessments** are undertaken in detail on the shortlisted routes. Refer to Chapter 4.

j) **Public Consultation** opinion and submissions following from the 2nd Public Consultation in September 2005 are considered. Refer to Chapter 6.

k) **Framework Assessments and Recommendations** are presented in Chapter 7.

3 ROUTE OPTIONS - SELECTION AND EVALUATION

3.1 INTRODUCTION

The purpose of the Shannon Bridge Crossing project is to link the R525, R466 or R494 with the R463 via a new bridge across the River Shannon in the vicinity of Killaloe/Ballina and O'Briensbridge/Montpelier to improve the flow of traffic on the existing road network and to alleviate traffic congestion on the existing bridges.

The traffic problems within the Study Area are demonstrated at the narrow and historic Killaloe/Ballina Bridge crossing over the River Shannon, which links the towns of Killaloe and Ballina. This bridge has a 4.95 m wide carriageway, which is shared by both vehicles and pedestrians. As a result traffic on the approaches becomes congested and delayed at peak times. A set of traffic lights has recently been installed at either end of the bridge providing an alternating one-way traffic system, with a segregated footway on one side. This has improved the situation slightly but delays at peak times still remain.

A similar situation occurs on the two bridges at O'Briensbridge/Montpelier approximately eight kilometres south of Killaloe/Ballina. The bridge over the headrace canal is 5.0m wide with a segregated footpath on one side. The bridge over the River Shannon is 4.65m wide with no footpaths. Again traffic on the approaches becomes congested and delayed at peak times.

The Technical Steering Committee initially envisaged the provision of the proposed scheme generally to be located to the south of the existing Killaloe/Ballina Bridge and to the north of the existing O'Briensbridge/Montpelier Bridges. However Route 1 is located south of O'Briensbridge/ Montpelier while Route 8 is located north of Killaloe/Ballina.

The context for the study is illustrated in the attached figures in Volume B: -

- **Figure 2.1:** Existing Road Network.
- **Figure 2.2:** Study Area.

3.2 EVALUATION OF CONSTRAINTS

The key issues in the Constraints Study Report were presented in the Executive Summary of the report which included the following:-

The purpose of this Report is to map all the identified constraints within the Study Area that might impact on choosing potential routes for the Shannon Bridge Crossing. This data collection is focussed on determining what constraints (physical, procedural, legal, environmental, etc.) exist that could affect the ***design*** *of the scheme, that could delay the* ***progress*** *of the scheme, and that could influence the* ***cost*** *of the scheme.*

The constraints noted in this section have been identified as being of primary importance for the route selection of the Shannon Bridge Crossing project.

The primary constraints are identified to be the following:

Environmental Constraints

The Study Area overlaps three designated sites: Lower River Shannon candidate Special Area of Conservation (cSAC); Lough Derg (Shannon) Special Protection Area (SPA) and Lough Derg proposed Natural Heritage Area (pNHA). These sites collectively, are known to hold a number of habitats and species listed for protection under the EU Habitats Directive; the EU Birds Directive; The Wildlife Act (1976); The Wildlife (Amendment) Act (2000) and the Flora (Protection) Order (1999). Protected species and habitats are also known to occur outside of these designated sites in the vicinity of the Study Area.

National Parks and Wildlife Service of the Department of Environment, Heritage and Local Government, the statutory authority responsible for implementation of nature conservation legislation have provided recommendations and comments which have been addressed in this report, and have requested that consultation with their staff regarding the project should continue throughout the project.

The Study Area as a whole, and the River Shannon and its associated marginal habitats in particular, are considered to be environmentally sensitive, and of relatively high conservation value in a national context.

The River Shannon is an important fishery, the main fish of commercial and amenity value within the Study Area are salmon, pike, perch, bream, brown trout, eels and various coarse fish hybrids. There are also ranges of coarse fish species, which are part of the biodiversity of the area.

Given the importance of the Shannon River, with respect to angling and tourism, and other rivers within the Study Area, for several fish species, including salmon, trout and eel, it is likely that seasonal restrictions on in-stream works, or other mitigating measures to reduce temporary impacts on fish and fisheries may be prescribed.

The Shannon Regional Fisheries Board are the authority responsible for conservation, management and development of inland fisheries and sea angling resources of the Shannon catchment and much of the Mid-West. They have provided recommendations and comments, which have been incorporated into this report, and have requested that consultation with their staff regarding the project should continue throughout the project.

Physical Constraints

- ***Existing Road Infrastructure,*** *in particular the N7 (Dublin – Limerick), R494 (Birdhill – Ballina – Portroe - Nenagh), R463 (Limerick – Killaloe – Scariff) and R466 (Birdhill – O'Briensbridge), which are likely to be impacted by the proposed scheme. These are busy routes, and the short-term construction disruptions and long term junction needs must be carefully considered.*

- ***Proposed Road Infrastructure****, in particular the N7 Nenagh to Limerick High Quality Dual-carriageway, with its associated junction at Birdhill.*

- *Existing* ***Landuse****, in particular the built-up areas of Killaloe, Ballina, O'Briensbridge, Montpelier and Birdhill.*

- *Existing* ***Utilities,*** *in particular water, sewage, power and telecommunications apparatus.*

- *ESBI have indicated that a minimum lateral clearance of 35m must be maintained from the centre line of the high voltage Transmission Line at Moys.*

- *The River Shannon and associated headrace canal and flood embankments are major constraints. The width of the river at possible crossing locations will affect the length of the bridge, which will have a bearing on the cost and the viability of the scheme.*

Landscape and Visual Constraints

- *The proposed bridge will act as new a focal point for the selected area, altering the perception of the landscape.*

- *A range of landscape character types are found within the Study Area, each type having a different capacity to absorb the development of a new large scale structure spanning the width of the river.*

- *The concentration of short, medium, and long-range visual receptors varies between regions of high and low population densities, within the Study Area.*

These constraints in addition to other constraints within the broad categories above, and other constraints relating to cultural heritage, archaeology, leisure, recreation and general environmental factors have been identified in this study.

Potential routes will be examined as part of the Route Selection process having regard to these constraints and bearing in mind the need to mitigate adverse impact as far as possible.

3.3 ROUTES CONSIDERED

A number of route options for the Shannon Bridge Crossing have been considered since the publication of the Constraints Study Report in May 2005. These routes can be seen on Figure 3.1 in Volume B and are summarised in Table 3.1. Detailed layouts of the routes are shown on Figures 3.2 to 3.10 of Volume B. The route descriptions are as follows:-

- **Route 1**
  This route is approximately 1,050m long and includes a 60m long crossing of the headrace canal and a 120m long crossing of the River Shannon. It commences on the R463 in Co. Clare approximately 0.70km south of the existing bridge in O'Briensbridge/Montpelier. It travels in a south-easterly direction over the Canal, and across a narrow strip of land to the western shore of the River Shannon. It crosses the Shannon and continues in a south-easterly direction to join with the R525 approximately 0.6km south of Montpelier.

- **Route 2**
  This route is approximately 1,100m long and includes a 106 m long crossing of the headrace canal and a 116 m long crossing of the River Shannon. It also includes a 20m long crossing over the existing R463 at its western end. It commences on the R463 in Co. Clare approximately 0.75 km north of the existing bridge in O'Briensbridge. It travels in a south-easterly direction over the canal, and across a narrow strip of land to the western shore of the River Shannon. It crosses the Shannon and continues in a south-easterly direction to join with the R466 approximately 0.25 km east of Montpelier.

- **Route 3**
  This route is approximately 1,450m long and includes a 106m long crossing of the headrace canal and a 132m long crossing of the River Shannon. It commences on the R463 in Co. Clare just south of Parteen Weir. It travels in a south-easterly direction over the canal, and across a narrow strip of land to the western shore of the River Shannon. It crosses the Shannon and continues in a south-easterly direction to join with the R466, 1.5 km east of Montpelier.

- **Route 4**
  This route is approximately 2,550m long and includes a 200m long crossing of the River Shannon. The river basin is 550m wide at this location and 350m length of the roadway is founded on causeways constructed within the river basin area. It commences on the R463 in Co. Clare about 2.2km north of Parteen Weir. It travels in a south-easterly direction crossing the Shannon and the realigned Kilmastulla River to join with the R466, 0.6 km south of Birdhill.

- **Route 5**
  This route is approximately 2,480m long and includes a 200m long crossing of the River Shannon. The river basin is 820m wide at this location, and 620m length of the roadway is founded on causeways constructed within the river basin area. It commences on the R463 in Co. Clare about 2.7 km north of Parteen Weir. It travels in a south-easterly direction, crossing the Shannon to join with the R494, 1.6 km north of Birdhill.

- **Route 6**
  This route is approximately 1,090m long and includes a 272m long crossing of the River Shannon. It commences on the R463 in Co. Clare approximately 1.4 km south of the existing bridge in Killaloe/Ballina. It travels in a south-easterly direction, to the south of Clarisford Estate through the Townland of Moys, reaching the western shore of the River Shannon. It crosses the River Shannon and continues in an easterly direction across to join with the R494 in Co. Tipperary, approximately 1.6 km south of the existing Killaloe/Ballina Bridge. This route runs alongside on the north of the existing high voltage ESB line between Dunstown and Moneypoint.

- **Route 7a**
  This route is approximately 910m long including a 182m long crossing of the River Shannon. It commences on the R463 in Co. Clare approximately 1.1 km south of the existing bridge in Killaloe/Ballina (350m north of Route 6). It travels in a south-easterly direction, passing approximately 70m north of Clarisford Palace, continuing through a vacant site to the western shore of the River Shannon. It continues in an easterly direction across the River Shannon to join with the R494 at its junction with the R496 in Co. Tipperary, approximately 1.0 km south of the existing Killaloe/Ballina Bridge.

- **Route 7b**
  This route is approximately 890m long including a 170m long crossing of the River Shannon. It commences on the R463 in Co. Clare approximately 1.1 km south of the existing bridge in Killaloe/Ballina (same location as Route 7a). It travels in an easterly direction passing approximately 160m north of Clarisford Palace, continuing between two existing residential properties to the western shore of the River Shannon. It continues in an easterly direction across the River Shannon to join with the R494 at its junction with the R496 in Co. Tipperary, approximately 1.0 km south of the existing Killaloe/Ballina Bridge (same location as Route 7a).

- **Route 7c**
  This route is approximately 890m long including a 166m long crossing of the River Shannon. It commences on the R463 in Co. Clare approximately 1.1km south of the existing bridge in Killaloe/Ballina (same location as Route 7a). It travels in an easterly direction passing approximately 180m north of Clarisford Palace, continuing through an existing residential property, to the western shore of the River Shannon. It continues in an easterly direction across the River Shannon to join with the R494 at its junction with the R496 in Co. Tipperary, approximately 1.0km south of the existing Killaloe/Ballina Bridge (same location as Route 7a).

- **Route 8**
  Route 8, the northernmost route and north of Killaloe/Ballina, is a hypothetical route and was proposed for traffic modelling purposes only. It is physically difficult to plan a route through this area, due to the high level of development, and the link was inserted only to test the traffic demand on such a link. The rationale was that should the traffic model indicate that such a link would be desirable, the geometric feasibility would be investigated further. This turned out not to be the case and thus no physical alignment was determined.

In assessing the alignments for Routes 6 and 7, consideration has been given to the possibility that these routes may need to tie in to a future bypass around the western side of Killaloe. The need for a bypass was a consistent theme raised at the Public Consultation meeting for the Constraints Study phase and again at the consultation meeting for the current phase. While consideration of a bypass, and potential route corridors for a bypass, is outside the scope of this study, a preliminary study of potential corridors has been undertaken to assess the feasibility of tying in a bypass at the west ends of these two routes. The study considered geometrics and current land use and indicated that it would be possible to tie into either of Routes 6 or 7 as proposed above and that neither route offered a significantly more favourable tie-in than the other. The route corridors considered in the study are shown in Figure 3.21 of Volume B.

Table 3.1: Summary of Route Options Considered

Route No.	Total Length (m)	Length of R. Shannon Crossing (m)	Length of Canal Bridge (m)	Length of Causeway (m)	No. of Structures	At-Grade Junctions (No.)	Local Road Crossings (No.)
1	1,050	120	60	0	2	2	1
2	1,100	116	106	0	3	2	1
3	1,450	132	106	0	2	2	1
4	2,550	200	0	350	1	2	1
5	2,480	200	0	620	1	2	1
6	1,090	272	0	0	1	2	1
7a	910	182	0	0	1	2	2
7b	890	170	0	0	1	2	2
7c	890	166	0	0	1	2	2
8	Hypothetical crossing for traffic modelling purposes only						

3.4 ASSESSMENT CRITERIA

The following criteria were used in assessing the capacity of the route options to meet the objectives of the scheme.

- **Traffic**
  Traffic predicted to use the route and the effect of the route on the existing road network is a key criterion for selection. Maximum diversion of traffic to the crossing is a fundamental objective of the project in order to maximise relief to the existing bridges, reduce the problems being experienced at these bridges, and improve the efficiency of the road network.

- **Engineering**
  The engineering feasibility of each route having regard to the available corridors within existing and proposed land use, topography, waterways, ground conditions, services etc.

- **Cost**
  The expected cost of providing the route, the benefit to the road users, and the assessed benefit to cost ratio.

The foregoing criteria were applied to each of the routes in order to identify viable options for the scheme. Those options regarded as viable and which met the objectives of the scheme were shortlisted and assessed further under the following criteria:-

- **Environment**
  The various environmental impacts of constructing the scheme relating to the natural, built and human environments. This requires the identification of environmental impacts and the minimisation and/or mitigation of the impacts as far as is possible or practical. Particular attention is needed where significant community impacts will occur.

Consideration has been given to the necessary statutory processes (CPO, EIS) in order to ensure, as far as practicable, successful approval for the project in the future stages.

3.5 TRAFFIC ASSESSMENT

3.5.1 Introduction

The traffic surveys together with a review of the Study Area road network was presented in the Constraints Study, published in May 2005. The traffic data has been used to develop a traffic model that was subsequently used to test the traffic implications of route options for a new crossing of the River Shannon.

This section of the report details the subsequent traffic analysis undertaken under the following subject headings:-

- Model development and calibration/validation.
- Model test scenarios.
- Model test results.

The results of the model tests are assessed in conjunction with the procurement cost estimates to undertake a comparative economic appraisal in Section 3.8 and to identify preferred routes in traffic terms.

3.5.2 Model Development and Calibration/Validation

A traffic model was developed covering the Study Area network using the industry standard SATURN suite of programs. In summary, the model consists of two main elements:-

1. The highway network, and
2. The travel demand between various pockets of land, or zones.

The travel demand matrix is assigned to the network using route choice algorithms within SATURN, producing a network with forecast traffic volumes on each link. A comparison of observed and forecast traffic data for the base year permits the level of the accuracy, or the validity of the model, to be determined.

Details of the process used to develop the SATURN traffic model are presented in a separate report "Shannon Bridge Crossing Traffic Model". A summary of the base year 2005 observed and modelled flows are presented in Tables 3.2 to 3.4. The results for cars and LGV’s are shown in Table 3.2 while the results for HGV’s is shown in Table 3.3, and the total in Table 3.4. The results show that the model calibrates well for both vehicle types at both the radial routes and on the bridge crossings, with all total modelled flows being within 5% of observed. It was therefore concluded that the model was a suitable tool to use in order to assess the traffic implications of various route options for the new crossing. In each table, locations are shown twice, indicating traffic flow in each direction.

Table 3.2: AM Peak Hour Flow Comparison, Observed and Modelled Flows at Cordon Points and Existing Bridges: Cars and LGV's

Location	Observed Flow	Modelled Flow	Difference	% age Difference
R494	66	66	0	0%
R494	172	168	-4	-2%
N7 (north)	542	542	0	0%
N7 (north)	412	422	10	2%
R503	328	330	2	1%
R503	162	163	1	1%
N7 (south)	462	463	1	0%
N7 (south)	983	978	-5	-1%
R463	161	169	8	5%
R463	235	243	8	3%
R466	110	113	3	3%
R466	57	59	2	4%
R463	185	184	-1	-1%
R463	117	121	4	3%
Killaloe Bridge	252	251	-1	0%
Killaloe Bridge	319	319	0	0%
Montpelier Bridge	211	211	0	0%
Montpelier Bridge	175	171	-4	-2%
O’Briensbridge	199	198	-1	-1%
O’Briensbridge	164	162	-2	-1%

Table 3.3: AM Peak Hour Flow Comparison, Observed and Modelled Flows at Cordon Points and Existing Bridges: HGV's

Location	Observed Flow	Modelled Flow	Difference	% age Difference
R494	3	3	0	0%
R494	10	10	0	0%
N7 (north)	101	101	0	0%
N7 (north)	78	78	0	0%
R503	7	5	-2	-29%
R503	10	8	-2	-20%
N7 (south)	102	101	-1	-1%
N7 (south)	125	124	-1	-1%
R463	11	11	0	0%
R463	10	10	0	0%
R466	20	20	0	0%
R466	18	18	0	0%
R463	11	11	0	0%
R463	20	20	0	0%
Killaloe Bridge	17	17	0	0%
Killaloe Bridge	15	15	0	0%
Montpelier Bridge	27	27	0	0%
Montpelier Bridge	19	19	0	0%
O'Briensbridge	24	24	0	0%
O'Briensbridge	24	24	0	0%

Table 3.4: AM Peak Hour Flow Comparison, Observed and Modelled Flows at Cordon Points and Existing Bridges: PCU's

Location	Observed Flow	Modelled Flow	Difference	% age Difference
R494	72	72	0	0%
R494	192	188	-4	-2%
N7 (north)	744	744	0	0%
N7 (north)	568	578	10	2%
R503	342	340	-2	-1%
R503	182	179	-3	-2%
N7 (south)	666	665	-1	0%
N7 (south)	1233	1226	-7	-1%
R463	183	191	8	4%
R463	255	263	8	3%
R466	150	153	3	2%
R466	93	95	2	2%
R463	207	206	-1	0%
R463	157	161	4	3%
Killaloe Bridge	286	285	-1	0%
Killaloe Bridge	349	349	0	0%
Montpelier Bridge	265	265	0	0%
Montpelier Bridge	213	209	-4	-2%
O'Briensbridge	247	246	-1	0%
O'Briensbridge	212	210	-2	-1%

PCU's = Passenger car units = Cars + 2 x HGV's

3.5.3 Model Test Scenarios

3.5.3.1 Route Options

The locations of the route options for the new bridge crossing as incorporated in the model are shown in Figure 3.1 of Volume B. It should be noted that for traffic modelling purposes no distinction is made between Routes 7a, 7b and 7c, and that Route 8, located to the north of the Killaloe/Ballina Bridge, was developed for traffic modelling purposes only.

3.5.3.2 Time Periods

All route options were tested using the AM peak hour model (08:30 to 09:30). Average Annual Daily Traffic (AADT) volumes were then derived by factoring the AM peak hour traffic forecasts. The AM peak hour to AADT expansion factor was determined as follows:-

- Relationship between AM peak hour (08:30 to 09:30) to 10 hour (08:00 to 18:00) observed for the cordon counts is 6.76.
- Relationship between 11-hour count (08:00 to 19:00) to AADT, extracted from "NRA Expansion Factors for short periods" determined to be 1.29.
- Factor 10-hour to 11-hour, 1.1.
- Cumulative factor to covert AM peak hour to AADT = 9.46.

3.5.3.3 Base and Future Years

Traffic forecasts were produced for a base year of 2007, and a future year 15 years thereafter, 2022. Observed year 2005 trip patterns were factored to 2007 and 2022 using growth factor indices produced by the NRA and published in the document "Future Traffic Forecasts 2002–2040". The relevant indices and factors are listed in Table 3.5 and show that traffic will grow by 23% (cars and LGV's) and 24% (HGV's) between the years 2005 and 2022.

Table 3.5: Growth Factors by Period and Vehicle Type

Vehicle Type	NRA Growth Indices *			Factors	
	2005	2007	2022	2005 to 2007	2005 to 2022
Cars and LGV's	107	111	132	1.04	1.23
HGV's	105	109	130	1.04	1.24

* Indices applicable to non-national roads

3.5.4 Model Test Results

3.5.4.1 Do-Nothing Network Statistics

The following tables present summary statistics of the trips taking place within the Study Area network during the AM peak hour for the do-nothing scenario. Table 3.6 shows the number of cars and HGV's trips that were observed to travel in 2005, and are forecast to travel in 2007 and 2022, either through or within the Study Area network. In terms of the total number of trips on the network the total number is forecast to increase from 4,490 PCU's in the year 2005 to 4,670 (+4%) in 2007, and to 5,550 (+23%) by 2022.

Table 3.6: Trips on the Network by Year, AM Peak Hour

Year	Trips on Network		
	Cars	HGV's	PCU's
2005	3,650	420	4,490
2007	3,790	440	4,670
2022	4,490	530	5,550

PCU's = Passenger car units = Cars + 2 x HGV's

The total time spent travelling (PCU hours), and total distance travelled (PCU kms) on the Study Area network by all vehicles during the AM peak hour is shown by year for the do-nothing scenario in Table 3.7. The points of interest from this table are:-

- Worsening congestion due to increased traffic volumes on the network will result in average journey times rising by 16.5% between 2005 and 2007 (up from 10.9 minutes to 12.7 minutes).

- If nothing is done to enhance the highway network, congestion levels will increase further by 2022, with average journey times increasing by 53.2% compared to existing 2005 levels (up from 10.9 minutes to 16.7 minutes).

- As there is limited route choice within the existing network, average trip distances will remain fairly constant for the do-nothing scenario, increasing by just 1.5% (from 13.9 kms to 14.1 kms) between 2005 and 2022.

Table 3.7: Network Statistics by Year, Do-Nothing, AM Peak Hour

Year	Absolute			Average	
	PCU's	PCU hours	PCU kms	mins / trip	kms / trip
2005	4,490	819	62,504	10.9	13.9
2007	4,670	992	65,293	12.7	14.0
2022	5,550	1,539	77,957	16.7	14.1

3.5.4.2 Network Statistics by Route

Table 3.8 shows the network summary statistics by route for the years 2007 and 2022, while Table 3.9 shows the percentage reduction for each route compared to the do-minimum.

With respect to the overall distance travelled on the network, the various routes options have a fairly small impact compared to the do-minimum as some trips are shorter due to the additional bridge crossing, while others trips are longer due to selecting quicker but longer trips through the network. The maximum variation compared to the do-minimum is Route 5 with +0.3% in 2007 and +1.6% in 2022.

As would be expected, the introduction of an additional bridge across the Shannon in the proximity of the existing Killaloe/Ballina bridge has a greater impact on average journey times than alignments to the south with the greatest time saving resulting from Route 7, with savings of 10.5% and 11.6% in 2007 and 2022 respectively.

Table 3.8: Vehicle Time and Distance by Route, AM Peak Hour, All Vehicles

Route	Year 2007		Year 2022	
	Time (hrs)	Distance (kms)	Time (hrs)	Distance (kms)
Do min	992	65,293	1539	77,957
1	988	65,199	1530	77,750
2	946	65,310	1522	77,859
3	942	65,271	1509	77,590
4	904	65,399	1475	78,351
5	898	65,486	1369	79,221
6	895	65,373	1368	79,113
7	888	65,298	1361	79,006
8	898	65,278	1380	78,951

Table 3.9: Vehicle Time and Distance by Route, AM Peak Hour Percentage Difference Compared to Do-min

Route	Year 2007		Year 2022	
	Time	Distance	Time	Distance
Do min	-	-	-	-
1	-0.4%	-0.1%	-0.6%	-0.3%
2	-4.6%	0.0%	-1.1%	-0.1%
3	-5.0%	0.0%	-2.0%	-0.5%
4	-8.8%	0.2%	-4.2%	0.5%
5	-9.5%	0.3%	-11.1%	1.6%
6	-9.7%	0.1%	-11.1%	1.5%
7	-10.5%	0.0%	-11.6%	1.3%
8	-9.4%	0.0%	-10.4%	1.3%

Table 3.10 below shows the network summary statistics for the best performing route (Route 7) in 2007 and 2022 compared to summary statistics for 2005 existing conditions. It should be noted that although considerable time savings may be attributed to the new crossing in 2007 and 2022, as discussed above, the increased traffic volumes will result in increased average journey times network wide in the future compared to present levels. For example, the average journey time of 10.9 minutes within the Study Area network observed in 2005 is forecast to increase to 14.7 minutes in 2022, even with the inclusion of a new bridge at Route 7. This is due to increasing levels of congestion at other locations on the network not benefiting from the new crossing. For example, inspection of the traffic model reveals that while average peak hour journey times between the towns of Killaloe and Ballina will decrease from an average of 3.0 minutes in 2005 to 2.8 minutes in 2022 with the new crossing, journey times between O'Briensbridge and Birdhill will increase from 7.9 minutes to 9.6 minutes for the same scenarios.

Table 3.10: Network Statistics by Year, 2005 Existing, 2007 and 2022 Route 7, AM Peak Hour

Year	Absolute			Average	
	PCU's	PCU hours	PCU kms	mins/trip	kms/trip
2005 Existing	4,490	819	62,504	10.9	13.9
2007 Route 7	4,670	888	65,298	11.4 (12.7)	14.0 (14.0)
2022 Route 7	5,550	1,361	79,006	14.7 (16.7)	14.2 (14.1)

Note: 2007 and 2022 do minimum figures shown in brackets for comparison

3.5.4.3 Traffic Volumes

The AM peak hour and AADT traffic volumes forecast for each location in the Study Area, including the existing and proposed crossings, are shown in Tables 3.11 to 3.14 for the years 2007 and 2022. Locations referred to are shown in Figure 3.15 of Volume B. A breakdown of the traffic flows by vehicle type is included for the same years and time periods in Appendix A of Volume C. The expected influence of the traffic signals recently introduced on the Killaloe bridge during 2005 are shown in the columns headed “Signals”. The AADT predicted to use each of the route options is illustrated graphically in Figures 3.11 and 3.12 of Volume B, and the AADT predicted to use the existing and new crossings for the case of each route option is shown in Figures 3.13 and 3.14 below, for the years 2007 and 2022.

Table 3.11: AM Peak Hour Flow Comparison, PCU's, 2007

		Model Network										
	Observed				Route							
Location	Flows	Base	Signals	Do min	1	2	3	4	5	6	7	8
Year	2005	2005	2005	2007	2007	2007	2007	2007	2007	2007	2007	2007
R494	264	262	262	271	271	271	271	271	271	271	271	271
N7 (north)	1,312	1,359	1,359	1,412	1,412	1,412	1,412	1,412	1,412	1,412	1,412	1,412
R503	524	520	520	541	541	541	541	541	541	541	541	541
N7 (south)	1,899	1,909	1,909	1,986	1,986	1,986	1,986	1,986	1,986	1,986	1,986	1,986
R463	438	460	460	476	476	476	476	476	476	476	476	476
R466	243	249	249	261	261	261	261	261	261	261	261	261
R463	364	369	369	383	383	383	383	383	383	383	383	383
Killaloe Br.	635	641	575	585	583	565	564	520	506	373	304	457
M'pelier Br.	478	498	552	587	288	345	391	444	446	494	486	520
New Br	0	0	0	0	300	263	216	215	227	317	394	202
All Bridges	1,113	1,139	1,127	1,172	1,171	1,173	1,171	1,179	1,179	1,184	1,184	1,179
% on new crossing					26%	22%	18%	18%	19%	27%	33%	17%

Table 3.12: AADT Flows Comparison, PCU's, 2007

		Model Network										
	Observed				Route							
Location	Flows	Base	Signals	Do min	1	2	3	4	5	6	7	8
Year	2005	2005	2005	2007	2007	2007	2007	2007	2007	2007	2007	2007
R494	2,508	2,489	2,489	2,575	2,575	2,575	2,575	2,575	2,575	2,575	2,575	2,575
N7 (north)	12,464	12,911	12,911	13,414	13,414	13,414	13,414	13,414	13,414	13,414	13,414	13,414
R503	4,978	4,940	4,940	5,140	5,140	5,140	5,140	5,140	5,140	5,140	5,140	5,140
N7 (south)	18,041	18,136	18,136	18,867	18,867	18,867	18,867	18,867	18,867	18,867	18,867	18,867
R463	4,161	4,370	4,370	4,522	4,522	4,522	4,522	4,522	4,522	4,522	4,522	4,522
R466	2,309	2,366	2,366	2,480	2,480	2,480	2,480	2,480	2,480	2,480	2,480	2,480
R463	3,458	3,506	3,506	3,639	3,639	3,639	3,639	3,639	3,639	3,639	3,639	3,639
Killaloe Br.	6,033	6,090	5,463	5,558	5,539	5,368	5,358	4,940	4,807	3,544	2,888	4,342
M'pelier Br.	4,541	4,731	5,244	5,577	2,736	3,278	3,715	4,218	4,237	4,693	4,617	4,940
New Br	0	0	0	0	2,850	2,499	2,052	2,043	2,157	3,012	3,743	1,919
All Bridges	10,574	10,821	10,707	11,134	11,125	11,144	11,125	11,201	11,201	11,248	11,248	11,201
% on new crossing					26%	22%	18%	18%	19%	27%	33%	17%

Table 3.13: AM Peak Hour Flow Comparison, PCU's, 2022

Location	Observed Flows	Model Network										
					Route							
		Base	Signals	Do min	1	2	3	4	5	6	7	8
Year	2005	2005	2005	2022	2022	2022	2022	2022	2022	2022	2022	2022
R494	264	262	262	327	327	327	327	327	327	327	327	327
N7 (north)	1,312	1,359	1,359	1,676	1,676	1,676	1,676	1,676	1,676	1,676	1,676	1,676
R503	524	520	520	640	640	640	640	640	640	640	640	640
N7 (south)	1,899	1,909	1,909	2,353	2,353	2,353	2,353	2,353	2,353	2,353	2,353	2,353
R463	438	460	460	566	566	566	566	566	566	566	566	566
R466	243	249	249	307	307	307	307	307	307	307	307	307
R463	364	369	369	455	455	455	455	455	455	455	455	455
Killaloe Br.	635	641	575	701	694	691	683	651	537	420	360	506
M'pelier Br.	478	498	552	693	345	400	460	500	511	552	539	579
New Br	0	0	0	0	353	305	250	255	373	455	527	335
All Bridges	1,113	1,139	1,127	1,394	1,392	1,396	1,393	1,406	1,421	1,427	1,426	1,420
% on new crossing					25%	22%	18%	18%	26%	32%	37%	24%

Table 3.14: AADT Flows Comparison, PCU's, 2022

Location	Observed Flows	Model Network										
					Route							
		Base	Signals	Do min	1	2	3	4	5	6	7	8
Year	2005	2005	2005	2022	2022	2022	2022	2022	2022	2022	2022	2022
R494	2,508	2,489	2,489	3,107	3,107	3,107	3,107	3,107	3,107	3,107	3,107	3,107
N7 (north)	12,464	12,911	12,911	15,922	15,922	15,922	15,922	15,922	15,922	15,922	15,922	15,922
R503	4,978	4,940	4,940	6,080	6,080	6,080	6,080	6,080	6,080	6,080	6,080	6,080
N7 (south)	18,041	18,136	18,136	22,354	22,354	22,354	22,354	22,354	22,354	22,354	22,354	22,354
R463	4,161	4,370	4,370	5,377	5,377	5,377	5,377	5,377	5,377	5,377	5,377	5,377
R466	2,309	2,366	2,366	2,917	2,917	2,917	2,917	2,917	2,917	2,917	2,917	2,917
R463	3,458	3,506	3,506	4,323	4,323	4,323	4,323	4,323	4,323	4,323	4,323	4,323
Killaloe Br.	6,033	6,090	5,463	6,660	6,593	6,565	6,489	6,185	5,102	3,990	3,420	4,807
M'pelier Br.	4,541	4,731	5,244	6,584	3,278	3,800	4,370	4,750	4,855	5,244	5,121	5,501
New Br	0	0	0	0	3,354	2,898	2,375	2,423	3,544	4,323	5,007	3,183
All Bridges	10,574	10,821	10,707	13,243	13,224	13,262	13,234	13,357	13,500	13,557	13,547	13,490
% on new crossing					25%	22%	18%	18%	26%	32%	37%	24%

Fig. 3.13: Traffic Flow at Crossings: AADT 2007.

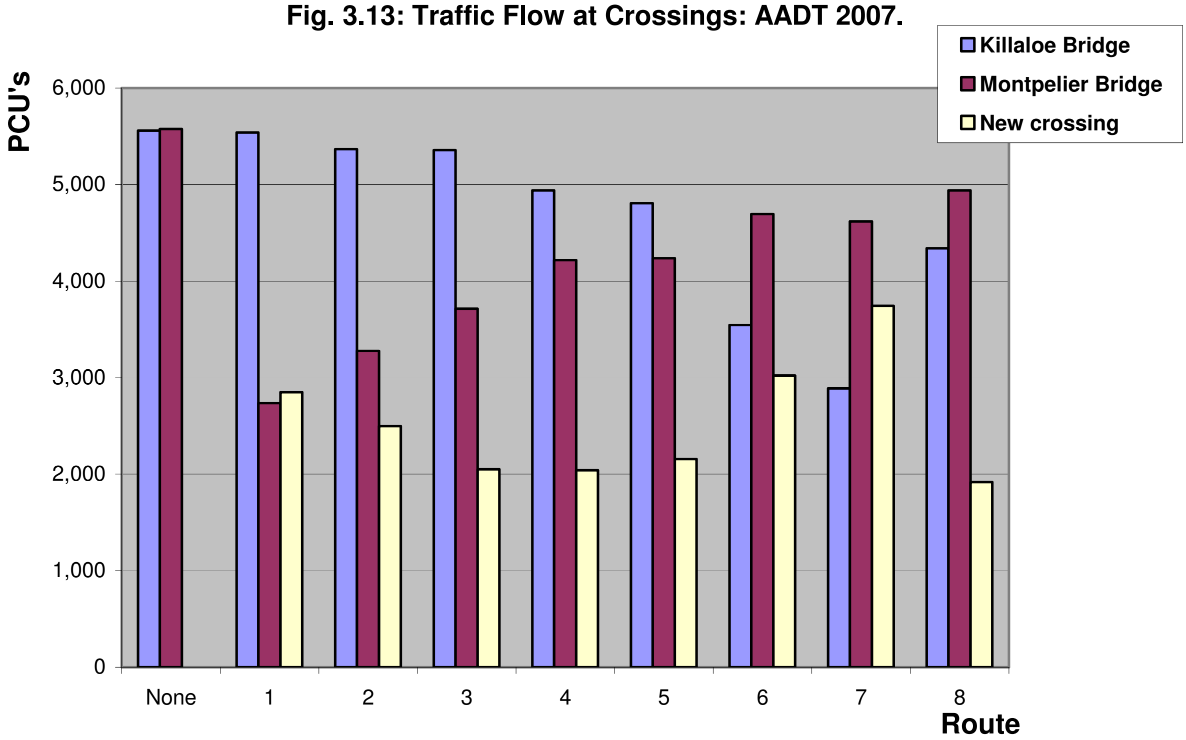
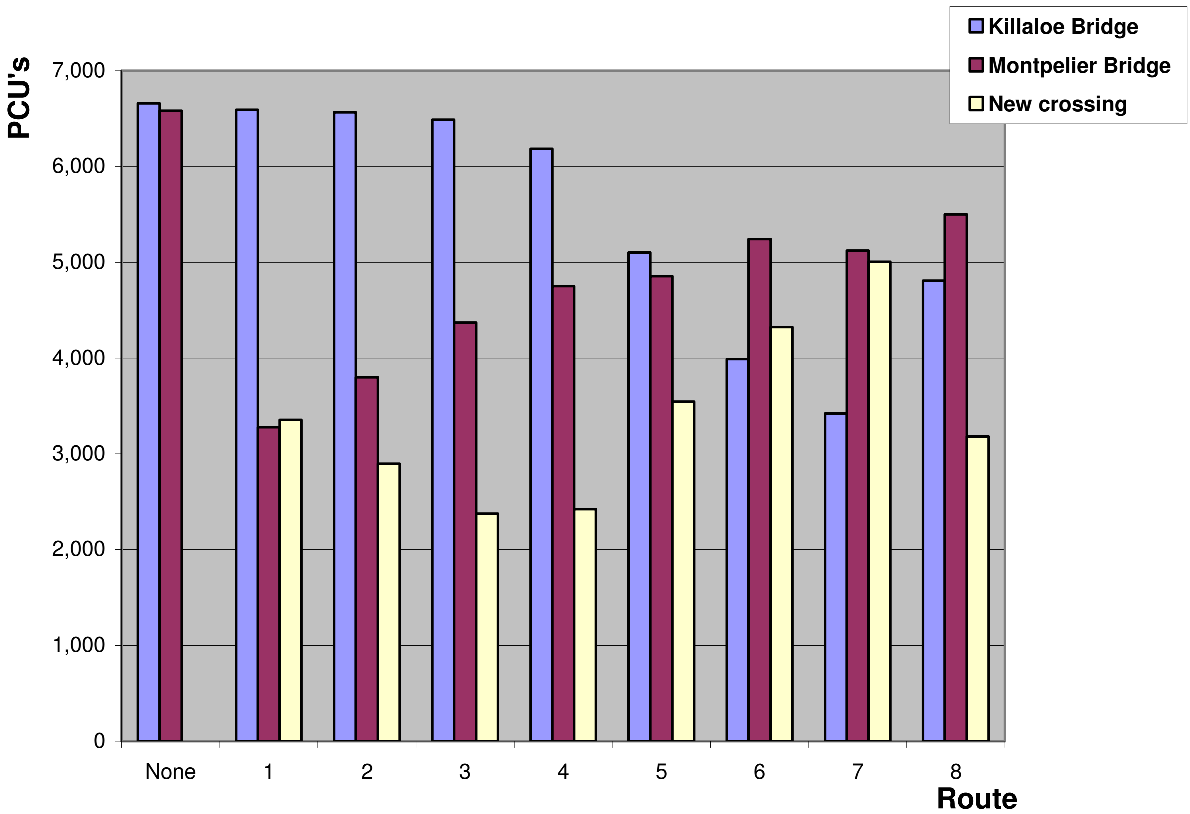


Fig 3.14: Traffic Flow at Crossings: AADT 2022



The principal conclusions in terms of traffic volumes, which can be drawn from the data in Tables 3.11 to 3.14, are set out below. Volumes referred to are in PCU's unless otherwise stated.

Route 7

Route 7 attracts the most traffic from the existing bridges with AADT forecasts of 3,740 (33% of all cross river traffic) and 5,000 (37% of all cross river traffic) in the years 2007 and 2022 respectively.

Route 7 provides considerable relief to the existing Killaloe/Ballina Bridge (-49% in 2007 rising to -49% in 2022) but gives little relief to the existing O'Briensbridge/Montpelier Bridge (-17% in 2007 and -22% in 2022).

With Route 7, flows on the Killaloe/Ballina Bridge would be just 47% of the current level in 2007, and will remain at just 56% of existing levels in 2022. Flows on the O'Briensbridge/ Montpelier Bridge would be 101% of the current level in 2007, and increase to 112% of existing levels in 2022.

Route 6

Route 6 performs second best, attracting 3,010 AADT (27% of all cross river traffic) in 2007, increasing to 4,320 AADT (32%) in 2022.

Route 6 provides reasonable relief to the existing Killaloe/Ballina Bridge (-36% in 2007 rising to -40% in 2022) but, like Route 7, gives little relief to the existing O'Briensbridge/Montpelier Bridge (-16% in 2007 and -20% in 2022).

With Route 6, flows on the Killaloe/Ballina Bridge would be 58% of the current level in 2007, and at 66% of existing levels in 2022. Flows on the O'Briensbridge/Montpelier Bridge would be 103% of the current level in 2007, and increase to 115% of existing levels in 2022.

Route 8

Route 8 performs the same function as Route 7, that is provide traffic relief on the Killaloe/Ballina Bridge, but not as well, attracting 1,920 AADT (17% of all cross river traffic) in 2007, increasing to 3,180 AADT (24%) in 2022.

Route 8 provides reasonable relief to the existing Killaloe/Ballina Bridge (-22% in 2007 rising to -28% in 2022) but gives little relief to the existing O'Briensbridge/Montpelier Bridge (-11% in 2007 and -16% in 2022).

With Route 8, flows on the Killaloe/Ballina Bridge would be 71% of the current level in 2007, and at 79% of existing levels in 2022. Flows on the O'Briensbridge/Montpelier Bridge would be 102% of the current level in 2007, and increase to 121% of existing levels in 2022.

Route 1

In terms of traffic demand Route 1 performs third best of all routes, attracting 2,850 AADT (26% of all cross river traffic) in 2007, increasing to 3,350 AADT (also 25%) in 2022.

In contrast to Routes 6 and 7, Route 1 provides no relief to the existing Killaloe/Ballina Bridge (0% in 2007 and just -1% in 2022) but gives substantial (the most of all routes) traffic relief to the existing O'Briensbridge/Montpelier Bridge (-51% in 2007 and -50% in 2022).

With Route 1, flows on the O'Briensbridge/Montpelier Bridge would be just 60% of the current level in 2007, rising to just 72% of existing levels in 2022. Flows on the Killaloe/Ballina Bridge would be 91% of the current level in 2007, rising to 109% of existing levels in 2022.

Route 2

Route 2 performs the same function as Route 1, that is provide traffic relief on the O'Briensbridge/Montpelier bridge, but not quite as well, attracting 2,500 AADT (22% of all cross river traffic) in 2007, increasing to 2,900 AADT (also 22%) in 2022.

In contrast to Routes 6 and 7, Route 2 provides no relief to the existing Killaloe/Ballina Bridge (just -1% in 2022) but gives significant traffic relief to the existing O'Briensbridge/Montpelier Bridge (-41% in 2007 and -42% in 2022).

With Route 2, flows on the O'Briensbridge/Montpelier Bridge would be 72% of the current level in 2007, rising to 83% of existing levels in 2022. Flows on the Killaloe/Ballina Bridge would be 88% of the current level in 2007, rising to 108% of existing levels in 2022.

Route 5

In terms of traffic demand Route 5 performs poorly in the short term, attracting 2,150 AADT (19% of all cross river traffic) in 2007, although its performance improves in the long term, attracting 3,540 AADT (26%) in 2022.

Route 5 provides little relief to the existing Killaloe/Ballina Bridge (just -14% in 2007) but gives reasonable traffic relief to the existing O'Briensbridge/Montpelier Bridge (-24% in 2007 and -26% in 2022).

With Route 5, flows on the O'Briensbridge/Montpelier Bridge would be 93% of the current level in 2007, rising to 107% of existing levels in 2022. Flows on the Killaloe/Ballina Bridge would be 79% of the current level in 2007, rising to 84% of existing levels in 2022.

Route 3

In terms of traffic demand Route 3 is the least attractive (along with Route 4) of all routes with 2007 and 2022 forecasts suggesting it would attract 18% of all cross river traffic in both 2007 and 2022

In contrast to Routes 6 and 7, Route 3 provides no relief to the existing Killaloe/Ballina Bridge (just -3% in 2022) but gives reasonable traffic relief to the existing O'Briensbridge/Montpelier Bridge (-33% in 2007 and -34% in 2022).

With Route 3, flows on the O'Briensbridge/Montpelier Bridge would be 81% of the current level in 2007, rising to 96% of existing levels in 2022. Flows on the Killaloe/Ballina Bridge would be 88% of the current level in 2007, rising to 107% of existing levels in 2022.

Route 4

In terms of traffic demand Route 4 is the least attractive (along with Route 3) of all routes with 2007 and 2022 forecasts suggesting it would attract just 18% of all cross river traffic in both 2007 and 2022.

Route 4 provides little relief to the existing Killaloe/Ballina Bridge (just -7% in 2022) but gives reasonable traffic relief to the existing O'Briensbridge/Montpelier Bridge (-24% in 2007 and -28% in 2022).

With Route 4, flows on the O'Briensbridge/Montpelier Bridge would be 93% of the current level in 2007, rising to 100% of existing levels in 2022. Flows on the Killaloe/Ballina Bridge would be 81% of the current level in 2007, rising to 103% of existing levels in 2022.

3.5.4.4 Junction Requirements

Junction capacity tests were undertaken at the junctions at each end of the proposed routes in order to establish the standard of intersection required to cope with forecast traffic demand. It was found in each case that a simple priority junction would cope with the maximum demand up to and beyond the year 2022. A roundabout has been proposed at the eastern end of Route 7 to facilitate the 4-arm layout of this junction.

3.5.4.5 Summary

It is clear from the above analysis of traffic volumes on the various routes, and the associated relief on the two existing bridges that:-

- There is no single route that will provide significant relief to both existing bridges.
- Route 7 is the optimum solution with regards relief to the Killaloe/Ballina Bridge, followed by Route 6.
- Route 1 is the optimum solution to provide relief for the existing O'Briensbridge/ Montpelier Bridge, followed by Route 2.
- Routes 6 and 7 offer some relief (-16% and –17% respectively in 2007) to the O'Briensbridge/Montpelier Bridge, but Route 1 offers no relief to the bridge at Killaloe/Ballina.

3.6 ENGINEERING ASSESSMENT

3.6.1 Design Standards and Criteria

The geometric design of the new carriageway and associated intersections for the Shannon Bridge Crossing is based on the guidelines of the National Roads Authority – Design Manual for Roads and Bridges (NRA DMRB). The mainline design speed is 80 kp/h, and the design speed of the intersections is consistent with the speed limits on the existing roads.

A single carriageway cross section is required for the predicted traffic volumes on the scheme (Refer to Section 3.5 of this report for traffic figures). In considering the cross-section, it is noted that the existing Regional roads, i.e., R525, R463, R466, R494 have varying cross-sections and are sub-standard in places. Subject to the need for tapering sections locally to tie-in to these end points, the following design standards are proposed.

3.6.1.1 Road Cross-Section

The proposed road cross-section for the Shannon Bridge Crossing is as follows:-

Traffic lanes	2 @ 3.5 m.	7.0 m
Hard strips	2 @ 0.5 m.	1.0 m
Grass verges	2 @ 3.0 m.	6.0 m
Total		**14.0 m**

This cross-section is shown on Figure 3.16 of Volume B.

3.6.1.2 Bridge Cross-Section

The proposed road cross-section over the bridge is as follows:-

Traffic lanes	2 @ 3.5 m.	7.0 m
Hard strips	2 @ 0.5 m.	1.0 m
Footpath	1 @ 2.0 m.	2.0 m
Rubbing strip	1 @ 0.5 m.	0.5 m
Parapet beams	2 @ 0.5 m.	1.0 m
Total		**11.5 m**

This cross section is shown on Figure 3.16 of Volume B.

3.6.2 Horizontal Alignment of Mainline

The horizontal geometry of the proposed alignments for each route has been determined in accordance with the above standards.

Geometric details have been developed for each of the routes with the exception of Route 8. There are specific difficulties associated with each route in terms of minimising land use and environmental impacts while at the same time ensuring engineering feasibility and adherence to road design standards. The horizontal road alignments selected do not incorporate departures or relaxations from standards and are shown in Figures 3.2 to 3.10 of Volume B.

3.6.3 Vertical Alignment of Mainline

Similarly, vertical alignments have been developed for each of the routes with the exception of Route 8. The maximum gradient used in the design of the mainline is 4%, which is the maximum recommended gradient in NRA DMRB. The minimum gradient adopted for the design is 0.5%, which is the desirable minimum gradient.

The other principal constraint on the vertical alignment is the need to cater for river traffic using the Shannon and/or Headrace Canal. It is required that adequate headroom is provided at the proposed bridge. Waterways Ireland have advised that it would be desirable to maintain air draught for vessels under a proposed bridge which would not be less than that prevailing at the existing bridges over the canal. This would apply to a new bridge over either the canal, or the river above the weir. They have requested a required bridge soffit level of 39.64 mOD Poolbeg (36.94 mOD Malin).

Due to the proximity of the Headrace Canal to the R463 at the western tie-in of Route 2, it is not possible for the vertical alignment of Route 2 to tie-in directly to the R463. It would be necessary to construct an additional bridge to take the new road over the R463 before looping back to tie-in.

The vertical road alignments selected do not incorporate departures or relaxations from standards and are shown in Figures 3.2 to 3.10 of Volume B.

3.6.4 Bridges Required

Each route contains at least one bridge to be constructed as part of the scheme.

Table 3.15 shows the bridges that are required on the different routes and the obstacle(s) crossed by each of the routes.

Table 3.15: Bridges Required

Route	Length (m)	Width (m)	Obstacle
Route 1	60	11.5	Headrace Canal
	120	11.5	Shannon River
Route 2	20	11.5	R463
	106	11.5	Headrace Canal
	114	11.5	Shannon River
Route 3	106	11.5	Shannon River
	132	11.5	Headrace Canal
Route 4	200	11.5	Shannon River Basin
Route 5	200	11.5	Shannon River Basin
Route 6	272	11.5	Shannon River
Route 7a	182	11.5	Shannon River
Route 7b	170	11.5	Shannon River
Route 7c	166	11.5	Shannon River
Route 8	Not assessed	11.5	Shannon River

Bridges are feasible from an engineering point of view in each of the locations considered, although the appropriate type of bridge and its cost would vary depending on the location and the length of structure.

The headrace canal and the river basin (above the weir) are contained in some locations by berms. The berms were constructed as part of the Ardnarusha scheme in about 1930, and provide for the raising of the water level above the surrounding natural ground level. Some of the routes cross these waterways at the locations where berms exist, with the result that a bridge abutment would be located at a berm. Extreme caution would be required to ensure that the construction of the bridge and road embankment would not adversely affect the berm either in the short or the long term. Rupture of a berm could result in flooding, and possible disruption to the Ardnacrusha scheme. While engineering solutions would be available to address this risk, it would be preferable to avoid construction of a bridge at these locations if a suitable alternative exists. The locations where this issue arises are as follows.

Route 2:	East and west side of canal.
Route 3:	East side of canal.
Route 4:	East side of river basin.
Route 5:	East side of river basin.

3.6.5 Earthworks

The earthworks are a substantial part of any road scheme. The majority of the project will be constructed on embankments, with isolated areas of cut. The embankments are of varying height and generally will have a 1 in 2 side slope.

Routes 2, 3 and 5 would contain areas of cut (refer to Fig.'s 3.3, 3.4 and 3.6 of Volume B). A small area of cut would also be required for Route 7a in the vicinity of Clarisford Palace (Figure 3.8 of Volume B). Preliminary site investigation data suggest that the excavated material from these cuttings may be reusable elsewhere on the scheme.

Route 1 would require extensive ground improvement where embankments are constructed over soft organic silts. Ground improvement is not envisaged at other route locations.

For Routes 4 and 5, reference to the bathymetric data shown in Figures 4.26 to 4.29 of Volume B, shows that there is relatively shallow water on either side of the former channel of the Shannon River as defined prior to the inundation of the basin area. In order to reduce the considerable length of a bridge required to span the full width of the basin, it is proposed that these routes would incorporate a length of causeway across part of the river basin on either side of the former channel where the depth of water is relatively shallow. The causeway would consist of rock fill with side slopes at a gradient of 1:2.5 up to a level of 1.0 metre above the water level. Normal roadworks would extend above this level to the finished roadway.

It is envisaged that fill and surfacing materials would be sourced from local quarries close to the scheme.

3.6.6 Pavement

The pavement for the scheme will be designed in accordance with the NRA DMRB.

3.6.7 Drainage

The River Shannon is the main river within the Study Area and any potential route will need to incorporate a bridge to cross the Shannon. There are four tributaries of the Shannon within the Study Area, namely Kilmastulla River, Ballytiege River, Ardcloony River and Black River. With the exception of Route 4, which crosses the Kilmastulla River where it has been realigned alongside the east bank of the Shannon River basin, none of the routes cross these tributaries or any other significant watercourse. The lands traversed by the proposed alignments are currently protected from flooding by the River Shannon with an embankment scheme.

The Headrace Canal is located within the Study Area and Routes 1, 2 and 3 would need to incorporate a bridge to cross this Canal.

Existing drainage channels will need to be crossed and possibly realigned in places to accommodate the road scheme. The existing drains and drainage networks will need to be maintained by culverts and currently independent drainage systems are not to be linked. The minimum culvert crossing size will be 900mm in diameter. This is in accordance with OPW requirements and will allow man entry for inspection and maintenance. It will also reduce the risk of serious obstruction.

Road runoff can affect the water quality of the receiving watercourse. It can contain suspended solids, volatile solids, oil, organic matter, chloride and metals. If the rainfall intensity of a storm event is sufficient, insoluble pollutants can be mobilized from the road surface. If the storm event is of sufficient magnitude, these insoluble pollutants will enter the road drainage system. The road drainage system must, therefore, include measures to improve the quality of road runoff prior to discharge to receiving waters.

Care must be taken, at detailed design stage, in the positioning of culverts and grading of interceptor ditches to ensure that the proposed road does not impede natural flow paths.

3.6.8 Utilities

3.6.8.1 ESB

Details of the ESB infrastructure within the Study Area were received from ESB Networks. The ESB infrastructure comprises high (38kV and 400kV) and medium voltage (10kV) lines and a 38 kV sub-station.

The high voltage lines passing through the Study Area are: -

- The Dunstown – Moneypoint 400kV line.
- The Ardna – Birdhill 38kV line (including a 38kV station at Birdhill).

It will be necessary to liaise closely with ESB staff during the Preliminary Design Stage, regarding existing facilities and future plans. Refer to Figures 3.17 and 3.18 of Volume B for details of existing ESB infrastructure.

Conflicts between ESB infrastructure and potential Routes are summarised in Table 3.16. Route 6 runs parallel and to the north of the 400kV line in the vicinity of Moys and even though there is no direct conflict this is also included on Table 3.16.

3.6.8.2 Eircom

Eircom infrastructure within the Study Area consists of overhead lines along the existing road network with some underground cables in the urban areas of O'Briensbridge and Killaloe/Ballina. There is also a fibre optic cable commencing in Killaloe, which crosses Killaloe Bridge to Ballina and follows the R494 southwards towards Birdhill.

The cost of dealing with Eircom conflicts will largely depend on whether the cable in question is copper or fibre optic, the latter being more expensive. It will be necessary to liaise closely with Eircom staff during the Preliminary Design Stage, regarding existing facilities and future plans. Refer to Figures 3.17 and 3.18 of Volume B for details of existing Eircom infrastructure.

Conflicts between Eircom infrastructure and potential Routes are summarised in Table 3.16.

3.6.8.3 Esat Telecom

There is no Esat Telecom plant in the vicinity of the Study Area.

3.6.8.4 Bord Gáis

There is a 250mm diameter Bord Gáis distribution main in the R494 carriageway between Ballina and Birdhill. The distribution network crosses the River Shannon approximately 600m south of the existing Killaloe Bridge. This crossing feeds a 90mm diameter network in Killaloe and a 90mm diameter branch running southbound along the R463.

There are no Bord Gáis transmission mains in the vicinity of the Study Area.

It will be necessary to liaise closely with Bord Gáis staff during the Preliminary Design Stage, regarding existing facilities and future plans. Refer to Figures 3.17 and 3.18 of Volume B for details of existing Bord Gáis infrastructure.

Conflicts between Bord Gáis infrastructure and potential Routes are summarised in Table 3.16.

3.6.8.5 Water and Sanitary Services

Clare County Council's water services network within the Study Area is concentrated in the urban areas of Killaloe and O'Briensbridge with a connecting main running along the length of the R463. The public sewers in Killaloe feed into the sewage treatment plant in Ballina on the opposite side of the River Shannon.

Limerick County Council has a network of water mains in the area surrounding Montpelier. There is currently no public sewerage system in Montpelier although one is currently being planned for O'Briensbridge/Montpelier. Treatment and disposal of wastewater from existing development is dependant for the most part on individual septic tank systems. There is one communal septic tank in Montpelier, which serves the Church, community hall and the housing estate (14 houses) immediately behind.

North Tipperary County Council's water services network within the Study Area is concentrated in the urban areas of Ballina and Birdhill with a connecting main running along the length of the R494. There is also a water main running along the R466 from Birdhill, which continues to Montpelier. The Ballina Sewage Treatment Plant is located in the town of Ballina.

It will be necessary to liaise closely with local authority staff during the Preliminary Design Stage, regarding existing facilities and future plans. Refer to Figures 3.17 and 3.18 of Volume B for details of existing Local Authority water and sanitary services infrastructure.

Conflicts between Local Authority infrastructure and potential routes are summarised in Table 3.16.

Table 3.16: Conflicts Between Potential Routes and Utilities

Route	Utility Conflicts	
	West of River Shannon	**East of River Shannon**
1	Local Authority watermain	Local Authority watermain
2	Local Authority watermain 10kV overhead ESB line (2 locations)	Local Authority watermain
3	Local Authority watermain 10kV overhead ESB line	Local Authority watermain 10kV overhead ESB line 38kV overhead ESB line
4	Local Authority watermain Eircom Cable 90mm PE Bord Gáis main	Local Authority watermain 10kV overhead ESB line 38kV overhead ESB line Eircom Cable
5	Local Authority watermain Eircom Cable 90mm PE Bord Gáis main	Local Authority watermain 10kV overhead ESB line 250mm PE Bord Gáis main
6	Local Authority watermain 90mm PE Bord Gáis main 10kV overhead ESB line 400kV overhead ESB line	Local Authority watermain Eircom Fibre Optic Cable 250mm PE Bord Gáis main
7a	Local Authority watermain 90mm PE Bord Gáis main 10kV overhead ESB line (2 locations)	Local Authority watermain Eircom Fibre Optic Cable 250mm PE Bord Gais main
7b	Local Authority watermain 90mm PE Bord Gáis main 10kV overhead ESB line (2 locations)	Local Authority watermain Eircom Fibre Optic Cable 250mm PE Bord Gáis main
7c	Local Authority watermain 90mm PE Bord Gáis main 10kV overhead ESB line (2 locations)	Local Authority watermain Eircom Fibre Optic Cable 250mm PE Bord Gáis main

3.6.9 Summary

The following conclusions can be drawn regarding the engineering feasibility of the various routes:-

(a) A single carriageway cross-section is required to cater for the expected traffic flows.

(b) All routes are feasible from an engineering point of view:-

(i) Drainage outfalls are possible for all routes.
(ii) Engineering solutions to geotechnical problems are available for all routes.
(iii) Effects on utilities can be allowed for in design.
(iv) Horizontal and vertical alignments feasible for all routes without departures or relaxations.

Engineering issues relating to the short-listed routes are developed further in Chapters 4 and 5.

3.7 COST ESTIMATES

3.7.1 General

The costs of procurement of each of the routes has been estimated based on the cost of construction and the cost of land acquisition and compensation, and are summarised below. The construction costs have been estimated separately for road works and bridge works. These costs estimated are based on 2005 prices.

Costs associated with the following requirements are not included: -

- Legal fees.
- Administration fees.

3.7.2 Road Works Costs

The road works cost estimate for each route consists of the following components and are summarised in Table 3.17 overleaf. All amounts exclude VAT.

Road Construction

The estimated construction costs relating to the road works elements of the scheme were calculated using a figure of €2,500 per metre run for each route. The road works are similar in nature and cross section for each route considered, and it is therefore considered appropriate to compare each of the routes using a uniform rate for the road works construction. There will be some variation in the quantities of bulk earthworks between the routes, but the difference in costs between routes associated with these variations will be small as a fraction of the total cost of the route and will not affect the route selection.

The figure includes for the following items:-

- Preliminaries.
- Site Clearance.
- Fencing.
- Safety Fencing.
- Drainage.
- Earthworks.
- Pavement.
- Signing & Lining.
- Junctions.
- Minor Road Realignments.
- Environmental (Noise) Barriers.
- Landscaping.
- Archaeology.
- Accommodation Works.
- Service Diversions/Utilities.
- Public Lighting.

The estimated road construction costs for each route are included in Table 3.17 overleaf.

Ground Improvements

Ground improvement costs have been included for Route 1 where a significant requirement exists, refer to Section 5.4.2. No significant requirements have been identified for the other routes.

The estimated ground improvement costs are included in Table 3.17 overleaf.

Causeways

The cost of construction of the causeways for Routes 4 and 5 has been estimated based on a calculated quantity of rock fill to the causeways priced at an all-inclusive rate of €20 per cubic metre. The cost so calculated does not include the cost of the road construction on the causeway, which has been separately measured and included in the cost for road construction.

The estimated costs of the causeways are included in Table 3.17 overleaf.

Land Acquisition

Paddy Browne and Co. Real Estate Alliance have produced preliminary estimates of the expected costs associated with land acquisition and compensation for each of the routes considered. It should be noted that the rates used are based on property values and compensation rates applicable to the category of properties affected, rather than on individual valuations applicable to the specific properties affected.

The land costs are in respect of properties to be wholly or partly acquired and include for the following items as and where appropriate: -

- Property valuation.
- Injurious affection.
- Severance.
- Disturbance.

The estimated land costs for each route are included in Table 3.17 below.

Table 3.17: Road Works Cost Estimate

Route	Road Works (€)
1	3,749,000
2	3,026,000
3	3,653,000
4	7,778,000
5	9,435,500
6	2,997,000
7a	4,980,000
7b	4,770,000
7c	4,632,000

3.7.3 Bridges Costs

The estimated costs relating to the bridges included in the routes, i.e. the crossing of the Shannon River, the Headrace Canal and R463 as appropriate, have been calculated using a figure of €2,500 per m² of bridge deck for each route. At this stage the form of the bridges has not been selected for any of the routes and thus a detailed cost estimate for a particular structure cannot be made. The proposed figure however is a reliable estimate of construction cost for the type of bridges, which would be appropriate in these circumstances and is based on the costs of several recently completed structures. The figure used is exclusive of VAT and includes for:-

- Preliminaries.
- Foundations.
- All structural members.
- Finishes and furniture.
- Surfacing.

The estimated costs for the bridges are shown in Table 3.18 overleaf.

Table 3.18: Bridges Cost Estimate

Route	BRIDGES				
	Length (m)	Width (m)	Cost (€/m^2)	Subtotal (€)	Total (€)
1	60	11.5	2500	1,725,000	**5,175,000**
	120	11.5	2500	3,450,000	
2	20	11.5	2500	575,000	**6,900,000**
	106	11.5	2500	3,047,500	
	114	11.5	2500	3,277,500	
3	106	11.5	2500	3,047,500	**6,842,500**
	132	11.5	2500	3,795,000	
4	200	11.5	2500	5,750,000	**5,750,000**
5	200	11.5	2500	5,750,000	**5,750,000**
6	272	11.5	2500	7,820,000	**7,820,000**
7a	182	11.5	2500	5,232,500	**5,232,500**
7b	170	11.5	2500	4,887,500	**4,887,500**
7c	166	11.5	2500	4,772,500	**4,772,500**

3.7.4 Overall Costs

The total of the costs as considered above for each of the routes under consideration are summarised in Table 3.19 below. Costs shown for road works include for ground improvement, causeways and land acquisition as discussed above. The miscellaneous costs shown in Table 3.19 include for design fees, supervision fees and contingencies.

Table 3.19: Overall Cost Estimate

Route	Roadworks €	Bridges €	Miscellaneous Costs €	Total (excl. VAT) €	VAT €	Total (incl. VAT) €
1	3,749,000	5,175,000	1,753,500	10,677,500	1,345,185	**12,022,685**
2	3,026,000	6,900,000	1,900,500	11,826,500	1,457,955	**13,284,455**
3	3,653,000	6,842,500	2,073,225	12,568,725	1,590,460	**14,159,185**
4	7,778,000	5,750,000	2,676,030	16,204,030	2,052,897	**18,256,927**
5	9,435,500	5,750,000	3,016,755	18,202,255	2,314,282	**20,516,537**
6	2,997,000	7,820,000	2,071,650	12,888,650	1,589,252	**14,477,902**
7a	4,980,000	5,232,500	1,481,025	11,693,525	1,136,158	**12,829,683**
7b	4,770,000	4,887,500	1,404,375	11,061,875	1,077,356	**12,139,231**
7c	4,632,000	4,772,500	1,382,325	10,786,825	1,060,441	**11,847,266**

3.8 COMPARATIVE ECONOMIC APPRAISAL

3.8.1 Benefit Cost Ratios

Although it is anticipated that a full cost benefit analysis based on COBA 11 will be undertaken for the emerging preferred route at the EIS stage, a comparative assessment of the relative "value for money" of each scheme has been undertaken based on the preliminary cost estimates and the network wide user benefits output from the SATURN traffic model. The method adopted is based on the following:-

- Capital costs of each scheme are as set out in Table 3.19.
- The total distance travelled during the AM peak hour for all vehicles is extracted from the SATURN model for each scenario for years 2007 and 2022. Values for intermediate years were determined for each route by interpolation.
- The total time travelled during the AM peak hour for all vehicles is extracted from the SATURN model for each scenario for years 2007 and 2022. Again, values for intermediate years are determined for each route by interpolation.
- AM peak hour time and distance savings for each year are determined for each route by comparison to the do-nothing network statistics.
- Values of time (VOT) and vehicle operating costs (VOC) are applied to convert AM peak hour time savings and savings in distance travelled on the network to monetary values. Values used are: VOT = € 15.5/hr and VOC = € 0.59/km.
- AM peak hour savings for each route are converted to daily values by factoring by 9.46 (see Section 3.5.3.2).
- Daily values are factored by 250 to produce an annual figure.
- Annual savings throughout the 15 year (2007-2022) assessment period are discounted at a rate of 5% per annum back to 2005 prices.
- The present value of benefits (PVB) of each route is an addition of the discounted benefits over the 15-year period.
- All land acquisition costs are assumed to be incurred in year 1, with all other construction costs split as follows: year 1 (2007) = 47%, year 2 = 50% and year 3 = 3%.
- All land acquisition and construction costs are discounted back to 2005 prices at a rate of 5%.
- The present value of costs (PVC) for each scheme is an addition of the discounted costs.
- The net present value (NPV) of each route is determined by subtracting the PVC from the PVB.
- The benefit to cost ratio of each route is the PVB/PVC.

The results of the comparative benefit cost analysis are shown in Table 3.20. As previously noted, each of the Routes 7 are equal from a traffic point of view and no differentiation has been made in the traffic model. The benefit cost analysis reveals that: -

- All routes, except Route 1,are forecast to have a benefit to cost ratio of 1.0 or over.
- Route 7 (a, b, or c) will provide the best value for money with an average NPV of €68.5m and an average B/C ratio of 7.6, followed by Route 6 with an NPV of €60m approx. and a B/C ratio of 6. B/C ratios of this magnitude indicate that a project is extremely viable.

Table 3.20: Results of Comparative Benefit Cost Analysis

Route	PV Costs € m	PV Benefits € m	NPV Scheme € m	B/C Ratio
1	-9.91	7.13	-2.79	0.72
2	-10.99	23.88	12.90	2.17
3	-11.67	31.9	20.24	2.73
4	-15.04	47.56	32.51	3.16
5	-16.9	68.4	51.51	4.05
6	-11.97	72.35	60.38	6.04
7a	-10.92	78.98	68.06	7.23
7b	-10.33	78.98	68.65	7.65
7c	-10.07	78.98	68.91	7.84

It should be noted that the value of the benefits as calculated above only include the monetary value of benefits accruing to the road user in terms of VOC and VOT as described previously. The calculated values do not include benefits due to enhanced road safety. The other benefits accruing to the community in general, as a result of the provision of the new route, are not included and would serve to increase the PVB and consequently the B/C ratio. Similarly, the costs as calculated above include for land take and construction costs only, and do not include for any non-monetary costs such as environmental impacts.

3.8.2 Preferred Routes in Traffic Terms

Based on the traffic assessment presented above it is clear that Routes 7, followed by Route 6, are the best of all routes examined in terms of traffic and value for money: -

- Route 7, followed by Route 6 was found to perform best in terms of time and cost savings for road users.
- Route 7, followed by Route 6 was established to attract the most cross river traffic.
- Route 7, followed by Route 6 was found to have the highest NPV and benefit/cost ratio.

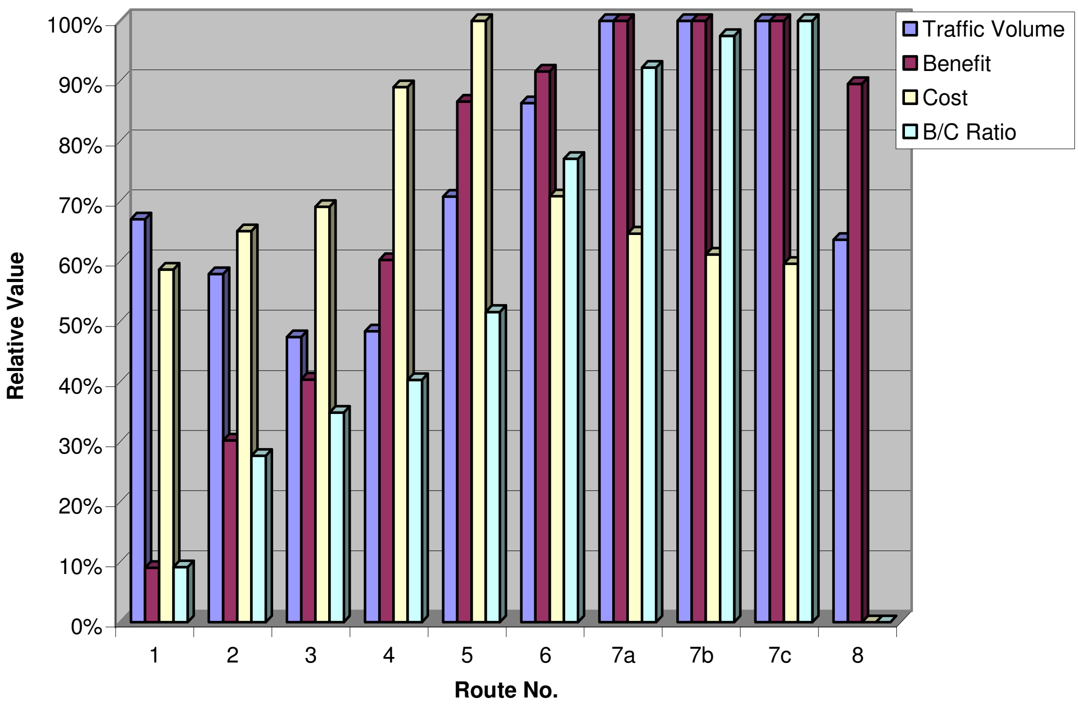
3.8.3 Summary

For each of the routes under consideration, the procurement cost as set out in Section 3.7.5 and the benefit amounts and benefit/cost ratios as described in Section 3.8.1 are given in absolute amounts. These amounts are shown graphically in Figure 3.19 below as relative amounts for comparative purposes.

In addition, the traffic volumes expected to use the routes, in terms of AADT of PCU's for the year 2022 as shown in Table 3.14 are also shown for comparative purposes.

For each item, the graph shows the relative value for each route, with the maximum value being 100% in each case.

Fig. 3.19 Relative Benefits and Costs for Routes



The following economic issues are noted as important for these routes: -

- Route 1 is the cheapest of all the routes considered.
- Routes 4 and 5 are the most expensive of all the routes considered.
- Traffic demand is the maximum for Routes 7 followed by Route 6, the routes nearest Killaloe/Ballina.
- Traffic demand is high for Route 1 near O'Briensbridge/Montpelier, ranking third in 2007 and fourth in 2022.
- The benefit to cost ratio is highest for Routes 7, with Route 6 being next best.
- The benefit to cost ratio decreases as the route option moves further south from Killaloe/Ballina.
- The benefit to cost ratio is lowest for Route 1, but refer also to Section 5.3.1 of Chapter 5.

3.9 CONCLUSIONS

Following evaluation of each of the routes, Routes 2, 3, 4, 5 and 8 were eliminated from further consideration for the following reasons:-

(i) Traffic volumes for Routes 2, 3, 4, 5 and 8 are the lowest of all routes considered, although Route 5 does exceed Route 1 in 2022. These routes thus remove less traffic from the existing bridges and are less effective in meeting the objectives of the scheme.

(ii) Routes 4 and 5 are significantly more expensive than the others and offer relatively low benefit. Reference to the AADT volumes as shown in Figures 3.12 and 3.14 show that these routes offer minimal relief to Killaloe in the short term, and volumes would equal current volumes prior to 2022. Although these routes offer some limited relief to O'Briensbridge in the short term, volumes would exceed current volumes prior to 2022. Furthermore, Routes 4 and 5 would cost 74% and 84% respectively of the total cost of providing both Routes 1 and 7, a solution which would provide maximum relief to the existing bridges at both Killaloe and O'Briensbridge.

(iii) Construction of Routes 4 or 5 would, in practice, permanently preclude providing the optimum solution, which is to provide an alternative crossing close to each of the existing crossings.

(iv) Routes 2 and 3, while similar in cost to Routes 6 and 7, yield significantly less benefits overall than Routes 6 or 7, and provide no relief to the critical problems being experienced in Killaloe/Ballina.

(v) The tie-in of Route 2 to the R463 is geometrically undesirable and requires an additional bridge over the R463 and a loop due to the proximity of the Headrace Canal to the tie-in.

(vi) Routes 2, 3, 4, and to some extent Route 5, require construction of a bridge abutment at a flood retention berm which is undesirable.

(vii) It would be extremely problematical to determine an alignment for Route 8 due to the built-up nature of the area through which it would pass, and would involve very high land acquisition costs. This is clearly not warranted as the traffic model shows Route 8 has less traffic demand and benefit in comparison to Routes 6 and 7.

(viii) There is no single route, which would effectively relieve existing traffic problems at both O'Briensbridge/Montpelier and at Killaloe/Ballina.

In relation to the remaining routes, i.e. Routes 1, 6, 7a, 7b and 7c, it was concluded that: -

(i) The construction of Route 6 or 7 will do very little to alleviate the congestion on the bridges at O'Briensbridge/Montpelier. Conversely the construction of Route 1 will do nothing to alleviate the congestion at Killaloe/Ballina.

(ii) Routes 6 and 7 offer significantly greater benefits than Route 1, and thus the selection process should focus on these routes.

(iii) Routes 6 and 7 should be investigated in greater detail from both an engineering and environmental point of view in order to select one of these routes as the preferred route for this project.

(iv) As Routes 6 or 7 would provide minimal relief to the problems being experienced in O'Briensbridge/Montpelier, Route 1 should be investigated in greater detail from both an engineering and environmental point of view, with a view to recommending an additional crossing at this location.

Following from the above, further investigations have been undertaken at Routes 1, 6 and 7 to determine the feasibility of these routes and to determine the preferred route, and are reported on in Chapter 4. Factors affecting the recommendation of an additional crossing at Route 1 are reported on in Chapter 5. The short listed routes (Routes 1, 6, 7a, 7b and 7c) can be seen on Figure 3.20 of Volume B.

4 ROUTE OPTIONS SHORTLIST

4.1 ENVIRONMENTAL ISSUES

4.1.1 Ecology

4.1.1.1 Terrestrial Ecology

4.1.1.1.1 Introduction

This section provides an assessment of the impact of each of the short-listed routes on features of ecological importance. Statutory designated sites; legally protected habitats, flora and fauna; and other features of ecological value are considered, and the relative impacts of each route are compared.

Five potential routes are considered: Route 1, Route 6, Route 7a, Route 7b and Route 7c. All involve a bridge across the River Shannon and associated feeder/access roads. Route 1 also includes a bridge across the Headrace Canal.

4.1.1.1.2 Methodology

A desktop study was undertaken in order to identify sites, species and habitats of ecological / nature conservation interest in the vicinity of the site.

A walkover survey of the routes was carried out on 29th and 30th August 2005. All land holdings, through which any of the potential routes pass, were surveyed, with the exception of land parcel 10198F, which was viewed from the adjacent property and a partial assessment of the ecological value of the site was made. In addition, land parcels adjacent to those that would be directly impacted by the various proposed routes were examined where possible, and any features of ecological interest were noted.

Habitats within the route corridors were assessed as to their likely importance for birds, mammals and other protected species of fauna, and any birds; signs of mammal activity or other signs of the presence of these species were noted.

In preparing this assessment, all the studies were carried out with reference, as applicable, to the appropriate guidelines, such as the National Roads Authority's *National Roads Project Management Guidelines* (March 2001), and *Guidelines for Assessment of Ecological Impacts of National Road Schemes* (2004); Environmental Protection Agency's (EPA) *Guidelines on the Information to be Contained in Environmental Impact Statements* (2002), the UK Highways Agency's '*Design Manual for Roads and Bridges'*, (DMRB 1997, 2001) and the Institute of Environmental Assessment's *Guidelines for Baseline Ecological Assessment* (1995), and using our experience of 'best practice' in the ecological assessment of road schemes.

Scientific names of plants and animal species mentioned in the text are presented in Appendix B of Volume C.

4.1.1.1.3 Existing Environment

DESIGNATED SITES

Lower River Shannon Candidate Special Area of Conservation (cSAC)

All of the proposed alternatives lie, at least partially, within the Lower River Shannon candidate Special Area of Conservation (cSAC) (site code 2165). cSACs are protected under the European Union (EU) Habitats Directive (92/43/EEC), as implemented in Ireland by the European Communities (Natural Habitats) Regulations, 1997.

The Lower River Shannon cSAC is a very large site, stretching from Loop Head at the mouth of the Shannon Estuary upstream to Killaloe, and also including the River Fergus estuary in Co. Clare. The site is designated on the basis of a number of Annex I habitats and Annex II species. Annex I habitats include priority habitats such as lagoons, mudflats, Atlantic salt meadows and old oak woodlands.

The cSAC supports a number of plant species protected under the Flora Protection Order (1999); Triangular Club-rush, Opposite-leaved Pondweed, Meadow Barley, Hairy Violet and Golden Dock. Two Red Data Book stonewort species occur in Shannon Airport Lagoon; Bearded Stonewort and Convergent Stonewort.

The Shannon and Fergus Estuaries support the largest number of wintering waterfowl of any site in Ireland, and the site supports several breeding bird species listed under Annex I of the EU Birds Directive; Peregrine, Sandwich Tern, Common Tern, Chough and Kingfisher.

There is a resident population of bottle-nosed dolphin, an EU Habitats Directive Annex II species in the Shannon Estuary, and other Annex II species include otter; the fish species, sea lamprey, river lamprey, brook lamprey, twaite shad and Atlantic salmon; and freshwater pearl-mussel.

The full National Parks and Wildlife Service (NPWS) site synopsis for the site is presented in Appendix C of Volume C.

None of the Annex I habitats for which the cSAC is designated were found at any of the proposed crossings during the field survey.

A number of Habitats Directive Annex II species, and Birds Directive Annex I species are likely to occur at all of the potential crossings, these include Kingfisher and Otter (see Section on Fauna below).

Requirements of the Habitats Directive

The ‘Habitats Directive’ was transposed into Irish law by the European Communities (Natural Habitats) Regulations, 1997 (S.I. No. 94 of 1997).

Article 6 of the 'Habitats Directive' sets out provisions that govern the conservation of Natura 2000 sites. The European Commission has produced an Interpretation Document for Article 6 (EU, 2000). While not legally binding, this document can be regarded as reflecting the views of the Commission.

Article 6(3) of the 'Habitats Directive' requires that any plans / projects, such as the proposed Shannon Bridge crossing, which may impact upon a cSAC shall be '*subject to appropriate assessment of its implications for the site in view of the site's conservation objectives*' (EU, 2000). This route assessment fulfils the first step required of the competent authorities; i.e. the examination of '*alternative solution, which better respect the integrity of the site in question*' (EU, 2000). This assessment should be made against the site's conservation objectives.

In general terms, development projects that impact upon cSACs are prohibited unless, in the absence of suitable alternative solutions, it can be demonstrated that there are "*imperative reasons of overriding public interest*". While '*imperative reasons of overriding public interest*' is not defined in the directive, Article 6(4) second subparagraph mentions human health, public safety and beneficial consequences of primary importance for the environment as examples of such imperative reasons of overriding public interests (EU, 2000). The European Union's interpretative document '*Managing Natura 2000 Sites*' (EU, 2000) states "*So far the European Court of Justice has not given clear indications for the interpretation of this specific concept*". Other community law, where similar concepts apply, has tended to interpret the phrase quite broadly, including for example, public health; environmental protection and "*the pursuit of legitimate goals of economic and social policy*". However, the interpretative document also states that "*imperative reasons of overriding public interest*" excludes "*projects that lie entirely in the interest of companies or individuals*".

'Managing Natura 2000 Sites' (EU, 2000) summarises the interpretation of *'imperative reasons of overriding public interest'* as follows: -

- *It is reasonable to consider that the 'imperative reasons of overriding public interest, including those of a social and economic nature' refer to situations where plans or projects envisaged prove to be indispensable:*
  - *within the framework of actions or policies aiming to protect fundamental values for citizen's lives (health, safety, environment);*
  - *within the framework of fundamental policies for the State and society;*
  - *within the framework of carrying out activities of an economic or social nature, fulfilling specific obligations of public service.*

Other Designated Sites

The *Guidelines for Assessment of Ecological Impacts of National Road Schemes* (2004) states that the Route Corridor Selection Study should include details and descriptions of designated conservation areas '…*along or in close proximity to any of the route options…*'

Whilst it is not anticipated that any of the Routes will have any negative impacts on any other designated sites, Table 4.1 gives details of other designated sites within 5km of any of the Routes.

Table 4.1: Other Designated Sites Within 5 km of Any of the Routes

NPWS Site Name	NPWS Site Code	Details	Distance and Direction from the Routes
Glenomra Wood cSAC / pNHA	1013	Birch and Sessile Oak woodland, corresponding to the Habitats Directive Annex I habitat 'old oak woodland'. The site also supports the Red Data Book mammals badger, pine marten and Irish hare.	4.1km west of Route 1
Slieve Bernagh Bog cSAC	2312	An upland area. NPWS Site Synopsis not available.	3.6km northwest of Routes 7a, 7b and 7c
Lough Derg pNHA	0011	One of the major freshwater lakes in Ireland. Supports five EU Habitats Directive Annex I habitats; a number of Red Data Book and Flora (Protection) Order plant species; and Habitats Directive Annex II fauna species.	Less than 1km north of Route 7c
Lough Derg (Shannon) SPA	4058	Supports the Annex 1 bird species Bewick's Swan, Whooper Swan, Greenland White-fronted Goose, Golden Plover, common Tern, Kingfisher and Hen Harrier (MacLochlainn *et. al.,* 2002). NPWS site Synopsis not available.	2.2km north of Routes 7a, 7b and 7c

Candidate Special Areas of Conservation (cSAC) are protected under the Habitats Directive (92/43/EEC), as implemented in Ireland by the European Communities (Natural Habitats) Regulations, 1997 (Hickie, 1997). Special Protection Areas (SPAs) are protected under the EU Habitats Directive, which complements EU Birds Directive 79/409/EEC, The Directive on the Conservation of Wild Birds ('The Birds Directive'), under which the SPA's were initially established. Whilst the Wildlife (Amendment) Act 2000, under which proposed Natural Heritage Areas (pNHAs) are protected, has been passed into law, the pNHAs will not have statutory recognition until the consultative process with landowners has been completed.

HABITATS

Areas of Ecological Constraint

During the field visit to the site, a preliminary habitat survey was undertaken along each of the proposed route corridors. A review of aerial photographs was also carried out to assist with the identification of semi-natural habitats. Where land parcels of semi-natural habitat were encountered, these were classified according to '*A Guide to Habitats in Ireland*' published by the Heritage Council (Fossitt, 2000). Areas of ecologically valuable, semi-natural, habitat identified during this process were classified as Areas of Ecological Constraint (AECs). The locations of these AECs are illustrated in Figures 4.1 and 4.2 of Volume B. Codes included in the text refer to Heritage Council habitat codes (Fossit, 2000).

The term "AEC" should not be taken to imply that these sites have any formal designation, but is a term used in this assessment for ease of description.

The ecological value of each AEC was evaluated according to the Site Evaluation Scheme described in Appendix 3 of *Guidelines for Assessment of Ecological Impacts of National Road Schemes* (NRA 2004), on the following scale of importance: -

- Internationally Important,
- Nationally Important,
- High Value, Locally Important,
- Moderate Value, Locally Important and,
- Low Value, Locally Important.

For a full explanation of the criteria used in this assessment see Appendix D of Volume C.

According to these criteria, a significant portion of each Route passes through sites of International Importance as they are designated as part of the Lower River Shannon cSAC. However, for the purposes of the habitats section below, the habitats are also assessed in their own right as to their ecological value.

The significance of impacts on the AECs was assessed according to the Criteria for Assessing Impact Significance described in Appendix 4 of *Guidelines for Assessment of Ecological Impacts of National Road Schemes* (NRA 2004). Impacts on features of less than **Low Value, Locally Important** are not considered to be potentially significant. The terminology used to define impact significance is described in Appendix D of Volume C.

AEC 1 Alder Woodland at Killaloe

Lying immediately to the west of the 'Killaloe Canal', this site consists of two fragments of Alder dominated woodland. Each of Routes 7a, 7b and 7c pass through one or other of the woodland fragments (see Figure 4.1 of Volume B). The woodlands are dominated by semi-mature Alder, with some waterlogged 'carr' type areas, and some dryer areas where Downy Birch, Grey Willow, Pedunculate Oak and Beech are present. Oak is particularly prominent in the woodland impacted by Route 7a. Most of this AEC lies outside the Lower River Shannon *cSAC, and all three Routes 7a, 7b and 7c pass through the AEC outside the boundary of the cSAC, but the section through which Route 7a passes lies on the boundary of the cSAC.*

Whilst all areas lying within the boundary of an cSAC must be viewed as being ***Internationally Important****, this area in its own right is assessed as being of* ***Moderate Value, Locally Important;*** *as a site "…*containing some semi-natural habitat*…" (NRA, 2004).*

AEC 2 Riparian Woodland on Eastern Bank of the River Shannon

The eastern bank of the River Shannon, to the south of Ballina, has an almost continuous strip of Alder and Willow dominated riparian woodland extending to the south for several kilometres, interrupted only by occasional residential gardens. The woodland varies in width, but is in many sections continuous with other drier woodland types that lie to its east, in discrete blocks. Routes 6, 7a, 7b and 7c all pass thorough this AEC. The riparian woodland at Routes 6, 7a, 7b, and 7c lie within the *Lower River Shannon* cSAC, but some sections of the bank are outside of its boundary. This AEC may not be mapped fully in Figure 4.1 of Volume B, as only the sections adjacent to the Routes was examined in detail, and the precise extent of the riparian woodland elsewhere is not known. The approximate boundary of the AEC has been drawn from aerial photographs.

Whilst all areas lying within the boundary of an cSAC must be viewed as being **Internationally Important**, this area as a whole is assessed as being of **High Value, Locally Important;** as a site containing "*semi-natural habitat types with high biodiversity in a local context and a high degree of naturalness...*" (NRA, 2004).

AEC 3 'Killaloe Canal' Wetland

The canal itself and its western margin comprise an undisturbed wetland habitat of some ecological value. Yellow Iris and Great Sweet-grass are the dominant larger emergent plant species, with Yorkshire Fog, Creeping Bent, Soft Rush, Common Reedmace and other species typical of wet grassland and marsh also present. This area has some potential to support rare plants or invertebrates.

This AEC lies entirely within the *Lower River Shannon* cSAC, and as such must be assessed as being **Internationally Important**. In their own right, the habitats within this AEC are assessed as being "*semi-natural habitat types with high biodiversity in a local context and a high degree of naturalness...*" (NRA, 2004) and are therefore assessed as being of **High Value, Locally Important.**

AEC 4 Moys Woodland

This strip of mature deciduous woodland holds a diverse range of species including Ash, Pedunculate Oak, Sycamore, Holly, Hawthorn, Grey Willow and Horse Chestnut. This area appears highly suitable for red squirrel, badger and bats of several species. In an area close to the line of the route, a swathe has been cut through the woodland to accommodate overhead power cables, which holds dense willow scrub and a hard standing tarmac area. This section of the woodland also holds two large (>20m in height) specimen oaks and other similar trees occur in the parkland area to the east.

This woodland lies mainly outside the boundary of the Lower River Shannon *cSAC. This AEC is assessed as being of* ***Moderate Value, Locally Important;*** *as a site "…*containing some semi-natural habitat*…" (NRA, 2004).*

AEC 5 O'Briensbridge Flood Plane

This is an extensive area of flat river valley grassland within the flood plane of the River Shannon. The site is likely to be part of a very extensive area of similar habitat. Part of the site is grazed by cattle and horses and has a somewhat improved quality. The sward in this area is predominantly grass, with Yorkshire Fog, Crested Dogstail, bents, rye-grasses appear to dominate, with much Creeping Thistle and Creeping Buttercup also present. The area has many hollows and ridges, and some Tufted Hair-grass also present in wetter depressions with Yellow Iris and Creeping Bent. The eastern part of the site is currently ungrazed and consists of tall rank vegetation with Yorkshire Fog, Creeping Bent, cock's-foot and meadow-grasses conspicuous. A high component of herbs includes Meadowsweet, Soft Rush, Sharp-flowered Rush, Devil's-bit Scabious, Creeping Bent, Common Knapweed, Greater Bird's-foot Trefoil and Ribwort Plantain. This area lies partially within the Lower River Shannon *cSAC, and these sections must therefore be viewed as being* ***Internationally Important****. In its own right, the AEC as a whole is assessed as being of* ***Moderate Value, Locally Important;*** *as a site "…*containing some semi-natural habitat*…" (NRA, 2004).*

FLORA

Table 4.2: Rare and Protected Flora Species Recorded by Preston *et. al.* (2000) from the OS National Grid 10km Squares in which the Routes are Located.

Species	R66	R67	Details
Opposite-leaved Pondweed	Not recorded	1970-1986	Flora Protection Order, Red Data Book 'Vulnerable'.
Bird Cherry	Pre-1970	1987-1999	Red Data Book – 'not threatened'
Cowslip	1987-1999	1987-1999	Red Data Book – 'not threatened'
Heath Cudweed	Not recorded	Pre-1970	Red Data Book 'Rare'.
Annual Knawel	1970-1986	Not recorded	Flora Protection Order.

Route 1 lies within Ordnance Survey (OS) National Grid 10km square R66, whilst the other Routes; 6, 7a, 7b and 7c lie within R67.

Opposite-leaved Pondweed has most recently been recorded in Counties Limerick, Laois and Dublin. It occurs in, '*ditches, streams, ponds and canals and on marginal mud in estuaries'* (Curtis and McGough, 1988). Webb *et. al*. (1996) describe the species as occurring in '*rivers and canals; very rare, and apparently declining.*'

Bird Cherry is included in the Irish Red Data Book on the basis of its protected status in Northern Ireland. It is a '*shrub or small tree of woods and damp rocky places'* (Curtis and McGough, 1988). Webb et. al. (1996) describe it as being '*frequent in the North-west, rare elsewhere*.'

Cowslip is included in the Irish Red Data Book on the basis of its protected status in Northern Ireland. It '*occurs frequently in meadows and pastures in central Ireland*.' (Curtis and McGough, 1988).

Heath Cudweed occurs in '*upland pastures and damp sandy places'*, there are recent records only from northern counties (Curtis and McGough, 1988).

Annual Knawel is an annual or biennial the current status of which is unclear in the literature. The species is not listed in the Irish Red Data Book. Webb *et. al.* (1996) state that it has been '*recently discovered on a grassy cliff-top on an island in West Cork'*, but give no further indication of its status or distribution. Preston *et. al.* (2000) give 1987 to 1999 records from one 10km square in Co. Kerry, two in Co. Wexford and five 10km squares in the northern counties.

It is possible that Opposite-leaved Pondweed could occur at any of the Route crossing points. Cowslip could occur in grassland west of the Shannon on Route 6, or east of the Shannon on Route 1 (AEC 5), and these are probably the most likely locations for other rare or noteworthy species of flora to occur.

FAUNA

Protected Mammals Species

Hayden and Harrington (2000) give the distribution of mammal species in Ireland by 20km squares, each of which is composed of four National Grid 10km squares. All of the Routes lie within the 20km square comprising National Grid 10km squares, R66, R67, R76 and R77. Table 4.3 shows the protected mammal species recorded in this 20km square by Hayden and Harrington (2000).

Table 4.3: Protected Mammal Species Recorded from the 20 km Square Within Which the Proposed Development Site is Located, Comprising OS 10 km Grid Squares R66, R67, R76 and R77. Information from Hayden and Harrington (2000)

Species	Indication of Population	Level of Protection
Badger	Found throughout Ireland	Wildlife Act, though exceptions are written into the Act for road building
Brown long-eared bat	Found throughout Ireland	Protected through Wildlife (Amendment) Act 2000. Appendix II of the Bern Convention. Bonn Convention. Annex IV of the EU Habitats Directive. Red Data Book 'Internationally Important'.
Common/soprano pipistrelle	Found throughout Ireland	Both species are protected through Wildlife (Amendment) Act 2000; Appendix III of the Bern Convention; Bonn Convention. Habitats Directive Annex IV.
Daubenton's bat	Scattered throughout Ireland	Irish Red Data Book 'Internationally Important'. Habitats Directive Annex IV. Bern Convention Appendix II.
Fallow deer	Found mainly in central and northern parts of Ireland	Protected under the Wildlife Acts of 1976, but also designated as a quarry species and may be hunted under licence.
Hedgehog	Found throughout Ireland	Appendix III of the Bern Convention
Irish (mountain) hare	Found throughout Ireland	Irish Red Data Book 'Internationally important'. Annex V of the Habitats Directive. Appendix III Bern Convention.
Irish stoat	Found throughout Ireland.	Appendix III of the Bern Convention
Leisler's bat	Found throughout Ireland	Protected through Wildlife (Amendment) Act 2000. Appendix II of the Bern Convention. Bonn Convention. Annex IV of the EU Habitats Directive. Red Data Book 'Internationally Important'.
Lesser horseshoe bat	Restricted to portions of western and south-western Ireland.	Irish Red Data Book 'Internationally important'. Annex IV of the Habitats Directive. Appendix II Bern Convention and Annex II of the Habitats Directive.

Table 4.3 (Continued)

Species	Indication of Population	Level of Protection
Natterer's bat	Distributed widely throughout Ireland	Protected through Wildlife (Amendment) Act 2000. Appendix II of the Bern Convention. Bonn Convention. Annex IV of the EU Habitats Directive. Red Data Book 'Indeterminate'.
Otter	Found throughout Ireland	Annex II and IV of Habitats Directive Appendix III of the Bern Convention.
Pine marten	Found predominantly in western Ireland with scattered sites elsewhere.	Wildlife (Amendment) Act (2000). Bern Convention Appendix III. Irish Red Data Book 'Internationally Important'.
Pygmy shrew	Found throughout Ireland	Appendix III of the Bern Convention
Red deer	Found in the northwest and the southeast portions of the country	Protected under the Wildlife Acts of 1976, but also designated as a quarry species and may be hunted under licence.
Red squirrel	Distributed widely through Ireland	Protected under the Wildlife Act; classified as near threatened in a global context in the 2000 IUCN Red List of Threatened Species
Whiskered bat	Distributed widely through Ireland	Protected through Wildlife (Amendment) Act 2000. Appendix II of the Bern Convention. Bonn Convention. Annex IV of the EU Habitats Directive. Red Data Book 'Indeterminate'.

Field Observations of Mammals, and an Assessment of Mammalian Habitats

Whilst no full mammal survey has been undertaken, mammal signs were searched for at likely locations during the field visit, 29th and 30th August 2005, and the habitats encountered were assessed as to their suitability to support rare or protected mammal species. Details are presented below.

Badger

During the course of the field survey on August 29th and 30th, 2005, a number of tracks and signs of badger were observed. Fresh footprints were evident at the extreme western end of Route 6, and highly suitable habitat for this species is located between the western end of Route 6 and the 'Killaloe Canal' and River Shannon. The woodland to the east of the River Shannon at Route 6 also held some evidence of badger activity in the form of a fairly well used path.

The habitats to the east of the Shannon in the vicinity of Route 1 appear to provide highly suitable feeding habitat for badger, but no evidence of their presence was recorded. Areas between the River Shannon and the Headrace Canal; and to the east of the River Shannon, at Route 1 also provide suitable habitat for this species and have steep scrub and woodland covered banks in the vicinity that could support setts.

Badger foraging activity and paths were found to the west of the River Shannon and 'Killaloe Canal', at a point traversed by Routes 7a, 7b and 7c. Much suitable habitat for badger is present in this area.

Otter

Whilst no direct evidence for the presence of otters was found during the course of the field survey; there is highly suitable habitat for this species at all the points where the various route options cross watercourses such as the River Shannon, and this species is undoubtedly present throughout the area.

Red Squirrel

Highly suitable habitat for this species is found in the vicinity of Shantraud, Moys and Clarisford, to the west of the River Shannon close to Routes 6, 7a, 7b and 7c. Areas of woodland habitat to the east of the Shannon at Routes 7a, 7b, 7c and 6, and to the west of the Headrace Canal at Route 1 may also be suitable for this species.

Bats

Whilst it is highly likely that bats are present on all sections of all of the routes, the woodland and wetland habitats to the west of the River Shannon at Route 6 and, to a lesser extent, at Routes 7a, 7b and 7c, appear highly suitable to support good populations of bats of a number of species. The pastureland, hedgerows and treelines to the east of the Shannon at Route 1 also appear to provide good quality foraging habitat for bats, although roosting opportunities appear rather limited in this area.

Pine Marten

Suitable habitat for this species is present in the vicinity of Shantraud, Moys and Clarisford, to the west of the River Shannon close to Routes 6, 7a, 7b and 7c. Areas of woodland habitat to the east of the Shannon at Routes 6, 7a, 7b, and 7c, and to the west of the Headrace Canal at Route 1 may also be suitable for this species.

Red Deer, Fallow Deer

No highly suitable habitat for deer is present at any of the Routes, however sub-optimal habitat for fallow deer is present at all of the Routes and it is possible that this species may be present.

Other Mammal Species

Of the other mammal species listed in Table 4.3, suitable habitat for Irish hare is present to the east of the River Shannon at Route 1, and to the west of the River Shannon at Route 6, and possibly also at Routes 7a, 7b and 7c. Suitable habitat for Irish Stoat, pygmy shrew and hedgehog is present along the length of all of the Routes, and it is likely that these species occur.

Bird Species of High Conservation Concern – Desktop Review

Gibbons *et. al*. (1993) give the distribution of breeding bird species by 10km OS National Grid Squares. Table 4.4 shows the species of high conservation concern recorded breeding in 10km National Grid Squares R66 and R67. The species included are those listed either on the 'Red List' by Newton *et. al*. (2000), as being of high conservation concern in Ireland; listed in the Irish Red Data Book (Whilde, 1993) or listed under Appendix 1 of the EU 'Birds Directive'.

Table 4.4: Bird Species of High Conservation Concern Recorded in OS 10 km Square R66 and R67 by Gibbons *et. al*. (1993)

Species	Status Within R66	Status Within R66	Conservation Status
Curlew	Possible Breeding	Not Recorded	'Red list'
Corncrake	Possible Breeding	Not Recorded	'Red list' ; Annex I of the EU Birds Directive and Red Data Book 'Endangered'.
Lapwing	Possible Breeding	Breeding	'Red list'
Barn Owl	Breeding	Not Recorded	'Red list' and Red Data Book 'Indeterminate'.

Route 1 lies within Ordnance Survey (OS) National Grid 10km square R66, whilst the other Routes; 6, 7a, 7b and 7c lie within R67.

The breeding distribution of Peregrine, a species listed under Annex 1 of the EU Habitats Directive, is shown in Gibbons *et. al*. (1993) by 50km Squares rather than by 10km Squares for confidentiality reasons, as this species is highly vulnerable to human persecution. Peregrine was recorded as confirmed breeding within the 50km square in which the proposed Routes are located.

Whilst the flood plain of the River Shannon may provide potentially suitable breeding habitat for all of the four species listed in Table 4.4, the habitats currently present at the route options are unlikely to be suitable for Curlew or Corncrake.

The habitats to the east of the River Shannon at Route 1 could provide potentially suitable breeding habitat for Lapwing, but the level of disturbance in this area is probably too high for this species to attempt to breed here.

The habitat to the east of the River Shannon at Route 1 appears suitable for breeding Barn Owl and it is possible that this species is present here. The habitat to the west of the Shannon at Route 6 may also be suitable for Barn Owl.

Field Observations of Birds

Whilst no full breeding bird survey has been undertaken, mammal signs were searched for at likely locations during the field visit, 29th and 30th August, and the habitats encountered were assessed as to the breeding bird communities they would support during the breeding season. A number of birds of high conservation concern, or of limited range in Ireland, were observed. Details are presented below.

Kingfisher

This species is listed under Annex 1 of the EU Birds Directive. Two birds flew south together along the 'Killaloe Canal' at the point where it is crossed by Route 7a on the 30th August, 2005. One bird flew south along the River Shannon where it is crossed by Routes 7a, 7b and 7c on the 30th August, 2005. One bird was present on the River Shannon where it is crossed by Route 6 on the 29th August, 2005. Despite the fact that it was not recorded as a breeding species in either 10 km square R66 or R67 by Gibbons *et. al.* (1993) (see Table 4.4), this area, to the south of Killaloe, provides high quality breeding habitat for Kingfisher, and the large number of sightings probably reflects a relatively dense population of Kingfishers in this area. The River Shannon and Headrace Canal where they are crossed by Route 1 also provide high quality habitat for Kingfisher, although suitable nesting banks are not in evidence in the immediate vicinity of Route 1.

Jay

This species, which as a breeding bird is restricted to mature woodland with oak, was present in the vicinity of Clarisford and Moys, in the vicinity of Route 6, and in the area between Route 6 and Route 7a.

Great Crested Grebe

This species, which has a sparsely scattered breeding distribution in Ireland, was recorded on the western shore of the River Shannon, immediately south of the location of Route 6, where a pair with a brood of recently fledged, dependent, juveniles were seen.

Other Bird Species

None of the habitats present at any of the routes is considered likely to support bird species of high conservation concern other than those discussed above. All of the Routes include areas of woodland, open country, and it is likely that all support a relatively rich lowland bird community. The habitats along Route 6 are the most varied, and include areas of wetland and mature woodland. This Route is therefore likely to support a greater diversity of species than other Routes. In addition to the species discussed above, Little Grebe and Mute Swan were recorded, and the woodland areas are suitable for specialist woodland species such as Blackcap and Treecreeper to breed.

Other Fauna

Aquatic species such as fish and freshwater invertebrates are beyond the scope of this report, however, in general terms it can be stated that River Shannon is likely to be of importance to a large number of rare and protected aquatic species at all of the Route crossing points, as reflected by its designation as a candidate Special Area of Conservation.

4.1.1.1.4 Route Option Assessment

DESIGNATED SITES

Impact Significance

As far as is currently known, all of the routes have a similar impact on the *Lower River Shannon* cSAC. The significance of this impact depends upon:-

a) Whether a large part of the site, or a small part of the site is affected;
b) Whether the impact is temporary or permanent.

Any of the routes will affect only a small part of this very large cSAC; the significance of the impact will therefore be determined by whether it is viewed as temporary or permanent. If impacts are viewed as permanent, this constitutes a **Severe Negative Impact;** if viewed as temporary, this constitutes a **Moderate Negative Impact** (NRA, 2004).

Whether or not construction of any of the proposed routes will result in significant permanent impacts is not currently known, but there is no reason to suppose that any of the route options is more likely than any another to result in such an impact. Hence, the impacts of all routes on the Lower River Shannon cSAC are assessed as being similar, as **at least Moderate Negative Impacts.** This assessment will increase to **Severe Negative Impacts** should any significant permanent impacts upon the habitats and species for which the cSAC was designated be identified.

Quantified Impact in Terms of Route Length within the Lower River Shannon cSAC

The total length (and therefore land area) impacted within the cSAC boundary will be highest (704m length) for Route 6, followed by Route 1 (519m length). The three remaining routes have similar lengths within the cSAC to one another, (between 184m and 220m length), refer to Table 4.5.

A large part of each route will, however take the form of a bridge, and in these sections there will be very limited impact on the cSAC following construction. Hence, the lengths of each route that run over land surfaces have been measured. On this basis, the impact within the cSAC would be most serious for Routes 1 and 6, which have a similar impact to one another (between 420m and 430m length), and very substantially less for Routes 7a, 7b and 7c (between 35m and 65m length).

Table 4.5: Total Lengths of Each Route Lying Within the Lower River Shannon cSAC and Lengths of Each Route Running Over Land and Over Water

Route	Length Within the cSAC Over Land	Length Within the cSAC Over Water	Total Length Within the cSAC
1	428m	91m	519m
6	423m	271m	704m
7a	65m	155m	220m
7b	48m	141m	189m
7c	35m	149m	184m

Hence, in terms of the impact of direct land-take within the *Lower River Shannon* cSAC, Routes 7a, 7b and 7c are significantly preferable to Routes 1 and 6. Route 6 being the least preferable. Route 7c is preferable to 7b, which is preferable to 7a, but these preferences are relatively marginal, based on a difference in land take of only some 30m (length).

AREAS OF ECOLOGICAL CONSTRAINT

Impact Assessment

The impact of each Route upon each AEC is presented in Table 4.6, according to the criteria outlined in Appendix 4 of *Guidelines for Assessment of Ecological Impacts of National Road Schemes* (NRA 2004).

Table 4.6: Significance of Impacts of Routes on AECs

Route	AEC 1 (Moderate Value)	AEC 2 (High Value)	AEC 3 (High Value)	AEC 4 (Moderate Value)	AEC 5 (Moderate Value)
1	None	None	None	None	**Moderate**
6	None	**Moderate**	**Moderate**	**Minor**	None
7a	**Moderate**	**Moderate**	None	None	None
7b	**Moderate**	**Moderate**	None	None	None
7c	**Moderate**	**Moderate**	None	None	None

Hence, on this basis, Route 6 has the most significant impact on AECs, followed by Routes 7a, 7b and 7c which are similar; and Route 1 which has the least Impact.

Quantified Impact in Terms of Route Length Within the AECs

Route 7c passes through the shortest length of AEC, followed by Route 6; Route 7a, Route 7b and Route 1. On this basis Route 1 is least favoured, but the situation is complicated by the fact that the AEC through which Route 1 passes is of significantly lower ecological value than some of those impacted by the other Routes.

Hence, two separate assessments are presented in Table 4.7; one for AECs of High Value, Locally Important, and one for AECs of Moderate Value, Locally Important.

For AECs of High Value, Route 1 has no direct impact and is therefore preferable, followed by Routes 7a, 7b and 7c, all of which have a very similar impacts; and Route 6, which is least preferable.

For AECs of Moderate Value, Route 6 is marginally preferable to Route 7c, followed by Route 7b, Route 7a and finally Route 1, which is significantly less preferable with respect to sites of Moderate Value.

Table 4.7: Approximate Lengths of Routes within AECs

Route	Moderate Value, Locally Important[1]	High Value, Locally Important[1]	Total
1	550m (AEC 5)	0m	550m (one AEC)
6	70m (AEC 4)	41m (14m in AEC 2; 27m in AEC 3)	111m (three AECs)
7a	136m (AEC 1)	18m (AEC 2)	154m (two AECs)
7b	120m (AEC 1)	20m (AEC 2)	188m (two AECs)
7c	80m (AEC 1)[2]	18m (AEC 2)	102m (two AECs)

Overall Assessment of Relative Impacts on AECs

Overall, Route 1 has the least Impact on Areas of Ecological Constraint, followed by Route 7c, then 7b and 7a, all which have quite similar impacts to one another. Route 6 has significantly greater impacts on AECs.

FLORA

There is little evidence that any scarce or protected plants species occur within the land take of any of the Routes. AEC 3, 'Killaloe Canal' wetland and AEC 5 O'Briensbridge flood plane have been tentatively identified as the sites most likely to hold such species. On this basis, Routes 6 and 1 may potentially have more impact on Flora than Routes 7a, 7b and 7c.

FAUNA

Mammals

It is considered likely that otter occurs at all of the Route crossing points; and there is potential for otter holts to be present within the land take of all of the Routes. Hence, all of the Routes have similar potential impacts on this species.

Badger activity has been recorded at two locations on Route 6, and at one location on Routes 7a, 7b and 7c. Habitats on Route 1 are also considered suitable for this species. There is potential for badger setts to be present within the land take of any of the Routes. Hence, all of the Routes have similar potential impacts on this species.

Suitable habitat for bats occurs on all of the Routes. Route 7c will involve the demolition of a residential property, and there is therefore a possibility that a roost may be impacted if bats happen to be using this building. Route 6 will involve the felling of mature and over-mature trees that could also potentially hold roosts. Hence there is a possibility that Routes 7c and 6 could potentially have a greater impact on bats than the other Routes.

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1 Note that these evaluations of 'Moderate Value, Locally Important' and 'High Value, Locally Important' refer to the habitat types and quality of each AEC in its own right. All sections within the Lower River Shannon cSAC should be considered to be Internationally Important.

2 This is an estimate as this land parcel was not entered during the survey. 80m should be taken only as an approximate distance.

Potential red squirrel habitat is present at all of the Routes, and hence, all of the Routes have similar potential impacts on this species. No clear preferences between the Routes are apparent for any other mammal species.

Birds

Route 6 holds a greater variety of habitat types with respect to breeding birds, and may therefore have a marginally greater impact on breeding bird assemblages. The habitats at all of the Routes are suitable for Kingfisher, whilst sections of Route 1 may hold suitable habitat for Barn Owl. Otherwise no clear preferences between the Routes are apparent for birds.

Other Faunal Groups

No clear preferences between the Routes are apparent for invertebrates or any other faunal groups.

Overall Route Selection With Respect to Ecology

Table 4.8 gives an overall summary of the relative impact of each Route on each element of the ecological environment. Where Routes will have a similar impact to one another, table cells have been merged.

Table 4.8: Overall Summary Matrix of the Relative Impacts of the Routes

	Greatest Impact - - - - - - - - - - - - - - - - - Least Impact				
Lower River Shannon cSAC	**6**	**1**	**7a**	**7b**	**7c**
Areas of Ecological Constraint	**6**	**7a**	**7b**	**7c**	**1**
Flora (potential)	**1 / 6**		**7a / 7b / 7c**		
Fauna (potential)	**7c**	**6**	**1**	**7a / 7b**	

Hence, the overall conclusion is that Route 6 is clearly the least preferable with respect to ecology. The situation with regard to the other Routes is a little less clear cut, however Route 1 is somewhat less preferable to Routes 7a, 7b or 7c. Differences are very marginal between the three remaining Routes, but 7c is probably preferable to 7b, which is preferable to 7a.

In summary, the order of preference (most to least preferable) is Route 7c, Route 7b, Route 7a, Route 1, Route 6.

4.1.1.2 Aquatic Ecology

4.1.1.2.1 Introduction

This section of the report assesses the implications on surface fisheries, aquatic ecology and water quality for possible bridge crossing locations being developed as part of the scheme. A total of five route options are being considered. Route 1 is located near O'Briensbridge/ Montpelier while Routes 6 and 7a, 7b and 7c are located near Killaloe/Ballina.

4.1.1.2.2 Methodology

This methodology involved a desk based review of the available information on the lower River Shannon. This information included internal ESB fisheries reports, EPA reports, and published papers. A walk over assessment of the affected areas was also undertaken.

The comparative potential impact on fisheries, aquatic ecology and water quality for the bridge options is assessed and a preferred option is recommended.

Aquatic sites were evaluated and given an overall significance rating on the basis of the criteria outlined in the National Roads Authority Publication - Guidelines for Assessment of Ecological Impacts of National Road Schemes (2004).

4.1.1.2.3 Study Area

The lower River Shannon is a highly modified watercourse and Sean Kierse (1991) has reviewed works on the Killaloe/O'Brien's Bridge area of the river in the paper '*River Works at Killaloe*'. The river was first modified during the period 1840-1883 with the excavation and widening of the channel and the construction of a regulating weir upstream of Killaloe Bridge. Additional drainage works were carried out in the 1880s from Killaloe to O'Briens Bridge and the Killaloe weir was replaced with sluice gates at this time. The Shannon Hydro-electric scheme was constructed during the period 1925-29 and included the construction of a regulating weir on the Shannon upstream of O'Briensbridge and the diversion of water via a headrace to the hydroelectric generating station at Ardnacrusha. The construction of the regulating weir resulted in the flooding of a large area of farmland and the creation of a reservoir downstream of Killaloe. The sluice gates at Killaloe were also removed at this time and further dredging of the river both upstream and downstream of Killaloe Bridge was undertaken. The weir at Parteen now maintains water levels in Lough Derg and regulates water flow through Killaloe. A statutory minimum discharge of 10 m^3sec^{-1} is maintained in the old river Shannon at O'Brien's Bridge.

Fish Community of the River Shannon

The fish community found in the Shannon is like that of Ireland as a whole and includes a large proportion of introduced species. McCarthy (1997) reported a total of twenty three freshwater fish species in the catchment area above Limerick and noted that the fish community includes a large proportion of introduced species. Dace (*Leuciscus Leuciscus*, L) and Chub (*Leuciscus cephalus*, L.) have been illegally introduced into the Shannon system in recent years bringing the current number of species in the river system to twenty five. The fish community includes the catadromous European eel and Flounder (*Platichthys flesus*, L.) and the anadromous sea (*Peteromyzon marinus*, L.) and river (*Lampetra fluvialitis*, L.) lampreys, Atlantic salmon (*Salmo salar*, L.), and smelt (*Osmerous eperlanus*, L.). The

Shannon also contains a variety of resident fish species and fish species, which migrate only within the catchment itself. This group includes the Pollan (*Coregonus augustinalis*, L.), Brown Trout (*Salmo trutta*, L), Northern Pike (*Esox lucius*, L.), Perch (*Perca fluvialitis*, L.) and members of the cyprinidae family; Bronze Bream (*Abramis brama*, L.), Roach (*Rutilus rutilius*, L.), Tench (*Tinca tinca*, L.), Minnow (*Phoxinus phoxinus*, L.) Gudgeon (*Gobio gobio*, L.) and Rudd (*Scardinius erythrophthalmus,* L.).

Impact of the Shannon Scheme on Diadromous Fish in the River Shannon

It is now known that the River Shannon hydroelectric scheme resulted in major impacts on salmon and eel populations in the catchment (Went, 1970, Moriarty, 1987, O' Farrell *et al,* 1995, O' Farrell *et al*, 1996). Although undocumented, it is likely that significant impacts on other migratory fish such as sea and river lampreys also occurred. The original designers of the Shannon scheme had erroneously assumed that salmon and other fish would use the 'pool and traverse' type pass located at Parteen Regulating weir, or perhaps utilize the navigation lock at Ardnacusha. It is now clear that these facilities were inadequate, particularly for fish species other than salmon. In March 1959 a Borland type fish-lock was opened at Ardnacrusha, and a juvenile eel trapping and overland transport programme was initiated (Moriarty, 1982, Reynolds *et al*, 1994, McCarthy *et al*, 1994). Although these measures improved fish passage on the Shannon in the short term, both eel recruitment and salmon escapement to above the dams continued to decline and has been particularly poor in recent years.

4.1.1.2.4 Receiving Environment

River Shannon near Killaloe

The River Shannon between Lough Derg and the Parteen Reservoir is located in the cascade catchment of the River Shannon, or that part of the catchment area of the river which is harnessed for hydroelectricity production. River levels in this area are regulated by Parteen Weir and Ardnacrusha Generating Station and both water levels and flows vary with hydroelectric production. The affected section of river is located within the boundary of the Lower Shannon candidate Special Area of Conservation (cSAC). The area is of importance for angling but is not an important shore coarse angling area. Angling in this area is mainly carried out by trolling for trout and pike. A 'commercial' silver eel weir is operated by the ESB at Killaloe Bridge.

This area of the river is physically unsuitable for spawning by salmon, trout or lamprey. Some coarse fish spawning may take place, however more suitable areas for this purpose are located in the reservoir and Lough Derg. Some adult and juvenile salmon pass though this area but the area is not used for angling for this species. The rare pollan has been recorded in small numbers as bycatch in eel nets operated at Killaloe Bridge and in the headrace at Clonlara during the 1990's (O'Connor, personal observation). However, it is thought that these fish are 'washed out' of Lough Derg itself – the main habitat for this species. No suitable spawning habitat for this species is thought to occur along the affected stretch of the river or downstream areas. Sea lampreys migrating upstream from the estuary do not pass the Shannon dams in any significant numbers (O'Connor, 2003). However landlocked sea lampreys are thought to occur in Lough Derg (O'Connor, unpublished). As there is no suitable spawning habitat for lampreys in the area it is also unlikely that juvenile lampreys would be present in any significant numbers. The affected stretch of river is likely to be used by otters.

It is possible that the Annex II white clawed crayfish *Austropotamobius pallipes* is present in the area in small numbers. The rare glacial relic Opossum shrimp *Mysis relicta* has been recorded here in significant numbers (O'Connor, unpublished) but is thought to be washed out from the lake and does not breed here.

Assessment: Internationally Important (A) due to its cSAC status. Important mainly as a wildlife corridor which allows fish and other wildlife to migrate upstream and downstream.

Old River Shannon near O'Brien's Bridge

The River Shannon downstream of Parteen Weir is referred to as the Old River Shannon and is part of the residual catchment (i.e. the area of the catchment that is not harnessed for hydroelectricity production). River flows in this area are regulated by Parteen Weir and the river receives a statutory minimum discharge of 10 m^3 sec^{-1} (approximately 5% of the mean annual discharge on the Shannon). The affected section of river is located within the boundary of the Lower Shannon candidate Special Area of Conservation (cSAC). The area is an important shore coarse angling area which often hosts international competitions. The most important coarse species are bream and pike. O'Briensbridge is also an important salmon fishery with anglers fishing on and near the existing bridge for mainly reared salmon returning to Parteen hatchery. A number of large trout are also taken in this area each year. As with the Shannon near Killaloe, this is a large sluggish river which is physically unsuitable for spawning by salmon, trout or lamprey. However, important spawning areas for these species are located downstream from here at Castleconnell which also contains important habitats such as floating river vegetation and alluvial woodland. The area is likely to be of importance to coarse fish spawning; although the areas located around Inishlosky Island and immediately downstream from Parteen weir are more important in this respect. Otters are likely to be present in the area.

Assessment: Internationally Important (A) due to its cSAC status. Important coarse angling area and salmon fishing also takes place. Located upstream from important salmon and lamprey spawning areas at Castleconnell.

Headrace Canal near O'Brien's Bridge

Parteen weir diverts water via a 12.6 km headrace to the 85MW Ardnacrusha hydroelectric station. This canal now carries the main flow of the River Shannon and has a capacity of 400 m^3sec^{-1}. Despite its artificial nature it provides important aquatic habitats and is the main fish migration corridor along the Shannon. A commercial eel fishery was operated by ESB in the past at Clonlara. Angling is not allowed in the headrace canal but locals are known to catch significant numbers of trout here in the spring. Some salmon are also caught here each year, for example at the 'barrels' in Clonlara. The area near the Route 1 crossing point is also known as a potential angling area due to a narrowing of the canal in this area. It is likely that this canal will be opened as a fishery in the future.

Assessment: Internationally Important (A) due to its cSAC status. Important mainly as a wildlife corridor which allows fish and other wildlife to migrate upstream and downstream.

4.1.1.2.5 Characteristics of the Proposal

All the bridge crossing options would affect the lower River Shannon. Route 1 would be located near O'Briensbridge and would involve crossings of both the Old River Shannon and the Headrace Canal. Routes 6, 7a, 7b and 7c would affect the River Shannon near Killaloe (cascade catchment) and would involve one bridge crossing.

4.1.1.2.6 Bridge Location Assessment

The current assessment considers the comparative potential impact on fisheries, aquatic ecology and water quality of the three proposed route/bridge locations. In Table 4.9 a summary of the assessment and evaluation is provided.

The River Shannon and Headrace Canal are both identified as being sensitive receptors from a fisheries, aquatic ecology and water quality perspective. The potential impacts of Routes 6, 7a, 7b, and 7c would all be very similar due to their close proximity.

All crossing options would affect the River Shannon and impacts on this river could occur during both the construction and operation phases. Route 1 would affect both the River Shannon and the Headrace Canal. Potential impacts of the bridge crossings on fisheries, aquatic ecology and water quality may include the following:-

- Pollution of the river with suspended solids due to runoff of soil from the construction area.
- Pollution of the river with other substances such as fuels, lubricants, waste concrete, waste water, etc.
- Loss of habitat.
- Interference with fish migrations or angling activities.
- Pollution of the river with contaminated surface runoff draining from the road surface during its operation.
- Increased risk of accidental spills on the additional impermeable surfaces.

These potential impacts will be addressed in detail in the final EIS which will be prepared for the recommended bridge option. Many of the above impacts would be temporary in nature and others can be avoided with careful project management measures. Significant scope for mitigating other potential problems also exists. Provided appropriate mitigation measures are taken to prevent excessive contaminants from entering the River Shannon, it is not expected that the current water quality classification or fisheries/conservation value would change as a result of the construction of any of the bridge options. It is therefore concluded that all the routes could be built provided appropriate mitigation measures were provided.

The method for assessing impacts on aquatic sites given on page 40 of the National Roads Authority Publication "Guidelines for Assessment of Ecological Impacts of National Road Schemes", the method used here, does not provide for assigning a magnitude level to potential impacts. In this method all impacts on 'A' sites are rated as 'Major' no matter how small a magnitude they are or how temporary or localised they may be. Likewise, all long term impacts on 'A' sites are arbitrarily rated as being 'Severe' no matter what the magnitude of this impact may be.

4.1.1.2.7 Preferred Bridge Location

The least preferred option would be Route 1 as this would require a bridge over both the old River Shannon and the Headrace Canal. However, this route could be built with appropriate mitigation measures. Routes 6, 7a, 7b and 7c would be the joint preferred options. Routes 7a, 7b and 7c would be slightly more preferred as these are located closer to the urban area of Killaloe/Ballina and are therefore considered to be already disturbed.

Table 4.9: Comparative Impact of Various Bridge Location Options on Water Quality, Fisheries and Aquatic Ecology

Waterbody	Overall Evaluation	Route 1	Route 6	Route 7a	Route 7b	Route 7c
River Shannon (Cascade)	A Internationally Important	C=Major Negative O=Severe Negative	C=Major Negative O=Severe Negative	C=Major Negative O=Severe Negative	C=Major Negative O=Severe Negative	C=Major Negative O=Severe Negative
River Shannon (residual)	A Internationally Important	C=Major Negative O=Severe Negative	C=Major Negative O=Severe Negative	C=Major Negative O=Severe Negative	C=Major Negative O=Severe Negative	C=Major Negative O=Severe Negative
Headrace Canal	A Internationally Important	C=Major Negative O=Severe Negative	C=Major Negative O=Severe Negative	C=Major Negative O=Severe Negative	C=Major Negative O=Severe Negative	C=Major Negative O=Severe Negative
Number of crossings		**2**	**1**	**1**	**1**	**1**
Overall Route Impact Evaluation		**C=Major Negative O=Severe Negative**	**C=Major Negative O=Severe Negative**	**C=Major Negative O=Severe Negative**	**C=Major Negative O=Severe Negative**	**C=Major Negative O=Severe Negative**

C=Construction Phase, O=Operational Phase

All impacts predicted are localised

4.1.2 Noise

4.1.2.1 Introduction

This section of the report assesses the comparative noise impacts of the routes for the Shannon Bridge Crossing project denoted as Routes 1, 6, 7a, 7b and 7c.

In this section, the noise impact associated with the five routes is assessed by comparing the overall noise exposures of dwellings along the route. Further detailed assessment of the noise impact at individual houses may be required when a final route has been selected.

4.1.2.2 Methodology

The assessment is made by comparing the relative noise impacts at noise sensitive receptors along the routes. A visual inspection and a baseline noise survey was carried out in the area on the 10th and 11th of August 2005 and 5th September 2005. The baseline noise survey was carried out in accordance with ISO 1996 “Description and Measurement of Environmental Noise”, and in accordance with NRA methodology (“Guidelines for the Treatment of Noise and Vibration in National Roads Schemes”, October 2004).

The noise sensitive locations (i.e. noise sensitive receptors) considered are the houses indicated on Figures 4.3 and 4.4 of Volume B. The assessment of residential dwellings was supplemented by information from the aerial photographs of the Study Area and visual inspection.

The assessment methodology follows the guidelines for routes assessment in the NRA Guidelines for the Treatment of Noise and Vibration in National Road Schemes (NRA, October, 2004).

The assessment examined:

- All houses which are located within 300m of each of the routes as follows:-

  Band 1 (0 to 50m)
  Band 2 (50-100m)
  Band 3 (100-200m)
  Band 4 (200-300m)

- The number of houses potentially falling into noise exposure zones was assessed for each route.

- The number of houses were ranked on the basis of potential impacts from expected traffic levels on each of the routes.

- Potential Impact Ratings (PIR) for each of the routes.

- Prediction of noise levels at each of the routes for each noise exposure band for 2007 and 2022.

The impact of traffic noise is a function of the noise level, and the change in noise level brought about by the road development. The impact associated with different traffic noise levels is illustrated in Figure 4.5 below.

The assessment and calculation procedure is based on the U.K. Design Manual for Roads and Bridges. Predictions of noise level are made according to the methods described in the U.K. Department of Transport document "Calculation of Road Traffic Noise" (CRTN).

The U.K. traffic calculation method produces results in terms of the $L_{A10,18hrs}$ parameter. This represents the noise level exceeded for 10% of the time, measured on an hourly basis, and averaged over an eighteen hour period from 06.00 a.m. to 00:00 (midnight).

In this report the $L_{A10,18hrs}$ parameter is converted to the new EU common noise index termed the L_{den}. This is in accordance with the change from the traditional $L_{A10,18hrs}$ parameter, following the European Union Environmental Noise Directive 2002/49/EC. The L_{den} represents the average noise level over a 24-hour period (day, evening, night), with additional penalty weightings applied to the evening and night periods. The Transport Research Laboratory in the U.K. has published conversion factors from $L_{A10,18hrs}$ to L_{den}.

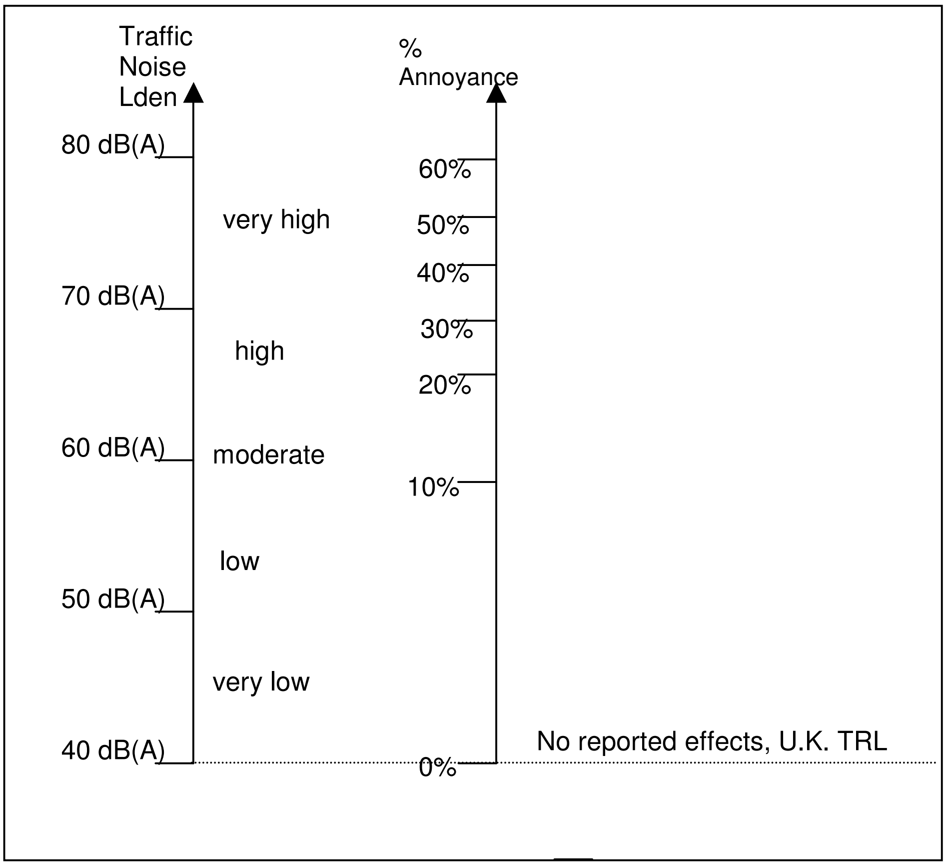

Figure 4.5: Relationship Between Traffic Noise Exposure in Terms of the L_{den} Parameter and Reported Annoyance (Derived from Values in UK Design Manual for Roads and Bridges). The traditional mitigation criterion of 68 dB(A) L_{A10} corresponds to approximately 65 dB(A) on the L_{den} scale.

There is no definitive standard for categorising the perceived loudness of traffic noise as a function of noise level. In this report the following qualitative descriptions are used:-

- Less than 55 dB(A): low traffic noise levels
- 55-60 dB(A): low/moderate traffic noise levels
- 60-65 dB(A): moderate traffic noise levels
- 65 -70 dB(A): high traffic noise levels - mitigation required
- Greater than 70 dB(A): very high traffic noise levels - mitigation required

The Design Manual for Roads and Bridges (DMRB) provides a general methodology for assessing impact based on the number of houses exposed to noise and the change in noise exposure of these houses. It does not however provide a methodology for determining a single number rating for each route, which is desirable for an unambiguous ranking of routes in terms of noise impact.

This report supplements the basic DMRB methodology with a single number ranking for each route. This ranking is based on the number of houses that are likely to be exposed to noise levels in excess of 60 dB(A) L_{den}. The criterion of 60 dB(A) L_{den} is the design standard specified by the NRA which new national road schemes should comply with.

Noise Terminology

$\mathbf{L_{AeqT}}$, this is the A-weighted equivalent continuous steady sound level during the sample period and effectively represents an average value.

$\mathbf{L_{A10}}$, this is the A-weighted sound level that is exceeded for 10% of the sample period as is used to quantify traffic noise.

$\mathbf{L_{A90}}$, this is the A-weighted sound level that is exceeded for 90% of the sample period and is used to quantify background noise.

4.1.2.3 Existing Noise Environment

Noise Survey

Measurements were made at twelve locations, which were judged to be representative of existing noise levels within the Study Area, where the proposed routes would pass. The noise survey was conducted in accordance with CRTN ("Calculation of Road Traffic Noise").

Weather conditions on August 10th were dry, mild and sunny with low wind conditions and similarly conditions on August 11th were dry, although at times were dull and overcast. Conditions on September 5th were dry and mild and overcast at times.

Survey locations N1 to N10 were surveyed on August 10th and 11th 2005. Locations N11 and N12 were measured on 5th September 2005. It should be noted that locations N13 and N14 could not be surveyed on 5th September because of road surfacing works taking place on the R463 outside these houses, which would have rendered ambient noise levels in the area higher that typical levels in the area as a consequence of plant/machinery noise. The measurement locations are shown in Figures 4.3 and 4.4 of Volume B. A summary of results is given in Table 4.10.

Table 4.10: Summary of Existing Noise Environment from Baseline Studies in the Study Area

Location (see Figures 4.3 and 4.4)	Noise levels dB(A)				Description of Existing Noise Environment
	Start Time	L_{Aeq}	L_{A90}	L_{A10}	
N1	09:57	49	30	54	Dominant noise source intermittent traffic passing front of house on R466. Birdsong dominant between traffic gaps. 2 planes passing at high altitude during measurement
	17:00	59	38	62	Dominant noise source from traffic as above with birdsong audible. Other contributory sources during measurement was from passing tractor/trailer (twice) and helicopter which passed overhead at altitude.
	11:29	48	35	51	Dominant noise source from passing traffic on R466, also agricultural machinery activity noted.
Mean	55		35	58	
$L_{A10,\ 18\ hrs}$	57				
L_{den}	**59**				
N2	10:39	41	34	43	Dominant noise source is birdsong and working agricultural machinery. Traffic noise from R466 in distance also audible here.
	17:21	42	36	43	Noise sources as above with some additional noise from plane passing at high altitude and people in field adjacent to house.
	16:05	42	37	44	Noise sources as above with 2 planes passing at high altitude and reversing vehicle noise during measurement.
Mean		42	36	43	
$L_{A10,\ 18\ hrs}$	42				
L_{den}	**46**				
N3	11:28	39	29	37	Dominant noise source from rustling trees/leaves, insect noises and birdsong. Some dog barking also noted and passing tractor on ESB lands to front of property.
	17:46	38	33	41	Dominant noise source from rustling trees/leaves, insect noises and birdsong. Traffic noise in distance also noted.
	10:57	42	29	44	Noise sources as above with some additional noise from hammering sounds at neighbour's house.
Mean		40	31	42	
$L_{A10,\ 18\ hrs}$	41				
L_{den}	**45**				

Location (see Figures 4.3 and 4.4)		Noise levels dB(A)			Description of Existing Noise Environment
	Start Time	L_{Aeq}	L_{A90}	L_{A10}	
N4	12:00	45	31	50	Dominant noise source from traffic passing (intermittent) on R463. Birdsong dominant between traffic noise gaps.
	18:12	49	35	53	Noise sources as above. Some dog barking in distance also noted, tractor and large trailer which passed along R463 and 1 plane passed at high altitude.
	11:54	49	36	53	Noise sources traffic passing on R463 audible from this location as above with birdsong and also sounds of agricultural activity in nearby fields noted.
Mean		48	35	52	
$L_{A10, 18 hrs}$	51				
L_{den}	**54**				
N5	12:39	45	30	49	Dominant noise source from passing traffic on R463 (intermittent). Between gaps, dominant noise rustling of leaves/trees and birdsong.
	18:42	47	30	51	Noise sources as above. Dog barking also noted during interval.
	14:35	50	38	53	Noise sources as above with dog barking. Increased levels from leaves rustling due to breeze, which strengthened periodically, 3 planes passed at high altitude during interval.
Mean		48	34	51	
$L_{A10, 18 hrs}$	50				
L_{den}	**53**				
N6	13:03	46	35	50	Dominant noise source noted from passing traffic on R463 to front of house. Between traffic noise, dominant noise from birdsong and agricultural activity in area.1 plane passed overhead at high altitude.
	19:03	46	32	51	As above without plane.
	14:17	45	33	50	As above, lawn mowing in distance also noted.
Mean		46	34	50	
$L_{A10, 18 hrs}$	49				
L_{den}	**52**				

Location (see Figures 4.3 and 4.4)		Noise levels dB(A)			Description of Existing Noise Environment
	Start Time	L_{Aeq}	L_{A90}	L_{A10}	
N7	15:17	36	32	38	Dominant noise source from birdsong and insects and some trees/leaves rustling in very light breeze. Traffic noise in distance at Killaloe audible, also sound of strimmer operating in distance noted.
	12:25	38	31	41	Noise sources as above. 1 plane passed overhead at high altitude during interval.
	14:55	38	34	40	Noise sources as per 1st measurement. Sounds of children playing is distance and intermittent dog barking also noted.
Mean		37	33	40	
$L_{A10,\ 18\ hrs}$	39				
L_{den}	**43**				
N8	15:47	42	34	44	Dominant noise from rustling leaves/trees and birdsong. 1 plane passed overhead at high altitude. Traffic noise audible in distance.
	17:16	47	43	49	Noise sources as above with more constant traffic noise audible in distance and intermittent dog barking.
	17:35	43	40	45	Noise sources as before with also noise noted from children playing near schoolground, chainsaw/mower operating on R463.
Mean		45	40	47	
$L_{A10,\ 18\ hrs}$				46	
L_{den}	**49**				
N9	16:18	49	41	52	Dominant noise source traffic passing on R494 to front of house. Between traffic noise, birdsong audible. Other sources noted were some construction noise in distance across R. Shannon, dog barking in distance and 1 plane which passed at high altitude.
	13:28	48	39	52	Noise sources as above, also noted noise from speedboats passing on river.
	15:28	51	44	54	Noise sources as above.
Mean		50	42	53	
$L_{A10,\ 18\ hrs}$				52	
L_{den}	**55**				
N10	14:20	42	31	45	Noise sources from traffic passing front of house along R463, agricultural activity in area, birdsong, strimmer used (intermittent) in distance. 1 plane passed at high altitude.
	19:23	43	34	47	Noise sources from traffic passing front house on R463, also noted children playing in distance and phone rang inside house briefly.
	13:53	44	36	47	Similar to above from R463 (intermittent), birdsong, dog barking in distance, 2 planes overhead at altitude. Tapping noise also noted from inside house (intermittent).
Mean		43	34	46	
$L_{A10,\ 18\ hrs}$	45				
L_{den}	**49**				

Location (see Figures 4.3 and 4.4)		Noise levels dB(A)			Description of Existing Noise Environment
	Start Time	L_{Aeq}	L_{A90}	L_{A10}	
N11	10:12	52	36	57	Loudest noise from traffic passing front of house on R463. Between traffic noise, birdsong and sounds of adjacent stream dominant. Also noted lawn mowing
	11:45	53	36	57	Noise sources as above. Also noted radio in distance in neighbouring field, agricultural activity in distance, and bell ringing noise in distance
	13:51	53	37	57	Noise sources as above. Also noted 2 planes passing at high altitude, intermittent dog barking in distance, passing waste collection truck on R463
Mean		53	36	57	
$L_{A10,\ 18\ hrs}$	56				
L_{den}	**58**				
N12	13:11	43	35	45	Noise sources from children talking/playing at nearby school. Traffic audible in distance at Killaloe. Dominant noise sources between these sources was birdsong in garden
	17:07	43	38	46	Noise sources as above. Lawn Mowing in field behind school audible from this location and 1 plane which passed at high altitude also noted
	18:35	41	37	43	Noise sources as above. Some dog barking noted from property N8 during measurement. No planes
Mean		42	37	45	
$L_{A10,\ 18\ hrs}$	44				
L_{den}	**48**				

4.1.2.4 Potential Impacts

Property Counts

The different routes will potentially impact upon a varying number of properties within the Study Area as shown in Figures 4.6 – 4.10 of Volume B. The number of properties, residential, commercial, industrial and educational falling into each of the different noise exposure categories for each route is given in Table 4.11.

Table 4.11: Comparison of Impacts of Routes on All Properties

Route	Residential Properties Within Noise Exposure Zones				
	0-50	50-100	100-200	200-300	Total
1	2	2	12	18	34
6	2	3	8	8	21
7a	4	8	23	16	51
7b	4	10	26	13	53
7c	4	12	25	13	54
	Commercial Properties (Including Farms and B&Bs) Within Noise Exposure Zones				
	0-50	50-100	100-200	200-300	Total
1	0	1	1	3	5
6	0	1	0	2	3
7a	0	1	0	0	1
7b	0	0	1	0	1
7c	0	0	1	1	2
	Industrial Properties Within Noise Exposure Zones				
	0-50	50-100	100-200	200-300	Total
1	0	0	0	1	1
6	0	0	0	0	0
7a	0	0	0	1	1
7b	0	0	0	1	1
7c	0	0	0	1	1
	Educational Properties Within Noise Exposure Zones				
	0-50	50-100	100-200	200-300	Total
1	0	0	0	0	0
6	0	0	0	0	0
7a	0	0	0	0	0
7b	0	0	0	1	1
7c	0	0	0	1	1

Table 4.12: Summary of Receptors Within 300m of Each Route

Route	1	6	7a	7b	7c
Total Residential	34	21	51	53	54
Total Commercial (Inc. Farms/B&Bs)	5	3	1	1	2
Total Industrial	1	0	1	1	1
Total Educational	0	0	0	1	1

Traffic Data

The AADT traffic volume figures for each of the Routes, 1, 6 and 7 for the years 2007 and 2022 were derived as described in Chapter 3 and are presented below in Table 4.13. Year 2007 is assumed to be the first year of operation of the proposed scheme.

Table 4.13: AADT Flows for 2007 and 2022 for Each Route

Route	1	6	7
AADT Flow 2007	2,850	3,183	3,743
AADT Flow 2022	3,354	4,323	5,007
Percentage Change (Between 2007 and 2022)	17.7%	35.8%	33.8%

4.1.2.5 Predicted Traffic Noise Levels

Traffic noise levels for the proposed routes have been predicted to determine noise exposure levels for each route at each of the noise exposure bands (0-50m; 50-100m; 100-200m; 200-300m). It should be noted that the route option assessment is carried out on the basis of the potential impact of the proposed route with regard to possible noise exposure, without allowing for possible noise attenuation by implementation of mitigation measures, in accordance with the NRA Guidelines. Detailed assessment of the potential impact of the preferred route and specification of mitigation measures will be carried out as part of the Environmental Impact Assessment (EIA).

The calculated noise levels have been converted to L_{den} values (day-evening-night noise index). These calculations are based on the traffic flow data for 2007 and 2022.

The noise calculations allow for ground absorption, but do not take account of screening provided by the terrain or by house boundary walls. Noise levels at houses may therefore be overestimated. Calculations are made for a height of 4m off the ground, as specified in the European Union Environmental Noise Directive. The route option assessment has been carried out allowing for a design speed of 80 km/hr for the proposed route, i.e. the traffic speed used in the calculations for predicted noise levels was 80km/hr. Predicted noise levels for 2007 and 2022 are given in Tables 4.14 and 4.15.

Table 4.14: Predicted Noise Level (L_{den}) for the Year 2007 within Noise Exposure Zones

Route	Predicted Noise Level (L_{den}) 2007 within Noise Exposure Zones							
	(L_{den}) 2007	No. Properties	(L_{den}) 2007	No. Properties	(L_{den}) 2007	No. Properties	(L_{den}) 2007	No. Properties
	0-50		50-100		100-200		200-300	
1	62	2	59	2	57	12	55	18
6	62	2	59	3	57	8	55	8
7a	61	4	58	8	55	23	53	16
7b	61	4	58	10	55	26	53	13
7c	61	4	58	12	55	25	53	13

Table 4.15: Predicted Noise Level (L_{den}) for the year 2022 within Noise Exposure Zones

Route	Predicted Noise Level (L_{den}) 2022 within Noise Exposure Zones							
	(L_{den}) 2022	No. Properties	(L_{den}) 2022	No. Properties	(L_{den}) 2022	No. Properties	(L_{den}) 2022	No. Properties
	0-50		50-100		100-200		200-300	
1	63	2	60	2	58	12	56	18
6	67	2	64	3	61	8	60	8
7a	68	4	66	8	63	23	62	16
7b	68	4	66	10	63	26	62	13
7c	68	4	66	12	63	25	62	13

4.1.2.6 Route Options Assessment

Potential Impact Rating

The potential impact rating for each of the routes was calculated according to the NRA Guidelines (October, 2004). The total number of receptors in each band is multiplied by an arbitrary rating factor, which decreases with increasing distance from the noise source. The resultant values are summed to give a single number for each route, which is termed the Potential Impact Rating (PIR). The PIR values may be used to assess the potential impact of each route. The rating factors and calculation of the PIR is given in Table 4.16.

Table 4.16: Example of Calculation of Potential Impact Rating Based on Residential Receptor Counts for Route 1

Band	No. of Residential Receptors in Band (A)	Rating Factor (B)	A x B
1 (0-50m)	2	4	8
2 (50-100m)	2	3	6
3 (100-200m)	12	2	24
4(200-300m)	18	1	18
Potential Impact Rating			**56**

The Potential Impact Ratings for each of the routes are presented in Table 4.17 below.

Table 4.17: Potential Impact Ratings (PIRs), in Ascending Order, for the Routes

Route	Potential Impact Rating
6	41
1	56
7a	102
7b	111
7c	115

Based on the PIR calculation, the greatest potential impact will arise from Route 7c, followed closely by Routes 7b and 7a, and then by Route 1 and the least potential impact from Route 6. On this basis of the potential impact ratings, Route 6 would be the preferred route for the new bridge.

Predicted Impact

The predicted impact of traffic noise is assessed with reference to the NRA design criterion of 60 dB(A) L_{den} as shown in Table 4.18.

Table 4.18: Predicted Noise Impacts for Each of the Routes for 2007 and 2022

Predicted Impact for the Year 2007		
Route	**Degree of Impact**	**Houses >60 dB(A) L_{den}**
1	Least Impact	2
6	↓	2
7a		4
7b		4
7c	Greatest Impact	4
Predicted Impact for the Year 2022		
Route	**Degree of Impact**	**Houses >60 dB(A) L_{den}**
1	Least Impact	2
6	↓	13
7a		51
7b		53
7c	Greatest Impact	54

As outlined above, it should be noted that the predicted levels do not allow for possible attenuation that may be achieved by implementation of specific mitigation measures. A detailed assessment of the predicted impact incorporating mitigation measures as appropriate will be carried out for the EIA. Therefore, it may be possible that the predicted noise levels at the representative properties outlined in Table 4.18 that are raised above 60 dB(A) L_{den}, may be maintained within the NRA Guideline level. This will be considered in the EIA.

For 2007, the L_{den} noise levels predicted for Routes 1 and 6 are the same for all noise exposure bands from the route, i.e. the predicted L_{den} levels for both Route 1 and 6 are 62 dB for properties within 0 – 50m; 59 dB for properties within 50 – 100m; 57 dB for properties within 100 – 200m and 55 dB for properties within 200 – 300m (see Table 4.14). However, with the exception of the noise exposure band 0 – 50m, the number of sensitive receptors within each of the noise exposure bands is not the same for both routes. The predicted levels for Routes 1 and 6 exceed the NRA design criterion of 60 dB(A) L_{den} within the 0-50m noise exposure band for two residential receptors on both routes. However predicted noise levels within the remaining noise bands for both routes are below the 60 dB(A) L_{den} criterion. Overall, it is considered that the predicted impacts of Route 1 for 2007 would be greater than for Route 6 as a result of potential increased noise exposure due to a greater number of residential receptors along Route 1 (34 total residential receptors) than on Route 6 (21 total residential receptors). This is coupled with a higher PIR calculated for Route 1 (PIR: 56) compared with Route 6 (PIR: 41).

The predicted noise impacts and number of sensitive receptors for Routes 7a, 7b and 7c for 2007 are broadly similar and four residential receptors, located within the 0-50m band, exceed the NRA design criterion of 60 dB(A) L_{den} on each of the Route 7 options (refer to Table 4.14). However predicted noise levels within the remaining noise bands are below this criterion for 2007, (refer to Table 4.14). The number of residential receptors within the 50-100m noise band for Route 7c is greatest (12 receptors) followed by 7b (10 receptors) and 7a (8 receptors) and it is considered that potential noise impacts which may arise to properties within this band will be greatest for Route 7c. Overall for 2007, it is considered that the greatest potential impact from noise would arise from Route 7c (total 54 receptors), followed by Route 7b (total 53 receptors) and Route 7a (51 total receptors). In addition, St. Anne's Community College in Killaloe is outside the noise exposure bands for Route 7a but potentially within the 200-300m noise exposure band for Routes 7b and 7c, which also renders Route 7a the most favourable of the Route 7 options.

The lowest predicted increase in traffic volumes from 2007 to 2022 is 18% for Route 1 (see Table 4.13) and the associated predicted traffic noise levels for 2022 show an increase of 1 dB(A) L_{den}, across each of the noise exposure bands from 2007 to 2022. However, the predicted noise levels for Route 6 for 2022 increase significantly from the levels predicted for 2007, based on a 36% increase of traffic volumes estimated for this route for 2022 (see Table 4.13 and Tables 4.14 and 4.15). The predicted increase in traffic volumes for Route 7 is marginally lower (34%) when compared to the percentage change in levels on Route 6. However, the actual traffic volumes predicted on the Route 7 options for 2022 is 5,007; whereas the predicted AADT on Route 6 for 2022 is 4,323. The predicted noise level associated with greater potential vehicular usage of the Route 7 options in 2022 has resulted in a significantly higher predicted noise level for 2022, in comparison to the predicted level for 2007, due to an increase in traffic volumes. Residential receptors within 0-50m of Routes 7a, 7b and 7c would experience a predicted noise level of 61 dB(A) L_{den} in 2007 which would increase to 68 dB(A) L_{den} in 2022.

All predicted noise levels in excess of the NRA design criterion of 60 dB(A) L_{den} will require mitigation. Table 4.18 shows that the number of houses which exceed the NRA design criterion of 60 dB(A) $L_{den.}$ The degree of potential impact as outlined in Table 4.18 is considered to be the least from Route 1 and greatest at Route 7c.

4.1.2.7 Conclusion

The routes proposed for the new Shannon Bridge Crossing have been assessed with respect to potential noise impact. The assessment involved identification of the number of sensitive receptors, particularly, residential and educational receptors, within noise exposure bands, and calculated the Potential Impact Rating (PIR) and predicted impact for each route.

On the basis of the Potential Impact Rating (PIR), the least favourable route, with the greatest PIR, is Route 7c, followed by Route 7b and then by Route 7a and then by Route 1. On the basis of the PIR, the least potential impact is considered to be Route 6.

Upon assessment of the predicted impact, using traffic predictions for each of the routes (but excluding consideration of mitigation measures), the resultant predicted noise levels indicate that the least impact will be from Routes 1 and 6. The predicted noise levels for Route 6 in 2022 are slightly higher than the predicted noise levels for Route 1 in 2022. Although there are a greater number of sensitive receptors within the outer noise exposure bands of 100 – 200m and 200 – 300m for Route 1, the predicted noise levels for Route 1 are lower than the levels predicted for Route 6. Furthermore, the properties affected within the exposure bands of 50 – 100, 100 – 200m and 200 – 300m for Route 1 are within the NRA Guideline criterion of 60 dB(A) L_{den}, (with the exception of the 0 – 50m band), whereas the predicted levels for the exposure bands 50 – 100 and 100 – 200m for Route 6 are raised above the NRA criterion (refer to Table 4.15).

As a consequence of significantly higher traffic volumes, the resultant predicted noise levels indicate a greater negative impact for the Route 7 options, than that for the Route 6 or Route 1 options. The predicted noise levels across all of the noise exposure bands of 0 – 50, 50 – 100, 100 – 200m and 200 – 300m are raised above the NRA criterion (refer to Table 4.15). The degree of impact is considered to be greatest in the long term to 2022, for Route 7c, and therefore this would be the least favoured route (refer to Table 4.15).

In summary, the order of preference (most to least preferable) is Route 1, Route 6, Route 7a, Route 7b, and Route 7c.

4.1.3 Cultural Heritage

4.1.3.1 Introduction

This assessment outlines the potential impacts of Routes 1, 6, 7a, 7b and 7c on known or potential cultural heritage resources and ranks the routes in order of preference.

The Study Area for this assessment is located along the area of the River Shannon containing Lough Derg and the river crossings located to the north and south of the lough at Killaloe and O'Briensbridge respectively. Given the significant presence of the waters of the Shannon and Lough Derg this natural feature has acted as a territorial boundary for many centuries and today demarcates the County boundaries of Tipperary, Clare and Limerick. The area has been settled by humans since prehistoric times and the urban centres of Killaloe (Co. Clare) and Ballina (Co. Tipperary) at the northern limits; Birdhill (Co. Tipperary) at the east, and O'Briensbridge (including Montpelier) (Co. Limerick) at the southern limits, act as the central foci of the area today.

The Study Area itself is characterised by the low-lying floodplains of the Shannon located on both its eastern and western banks. On the western side, the ground rises towards a mountainous ridge located to the north-west while there are also a series of river networks flowing into the Shannon including the Black River; Ardcloony River and Ballyteige River on the western side and Killmastulla River on the eastern side. Friar's Island is located south of Killaloe Bridge while the Headrace Canal associated with the Ardnacrusha hydroelectric scheme (1929) extends parallel to the Shannon from the southern limits of the Study Area to the weir and southern opening of Lough Derg. The hydroelectric scheme also resulted in the flooding and division of agricultural holdings adjacent to the river located within the Study Area.

4.1.3.2 Methodology

This assessment is based on a desktop survey of references and sources, including:-

- Record of Monuments and Places for County Clare (Archaeological Survey of Ireland).
- Record of Monuments and Places for County Limerick (Archaeological Survey of Ireland).
- Record of Monuments and Places for County Tipperary (North) (Archaeological Survey of Ireland).
- Archaeological inventory of County Tipperary, Volume 1: North Tipperary (2002).
- Various editions of the *Excavations Bulletin* - the State-sponsored catalogue of licensed archaeological investigations as summarised on an annual basis.
- Cartographic sources for the Study Area including the Down Survey and various editions of the Ordnance Survey mapping for the Study Area.
- Articles and publications in local, regional and national journals.

- Constraints Study Report: Shannon Bridge Crossing (Clare County Council).
- Topographical Files held by the National Museum of Ireland.

In August 2005, a walkover survey of each proposed route was undertaken by a team of two archaeologists. There were some areas that were inaccessible along the proposed routes. The fields were systematically walked and assessed in terms of landscape, land use, vegetation cover, presence or lack of archaeological sites and potential for undetected archaeological sites/features. In addition, the proposed routes were assessed for the feasibility of setting out a geophysical programme of archaeological resolution in advance of proposed construction phase.

4.1.3.3 Framework for the Protection of Cultural Heritage

Protection of Cultural Heritage

The management and protection of cultural heritage in Ireland is achieved through a framework of international conventions and national laws and policies (Department of Arts, Heritage, Gaeltacht and the Islands 1999, 35). This is undertaken in accordance with the provisions of the 'European Convention on the Protection of the Archaeological Heritage' (the Valletta Convention) and 'European Convention on the Protection of Architectural Heritage' (Grenada Convention). Cultural heritage can be divided loosely into the *archaeological resource* covering sites and monuments from the prehistoric period until the post-medieval period and the *built heritage resource*, encompassing standing structures and sites of cultural importance dating from the post-medieval and modern period.

The Archaeological Resource

The Minister for Environment, Heritage and Local Government is responsible for the statutory functions and the administration of the national policy in relation to archaeological heritage management.

The National Monuments Act 1930 (and subsequent amendments in 1954, 1987, 1994 and 2004), the Heritage Act 1995 and relevant provisions of the National Cultural Institutions Act 1997 are the primary means of ensuring the satisfactory protection of archaeological remains, which are held to include all man-made structures of whatever form or date except buildings habitually used for ecclesiastical purposes. A national monument is described as 'a monument or the remains of a monument the preservation of which is a matter of national importance by reason of the historical, architectural, traditional, artistic or archaeological interest attaching thereto' (Section 2, National Monument Act, 1930).

There are a number of mechanisms under the National Monuments Act that are applied to secure the protection of archaeological monuments. These include the Register of Historic Monuments, the Record of Monuments and Places (formerly the Sites and Monuments Record), and the placing of Preservation Orders and Temporary Preservation Orders on endangered sites.

Ownership and Guardianship of National Monuments

National monuments may be acquired by the Minister for Environment, Heritage and Local Government whether by agreement or by compulsory order. The State or Local Authority may assume guardianship of any national monument (other than dwellings). The owners of national monuments (other than dwellings) may also appoint the Minister or the Local Authority as guardian of that monument if the State or Local Authority agrees. Once the site is in ownership or guardianship of the State it may not be interfered with without the written consent of the Minister. There are no sites in ownership or in guardianship within the Study Area.

Register of Historic Monuments

Section 5 of the National Monuments (Amendment) Act 1987 states that the Minister is required to establish and maintain a Register of Historic Monuments. Historic monuments and archaeological areas listed on the register are afforded statutory protection under the 1987 Act. Any interference of sites recorded in the Register without the permission of the Minister is illegal, and two months notice in writing is required prior to any work being undertaken on or in the vicinity of a registered monument. The register was made largely redundant with the establishment of the Record of Monuments and Places by regulations under the National Monuments (Amendment) Act, 1994. There are no registered monuments within the Study Area.

Preservation Orders and Temporary Preservation Orders

Sites deemed to be in danger of injury or destruction can be allocated Preservation Orders under the 1930 Act. Preservation Orders make any interference to the site illegal. Temporary Preservation Orders can be attached under the 1954 Act. These perform the same function as a Preservation Order but have a time limit of six months, after which the situation surrounding the site must be reviewed. Work may only be undertaken on or in the vicinity of sites under Preservation Orders by the written consent, and at the discretion, of the Minister. There are no preservation orders on any structures within the Study Area.

Record of Monuments and Places

Section 12 (1) of the National Monuments (Amendment) Act 1994 provides that the Minister for Environment and Local Government shall establish and maintain a record of monuments and places where the Minister believes that such monuments exist. The record comprises of a list of monuments and relevant places and a map or maps showing each monument and relevant place in respect of each county in the State. Sites recorded on the Record of Monuments and Places all receive statutory protection under the National Monuments Act 1994.

Section 12 (3) of the 1994 Act provides that:-

> *'where the owner or occupier (other than the Minister for Environment and Local Government) of a monument or place included in the Record, or any other person, proposes to carry out, or to cause or permit the carrying out of, any work at or in relation to such a monument or place, he or she shall give notice in writing to the Minister for Environment and Local Government to carry out work and shall not, except in the case of urgent necessity and with the consent of the Minister, commence the work until two months after the giving of notice.'*

Within the Study Area, there are twenty-nine recorded monuments (see Table 4.19).

Architectural and Built Heritage

Protection of architectural or built heritage is provided for through a range of legal instruments that include the Heritage Act, 1995, the Architectural Heritage (National Inventory) and National Monuments (Misc. Provisions) Act, 1999, and the Local Government (Planning and Development) Act 2000. Section 2.1 of the Heritage Act, 1995, describes architectural heritage as:-

> *'all structures, buildings, traditional and designed, and groups of buildings including streetscapes and urban vistas, which are of historical, archaeological, artistic, engineering, scientific, social or technical interest, together with their setting, attendant grounds, fixtures, fittings and contents, and, without prejudice to the generality of the foregoing, includes railways and related buildings and structures and any place comprising the remains or traces of any such railway, building or structure'.*

The Heritage Council was established by the Heritage Act. The Council seeks to promote the interest in, knowledge and protection of Irish heritage, including the architectural resource. The 1995 Heritage Act protects all heritage buildings owned by a Local Authority from damage and destruction.

The Architectural Heritage Act, 1999, requires the Minister to establish a survey to identify, record and evaluate the architectural heritage of the country. The function of the National Inventory of Architectural Heritage (NIAH) is to record all built heritage structures within the Republic of Ireland. Inclusion in an NIAH inventory does not provide statutory protection; the document is used to advise local authorities on compilation of a Record of Protected Structures as required by the Local Government (Planning and Development) Act, 2000.

Under the Local Government (Planning and Development) Act, 2000, all Planning Authorities are obliged to keep a 'Record of Protected Structures' of special architectural, historical, archaeological, artistic, cultural, scientific, social or technical interest. As of the 1st January 2000, all structures listed for protection in current Development Plans, have become 'protected structures'.

Since the introduction of this legislation, planning permission is required for any works to a protected structure that would affect its character. If a protected structure is endangered, planning authorities may issue a notice to the owner or occupier requiring works to be carried out. The Act contains comprehensive powers for local authorities to require the owners and occupiers to do works on a protected structure if it is endangered, or a protected structure or a townscape of special character that ought to be restored.

The Study Area covers the jurisdiction of Clare County Council; North Tipperary County Council and Limerick County Council. There are a number of protected structures within the town of Killaloe however there are four structures located directly within the Study Area that are protected:

1. Killaloe Bridge (RPS# 210 Clare County Development Plan 2005).

2. The canal bridge at O'Brien's Bridge (RPS# 193 Clare Co. Dev. Plan 2005).

3. O'Brien's Bridge (RPS# 215 Clare County Development Plan 2005; RPS# H1 (1) Limerick County Development Plan 2005).

4. Clarisford House at Moys, Killaloe (RPS# 441 Clare Co. Dev. Plan 2005).

4.1.3.4 Existing Environment

There are twenty-nine recorded archaeological sites located within the Study Area (see Table 4.19 and for further detail Appendix E of Volume C). It should be noted that whilst these are *recorded* archaeological sites, it is possible that further archaeological sites still remain undetected just below the present ground surface.

Table 4.19: Recorded Archaeological Monuments Located within the Study Area

Mon. No.[3]	National Grid	Townland	Classification
CL045-032---	16977, 17321	Knockyclovaun	Holy Well
CL045-033---	17018, 17296	Knockyclovaun/Shantraud	Historic Town
CL045-047---	16847, 17021	Cloonfadda	Fulacht Fiadh
CL045-04801-	16908, 17096	Cloonfadda	Standing Stone
CL045-04802-	16920, 17096	Cloonfadda	Standing Stone
CL045-04803-	16924, 17103	Cloonfadda	Standing Stone
CL045-049---	16960, 17176	Killestry	Enclosure
CL045-050---	17051, 17192	Moys	Cross (site of)
CL054-003---	16537, 16676	Ardataggle	Road
CL054-005---	16647, 16705	O'Brien's Bridge	Cist
CL054-006---	16689, 16796	O'Briensbridge	Enclosure
CL054-00701-	16716, 16721	O'Briensbridge	Church
CL054-00702-	16716, 16721	O'Briensbridge	Graveyard
CL054-008---	16725, 16756	O'Briensbridge	Enclosure
LI001-005---	16639, 16686	Montpelier	Bridge
LI001-006---	16683, 16691	Montpelier	Graveyard
TN025-008---	17010, 17321	Cullenagh (Templeachally Parish)	Weir
TN025-015---	17082, 17258	Ballina	Castle (possible Hall House)
TN025-016---	17079, 17243	Roolagh	Church & Graveyard
TN025-01901-	17102, 17233	Roolagh	Standing Stone
TN025-01902-	17098, 17228	Roolagh	Standing Stone
TN025-021---	17062, 17208	Friars Island	Holy Well
TN025-022---	17062, 17197	Friar's Island	Church (site of)
TN025-094---	17052, 17316	Ballina/Cullenagh	Town
TN025-09401-	17042, 17308	Ballina/Cullenagh	Bridge
TN025-09402-	17047, 17316	Ballina/Cullenagh	Tower House
TN025-09403-	17041, 17306	Ballina/Cullenagh	Weir
TN031-005---	16917, 16771	Birdhill	Standing Stone
TN031-006---	16945, 16764	-	Burial Ground

The Killaloe-O'Briensbridge area has been of considerable importance for millennia as the site of a number of fording points across the Shannon. The Shannon, throughout history and indeed today as evidenced by the pressing need for a new bridging point, offered a formidable barrier to land travel but also acted as an important north-south extending route for waterborne traffic. Control of fording points therefore gave the local community a considerable degree of power and wealth as it allowed the imposition of levies and tolls.

[3] The term 'Monument Number' or 'Mon. No.' refers to a coding system developed by the Archaeological Survey of Ireland for their *Sites and Monuments Record* (SMR) and *Record of Monuments and Places* (RMP). The system ensures that every known archaeological site in the country is accorded a unique reference number. The SMR/RMP consists of a computer database and a map register based on the Ordnance Survey's Six-Inch Map Series. The first two letters refer to the county and the next number referring to the relevant map sheet (i.e. for 'CL045-032--- the element 'CL045-' stands for OS map number 45 for County Clare). The next component relates to a specific site (i.e. 032--- stands for the thirty-second archaeological monument/site recorded on that particular map sheet).

Prehistoric Period

It is believed that as far back as the Neolithic Period (*c.*6000-4500 years ago) the area witnessed what have been termed "fording rituals" (Condit and O'Sullivan, 1996) which involved the deposition of stone axes in the river itself and on its flood plain close to fording points. In the Killaloe/O'Briensbridge area, up to 900 stone axes have been dredged from the river and its environs, a concentration which can hardly be accidental (see Appendix H of Volume C). In the Bronze Age (*c.* 4500-2,500 years ago) the practice continued with a number of bronze weapons (mainly swords and spearheads) being ritually deposited. These include two bronze daggers and three rapiers, and a small number of axe heads found on the river bed at Killaloe itself.

The area also contains a number of Neolithic / Bronze Age field monuments including a megalithic structure at Ross, a wedge tomb at Ardataggle, a *fulacht fia* or ancient cooking place at Cloonfadda (CL045-047---) and a large number of standing stones and stone pairs, for example at Roolagh (TN025-01901-/01902-), Birdhill (TN031-005---) Creeveroe and Cloonfadda (CL045-048---/04801-/04802-/04803-). This period, and the subsequent Iron Age (*c.* 2,500-1,500 years ago), may also have seen the establishment of a number of fortified sites guarding the fording points and the approaches thereto. These include the large trivallate hillfort recently discovered at Formoyle Beg *c.*10km west of Killaloe which it is believed guarded a major route from central Clare through the Broadford Gap to the Killaloe fording point. A similar hillfort occurs on the Tipperary side at Laghtea, north of Ballina.

Early Medieval Period (AD 400-1169)

The importance of the area continued into the Early Medieval Period (*c.* 1,500 –900 years ago) with the rise of the Dál gCais, also known as the O'Briens, who became Kings of Thomond and, under Brian Ború in the eleventh century, Kings of Ireland. Before moving their seat to Limerick in the late eleventh century, the dynasty was based in the Killaloe area and established residences at Kincora, Béal Ború, and Grianán Lachtna. Kincora was located within the site of the present town of Killaloe and no longer survives although some vestiges were still visible in the nineteenth century. The large ringfort known as Béal Ború, survives just north of the town, and Grianán Lachtna survives to the north-west of the town on the southeast slopes of Craglea. As well as these high status sites, the area also contains large numbers of more modest ringforts, which served as enclosed farmsteads in the Early Medieval Period. Probable examples include an enclosure at Killestry (CL045-049---) and two others at O'Briensbridge (CL054-006--- & CL054-008---).

There also appears to have been a Viking element in the community as evidenced by the rune-inscribed cross shaft which was found built into the Cathedral boundary wall in 1916. Tentatively dated to the early eleventh century by Macalister (1916, 497), the runic inscription reads "Thurgrim Risti Krus Thina" ("Thurgrim raised this cross"). Interestingly, the stone also bears an ogham inscription requesting a prayer for Thurgrim. The presence of Vikings at Killaloe is not surprising given its relative proximity to Limerick City, an important Viking town established in 922 AD. The ogham inscription suggests that at least some Vikings had successfully integrated into Irish society *c.*100 years later. Further evidence of Viking connections with Killaloe comes in the form of two Hiberno-Norse coins, minted in 1035 AD and 1070 AD, discovered at Béal Ború.

The Early Medieval Period is also associated with the arrival and spread of Christianity in Ireland. The earliest monastic foundation at Killaloe is associated with St Lua or Molua who is said to have been a seventh century saint and grandson of Eocha Baildearg, King of Munster (Lewis, 1837). He was succeeded by St. Flannan, perhaps in the eighth century, who is also reputedly to have been of royal lineage. The identities and historical position of these two saints is extremely uncertain. The site received a considerable degree of royal patronage from the O'Briens and under Brian Ború became the principal church in the kingdom of Dál gCais. This was despite the fact that Inishcealtra and Iniscathaig (Scattery Island) both had stronger claims to prestige and antiquity. They could not, however, compete with Brian's place of birth and in 1111 AD Killaloe became a diocesan see at the Synod of Rathbreasil.

The surviving ecclesiastical remains in the area date mostly to the twelfth century or shortly before. Perhaps the earliest structures occurred on Friar's Island, a small island south of Killaloe. Here a small oratory dedicated to St Lua (TN025-022---) stood until it was moved to the grounds of the Catholic Church in 1929-30 as part of the Shannon Hydroelectric Scheme. It is a small structure consisting of a nave and a chancel. The latter is roofed in stone. The dating of the oratory is uncertain but it is likely to be ninth – twelfth century. The oratory originally stood on the central part of the island protected by a surrounding revetment wall. Eleven burials were found on its northern side. A holy well (TN025-021---) described as a "pool of water probably fed by infiltration from the river" (Macalister 1929, 17) is located on the northern end of the island. A second small church, known as St Flannan's, stands in the grounds of the cathedral. It consists of a nave and chancel and is completely roofed in stone. The inclusion of a romanesque doorway in its western end suggests that the building is twelfth century in date. A cathedral is likely to have been erected by Brian Ború on the site's elevation to diocesan see but no trace of this building survives. The present cathedral dates to the early thirteenth century and is gothic in style. It incorporates a fine Romanesque doorway in its south wall, which is likely to be late twelfth century in date and probably belongs to a late twelfth century cathedral which preceded the present one. This may have been the cathedral built by Domnall Mor O'Brien *c.*1180. Other ecclesiastical sites within the area include Templeachally church and graveyard (TN025-016-) at Roolagh, a late medieval parish church, on the Tipperary side of the river, just south of Ballina, and Inishlosky Church and graveyard (CL054-00701-/00702-) a short distance upstream from O'Brien's Bridge.

Late Medieval Period (AD 1169-1600)

The importance of the Shannon crossing points continued into the Medieval Period with the establishment of castles at Ballina, Killaloe and O'Brien's Bridge and the fortifying of the associated bridges themselves. These crossing points became focal points for disputes and battles throughout the period and well into the post medieval period. Apart from a period of Norman rule in the thirteenth century when Edward I granted Thomond to Thomas De Clare, the Killaloe area remained under O'Brien influence throughout the medieval period and beyond - the O'Brien's were one of the few Gaelic families who managed to hold on to their territories and eventually entered the ranks of the landed gentry in the eighteenth century.

When the Normans first entered the area in 1207, they attempted to build a castle, perhaps an earthen and wooden structure (Barry 1987, 48), on the site of Béal Ború, but they failed in their efforts due to the persistent attacks from the O'Brien's. In 1216 Geoffrey de Marisco eventually succeeded in constructing a castle at Killaloe of which no trace survives today. The Killaloe crossing point appears to have been protected with a tower at each end: Ballina Castle (TN025-09402-) stood on the eastern bank and is likely to have been a late medieval tower house and a similar structure stood on the Killaloe side. The *Parliamentary Gazetteer of Ireland*, published in 1845, describes the fortifications as *"two ruinous castlets of the ante-Tudor era [which] occupy two small islets at the ends of the bridge"* (quoted on Clare Library website). Accounts of the battle at O'Brien's bridge in 1536 between Lord Deputy Grey representing the Crown and the O'Brien's mention the fact that the bridge was protected at each end by a stone fortification. The *"castell[s]" were "booth buylde within the water,* *somewhat distaunt from the land"* (Report of the Council of Ireland to Cromwell, quoted in Hodkinson 1998, 22-23). The ruins of a Cloghaneena Castle (TN025-015---) survive in Ballina townland just south of the town and overlooking nearby Templeachally Church. From the remaining masonry on-site, it seems that the castle may have had a multi-period usage and there is possible evidence for a bawn wall at its south-eastern corner.

Post Medieval Period (AD 1600-Present)

The sixteenth century was a turbulent time in Irish political matters. A new order of Irish lordships emerged as previous English settlements were almost eliminated. During the later sixteenth century the Irish lords came into bitter conflict with England when the Tudor kings and queens, particularly Elizabeth I, were determined to assert (or re-assert) English control tightly over Ireland. The resulting wars dating from the 1560s to 1603 bring this unsettled period to an end.

The eighteenth century was a time of prosperity for newly established Protestant gentry and landowners in Ireland. The success of the Protestant cause and the effective obliteration of political opposition brought to the country a century of peace. From 1691 until the Rebellion of 1798, Ireland witnessed few dramatic events. The eighteenth and nineteenth centuries were also a time for an upturn in industrial growth and this is demonstrated by the industrial archaeological features located within the Study Area such as bridges, the construction of canal waterways and the Shannon hydro-electric power scheme.

Throughout the eighteenth and nineteenth centuries, there was the development of high and low status housing and urban settlements throughout Ireland. In particular local landlords improved their estates and built residences for themselves. This is demonstrated in the environs of the proposed road development by country houses such as Clarisford House and demesne and Fort Henry Estate.

Bridges

The present stone bridges at Killaloe (TN025-09401-) and O'Brien's Bridge (LI001-005---) probably date to the seventeenth and eighteenth centuries respectively but both appear to have been preceded at various periods by wooden bridges (both bridges are protected structures). The first recorded bridge at Killaloe is mentioned in the Annals where a messenger from Brian Boru met with the king of Leinster *"at the end of the plank bridge of Cill Dalua"*. The date is not given but it was certainly in the period 1000-1014. There are no bridges marked on the Shannon at Killaloe or O'Brien's Bridge on the Down Survey map of 1656. In Moll's map of 1714, ferries are indicated at both locations and by the publication of Taylor and Skinner's atlas in 1778, bridges are indicated at both crossing points. The Annals of Ulster under 1510 mention *"a very good bridge of wood that was made by O'Briain across the Shannon"*. There is a further reference to O'Brien's Bridge in a report by the Council of Ireland to Cromwell in 1536 describing the Lord Deputy Grey's capture of the bridge with its fortification. It specifically describes the bridge as being of timber (Hodkinson 1998).

The building of a stone bridge at O'Brien's Bridge is believed to have begun on the Clare side in 1691. This initial phase consisted of six arches and was funded by John Brown of Clanboy at a cost of £800. The bridge on the Limerick side was a temporary structure built of wood and remained so for some decades. It is likely that the bridge was heavily reconstructed in the period 1757-1799 during navigation works on the Shannon. These works gave the bridge its present form of twelve segmental arches.

The 13-arched stone bridge at Killaloe is of uncertain date but there appears to have been a bridge erected here between 1715-1770. It has been considerably altered since, with several arches apparently being removed and enlarged on the building of the canal to allow the passage of large boats. In the early 1820s part of the centre of the bridge was damaged and had to be rebuilt.

Clarisford House Demesne

This fine house, situated *c.* 1.5km south of Killaloe, was originally built as a residence for the Church of Ireland Bishops of Killaloe. It was built by Robert Fowler while he was Bishop of Killaloe and Clonfert between 1771-1779. The property was sold into private ownership in 1977 and is a listed building (No. 441 in Clare County Council's Record of Protected Structures).

The house and much of the demesne survive and are well maintained although a certain amount of recent housing development has taken place on the west bank of the canal. The house itself is a three-storey, five-bay, over basement structure with a hipped roof. It has a central side-lit doorway with a shallow pedimented porch supported on Doric columns. There is a walled garden to the south of the house and a courtyard and ranges of farm buildings to the west. The original demesne entrance is located to the north and gives access to an avenue which splits in two, the easternmost branch leads to the house while the southernmost swings to the west of the house and allows access to the south end of the demesne. A section of the Limerick-Killaloe Canal built between 1750 and 1799 (described below) runs through the east part of the demesne. Features marked on the 1st edition OS map (surveyed in 1840) include an ice house located at the southern limit of the demesne, and a stone cross on the west bank of the canal, just east of the house. The ice house does not appear to survive. The stone cross (CL045-050--) indicated on the map is in fact a cross which was removed from Kilfenora in 1820 and re-erected at Clarisford by Bishop Mant (Kierse 1982, 28-9). It was subsequently moved by Bishop Ludlow Tonson (1839-62) to the position indicated on the OS map. Having been blown down in a storm, it was moved again in the early 1850s and was finally moved to St. Flannan's cathedral in 1934.

The Limerick-Killaloe Canal

The course of the river Shannon south of Killaloe is interrupted in places by rock outcrops, now largely invisible following flooding resulting from the Shannon Hydroelectric Scheme, which hindered the passage of boats to and from Limerick. In 1697 the first proposal was put forward to make the river navigable from Limerick City to Jamestown, Co. Leitrim. No works were undertaken, however, until the 1750s. In 1755 work commenced at Meelick under the supervision of an engineer named Thomas Omer who is believed to have been Dutch. Work in the Lower Shannon area began in Limerick in 1757 under an engineer called William Ockenden who was probably also Dutch. In 1767 the Limerick Navigation Company was set up to oversee the work and to levy tolls on river traffic. The canal itself opened in 1799 and consisted of three main stretches: the northernmost, cuts through Clarisford Demesne from just south of Killaloe Bridge; the second and longest stretch runs from south of O'Brien's Bridge to just east of Limerick; the third section runs through Limerick City itself. Between the sections of canal the river bed was deepened where necessary. The canal was important for the development of the tourist industry in the Killaloe area and also allowed the transport of heavy materials such as slate, which was quarried locally. Steamers were introduced on the Shannon in 1826 allowing more rapid travel but requiring further works to enlarge bridges and locks. By the 1860s the establishment of the railway led to a dramatic fall in river traffic. The canal became redundant in 1929 following the completion of the Shannon Hydroelectric Scheme, which raised the water level south of Killaloe.

The Shannon Hydro-Electric Scheme

In 1924 a plan was proposed to build a hydroelectric dam on the Shannon. The area south of Killaloe was deemed particularly suited due to the large volume of water and the 30m fall in gradient between Killaloe and Limerick. The contract for the dam at Ardnacrusha and the associated works including the construction of a Headrace Canal from south of Killaloe to Ardnacrusha, was awarded to a German Company, Siemens Schuckert. Work began in 1925 and was completed in 1929. The scheme had a substantial impact on the area. It resulted in a new linear waterway, the Headrace Canal, with its associated retention banks and bridges. It also necessitated the removal of St Lua's Oratory from Friar's Island. Finally, it resulted in the flooding and division of agricultural holdings.

4.1.3.5 Route Option Assessment

Route 1 – Assessment of Cultural Heritage Impacts

This route (refer to Figure 4.11 of Volume B) is orientated east/west, located *c.* 0.5 kilometres south of O'Brien's bridge. The area to the easternmost extent of the route runs in line with a modern track way, which has a drain running parallel to it (Ch. 1,500 - 900). The route veers right, heading northwest into a field away from the track way. Some modern residences run along the road perpendicular to this track way. Some of the gardens connected with these houses extend for some distance to the rear; one is used for the husbandry of horses. The field behind these gardens is flat with very rough grazing. The field boundary has a stream/drain running northeast/southwest (Ch. 670). The area is quite marshy. There is no extant evidence of archaeology here. To the west in the adjoining field is an area of archaeological potential. Situated in the north-east section of the field, running into the northern field boundary is what can be loosely defined as a pair of curvilinear, semi-circular parallel banks running southeast/northwest.

An L-shaped drain running north/south then east west is located from the middle of the field to the earthen banks on the shore of the river (Ch. 550-400). The first edition map revealed that at the time of survey (1840) the area was liable to flooding. The drains may have been an addition to alleviate the excess water. The northwest section of this field exhibited some interesting but undefined earthen features, which warrant detailed geophysical investigation (see below).

On the western side of the river there is little evidence for archaeological activity. The section between the river and the Headrace Canal runs uphill from the river to the canal and cuts through a raised pathway (Ch. 280) firstly on the edge of the river with a ditch or dry channel *c.* 3m deep on its western side. To the north and outside the route but of notable significance, is what could loosely be defined as a stone bridge with a single parapet on its eastern face.

The route then becomes overgrown and slopes upwards to the road/laneway, which runs parallel to the canal. A noteworthy feature on the banks of the eastern bank of the Headrace Canal is a protruding section (Ch. 120), which appears to be an outcrop of natural bedrock, exhibiting modern alterations. Its purpose is unclear but may be associated with the Ardnacrusha hydro-electric power station downstream.

Across the canal to the west the area was overgrown with trees, sloping to the east. The area was inaccessible.

Assessment of Cultural Heritage Impacts

- This route does not impact on any visible archaeological features. It does however impact on a number of drains in Montpelier townland, which are indicated on the 1st edition OS map. These are probably not of any great antiquity and are most likely to be associated with eighteenth/nineteenth century land improvement works.

- The raised pathway mentioned above (Ch. 280), which is cut by the route, may be a tow path associated with late eighteenth century works to make the river navigable.

- The route also impacts on the headrace of Ardnacrusha hydro-electric dam. The dam itself is listed as structure No. 311 in Clare County Development Plan 2005.

- As with all the other proposed routes, this option may have an impact on the bed of the Shannon at the proposed bridging points. It should be noted that the stretch of river between Killaloe and Castleconnell has produced large numbers of prehistoric artefacts, probably due to ritual deposition, and so the river bed itself can be seen as archaeologically sensitive.

Geophysical Evaluation

The area to the west of the river is too overgrown to be conducive for effective geophysical survey and another means of testing should be implemented considering the proximity of this area to the river and the historical propensity for anthropogenic activity in such areas.

It is recommended that intensive geophysical survey be implemented on the eastern side of the river. The field adjacent to the river (as described above) exhibited interesting raised earthen features whose identification would benefit from a detailed magnetic gradiometry survey. Considering that this area has been historically liable to flooding and is quite marshy, electrical resistivity survey could prove fruitless since the electrical current would simply dissipate into the moisture.

The field adjacent to the east of this area is heavily overgrown with grass and shrub. Any survey should be conducted outside the spring or summer seasons as the grass would be lower and easier to traverse. It is recommended that detailed magnetic gradiometry would act as an efficient survey method at this location.

Route 6 – Assessment of Cultural Heritage Impacts

This route (refer to Figure 4.12 of Volume B) is oriented generally east/west, approximately 1.2 kilometres south of the Killaloe/Ballina bridge. The area to the easternmost extent of the proposed route proved difficult to survey due to access denial at the time of assessment. Consultation of the SMR maps revealed a dearth in archaeological evidence in this area. Inspection of the area from the property boundary was unhelpful. It appears the area near the road is significantly overgrown. There is a nineteenth century lodge, associated with Fort Henry House, immediately to the south of the route starting point. From map evidence the route also appears to cut through an embankment, probably part of the disused Great Southern Railway Killaloe Line, running along the eastern bank of the Shannon (Ch. 1400). Further south of the proposed route, along the railway embankment is a granite, cut stone railway bridge located under the access avenue of the Fort Henry Estate from the public road, however this will not be directly impacted.

What is immediately apparent about the section of the route on the western side of the Shannon is the possible implications of the development on the estate landscape associated with the eighteenth century Clarisford House. The house is located approximately 250 metres due north of the centre of this proposed route and is typical of mansion estates found in Ireland in the late eighteenth and nineteenth century. The house is surrounded by trees and out-buildings to the north and west and a substantial walled garden to the south.

The proposed route will affect the southerly section of the original estate. To the east and south of the walled garden is an extensive area of mature woodland (Ch. 500) most probably associated with the original estate. The walled garden is a common feature in estate landscapes of this period as are formalised ponds and ice houses which are both listed on the 1st edition OS map of the estate but on inspection however, no evidence for these two features were found. This was probably due to the significantly heavy brush and tree growth in this area, which ultimately made archaeological reconnaissance difficult.

However, a well, marked on the 1st edition OS map, was indeed evident within the woodland area. It is dry stone lined well, stepped on the north side with a water outlet on the south side. Beside this well and running through the woodland is a wood lined walkway which runs from the southern part of the wooded area from its western side, to a paved area approximately forty metres away to the south west. A ring of six mature beech trees is evident to the east of the wooded area, most probably associated with the estate landscape and in close proximity to the proposed route.

The estate wall runs (discontinuously in places) the entire length from the estate gate to the north to the lake to the south. East of this, in a large field (Ch. 460-300), presently used to graze horses are two features of archaeological potential. The first is an earthen feature, defined as an irregular oval depression measuring approximately 20-30m north/south and approximately 1.5 - 2m at its deepest, below surrounding ground level. This feature is indicted on the 1938 OS map but not on the 1st Edition OS. The second feature is what appears to be a standing stone, which is not marked on any map. Consequently it was initially assumed to be a rubbing stone for grazing animals, however, the main faces of the stone appear to be roughly dressed. The stone is rectangular in cross section, measuring 1.4m in height, 38cm at its maximum width and 28cm at its maximum base width. The stone and the earthen feature are situated directly within the proposed route (Ch. 400 and 460 respectively).

Moving west there are two fields affected by the route (Ch. 300-0). Both areas are of rough pasture, sloping gently to the east and are marshy in places. A feature marked as a hachured enclosure on the 1st edition OS map (CL045-049---) was investigated but although a raised area is evident there is no bank or ditch evident.

Assessment of Cultural Heritage Impacts

- This route involves a number of significant impacts.
- It cuts through the line of the Great Southern Railway Killaloe Line, running along the east bank of the Shannon.
- It cuts through part of the Limerick-Killaloe Canal just north of Moys Lock.
- It impacts on Clarisford Demesne, passing through an avenue and passing close to both a tree ring (landscape feature) and a well.

- It impacts physically on an area of archaeological potential, indicated as a hachured oval feature on the 1938 OS, south/southwest of Clarisford House in the southern part of Moys townland.

- It impacts physically on a standing stone, which has hitherto not been noted on maps. It is located close to the feature described above, southwest of Clarisford House, in the southern part of Moys townland.

- As with all the other proposed routes, this option may have an impact on the bed of the Shannon at the proposed bridging point. It should be noted that the stretch of river between Killaloe and Castleconnell has produced large numbers of prehistoric artefacts, probably due to ritual deposition, and so the river bed itself can be seen as archaeologically sensitive.

Geophysical Evaluation

This route has revealed areas of significant archaeological potential and the implementation of geophysical survey would prove useful in determining the archaeological extent of such areas.

The area east of the woodland is heavily overgrown and has high-powered electrical pylons throughout and is thus not conducive to archaeo-geophysical survey. However, the area to the west is ideal for detailed magnetometry survey since it contains little or no obstacles or ferrous interference. It should be noted that the electrical pylons do run in the field adjacent to this area and it is generally recommended as a geophysical survey convention that a distance of 40m is maintained away from these types of interference due to the amplitude of their magnetic signal.

In considering the archaeological potential of estate landscapes such as these, it is generally recommended that in any areas conducive to detailed survey or reconnaissance survey using magnetic susceptibility a geophysical programme should be implemented.

Routes 7a, 7a and 7a

These three routes (refer to Figures 4.13, 4.14 and 4.15 of Volume B) are situated a short distance south of Killaloe and Ballina. They share a common starting point and end point. Route 7a is the southernmost route while Route 7c is the northernmost.

Route 7a – Assessment of Cultural Heritage Impacts

Route 7a (refer to Figure 4.13 of Volume B) begins on the R494, *c.*500m south of Ballina (Ch. 920). It initially runs in a west/southwest direction across a field of pasture, which slopes gently down to the west. In the north-western corner of this field is an overgrown mound. The proposed route crosses a line of trees and undergrowth forming the western border of the field and separating it from the bank of the river (Ch. 820-800). This corresponds with the line of the Great Southern Railway Killaloe line. It was not possible to gain access to this area due to the undergrowth. The route then traverses the Shannon, clipping the northern part of Friar's Island (Ch. 750) before reaching the west bank of the river. It was not possible to gain access to this area from the landward side due to the wooded nature of the terrain. The route traverses the Limerick-Killaloe Canal at this point (Ch. 650) and then crosses a plot of dense woodland (Ch. 600-460), which slopes up to the west. The route then crosses a private roadway, giving access to Clarisford House, and continues in a westerly direction across a field of level pasture. Clarisford House stands immediately to the south of the route and its upper storey is visible above a screen of trees. The route then traverses a second private road associated with Clarisford House and continues in a west/north-west direction across an area of pasture, which slopes gently to the west. On the western side of this field it crosses a stream and substantial field boundary (Ch. 150), corresponding to the boundary between Moys and Killestry townlands. It then crosses an area of waste ground occupied by a disused warehouse and bounded on its northern side by an area of dense woodland before joining the R463 *c.*1km southwest of Killaloe.

Assessment of Cultural Heritage Impacts

- The proposed Route 7a does not impact on any visible archaeological features however one area of concern is Friar's Island which is an area of high archaeological potential and the site of recorded ecclesiastical remains (TN025-021---/022---).

- On the east bank of the river the route passes through a field of rough pasture in the north-western corner of which is a low overgrown mound which will require testing to ensure that it is not an archaeological feature.

- The route will also have an impact on Clarisford House demesne. It traverses two avenues, one accessing the house itself and the other to the southern part of the demesne, which are both indicated on the 1st edition OS map. The house is not physically impacted upon but there may be a visual impact as the route passes *c.* 70m to the north of its front façade. Of the three routes (7a, 7b, and 7c) proposed in this area, 7a passes closest to Clarisford House.

- The route also physically impacts on a section of the Limerick-Killaloe Canal, which was constructed in the second half of the eighteenth century. It also cuts through the disused line of the Great Southern Railway Killaloe line on the east bank of the Shannon.

- As with all the other proposed routes, this option may have an impact on the bed of the Shannon at the proposed bridging point. It should be noted that the stretch of river between Killaloe and Castleconnell has produced large numbers of prehistoric artefacts, probably due to ritual deposition, and so the river bed itself can be seen as archaeologically sensitive. In 1997 a portion of the river bed between Roolagh and Moys townland was monitored by archaeologists during pipe-laying works but nothing of archaeological significance was found (excavation licence no. 97E0135).

Geophysical Evaluation

Moving westwards, the route branches off from the R494; impacting upon the modern residence into which access was denied at the time of survey. Consequently geophysical evaluation could not be made of this area. However, when viewed from the adjacent landholding, over the property boundary, that the grounds around the residence are quite densely planted with tree and plants. These variables ultimately mean the area would not be conducive to geophysical survey. The trees blocked visibility beyond this area.

Route 7a is the only route, which impacts any of the islands on the river. On the day of survey this area was inaccessible. However, when viewed from the western bank of the Shannon, it was observed that the island is heavily overgrown and not conducive to geophysical survey.

On the western side of the Shannon Route 7a impacts a wooded area in which geophysical survey could not be carried out. The route extends into an area associated with Clarisford House and its demesne landscape. The route traverses the area to the north of the house itself which is characterised by large open field systems with modern boundaries with one mature deciduous tree growing in the most eastern field. Considering the archaeological sensitivity of this area, it is recommended that intensive geophysical survey be utilised in this area and more specifically, magnetic susceptibility in conjunction with more intensive magnetic gradiometry. Where the possibility of buried masonry or foundations is suspected, complementary electrical resistivity should be implemented.

The route then moves into an area, which is entirely unsuitable for the methods of geophysical survey mentioned above. It extends westwards through a drain system then into an area with a modern warehouse, various heavy machinery and intensive accumulations of modern ferrous rubbish. The entire area is covered in concrete. Geophysical survey cannot be undertaken at this location. In addition, no offsets from the main routes can be surveyed due to tree growth on either side. The route then terminates at the R463, which runs north into Killaloe.

Route 7b – Assessment of Cultural Heritage Impacts

Route 7b (refer to Figure 4.14 of Volume B) begins on the R494, *c.*500m south of Ballina. It initially runs in a westward direction across a field of pasture, which slopes gently down to the west (Ch. 900-820). In the north-western corner of this field, on the line of the route, is an overgrown mound (Ch. 840). The proposed route crosses a line of trees and undergrowth forming the western border of the field and separating it from the bank of the river. This corresponds with the line of the Great Southern Railway Killaloe line (Ch. 800). It was not possible to gain access to this area due to the undergrowth. The route then traverses the Shannon and the Limerick-Killaloe Canal. Again, access to this area was not possible from the landward side. After crossing an area of dense woodland the route traverses a private roadway (Ch. 450), giving access to Clarisford House, and continues in a westward direction across a field of level pasture. Clarisford House stands immediately to the south of the route and its upper storey is visible above a screen of trees. The route then crosses a second private road (Ch. 360) associated with Clarisford House and continues in a west/southwest direction across an area of pasture which slopes gently up to the west. It clips the corner of an area of woodland and then continues across the pasture land. On reaching the western boundary of this field it crosses a stream and part of a discontinuous demesne wall (Ch. 150) before entering the corner of an area of dense woodland. It then re-emerges to follow the north-eastern boundary of an area of wasteland occupied by a disused warehouse. It joins the R463 *c.* 1km south-west of Killaloe.

Assessment of Cultural Heritage Impacts

- The proposed Route 7b does not impact on any known archaeological features. On the east bank of the river the route passes through a field of rough pasture in the northwest corner of which is a low overgrown mound, which will require testing to ensure that it is not an archaeological feature.

- The route will also have an impact on Clarisford House Demesne in that it traverses two avenues, one accessing the house itself and the other to the southern part of the demesne, both of which are indicated on the 1st edition OS map. The house is not physically impacted upon but there may be a visual impact as the route passes *c.* 160m to the north of its front façade.

- The route also physically impacts on a section of the Limerick-Killaloe Canal, which was constructed in the second half of the eighteenth century. It also cuts through the disused line of the Great Southern Railway Killaloe line on the east bank of the Shannon.

- As with all the other proposed routes, this route may have an impact on the bed of the Shannon at the proposed bridging point. It should be noted that the stretch of river between Killaloe and Castleconnell has produced large numbers of prehistoric artefacts, probably due to ritual deposition, and so the river bed itself can be seen as archaeologically sensitive. In 1997 a portion of the river bed between Roolagh and Moys townland was monitored by archaeologists during pipe-laying works but nothing of archaeological significance was found (excavation license no. 97E0135).

Geophysical Evaluation

Moving westwards, the route branches off from the R494; impacting upon the modern residence into which access was denied at the time of survey. Consequently geophysical evaluation could not be made of this area. However, when viewed from the adjacent landholding, over the property boundary, it could be seen that the grounds around the residence are quite densely planted with tree and plants. These variables ultimately mean the area would not be conducive to geophysical survey. The trees blocked visibility beyond this area.

The route extends into an area associated with Clarisford House and it's estate landscape. The route traverses the area to the north of the house itself which is characterised by large open field systems with modern boundaries with one mature deciduous tree growing in the most eastern field. Considering the archaeological sensitivity of this area, it is recommended that intensive geophysical survey be utilised in this area and more specifically, magnetic susceptibility in conjunction with more intensive magnetic gradiometry. Where the possibility of buried masonry or foundations is suspected, complementary electrical resistivity should be implemented.

The route then moves into an area, which is entirely unsuitable for the methods of geophysical survey mentioned above. It extends eastwards through a drain system then into an area with a modern warehouse, various heavy machinery and intensive accumulations of modern ferrous rubbish. The entire area is covered in concrete. Geophysical survey cannot be undertaken at this location. In addition, no offsets from the main routes can be surveyed due to tree growth on either side. The route then terminates at the R463, which runs north into Killaloe.

Route 7c – Assessment of Cultural Heritage Impacts

Route 7c (refer to Figure 4.15 of Volume B) begins on the R494, *c.*500m south of Ballina. It initially runs in a west direction across a field of pasture, which slopes gently down to the west. In the north-western corner of this field, on the line of the route, is an overgrown mound (Ch. 850). The proposed route crosses a line of trees and undergrowth forming the western border of the field and separating it from the bank of the river. This corresponds with the line of the Great Southern Railway Killaloe line (Ch. 800). It was not possible to gain access to this area due to the undergrowth. The route then traverses the Shannon and a section of the Limerick-Killaloe Canal. Again, access to this area was not possible from the landward side. After crossing an area of dense woodland the route runs through a recently constructed dwelling (Ch. 490) and its grounds. It then traverses a private roadway (Ch. 450), giving access to Clarisford House, and continues in a westerly direction across the northern tip of a field of level pasture. Clarisford House stands a short distance to the south of the route and its upper storey is visible above a screen of trees. The route then traverses a second private road (Ch. 410) associated with Clarisford House and continues in a west/south-west direction across an area of pasture, which slopes gently to the west. It enters an area of dense woodland (Ch. 340-260) and then re-emerges to continue across the pasture land. On reaching the western boundary of this field it crosses a stream and part of a discontinuous demesne wall (Ch. 150) before entering the corner of an area of dense woodland. It then re-emerges to follow the north-eastern boundary of an area of wasteland occupied by a disused warehouse. It joins the R463 *c.* 1km south-west of Killaloe.

Assessment of Cultural Heritage Impacts

- The proposed Route 7c does not impact on any known archaeological features. On the east bank of the river the route passes through a field of rough pasture in the northwestern corner of which is a low overgrown mound which will require testing to ensure that it is not an archaeological feature.

- The route will also have an impact on Clarisford House demesne in that it traverses two avenues, one accessing the house itself and the other to the southern part of the demesne, which are both indicated on the 1st edition OS map. The house is not physically impacted upon but there may be a visual impact as the route passes *c.* 180m to the north of its front façade.

- The route also impacts physically on a section of the Limerick-Killaloe Canal, which was constructed in the second half of the eighteenth century. It also cuts through the disused line of the Great Southern Railway Killaloe line on the east bank of the Shannon.

- The route will involve the removal of a modern dwelling however this is not of cultural heritage significance.

- As with all the other proposed routes, this option may have an impact on the bed of the Shannon at the proposed bridging point. It should be noted that the stretch of river between Killaloe and Castleconnell has produced large numbers of prehistoric artefacts, probably due to ritual deposition, and so the river bed itself can be seen as archaeologically sensitive. In 1997 a portion of the river bed between Roolagh and Moys townland was monitored by archaeologists during pipe-laying works but nothing of archaeological significance was found (excavation license no. 97E0135).

Geophysical Evaluation

Moving westwards, the route branches off from the R494; impacting upon the modern residence into which access was denied at the time of survey. Consequently geophysical evaluation could not be made of this area. However, when viewed from the adjacent landholding, over the property boundary, that the grounds around the residence are quite densely planted with tree and plants. These variables ultimately mean the area would not be conducive to geophysical survey. Visibility beyond this area was blocked by the trees.

On the western banks of the river Route 7c impacts on a modern residence into which access was denied and visibility to the rear of the house was impossible, thus assessing the geophysical suitability of this area could not be achieved.

The route extends into an area associated with Clarisford House and it's estate landscape. The route traverses the area to the north of the house itself which is characterised by large open field systems with modern boundaries with one mature deciduous tree growing in the most eastern field. Considering the archaeological sensitivity of this area, it is recommended that intensive geophysical survey be utilised in this area and more specifically, magnetic susceptibility in conjunction with more intensive magnetic gradiometry. Where the possibility of buried masonry or foundations is suspected, complementary electrical resistivity should be implemented. However, Route 7c impacts on a wooded area for a portion through this area, which would not be feasible for surveying.

The route then moves into an area, which is entirely unsuitable for the methods of geophysical survey mentioned above. It extends westwards through a drain system then into an area with a modern warehouse, various heavy machinery and intensive accumulations of modern ferrous rubbish. The entire area is covered in concrete. Geophysical survey cannot be undertaken at this location. In addition, no offsets from the main routes can be surveyed due to tree growth on either side. The route then terminates at the R463, which runs north into Killaloe.

Comparison of Impacts of the Proposed Route Options

From the perspective of minimising potential impacts on cultural heritage resources and the level of direct physical impact on these features, it is considered that Route 1 has the highest merit though Routes 7b and 7c are only marginally worse. Route 7a is the least preferred option from a cultural heritage perspective, as it would involve higher amount of impacts on known and potential cultural heritage sites. Route 6 also poses a high risk of encountering archaeological remains as well as carrying a series of direct physical impacts on cultural heritage features.

Table 4.20: Comparison of Alternative Routes

Route	Impacts	Preference
Route 1	(1) Partial physical removal of 18th/19th century drains (2) Partial physical removal of possible late 18th century tow path (3) Partial physical interference of Ardnacrusha Headrace (4) Likely disturbance / removal of an area of high archaeological potential on the Shannon riverbed	1st (Most preferred)
Route 6	(1) Partial physical removal of the Great Southern Railway Killaloe Line (2) Partial physical interference of the Limerick-Killaloe Canal (3) Partial physical modification of elements associated with Clarisford House demesne (avenue; tree-ring and well) (4) Likely disturbance / physical removal of an area of high archaeological potential S/SW of Clarisford demesne (5) Total physical removal of standing stone located SW of Clarisford house (6) Likely disturbance / removal of an area of high archaeological potential on the Shannon riverbed	4th

Route	Impacts	Preference
Route 7a	(1) Potential for partial/full physical removal of sub-surface archaeological features on Friar's Island (2) Partial physical destruction of potential archaeological feature on east river bank (3) Partial physical destruction of Clarisford House demesne (two access avenues) (4) Visual impact on north façade of Clarisford House (5) Partial physical destruction of Limerick-Killaloe Canal (6) Partial physical destruction Great Southern Railway Killaloe Line (7) Likely disturbance / removal of an area of high archaeological potential on the Shannon riverbed	5th (Least preferred)
Route 7b	(1) Partial physical destruction of potential archaeological feature on east river bank (2) Partial physical destruction of Clarisford House demesne (two access avenues) (3) Visual impact on north façade of Clarisford House (4) Partial physical destruction of Limerick-Killaloe Canal (5) Partial physical destruction Great Southern Railway Killaloe Line (6) Likely disturbance / removal of an area of high archaeological potential on the Shannon riverbed	2nd (joint with Route 7c, only marginally different from Route 1)
Route 7c	(1) Partial physical destruction of potential archaeological feature on east river bank (2) Partial physical destruction of Clarisford House demesne (two access avenues) (3) Visual impact on north façade of Clarisford House (4) Partial physical destruction of Limerick-Killaloe Canal (5) Partial physical destruction Great Southern Railway Killaloe Line (6) Likely disturbance / removal of an area of high archaeological potential on the Shannon riverbed	2nd (joint with Route 7b, only marginally different from Route 1)

4.1.3.6 Conclusions and Recommendations

From the perspective of minimising potential impacts on cultural heritage resources, it is considered that Route 1 has the highest merit though Routes 7b and 7c, both of equal merit, are considered only marginally worse. Route 6 is less preferred after Routes 1, 7b and 7c due to the level of direct physical impact on known and potential cultural heritage features. Route 7a is the least preferred option from a cultural heritage perspective, as it would involve a higher amount of impacts on known and significant cultural heritage sites.

Irrespective of the route that is chosen, it is important that a programme of archaeological mitigation be undertaken at pre-construction stage which may involve geophysics, test-excavation and/or monitoring along the selected route option, particularly in the areas of archaeological potential that have been identified from field survey. Furthermore, it is imperative that the relevant agencies of State with responsibility for archaeological heritage be made aware of the selected route and that representatives of the relevant County Councils ensure that all requirements of these agencies are addressed.

4.1.4 Underwater Archaeology

4.1.4.1 Introduction

The pre-development assessment, geophysical surveys and site investigations were conducted by Mr. Donal Boland under guidelines and acquisition parameters as recommended by the Maritime Unit of The Department of the Environment, Heritage and Local Government.

The Killaloe-O'Briensbridge area has been of considerable importance for millennia as the site of a number of fording points across the Shannon. The Shannon throughout history, and indeed today as evidenced by the need for a new bridging point, offered a formidable barrier to land travel, and also acted as an important north-south route for waterborne traffic.

The full text of the underwater archaeology report is included as Appendix I of Volume C. A summary of the principal findings and the recommendations are included here. Further details of the features referred to in this section are provided in the report in Appendix I.

Site surveys and investigations at the location of the proposed crossing Route 7 revealed two features SS2 an area of collapsed drystone wall and M3 a drystone culvert which are of archaeological interest. The magnetic anomaly M4 should be treated as an area of possible archaeological potential.

4.1.4.2 Recommendations and Ranking of Proposed Routes

General

The riverbed at the location of all the proposed crossings should be treated as areas of high archaeological potential.

The flooded landscape at the location of the proposed Routes 6 & 7 should be treated as an area of very high archaeological potential as this area was inundated prior to the development of modern archaeological surveys and records.

The results of survey revealed no features which would prohibit the construction of a crossing at any of the locations under consideration.

When the engineering design is complete, it is recommended that the riverbed within the area of impact of the proposed construction works be subject to a further detailed assessment.

Route 1

Site surveys and investigations at the location of the proposed crossing Route 1 revealed no features, which could be interpreted as being archaeological.

Nine magnetic anomalies M1-M9 were interpreted from the survey record. Of these, the anomalies M3-M6 are within or adjacent to the construction zone of the proposed crossing Route 1. The magnetic anomalies M3, M4, M5 and M6 should be treated as areas of possible archaeological potential.

The construction of a crossing at the location of Route 1 will not impact on a flooded landscape as would be the case for Route 6 or 7.

Consequently, Route 1 is the most preferred location for construction of a crossing.

Route 6

Site surveys and investigations at the location of the proposed crossing Route 6 revealed no features, which could be interpreted as being archaeological.

Construction of a crossing at the location of Route 6 will impact on or adjacent to an area of riverbed which has apparently been disturbed by previous modern river crossings, possibly cables or a pipeline.

Route 6 is the second preference location for construction of a crossing.

Route 7a

Site surveys and investigations at the location of the proposed Route 7a revealed no features, which could be interpreted as being archaeological.

Construction of a crossing at the location of Route 7a will possibly impact on an area of riverbed which was previously an island on which a holy well was located. No evidence of this holy well was identified by way of the surveys conducted.

Route 7a is the third preference location for the construction of a crossing.

Route 7b

Construction of a crossing at the location of Route 7b will possibly impact on the feature SS2 (dry-stone wall), which is of archaeological interest, and the unidentified magnetic anomaly M4. The magnetic anomaly M4 should be treated as an area of possible archaeological potential.

Site surveys and investigations at the location of the proposed crossing 7b revealed a feature SS2 (dry-stone wall) which will require further investigation to determine its archaeological importance, prior to it being impacted by engineering works associated with the proposed crossing.

Route 7b at Killaloe/Ballina is the least preferred location for the construction of a crossing.

Route 7c

Site surveys and investigations at the location of the proposed Route 7c revealed no features, which could be interpreted as being archaeological.

Construction of a crossing at the location of Route 7c will possibly impact on an area of riverbed which is adjacent to the features M3 (stone culvert) and SS2 (dry-stone wall) which are of archaeological interest, and the unidentified magnetic anomaly M4. The magnetic anomaly M4 should be treated as an area of possible archaeological potential.

Route 7c is the fourth preference location for the construction of a crossing.

Ranking Summary

The ranking of routes from most to least preferred is Route 1 – Route 6 – Route 7a – Route 7c – Route 7b.

4.1.5 Landscape and Visual

4.1.5.1 Introduction

A landscape and visual impact assessment has been undertaken to aid in the route selection of a crossing of the River Shannon, near the towns of Killaloe/Ballina and O'Briensbridge/ Montpelier. This assessment evaluates the implications of the five routes under consideration, Routes 1, 6, 7a, 7b and 7c, in terms of landscape character and visual amenity that will potentially occur due to the proposals.

4.1.5.2 Methodology

The landscape assessment follows the methods described in the Design Manual for Roads and Bridges Volume 11, Section 4, Part 2 (Chapter 2), for a Stage Two Report (DMRB, 1999). The report sets out to make a comparative assessment of the likely impacts, environmental advantages, disadvantages and constraints associated with each route. The appraisal of each route begins with a description of the existing landscape setting to establish baseline conditions.

The landscape context, classification and sensitivity are described in the following Section 4.1.5.4 which will assess the impact each route will have on the landscape character of the surrounding environs. Assessment was undertaken through analysis of up to date maps and aerial photography in conjunction with detailed plans and sections of the route proposals. Site visits were undertaken during the spring and summer, to assess the routes. Assessment has therefore been judged on a “best-case” basis when, due to leaf cover being at a maximum, any potential visual implications or alterations would be less apparent.

The landscape assessment follows the methods described in the Design Manual for Roads and Bridges Volume 11, Section 3 (Chapter 9) for Stage Two Assessment (DMRB, 1999). The objective is to undertake sufficient assessment to identify the landscape and visual factors and the likely effects upon them, which are taken into consideration in developing and refining the route options. The landscape has been appraised to allow it to be described and classified into landscape character types, which enables the categorisation of landscape quality. The routes are then applied to this baseline and potential impacts recorded.

The capacity of a landscape to accept change of the type proposed is assessed. The key landscape components are landform, vegetation and historical and cultural components. Landform relates to topography, drainage problems and geology. Historical and cultural components include historic landscapes, listed buildings, conservation areas and historic designed landscapes.

4.1.5.3 Existing Environment

The Constraints Study Report for this project, published in May 2005, identified the basic landscape character and the sensitivity of the landscape in the vicinity of O'Briensbridge/ Montpelier and Killaloe/Ballina. The report identified constraints and opportunities within the Study Area.

The greatest landscape and visual constraints identified were:

- The historical character and heritage-oriented theme of the town centres, particularly Killaloe and O'Briensbridge.
- Scenic Route R463 between O'Briensbridge and Killaloe, within the Study Area.
- Rural, agricultural, and scenic landscape character of lands surrounding the R463, Co. Clare.
- Open exposed lowlands with low growing vegetation, and long distance views.
- Distant ridgelines, high in elevation, overlooking the Study Area, Co. Clare.
- Areas of mature woodland or carefully managed estate grounds.

Features in Study Area potentially absorbing landscape and visual impacts were identified as:

- Modern, newly-developed character of the Killaloe/Ballina town fringes.
- Well-established hedgerows and stands of trees.
- Undulating terrain and sloping contours, intruding upon long-range views across the valley.

The rural countryside is scenic with distant views to Ballykildea Mountain and associated foothills as a backdrop. However the mountain and hills are distant in proximity to the proposed routes and do not act as constraints to development.

For the purposes of the assessment the Study Area has been divided into two sectors: lands east of the Shannon, and lands west of the Shannon. The proposals seen to cause the minimum amount of adverse impact, have been selected in each sector.

4.1.5.4 Landscape Assessment

As previously described, the landscape assessment follows the methods described in the Design Manual for Roads and Bridges Volume 11, Section 3 (Chapter 9) for Stage Two Assessment (DMRB, 1999). Further reference was made to Guidelines for Landscape and Visual Impact Assessment by The Landscape Institute (LI) and Institute of Environmental Assessment (IEA) 1995.

The LI and IEA Guidelines describe landscape impacts as follows:

> *"Landscape impacts include the direct and indirect impacts of the development upon the landscape elements and features as well as the effect upon the general landscape character and quality of the surrounding area."*

The previous Constraints Study Report (May 2005) identified the basic landscape character types in the Study Area. For the purposes of this report it will be necessary to examine the landscape character in more detail to establish the degree of impact each of the routes has upon the landscape character.

Landscape Character Classification

Data pertaining to existing landscape character and visual amenity was collected through desk studies and field studies. Analysis of the collected data enabled the landscape resources to be sorted into units of distinct and recognisable character, by application of the following criteria:

- Landform - Important visual characteristics related to landform, e.g., visual containment by ridgelines, or distant hills.
- Landcover and landscape elements - Important visual elements in the landscape; historical, cultural, or natural.
- Aesthetic Features - The most basic components of the landscape/townscape by which an opinion about quality can be reached, e.g. balance of the elements, scale of the landscape in human terms, sense of enclosure, type of texture, sense of colour, extent of diversity.
- Condition of the Landscape - The amount of regard shown for the landscape.
- Sensitivity to change - the ability of the landscape to accept change without fundamentally destroying the character.

Landscape Sensitivity

The sensitivity of the landscape can be assessed according to the following categories:-

- **Not sensitive:** The landscape can absorb development of any scale without any negative change to the existing character.
- **Slightly sensitive:** The landscape would tolerate development of a small scale.
- **Moderately sensitive:** The landscape would only tolerate small-scale development of very sensitive design.
- **Highly sensitive:** The landscape would not tolerate development without changing the existing character.

Landscape Character Types

The route selection field assessment identified the following distinct landscape character types:-

- Undulating Agricultural Land.
- Mature Woodland/Woodland Fringe.
- Killaloe/Ballina Urban Fringe.
- Estates and Demesnes.
- Dike and canal System.
- Coniferous Plantation.

The locations of these areas are shown on Figures 4.16 and 4.17 of Volume B.

Undulating Agricultural Landscape

The dominant landscape type in the area is characterised by irregularly shaped fields with robust (often tree-lined) hedgerows designating boundaries, in places with stands of trees. Farm buildings, rural residences, and country lanes are scattered throughout the countryside. The topography within this landscape character type is gently rolling, often more level around the riverside, and is part of a greater plain stretching between the Ballykildea Mountain range to the northwest and the Ballina ridgeline to the northeast, extending south. Small streams and larger watercourses such as the Ardcloony and Ballyteige Rivers cross the plain feeding into the River Shannon.

This landscape is of a large enough scale to absorb changes related to a river crossing without destroying the overall character. The changes that occur locally will be mostly contained by the undulating landscape, and potential for landscape mitigation is high given the existing vegetated character. Overall, this particular landscape character type is **slightly sensitive** to change.

Mature Woodland Landscape/Woodland Fringe

Mature woodland and associated woodland fringe is located in several places within the Study Area. The uninterrupted treeline of such woodland blocks makes up an integral portion of the skyline, when viewed from the lowlands of the Shannon valley, as well as from the ridgelines paralleling the river to the east and west. Any clearing of woodland done in conjunction with the proposed river crossing will potentially result in permanent loss of part of the existing woodland, which is an important component of the rural landscape. Likewise, most woodland blocks potentially affected by the various route options are not of a significant enough scale to visually absorb change, should the proposed alignment adversely impact upon them during construction and operational phases of the proposal. Therefore it can be concluded that the deciduous woodland/fringe landscape character areas within the route corridor are considered in this assessment to be **highly sensitive** to change.

Killaloe/Ballina Urban Fringe

The urban fringe of Killaloe/Ballina is divided between many new-built residential areas and industrial/commercial areas, both which differ in form and function and have different characters. The industrial/commercial areas are robust landscapes that can tolerate further development. Notwithstanding, the residential areas on the fringe of the town are built to take advantage of the rural landscape. Consideration is also given to the fact that relief of local traffic congestion in town fringe and urban areas is considered to be a positive impact upon completion of most relief road and river crossing schemes. Overall, the portion of town fringe landscape within the Study Area is considered in this assessment to be **slightly sensitive.** Where individual residences are concerned, the severity of the impact upon individual properties would largely depend on distance between the property and the proposed river crossing and associated roads.

Estates and Demesnes

Fort Henry and Clarisford House estates are two properties falling under this landscape character category. Fort Henry will not be impacted by the route options.

The estates and demesnes landscape character type is an important landscape both historically and visually. The grounds were carefully designed to enhance the natural features of the landscape, for the benefit of the main house. The estates have matured and developed since, many examples of this type of landscape have been lost in Ireland. The estate lands are not therefore capable of absorbing large scale changes, without destroying their existing character. The demesnes and estates are **highly sensitive** to change.

Dike and Canal system

At O'Briensbridge, the Headrace Canal and dike system runs parallel to the Shannon, west of the town centre. The canal itself is significantly higher in elevation than the River, and is bound on either side by grassed dikes, currently grazed by sheep. A bridge currently crosses the canal, linking O'Briensbridge town to the R463. Coniferous plantations are planted on either side of the canal, providing visual enclosure from most outside views, around the section potentially affected by the proposed river crossing. This is a scenic landscape character type that includes formally manicured grassy slopes, fencing or other type of boundary marking elements, and is conducive to adjacent walking trails, grazing, and use by small boats. The dike and canal system landscape is **highly sensitive** to change.

Coniferous Plantation

Several locations within the Study Area are comprised of coniferous plantation. Species found within the plantation areas include coniferous species at heights between 2-15m. The plantations are dense farms of closely planted, non-native species, which form a significant visual entity within the viewshed evident from many viewpoints across the river valley. Currently, the section of plantation bisected by the Headrace Canal is used for trail walking, by visitors and locals, south of O'Briensbridge.

The dense nature, evergreen characteristics, and vast expansion of the plantations ensure that the effect of a road passing through the affected area will be minimal, and have less impact on plantation areas, compared to the previously described mature deciduous woodland. However, this same dense nature ensures that any potential cutting made through such a plantation will appear as evident fragmentation of a consistent tree-line, when viewed against the horizon. Overall this landscape character type is considered to be **slightly sensitive** to change.

Comparative Landscape Impact Assessment

Landscape and visual impact terminology used in this assessment is summarized in Tables 4.21 and 4.22.

The potential change in landscape character due to each of the proposed routes is described using the following scale. Table 4.22 indicates the significance criteria used to describe the extent to which the proposal changes the landscape with respect to landscape features.

Table 4.21: Terminology: Scale of Change *

SCALE OF CHANGE	DESCRIPTION OF SCALE
ADVERSE	A change that reduces the quality of the visual environment or adversely affects the character of the landscape.
NEUTRAL	A change, which does not affect the quality of the landscape.
POSITIVE	A change, which improves the quality of the landscape.

* Taken from EPA Guidelines on information to be contained in EIS, Glossary of Impacts (2002)

Table 4.22: Terminology: Significance/Degree of Impact

DEGREE OF IMPACT	GENERAL DESCRIPTION
IMPERCEPTIBLE/ NO IMPACT	An impact capable of measurement, but without noticeable consequences
SLIGHT IMPACT	An impact which causes noticeable changes in the character of the environment, without affecting its sensitivities
MODERATE IMPACT	An impact that alters the character of the environment in a manner that is consistent with existing and emerging trends
SIGNIFICANT IMPACT	An impact which, by its character, magnitude, duration or intensity alters a sensitive aspect of the environment
PROFOUND IMPACT	An impact which obliterates sensitive characteristics

Using the terminology set forth in the above tables, the following assessment matrix was constructed for each route, focusing on the eastern extents of the Study Area:-

Table 4.23: East of Shannon Sector Landscape Character Assessment

Key Landscape Elements/Character Types	Route 1	Route 6	Route 7a	Route 7b	Route 7c
Undulating Agricultural Landscape	**Significant Adverse**	**No Impact**	**Slight Adverse**	**Slight Adverse**	**Slight Adverse**
Killaloe/Ballina Urban Fringe	N/A	**No Impact**	**No Impact**	**No Impact**	**No Impact**
Mature Woodland/fringe	**Slight Adverse**	**Significant Adverse**	**Slight Adverse**	**Slight Adverse**	**Slight Adverse**
Estates and Demesnes	N/A	N/A	N/A	N/A	N/A
Dike and canal system	N/A	N/A	N/A	N/A	N/A
Coniferous plantation	N/A	N/A	N/A	N/A	N/A
Ranking	Intermediate	Worst	Equally Best	Equally Best	Equally Best

Analysis: East of Shannon Sector

The landscape character areas encountered by the five routes in the east of Shannon sector consist of Undulating Agricultural, Urban Fringe, and Mature Woodland landscapes. These are catagorised as slightly sensitive (undulating agricultural, urban fringe) and highly sensitive (mature woodland), respectively. Therefore, routes crossing less mature woodland landscapes, comparatively, will cause less landscape impact.

While all routes would yield a moderately positive landscape impact on the town centres of Killaloe and Ballina by relieving existing traffic congestion, the physical river crossings set within the urban fringe landscapes (Routes 6, 7a, 7b and 7c) will not alter the character of the fringe itself.

The overall distance travelled by Route 1, east of the Shannon, is greater, and crosses a larger expanse of undulating agricultural land in the rural town of Montpelier, than the remaining routes, in their Ballina town fringe locations. Therefore, the route would potentially have a greater degree of adverse impact on undulating agricultural lands, comparatively. Route 1 would subsequently require a greater scale of earthworks, or possibly a larger scale bridge structure, and more alterations to the existing landform than the remaining options, giving the landscape character impact of Route 1 an overall adverse impact of a slight-to significant degree, making it less ideal than Routes 7a, 7b, and 7c, which pass through only minimal stands of mature vegetation, at the river's edge, and along property boundaries.

In the same manner, the lands west of the River Shannon were also assessed, and compiled into the following landscape character assessment matrix:

Table 4.24: West of Shannon Sector Landscape Character Assessment

Key Landscape Elements/Character Types	Route 1	Route 6	Route 7a	Route 7b	Route 7c
Undulating Agricultural Landscape	**Slight Adverse**	**Slight Adverse**	**Slight Adverse**	**Slight Adverse**	**Slight Adverse**
Killaloe/Ballina Urban Fringe	N/A	**No Impact**	**No Impact**	**No Impact**	**No Impact**
Mature Woodland/fringe	**Significant Adverse**	**Significant Adverse**	**Significant Adverse**	**Slight Adverse**	**Slight Adverse**
Estates and Demesnes	N/A	N/A	**Significant Adverse**	**Slight Adverse**	**Slight Adverse**
Dike and canal system	**Significant Adverse**	N/A	N/A	N/A	N/A
Coniferous plantation	**Moderate Adverse**	N/A	**No Impact**	**Slight Impact**	**Slight Adverse**
Ranking	Equally Worst	Intermediate	Equally Worst	Equally Best	Equally Best

Analysis: West of Shannon Sector

The landscape character types in the west of Shannon sector consist of all the previously listed landscapes. All routes will have a slight adverse impact on undulating agricultural lands, as they will necessitate the addition of traffic infrastructure into an otherwise undeveloped, rural landscape. However this is a landscape type that is more conducive to absorbing landscape impact than other more highly sensitive types.

Route 1 is likely to have the greatest adverse impact upon local landscape character, as it would include the provision of two separate crossing structures, one which would cross the Headrace Canal and dike system, and one which would cross the River Shannon. The addition of two new structures and a heightened component of passing traffic into the rural lands south of O'Briensbridge, would have a significant adverse landscape impact on the character of O'Briensbridge town and its surrounding rural outskirts. Two landscape character types of high sensitivity (Dike and canal system, Mature Woodland/fringe) would be significantly impacted in an adverse nature, making Route 1 the least favourable, within the western sector of the Study Area.

Route 7a is equally less favourable, west of the Shannon, as the route would also significantly impact upon two landscape character types of high sensitivity (Mature Woodland/fringe, Estates and Demesnes), in an adverse manner. The route crosses lands belonging to Clarisford Estate, necessitating the removal of mature mixed woodland to the east of the Clarisford House, and pasture land with mature trees to the north of the house.

Route 6 is within close proximity to the highly sensitive Clarisford Estate, gardens, and associated woodland vegetation. The route will likewise yield an adverse impact on a number of robust, tree-lined hedgerows in the agricultural fields between the R463 and the river, through which it passes in its westernmost extents. This, in combination with the fact that Route 6 is the longest in length (thereby yielding greater construction impacts and necessitating a larger footprint than other options), it would likely yield a greater degree of adverse impact on the landscape west of the River Shannon, than the remaining routes 7b and 7c, which would, subsequently be more favourable for the west of Shannon sector.

Overall Comment on Landscape Impacts of Route Options

Findings show that based on landscape character impacts alone, the western sector of the Shannon crossing options is more highly sensitive than the eastern extents.

The adverse landscape impacts arising from any Shannon crossing on the O'Briensbridge/ Montpelier area will be significant due to the nature of road construction and projected use in an area sensitive to change. O'Briensbridge is a small, rural village with a compact town centre and small population, within undeveloped agricultural lands, woodland, a wildlife sanctuary, and dike/canal system. Crossing the Shannon at O'Briensbridge town would require the crossing of 2 watercourses: the river itself and a smaller canal. A new crossing structure at the location of Route 1 will both improve the quality of the town centre by relieving traffic, and simultaneously adversely impact the landscape character of the surrounding undeveloped environs, river amenity and amenity associated with the Headrace Canal and the local wildlife sanctuary. From a landscape character perspective, the location of Route 1 is not favourable to the landscape character through which it passes, albeit favourable to the landscape character of the nearby town of O'Briensbridge.

Killaloe and Ballina are evolving towns with robust town centres and a continually expanding urban fringe. Entities such as service stations, modern dwellings, an abandoned warehouse (at western extents of Routes 7a, 7b and 7c), existing junctions of local and national roads with high traffic flow are currently found in the fringe areas either side of the River Shannon. Residences in the fringes of the towns are gradually spreading southward, in a linear manner along the R463 and R494. A new residential development has been proposed for lands currently covered in coniferous plantation, at the junction of proposed Routes 7a, 7b, and 7c and the R493. As the urban fringe landscape character types are more likely to absorb infrastructure development than rural landscapes, those options set within the immediate fringe of the larger towns will likely be the most successfully absorbed by the landscape.

4.1.5.5 Visual Assessment

Both east and west sectors of the Study Area are characterised by undulating topography, descending into the Shannon river valley at the proposed crossing points. The preliminary landscape assessment identified the ridgelines as possible visual constraints within this area, as they provide several viewpoints overlooking the river itself, and subsequently the potential crossing points and associated roads. It also identified mature vegetation such as blocks of woodland along the river, agricultural hedgerows and tree stands, or existing roadside hedgerows, as providing potential screening and limiting the extent of visual intrusion by a river crossing structure.

Viewers predicted to be adversely impacted by the five route options include residents within close proximity to the route tie-ins with the R494 and R463, or the river itself, and those situated in areas of higher elevation overlooking the River Shannon. Existing road users, particularly those on the R494 and R463 (a designated scenic route), local amenity users, and river traffic are also considered to be sensitive visual receptors affected by the proposal (refer to Figure 4.18 and 4.19 of Volume B).

The most significant visual constraint in the Study Area is the rising topography on either side of the River Shannon, providing clear views to the river valley from a variety of elevated viewpoints. Sensitive visual receptors located in high elevations will have wide viewsheds, taking in a larger panorama than those situated immediately adjacent to the river crossing or associated link roads. Therefore these residences will observe the proposed crossing as a small element within a wide field of view, while visual receptors closer to the crossings will be more severely impacted by the larger scale of the structure, in their viewshed.

Figures 4.18 and 4.19 of Volume B illustrate predicted sensitive visual receptors for each option, including motorists, river traffic, and residents. However, it should be noted that visual impacts on individual residences in rural and fringe areas should be assessed individually, for individual degrees of impact, when a preferred route is selected. For this assessment, all routes are assumed to impact on similar numbers of properties.

Analysis: Visual

Potential visual impacts and benefits associated with Route 1 include:-

- Removal of significant mature trees and hedgerows in the Shannon river valley between Montpelier outskirts and the river, as well as significant scrub and woodland between the river and canal, minimising screening potential.
- Intersection of the "Lough Derg Way" amenity/walking trail, west of Shannon River.
- Significant reduction in visual amenity of the Headrace Canal and public walk to Falls.
- Route 1 includes construction at the highest elevations of all options, (at potential canal crossing point) thereby becoming the most visually exposed of all routes, and disrupting continuous skyline when viewed from the east, by fragmenting existing conifer plantation immediately west of canal.
- Proposed Shannon bridge would be in close proximity and thereby within the same viewshed as the existing bridge, when viewed from O'Briensbridge and Montpelier towns and residents in town outskirts. This would add constraints to the aesthetic design of the proposed structure, to fit in with the existing structure.

- Route 1 is approximately 150m longer, than Routes 7a, 7b and 7c, increasing its potential visual impact, comparatively.

Potential visual impacts and benefits associated with Route 6 include:-

- Reduction in visual amenity and character from Clarisford Estate.
- New junction required at meeting point with designated Scenic Route R463.
- Views to Route 6 are not within the same viewshed as the existing Killaloe/Ballina bridge, minimising constraints upon visual appearance and design of bridge structure.
- Proposed access road to bridge east of the Shannon will cut through existing woodland, which has the capacity to visually absorb the road between the R494 and the river crossing.
- Existing robust hedgerows in the agricultural lands west of the Shannon have the capacity to aid in visually absorbing the road between the R463 and river crossing.
- Route 6 is between 40m and 200m longer than Routes 1, 7a, 7b and 7c, increasing its potential visual impact, comparatively.

Potential visual impacts and benefits associated with Route 7a include:-

- Major disruption to Clarisford demesne including fragmentation of pastoral area, fragmentation of woodland, landscaped gardens, and reduction in visual amenity and character from the house.
- New junction required at meeting point with designated Scenic Route R463.
- Proposed access road to bridge east of the Shannon will cut through existing woodland, which has the capacity to visually absorb the road between the R494 and the river crossing.
- Existing robust hedgerows in the agricultural lands west of the Shannon have the capacity to aid in visually absorbing the road between the R463 and river crossing, if retained.
- Existing coniferous plantation north of Route 7a in western extents currently provides potential for visual screening from views north of the route, however this area is proposed for future housing.
- The viewshed within which Route 7a would cross the River Shannon does not contain the existing structure at Killaloe/Ballina, minimising constraints upon visual appearance and design of bridge structure.
- Undulating topography east of the River Shannon is relatively steep at the proposed crossing point, ensuring a high degree of visual enclosure for the bridge itself, and eastern leg of access road, when viewed from Ballina fringe. This creates a situation in which views to Route 7a from residences in the Ballina fringe will be mostly confined to the westernmost extents of the route.

Routes 7b and 7c are relatively similar in alignment, with the most extreme differences occurring in the midsection where the two routes diverge north of Clarisford Estate. When compared against one another for overall ranking, Route 7c would prove more favourable than Route 7b, as Route 7c would be more amply screened by existing mature woodland, provided the existing woodland on either side of the option would be retained. Route 7b would be comparatively more exposed to views from the south.

Potential visual impacts and benefits associated with Routes 7b and 7c include:-

- Fragmentation of mature, mixed woodland immediately west of River Shannon (Route 7b more so than Route 7c).
- New junction required at meeting point with designated Scenic Route R463.
- Fragmented woodland/plantation west of river provides an element of visual screening, particularly when viewed from north of Routes 7b and 7c, however this area is proposed for future housing.
- The viewshed within which Routes 7b and 7c would cross the River Shannon does not contain the existing structure at Killaloe/Ballina, easing constraints on visual aesthetics of the structure itself.
- Undulating topography east of the River Shannon is relatively steep, ensuring a high degree of visual enclosure for the bridge itself, and eastern leg of access road, when viewed from Ballina fringe. This creates a situation in which views to Routes 7b and 7c from residents in the Ballina fringe will be mostly confined to the westernmost extents of the options.

Overall Comment on Visual Impacts of Route Options

When viewed from the east sector of the Study Area, the proposed Routes 6, 7a, 7b and 7c bridge structures will be largely contained, visually, by the existing steep contours of the Ballina fringe, east of the Shannon. This indicates that the lands west of the Shannon have a higher visual sensitivity than the lands to the east. Those routes necessitating the highest amount of land take on the west side of the river, such as Route 6, will likely prove to have a high level of visual impact, compared to those alignments which meet the existing road with as little need for link road construction, as possible.

Existing potential for screening by existing vegetation of the routes is most favourable for Routes 1 and 7a, 7b and 7c, as the westernmost extents of these routes passes through or adjacent to land planted with coniferous tree stands. However, Route 1 would prove to be comparatively less favourable in this aspect, as the road would visibly fragment a block of plantation, yielding an adverse impact on the skyline, while Routes 7a, 7b and 7c would all pass by the outskirts of a plantation, and not affect the plantation block in an adverse visual manner.

In conclusion, each route will have a degree of adverse visual impact on various sensitive visual receptors such as residences, river traffic, and motorists on routes R494 and R463. Each route has the potential for visual mitigation (screening) measures to be implemented at a more detailed design stage, as the majority of lands traversed by the options consist of existing vegetation, which is possible to be enhanced and supplemented through sensitive landscape design.

4.1.5.6 Conclusions

In assessing how a route would affect the existing landscapes and visual amenity the following factors were considered:

- The extent to which the road will be visible in the landscape (refer to Figures 4.18 and 4.19 of Volume B).
- The character of the landscape and its capacity to accept changes of the type and scale proposed.
- The extent to which impacts can be mitigated and the road can be integrated into the landscape.

An assessment of the impact of the proposed routes on the landscape character is summarised in the first column of Table 4.25 below, on a 3-point scale of Worst-Intermediate-Best. The negative impacts arising from the routes in the Study Area relate to the quality and sensitivity of the landscape types affected. Opportunities for absorbing the impact of road realignment into the landscape are confined to existing vegetation, the existing nature of development in the urban fringe, contours of undulating lands surrounding the River Shannon, and future landscaping strategy. However, some landscape types offer better mitigation potential than others, as shown in Table 4.25. Generally low-lying agricultural land provides for more natural, landscape-based mitigation opportunities than estate and demesne landscapes, or dike and canal systems. This can be seen by the rankings of the less-favourable Routes 1 and 7a, in the categories of “Landscape Fit” and “Mitigation Potential”.

The visual fit of each route into the landscape is assessed within the second column in Table 4.25. This category assesses the routes and the potential fit of each within the existing landscape character described in Section 4.1.5.4. Using both the predicted visual impact locations as shown in Figures 4.18 and 4.19 of Volume B, and the road design drawings, the impacts of each option are appraised. Routes that are most likely to have the best fit will generally be routes that are aligned along existing topographical contours; are set low in the local landform; and avoid listed structures, areas of public amenity or cultural value, ridges, and open landscapes.

Table 4.25: Analysis of Impacts on the Landscape for Each Route

Route	Landscape Fit	Visibility Fit	Mitigation Potential	Overall Rating
1	Worst	Worst	Moderate	5th – Least preferred
6	Intermediate	Best (Equal)	Easy	3rd
7a	Worst	Worst	Moderate	4th
7b	Best	Intermediate	Easy	2nd
7c	Best	Best (Equal)	Easy	1st – Most preferred

When landscape and visual impacts of the routes are considered, there is little difference between them, however Route 7c and its landscape impact on the least amount of sensitive character types as well as its visual mitigation potential due to existing woodland vegetation and visual enclosure by topography is the preferred route overall. Of the remaining Routes, 7b followed by 6, 7a, and 1 would be the remaining preferences as shown in Table 4.25 above.

4.1.6 Human Environment

4.1.6.1 Introduction

This section of the report considers the potential impacts of Routes 1, 6, 7a, 7b and 7c for the new Shannon Bridge Crossing on the human environment of the Study Area.

4.1.6.2 Methodology

The human environment section is based on site visits, review of aerial photographs and relevant reference material and consultation with appropriate authorities.

For evaluation of the proposed routes on the local human environment, all residential, commercial and educational properties are identified within a 300m band from each of the routes. The Constraints Study for the project, completed in May 2005, identified and described the human environment constraints, and this section assesses the impact of the proposed routes on these constraints.

While this assessment represents a route selection report, due cognisance was given to the following Environmental Protection Agency's (EPA) documents:

Advice notes on Current Practice (in the preparation of Environmental Impact Statements) (EPA, 1995).

Guidelines on the Information to be contained in Environmental Impact Statements (EPA, 2002).

4.1.6.3 Existing Environment

During the Constraints phase of the Project, the existing constraints within the entire Study Area which may affect the project were identified and described in the Constraints Report. The following issues were discussed in the Section 5: Physical Constraints:-

- **Community and Business**
    - Community Activities
        - *Police Boundaries*
        - *Fire Station*
        - *Hospitals*
        - *Schools*
        - *Churches*
    - Sports, Leisure and Recreation Facilities
        - *Playing Fields*
        - *Tennis*
        - *Golf*
        - *Lough Derg Equestrian Centre*
        - *Leisure Craft and Watersports*
        - *Tourism*
        - *Recreation*
    - Retail, Commercial and Industrial Activities
    - Agricultural Activity

- **Planning and Land Ownership**
  Planning Constraints (Applications)
  Land Holdings
  Planning Land Usage (Zoning)

The existing human environment was discussed further in Section 6: Environmental Constraints under the following headings:-

- **Human Environment**
  Development Context
  The Resident Community
  The Working Community
  The Visiting Community

The impact of each of the routes under consideration on these constraints has been assessed, and is discussed below under each of the route assessments.

4.1.6.4 Route Options Assessment

Community and Business

Each of the route options will fall under the jurisdiction of the Killaloe sub-district police, served by Killaloe Garda Station and speed limits on the new bridge will be enforced by them.

The fire station at Killaloe will not be impacted by any of the proposed routes.

One of the schools, St. Anne's Community College, Clarisford in Killaloe, is within 300m of routes 7b and 7c. This is discussed further under the Assessment of Routes 7b and 7c. The remaining schools identified within the Study Area, during the constraints stage, will not be affected by the proposed routes.

The proposed routes will affect none of the churches identified during the Constraints Study.

Sports, Leisure and Tourist Activities

The playing fields associated with St. Anne's Community College are the only playing fields located within 300m of any of the routes. This is discussed further under the Assessment of Routes 7b and 7c. The remaining playing pitches identified by the Constraints Study will not be affected by any of the routes.

Retail, Commercial and Industrial Activities

None of the retail, commercial or industrial activities identified within the Study Area during the Constraints Study will be affected by the various route options. There is however some commercial/tourist activity at Clasiford Palace which may be affected by routes 6 and 7. This is discussed under the route options assessment of Routes 6 and 7.

Planning and Landownership

Recent planning applications granted or pending are shown in the Constraints Study Report. Those which may be potentially affected by each of the proposed routes are identified for each route below. Further information is required on planning application 98/1963, (houses/ apartments at Moys) to determine if this application is affected.

Land use and zoning plans are shown in Figures 3.16 to 3.21 of the Constraints Report.

Fig. 5.20 of the Constraints Study Report shows an Infrastructure Safeguard corridor for the proposed Shannon Bridge Crossing which approximately corresponds to the currently proposed Route 7b. This corridor is taken from the East Clare Draft Local Area Plan (2004) and is referenced therein on page 155.

Adjacent Properties

All properties, residential, commercial, industrial and educational, situated within 300m of the route centre lines have been identified. These include those that were occupied, newly constructed and derelict. Table 4.26 illustrates the property counts for each of the routes.

Table 4.26: Property Counts for Each of the Routes

Route	1	6	7a	7b	7c
Residential	34	21	51	52	54
Commercial (Inc. Farms/B&Bs)	5	3	1	1	2
Industrial	1	0	1	1	1
Educational	0	0	0	1	1
Disused Commercial	0	0	1	1	1
Total Properties	40	24	54	56	59

The table illustrates that all routes will have residential and commercial properties within 300m. Routes 7b and 7c in addition will also have one educational property, St. Anne's Community College at Killaloe, within 300m of their centre lines. Route 6 has the least number of properties within 300m of its centreline and, therefore, would be preferred over Route 1 and Routes 7. Routes 7a, 7b and 7c are the most densely populated residential areas so potential impacts to those properties will be greatest. Potential impacts on the environment of each of these properties is addressed separately in the noise, agriculture and landscape and visual sections of this Route Selection Report.

Route 1

The existing landuse at Route 1 is predominantly agricultural with some lands zoned for residential development and lands with existing residential development. The western end of Route 1 crosses forested lands which are owned by the E.S.B.

No planning applications are affected.

Route 1 contains 34 residential and 5 commercial properties, including 3 farms within 300m of its centre line. There will be potential impacts on the properties in this area, which are addressed in the noise and the landscape and visual environment section of this report. Potential impacts on agriculture are addressed in Section 4.1.7 of this report.

Route 6

The landuse at Route 6, on the eastern side of the River Shannon is predominantly residential and the route passes through an undeveloped plot within an area zoned as “pressure area”. On the western side of the River Shannon, lands around Moys were acquired by Clare Co. Co. from the ESB on the basis that they be developed as a public amenity for the area. No formal planning application in respect of this work has yet been made. Construction of Route 6 would limit the development potential of this area as a public amenity and this would be considered an adverse impact on the human environment of the Study Area as a whole.

There is a pending planning application by St. Flannan’s Fishing Club to erect a boathouse and tackle room at Moys. This is south of the ESB line and would not be directly affected but the area would be indirectly affected by the construction of Route 6.

Route 6 contains a total of 21 residential and 3 commercial properties within 300m of the centre line of the route, the least number of properties impacted by any of the routes.

Routes 7 – General

Routes 7 all have a common start and end point with broadly similar land uses throughout. On the eastern side of the River Shannon, the land use is predominantly residential, and the route passes through an undeveloped plot. At the west end, Routes 7 pass through a property where planning permission for 32 houses (Portard Developments Ltd.) has recently been granted, but it is understood that an appeal is pending to An Bord Pleanala. A 20m reservation for the roadway along the southern boundary of this planning permission has been made and the route will therefore not affect this development. A limited encroachment into the adjoining undeveloped property to the south of this development may be required.

Landuse at routes 7b and 7c is predominantly residential and the centre line of the routes will pass within 300m of St. Anne’s Community College and playing fields, however the current access to the school will not be affected.

Route 7a

Route 7a passes through an undeveloped plot on the west side of the River Shannon where planning permission has been granted for one house and outline planning permission granted for a second house.

The route contains a total of 54 properties within 300m of the centre line of the route. The route passes north of Clarisford Palace which is situated on private grounds with recently constructed holiday residences, which are rented to visitors to the area. There is potential for adverse impacts arising from noise and from visual intrusion which may impact on this house and associated holiday accommodation, and which are addressed in the noise and the landscape and visual environment section of this report.

Route 7b

This route contains a total of 56 properties within 300m of the centre line of the route. The route passes between and close to two modern homes, which will potentially experience adverse impacts from noise and visual intrusion. The centre line of this route is within 300m of St. Anne’s Community College at Killaloe, and there is potential for adverse noise impacts on the school. Access to the school is from the R493 and construction of this route would therefore not impact upon access to and from the school.

No planning applications are affected by this route.

Route 7c

This route contains a total of 59 properties within 300m of the centre line of the route, the greatest number of all the route options. Route 7c will require the complete acquisition of one substantial modern house, and is the only route with such a requirement. It will also pass in close proximity to a new house currently under construction. Route 7c therefore potentially has the most severe adverse impact for any of the routes in terms of potential impacts on the human environment within 300m of the proposed routes. The centre line of this route is also within 300m of St. Anne's Community College at Killaloe. Access to the school is from the R463 and construction of this route would therefore not impact upon access to and from the school.

No planning applications are affected by this route

4.1.6.5 Conclusion

In the context of the local human environment located within 300m of the centre line of each route, Route 6 is considered the favoured option, followed by Route 1 as these routes will impact on the least number of existing residential properties. Routes 7 (a, b and c) are broadly similar containing the greatest number of existing residential receptors and are therefore considered to be the least favoured options. Route 7c, the least favoured of the Route 7 options, would require complete acquisition of one modern house and pass close to a new house currently under construction. Route 7b would pass close between two modern houses. Route 7a would pass closest to the Clarisford Estate.

Conversely, in the context of the potential impacts on the human environment of the Study Area as a whole, cognisance should be given to the potential of a public amenity area at Moys, which may not be realised or would be significantly adversely affected should Route 6 be constructed. The proposal for development of this area as a public recreation area is within the public domain and it can be anticipated that construction of a bridge at this location and immaterialisation of this proposal could be considered a negative impact on the human environment of the Study Area.

4.1.7 Agriculture

4.1.7.1 Methodology

The potential impact of each of the proposed routes on agriculture has been assessed. Three methods were used to assess the proposed routes and the potential impact these routes may have on agriculture:-

- Desktop study using the CSO, Census of Agriculture, June 2000, aerial photography and mapping.
- Windscreen survey of the Study Area.
- Discussions with local landowners regarding current agricultural practices within the Study Area.

Fields with obvious paddock grazing systems and/or yards observed with milking facilities were assumed to be involved in dairying. Other grass fields with no evidence of being used for dairying or that had sheep or beef animals grazing were assumed to be involved in drystock. Stud railing and/or bloodstock in fields were categorised as horse or drystock/horse enterprises. Fields with cereal stubble or growing a cereal or vegetable crop were categorised as tillage.

Potential Impact

The potential impact on an individual farm is based on a number of factors:-

- Degree of severance;
- Enterprise type;
- Farm buildings removed;
- Land take; and
- The overall size of the holding

Degree of Severance

The degree of severance has been determined for each land parcel affected by the route with four categories used as shown in Table 4.27.

Table 4.27: Degree of Severance

Degree of Severance	Criteria
None	No severance
Minor	Small portion of land severed or boundary ditch encroached by the road.
Moderate	Land severed to such a degree that access would have to be provided to ensure day to day farming could continue. Additional management will be required but effect of route will not prevent current enterprises from continuing.
Significant	Land divided into multiple portions. May be difficult for current enterprise to continue.

Significance of Impact on Enterprise Type

Dairy farms and other livestock farms where stock are moved on a daily basis are generally the most vulnerable to severance caused by the proposed alignment. A reduction in the areas available for grazing may lead to a reduction in stock numbers and could subsequently result in income reduction or a reduction in the viability of the farm.

Stud farms may also be severely impacted, as equine stock is prone to stress caused by irregular stimuli such as noise and/or moving vehicles. Such stress may render individual land parcels unsuitable for grazing equine stock. In some cases fields left in an irregular shape (e.g. triangle shaped fields, fields with sharp/narrow corners) may also be unsuitable for grazing with equine livestock due to possible damage caused to animals turning in these tight corners.

Drystock enterprises (e.g., beef, sheep) are generally less severely impacted as these animals are more placid by nature and are not usually moved on a daily basis. Most impacts on these farms can be mitigated if the overall impact caused by severance and loss of land is not classified “Severe”.

Tillage farms are generally less severely impacted than dairy or stud farms as machinery can move with relative ease from one land parcel to another. Triangulation of fields or the reduction in field size may lower the productivity of machinery operation in a field and decrease area-based payments.

Farm Buildings

Removal or severance of farm buildings may significantly impact on the day-to-day management of a farm and in the case of dairy farms may make the continuation of the enterprise unviable.

Farm Size

The overall farm size will reflect impact significance. The division of a single field on a large farm may result in a minor impact when assessed in relation to the total farm size, whereas the division of a similar sized field on a small farm may put at risk the viability of that farm.

Degree of Impact

The overall impact of the scheme on agriculture and the affect of the scheme on individual farms are assessed taking into account all the above factors. Categorisation of the level of significance on the individual farms is shown in Table 4.28.

Table 4.28: Significance of Impact

Significance of Impact	Criteria
No significance	Farm is not affected by the scheme or the scheme may encroach slightly on a boundary causing a slight inconvenience.
Minor	Scheme causes a small inconvenience but does not require a significant change in current management practices. Mitigation would overcome any problems.
Moderate	Scheme causes a degree of severance that will cause a change in management practices. No changes should occur in current enterprises although there may be an increase in labour charges or machinery costs. Mitigation measures should overcome most difficulties.
Major	Possible change in enterprise due to severance, land take or loss of buildings. This change would usually occur with dairy or stud farms changing to drystock or tillage. The impact would require a significant change in management practices with associated costs. This level of impact would require considerable mitigation measures and not all difficulties would be overcome.
Severe	Farming operations can no longer continue. No mitigation measures would overcome impact.

4.1.7.2 Existing Environment

Agriculture in County Clare

There are a total of 6,720 farms in Clare with an average size of 31.3 hectares, which is similar to the national average. The principal enterprise is specialist beef production accounts for 70% of the farms in Clare. The next largest is dairying at 19%. Tillage and sheep account for less than 2%.

Agriculture in County Limerick

There are a similar number of farms in Limerick at 6,190 farms with an average size of 32.6 hectares per farm. The principal enterprise is specialist beef production at 52% followed closely by dairying at 37%. This is possibly indicative of the better lands in County Limerick, particularly in the east of the county. The numbers of specialist sheep and tillage farms are small.

Agriculture in North Tipperary

There are 3,855 farms in North Tipperary with an average size of 38.8 hectares per farm. The numbers in specialist beef production is 1,875 or 49% and the numbers in dairying is 1,079 or 28%. The percentages in tillage and sheep are considerably greater than the other two counties at 4% and 3% respectively.

Agriculture in the Study Area

The farms in the area of the proposed development appear to be involved in beef production and horses. The windscreen survey and discussions with local landowners indicated that there were no dairy farms affected by any of the proposed routes. Many of the fields had rushes indicating impeded drainage and were somewhat overgrown indicating lands that were not actively farmed.

The lands in this area are low lying, although flood mapping of the area shows that the lands are above the flood plain for all the proposed routes.

Routes 7a, 7b and 7c

There are two farms or land holdings affected by the proposed routes and both of these is affected by each of the routes. Area B (refer to Figure 4.20 of Volume B) was bought for development purposes and is currently being used for drystock grazing. This holding is to the west of Routes 7a, 7b and 7c and is the furthest landholding from the River Shannon for these Routes. The other landholding i.e. Area C was recently purchased and has been fenced using post and rail. This would suggest that this landholding is/would be used for horses and discussions with landowners in the area indicated that there have been horses grazing this area. The significance of the impacts of Route 7a on Areas B and C could be described as moderate. The significance of the impacts of Route 7b and 7c could be described as moderate for Area B and minor for Area C.

The area of agricultural land that would be acquired if any of these routes were to be constructed amounts to between 0.48ha (Route 7c) and 0.77ha (Route 7a) approximately (refer to Table 4.29 below). The remaining land through which these routes pass could be described as woodland (partly) and residential (partly).

Route 6

Route 6 also affects two landholdings. Area B (refer to Figure 4.20 of Volume B) is the nearest landholding from the River Shannon for this route. As stated previously this landholding is affected by all Routes (i.e. 6, 7a, 7b and 7c) and is currently rented for drystock grazing and is intended for development in the long term. Two parties currently lease the second landholding affected by Route 6 i.e. Area A. The lessee of the southern section of this landholding does not appear to be affected by the scheme at all, although there may be accommodation works required. The lessee of the northern section is affected by Route 6 and will have a significant portion of the lands severed. Both of the lessees are involved in beef enterprises. The significance of the impacts of Route 6 on Areas A and B could be described as moderate.

The area of agricultural land that would be acquired if this Route were to be constructed amounts to 1.30ha approximately (refer to Table 4.29). The remaining land through which this route would pass could be described as amenity (partly) and residential (partly).

Table 4.29: Estimated Agricultural Landtake for Each Route

Route No.	Length of Route (m)	Total Landtake (Ha)	Agricultural Landtake (Ha.)
6	1090	2.65	1.30
7a	890	2.50	0.77
7b	870	2.39	0.62
7c	870	2.34	0.48

4.1.7.3 Conclusion

The farming in the area of the proposed routes appears to be of low intensity and none of the farms are of national or regional importance.

Route 6 has the largest landtake and will have the greatest severance issues. Therefore, Route 6 is the least favourable from an agricultural perspective.

Routes 7a, 7b and 7c have smaller landtakes and therefore the least impact on agriculture in the area. However, this is somewhat dependent on if the landholding nearest the River Shannon (Area C) is only involved in horses on a non-commercial, and only for pleasure basis.

4.2 SITE INVESTIGATIONS/SOILS OVERVIEW

4.2.1 Soils, Geology and Hydrogeology

4.2.1.1 Introduction

This section examines the soils, geology and hydrogeology of the proposed Study Area. The Study Area extends from approximately 1.5km north of Killaloe/Ballina to 0.5km south of O'Briensbridge/Montpelier.

4.2.1.2 Methodology

This report is based on a desk study. Information on the geology and hydrogeology of the area has been obtained from the Geological Survey of Ireland (GSI). Information supplied by the GSI in electronic format included:

- Bedrock Geology Data.
- Aquifer Classification.
- Subsoils/Quaternary Geology.
- Well Database.
- Karst Database.
- Geology map of the Shannon Estuary. Sheet 18. Geological Survey of Ireland (GSI) scale 1:100,000 (1999) and accompanying report.
- Groundwater protection schemes for the counties of Limerick and Clare.
- GSI 6" geological sheets.
- GSI well records within 2km of the route.
- Constraints Study undertaken prior to May 2005.
- 1:100,000 Ordnance Survey (OS) Map; Discovery Series.

This report follows the guidelines set out by the Environmental Protection Agency for Environmental Impact Statements (EPA, 2002) and by the Institute of Geologists in Ireland regarding Geology and the EIS Process (IGI, 2002).

4.2.1.3 Description of the Existing Environment

Topography

The area through which the proposed road/bridge will pass lies on the alluvial plain of the River Shannon and as such the local topography is generally low lying. The elevation is typically between 1m and 110m (OD Malin Head). There are three areas of significant local elevations along the scheme:-

- Located to the south east of Bridgetown, at the southwestern boundary of the Study Area, a hill rises to 80m OD.

- In the vicinity of Birdhill, a hill rises to 110m OD; this is at the southeastern corner of the Study Area and is unlikely to intercept the proposed route.

- Located at the northeastern boundary of the Study Area, a hill rises to 100m OD. This is in the vicinity of Drumbane.

Flood defences, in the form of embankments, have been constructed along the banks of the Shannon and the associated creeks and represent the only change in natural elevation in an otherwise low lying Shannon flood plain.

Hydrology

The route is in the immediate vicinity of the River Shannon, which flows through the Study Area from north to south. The width of the channel varies considerably within the Study Area.

There are also a number of rivers, Black River, Ardcloony River, Ballyteige River and Kilmastulla River, which meander through the Study Area and are tributaries of the River Shannon.

Bedrock Geology

Information on the bedrock geology was obtained in digital format from the GSI. The Study Area is covered by Geological Survey of Ireland, Sheet 18 Geology of Tipperary (Scale 1:100,000) map and accompanying geological description. The geological description has been prepared based on the GSI report accompanying Sheet 18. Bedrock within the Study Area ranges in age from Silurian to Carboniferous. The oldest rocks (Silurian) are found to the north of Killaloe with the youngest rocks found north of O'Briensbridge (Carboniferous). The bedrock geology of the area is illustrated on Figure 4.21 of Volume B.

In the northern portion of the Study Area the bedrock is composed of rocks of Silurian age. The River Shannon cuts through the area of Slieve Bernagh to the west (height 532m) and the Arra Mountains to the east (457m). Within the area immediately south of Killaloe and immediately north of O'Briensbridge Devonian age rocks form the bedrock. These rocks are not differentiated into different formation names and have been grouped together as Old Red Sandstone (undifferentiated). The Devonian rocks outcrop on the northern and southern edges of the limestone cored syncline. These areas are generally found on the perimeter of the uplands with the Silurian rocks forming the higher areas.

An unusual feature within the Study Area is the Killaloe Gorge in the southern portion of Lough Derg. In this area the River Shannon departs from the limestone floored lowlands to cut through the Slieve Bernagh and Slieve Arragh Mountains via the Killaloe Gorge. The river cuts through an upland area of relatively hard rocks (Silurian & Devonian in age) instead of following the limestone floored corridor at Tuamgraney to the sea at Newmarket on Fergus (GSI, Sheet 18 Report). This is considered to be in some way a result of glacial erosion.

The following is a description of each of the geological units.

Broadford Formation (BF)

This formation forms the bedrock in the area north of Killaloe and extends as far north as Rinnaman Point. The Broadford Formation is described as a fine to conglomeratic graded greywacke which is Silurian in age. There is some variation in lithology within this formation depending on its location. On the southern limb of the Slieve Bernagh Syncline it is predominantly argillaceous in character (60% of outcrop) but contains a higher proportion of coarser grained clastics. On the northern limb of the syncline fine grained greywackes predominate. These greywackes are indicated on the bedrock geology map as (gw). There are reported (GSI) to be a number of slate quarries on both sides of the Shannon within the Broadford Formation.

Hollyford Formation (HF)

The Hollyford Formation forms the bedrock in a small area immediately to the north of Birdhill. This formation is composed of greywackes and greenish grey mudstones, interbedded with thin siltstones and or blackish grey laminated siltstones with a few fossils occasional grits and a few ashes.

Old Red Sandstone (ORS)

Within the Study Area the boundary between the Silurian and Devonian is represented by an unconformable boundary. This means that some of the geological succession is absent. The Old Red sandstone (undifferentiated) is described as comprising of red conglomerate, sandstone and mudstone. In this part of the country the Old Red Sandstone is thinner than seen further south as it is located outside of the Munster Basin. The thickness of Old Red sandstone in the Study Area is no more than a few hundred metres thick.

Lower Limestone Shale

The Lower Limestone Shale forms the bedrock in the area south of O'Briensbridge, Ardbacartan Cross Roads and Cloonfadda. This formation is composed of grey sandstones, siltstones, shales and mudstone and thin limestone. This unit is Lower Carboniferous in age and represents the transition from the sandstones and mudstones of Devonian age to the Carboniferous Limestones.

Ballysteen Formation (BA)

The Ballysteen Formation forms the bedrock to the north of Bridgetown (west side) and north of Birdhill (east side). This formation is composed of well-bedded blue grey to mid grey argillaceous limestones. The shales and limestones are very fossiliferous. This formation is composed mainly of wackestones and packstones and only locally grainstones.

The Ballynash Member (BAbn) is often found at the top of the Ballysteen Formation associated with transmission to Waulsortian Limestones. This is a grey, orange weathering shaly cherty and wavy nodular often micritic wackestones which is variably fossiliferous.

Waulsortian Limestone

The Waulsortian Formation forms the bedrock in the centre of the core and therefore outcrops only over a small area to the north west of Birdhill. The bedrock is composed of pale grey, sparry, fossiliferous poly mud micritic limestones, often massive knoll forms with crinoidal or pale cherty shaly interbeds, frequently dolomitised.

Cross Patrick Formation

The Cross Patrick Formation within the Study Area forms the bedrock beneath a limited area south of Bridgetown. This formation is a pale grey well bedded crinoidal limestones with nodules of blue or black chert.

Karst Database

The Geological Survey of Ireland conducted a search of their Karst Database and there are no reported karst localities within the Study Area.

Soils and Subsoils

Information on the subsoil/Quaternary geology of the area has been obtained from the GSI.

The following overburden types have been classified by the GSI:-

- Alluvium (undifferentiated).
- Glaciofluvial Gravel.
- Peat.
- Sandstone Till.
- Rock within 1m of surface.
- Estuarine Sediments.
- Till derived from Devonian Sandstone.
- Till derived from Lower Palaeozoic Shale.

According to the GSI there is no information on quaternary deposits available at this time for the North Tipperary area, which makes up the east portion of the Study Area.

Areas of soft soil deposits have been identified to the South of O'Briensbridge and North West of Birdhill. The GSI Quaternary soils information indicates peat in several areas to the south of O'Briensbridge and to east of Bridgetown.

On the west side of the River Shannon immediately adjacent to the River Shannon the subsoils deposits are as follows. From Killaloe area as far south as the Ballyteige River there is an area of alluvium deposits. The area of Cloonfadda is mapped as being underlain by till derived from Lower Palaeozoic Shale while the area north of the Black River is underlain by estuarine deposits. Further west an area of glaciofluvial gravel is found extending to the edge of the lowland from Killaloe to Bridgetown.

There is no subsoil information available for the east side of the River Shannon at this time apart from the O'Briensbridge area and the area north of Birdhill indicated as being underlain by a locally important sand and gravel aquifer (Figure 4.22 of Volume B). The area immediately adjacent to the river is underlain by alluvium while further south there is sandtones till, glaciofluvial gravel and peat deposits.

Hydrogeology

Regional Hydrogeology

The Study Area includes a portion of counties Limerick, North Tipperary and Clare. Information on the hydrogeology of the area is based on the aquifer classification data provided by the Geological Survey of Ireland for the Study Area. The Geological Survey of Ireland aquifer classification scheme is based on the value of the groundwater resources and the hydrogeological characteristics of the aquifer.

Eight categories of aquifer have been defined by the GSI as follows:-

Regionally Important Aquifers (R)

- Karstified Aquifers (Rk)
- Fissured Bedrock Aquifers (Rf)
- Extensive Sand and Gravel Aquifers (Rg)

Locally Important Aquifers (L)

- Sand / gravel (Lg)
- Bedrock which is Moderately Productive (Lm)
- Bedrock which is Moderately Productive Only In Local Zones (Ll)

Poor Aquifers (P)

- Bedrock which is Generally Unproductive Except for Local Zones (Pl)
- Bedrock which is Generally Unproductive (Pu)

In general the Silurian rocks are generally fine grained siltstones, mudstones and sandstones. Within these formations secondary permeabilities are increased by intense folding, faulting and cleaving. However openings have become recemented in places by siliceous infiltration. Due to the rock type and absence of secondary permeability these formations tend to form Poor Aquifers with low groundwater potential.

Within the Study Area the Old Red Sandstone is thin in comparison to the typical thickness seen elsewhere in the country. In the County Limerick Groundwater Protection Scheme Report the GSI indicate that the unconformity between Devonian and the underlying Silurian rocks may represent a high transmissivity zone. Structural deformation is likely to have increased secondary permeability. Higher groundwater yields may be found in proximity to major fault zones. The GSI have classed the formation as a Locally Important aquifer that is moderately productive only in local zones.

The Carboniferous rocks with the exception of the Lower Limestone Shale are classed as a Locally Important aquifer which is moderately productive only in local zones. The Lower Limestone Shale is classed as a Poor Aquifer.

There is one area of Locally Important Sand and Gravel Aquifer (Lg) between Birdhill and Ballina (Figure 4.22 of Volume B).

The aquifer types within the Study Area are limited to Locally Important Aquifers and Poor Aquifers (Figure 4.22 of Volume B). The Geological Survey of Ireland Aquifer Classification System is linked to potential well yield.

Locally important aquifers are capable of good well yields 100 – 400m^3/d. Typically poor aquifers would generally have moderate or low well yields less than 100m^3/d. The poor aquifers will typically yield enough water to supply a house or small farm, however supplies tend to be unreliable as the permeability tends to be limited to the upper most few metres of broken and weathered rock and yield decreases markedly during dry spells.

Table 4.30: Aquifer Classification within Study Area

Geological Formation	Aquifer Classification
Broadford Formation	Pl
Old Red Sandstone	Ll
Lower Limestone Shale	Pl
Ballysteen Formation	Ll
Ballynash member of Ballysteen	Ll
Waulsortian	Ll
Volcanics	Ll
Cross Patrick Formation	Pl
Hollyford Formation	Pl
Birdhill Sand and Gravel	Lg

Hydrogeology Along the Proposed Route

Information on private wells within the Study Area was obtained from the Groundwater Section of the GSI. The well database provides approximate locations for private wells within the Study Area. There are likely to be additional private wells within the Study Area. The locations of the known private wells are illustrated in Figure 4.24 of Volume B. The GSI well data is categorised into 6 different yield categories these being:-

F – Failure
P – Poor (< 40m^3/d)
M – Moderate (40 – 100m^3/d)
G – Good (100 – 400m^3/d)
E - Excellent (> 400m^3/d)
U – Unknown yield

Within the Study Area the well data indicates 3 no. good wells, 17 no. moderate wells, and 2 no. poor wells. No excellent yielding wells were identified. There are no records of public supplies or group supplies in the vicinity of the proposed route. The majority of identified wells are greater than 1 km from the proposed routes.

No water level information is available for discrete boreholes within the Study Area however the groundwater flow direction is likely to be a reflection of the topography with the discharge of groundwater to the River Shannon. In lowland areas the water table is expected to be within 10m of ground surface. The GSI report that the annual fluctuation in the water table is generally 3m to 7m in lowland areas. In the uplands water levels are within a few metres of ground level in winter but may fall to 20m below ground level in dry summers.

The Environmental Protection Agency / Geological Survey of Ireland Aquifer Vulnerability / Protection Zone Classification scheme is based on the aquifer's vulnerability to contamination from point and diffuse sources of contamination. The following table outlines the hydrogeological conditions associated with the vulnerability classifications.

Table 4.31: GSI, Vulnerability Mapping Guidelines

	Hydrogeological Conditions				
	Subsoil Permeability (Type) and Thickness)			Unsaturated Zone	Karst Features
Vulnerability Rating	High permeability (sand/gravel)	Moderate permeability (e.g. sandy subsoil)	Low permeability (e.g. clayey subsoil, clay, peat)	(Sand/gravel aquifers only)	(<30m radius)
Extreme (E)	0 – 3.0m	0 – 3.0m	0 – 3.0m	0 - 3.0m	-
High (H)	>3.0m	3.0 – 10.0m	3.0 – 5.0m	>3.0m	N/A
Moderate (M)	N/A	>10.0m	5.0 – 10.0m	N/A	N/A
Low (L)	N/A	N/A	>10.0m	N/A	N/A

Information on the aquifer classification for the aquifers within the Study Area was obtained from the Geological Survey of Ireland. The data is illustrated on Figure 4.22 of Volume B.

The vulnerability classification illustrated on Figure 4.23 of Volume B was obtained from the Geological Survey of Ireland and is generally taken as being conservative. The classification would be likely to change based on site specific data collected during future site investigations within the Study Area.

4.2.1.4 Route Option Assessment

Introduction

In this section the impact of the various routes on the existing environment as it relates to geology and hydrogeology will be assessed. In as far as possible the various impacts will be quantified to allow for comparison between the various parameters and therefore facilitate the selection of the optimum route.

In general the main parameters that the route would impact on are as follows:-

- Existing wells used for water supply.
- Major aquifers in particular RK and RG aquifers.

The following geological features will impact on the route selection:-

- Length of cut in each route.
- Length of cut in rock in each route.
- Length of route over known Karst areas.

Table 4.32: Evaluation Parameters for Route Assessment

Parameter		Probable Impact
No.	Description	
Geological Parameters		
1	Length of route	The longer the route the greater the possibility of an impact on the geology/hydrogeology
2	Length of cut	Where part of the route in cut the overburden/rock is removed – reducing the natural protection to the underlying aquifer. Where the cut is below the water table level this will locally lower the water table and impact on neighbouring wells – possibly reducing the well yields
3	Length of cut in rock	When part of the cut is in rock any protection to the underlying aquifer is removed. An estimate of the chainage (length) of cut in rock is made in the absence of any drilling data.
Hydrogeological Parameters		
4	Length of route in RK aquifers	RK aquifers are Regionally important and the longer the route overlies these aquifers the greater the possibility of pollution to the aquifer
5	Length of route in RG aquifers	RG aquifers are Regionally important and the longer the route overlies these aquifers the greater the possibility of pollution to the aquifer
6	Length of cut in RK aquifers	The longer the length of cut in RK aquifer the more vulnerable the aquifer becomes to pollution
7	Length of cut in RG aquifers	The longer the length of cut in RG aquifers the more vulnerable the aquifer becomes to pollution
8	Number of private wells/possible impact on private wells	Number of private wells that route may impact on

The route is described below regarding the above parameters and numerical values are placed on each impact of each route. Chainage refers to the section of the proposed new route relative to the distance from the commencement point of the route.

Impact of Route 1

The length of this route is approximately 1050m. The impact of the route is evaluated under a number of headings; the results of the assessment are presented in Table 4.33 below.

Table 4.33: Geological and Hydrogeological Impact of Route 1

No.	Parameter	Numerical Impact
Geological Parameters		
1	Length of route	1050
2	Length of cut	0
3	Length of cut in rock	0
Hydrogeological Parameters		
4	Length of route in RK aquifers	0
5	Length of route in RG aquifers	0
6	Length of cut in RK aquifers	0
7	Length of cut in RG aquifers	0
8	Number of private wells/possible impact on private wells	1 well, located west of proposed route at study boundary, impact unlikely

Impact on Route 6

The length of this route is approximately 1,090m. The impact of the route is evaluated under a number of headings; the results of the assessment are presented in Table 4.34 below.

Table 4.34: Geological and Hydrogeological Impact of Route 6

No	Parameter	Numerical Impact
Geological Parameters		
1	Length of route	1090
2	Length of cut	0
3	Length of cut in rock	0
Hydrogeological Parameters		
4	Length of route in RK aquifers	0
5	Length of route in RG aquifers	0
6	Length of cut in RK aquifers	0
7	Length of cut in RG aquifers	0
8	Number of private wells/possible impact on private wells	1 well, located south of proposed route at study boundary, impact unlikely

Impact of Route 7a

The length of this route is approximately 910m. The impact of the route is evaluated under a number of headings; the results of the assessment are presented in Table 4.35 below.

Table 4.35: Geological and Hydrogeological Impact of Route 7a

No	Parameter	Numerical Impact
Geological Parameters		
1	Length of route	910
2	Length of cut	120
3	Length of cut in rock	Cut in rock not expected, max cut depth 1.7m.
Hydrogeological Parameters		
4	Length of route in RK aquifers	0
5	Length of route in RG aquifers	0
6	Length of cut in RK aquifers	0
7	Length of cut in RG aquifers	0
8	Number of private wells/possible impact on private wells	0

Impact of Route 7b

The length of this route is approximately 890m. The impact of the route is evaluated under a number of headings; the results of the assessment are presented in Table 4.36 below.

Table 4.36: Geological and Hydrogeological Impact of Route 7b

No	Parameter	Numerical Impact
Geological Parameters		
1	Length of route	890
2	Length of cut	0
3	Length of cut in rock	0
Hydrogeological Parameters		
4	Length of route in RK aquifers	0
5	Length of route in RG aquifers	0
6	Length of cut in RK aquifers	0
7	Length of cut in RG aquifers	0
8	Number of private wells/possible impact on private wells	0

Impact of Route 7c

The length of this route is approximately 890m. The impact of the route is evaluated under a number of headings; the results of the assessment are presented in Table 4.37 below.

Table 4.37: Geological and Hydrogeological Impact of Route 7c

No	Parameter	Numerical Impact
Geological Parameters		
1	Length of route	890
2	Length of cut	40
3	Length of cut in rock	Cut in rock not expected, Max cut depth 0.30m
Hydrogeological Parameters		
4	Length of route in RK aquifers	0
5	Length of route in RG aquifers	0
6	Length of cut in RK aquifers	0
7	Length of cut in RG aquifers	0
8	Number of private wells/possible impact on private wells	0

Selection of Preferred Route

The Study Area extends from approximately 1.5km north of Killaloe/Ballina to 0.5km south of O'Briensbridge/Montpelier. There are five short-listed routes, as follows:-

- Route 1.
- Route 6.
- Route 7a.
- Route 7b.
- Route 7c.

The selection of the preferred route is based on its impact under the parameters as indicated in Table 4.32.

A comparison of the impact of each route on each of the parameters described in Table 4.32 is shown in Table 4.38. The key to the impact ratings are:-

L = Low Impact, M = Medium Impact, H = High Impact and E = Extreme Impact.

Table 4.38: Comparison of Impacts of Routes on Geology/Hydrogeology

Route Number	Parameter Number (ref Table 4.32)								Overall Ranking
	1	2	3	4	5	6	7	8	
1	L	L	L	L	L	L	L	M	3
6	L	L	L	L	L	L	L	M	3
7a	L	M	M	L	L	L	L	L	5
7b	L	L	L	L	L	L	L	L	1
7c	L	L	L	L	L	L	L	L	1

As can be seen from Table 4.38 above, Routes 7b and 7c are the preferred routes, as they have the least impact on the existing environment. These routes are followed by Routes 1 and 6 and then by Route 7a.

4.2.1.5 Conclusions

Route 6 has greatest impact in relation to its overall length being the greatest. With respect to route length Route 7b or 7c are the preferred choices. In relation to length of cut required, Routes 1, 6 and 7b and 7c require no cutting operations to be undertaken and are thus the preferred choices at these locations. No karsified aquifers (Rk) or extensive sand and gravel aquifers (Rg) are located in close proximity to the proposed routes and as such none of the routes are likely to impact on Rk or Rg aquifers. Finally, no private water supply wells are in the vicinity of Routes 7a, 7b or 7c, making these the preferred routes in this respect. However, one private water supply well is located at distance from Route 1 and Route 6, and this has classified these as having potential impact in relation to water supply wells.

Subject to further on-site geotechnical testing, and taking into consideration that further information is required in relation to the private water supply wells that may potentially be impact by Route 1 and 6, it would appear that there is a preference for Route 7b or 7c in terms of the residual impact on hydrogeology.

4.2.2 Geotechnical Site Investigation

4.2.2.1 Introduction

A preliminary geotechnical ground investigation was undertaken at each of the proposed Routes 1, 6 and 7 by Glover Site Investigations Ltd. Site operations commenced on site on Tuesday 6th September 2005 and were completed on Friday 14th October 2005.

The object of the ground investigation work was to establish the following:-

(a) The nature of the geological strata, both solid and overburden, in which it is proposed to route the proposed road, junctions and bridge structure.

(b) The presence of any irregularities in the geological structure that may affect the proposed routes.

(c) Evaluate the strength at formation level of the proposed routes.

(d) Sufficient site data on which predictions of the rate and amount of future settlement can be made.

(e) Water levels in selected boreholes and trial pits.

A Factual Report, containing the trial pit and borehole logs, photographs and laboratory test results has been produced by Glover Site Investigations.

4.2.2.2 Route 1

A total of three exploratory locations were investigated along Route 1. One trial pit, TP6, was excavated and two boreholes, R5 and R6, were drilled in the vicinity of the proposed river bridge abutments.

Trial pit TP6 encountered a thin layer, 0.8m thick of SAND and GRAVEL just below the topsoil. The GRAVEL and SAND was underlain by sandy SILT.

The rotary boreholes were located in the vicinity of the proposed river bridge abutments. Borehole R5, located adjacent to the Headrace Canal, encountered a medium dense gravely SAND and sandy gravely CLAY, being firm to stiff. Moderately weak Sandstone was encountered at a depth 9.2m below existing ground level. The average Standard Penetration Test, N value in the overburden materials was 15 with a range of 10 to 24. Groundwater was encountered at rock level, 9.2m below existing ground level. Borehole R6 encountered organic sandy SILTS to a depth of 23.5m below existing ground level. Standard Penetration Test (SPT) N values indicated that these materials were very soft to soft. The average N value was 2 with a range 1 – 4. Below the organic SILT, medium dense silty SAND was encountered. Groundwater was recorded at a depth 1.25m below existing ground level.

The proposed vertical alignment shows the proposed road level from Chainage 0m to 600m will be in fill, up to 9.0m high. The proposed road level will be close to existing ground levels between Chainage 600m and 900m. The pavement will be constructed in the sandy SILT over this interval. The remainder of the proposed route between Chainage 900m and 1050m the pavement is in marginal fill, 1.2m on average.

Foundations are likely to be a combination of pad founded on Sandstone rock and pad with piled support in soft organic SILTS. Steel piles will be required due to the excessive depth of soft material and poor lateral restraint.

Settlements of embankment are expected in the soft organic SILTS. The magnitude of these settlements is estimated at 1.2m to 1.6m. Secondary settlements can be expected. Ground improvement techniques will be required along the embankment sections to prevent settlement and slip circle failure. Improvement is expected to be in the form of pre-consolidation using vertical drains and surcharge. Basal reinforcement will also be required under embankment sections and in areas of marginal cut.

The locations of trial pits and rotary boreholes are shown on Figure 4.25 of Volume B.

4.2.2.3 Route 6

A total of four exploratory locations were investigated along Route 6. Two trial pits, TP1 and TP2, were excavated and two boreholes, R1 and R2, were drilled in the vicinity of the proposed bridge abutments.

TP1 encountered GRAVELS to a depth of 1.5m below existing ground level. Below this SAND was encountered. Groundwater was recorded at a level 2.5m below existing ground level, within the SANDS. TP2 encountered GRAVELS to a depth of 3.5m below which a firm to stiff gravely CLAY was found. Groundwater was encountered within the GRAVELS at a depth of 2.5m below existing ground level.

Borehole R2 encountered firm to stiff sandy gravely CLAY to a depth 4.0m below existing ground level. A Standard Penetration Test SPT, N value of 14 was recorded over this interval. Below this, very dense gravely SAND and stiff to very stiff gravely sandy CLAYS were encountered to a depth of 15.0m below existing ground level. Borehole R1 encountered loose to medium dense sandy GRAVEL to a depth 8.4m below existing ground level. An average Standard Penetration Test SPT, N value of 22 was recorded over this interval, with a range 10 to 25. Below this dense silty sandy GRAVEL was found.

The proposed vertical alignment shows the proposed road level to be in fill between Chainage 0m and 350m. The fill ranges from approximately 1.0m to 3.0m in height. Between Chainage 350m and 450m the proposed road level will be close to existing ground levels. The remainder of the propose route between Chainage 450m and 1090m is in fill up to a height of 8.0m.

Foundations are expected to be pads with friction/end bearing piles in the medium dense GRAVEL at R1. At R2 foundations are expected to be pads on bearing stiff gravely CLAY at a depth 4.0m below existing ground level. Due to the proximity to the river channel at the exact location of the bridge abutments it may be necessary to use a piled support to bear on/in suitable strata where soft deposits exist below a depth 4.0m below existing ground level at the location R2. Embankment settlements are expected to be of the order of 75mm.

From the Geological Survey of Ireland, rock is expected at a depth of 24.0m in the riverbed. It is assumed that SAND and GRAVEL deposits overlie the rock. The upper layers are expected to be unsuitable for direct bearing and some form of piled support will be needed.

The locations of trial pits and rotary boreholes are shown on Figure 4.25 of Volume B.

4.2.2.4 Routes 7a, 7b and 7c

A total of four exploratory locations were investigated along Routes 7a, 7b and 7c. Two trial pits, TP4 and TP5, were excavated and two boreholes, R3 and R4, were drilled.

TP4 encountered CLAY to a depth 2.8m below existing ground level, below which SAND was found. The CLAY was described as very stiff. No groundwater was encountered. In TP5 GRAVEL was encountered to a depth 1.8m below existing ground level. Below the GRAVEL, CLAY was encountered to a depth 3.0m below existing ground level. This was in turn underlain by SAND. The SAND was noted as being mobile at the base under pore water pressures. Groundwater was encountered within the GRAVEL at a level of 2.5m below existing ground level.

Borehole R3 encountered soft to firm gravely CLAY to a depth 3.8m below existing ground level, dense silty sandy GRAVEL overlying a moderately weak slightly weathered Sandstone at a 6.8m below existing ground level. A Standard Penetration Test SPT, N value of 9 was recorded in the CLAY and a value greater than 50 in the GRAVELS. Groundwater was encountered at a depth of 3.8m below existing ground level at the GRAVEL – CLAY interface. Borehole, R4 encountered soft to firm gravely sandy CLAY between ground level and 3.5m below existing ground level. A Standard Penetration Test SPT, N value of 9 was recorded over this interval. Below this stiff to very stiff gravely sandy CLAY was found to a depth of 25.0m below existing ground level. Groundwater was encountered at a level of 3.5m below existing ground level.

The proposed vertical alignment for Route 7a shows the proposed road level close to existing ground levels between Chainage 0m and 350m. Over the interval Chainage 350m to 450m the route is in cut, up to 2.0m. The remainder of the proposed alignment is in fill between Chainage 450m and 890m, up to a height of 8.5m.

The proposed vertical alignment for Route 7b shows the proposed road level close to existing ground level or in marginal fill between Chainage 0m and 430m. The remainder of the proposed alignment is in fill, up to a height of 8.5m.

The proposed vertical alignment for Route 7c shows the proposed road level close to existing ground levels or in marginal fill between Chainage 0m and 330m. Over the interval Chainage 330m to 380m the route is in marginal cut. The remainder of the proposed alignment is in fill, up to a height of 9.0m.

Foundations are expected to be pad foundations within the dense GRAVELS at a depth 4.0m below existing ground level. Due to the proximity to the river channel, at the exact location of the bridge abutments is may be necessary to use a piled support to bear on/in suitable strata where soft deposits exist below a depth 4.0m below existing ground level. Embankment settlements are expected to be of the order of 75mm.

From the Geological Survey of Ireland, rock is expected at a depth of 24.0m in the riverbed. It is assumed that SAND and GRAVEL deposits overlie the rock. The upper layers are expected to be unsuitable for direct bearing and some form of piled support will be needed.

The locations of trial pits and rotary boreholes are shown on Figure 4.25 of Volume B.

4.2.2.5 Conclusion

Having assessed all the available geotechnical data obtained for Routes 1, 6, 7a, 7b and 7c the following conclusions were made:-

- All routes are feasible from a geotechnical engineering point of view.
- Route 1 requires significant ground improvement in order to construct the required embankments within the river Shannon's flood plains.
- There is no significant difference between Route 6 and Route 7a, 7b and 7c from a geotechnical perspective.
- A detailed geotechnical ground investigation is required to further progress detailed design. Any detailed geotechnical ground investigation should consider boring in the river to assess pier foundations.

4.2.3 Topographical Site Investigation

Aztech Surveys Ltd. undertook a topographical survey along proposed Routes 1, 6, 7a, 7b and 7c in August/September 2005. The purpose of the survey was to obtain information relating to the existing ground levels along the line of the proposed routes.

There were some areas which the contractor was unable to access due to the existence of dense overgrowth. In order to achieve a more complete picture, the digital terrain model (DTM) which was received from the Ordnance Survey was used to supplement the topographic survey. This combined information along with bathymetric data provided by the ESB allowed long sections of the various routes to be plotted. These long-sections show the profile of each route and also give an indication of the cut and fill requirements associated with each route. The long sections for Routes 1, 6, 7a, 7b and 7c are indicated on Figures 3.2, 3.7, 3.8, 3.9 and 3.10 respectively of Volume B.

A more detailed topographic survey may be necessary at detailed design stage.

4.3 STRUCTURES

4.3.1 Introduction

Structures for the preferred Routes, 6, 7a, 7b and 7c are discussed in this section. Structures for Route 1 are discussed in Chapter 5. For each of Routes 6 & 7, there is a requirement for a single major structure crossing the River Shannon. No other structures of significance are required for any of the routes. The principal constraints and issues affecting the selection of the river bridge in each case are as discussed in this section.

It should be noted in the following sections that reference is made to the former ordinance level datum at Poolbeg and the current ordinance level datum at Malin Head. All hydraulic, bathymetric and other data received from, or referred to, by the ESB or Waterways Ireland relates to OD Poolbeg, whereas all engineering levels in this document refer to OD Malin Head. For completeness, and where appropriate, both datums are referred to below. Malin Head datum is approximately at 2.7 m OD Poolbeg.

4.3.2 Deck Cross Section

The proposed deck cross section consists of the following configuration, resulting in an overall structural section width of 11.5 metres. The proposed cross-section is shown in Figure 3.16 of Volume B.

Traffic lanes	2 @ 3.5 m.	7.0 m
Hard strips	2 @ 0.5 m.	1.0 m
Footpath	1 @ 2.0 m.	2.0 m
Rubbing strip	1 @ 0.5 m	0.5 m
Parapet beams	2 @ 0.5 m.	1.0 m
Total		**11.5 m**

4.3.3 Structural Loading

The proposed routes link into regional roads R463 and R494. Both these regional roads carry significant volumes of heavy goods vehicles, many of which are associated with quarrying activities in the region. Having regard to the size and significance of the bridge, and the fact that it is the only modern bridge over the Shannon for a considerable distance up and down stream, it is proposed that the design loading shall consist of HA and HB45 in accordance with BD 37/01 of the DMRB.

4.3.4 River Hydraulics

The river hydraulics prevailing at the proposed bridge site are unusual inasmuch as the flow in the river is rigorously controlled by the Parteen Weir at the head of the Ardnacrusha Headrace Canal, some five kilometres downstream, which forms part of the Ardnacrusha power station works constructed in about 1930. The ESB have kept extensive hydraulic records for the river, including water levels and flow volumes, continuously since the time of construction and these are very helpful in the planning for the bridge.

Parteen weir consists of two weirs, one across the canal and the other across the river. The discharge to the river below the weir is continually adjusted by means of the river weir such that the water level in the river basin above the weir is maintained at a constant level. The canal weir has remained permanently open since its construction in c. 1930 so that the level in the canal is held at the same constant level as the level in the river basin above the weir. On the basis that inflow into the basin always exceeds the demand from the canal, there is always a discharge into the river, and controlling this discharge allows the basin level to be maintained, whatever variations there may be in the volume of the inflow into the basin, or the demand from the canal.

The water level at the bridge sites is virtually the same as in the basin above the weir, which is maintained at a target level of 33.5 m OD Poolbeg (30.8m OD Malin). Records from 1932 to 1996 show minimum and maximum levels for the period being 31.99m and 33.98m OD Poolbeg respectively. The normal water level in the river at the bridge sites was typically about 29.7m OD Poolbeg prior to the construction of the weir, which indicates that the water level has been raised at the sites by some 3.8m above the natural level. This has resulted in a very large increase in the cross sectional area of the flow channel at the sites, with a consequent lowering of the water velocities. The maximum recorded peak flow at the sites is 950 cumecs (1960) and based on this flow and on the existing cross section areas, the expected maximum average flow velocity across the section will be 0.8 m/s at the Route 6 site and 1.9 m/s at the Route 7 site. The average of the annual peak flow volumes is 535 cumecs, which would result in concomitantly lower velocities. While these figures may be adjusted following detail design, it is evident that peak water velocities will be low at either of the sites. This indicates that related issues such as scour at the piers and hydraulic forces on the piers, both during construction and in service, should not be a significant problem.

The maintenance of a constant water level at the sites provides a further unusual situation inasmuch as it results in the plan position of the water's edge remaining approximately constant on each river bank. There are thus no flood plains occurring at the sites, which would normally need to be taken into account in planning the position of the abutments and the length of the bridge. The water level is not expected to rise significantly above the target level, as the weir has sufficient capacity to discharge whatever volume is required to maintain the basin at the target level. During an exceptional flood, the basin level would be allowed to rise slightly, where this would help to attenuate flooding downstream of the weir, but the ESB have advised that the basin level would always be maintained below 34.0m OD Poolbeg under all flood conditions.

It may be noted that the water level is in any event limited by the basin berms which only extend to level 35.0m OD Poolbeg. Furthermore, if the level should rise above 34.0m OD Poolbeg, the velocities at the bridge would remain low due to the large cross section area, and thus no damage is likely to occur.

It can be concluded therefore that the water level at the sites will not rise significantly higher than the target level of 33.5m OD Poolbeg (30.8m OD Malin), nor the flow velocities significantly exceed the values shown above for each bridge site.

4.3.5 Horizontal and Vertical Clearances

The vertical clearance from the river surface to the soffit of the bridge needs to provide for navigation requirements for vessels using the Shannon River. Vessels have access to the bridge location from the north and the south.

Access from the south (downstream) is from the Shannon estuary via the Ardnacrusha tail race canal, the high-lift double lock facility at Ardnacrusha power station, the Ardnacrusha Headrace Canal, the Headrace weir at Parteen Weir and thence into the river basin within the Study Area. Air draught restrictions exist at these structures, and at a number of bridges over the tail race and headrace canals.

Navigation issues are controlled by Waterways Ireland who have advised that the minimum soffit level for a bridge over the basin in the Study Area should be 39.64m OD Poolbeg (36.94m OD Malin) in order to provide for at least the same air draught as exists downstream. Based on a normal water level of 30.80m (OD Malin) this will provide a vertical clearance of 6.14m under normal conditions. This clearance need only be provided under the centre of one of the spans which should be designated the navigation span and which should be an appropriate span considering other navigational requirements including water depth. There is no requirement for the bridge to have an opening section to facilitate river traffic.

Access from the north is from Lough Derg and is restricted by the existing bridge at Killaloe. Vessels are restricted at this bridge which affords a vertical clearance of approximately 4.0 metres only. An opening steel deck section has been fitted to one of the spans of the bridge, but there is no existing mechanical provision for opening the span and it is understood that the facility has never been used, and is unlikely to be used in the future. Providing a vertical clearance of 6.14 metres at the proposed bridge site has only a limited benefit therefore, in that it would allow access for vessels exceeding 4 metres in height to the short stretch of river between the proposed bridge and the existing bridge. While this benefit may seem limited in present terms, it is possible that the opening section of the existing bridge may be rehabilitated in the future, allowing passage of taller vessels. In addition, there are proposals to provide a new marina in the stretch of river concerned, and thus the greater vertical clearance for access may be advantageous.

It is, therefore, proposed that the vertical clearance for the bridges shall be 6.14 metres above normal water level.

The horizontal navigational clearances between the piers are in excess of 30 metres which is more than sufficient for the type of river traffic expected.

As discussed in the preceding section, the position of the water's edge remains approximately constant at all times. It is therefore proposed that the toe of fill of the roadway embankments, which extend in front of the bridge abutments, be set back a nominal distance from the position of the normal water's edge. It is proposed that the toe of the embankments be set back a distance of 4.0 metres from that water's edge which would result from a water level of 33.7m OD Poolbeg, (31.0m OD Malin). This setback would allow for pedestrian access along the water's edge. It should be noted that should a slightly wider strip be required at a later date, the toe of the embankment could be readily trimmed back by providing a low retaining wall to the toe of the embankment fill.

4.3.6 Existing Canal

There is an existing canal alongside the river on the west side, which served a navigational function up to the time of the construction of the Parteen Weir and the raising of the water level in the river. The canal at present is mostly inundated by the river and now merely forms a parallel channel alongside the river. As the river is now fully navigable, the canal serves no navigational function except that pleasure vessels wishing to access properties on the western shore can only do so by entering the canal through certain access points and travelling along the canal to their desired destination on the shore.

The bridge abutment on the western side could be placed behind the canal such that the canal would be left intact and pass under the bridge span, or the canal could be locally filled in, such that the abutment would be set back from the river water's edge as described above. This would result in the canal being terminated on each side of the new bridge embankment, just behind the bridge abutment. Should this interfere with existing access arrangements to the properties on the western shore, an additional connection between the river and canal could be dredged on either side of the bridge embankment.

Placing the abutment behind the canal would clearly increase the required length of the bridge, which would have a significant cost implication. The additional length required would be different for each of the routes under consideration as follows:-

Route No.	Additional Length
6	24 m
7a	62 m
7b	44 m
7c	38 m

The additional cost would be approximately €20,000 per metre, and it is felt that such an amount would be disproportionate to any cultural heritage benefit associated with retaining the continuity of the canal at the location concerned. It is proposed therefore that the canal be in-filled under the bridge embankment, which would be brought to within 4 metres of the river water's edge as proposed in the section above.

4.3.7 Bathymetric Data

Bathymetric data has been discovered from the ESBI based on a bathymetric survey conducted in 1987. The assistance of the ESB and the ESBI in this regard is acknowledged. A total of 32 cross sections through the river and river basin between Parteen Weir and the south end of Lough Derg were taken during the survey. The data was supplied in the format of a map showing the positions of the section lines, with river bed levels (to OD Poolbeg) recorded at offset distances from a start point on the section line.

Twelve of the sections, which are near to Routes 4, 5, 6 & 7 which cross the river or river basin in the surveyed area, have been considered in this study. These sections have been marked on the key plan shown in Figure 4.26 of Volume B, and a graphical representation of the corresponding bathymetric data is shown on Figures 4.27, 4.28 and 4.29 of Volume B. It should be noted with regard to the data received, that the position of the sections was shown on mapping which does not fully correspond to current OS mapping, and furthermore, the position of the start point on the section line was not shown. Some estimation of the section locations and start points was therefore required, which may have introduced some inaccuracies in mapping the position of the levels recorded. In addition, it can be assumed that there were limits to the accuracy of the mapping of the surveyed levels onto the section lines at the time of the survey. Nonetheless, it can be expected that the sections shown are reasonably reliable.

The bathymetric data from the sections shown have been used to create a digital terrain model (DTM) for the river bed in the vicinity of Routes 4, 5, 6 & 7. This DTM has been spliced into the DTM derived from Ordinance Survey data for the land levels on either side of the river. The Ordinance Survey data has in turn been corrected along the corridors for Routes 6 and 7 based on data collected from the topographical survey undertaken as part of this study. The long sections shown for Routes 4, 5, 6 & 7, shown in Figures 3.5 – 3.10 of Volume B, include the ground and river bed line which is derived from this combined DTM.

4.3.8 Route 6 Bridge

4.3.8.1 Geotechnical

A limited geotechnical site investigation has been undertaken near the sites of the bridge abutments. Founding conditions for piers in the river have been inferred from GSI data and the data at the abutments. Founding for a bridge in this location is feasible, and is reported on in Section 4.2.2.

4.3.8.2 Landscape

The landscape and visual context at the bridge site is dominated by the wide expanse of the river, which is 260 metres wide at the Route 6 site. Immediately south of Route 6 the river widens abruptly to about 550 metres, providing a dramatic visual setting.

There is no flood plain on either side, and rich vegetation and mature trees extend virtually to the water's edge on both sides of the river. The land is moderately sloping on the east side, falling a height of 8 metres over the distance of 68 metres between the R493 and the bank of the river. On the west side the terrain is relatively flat, with a parkland landscape containing a large number of mature trees. In addition, there are the remains of the inundated canal running parallel to the shoreline as discussed above.

The landscape is very scenic and complements the historic nature of the environment at Killaloe. The choice of bridge form, and the detailing and finishes of the bridge should therefore be carefully considered.

4.3.8.3 Alignment

The horizontal alignment is straight over the full length of the bridge. The vertical alignment is on a uniform crest curve over the full length of the bridge.

4.3.8.4 Bridge Forms

The selection of a particular bridge form shall be undertaken as part of the preliminary design stage of this project. At this stage however, it may be useful to consider the type of bridge forms, which could be considered for this route. The overall length of the bridge is expected to be approximately 272 metres.

Incremental Launch

The nature of the site and the road alignment would allow for the construction of the bridge by incremental launching. Space exists for a casting yard to be established on the west side of the river. A suitable span arrangement would consist of four internal spans of 48 metres and two end spans of 41 metres, with a structural deck thickness of approximately 2.5 metres. The deck would consist of an in-situ concrete box girder. By the nature of this method of construction, the thickness of the deck would be uniform for the full length of the deck. A visualisation of the proportions of this arrangement is shown in Figure 4.30 of Volume B. Due to the high establishment costs associated with incremental launching, the method becomes more economical as the bridge length increases and/or where a pair of decks is required. For a single bridge deck of this length, the economic advantage of launching is likely to be marginal, and it may be more expensive than other forms of construction.

Balanced Cantilever

This form of construction would be technically feasible in this location. Long spans are achievable with this method and either a three span or four span arrangement could be considered. A suitable three span arrangement would consist of a main span of 106 metres with end spans of 83 metres. A four span arrangement would consist of two internal spans of 78 metres with end spans of 59 metres. A feature of this form of construction is a relatively deep structural depth at the piers, reducing to a slender deck at midspans with a distinctly arched soffit. A three span arrangement would have a structural depth of approximately 6.5 metres reducing to 2.2 metres, and a four span arrangement 4.7 metres reducing to 1.8 metres. The deck would consist of an in-situ concrete box girder. A visualisation of the proportions of the four span arrangement is shown in Figure 4.30 of Volume B. It can be seen that the structural depth at the piers is a large proportion of the clear height under the bridge. This form of construction would be significantly more expensive than the others shown, and a premium would need to attach to the length of the spans or the particular form of the bridge for this option to warrant further consideration.

Precast Beam and Slab

This would be a very conventional form of construction. Due to considerations of transporting precast beams by road and erecting the beams over water, the span lengths should preferably not exceed about 35 metres. Eight spans of 34 metres would therefore be an appropriate arrangement. The deck would have a uniform structural depth of 1.8 metres. A visualisation of the proportions of this arrangement is shown in Figure 4.30 of Volume B, and the structural cross section would be as shown in Figure 3.16 of Volume B.

Insitu/Precast Hybrid

A variation of the precast beam arrangement could be considered in which a short length of in-situ deck is constructed at each pier, cantilevering out on each side. Precast beams of approximately 35 metres length, similar to those considered above, would span between the in-situ sections, and be cast in monolithically with the in-situ sections to produce a structurally continuous deck. The in-situ deck section would have a curved soffit and a deeper structural section than the precast section. A concrete facia panel would be required to continue the line of the curved soffit through the precast beam section of the span. The span lengths would be similar to the arrangement for the incrementally launched form. A visualisation of the proportions of this arrangement is shown in Figure 4.30 of Volume B. This form would provide for longer spans than the conventional precast beam form, with fewer piers, and would have the aesthetic advantage of the curved soffit.

Cable-Stayed

A cabled stayed bridge would be technically feasible for this site and length of bridge. Various configurations could be considered which would be based on the use of either one or two pylons. A single pylon arrangement would be asymmetrical with the pylon in the river, effectively creating two spans where one span would be significantly longer than the other. A two pylon arrangement would be symmetrical with both pylons in the river, but with the main span significantly more that twice the length of each end span. While this form may be technically feasible, it is not considered appropriate because:-

- It would be significantly more expensive than other forms of construction.
- Route 6 runs parallel and close to the existing 400kV ESB line and the fan shaped line of the bridge cables would aesthetically clash with draped ESB cables.
- A cable stay bridge is an architectural feature whose merit depends on its clear visibility, which would not be the case at this site given the number of mature trees close by.
- The aesthetic impact of a tall pylon in this particular landscape may not be viewed as desirable.

Conclusion

For Route 6, it is proposed that the in-situ / precast hybrid be considered a preferred form at this stage.

In comparison to the precast beam form, it has the functional and aesthetic advantages of the longer spans and the arched soffit profile, and there would be less environmental risk as a result of fewer piers being constructed in the river. It may be slightly more expensive, but the premium would be marginal and would represent value for the advantages gained.

In comparison to the launched form, the hybrid form would have the aesthetic advantage of the curved soffit and it would have an engineering advantage in that the depth of the structural section at midspan would be some 0.6 m or 0.7 m less than the launched deck, which would allow the vertical road alignment to be lower by this amount. This would reduce the visual impact and the cost of the approach embankments. The cost of the bridge is unlikely to significantly exceed the cost of the incrementally launched form, and may be cheaper.

4.3.9 Routes 7 Bridge

4.3.9.1 Geotechnical

A limited geotechnical site investigation has been undertaken near the sites of the bridge abutments. Founding conditions for piers in the river have been inferred from GSI data and the data at the abutments. Founding for a bridge in this location is feasible, and is reported on in Section 4.2.2.

4.3.9.2 Landscape

The landscape and visual context at the bridge site is dominated by the expanse of the river, which is 155 metres wide at the Route 7a site, and 143 metres wide at the Route 7b and 7c sites. As the sites are very similar they will not be individually considered here.

As for Route 6, there is no flood plain on either side, and rich vegetation and mature trees extend virtually to the water's edge on both sides of the river. The land is moderately sloping on the east side, falling a height of 11.5 m over the distance of 94 m between the R493 and the bank of the river. On the west side the terrain is gently sloping, falling a height of 6 m over the distance of 170 m between the residential access road and the bank of the river. In addition, there are the remains of the inundated canal running parallel to the shoreline as discussed above.

As for Route 6, the landscape is very scenic and complements the historic nature of the environment at Killaloe. The choice of bridge form, and the detailing and finishes of the bridge should therefore be carefully considered.

4.3.9.3 Alignment

The horizontal alignment is straight over the full length of the bridge. The vertical alignment is on a uniform slight gradient over the length of the bridge.

4.3.9.4 Bridge Forms

The selection of a particular bridge form will be undertaken as part of the preliminary design stage of this project. The number of viable bridge forms, which can be considered for Route 7 is more limited than for Route 6. The length of the bridge for Route 7a is approximately 182 metres, which is slightly longer than for Routes 7b and 7c, which are 170 and 166 metres long respectively. Some of the forms, which could be considered for Route 6, would not be appropriate for Routes 7, mainly for economic reasons. Inappropriate forms would be incrementally launched, balanced cantilever and cable stay. The forms, which could be considered, are as below. Visualisations of the proportions of the arrangements are shown in Figure 4.31 of Volume B, which has been drawn, arbitrarily, for Route 7b but will be very similar for Routes 7a and 7c. The structural cross section is shown in Figure 3.16 of Volume B.

Precast Beam and Slab

Span lengths would be similar to those considered for Route 6. Five spans of approximately 34 metres would therefore be an appropriate arrangement. The deck would have a uniform structural depth of 1.8 metres.

Insitu/Precast Hybrid

This structural form would be as described for Route 6 above. An appropriate span arrangement would consist of two internal spans of 46 metres and two end spans of 39 metres.

Conclusion

For Routes 7, it is proposed that the in-situ / precast hybrid be considered a preferred form at this stage.

In comparison to the precast beam form, it has the functional and aesthetic advantages of the longer spans and the arched soffit profile, and there would be less environmental risk as a result of fewer piers being constructed in the river. It may be slightly more expensive, but the premium would be marginal and would represent value for the advantages gained.

5 ROUTE 1

5.1 INTRODUCTION

Based on the results of the studies as reported in Chapter 3, the preferred route for the current Shannon Bridge Crossing project is either of Routes 6, 7a, 7b or 7c. The issues affecting the selection of these routes have been further developed in Chapter 4. It is evident from the traffic figures presented in Chapter 3 that a crossing provided at Route 6 or 7 will provide only minimal relief to the traffic problems being experienced at O'Briensbridge and Montpelier.

The relief of the problems at O'Briensbridge/Montpelier was one of the objectives of this project, but it has become evident that there is no single crossing location, which will satisfactorily address the traffic problems both there and at Killaloe/Ballina. It is recommended therefore that consideration be given to providing an additional crossing in the location of Route 1.

This section of the report relates to issues relevant to this consideration.

Existing Road

The existing crossing at O'Briensbridge/Montpelier consists of two bridges, one over the headrace canal and the second over the River Shannon. The overall length of the section of the R466 through the two villages and including the two bridges is 1,050 metres between the junction with the R463 on the west side and the R525 on the east side.

The bridge over the canal is 80 metres long with a carriageway width of 5.0 metres. There is a separate footpath 1.07 m wide. It was constructed as part of the Ardnacrusha scheme in about 1930. The bridge is on an acute crest curve which restricts visibility along the length of the bridge as shown in Fig. 2.5 in Chapter 2. In the context of the high number of HGV's using the road as discussed in Section 5.2 below, the width of this bridge is unsatisfactory for two way flow.

The bridge over the Shannon is 120 metres long with a carriageway width between stone parapets of 4.65 metres. There is no footpath. The bridge is an historic structure, probably dating to the 18^{th} century. The width of the bridge is unsatisfactory for two way traffic, particularly in the context of the high number of HGV's using the road. Two HGV's cannot pass, and a light vehicle may only pass an HGV with difficulty. The bridge can be seen in Fig. 2.4 in Chapter 2.

Safety is a major concern at the river bridge. Pedestrians using the bridge are at risk due to a combination of the lack of a footpath, the length of the bridge between points of refuge, the lack of adequate carriageway width for vehicles, and the large number of HGV's using the bridge. This combination compromises the safety of pedestrians and is a matter of concern at this bridge. In addition, the parapet walls of the bridge are of stone masonry construction and their resistance to impact is likely to be inadequate to contain the impact of a vehicle. This risk becomes more serious when the difficult conditions for traffic on the bridge and the width and depth of the Shannon River below are taken into consideration.

The structural assessment of this bridge does not form part of this study, but the suitability of the bridge, in view of its age, for the carriage of HGV's and the risks these vehicles may pose to the condition of the bridge should be assessed.

At the west bank of the river, the bridge meets the road through the village at a T-junction, requiring bridge traffic to execute a sharp turn. This movement is particularly difficult for the longer articulated vehicles, and the lateral movement of these vehicles during the turn poses an additional risk to pedestrians. At the same point, the vertical alignment of the road rises steeply to go over the bridge. This alignment is not suitable for heavy vehicles, and the passing of oncoming vehicles at this junction is not possible.

The geometric restrictions at the existing bridges cause traffic delays on this section of the R466 across the river and canal, although the situation is less critical than the severe situation which arises in Killaloe/Ballina.

During the course of this study, representations were made from members of the public and elected members pointing out the problems being experienced by the residents of O'Briensbridge and Montpelier and members of the public as a result of the high number of HGV's passing through the villages. Road safety and the amenities afforded by the villages are regarded as being severely compromised by the HGV volumes.

Attention has been drawn to these problems and the need for their resolution in a number of development plans in recent years. Reference should be made to the extracts from the following development plans which have been reproduced in the sections of the Constraints Study Report indicated below.

Development Plan	Constraints Report
East Clare Draft Local Area Plan (2004)	3.3.1.2
South Clare Economic Corridor Local Area Plan (2003)	3.3.1.3
North Tipperary County Development Plan (2004)	3.3.2

Should an alternative crossing be provided at Route 1, the alternative route would naturally attract a large proportion of both the heavy and light traffic currently using the existing crossing through O'Briensbridge, as shown in the results of the traffic model. In addition to the relief thus gained, it would be desirable to close the existing Shannon Bridge to HGV's and divert all HGV through traffic to the new route. In either case, but particularly in the latter case, the problems discussed above at the existing bridges and in the two villages would be greatly reduced.

Proposed Route 1

Route 1 is approximately 1,050m long and includes a 60m long crossing of the headrace canal and a 120m long crossing of the Shannon. It commences on the R463 in Co. Clare approximately 0.70 km south of the existing canal bridge in O'Briensbridge. It travels in a south-easterly direction over the canal, and across a narrow strip of land to the western shore of the River Shannon. It continues in a south-easterly direction over the Shannon and over low lying land to the east of the Shannon, to join with the R525 approximately 0.6km south of Montpelier.

5.2 TRAFFIC

It is clear from the traffic assessment shown in Chapter 3, that Routes 6 and 7 perform the best of all routes considered in terms of the Study Area network. It is also clear that the vast majority of the benefit of these routes will be gained in Killaloe/Ballina, with relatively little benefits in terms of traffic relief for the O'Briensbridge/Montpelier Bridge.

Although the traffic problems in Killaloe/Ballina are more acute than they are on the O'Briensbridge/Montepelier Bridge, and hence routes relieving the former result in much greater benefits, it is clear that there are traffic issues on the latter that require to be addressed.

The observed results of the traffic survey show that currently the both the absolute volume of HGV's, and the volume HGV's as a proportion of total traffic are high at O'Briensbridge, and significantly higher than at the Killaloe bridge, as shown in Table 5.1. The table also shows the effect of the provision of a new crossing at Route 7 on these figures for the years 2007 and 2022.

Table 5.1: AADT Volumes at Existing Bridges

Location	Vehicle Class	Observed 2005	With Route 7 2007	With Route 7 2022
O'Briensbridge Br.	Cars & LGVs	3,667	3,667	3,981
	HGVs % (of total)	437 10.6%	475 11.5%	570 12.5%
Killaloe Br.	Cars & LGVs	5,425	2,679	3,154
	HGVs % (of total)	304 5.3%	105 3.8%	133 4.0%

Compared to the existing traffic volumes, there will be no benefit accruing to O'Briensbridge from the provision of Route 7 in the short or long term, with HGV traffic expected to grow to 570 AADT in 2022, an increase of 30% on 2005 levels. The provision of Route 6 yields very similar figures to those shown above, and would not provide any better relief to O'Briensbridge.

The traffic model described in Section 3.5 has been revised to model the provision of a second new crossing at O'Briensbridge/Montpelier in addition to a new crossing in position at Killaloe/Ballina. The analysis was based on the provision of Route 1 combined with Route 7, as Route 7 is the most favourable from a traffic point of view. It can be expected that an analysis of Route 1 combined with Route 6 would provide similar results.

It was proposed in Section 5.1 above that the existing Shannon Bridge at Montpelier might be closed to HGV traffic in the event that an alternative crossing at Route 1 is provided. It should be noted that this scenario has not been included in the traffic model and thus the traffic volume shown as expected to use Route 1 reflects the volume naturally attracted to the route. The volume of HGV traffic expected to continue using the existing Montpelier bridge is 276 AADT (2007) and 333 AADT (2022) as shown in Appendix A of Volume C for the case of "Option 1 + 7". Closure of the existing bridge at Montpelier would increase the HGV traffic on a new crossing at Route 1 by a similar amount.

The am peak hour and AADT traffic volumes forecast for Routes 1 and 7 combined are shown in Tables 5.2 to 5.5 for years 2007 and 2022. These tables are similar to Tables 3.11 to 3.14 and also include the relevant data for the provision of Route 1 only and Route 7 only, for comparison purposes. A breakdown of the traffic flows by vehicle type is included for the same years in Appendix A of Volume C.

Table 5.2: AM Peak Hour Flow Comparison, PCU's, 2007

Location	Do min	Route Provided		
		1	7	1+7
R494	261	271	271	271
N7 (north)	1,364	1,412	1,412	1,412
R503	534	541	541	541
N7 (south)	1,938	1,986	1,986	1,986
R463	462	476	476	476
R466	257	261	261	261
R463	374	383	383	383
Killaloe Bridge	523	583	304	304
M'pelier Bridge	561	288	472	268
Route 1 Bridge		300		234
Route 7 Bridge			394	377
All Bridges	1,084	1,171	1,184	1,183

Table 5.3: AADT Flows Comparison, PCU's, 2007

Location	Do min	Route Provided		
		1	7	1+7
R494	2,480	2,575	2,575	2,575
N7 (north)	12,958	13,414	13,414	13,414
R503	5,073	5,140	5,140	5,140
N7 (south)	18,411	18,867	18,867	18,867
R463	4,389	4,522	4,522	4,522
R466	2,442	2,480	2,480	2,480
R463	3,553	3,639	3,639	3,639
Killaloe Bridge	4,969	5,539	2,888	2,888
M'pelier Bridge	5,330	2,736	4,484	2,546
Route 1 Bridge	0	2,850		2,223
Route 7 Bridge			3,743	3,582
All Bridges	10,299	11,125	11,115	11,239

Table 5.4: AM Peak Hour Flow Comparison, PCU's, 2022

Location	Do min	Route Provided		
		1	7	1+7
R494	327	327	327	327
N7 (north)	1,676	1,676	1,676	1,676
R503	640	640	640	640
N7 (south)	2,353	2,353	2,353	2,353
R463	566	566	566	566
R466	307	307	307	307
R463	455	455	455	455
Killaloe Bridge	701	694	360	360
M'pelier Bridge	569	318	518	321
Route 1 Bridge	0	353		248
Route 7 Bridge			527	503
All Bridges	1,270	1,365	1,405	1,432

Table 5.5: AADT Flows Comparison, PCU's, 2022

Location	Do min	Route Provided		
		1	7	1+7
R494	3,107	3,107	3,107	3,107
N7 (north)	15,922	15,922	15,922	15,922
R503	6,080	6,080	6,080	6,080
N7 (south)	22,354	22,354	22,354	22,354
R463	5,377	5,377	5,377	5,377
R466	2,917	2,917	2,917	2,917
R463	4,323	4,323	4,323	4,323
Killaloe Bridge	6,660	6,593	3,420	3,420
M'pelier Bridge	5,406	3,021	4,921	3,050
Route 1 Bridge	0	3,354		2,356
Route 7 Bridge			5,007	4,779
All Bridges	12,066	12,968	13,348	13,605

The figures show that the provision of the second new bridge at Route 1, in addition to the two existing bridges and a new bridge at Route 7:-

- Makes very little difference to, but slightly increases, the total number of vehicles crossing the River in the Study Area.
- Makes no difference to the traffic volumes at the existing Killaloe/Ballina Bridge.
- Provides a very similar level of relief, or slightly more relief, to O'Briensbridge/ Montpelier as would have been the case for the provision of Route 1 only.

There is a potential alignment under consideration by Limerick County Council for a Limerick Northern Relief Road (LNRR) as defined in the Limerick PLUTS study, connecting Annacotty /Castletroy on the N7 to Gortatogher on the R463 Corbally Road (just east of Parteen) linking back into the N18 at the existing roundabout just west of Caherdavin. During the PLUTS study the western section of the LNRR was not found to attract particularly high volumes of traffic, with the eastern section (between Annacotty and the R463) forecast to carry in the region of 4,000 AADT in 2008. Forecasts suggested that N7 to N18 traffic passing straight through Limerick would use the Limerick Southern Ring Road and its new tunnel crossing, the construction of which is due to commence in 2006. Of the traffic using the LNRR, most of it is forecast to be of a local nature generated by the Annacotty/Castletroy area and the new and existing development on the R463 Corbally Road. It is therefore our view that these trips are not likely to divert onto a new crossing just south of O'Briensbridge/Montpelier, some 8km to the east and accessed by regional roads. It is therefore concluded that the Limerick NRR and Route 1 will serve different travel markets

5.3 COSTS

The cost of the construction of Route 1 was shown in Table 3.19 as:-

Item	Amount (€)
Road works	3,749,000
Structure	5,175,000
Miscellaneous	1,753,500
Total (excl. VAT)	**10,677,500**
VAT	1,345,185
Total (incl. VAT)	**12,022,685**

The above figures are based on current prevailing cost. The cost of road works includes for land costs and ground improvement costs. Miscellaneous costs include for design fees, supervision fees and contingencies.

5.3.1 Benefit/Cost Ratio

The amounts of the costs and benefits, discounted to present value, for each of Routes 1 to 7 are shown in Section 3.7.6 and the relevant figures for Routes 1 and 7 are carried forward to Table 5.6 below. The provision of a second new crossing at Route 1, in addition to Route 7, affects the benefit of Route 7 as previously calculated. In considering therefore the benefit/cost ratio of providing the second new crossing at Route 1, it is necessary to consider the amount of the benefit of providing Route 1 combined with Route 7, less the benefit of providing Route 7 only. These benefit amounts are also shown in Table 5.6. The analysis was based on the provision of Route 1 combined with Route 7, as Route 7 is the most favourable from a traffic point of view. As the costs of providing the two routes are independent of each other, the costs are considered independently in Table 5.6. For simplicity, as the costs for each of Routes 7a, 7b & 7c are similar; an average value has been used. All amounts in Table 5.6 are in millions of euro.

Table 5.6: Benefit Cost Analysis: Route 1+7

Route	PV Costs EUR	PV Benefit EUR	NPV Scheme EUR	B/C Ratio
1	-9.91	7.13	-2.78	0.72
7	-10.44	78.98	68.54	7.57
(7+1)	-20.35	82.45	62.10	4.05
(7+1) - 7	-9.91	3.47	-6.44	0.35

The values in the last line of Table 5.6 reflect the net additional benefit, and related benefit/cost ratio, of providing Route 1 in addition to Route 7. It can be seen that the B/C ratio for Route 1 on its own is 0.72, and the B/C ratio for Route 1 in addition to Route 7, is about 0.35. This should not necessarily suggest that the justification of providing Route 1, either on its own or in addition to Route 7, is marginal. The benefits calculated in the analysis only include the benefits accruing to the motorist as a result of savings in value of time (VOT) or vehicle operating costs (VOC) as described in Section 3.7.6. The benefit calculations do not include the benefits accruing to residents and other community interests as a result of providing the new route. In this case, significant benefits would accrue to the residents of O'Briensbridge and Montpelier, to road safety and to the conservation of the existing historic bridge by providing Route 1.

This consideration applies to all the benefits and benefit/cost ratios considered in Section 3.7.6. It can be seen from Tables 5.2 to 5.5 that the traffic demand on Route 1 is some 76% of that on Route 7 in 2007 and 67% in 2022 yet the benefit calculated for Route 1 is only some 10% of that for Route 7. This is largely a result of the fact that traffic congestion and resulting delays in Killaloe/Ballina are greater than in O'Briensbridge/Montpelier, and thus there are greater saving in VOT and VOC for motorists in Killaloe/Ballina diverting to Route 7 than for motorists in O'Briensbridge/Montpelier diverting to Route 1, even though a similar total number of motorists would divert in each case. There are substantial community benefits accruing in each case, and in comparing calculated benefit/cost ratios, it should be noted that such community benefits are not included in the analysis.

5.4 ENGINEERING

5.4.1 Roadworks

The vertical alignment for Route 1 can be seen on Figure 3.2 of Volume B. The existing ground level at Chainage 0 on the R463 is approximately 42.3m OD. At Chainage 580, the existing ground level is approximately 24.0m OD. This results in the necessity to incorporate a 4% gradient on the mainline over this length.

Embankments of up to 9.0m in height will be required between the eastern bank of the Headrace Canal (Ch. 140) and the western bank of the River Shannon (Ch. 280). In total it is anticipated that approximately 50,000m³ of imported fill material would be required to construct this route. The remainder of the route (Ch. 580 to 1,050) will be more or less at grade.

The tie-in locations at either end of Route 1 are reasonably good in terms of sight lines.

5.4.2 Geotechnical

Details of the site investigation carried out along Route 1 are contained in Section 4.2.2 of this report. A total of three exploratory locations were investigated, 1 trial pit (TP6) and 2 boreholes (R5 and R6). These locations are indicated on Figure 4.25 of Volume B.

This route would partly be built on a high embankment, up to 9.0m high in places. Standard Penetration Test (SPT) N values indicated that the materials on which these embankments would be built were soft and loose. Settlement of the embankments in the range 1.2m – 1.6m is expected. Ground improvement techniques will be required along the embankment sections to prevent settlement and slip circle failure. Improvement is expected to be in the form of pre-consolidation using vertical drains and surcharge. Basal reinforcement will also be required under embankment sections and in areas of marginal cut.

5.4.3 Structures

Introduction

Route 1 involves the provision of two bridge structures, one over the Headrace Canal and the other over the Shannon River.

Canal Bridge

The site at the headrace canal is particularly favourable for the construction of a bridge. Whereas the normal width of the canal is 70 - 80 metres, the width narrows down to approximately 36 metres at the proposed bridge site. A 60m long crossing of the headrace canal would be required. The narrowing of the canal is due to the presence of rock at that location, and was to limit the amount of excavation of rock through which the canal had to be cut. There is thus exposed rock present on each side of the canal, to above the water level, on which bridge abutments could be founded. The cost of the bridge would be relatively low due to its limited length and the presence of rock at a high level for the founding of the abutments.

Route 1 joins the R463 at a distance of 75 metres to the west of the canal. The existing road level is 11.5m above the canal water level and thus there will be more than the minimum required vertical clearance of 6.14 metres under the bridge for navigation requirements. From the preliminary long section shown in Figure 3.2 of Volume B, the road level at the centreline of the canal is approximately 10.0 metres above normal water level.

The high clearance and good founding conditions would permit the employment of an arch bridge as shown conceptually in Figure 5.1 of Volume B. Alternatively, a visually simpler trestle bridge would also be appropriate as shown in Figure 5.1 of Volume B. In both cases, piers within the waterway are avoided which would not only facilitate construction, but would also facilitate navigation, particularly as the waterway is constricted at that point.

River Bridge

The width of the river at the site of the bridge is approximately 94 metres, which would require a bridge of approximately 120 metres in length. The bridge structure will be influenced from both a technical and a visual point of view by the vertical alignment of the new road. The vertical alignment at the bridge site is governed by geometric constraints relating to the route as a whole rather than vertical clearance requirements over the river. From the preliminary long section shown in Figure 3.2 of Volume B, the longitudinal gradient at the bridge site is 4%, resulting in a significant variation in the height of the deck above the water over the length of the bridge. At the west bank, the vertical clearance under the deck is approximately 9.3 metres reducing to 4.9 metres at the east bank. There is no specified clearance requirement for navigational purposes on the river at site as there is no facility for through traffic at the weir upstream. It is evident however that there would be a high clearance anyway.

The form of the bridge could be similar to that described in Chapter 4 for the Route 7 Bridge, although the appearance would be affected by the longitudinal gradient of the deck. Conceptual arrangements utilising precast beams or alternatively a hybrid combination of precast and in-situ construction are shown in Figure 5.2 of Volume B.

A hydraulic analysis of the river would be required to establish the required length of the bridge in order to provide an adequate hydraulic opening. From the foregoing, it is clear that the height of the bridge will be sufficient for hydraulic purposes. Records have been obtained from the ESB showing that the water level at the site resulting from the flood of February 1990 was 24.5m OD Malin. The flood volume of that event was 700 cumecs in the river above the weir, whereas the maximum flood shown in the records is 750 cumecs in 1960. The ESB records also show that the expected flood level at the bridge site for the ultra extreme event of a 1:1000 year flood event would be 26.4 metres. It is likely therefore that the flood level associated with a typical 1:100 year design flood volume would be approximately 25.0 m to 25.5 m OD Malin. The west bank of the river is at 27.0 m and the east bank is at 25.0 m OD Malin, and thus additional setback of the abutments for hydraulic purposes would provide insignificant additional capacity and would not be required. The proposed bridge length of 120 metres would likely therefore be sufficient.

5.5 ENVIRONMENTAL

Following from the selection of Routes 6 and 7 as the preferred routes for the crossing to be considered for this project, and the identification of Route 1 as being a potential route for a second crossing in addition to Route 6 or 7, environmental assessments and surveys have been undertaken on all of Routes 1, 6 and 7. The inclusion of Route 1 in the assessments undertaken was to provide information on whether there were environmental considerations which might preclude the provision of a crossing at Route 1. The environmental assessments have been comprehensively reported on in Chapter 4 and due to the nature of those reports and the descriptions and explanations contained therein, it has been considered appropriate to include the detail reporting for Route 1 in Chapter 4 along with that for Routes 6 and 7.

Conclusions from the detail environmental assessments presented in Chapter 4 relating to the provision of a crossing at Route 1, are presented in summary form below.

5.5.1 Ecology

The assessment of terrestrial ecology reported in Section 4.1.1.1 concludes that the impact of Route 1 is similar to the impact of any of the Routes 7, and is less critical than Route 6. The general constraints in terms of the cSAC designation, which are set out in Section 4.1.1.1 will apply to the provision of Route 1. However, there is no reason to suppose that the impacts at Route 1 in this regard are more severe than for the other routes considered, or that the constraints in terms of the cSAC designation should preclude the provision of a crossing at Route 1.

The assessment of aquatic ecology reported in Section 4.1.1.2 concludes that the least preferred option would be Route 1 as this would require a bridge over both the old River Shannon and the Headrace Canal. However, this route could be built with appropriate mitigation measures.

5.5.2 Noise

The environmental noise assessment reported in Section 4.1.2 concludes that Route 1 results in less impact than would be the case for any of the other routes considered, and that the impact of Route 1 would not be unacceptable. There is no reason therefore to preclude the provision of a crossing at Route 1 on this basis.

5.5.3 Cultural Heritage

The cultural heritage assessment reported in Section 4.1.3 concluded that Route 1 would have the least impact of the routes considered on issues of cultural heritage. There are no issues in this regard to preclude the provision of a crossing at Route 1 on this basis.

5.5.4 Underwater Archaeology

The underwater archaeological assessment reported in Appendix I of Volume C concluded that no relevant features had been identified in the location of Route 1. The assessment indicated that four magnetic anomalies had been identified on the route location which should receive further investigation should Route 1 be selected as a preferred route for a crossing at a future stage. This however should not preclude the provision of a crossing at Route 1.

5.5.5 Landscape and Visual

The landscape and visual assessment reported in Section 4.1.5 concludes that Route 1 has the potential to yield greater adverse impacts on landscape character, compared with the more northern alternatives. Notwithstanding this, the provision of an eventual O'Briensbridge bypass would create a cumulative positive impact on the town centre, in which existing congested traffic would be relieved and thereby lessen a negative townscape quality currently experienced by locals and visitors.

Potential visual impacts related to Route 1 focus on the relationship between the location of designated scenic amenities (the Lough Derg Way, Scenic Route R463), and the proposed route location, as well as the shared viewshed of the existing, historical town bridge, and the proposed new bridge structure.

5.5.6 Human Environment

The human environment assessment reported in Section 4.1.6 that Route 6 contained the least number of sensitive receptors within 300m of the centreline of each of the routes. Route 1 contained the second least number of sensitive receptors within 300m of its centreline and consequently was ranked as the 2nd most preferred route after Route 6. There are no significant issues in this regard to preclude the provision of a crossing at Route 1 on this basis.

5.6 CONCLUSION

Route 1 attracts significant traffic volumes. Reference to Tables 3.12 and 3.14 show that in terms of AADT of PCU's, Route 1 attracts volumes not very much less than Routes 6 and 7. Importantly, reference to Appendix A of Volume C show that in terms of AADT of HGV's, Route 1 attracts volumes similar to Routes 6 and 7. Thus in terms of volumes, Route 1 is a viable option. However, due to limited time and cost savings to the road user in using Route 1 compared to the existing bridges, the benefit cost ratio is relatively low. The benefit of providing Route 1 should therefore be seen as mainly accruing to the local community, who are adversely affected by the high volumes of traffic, and in particular, the high proportion of HGVs, currently using the existing bridges in O'Briensbridge and Montpelier.

The provision of Route 1 as proposed herein is technically viable and would come at a relatively low cost in comparison to the other routes considered in this study. There are no environmental issues which would preclude the provision of a crossing at Route 1.

It is therefore recommended that consideration be given to the provision of a crossing at Route 1, in addition to the provision of a crossing at either Route 6 or Route 7.

6 SECOND PUBLIC CONSULTATION

6.1 INTRODUCTION

The second Public Consultation was held on the 6th of September 2005. The purpose of this exercise was to inform the public about the progress of the study, receive public views and opinion, and respond to queries. The venue was the Lakeside Hotel in Ballina, Co. Tipperary.

Figure 6.1: Display Panels

Two sets of displays; each containing nine display boards, were shown at the Public Consultation, refer to Figure 6.1. The display boards contained information and mapping as follows, generally to A1 size: -

1. General information on the project, including the phases and the parties involved.
2. Site location map.
3. Aerial photography of Study Area.
4. Study area map showing all routes considered.
5. Relative traffic demand, costs, benefits and B/C ratios for all routes.
6. Constraints mapping.
7. Mapping and text details of Route 1.
8. Mapping and text details of Route 6.
9. Mapping and text details of Routes 7a, 7b and 7c.

In addition, each attendee was provided with an A4 Information Leaflet and A4 Questionnaire. Copies of these documents are included in Appendix J of Volume C. Due to the large number of attendees, and the fact that some people took more than one pair of documents, the supply of 200 pairs of documents ran out during the last hour of the meeting. Additional copies were later produced and posted out to those who had so requested.

The first hour of the consultation (2:00pm to 3:00pm) was reserved for a presentation to the Elected Public Representatives of Clare County Council, Limerick County Council and North Tipperary County Council. This session included a slide presentation of the key aspects of the scheme and its progress. The display was open to the general public for the remainder of the session from 3:00 pm to 8:00 pm.

Four staff members from consultants RPS Consulting Engineers and traffic sub-consultants Colin Buchanan & Partners attended the meeting. Officials from all three Local Authorities also attended and were available to address any queries raised. The total number of people who 'signed in' was 190. This record included eight public representatives, although more than eight attended the initial presentation.

In addition to the Public Consultation meeting, two additional meetings were held with elected representatives of each of the three Local Authorities in order to brief the representatives on the progress of the study. The meetings were held at the Castle Oaks Hotel in Castleconnell on the 15th and 29th November, 2005.

6.2 SUMMARY OF PUBLIC RESPONSES

The original closing date for receipt of completed questionnaires from the Public Consultation meeting was Tuesday 13th September. This was extended to Monday 19th September due to the fact that some people did not receive questionnaires on the day of the Public Consultation and had to wait until they arrived by post. A total of 137 completed questionnaires were received and the summary below is based on these. A number of elected public representatives (TD's, Councillors etc.), community groups and individuals made contributions by letter.

6.2.1 Questionnaires

In response to the questions posed on the questionnaire, the following is a summary of the questions asked and responses returned.

"Are you in favour of a new bridge crossing in the Study Area?"

The vast majority of people who completed the questionnaire were in favour of a new bridge crossing in the Study Area:-

- 129 in favour.
- 5 not in favour
- 3 had no opinion

"Which route would you be in favour of?"
"Which route would you not be in favour of?"

In response to these questions, the opinions expressed were as follows: -

- The vast majority of people were in favour of either Route 6 or 7 i.e. a Route close to Killaloe/Ballina.
- Route 6 was favoured by more people than Route 7.
- A far greater number of people were in favour of Route 6 than were not in favour of it.
- Only slightly more people were in favour of Route 7 than were not in favour of it.

The preferences of the public are illustrated graphically in Figure 6.2 below.

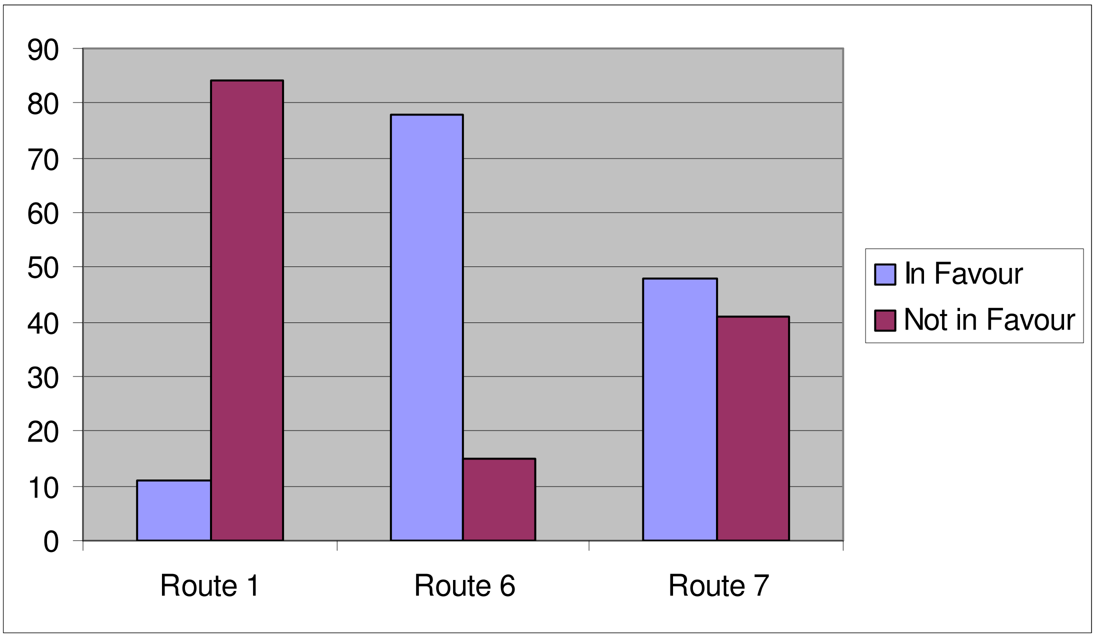

Figure 6.2: Public Preferences Relating to Short-Listed Routes

"In your opinion, how important in relation to this project are the following?"

Improvement in Traffic Conditions
Improvement in Road Safety
Impact on Community near Crossing
Best Value for Money
Effect on Business
Effect on Tourism
Conservation of Archaeology
Conservation of Flora and Fauna
Impact on Landscape

People were requested to rate these issues as being: -

- Very Important
- Important
- Least Important

The responses returned are shown graphically in Figure 6.3 overleaf, in which the responses are sorted in order of issues regarded as "Very Important".

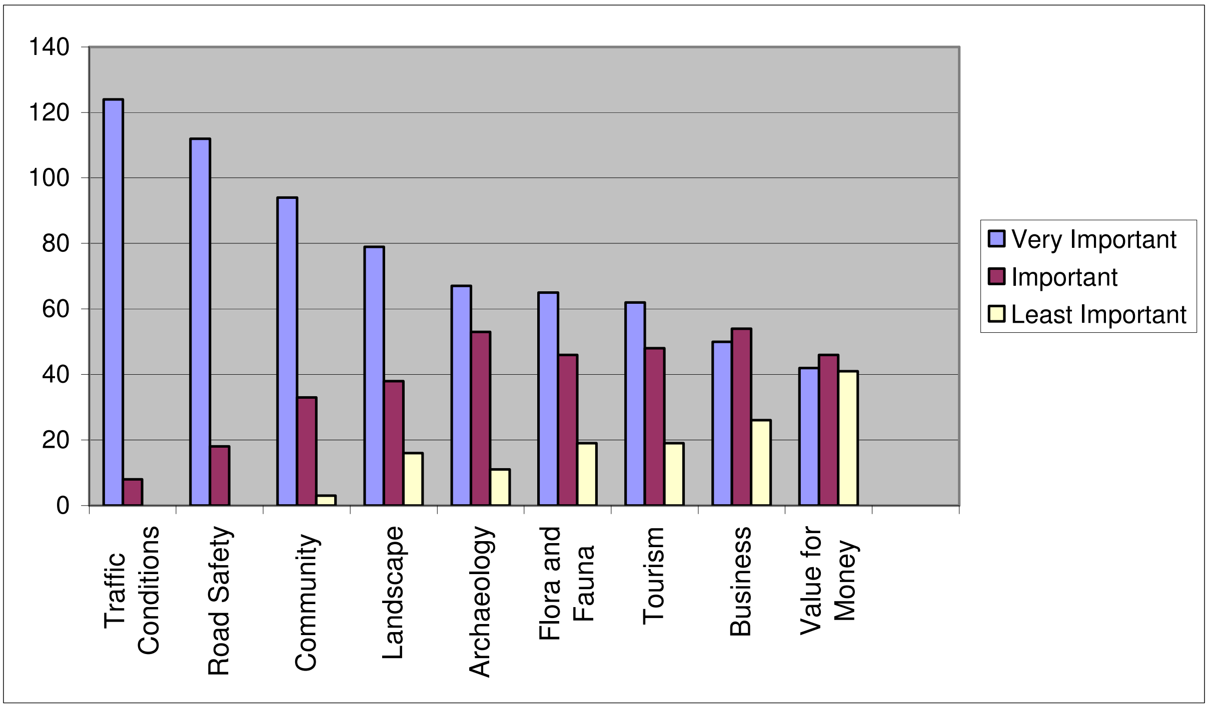

Figure 6.3: Public Opinion Relating to the Importance of Different Issues

"Please record below any other comments you may wish to make in connection with any of the proposed crossings and the selection of the preferred route.

Some of the key issues raised on the questionnaires under this general section related to the following:-

- The need for a bypass of Killaloe. This is clearly a very important issue, raised by many people, both verbally at the consultation meeting and through the responses to the questionnaires.
- Increased congestion in Killaloe after construction of new crossing due to existing narrow streets.
- The need to prohibit HGV's from using the existing bridge(s).
- Dissatisfaction that the project would not benefit O'Briensbridge/Montpelier.
- Existing bridge in Killaloe/Ballina is unsafe for pedestrians.

6.2.2 Written Submissions

In addition to the completed questionnaires, a number of submissions were also received from the following groups/individuals:-

- Alfie Byrne and Una Murphy.
- Brian Byrne.
- Herman Kikkers.
- Unigrund GmbH.
- AGT Services Ltd.
- Clarisford Palace
- O' Briensbridge/Montpelier Environmental Protection Group.
- Kevin Grimes.
- Richard O'Toole

A summary of the issues raised and sentiments expressed in these submissions is contained in Appendix K of Volume C.

Original copies of the completed questionnaires and submissions received during the Route Selection phase of the project can be viewed at the offices of Clare County Council. The opinions expressed have been taken into consideration during this phase of the project.

6.3 CONCLUSIONS

The 2nd Public Consultation was very well attended with over 190 people present. In general, people agreed with the need for the scheme to progress and felt that it was imperative that the scheme progress as quickly as possible in order to try and alleviate some of the traffic congestion in the vicinity of Killaloe/Ballina and O'Briensbridge/Montpelier. There would appear to be widespread disappointment however that a proposed bypass of Killaloe does not form part of the current project, and that O'Briensbridge/Montpelier would not benefit from the provision of a crossing at Route 6 or Route 7.

7 FRAMEWORK ASSESSMENT AND RECOMMENDATION

7.1 INTRODUCTION

The decision on selecting a preferred route for the Shannon Bridge Crossing is a decision that will affect the lives of many people and the environment along the chosen route. It is therefore a decision that should involve full assessment of route options and should have regard to a full range of criteria. At the core of the assessment, must be the objective that the preferred route provides the greatest benefit in terms of traffic and community needs, and causes the least amount of impact to the least number of people and to the environment, while offering value for money.

The Framework Assessment is generally based on the NRA DMRB Volume 5 – Assessment and Preparation of Road Schemes with regard for specific conditions encountered on this scheme.

7.2 METHODOLOGY

The assessment deals with three main categories of criteria:-

- Engineering including Traffic.
- Costs including Benefit/Cost Ratios.
- Environmental.

Based on engineering and cost considerations described in Chapter 3, the range of route options considered in Chapter 3 was short-listed to those assessed in detail in Chapter 4. The criteria assessed under each of the above main headings are described in detail in Chapter 4 and, where possible, rankings are assigned to the criteria. The following Table 7.1, Framework Assessment Matrix, summarises the key findings of the assessments undertaken in both Chapters 3 and 4 relating to the short-listed routes. Taking account of the various assessments as reported in Chapters 3 and 4 and as summarised in the Table, a recommendation has been taken on the Preferred Route to be developed in the next stage of the project, the Preliminary Design Stage.

7.3 RECOMMENDATION

The following recommendations are made:-

a) Route 7c is to be selected as the Preferred Route for this project. This route is to be prioritised and progressed to Preliminary Design.

b) In view of the limited benefit which Route 7c will afford to the O'Briensbridge/ Montpelier area, a second crossing is also recommended at Route 1.

Table 7.1: Framework Assessment Matrix

Criterion		Route 6	Route 7a	Route 7b	Route 7c	Comment
ENGINEERING						
Traffic						
Volumes: 2007: AADT in PCU's						
New Crossing		3,012		3,743		
Killaloe Bridge	(do min = 5,558)	3,544		2,888		
O'Briensbridge Bridge	(do min = 5,577)	4,693		4,617		
Volumes: 2022: AADT in PCU's						
New Crossing		4,323		5,007		
Killaloe Bridge	(do min = 6,660)	3,990		3,420		
O'Briensbridge Bridge	(do min = 6,584)	5,244		5,121		
Benefit (PVB, € 1,000,000's)		72		79		
Ranking		4		1		
Engineering Feasibility						
Roads		equal	equal	equal	equal	Route 6 is longer, but this is reflected in cost
Bridge		equal	equal	equal	equal	Route 6 is longer, but this is reflected in cost
Soils, Geology & Hydrogeology		equal	equal	equal	equal	
Geotechnical		equal	equal	equal	equal	
Utilities impacts		1		2		All routes similar
COST						
Overall Cost (incl. VAT)						
Amount (€1,000s)		14,478	12,830	12,139	11,847	
Ranking		4	3	2	1	
Benefit/Cost Ratio						
Ratios		6.0	7.2	7.7	7.8	
Ranking		4	3	2	1	

Criterion	Route 6	Route 7a	Route 7b	Route 7c	Comment
ENVIRONMENTAL					
Terrestrial Ecology					
Length of cSAC impacted (m)	704	220	189	184	
Ranking: cSAC impact	4	3	2	1	
Ranking: Areas of ecological constraint	4	3	2	1	Routes 7 all similar
Ranking: Flora	4		1		All routes similar
Ranking: Fauna	3	1		4	All routes similar
Ranking: Overall	4		1		Routes 7 all similar
Aquatic Ecology					
Ranking	4		1		All routes similar
Noise					
Ranking	1	2	3	4	
Cultural Heritage					
Ranking	3	4	1		
Underwater Archaeology					
Ranking	1	2	4	3	No route is critical
Landscape and Visual					
Ranking	3	4	2	1	
Human Environment					
Residential					
Properties within 300 m	21	51	52	54	
Residences affected in part	0	0	2	0	
Residences affected in whole	0	0	0	1	
Planning applications affected	0	2	0	0	
Community Facilities affected					
Moys amenity area	Yes	No	No	No	
School within 300m	No	No	Yes	Yes	
Agriculture					
Ranking	4		1		

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